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  - http://support.huawei.com/learning/NavigationAction!createNavi?navId=_31&lang=en
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HCIE-Routing & Switching Lab Guide

V3.0



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1 LAN Configuration

1.1 Introduction

1.1.1 About This Lab

Ethernet is a simple, cost-effective, and easy-to-implement local area network (LAN) technology that is most widely used in the industry.

In this lab, you will learn how to configure Ethernet-related Eth-Trunk and MSTP on a LAN.

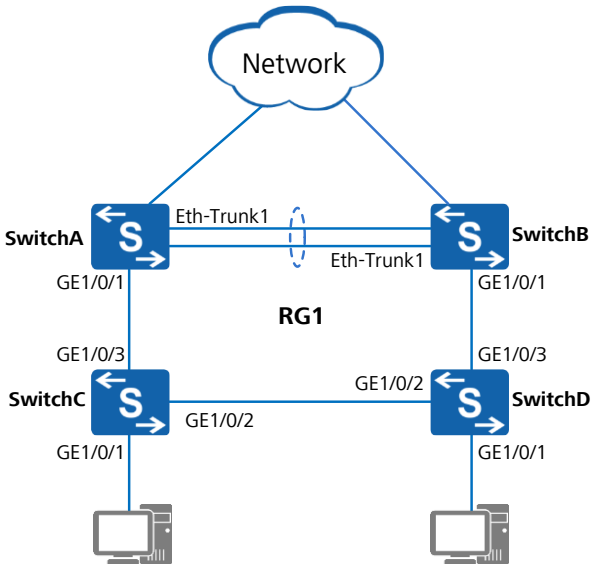
1.1.2 Objectives

Upon completion of this task, you will be able to understand:

- How to create and maintain an Eth-Trunk in manual and static LACP modes.
- How to configure and maintain MSTP, including an MST region, MSTIs, and MSTI-VLAN mapping.

1.1.3 Networking Topology

Figure 1-1 MSTP+Eth-Trunk networking topology



1.1.4 Networking Design

MSTP is enabled on switches A, B, C, and D. To balance traffic of VLAN 2 through VLAN 10 and VLAN 11 through VLAN 20 on different paths, an MSTI-VLAN mapping table needs to be set, with VLAN 2 through VLAN 10 being bound to MSTI 1 and VLAN 11 through VLAN 20 being bound to MSTI 2. To ensure that the links between SwitchA and SwitchB provide sufficient bandwidth and high stability, an Eth-Trunk link needs to be deployed.

Table 1-1 Design of the primary/secondary MSTI root bridges

Device	Instance	Primary/Secondary
SwitchA (S5700)	MSTI 1 (VLAN 2–VLAN 10)	Primary
	MSTI 2 (VLAN 11–VLAN 20)	Secondary
SwitchB (S5700)	MSTI 1 (VLAN 2–VLAN 10)	Secondary
	MSTI 2 (VLAN 11–VLAN 20)	Primary
SwitchC (S5700)	MSTI 1 (VLAN 2–VLAN 10)	N/A
	MSTI 2 (VLAN 11–VLAN 20)	N/A
SwitchD (S5700)	MSTI 1 (VLAN 2–VLAN 10)	N/A
	MSTI 2 (VLAN 11–VLAN 20)	N/A

1.2 Lab Configuration

1.2.1 Configuration Roadmap

1. Configure basic MSTP functions on the switches on the ring network. The ports connected to PCs do not participate in MSTP calculation and therefore need to be configured as edge ports.
2. Configure protection functions to protect the devices or links. For example, configure root protection for the designated ports of the root bridge in each MSTI.
3. Configure Layer 2 forwarding functions on switches.

1.2.2 Configuration Procedure

Step 1 **Add switches A, B, C, and D to an MST region named RG1 and create two MSTIs, MSTI 1 and MSTI 2.**

Configure an MST region for SwitchA.

```
<Huawei>system-view
[Huawei]sysname SwitchA
[SwitchA]stp region-configuration
[SwitchA-mst-region]region-name RG1
[SwitchA-mst-region]instance 1 vlan 2 to 10
[SwitchA-mst-region]instance 2 vlan 11 to 20
[SwitchA-mst-region]active region-configuration
[SwitchA-mst-region]quit
```

Configure an MST region for SwitchB.

```
<Huawei>system-view
[Huawei]sysname SwitchB
[SwitchB]stp region-configuration
[SwitchB-mst-region]region-name RG1
[SwitchB-mst-region]instance 1 vlan 2 to 10
[SwitchB-mst-region]instance 2 vlan 11 to 20
[SwitchB-mst-region]active region-configuration
[SwitchB-mst-region]quit
```

Configure an MST region for SwitchB.

```
<Huawei>system-view
[Huawei]sysname SwitchC
[SwitchC]stp region-configuration
[SwitchC-mst-region]region-name RG1
[SwitchC-mst-region]instance 1 vlan 2 to 10
[SwitchC-mst-region]instance 2 vlan 11 to 20
[SwitchC-mst-region]active region-configuration
[SwitchC-mst-region]quit
```

Configure an MST region for SwitchD.

```
<Huawei>system-view
[Huawei]sysname SwitchD
[SwitchD]stp region-configuration
[SwitchD-mst-region]region-name RG1
```

```
[SwitchD-mst-region]instance 1 vlan 2 to 10
[SwitchD-mst-region]instance 2 vlan 11 to 20
[SwitchD-mst-region]active region-configuration
[SwitchD-mst-region]quit
```

Step 2 **Configure primary and secondary root bridges for MSTI 1 and MSTI 2.**

Configure SwitchA as the primary root bridge of MSTI 1.

```
[SwitchA]stp instance 1 root primary
```

Configure SwitchB as the secondary root bridge of MSTI 1.

```
[SwitchB]stp instance 1 root secondary
```

Configure SwitchB as the primary root bridge of MSTI 2.

```
[SwitchB]stp instance 2 root primary
```

Configure SwitchA as the secondary root bridge of MSTI 2.

```
[SwitchA]stp instance 2 root secondary
```

Step 3 **Set the path costs of the ports to be blocked in MSTI 1 and MSTI 2 to be larger than the default value.**

Configure SwitchA to use Huawei's proprietary algorithm to calculate the path cost.

```
[SwitchA]stp pathcost-standard legacy
```

Configure SwitchB to use Huawei's proprietary algorithm to calculate the path cost.

```
[SwitchB]stp pathcost-standard legacy
```

Configure SwitchC to use Huawei legacy standard to calculate the path cost and set the path cost of GE 1/0/2 in MSTI 2 to 20000.

```
[SwitchC]stp pathcost-standard legacy
[SwitchC]interface gigabitethernet 1/0/2
[SwitchC-GigabitEthernet1/0/2]stp instance 2 cost 20000
[SwitchC-GigabitEthernet1/0/2]quit
```

Configure SwitchD to use Huawei legacy standard to calculate the path cost and set the path cost of GE 1/0/2 in MSTI 1 to 20000.

```
[SwitchD]stp pathcost-standard legacy
[SwitchD]interface gigabitethernet 1/0/2
[SwitchD-GigabitEthernet1/0/2]stp instance 1 cost 20000
[SwitchD-GigabitEthernet1/0/2]quit
```

Step 4 **Enable MSTP and configure the ports connected to PCs as edge ports.**

Enable MSTP on SwitchA.

```
[SwitchA]stp enable
```

Enable MSTP on SwitchB.

```
[SwitchB]stp enable
```

Enable MSTP on SwitchC.

```
[SwitchC]stp enable
```

Enable MSTP on SwitchD.

```
[SwitchD]stp enable
```

Configure GE 1/0/1 on SwitchC as an edge port.

```
[SwitchC]interface gigabitethernet 1/0/1
[SwitchC-GigabitEthernet1/0/1]stp edged-port enable
[SwitchC-GigabitEthernet1/0/1]quit
```

(Optional) Configure BPDU protection on SwitchC.

```
[SwitchC]stp bpdu-protection
```

Configure GE 1/0/1 on SwitchD as an edge port.

```
[SwitchD]interface gigabitethernet 1/0/1
[SwitchD-GigabitEthernet1/0/1]stp edged-port enable
[SwitchD-GigabitEthernet1/0/1]quit
```

(Optional) Configure BPDU protection on SwitchD.

```
[SwitchD]stp bpdu-protection
```

Step 5 **Configure MSTP protection functions. For example, configure root protection for the designated ports of the root bridge in each MSTI.**

Configure root protection on GE 1/0/1 of SwitchA.

```
[SwitchA]interface gigabitethernet 1/0/1
[SwitchA-GigabitEthernet1/0/1]stp root-protection
[SwitchA-GigabitEthernet1/0/1]quit
```

Configure root protection on GE 1/0/1 of SwitchB.

```
[SwitchB]interface gigabitethernet 1/0/1
[SwitchB-GigabitEthernet1/0/1]stp root-protection
[SwitchB-GigabitEthernet1/0/1]quit
```

Step 6 **Configure Layer 2 forwarding functions on the switches on the ring network.**

Create VLANs and add interfaces to the VLANs on SwitchA.

```
[SwitchA]vlan batch 2 to 20
```

```
[SwitchA]interface gigabitethernet 1/0/1
[SwitchA-GigabitEthernet1/0/1]port link-type trunk
[SwitchA-GigabitEthernet1/0/1]port trunk allow-pass vlan 2 to 20
[SwitchA-GigabitEthernet1/0/1]quit
[SwitchA]interface Eth-Trunk 1
[SwitchA-Eth-Trunk1]trunkport gigabitethernet 1/0/2
[SwitchA-Eth-Trunk1]trunkport gigabitethernet 1/0/3
[SwitchA-Eth-Trunk1]port link-type trunk
[SwitchA-Eth-Trunk1]port trunk allow-pass vlan 2 to 20
[SwitchA-Eth-Trunk1]quit
```

Create VLANs and add interfaces to the VLANs on SwitchB.

```
[SwitchB]vlan batch 2 to 20
[SwitchB]interface gigabitethernet 1/0/1
[SwitchB-GigabitEthernet1/0/1]port link-type trunk
[SwitchB-GigabitEthernet1/0/1]port trunk allow-pass vlan 2 to 20
[SwitchB-GigabitEthernet1/0/1]quit
[SwitchB]interface Eth-Trunk 1
[SwitchB-Eth-Trunk1]trunkport gigabitethernet 1/0/2
[SwitchB-Eth-Trunk1]trunkport gigabitethernet 1/0/3
[SwitchB-Eth-Trunk1]port link-type trunk
[SwitchB-Eth-Trunk1]port trunk allow-pass vlan 2 to 20
[SwitchB-Eth-Trunk1]quit
```

Create VLANs and add interfaces to the VLANs on SwitchC.

```
[SwitchC]vlan batch 2 to 20
[SwitchC]interface gigabitethernet 1/0/1
[SwitchC-GigabitEthernet1/0/1]port link-type access
[SwitchC-GigabitEthernet1/0/1]port default vlan 2
[SwitchC-GigabitEthernet1/0/1]quit
[SwitchC]interface gigabitethernet 1/0/2
[SwitchC-GigabitEthernet1/0/2]port link-type trunk
[SwitchC-GigabitEthernet1/0/2]port trunk allow-pass vlan 2 to 20
[SwitchC-GigabitEthernet1/0/2]quit
[SwitchC]interface gigabitethernet 1/0/3
[SwitchC-GigabitEthernet1/0/3]port link-type trunk
[SwitchC-GigabitEthernet1/0/3]port trunk allow-pass vlan 2 to 20
[SwitchC-GigabitEthernet1/0/3]quit
```

Create VLANs and add interfaces to the VLANs on SwitchD.

```
[SwitchD]vlan batch 2 to 20
[SwitchD]interface gigabitethernet 1/0/1
[SwitchD-GigabitEthernet1/0/1]port link-type access
[SwitchD-GigabitEthernet1/0/1]port default vlan 11
[SwitchD-GigabitEthernet1/0/1]quit
[SwitchD]interface gigabitethernet 1/0/2
[SwitchD-GigabitEthernet1/0/2]port link-type trunk
[SwitchD-GigabitEthernet1/0/2]port trunk allow-pass vlan 2 to 20
[SwitchD-GigabitEthernet1/0/2]quit
[SwitchD]interface gigabitethernet 1/0/3
[SwitchD-GigabitEthernet1/0/3]port link-type trunk
[SwitchD-GigabitEthernet1/0/3]port trunk allow-pass vlan 2 to 20
[SwitchD-GigabitEthernet1/0/3]quit
```

1.3 Verification

After MSTP calculation becomes stable on the network, perform the following operations to verify the configuration.

Run the **display stp brief** command on SwitchA to check the port status and protection type. The command output is as follows:

```
[SwitchA] display stp brief
 MSTID   Port                Role  STP State     Protection
   0     GigabitEthernet1/0/1     DESI  FORWARDING    ROOT
   0     Eth-Trunk1               DESI  FORWARDING    NONE
   1     GigabitEthernet1/0/1     DESI  FORWARDING    ROOT
   1     Eth-Trunk1               DESI  FORWARDING    NONE
   2     GigabitEthernet1/0/1     DESI  FORWARDING    ROOT
   2     Eth-Trunk1               ROOT  FORWARDING    NONE
```

In MSTI 1, SwitchA is the root bridge, and Eth-Trunk1 and GE 1/0/1 on SwitchA then become the designated ports. In MSTI 2, GE 1/0/1 and Eth-Trunk1 on SwitchA are designated and root ports respectively.

Run the **display stp brief** command on SwitchB. The command output is as follows:

```
[SwitchB] display stp brief
 MSTID   Port                Role  STP State     Protection
   0     GigabitEthernet1/0/1     DESI  FORWARDING    ROOT
   0     Eth-Trunk1               ROOT  FORWARDING    NONE
```

```
1    GigabitEthernet1/0/1      DESI  FORWARDING      ROOT
1    Eth-Trunk1                ROOT  FORWARDING      NONE
2    GigabitEthernet1/0/1      DESI  FORWARDING      ROOT
2    Eth-Trunk1                DESI  FORWARDING      NONE
```

In MSTI 2, SwitchB is the root bridge, and Eth-Trunk1 and GE 1/0/1 on SwitchB then become the designated ports. In MSTI 1, GE 1/0/1 and Eth-Trunk1 on SwitchB are designated and root ports, respectively.

Run the **display stp interface brief** command on SwitchC. The command output is as follows:

```
[SwitchC] display stp interface gigabitethernet 1/0/3 brief
 MSTID  Port                      Role  STP State       Protection
   0    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
   1    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
   2    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
[SwitchC] display stp interface gigabitethernet 1/0/2 brief
 MSTID  Port                      Role  STP State       Protection
   0    GigabitEthernet1/0/2      DESI  FORWARDING      NONE
   1    GigabitEthernet1/0/2      DESI  FORWARDING      NONE
   2    GigabitEthernet1/0/2      ALTE  DISCARDING      NONE
```

GE 1/0/3 on SwitchC is the root port in both MSTI 1 and MSTI 2. GE 1/0/2 on SwitchC is blocked in MSTI 2 but is calculated as a designated port in MSTI 1.

Run the **display stp interface brief** command on SwitchD. The command output is as follows:

```
[SwitchD] display stp interface gigabitethernet 1/0/3 brief
 MSTID  Port                      Role  STP State       Protection
   0    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
   1    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
   2    GigabitEthernet1/0/3      ROOT  FORWARDING      NONE
[SwitchD] display stp interface gigabitethernet 1/0/2 brief
 MSTID  Port                      Role  STP State       Protection
   0    GigabitEthernet1/0/2      ALTE  DISCARDING      NONE
   1    GigabitEthernet1/0/2      ALTE  DISCARDING      NONE
   2    GigabitEthernet1/0/2      DESI  FORWARDING      NONE
```

GE 1/0/3 on SwitchD is the root port in both MSTI 1 and MSTI 2. GE 1/0/2 on SwitchD is blocked in MSTI 1 but is calculated as a designated port in MSTI 2.

1.4 Reference Configuration

1.4.1 SwitchA's Configuration

```
#
sysname SwitchA
#
vlan batch 2 to 20
#
stp instance 1 root primary
stp instance 2 root secondary
stp pathcost-standard legacy
#
stp region-configuration
 region-name RG1
 instance 1 vlan 2 to 10
 instance 2 vlan 11 to 20
 active region-configuration
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp root-protection
#
interface GigabitEthernet1/0/2
 eth-trunk 1
#
interface GigabitEthernet1/0/3
 eth-trunk 1
#
return
```

1.4.2 SwitchB's Configuration

```
#
sysname SwitchB
#
vlan batch 2 to 20
#
stp instance 1 root secondary
stp instance 2 root primary
stp pathcost-standard legacy
#
stp region-configuration
 region-name RG1
 instance 1 vlan 2 to 10
 instance 2 vlan 11 to 20
 active region-configuration
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp root-protection
#
interface GigabitEthernet1/0/2
 eth-trunk 1
#
interface GigabitEthernet1/0/3
 eth-trunk 1
#
return
```

1.4.3 SwitchC's Configuration

```
#
sysname SwitchC
#
vlan batch 2 to 20
#
stp bpdu-protection
stp pathcost-standard legacy
#
stp region-configuration
 region-name RG1
 instance 1 vlan 2 to 10
 instance 2 vlan 11 to 20
 active region-configuration
#
interface GigabitEthernet1/0/1
 port link-type access
 port default vlan 2
 stp edged-port enable
#
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp instance 2 cost 20000
#
interface GigabitEthernet1/0/3
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
return
```

1.4.4 SwitchD's Configuration

```
#
sysname SwitchD
```

```
#
vlan batch 2 to 20
#
stp bpdu-protection
stp pathcost-standard legacy
#
stp region-configuration
 region-name RG1
 instance 1 vlan 2 to 10
 instance 2 vlan 11 to 20
 active region-configuration
#
interface GigabitEthernet1/0/1
 port link-type access
 port default vlan 11
 stp edged-port enable
#
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp instance 1 cost 20000
#
interface GigabitEthernet1/0/3
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
return
```

1.5 Quiz

After the preceding configuration, what do the spanning trees of MSTI 1 and MSTI 2 look like?

2 WAN Configuration

2.1 Introduction

2.1.1 About This Lab

In this lab, you will learn how to configure PPP, MP, IP-Trunk, and PPPoE on the WAN.

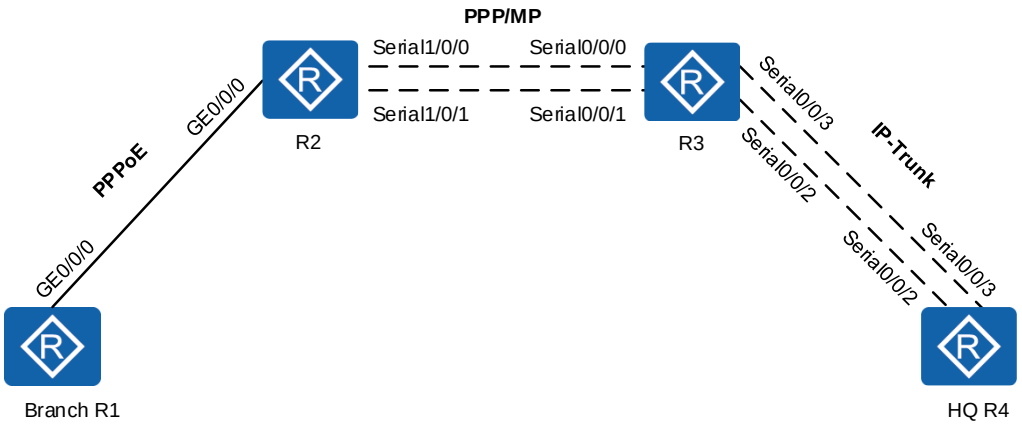
2.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand principles of PPP/MP, IP-Trunk, and PPPoE technologies.
- Grasp configurations of PPP/MP, IP-Trunk, and PPPoE technologies.

2.1.3 Networking Topology

Figure 2-1 PPP/MP, IP-Trunk, and PPPoE networking topology



2.1.4 Networking Design

As shown in the figure 1-1, the headquarters and branch routers need to communicate with each other. The branch router R1 accesses the network through PPPoE dialup and

obtains the IP address from R2. R2 and R3 are interconnected through serial links, and MP is deployed to improve reliability. R3 and R4 are interconnected through two serial links, and IP-Trunk is used to bind serial links.

Table 2-1 IP address planning

Device	Interface	IP Address
R1 (AR2220)	GE0/0/0	N/A
R2 (AR2220)	Mp-group0/0/0	20.1.1.1/24
R3 (Router)	Mp-group0/0/0	20.1.1.2/24
R3 (Router)	IP-Trunk1	10.1.1.1/24
R4 (Router)	IP-Trunk1	10.1.1.2/24

2.2 Lab Configuration

2.2.1 Configuration Roadmap

1. Configure the PPPoE client and server on R1 and R2.
2. Configure serial interfaces and MP on R2 and R3.
3. Configure serial interfaces and IP-Trunk on R3 and R4.
4. Configure static routes to implement the intercommunication between R1 and R4.

2.2.2 Configuration Procedure

Step 1 **Configure R1 and complete the configuration of the PPPoE client.**

```
# Configure a dialer ACL.
[R1]dialer-rule
[R1-dialer-rule]dialer-rule 1 ip permit
# Create a dialer interface and enter the dialer interface view.
[R1]interface Dialer 1
# Set the link-layer protocol to PPP.
[R1-Dialer1]link-protocol ppp
```

Configure the user name and password for PAP authentication.
[R1-Dialer1]ppp pap local-user HuaweiR1 password cipher R1
Configure IP address auto-negotiation.
[R1-Dialer1]ip address ppp-negotiate
Enable resource-shared DCC and specify the remote user name of the dialer interface.
[R1-Dialer1]dialer user HuaweiR1
Specify a dialer bundle for the dialer interface in resource-shared DCC mode.
[R1-Dialer1]dialer bundle 1
Add the dialer interface to a dialer access group.
[R1-Dialer1]dialer-group 1
Complete the physical interface configuration.
[R1]interface GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]pppoe-client dial-bundle-number 1

Step 2 **Configure R2 and complete the configuration of the PPPoE server.**

Configure an IP address pool.
[R2]ip pool pool1
[R2-ip-pool-pool1]gateway-list 1.1.1.1
[R2-ip-pool-pool1]network 1.1.1.0 mask 24
Create a user.
[R2]aaa
[R2-aaa]local-user HuaweiR1 password cipher R1
[R2-aaa]local-user HuaweiR1 service-type ppp
Configure a virtual template.
[R2]interface Virtual-Template 0
[R2-Virtual-Template0]ppp authentication-mode pap
[R2-Virtual-Template0]remote address pool pool1
[R2-Virtual-Template0]ip address 1.1.1.1 24
Bind a physical interface to the virtual template.
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]pppoe-server bind virtual-template 0

Step 3 **Configure R2 and complete the configuration of serial interfaces and MP.**

Create a PPP user as the authentication party.
[R2]aaa
[R2-aaa]local-user Huawei password cipher Hello
[R2-aaa]local-user Huawei service-type ppp
Create an MP group and configure an IP address.
[R2]interface Mp-group 0/0/0
[R2-Mp-group0/0/0]ip address 20.1.1.1 24

Configure serial interfaces and add the interfaces to the MP group.
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]link-protocol ppp
[R2-Serial1/0/0]ppp authentication-mode pap
[R2-Serial1/0/0]ppp mp Mp-group 0/0/0
[R2]interface Serial 1/0/1
[R2-Serial1/0/1]link-protocol ppp
[R2-Serial1/0/1]ppp authentication-mode pap
[R2-Serial1/0/1]ppp mp Mp-group 0/0/0

Step 4 **Configure R3 and complete the configuration of serial interfaces and MP.**

Create an MP group and configure an IP address.
[R3]interface Mp-group 0/0/0
[R3-Mp-group0/0/0]ip address 20.1.1.2 24
Configure serial interfaces and add the interfaces to the MP group.
[R3]interface Serial 0/0/0
[R3-Serial0/0/0]link-protocol ppp
[R3-Serial0/0/0]ppp pap local user Huawei password cipher Hello
[R3-Serial0/0/0]ppp mp Mp-group 0/0/0
[R3]interface Serial 0/0/1
[R3-Serial0/0/1]link-protocol ppp
[R3-Serial0/0/1]ppp pap local user Huawei password cipher Hello
[R3-Serial0/0/1]ppp mp Mp-group 0/0/0

Step 5 **Configure R3 and complete the configuration of serial interfaces and IP-Trunk.**

Create an IP-Trunk interface and assign an IP address.
[R3]interface Ip-Trunk 1
[R3-Ip-Trunk1]ip address 10.1.1.1 24
Set the link-layer protocol for packet encapsulation on the serial interface to HDLC and add the interface to an IP-Trunk group.
[R3]interface Serial0/0/2
[R3-Serial0/0/2]link-protocol hdlc
[R3-Serial0/0/2]ip-trunk 1
[R3]interface Serial0/0/3
[R3-Serial0/0/3]link-protocol hdlc
[R3-Serial0/0/3]ip-trunk 1

Step 6 **Configure R4 and complete the configuration of serial interfaces and IP-Trunk.**

Create an IP-Trunk interface and assign an IP address.

```
[R4]interface Ip-Trunk 1
[R4-Ip-Trunk1]ip address 10.1.1.2 24
```

Set the link-layer protocol for packet encapsulation on the serial interface to HDLC and add the interface to an IP-Trunk group.

```
[R4]interface Serial0/0/2
[R4-Serial0/0/2]link-protocol hdlc
[R4-Serial0/0/2]ip-trunk 1
[R4]interface Serial0/0/3
[R4-Serial0/0/3]link-protocol hdlc
[R4-Serial0/0/3]ip-trunk 1
```

Step 7 **Configure static routes for communication between the headquarter and branch.**

```
# Configure a default route on R1 to R2.
[R1] ip route-static 0.0.0.0 0.0.0.0 1.1.1.1
# Configure a static route on R2 to the headquarter.
[R2] ip route-static 10.1.1.0 255.255.255.0 20.1.1.2
# Configure a static route on R3 to the branch.
[R3] ip route-static 1.1.1.0 255.255.255.0 20.1.1.1
# Configure a default route on R4 to R3.
[R4] ip route-static 0.0.0.0 0.0.0.0 10.1.1.1
```

2.3 Verifying the Configuration

After the preceding configurations are successful, perform the following operations to verify the configuration.

```
# Check the PPPoE dialup status on R1.
[R1]display pppoe-client session summary
PPPoE Client Session:
ID     Bundle   Dialer   Intf              Client-MAC      Server-MAC      State
1      1        1        GE0/0/0           00e0fc944237    00e0fc6b445d    UP
# Check the IP address obtained using PPPoE on R1.
[R1]display ip interface Dialer  1
Dialer1 current state : UP
Line protocol current state : UP (spoofing)
The Maximum Transmit Unit : 1500 bytes
input packets : 30, bytes : 2520, multicasts : 0
output packets : 42, bytes : 3528, multicasts : 0
Directed-broadcast packets:
```

```
 received packets:                0, sent packets:                0
 forwarded packets:               0, dropped packets:             0
Internet Address is negotiated, 1.1.1.254/32
Broadcast address : 1.1.1.254
.........
.........
# Test the connectivity between R1 and the headquarters.
[R1]ping 10.1.1.2
  PING 10.1.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.1.1.2: bytes=56 Sequence=1 ttl=253 time=110 ms
    Reply from 10.1.1.2: bytes=56 Sequence=2 ttl=253 time=20 ms
    Reply from 10.1.1.2: bytes=56 Sequence=3 ttl=253 time=50 ms
    Reply from 10.1.1.2: bytes=56 Sequence=4 ttl=253 time=50 ms
    Reply from 10.1.1.2: bytes=56 Sequence=5 ttl=253 time=40 ms

  --- 10.1.1.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 20/54/110 ms
# Check the PPPoE status on R2.
[R2]display  pppoe-server session all
SID Intf                      State    OIntf           RemMAC          LocMAC
1    Virtual-Template0:0       UP     GE0/0/0         00e0.fc94.4237  00e0.fc6b.445d
# Check the MP status on R2.
<R2>display  ppp mp
 Mp-group is Mp-group0/0/0
 ===========Sublinks status begin======
 Serial1/0/0 physical UP,protocol UP
 Serial1/0/1 physical UP,protocol UP
 ===========Sublinks status end========
 Bundle Multilink, 2 members, slot 0, Master link is Mp-group0/0/0
  0 lost fragments, 0 reordered, 0 unassigned,
 sequence 0/0 rcvd/sent
 The bundled sub channels are:
       Serial1/0/0
       Serial1/0/1
# Check the IP-Trunk status on R3.
[R3]dis trunkmembership ip-trunk 1
Trunk ID: 1
TYPE: pos
Number Of Ports in Trunk = 2
Number Of Up Ports in Trunk = 2
```

```
Operate status: up

Interface Serial0/0/2, valid, operate up, weight=1
Interface Serial0/0/3, valid, operate up, weight=1
```

2.4 Reference Configuration

2.4.1 Configuration of R1

```
#
 sysname R1
#
interface Dialer1
 link-protocol ppp
 ppp pap local-user HuaweiR1 password cipher %$%$`m/)3p@~FB;YIkX7Yi3F,.7L%$%$
 ip address ppp-negotiate
 dialer user HuaweiR1
 dialer bundle 1
 dialer-group 1
#
interface GigabitEthernet0/0/0
 pppoe-client dial-bundle-number 1
#
dialer-rule
 dialer-rule 1 ip permit
#
ip route-static 0.0.0.0 0.0.0.0 1.1.1.1
#
return
```

2.4.2 Configuration of R2

```
#
 sysname R2
#
 board add 0/1 2SA
#
ip pool pool1
 gateway-list 1.1.1.1
 network 1.1.1.0 mask 255.255.255.0
```

```
#
aaa
 local-user huawei password cipher %$%$IA|.D}GT4I.E$b'4qBA~e'Ea%$%$
 local-user huawei service-type ppp
 local-user huaweir1 password cipher %$%$K-Ku/aF8cM=3lgO1Yz'3e"RS%$%$
 local-user huaweir1 service-type ppp
#
interface Mp-group0/0/0
 ip address 20.1.1.1 255.255.255.0
#
interface Serial1/0/0
 link-protocol ppp
 ppp authentication-mode pap
 ppp mp Mp-group 0/0/0
#
interface Serial1/0/1
 link-protocol ppp
 ppp authentication-mode pap
 ppp mp Mp-group 0/0/0
#
interface Virtual-Template0
 ppp authentication-mode pap
 remote address pool pool1
 ip address 1.1.1.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 pppoe-server bind Virtual-Template 0
#
ip route-static 10.1.1.0 255.255.255.0 20.1.1.2
#
return
```

2.4.3 Configuration of R3

```
#
sysname R3
#
interface Ip-Trunk1
 ip address 10.1.1.1 255.255.255.0
#
interface Mp-group0/0/0
 ip address 20.1.1.2 255.255.255.0
```

```
#
interface Serial0/0/0
 link-protocol ppp
 ppp pap local-user Huawei password cipher %@ENC;8HX\#Q=^Q`MAF4<1!!
 ppp mp Mp-group 0/0/0
#
interface Serial0/0/1
 link-protocol ppp
 ppp pap local-user Huawei password cipher %@ENC;8HX\#Q=^Q`MAF4<1!!
 ppp mp Mp-group 0/0/0
#
interface Serial0/0/2
 link-protocol hdlc
 ip-trunk 1
#
interface Serial0/0/3
 link-protocol hdlc
 ip-trunk 1
#
ip route-static 1.1.1.0 255.255.255.0 20.1.1.1
#
return
```

2.4.4 Configuration of R4

```
#
sysname R4
#
interface Ip-Trunk1
 ip address 10.1.1.2 255.255.255.0
#
interface Serial0/0/2
 link-protocol hdlc
 ip-trunk 1
#
interface Serial0/0/3
 link-protocol hdlc
 ip-trunk 1
#
ip route-static 0.0.0.0 0.0.0.0 10.1.1.1
#
return
```

2.5 **Quiz**

According to the preceding configuration, does the link-layer protocol need to be set to HDLC for IP-Trunk?

3 IPv6 Transition Technology Configuration

3.1 Introduction

3.1.1 About This Lab

IPv6 is shorted for Internet Protocol Version 6.

Both IPv6 and IPv4 are network-layer protocols, but they are different. It takes a long time for IPv6 to replace IPv4. The transition from IPv4 to IPv6 cannot be performed in a short time, but needs to be completed gradually and by phase. In the transition process, some IPv4-IPv6 interworking technologies are developed to ensure these two protocols can coexist and communicate with each other.

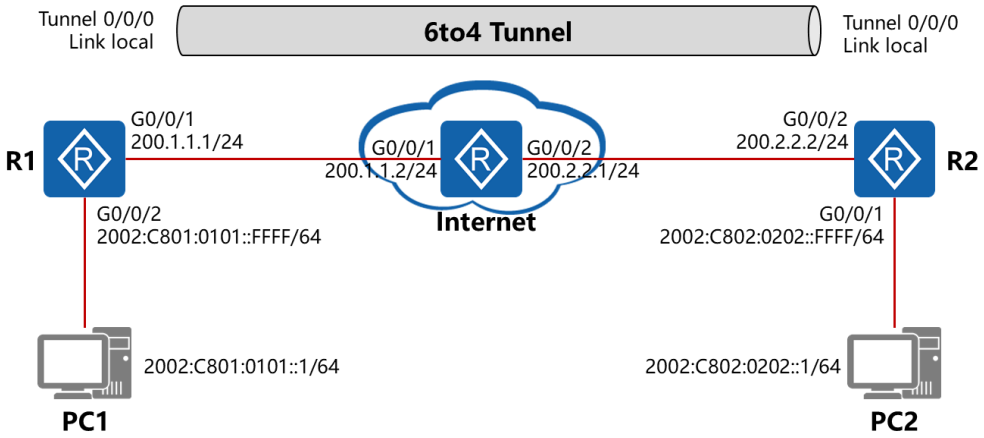
This lab uses the 6to4 technology as an example to describe how to configure IPv6 transition technologies.

3.1.2 Objectives

In this lab, you will learn how to configure 6to4 automatic tunnels for interworking between IPv6 and IPv4 networks.

3.1.3 Networking Topology

Figure 3-1 IPv6 transition networking topology



3.1.4 Networking Design

The R1-Internet-R2 network is an IPv4 network. PC1 and PC2 are IPv6 silos. R1 and R2 are IPv6/IPv4 dual stack devices. A 6to4 tunnel is deployed between R1 and R2 to allow PC1 and PC2 to communicate with each other.

Table 3-1 Device interface parameter design

Device	Interface	IP Address
PC1	Eth0/0/1	2002:C801:0101::1/64
R1	G0/0/1	200.1.1.1/24
	G0/0/2	2002:c801:0101::ffff/64
Internet	G0/0/1	200.1.1.2/24
	G0/0/2	200.2.2.1/24
R2	G0/0/1	2002:c802:0202::ffff
	G0/0/2	200.2.2.2/64
PC2	Eth0/0/1	2002:C802:0202::1

3.2 Lab Configuration

3.2.1 Configuration Roadmap

1. Configure IPv4 and IPv6 addresses for physical interfaces on PC1, PC2, R1, R2, and the Internet router. Configure IPv4 static routes so that devices can communicate with each other through IPv4.
2. Configure the IPv6 address, source interface, and tunnel mode of a 6to4 tunnel, configure IPv6 static routes, and establish a 6to4 tunnel.

3.2.2 Configuration Procedure

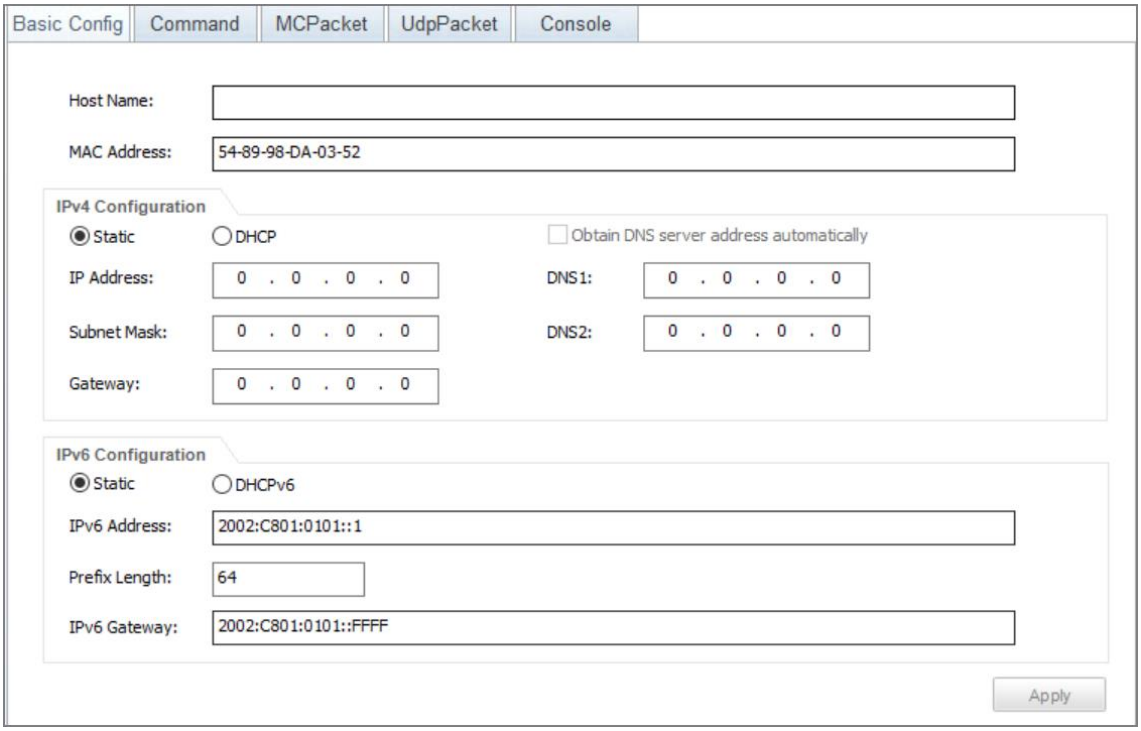
Step 1 **Enable the IPv6 function on routers and configure IP addresses.**

Enable IPv6 on R1 and configure its IPv4 and IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]ipv6
[R1]interface GigabitEthernet0/0/2
[R1-GigabitEthernet0/0/2]ipv6 enable
[R1-GigabitEthernet0/0/2]ipv6 address 2002:C801:0101::FFFF/64
[R1-GigabitEthernet0/0/2]quit
[R1]

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 200.1.1.1 24
[R1-GigabitEthernet0/0/1]quit
[R1]
```

Configure an IPv6 address on PC1.



Test the link between PC1 and R1.

```
PC>ping 2002:C801:0101::ffff

Ping 2002:c801:101::ffff: 32 data bytes, Press Ctrl_C to break
From 2002:c801:101::ffff: bytes=32 seq=1 hop limit=64 time=32 ms
From 2002:c801:101::ffff: bytes=32 seq=2 hop limit=64 time<1 ms
From 2002:c801:101::ffff: bytes=32 seq=3 hop limit=64 time=15 ms
From 2002:c801:101::ffff: bytes=32 seq=4 hop limit=64 time=16 ms
From 2002:c801:101::ffff: bytes=32 seq=5 hop limit=64 time=15 ms

--- 2002:c801:101::ffff ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 0/15/32 ms

PC>
```

Enable IPv6 on R2 and configure its IPv4 and IPv6 addresses.

```
<Huawei>system-view
```

Enter system view, return user view with Ctrl+Z.

[Huawei]sysname R2

[R2]ipv6

[R2]interface GigabitEthernet 0/0/1

[R2-GigabitEthernet0/0/1]ipv6 enable

[R2-GigabitEthernet0/0/1]ipv6 address 2002:c802:0202::ffff/64

[R2-GigabitEthernet0/0/1]quit

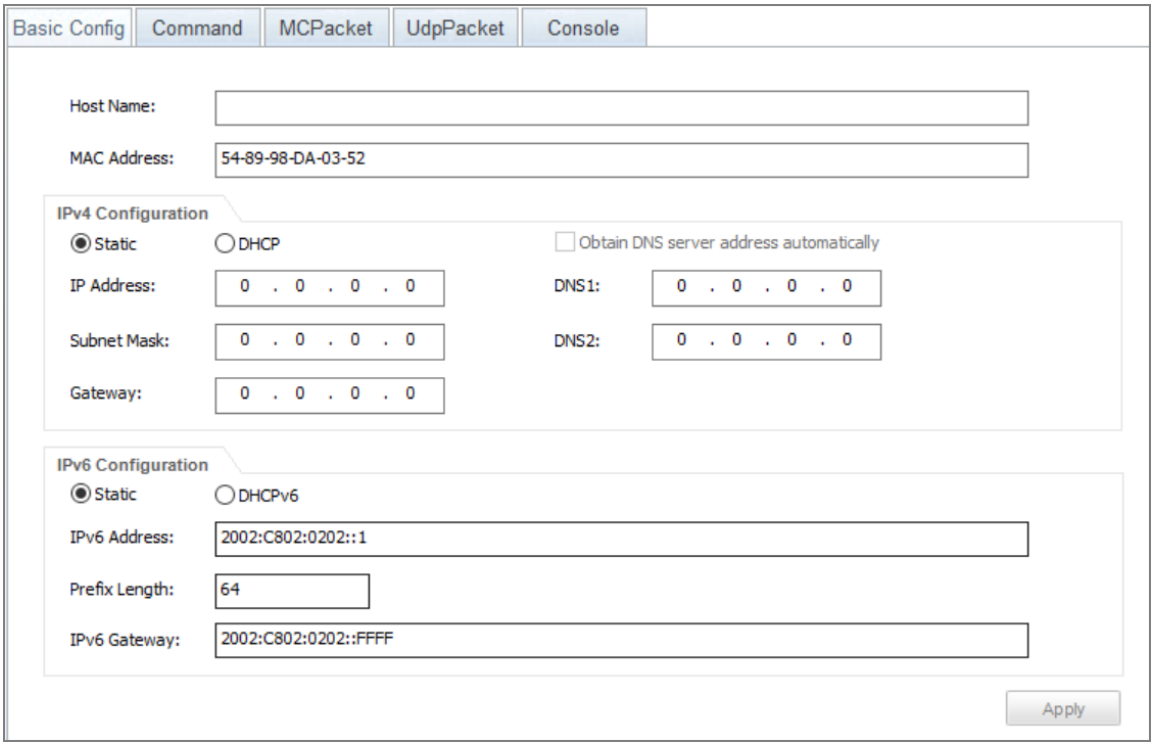
[R2]interface GigabitEthernet 0/0/2

[R2-GigabitEthernet0/0/2]ip address 200.2.2.2 24

[R2-GigabitEthernet0/0/2]quit

[R2]

Configure an IPv6 address for PC2.



Test the link between PC2 and R2.

PC>ping 2002:C802:0202::FFFF

Ping 2002:c802:202::ffff: 32 data bytes, Press Ctrl_C to break

From 2002:c802:202::ffff: bytes=32 seq=1 hop limit=64 time=15 ms

From 2002:c802:202::ffff: bytes=32 seq=2 hop limit=64 time=16 ms

From 2002:c802:202::ffff: bytes=32 seq=3 hop limit=64 time=16 ms

```
From 2002:c802:202::ffff: bytes=32 seq=4 hop limit=64 time=15 ms
From 2002:c802:202::ffff: bytes=32 seq=5 hop limit=64 time=16 ms

--- 2002:c802:202::ffff ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 15/15/16 ms

PC>
```

Configure IPv4 addresses on the Internet router.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sy
[Huawei]sysname Internet
[Internet]interface GigabitEthernet 0/0/1
[Internet-GigabitEthernet0/0/1]ip address 200.1.1.2 24
[Internet-GigabitEthernet0/0/1]quit

[Internet]interface GigabitEthernet 0/0/2
[Internet-GigabitEthernet0/0/2]ip address 200.2.2.1 24
[Internet-GigabitEthernet0/0/2]quit
```

Configure a static route to the peer on R1.

```
[R1]ip route-static 0.0.0.0 0.0.0.0 200.1.1.2
```

Configure a static route to the peer on R2.

```
[R2]ip route-static 0.0.0.0 0.0.0.0 200.2.2.1
```

Test the link between R1 and R2.

```
[R1]ping 200.2.2.2
  PING 200.2.2.2: 56  data bytes, press CTRL_C to break
    Reply from 200.2.2.2: bytes=56 Sequence=1 ttl=254 time=50 ms
    Reply from 200.2.2.2: bytes=56 Sequence=2 ttl=254 time=60 ms
    Reply from 200.2.2.2: bytes=56 Sequence=3 ttl=254 time=70 ms
    Reply from 200.2.2.2: bytes=56 Sequence=4 ttl=254 time=50 ms
```

```
  Reply from 200.2.2.2: bytes=56 Sequence=5 ttl=254 time=60 ms

--- 200.2.2.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 50/58/70 ms

[R1]
```

Step 2 **Configure 6to4 tunnels.**

Configure a 6to4 tunnel on R1.

```
[R1]interface Tunnel 0/0/0
[R1-Tunnel0/0/0]tunnel-protocol ipv6-ipv4 6to4
Info: Relevant configurations on this interface are deleted.
[R1-Tunnel0/0/0]ipv6 enable
[R1-Tunnel0/0/0]source 200.1.1.1
[R1-Tunnel0/0/0]ipv6 address auto link-local
[R1-Tunnel0/0/0]quit
```

Configure an IPv6 static route on R1.

```
[R1]ipv6 route-static 2002:C802:0202:: 64 Tunnel 0/0/0
```

Configure a 6to4 tunnel on R2.

```
[R2]interface Tunnel 0/0/0
[R2-Tunnel0/0/0]tunnel-protocol ipv6-ipv4 6to4
Info: Relevant configurations on this interface are deleted.
[R2-Tunnel0/0/0]ipv6 enable
[R2-Tunnel0/0/0]source 200.2.2.2
[R2-Tunnel0/0/0]ipv6 address auto link-local
[R2-Tunnel0/0/0]quit
```

Configure an IPv6 static route on R2.

```
[R2]ipv6 route-static 2002:C801:0101:: 64 Tunnel 0/0/0
```

3.3 Verification

3.3.1 Verifying the Configuration

Run the **display ipv6 interface brief** command on R1. The command output is as follows:

```
[R1]display ipv6 interface brief
*down: administratively down
!down: FIB overload down
(l): loopback
(s): spoofing
Interface                         Physical              Protocol
GigabitEthernet0/0/2              up                    up
[IPv6 Address] 2002:C801:101::FFFF
Tunnel0/0/0                       up                    up
[IPv6 Address] FE80::C801:101
[R1]
```

Access PC2 from PC1. The result is as follows:

```
PC>ping 2002:C802:0202::1

Ping 2002:c802:202::1: 32 data bytes, Press Ctrl_C to break
From 2002:c802:202::1: bytes=32 seq=1 hop limit=253 time=125 ms
From 2002:c802:202::1: bytes=32 seq=2 hop limit=253 time=79 ms
From 2002:c802:202::1: bytes=32 seq=3 hop limit=253 time=93 ms
From 2002:c802:202::1: bytes=32 seq=4 hop limit=253 time=94 ms
From 2002:c802:202::1: bytes=32 seq=5 hop limit=253 time=203 ms

--- 2002:c802:202::1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 79/118/203 ms

PC>
```

3.3.2 R1’ s Configuration

```
#
sysname R1
#
ipv6
#
interface GigabitEthernet0/0/1
 ip address 200.1.1.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2002:C801:101::FFFF/64
#
interface GigabitEthernet0/0/3
#
interface Tunnel0/0/0
 ipv6 enable
 ipv6 address auto link-local
 tunnel-protocol ipv6-ipv4 6to4
 source 200.1.1.1
#
ip route-static 0.0.0.0 0.0.0.0 200.1.1.2
#
[R1]ipv6 route-static 2002:C802:0202:: 64 Tunnel 0/0/0
#
return
[R1]
```

3.3.3 R2's Configuration

```
#
sysname R2
#
ipv6
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2002:C802:202::FFFF/64
```

```
#
interface GigabitEthernet0/0/2
 ip address 200.2.2.2 255.255.255.0
#
interface Tunnel0/0/0
 ipv6 enable
 ipv6 address auto link-local
 tunnel-protocol ipv6-ipv4 6to4
 source 200.2.2.2
#
ip route-static 0.0.0.0 0.0.0.0 200.2.2.1
#
ipv6 route-static 2002:C801:0101:: 64 Tunnel 0/0/0
#
return
<R2>
```

3.3.4 Internet Router's Configuration

```
#
sysname Internet
#
interface GigabitEthernet0/0/0
#
interface GigabitEthernet0/0/1
 ip address 200.1.1.2 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 200.2.2.1 255.255.255.0
#
return
<Internet>
```

4 Basic OSPFv3 Function Configuration

4.1 Introduction

4.1.1 About This Lab

Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. OSPF version 2 (OSPFv2) is a routing protocol for IPv4. To allow OSPF to support IPv6, OSPF version 3 (OSPFv3) is developed.

The basic operating principles of OSPF are the same regardless of OSPFv2 or OSPFv3. However, the differences between IPv4 and IPv6 and their different sizes of address space make OSPFv2 inevitably different from OSPFv3.

In this lab, you will learn how to configure basic OSPFv3 functions.

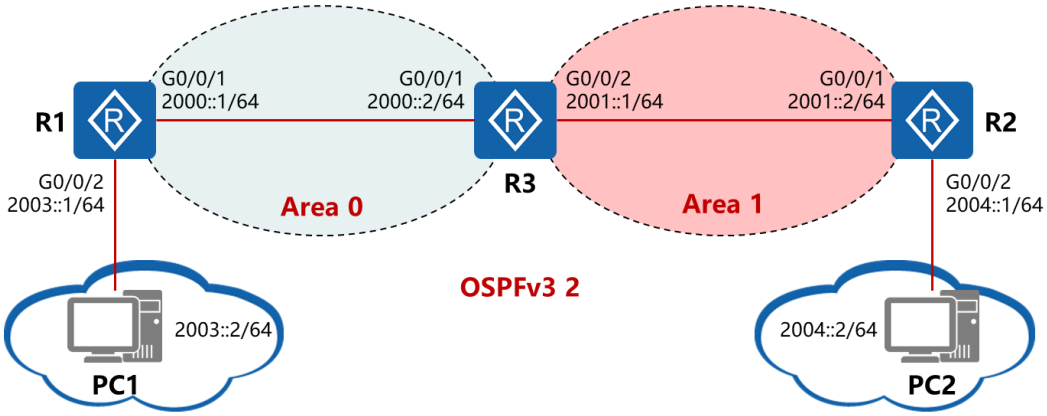
4.1.2 Objectives

Upon completion of this task, you will be able to:

- Grasp basic configurations of OSPFv3.

4.1.3 Networking Topology

Figure 4-1 Networking topology for configuring basic OSPFv3 functions



4.1.4 Networking Design

OSPFv3 is enabled on R1, R2, and R3. To allow R1 and R2 to interconnect with PC1 and PC2 so that PC1 can communicate with PC2, external direct routes need to be imported into OSPFv3 processes on R1 and R2.

Table 4-1 Device interface parameter design

Device	Interface	IP Address
PC1	Eth0/0/1	2003::2/64
R1	G0/0/1	2000::1/64
	G0/0/2	2003::1/64
R2	G0/0/1	2001::2/64
	G0/0/2	2004::1/64
R3	G0/0/1	2000::2/64
	G0/0/2	2001::1/64
PC2	Eth0/0/1	2004::2/64

4.2 Lab Configuration

4.2.1 Configuration Roadmap

1. Configure IPv6 addresses for PC1, PC2, R1, R2 and R3 so that the directly connected devices can communicate with each other.
2. Configure OSPFv3 on R1, R2 and R3 so that they can communicate with each other.
3. Import direct routes into OSPFv3 processes on R1 and R2 so that PC1 can communicate with PC2.

4.2.2 Configuration Procedure

Step 1 Enable IPv6 on routers and configure IPv6 addresses.

Enable IPv6 on R1 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1] ipv6
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ipv6 enable
[R1-GigabitEthernet0/0/1]ipv6 address 2000::1 64
[R1-GigabitEthernet0/0/1]quit

[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ipv6 enable
[R1-GigabitEthernet0/0/2]ipv6 address
[R1-GigabitEthernet0/0/2]quit
[R1]
```

Enable IPv6 on R2 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2] ipv6
```

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ipv6 enable
[R2-GigabitEthernet0/0/1]ipv6 address 2001::2 64
[R2-GigabitEthernet0/0/1]quit

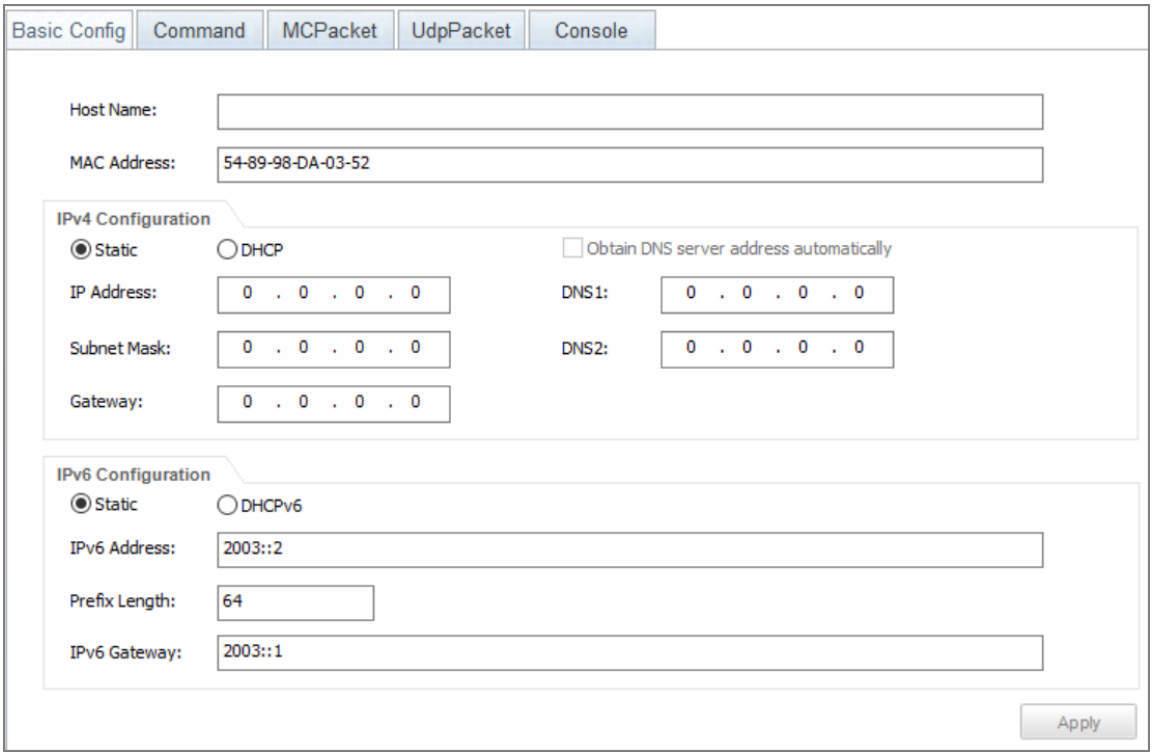
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ipv6 enable
[R2-GigabitEthernet0/0/2]ipv6 address 2004::1 64
[R2-GigabitEthernet0/0/2]quit
[R2]
```

Enable IPv6 on R3 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3] ipv6
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ipv6 enable
[R3-GigabitEthernet0/0/1]ipv6 address 2000::2 64
[R3-GigabitEthernet0/0/1]quit

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ipv6 enable
[R3-GigabitEthernet0/0/2]ipv6 address 2001::1 64
[R3-GigabitEthernet0/0/2]quit
[R3]
```

Configure an IPv6 address for PC1.



Test the connectivity between PC1 and R1.

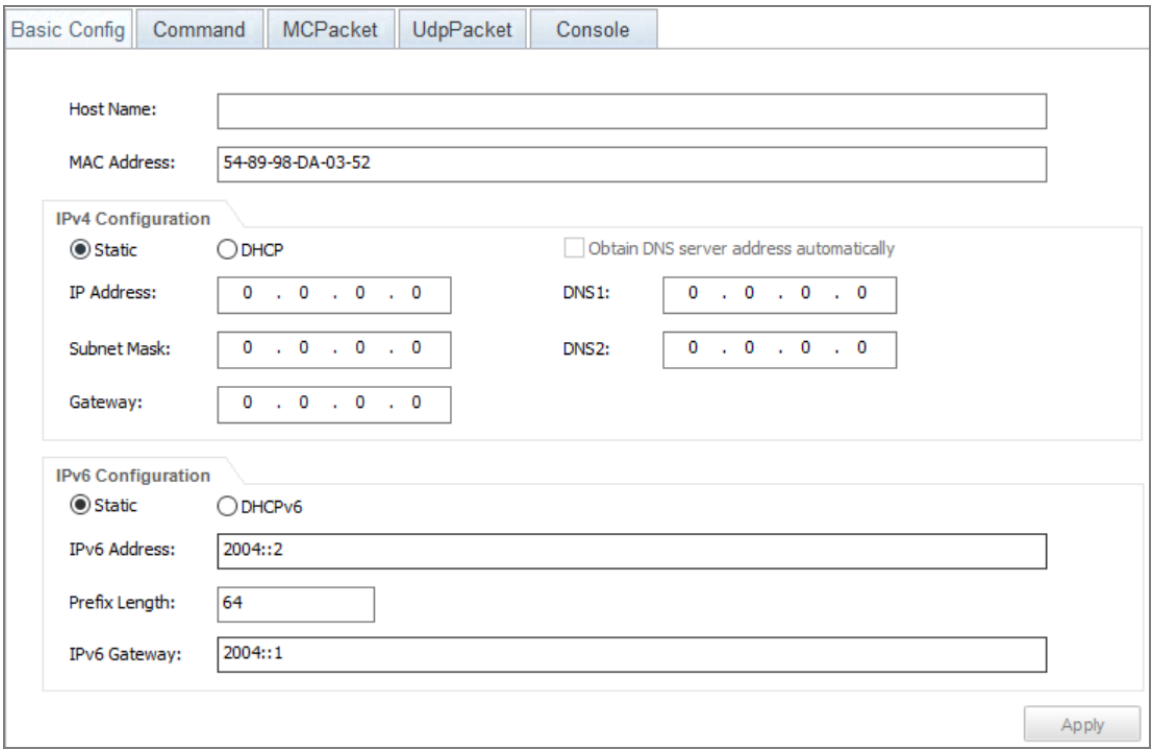
```
PC>ping 2003::1

Ping 2003::1: 32 data bytes, Press Ctrl_C to break
From 2003::1: bytes=32 seq=1 hop limit=64 time=16 ms
From 2003::1: bytes=32 seq=2 hop limit=64 time=31 ms
From 2003::1: bytes=32 seq=3 hop limit=64 time<1 ms
From 2003::1: bytes=32 seq=4 hop limit=64 time=16 ms
From 2003::1: bytes=32 seq=5 hop limit=64 time=16 ms

--- 2003::1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 0/15/31 ms

PC>
```

Configure an IPv6 address for PC2.



Test the connectivity between PC2 and R2.

```
PC>ping 2004::1

Ping 2004::1: 32 data bytes, Press Ctrl_C to break
From 2004::1: bytes=32 seq=1 hop limit=64 time=31 ms
From 2004::1: bytes=32 seq=2 hop limit=64 time=15 ms
From 2004::1: bytes=32 seq=3 hop limit=64 time=16 ms
From 2004::1: bytes=32 seq=4 hop limit=64 time=16 ms
From 2004::1: bytes=32 seq=5 hop limit=64 time<1 ms

--- 2004::1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 0/15/31 ms

PC>
```

Step 2 Configure OSPFv3.

Configure OSPFv3 on R1.

```
[R1]ospfv3 2
[R1-ospfv3-2]router-id 10.10.10.10
[R1-ospfv3-2]quit

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ospfv3 2 area 0
[R1-GigabitEthernet0/0/1]quit
[R1]
```

Configure OSPFv3 on R2.

```
[R2]ospfv3 2
[R2-ospfv3-2]router-id 20.20.20.20
[R2-ospfv3-2]quit

[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ospfv3 2 area 1
[R2-GigabitEthernet0/0/1]quit
[R2]
```

Configure OSPFv3 on R3.

```
[R3]ospfv3 2
[R3-ospfv3-2]router-id 30.30.30.30
[R3-ospfv3-2]quit
[R3]

[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ospfv3 2 area 0
[R3-GigabitEthernet0/0/1]quit

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ospfv3 2 area 1
[R3-GigabitEthernet0/0/2]quit
```

Check OSPFv3 neighbor relationships established on R3.

```
[R3]display ospfv3 peer
OSPFv3 Process (2)
OSPFv3 Area (0.0.0.0)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
10.10.10.10       1   Full/DR          00:00:36  GE0/0/1
0
OSPFv3 Area (0.0.0.1)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
20.20.20.20       1   Full/DR          00:00:30  GE0/0/2
0

[R3]
```

Import direct routes into OSPFv3 processes on R1 and R2.

```
[R1]ospfv3 2
[R1-ospfv3-2]import-route direct
[R1-ospfv3-2]quit

[R2]ospfv3 2
[R2-ospfv3-2]import-route direct
[R2-ospfv3-2]quit
```

4.2.3 Verifying the Configuration

Check IPv6 routes of the OSPFv3 routing table on R1. The command output shows that R1 learns all the routes to R2.

```
<R1>display ipv6 routing-table protocol ospfv3
Public Routing Table : OSPFv3
Summary Count : 3

OSPFv3 Routing Table's Status : < Active >
Summary Count : 2

 Destination  : 2001::                        PrefixLength : 64
 NextHop      : FE80::2E0:FCFF:FEE3:7EE4      Preference   : 10
```

```
  Cost           : 2                          Protocol       : OSPFv3
  RelayNextHop : ::                           TunnelID       : 0x0
  Interface      : GigabitEthernet0/0/1       Flags          : D

  Destination : 2004::                        PrefixLength : 64
  NextHop        : FE80::2E0:FCFF:FEE3:7EE4   Preference     : 150
  Cost           : 1                          Protocol       :
OSPFv3ASE
  RelayNextHop : ::                           TunnelID       : 0x0
  Interface      : GigabitEthernet0/0/1       Flags          : D

OSPFv3 Routing Table's Status : < Inactive >
Summary Count : 1

  Destination    : 2000::                     PrefixLength : 64
  NextHop        : ::                         Preference     : 10
  Cost           : 1                          Protocol       : OSPFv3
  RelayNextHop : ::                           TunnelID       : 0x0
  Interface      : GigabitEthernet0/0/1       Flags          :

<R1>
```

Check IPv6 routes of the OSPFv3 routing table on R2. The command output shows that R2 learns all the routes to R1.

```
[R3]display ipv6 routing-table protocol ospfv3
Public Routing Table : OSPFv3
Summary Count : 4

OSPFv3 Routing Table's Status : < Active >
Summary Count : 2

  Destination    : 2003::                     PrefixLength : 64
  NextHop        : FE80::2E0:FCFF:FEAF:7820   Preference     : 150
  Cost           : 1                          Protocol       :
OSPFv3ASE
  RelayNextHop : ::                           TunnelID       : 0x0
```

```
 Interface      : GigabitEthernet0/0/1                Flags          : D

 Destination    : 2004::                              PrefixLength : 64
 NextHop        : FE80::2E0:FCFF:FECC:F97             Preference     : 150
 Cost           : 1                                   Protocol       :
OSPFv3ASE
 RelayNextHop : ::                                    TunnelID       : 0x0
 Interface      : GigabitEthernet0/0/2                Flags          : D

OSPFv3 Routing Table's Status : < Inactive >
Summary Count : 2

 Destination    : 2000::                              PrefixLength : 64
 NextHop        : ::                                  Preference     : 10
 Cost           : 1                                   Protocol       : OSPFv3
 RelayNextHop : ::                                    TunnelID       : 0x0
 Interface      : GigabitEthernet0/0/1                Flags          :

 Destination    : 2001::                              PrefixLength : 64
 NextHop        : ::                                  Preference     : 10
 Cost           : 1                                   Protocol       : OSPFv3
 RelayNextHop : ::                                    TunnelID       : 0x0
 Interface      : GigabitEthernet0/0/2                Flags          :

[R3]
```

Ping PC2 from PC1. The command output is as follows:

```
PC>ping 2004::2

Ping 2004::2: 32 data bytes, Press Ctrl_C to break
From 2004::2: bytes=32 seq=1 hop limit=252 time=62 ms
From 2004::2: bytes=32 seq=2 hop limit=252 time=16 ms
From 2004::2: bytes=32 seq=3 hop limit=252 time=31 ms
From 2004::2: bytes=32 seq=4 hop limit=252 time=31 ms
From 2004::2: bytes=32 seq=5 hop limit=252 time=16 ms
```

```
--- 2004::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 16/31/62 ms

PC>
```

4.2.4 R1's Configuration

```
#
 sysname R1
#
ipv6
#
ospfv3 2
 router-id 10.10.10.10
 import-route direct
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2000::1/64
 ospfv3 2 area 0.0.0.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2003::1/64
#
return
<R1>'
```

4.2.5 R2's Configuration

```
#
 sysname R2
#
ipv6
#
```

```
ospfv3 2
 router-id 20.20.20.20
 import-route direct
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2001::2/64
 ospfv3 2 area 0.0.0.1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2004::1/64
#
return
<R2>
```

4.2.6 R3's Configuration

```
#
 sysname R3
#
ipv6
#
ospfv3 2
 router-id 30.30.30.30
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2000::2/64
 ospfv3 2 area 0.0.0.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2001::1/64
 ospfv3 2 area 0.0.0.1
#
return
```

<R3>

5 Configuration for Route Interworking Between Two OSPFv3 Processes

5.1 Introduction

5.1.1 About This Lab

In this lab, you will learn how to run two OSPFv3 processes on a router for route interworking.

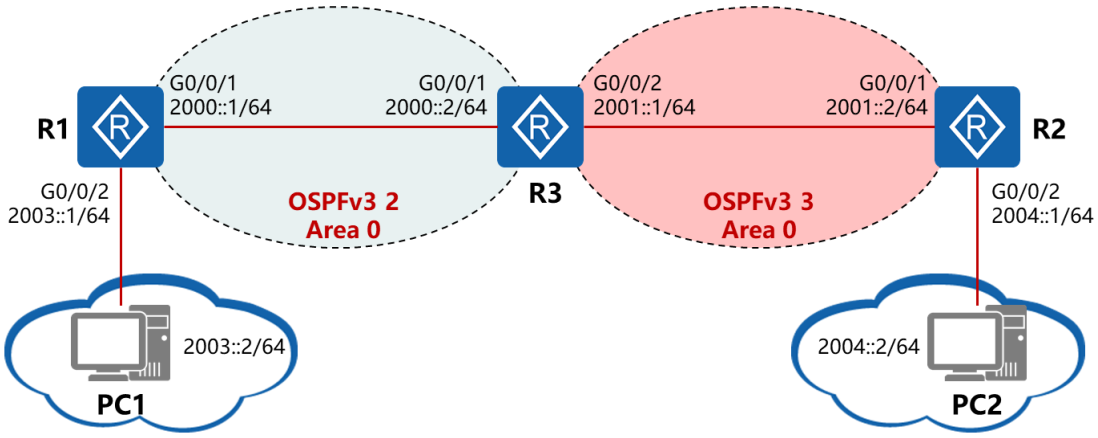
5.1.2 Objectives

Upon completion of this task, you will be able to:

- Configure two OSPFv3 processes on a router for route interworking.

5.1.3 Networking Topology

Figure 5-1 Networking topology for configuring route interworking between two OSPFv3 processes



5.1.4 Networking Design

OSPFv3 is enabled on R1, R2 and R3. To allow PC1 and PC2 to communicate with each other, OSPFv3 process 2 is needed on R1 and R3, and OSPFv3 process 3 is needed on R2 and R3.

Table 5-1 Device interface parameter design

Device	Interface	IP Address
PC1	Eth0/0/1	2003::2/64
R1	G0/0/1	2000::1/64
	G0/0/2	2003::1/64
R2	G0/0/1	2001::2/24
	G0/0/2	2004::1/24
R3	G0/0/1	2000::2/64
	G0/0/2	2001::1/64
PC2	Eth0/0/1	2004::2/64

5.2 Lab Configuration

5.2.1 Configuration Roadmap

1. Configure IPv6 addresses for PC1, PC2, R1, R2 and R3 so that the directly connected devices can communicate with each other.
2. Configure OSPFv3 process 2 on R1 and R3, and configure OSPFv3 process 3 on R2 and R3.
3. On R3, configure route import between two OSPFv3 processes so that network-wide connectivity is implemented and PC1 can communicate with PC2.

5.2.2 Configuration Procedure

Step 1 Enable IPv6 on routers and configure IPv6 addresses.

Enable IPv6 on R1 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ipv6 enable
[R1-GigabitEthernet0/0/1]ipv6 address 2000::1 64
[R1-GigabitEthernet0/0/1]quit

[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ipv6 enable
[R1-GigabitEthernet0/0/2]ipv6 address
[R1-GigabitEthernet0/0/2]quit
[R1]
```

Enable IPv6 on R2 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ipv6 enable
```

```
[R2-GigabitEthernet0/0/1]ipv6 address 2001::2 64
[R2-GigabitEthernet0/0/1]quit

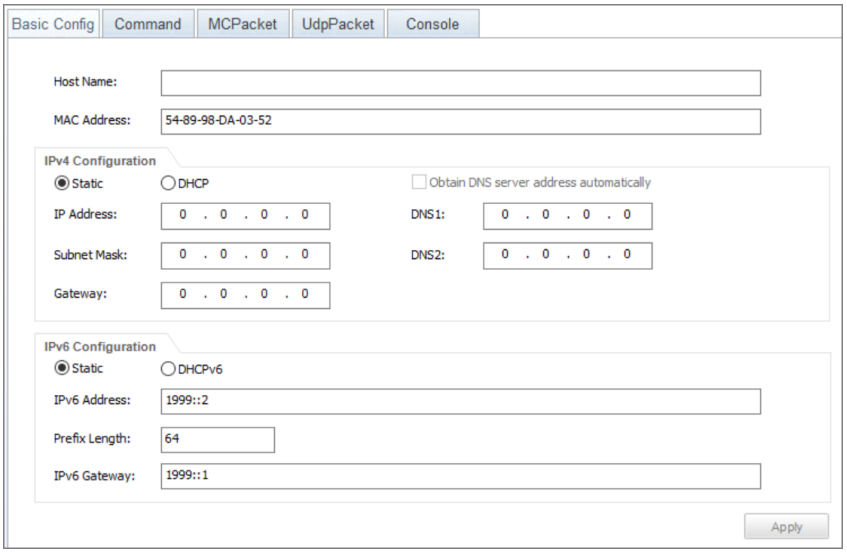
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ipv6 enable
[R2-GigabitEthernet0/0/2]ipv6 address 2004::1 64
[R2-GigabitEthernet0/0/2]quit
[R2]
```

Enable IPv6 on R3 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ipv6 enable
[R3-GigabitEthernet0/0/1]ipv6 address 2000::2 64
[R3-GigabitEthernet0/0/1]quit

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ipv6 enable
[R3-GigabitEthernet0/0/2]ipv6 address 2001::1 64
[R3-GigabitEthernet0/0/2]quit
[R3]
```

Configure an IPv6 address on PC1.



Test the connectivity between PC1 and R1.

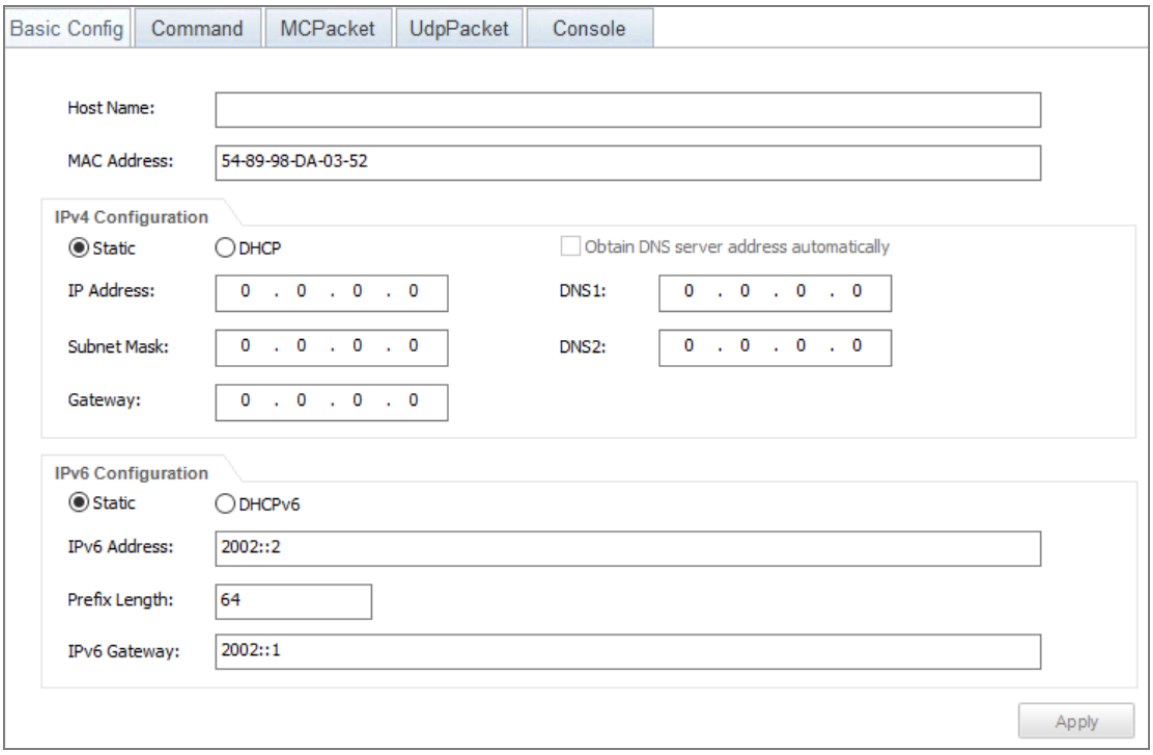
```
PC>ping 2003::1

Ping 2003::1: 32 data bytes, Press Ctrl_C to break
From 2003::1: bytes=32 seq=1 hop limit=64 time=16 ms
From 2003::1: bytes=32 seq=2 hop limit=64 time=31 ms
From 2003::1: bytes=32 seq=3 hop limit=64 time<1 ms
From 2003::1: bytes=32 seq=4 hop limit=64 time=16 ms
From 2003::1: bytes=32 seq=5 hop limit=64 time=16 ms

--- 2003::1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 0/15/31 ms

PC>
```

Configure an IPv6 address on PC2.



Test the connectivity between PC2 and R2.

```
PC>ping 2004::1

Ping 2004::1: 32 data bytes, Press Ctrl_C to break
From 2004::1: bytes=32 seq=1 hop limit=64 time=31 ms
From 2004::1: bytes=32 seq=2 hop limit=64 time=15 ms
From 2004::1: bytes=32 seq=3 hop limit=64 time=16 ms
From 2004::1: bytes=32 seq=4 hop limit=64 time=16 ms
From 2004::1: bytes=32 seq=5 hop limit=64 time<1 ms

--- 2004::1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 0/15/31 ms

PC>
```

Step 2 Configure OSPFv3.

Configure OSPFv3 process 2 on R1.

```
[R1]ospfv3 2
[R1-ospfv3-2]router-id 10.10.10.10
[R1-ospfv3-2]quit

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ospfv3 2 area 0
[R1-GigabitEthernet0/0/1]quit
[R1]
```

Configure OSPFv3 process 3 on R2.

```
[R2]ospfv3 3
[R2-ospfv3-3]router-id 20.20.20.20
[R2-ospfv3-3]quit
```

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ospfv3 3 area 0
[R2-GigabitEthernet0/0/1]quit
[R2]

[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ospfv3 3 area 0
[R2-GigabitEthernet0/0/2]quit
[R2]
```

Configure OSPFv3 process 2 and process 3 on R3.

```
[R3]ospfv3 2
[R3-ospfv3-2]router-id 31.31.31.31
[R3-ospfv3-2]quit
[R3]

[R3]ospfv3 3
[R3-ospfv3-3]router-id 32.32.32.32
[R3-ospfv3-3]quit
[R3]

[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ospfv3 2 area 0
[R3-GigabitEthernet0/0/1]quit

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ospfv3 3 area 0
[R3-GigabitEthernet0/0/2]quit
```

Check OSPFv3 neighbor relationships established on R3.

```
[R3]display ospfv3 peer
OSPFv3 Process (2)
OSPFv3 Area (0.0.0.0)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
```

```
10.10.10.10         1   Full/DR         00:00:39    GE0/0/1
0

OSPFv3 Process (3)
OSPFv3 Area (0.0.0.0)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
20.20.20.20         1   Full/DR         00:00:39    GE0/0/2
0

[R3]
```

Import routes of OSPFv3 process 3 into OSPFv3 process 2.

```
[R3]ospfv3 2
[R3-ospfv3-2]import-route ospfv3 3
[R3-ospfv3-2]quit
[R3]
```

Import routes of OSPFv3 process 2 into OSPFv3 process 3.

```
[R3]ospfv3 3
[R3-ospfv3-3]import-route ospfv3 2
[R3-ospfv3-3]quit
[R3]
```

5.3 Verification

5.3.1 Verifying the Configuration.

Check the IPv6 routes of the OSPFv3 routing table on R1. The command output shows that R1 learns all the routes destined to R2.

```
<R1>display ipv6 routing-table protocol ospfv3
Public Routing Table : OSPFv3
Summary Count : 4

OSPFv3 Routing Table's Status : < Active >
```

```
Summary Count : 2

 Destination  : 2001::                    PrefixLength : 64
 NextHop      : FE80::2E0:FCFF:FEE3:7EE4   Preference   : 150
 Cost         : 1                         Protocol     : OSPFv3ASE
 RelayNextHop : ::                        TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/1      Flags        : D

 Destination  : 2004::                    PrefixLength : 64
 NextHop      : FE80::2E0:FCFF:FEE3:7EE4   Preference   : 150
 Cost         : 1                         Protocol     : OSPFv3ASE
 RelayNextHop : ::                        TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/1      Flags        : D

OSPFv3 Routing Table's Status : < Inactive >
Summary Count : 2

 Destination  : 2003::                    PrefixLength : 64
 NextHop      : ::                        Preference   : 10
 Cost         : 1                         Protocol     : OSPFv3
 RelayNextHop : ::                        TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/2      Flags        :

 Destination  : 2000::                    PrefixLength : 64
 NextHop      : ::                        Preference   : 10
 Cost         : 1                         Protocol     : OSPFv3
 RelayNextHop : ::                        TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/1      Flags        :

<R1>
```

Check the IPv6 routes of the OSPFv3 routing table on R2. The command output shows that R2 learns all the routes destined to R1.

```
<R2>display ipv6 routing-table protocol ospfv3
Public Routing Table : OSPFv3
Summary Count : 4
```

```
OSPFv3 Routing Table's Status : < Active >
Summary Count : 2

 Destination   : 2003::                  PrefixLength : 64
 NextHop       : FE80::2E0:FCFF:FEE3:7EE5   Preference   : 150
 Cost          : 1                       Protocol     : OSPFv3ASE
 RelayNextHop : ::                       TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/1    Flags        : D

 Destination   : 2000::                  PrefixLength : 64
 NextHop       : FE80::2E0:FCFF:FEE3:7EE5   Preference   : 150
 Cost          : 1                       Protocol     : OSPFv3ASE
 RelayNextHop : ::                       TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/1    Flags        : D

OSPFv3 Routing Table's Status : < Inactive >
Summary Count : 2

 Destination   : 2001::                  PrefixLength : 64
 NextHop       : ::                      Preference   : 10
 Cost          : 1                       Protocol     : OSPFv3
 RelayNextHop : ::                       TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/1    Flags        :

 Destination   : 2004::                  PrefixLength : 64
 NextHop       : ::                      Preference   : 10
 Cost          : 1                       Protocol     : OSPFv3
 RelayNextHop : ::                       TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/2    Flags        :

<R2>
```

Ping PC2 from PC1. The command output is as follows:

```
PC>ping 2004::2
```

```
Ping 2004::2: 32 data bytes, Press Ctrl_C to break
From 2004::2: bytes=32 seq=1 hop limit=252 time=62 ms
From 2004::2: bytes=32 seq=2 hop limit=252 time=16 ms
From 2004::2: bytes=32 seq=3 hop limit=252 time=31 ms
From 2004::2: bytes=32 seq=4 hop limit=252 time=31 ms
From 2004::2: bytes=32 seq=5 hop limit=252 time=16 ms

--- 2004::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 16/31/62 ms

PC>
```

5.3.2 R1's Configuration

```
#
 sysname R1
#
ipv6
#
ospfv3 2
 router-id 10.10.10.10
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2000::1/64
 ospfv3 2 area 0.0.0.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2003::1/64
 ospfv3 2 area 0.0.0.0
#
return
<R1>
```

5.3.3 R2's Configuration

```
#
 sysname R2
#
ipv6
#
ospfv3 3
 router-id 20.20.20.20
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2001::2/64
 ospfv3 3 area 0.0.0.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2004::1/64
 ospfv3 3 area 0.0.0.0
#
return
<R2>
```

5.3.4 R3's Configuration

```
#
 sysname R3
#
ipv6
#
ospfv3 2
 router-id 31.31.31.31
 import-route ospfv3 3
#
ospfv3 3
 router-id 32.32.32.32
 import-route ospfv3 2
```

```
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2000::2/64
 ospfv3 2 area 0.0.0.0
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2001::1/64
 ospfv3 3 area 0.0.0.0
#
return
<R3>
```

6 Configuration for External Route Import into OSPFv3 Processes and Route Filtering

6.1 Introduction

6.1.1 About This Lab

On a large campus network, different routing protocols are deployed to implement network-wide interworking. In addition to routing protocols, external routes and route filtering are required for interconnection between different protocols.

In this lab, you will learn how to configure OSPFv3 to filter routes and import external routes.

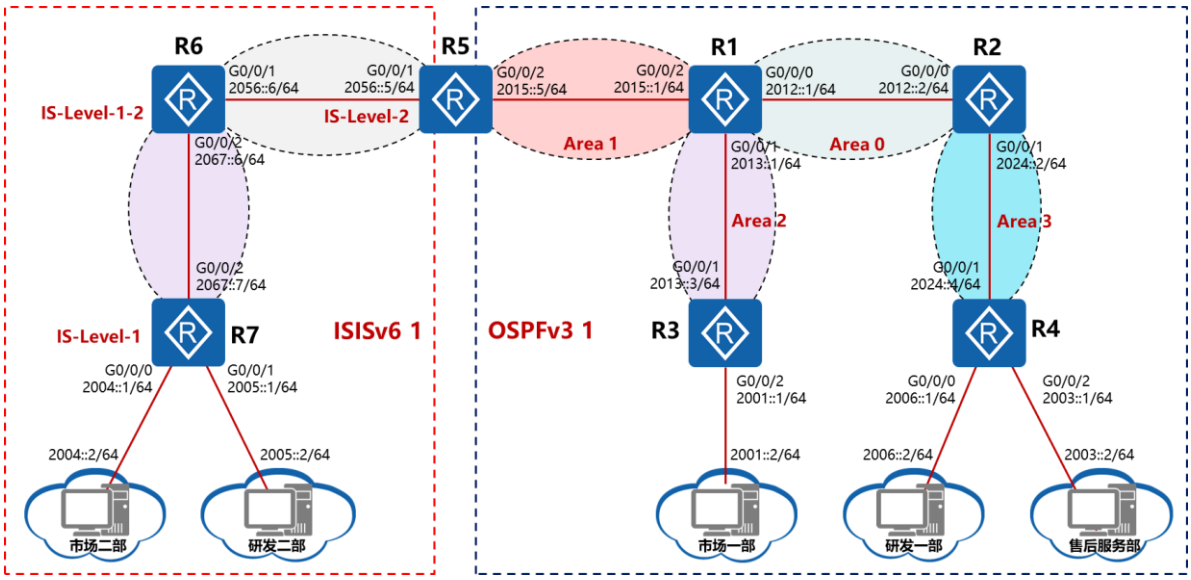
6.1.2 Objectives

Upon completion of this task, you will be able to:

- Configure OSPFv3 to filter routes and import external routes.

6.1.3 Networking Topology

Figure 6-1 Networking topology for configuring OSPFv3 to import external routes and filter routes



6.1.4 Networking Design

1. Enable OSPFv3 on R1, R2, R3, R4 and R5.
2. R1 and R2 are in Area 0, R1 and R3 are in Area 2, R1 and R5 are in Area 1, and R2 and R4 are in Area 3. After OSPFv3 neighbor relationships are established, R1, R2, R3, R4 and R5 can communicate with each other.
3. Enable IS-ISv6 on R5, R6 and R7. Set the IS-IS level of R5 and R6 to Level-1-2 and that of R7 to Level-1. After IS-IS neighbor relationships are established, R5, R6 and R7 can communicate with each other.
4. On R5, configure route redistribution from OSPFv3 into IS-ISv6 and from IS-ISv6 into OSPFv3. Filter imported routes on R5 to prevent R&D Dept. 2 from accessing the network segments of Marketing Dept. 1, R&D Dept. 1, and After-Sales Service Dept.
5. Filter routes on R3 to prevent Marketing Dept. 1 from accessing the network segment of R&D Dept. 1.
6. Filter routes on R4 to prevent R&D Dept. 1 and After-sales Service Dept. from accessing the network segment of Marketing Department 2.

Table 6-1 Device interface parameter design

Device	Interface	IP Address
R1	G0/0/0	2012::1/64
	G0/0/1	2013::1/64
	G0/0/2	2015::1/64
R2	G0/0/0	2012::2/64
	G0/0/1	2024::2/64
R3	G0/0/1	2013::3/64
	G0/0/2	2001::1/64
R4	G0/0/0	2006::1/64
	G0/0/1	2024::4/64
	G0/0/2	2003::1/64
R5	G0/0/1	2056::5/64
	G0/0/2	2015::5/64
R6	G0/0/1	2056::6/64
	G0/0/2	2067::6/64
R7	G0/0/0	2004::1/64
	G0/0/1	2005::1/64
	G0/0/2	2067::7/64
Marketing Dept. 1	Eth0/0/1	2001::2/64
Marketing Dept. 2	Eth0/0/1	2006::2/64
R&D Dept. 1	Eth0/0/1	2004::2/64
R&D Dept. 2	Eth0/0/1	2005::2/64
After-Sales Service Dept.	Eth0/0/1	2003::2/64

Table 6-2 Routing protocol parameter design

Protocol Type	Process ID	Device	Area or Router Level	Other Parameters
OSPFv3	1	R1	Area 0, Area1, Area 2	N/A
		R2	Area 0, Area 3	N/A
		R3	Area 2	N/A
		R4	Area 3	N/A
		R5	Area 1	N/A
IS-ISv6	1	R5	IS-IS Level-1-2	network-entity 10.0000.0000.0005.00
		R6	IS-IS Level-1-2	network-entity 10.0000.0000.0006.00
		R7	IS-IS Level-1	network-entity 10.0000.0000.0007.00

6.2 Lab Configuration

6.2.1 Configuration Roadmap

1. Configure IPv6 addresses for all devices so that the directly connected devices can communicate with each other.
2. Configure OSPFv3 on R1, R2, R3, R4 and R5 so that devices on the HQ network can communicate with each other.
3. Configure IS-ISv6 on R5, R6 and R7 so that branches can communicate with each other.
4. On R5, configure route redistribution from OSPFv3 into IS-ISv6 and from IS-ISv6 into OSPFv3. Filter imported routes on R5 to prevent R&D Dept. 2 from accessing

the network segments of Marketing Dept. 1, R&D Dept. 1, and After-Sales Service Dept.

5. Filter routes on R3 to prevent Marketing Dept. 1 from accessing R&D Dept. 1.
6. Filter routes on R4 to prevent R&D Dept. 1 and After-sales Service Dept. from accessing the network segment of Marketing Dept. 2.

6.2.2 Configuration Procedure

Step 1 Configure IPv6 addresses.

Enable IPv6 on R1 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]ipv6
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ipv6 enable
[R1-GigabitEthernet0/0/0]ipv6 address 2012::1 64
[R1-GigabitEthernet0/0/0]quit
[R1]

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ipv6 enable
[R1-GigabitEthernet0/0/1]ipv6 address 2013::1 64
[R1-GigabitEthernet0/0/1]quit
[R1]

[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ipv6 enable
[R1-GigabitEthernet0/0/2]ipv6 address 2015::1 64
[R1-GigabitEthernet0/0/2]quit
[R1]
```

Enable IPv6 on R2 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
```

```
[R2]ipv6
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ipv6 enable
[R2-GigabitEthernet0/0/0]ipv6 address 2012::2 64
[R2-GigabitEthernet0/0/0]quit
[R2]

[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ipv6 enable
[R2-GigabitEthernet0/0/1]ipv6 address 2024::2 64
[R2-GigabitEthernet0/0/1]quit
[R2]
```

Enable IPv6 on R3 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sy
[Huawei]sysname R3
[R3]ipv6
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ipv6 enable
[R3-GigabitEthernet0/0/1]ipv6 address 2013::3 64
[R3-GigabitEthernet0/0/1]quit
[R3]

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ipv6 enable
[R3-GigabitEthernet0/0/2]ipv6 address 2001::1 64
[R3-GigabitEthernet0/0/2]quit
[R3]
```

Enable IPv6 on R4 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R4
[R4]ipv6
```

```
[R4]interface GigabitEthernet 0/0/0
[R4-GigabitEthernet0/0/0]ipv6 enable
[R4-GigabitEthernet0/0/0]ipv6 address 2006::1 64
[R4-GigabitEthernet0/0/0]quit
[R4]

[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ipv6 enable
[R4-GigabitEthernet0/0/1]ipv6 address 2024::4 64
[R4-GigabitEthernet0/0/1]quit
[R4]

[R4]interface GigabitEthernet 0/0/2
[R4-GigabitEthernet0/0/2]ipv6 enable
[R4-GigabitEthernet0/0/2]ipv6 address 2003::1 64
[R4-GigabitEthernet0/0/2]quit
[R4]
```

Enable IPv6 on R5 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R5
[R5]ipv6
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1]ipv6 enable
[R5-GigabitEthernet0/0/1]ipv6 address 2056::5 64
[R5-GigabitEthernet0/0/1]quit
[R5]

[R5]interface GigabitEthernet 0/0/2
[R5-GigabitEthernet0/0/2]ipv6 enable
[R5-GigabitEthernet0/0/2]ipv6 address 2015::5 64
[R5-GigabitEthernet0/0/2]quit
[R5]
```

Enable IPv6 on R6 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sy
[Huawei]sysname R6
[R6]ipv6
[R6]interface GigabitEthernet 0/0/1
[R6-GigabitEthernet0/0/1]ipv6 enable
[R6-GigabitEthernet0/0/1]ipv6 address 2056::6 64
[R6-GigabitEthernet0/0/1]quit
[R6]

[R6]interface GigabitEthernet 0/0/2
[R6-GigabitEthernet0/0/2]ipv6 enable
[R6-GigabitEthernet0/0/2]ipv6 address 2067::6 64
[R6-GigabitEthernet0/0/2]quit
[R6]
```

Enable IPv6 on R7 and configure IPv6 addresses.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sy
[Huawei]sysname R7
[R7]ipv6
[R7]interface GigabitEthernet 0/0/0
[R7-GigabitEthernet0/0/0]ipv6 enable
[R7-GigabitEthernet0/0/0]ipv6 address 2004::1 64
[R7-GigabitEthernet0/0/0]quit
[R7]

[R7]interface GigabitEthernet 0/0/1
[R7-GigabitEthernet0/0/1]ipv6 enable
[R7-GigabitEthernet0/0/1]ipv6 address 2005::1 64
[R7-GigabitEthernet0/0/1]quit
[R7]

[R7]interface GigabitEthernet 0/0/2
```

```
[R7-GigabitEthernet0/0/2]ipv6 enable
[R7-GigabitEthernet0/0/2]ipv6 address 2067::7 64
[R7-GigabitEthernet0/0/2]quit
[R7]
```

Step 2 Configure OSPFv3.

Configure OSPFv3 on R1.

```
[R1]ospfv3 1
[R1-ospfv3-1]router-id 1.1.1.1
[R1-ospfv3-1]quit

[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ospfv3 1 area 0
[R1-GigabitEthernet0/0/0]quit

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ospfv3 1 area 2
[R1-GigabitEthernet0/0/1]quit
[R1]

[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ospfv3 1 area 1
[R1-GigabitEthernet0/0/2]quit
[R1]
```

Configure OSPFv3 on R2.

```
[R2]ospfv3 1
[R2-ospfv3-1]router-id 2.2.2.2
[R2-ospfv3-1]quit
[R2]

[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ospfv3 1 area 0
[R2-GigabitEthernet0/0/0]quit
[R2]
```

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ospfv3 1 area 3
[R2-GigabitEthernet0/0/1]quit
[R2]
```

Configure OSPFv3 on R3.

```
[R3]ospfv3 1
[R3-ospfv3-1]router-id 3.3.3.3
[R3-ospfv3-1]quit
[R3]

[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ospfv3 1 area 2
[R3-GigabitEthernet0/0/1]quit
[R3]
```

Configure OSPFv3 on R4.

```
[R4]ospfv3 1
[R4-ospfv3-1]router-id 4.4.4.4
[R4-ospfv3-1]quit
[R4]

[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ospfv3 1 area 3
[R4-GigabitEthernet0/0/1]quit
[R4]
```

Configure OSPFv3 on R5.

```
[R5]ospfv3 1
[R5-ospfv3-1]router-id 5.5.5.5
[R5-ospfv3-1]quit
[R5]

[R5]interface GigabitEthernet 0/0/2
```

```
[R5-GigabitEthernet0/0/2]ospfv3 1 area 1
[R5-GigabitEthernet0/0/2]quit
[R5]
```

Check the OSPFv3 neighbor states on R3. The command output shows that three OSPFv3 neighbor relationships have been established.

```
<R1>display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
2.2.2.2         1     Full/DR          00:00:38  GE0/0/0
0
OSPFv3 Area (0.0.0.1)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
5.5.5.5         1     Full/DR          00:00:31  GE0/0/2
0
OSPFv3 Area (0.0.0.2)
Neighbor ID     Pri   State            Dead Time Interface
Instance ID
3.3.3.3         1     Full/DR          00:00:34  GE0/0/1
0

<R1>
```

Import direct routes into OSPFv3 processes on R3 and R4 to access to the network segments of Marketing Dept. 1, R&D Dept. 1, and After-Sales Service Dept..

```
[R3]ospfv3 1
[R3-ospfv3-1]import-route direct
[R3-ospfv3-1]quit
[R3]

[R4]ospfv3 1
[R4-ospfv3-1]import-route direct
[R4-ospfv3-1]quit
[R4]
```

On R5, test the network connectivity between R5 and Marketing Dept. 1, R&D Dept. 1, and After-Sales Service Dept.. The ping operations succeed.

```
<R5>ping ipv6 2001::2
  PING 2001::2 : 56  data bytes, press CTRL_C to break
    Reply from 2001::2
    bytes=56 Sequence=1 hop limit=253  time = 70 ms
    Reply from 2001::2
    bytes=56 Sequence=2 hop limit=253  time = 40 ms
    Reply from 2001::2
    bytes=56 Sequence=3 hop limit=253  time = 30 ms
    Reply from 2001::2
    bytes=56 Sequence=4 hop limit=253  time = 30 ms
    Reply from 2001::2
    bytes=56 Sequence=5 hop limit=253  time = 40 ms

  --- 2001::2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 30/42/70 ms

<R5>ping ipv
<R5>ping ipv6 2006::2
  PING 2006::2 : 56  data bytes, press CTRL_C to break
    Request time out
    Reply from 2006::2
    bytes=56 Sequence=2 hop limit=252  time = 50 ms
    Reply from 2006::2
    bytes=56 Sequence=3 hop limit=252  time = 40 ms
    Reply from 2006::2
    bytes=56 Sequence=4 hop limit=252  time = 40 ms
    Reply from 2006::2
    bytes=56 Sequence=5 hop limit=252  time = 30 ms

  --- 2006::2 ping statistics ---
```

```
  5 packet(s) transmitted
  4 packet(s) received
  20.00% packet loss
  round-trip min/avg/max = 30/40/50 ms

<R5>ping ipv6 2003::2
  PING 2003::2 : 56  data bytes, press CTRL_C to break
    Reply from 2003::2
    bytes=56 Sequence=1 hop limit=252  time = 30 ms
    Reply from 2003::2
    bytes=56 Sequence=2 hop limit=252  time = 40 ms
    Reply from 2003::2
    bytes=56 Sequence=3 hop limit=252  time = 30 ms
    Reply from 2003::2
    bytes=56 Sequence=4 hop limit=252  time = 40 ms
    Reply from 2003::2
    bytes=56 Sequence=5 hop limit=252  time = 30 ms

  --- 2003::2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 30/34/40 ms

<R5>
```

Step 3 Configure IS-ISv6.

Configure IS-ISv6 on R5.

```
[R5]isis 1
[R5-isis-1]ipv6 enable
[R5-isis-1]is-level level-1-2
[R5-isis-1]network-entity 10.0000.0000.0005.00
[R5-isis-1]quit
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1] isis ipv6 enable
[R5-GigabitEthernet0/0/1]quit
```

```
[R5]
```

Configure IS-ISv6 on R6.

```
[R6]isis 1
[R6-isis-1]ipv6 enable
[R6-isis-1]is-level level-1-2
[R6-isis-1]network-entity 10.0000.0000.0006.00
[R6-isis-1]quit
[R6]interface GigabitEthernet 0/0/1
[R6-GigabitEthernet0/0/1] isis ipv6 enable
[R6-GigabitEthernet0/0/1]quit
[R6]interface GigabitEthernet 0/0/2
[R6-GigabitEthernet0/0/2] isis ipv6 enable
[R6-GigabitEthernet0/0/2]quit
[R6]
```

Configure IS-ISv6 on R7.

```
[R7]isis 1
[R7-isis-1]ipv6 enable
[R7-isis-1]is-level level-1
[R7-isis-1]network-entity 10.0000.0000.0007.00
[R7-isis-1]quit
[R7]interface GigabitEthernet 0/0/2
[R7-GigabitEthernet0/0/2] isis ipv6 enable
[R7-GigabitEthernet0/0/2]quit
[R7]
```

Check the IS-ISv6 neighbors states on R5.

```
[R6]display isis peer

                         Peer information for ISIS(1)

  System Id     Interface          Circuit Id         State HoldTime Type
PRI
-------------------------------------------------------------------------------
```

```
0000.0000.0005   GE0/0/1                0000.0000.0005.01 Up    9s
L1(L1L2) 64
0000.0000.0005   GE0/0/1                0000.0000.0005.01 Up    8s
L2(L1L2) 64
0000.0000.0007   GE0/0/2                0000.0000.0006.02 Up    23s       L1
64

Total Peer(s): 3
[R6]
```

Import direct routes on R7 and deliver default routes on R5 to access to the network segments of R&D Dept. 2 and Marketing Dept. 2.

```
[R7]isis 1
[R7-isis-1]ipv6 import-route direct level-1
[R7-isis-1]quit
[R7]
```

Test the network connectivity between R5 and Marketing Dept. 2 and R&D Dept. 2.

```
[R5]ping ipv6 2004::2
  PING 2004::2 : 56  data bytes, press CTRL_C to break
    Reply from 2004::2
    bytes=56 Sequence=1 hop limit=253   time = 60 ms
    Reply from 2004::2
    bytes=56 Sequence=2 hop limit=253   time = 50 ms
    Reply from 2004::2
    bytes=56 Sequence=3 hop limit=253   time = 30 ms
    Reply from 2004::2
    bytes=56 Sequence=4 hop limit=253   time = 30 ms
    Reply from 2004::2
    bytes=56 Sequence=5 hop limit=253   time = 50 ms

  --- 2004::2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 30/44/60 ms
```

```
[R5]ping ipv6 2005::2
  PING 2005::2 : 56  data bytes, press CTRL_C to break
    Reply from 2005::2
    bytes=56 Sequence=1 hop limit=253   time = 50 ms
    Reply from 2005::2
    bytes=56 Sequence=2 hop limit=253   time = 30 ms
    Reply from 2005::2
    bytes=56 Sequence=3 hop limit=253   time = 60 ms
    Reply from 2005::2
    bytes=56 Sequence=4 hop limit=253   time = 40 ms
    Reply from 2005::2
    bytes=56 Sequence=5 hop limit=253   time = 340 ms

  --- 2005::2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 30/104/340 ms

[R5]
```

Step 4 Configure route redistribution.

On R5, import IS-ISv6 routes into OSPFv3.

```
[R5]ospfv3 1
[R5-ospfv3-1]import-route isis 1
[R5-ospfv3-1]quit
```

On R5, import OSPFv3 routes into IS-ISv6.

```
[R5]isis 1
[R5-isis-1]ipv6 import-route ospfv3 1
[R5-isis-1]quit
[R5]
```

Enable R6 to advertise default IPv6 routes so that R7 can access the external network.

```
[R6]isis 1
[R6-isis-1]ipv6 default-route-advertise level-1
[R6-isis-1]quit
[R6]
```

Test network connectivity between the HQ and branches. In this example, connectivity is implemented on the network. Test network connectivity between R&D Dept. 2 and R&D Dept. 1 and Marketing Dept. 1.

```
PC>ping 2001::2

Ping 2001::2: 32 data bytes, Press Ctrl_C to break
From 2001::2: bytes=32 seq=1 hop limit=250 time=47 ms
From 2001::2: bytes=32 seq=2 hop limit=250 time=63 ms
From 2001::2: bytes=32 seq=3 hop limit=250 time=47 ms
From 2001::2: bytes=32 seq=4 hop limit=250 time=46 ms
From 2001::2: bytes=32 seq=5 hop limit=250 time=63 ms

--- 2001::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 46/53/63 ms

PC>ping 2006::2

Ping 2006::2: 32 data bytes, Press Ctrl_C to break
From 2006::2: bytes=32 seq=1 hop limit=249 time=46 ms
From 2006::2: bytes=32 seq=2 hop limit=249 time=63 ms
From 2006::2: bytes=32 seq=3 hop limit=249 time=47 ms
From 2006::2: bytes=32 seq=4 hop limit=249 time=62 ms
From 2006::2: bytes=32 seq=5 hop limit=249 time=47 ms

--- 2006::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
```

```
  round-trip min/avg/max = 46/53/63 ms

PC>
```

Step 5 Configure route filtering.

Filter the imported routes on R5 to prevent R&D Dept. 2 from accessing the network segments of Marketing Dept., R&D Dept. 1 and After-Sales Service Dept.

```
[R5]acl ipv6 2000
[R5-acl6-basic-2000]rule deny source 2005:: 64
[R5-acl6-basic-2000]rule permit
[R5-acl6-basic-2000]quit
[R5]ospfv3 1
[R5-ospfv3-1] filter-policy 2000 export
[R5-ospfv3-1]quit
[R5]
```

Filter routes on R3 to prevent Marketing Dept. 1 from accessing the network segment of R&D Dept. 1.

```
[R3]acl ipv6 2000
[R3-acl6-basic-2000]rule deny source 2006::/64
[R3-acl6-basic-2000]rule permit
[R3-acl6-basic-2000]quit
[R3]

[R3]ospfv
[R3]ospfv3 1
[R3-ospfv3-1]filter-policy 2000 import
[R3-ospfv3-1]quit
[R3]
```

Filter routes on R4 to prevent R&D Dept. 1 and After-sales Service Dept. from accessing the network segment of Marketing Dept. 2.

```
[R4]acl ipv6 2000
[R4-acl6-basic-2000]rule deny source 2004:: 64
[R4-acl6-basic-2000]rule permit
[R4-acl6-basic-2000]quit
```

```
[R4]

[R4]ospfv3 1
[R4-ospfv3-1]filter-policy 2000 import
[R4-ospfv3-1]quit
[R4]
```

6.3 Verification

6.3.1 Verifying the Configuration

Access the network segment of the HQ on the PC of R&D Dept. 2. The access is denied.

```
R&D Dept. 2 PC>ping 2001::2

Ping 2001::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!

--- 2001::2 ping statistics ---
  5 packet(s) transmitted
  0 packet(s) received
  100.00% packet loss

R&D Dept. 2 PC >ping 2006::2

Ping 2006::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!
```

```
--- 2006::2 ping statistics ---
  5 packet(s) transmitted
  0 packet(s) received
  100.00% packet loss

R&D Dept. 2 PC >ping 2003::2

Ping 2003::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!

--- 2003::2 ping statistics ---
  5 packet(s) transmitted
  0 packet(s) received
  100.00% packet loss

PC>
```

Access the network segment of R&D Dept. 1 from the PC of Marketing Dept. 1. The access is denied. However, the PC can access the network segments of After-sales Dept. and other departments. The traffic is normal.

```
Marketing Dept. 1 PC>ping 2006::2

Ping 2006::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!

--- 2006::2 ping statistics ---
  5 packet(s) transmitted
```

```
  0 packet(s) received
  100.00% packet loss

Marketing Dept. 1 PC>

Marketing Dept. 1 PC>ping 2003::2

Ping 2003::2: 32 data bytes, Press Ctrl_C to break
From 2003::2: bytes=32 seq=1 hop limit=251 time=47 ms
From 2003::2: bytes=32 seq=2 hop limit=251 time=31 ms
From 2003::2: bytes=32 seq=3 hop limit=251 time=32 ms
From 2003::2: bytes=32 seq=4 hop limit=251 time=937 ms
From 2003::2: bytes=32 seq=5 hop limit=251 time=31 ms

--- 2003::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 31/215/937 ms

Marketing Dept. 1 PC>ping 2004::2

Ping 2004::2: 32 data bytes, Press Ctrl_C to break
From 2004::2: bytes=32 seq=1 hop limit=250 time=62 ms
From 2004::2: bytes=32 seq=2 hop limit=250 time=47 ms
From 2004::2: bytes=32 seq=3 hop limit=250 time=47 ms
From 2004::2: bytes=32 seq=4 hop limit=250 time=63 ms
From 2004::2: bytes=32 seq=5 hop limit=250 time=46 ms

--- 2004::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 46/53/63 ms

Marketing Dept. 1 PC>
```

R&D Dept. 1 and After-sales Service Dept. cannot access the network segment of Marketing Dept. 2.

```
R&D Dept. 1 PC>ping 2004::2

Ping 2004::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!

--- 2004::2 ping statistics ---
  5 packet(s) transmitted
  0 packet(s) received
  100.00% packet loss

PC>

PC>ping 2004::2

Ping 2004::2: 32 data bytes, Press Ctrl_C to break
Request timeout!
Request timeout!
Request timeout!
Request timeout!
Request timeout!

--- 2004::2 ping statistics ---
  5 packet(s) transmitted
  0 packet(s) received
  100.00% packet loss

PC>
```

6.4 Reference Configuration

6.4.1 R1's Configuration

```
#
 sysname R1
#
ipv6
#
ospfv3 1
 router-id 1.1.1.1
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2012::1/64
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2013::1/64
 ospfv3 1 area 0.0.0.2
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2015::1/64
 ospfv3 1 area 0.0.0.1
#
return
<R1>
```

6.4.2 R2's Configuration

```
#
 sysname R2
#
ipv6
#
```

```
ospfv3 1
 router-id 2.2.2.2
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2012::2/64
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2024::2/64
 ospfv3 1 area 0.0.0.3
#
interface GigabitEthernet0/0/2
#
return
<R2>
```

6.4.3 R3's Configuration

```
#
 sysname R3
#
ipv6
#
acl ipv6 2000
   rule deny source 2006::/64
   rule permit
#
ospfv3 1
 router-id 3.3.3.3
 filter-policy 2000 import
 import-route direct
#
firewall zone Local
 priority 15
#
```

```
interface GigabitEthernet0/0/0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2013::3/64
 ospfv3 1 area 0.0.0.2
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2001::1/64
#
return
<R3>
```

6.4.4 R4's Configuration

```
#
 sysname R4
#
acl ipv6 number 2000
 rule 5 deny source 2004::/64
 rule 10 permit
#
ipv6
#
ospfv3 1
 router-id 4.4.4.4
 filter-policy 2000 import
 import-route direct
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2006::1/64
#
interface GigabitEthernet0/0/1
 ipv6 enable
```

```
 ipv6 address 2024::4/64
 ospfv3 1 area 0.0.0.3
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2003::1/64
#
return
<R4>
```

6.4.5 R5's Configuration

```
#
 sysname R5
#
acl ipv6 number 2000
 rule 5 deny source 2005::/64
 rule 10 permit
#
ipv6
#
isis 1
 is-level level-2
 network-entity 10.0000.0000.0005.00
 #
 ipv6 enable topology standard
 ipv6 import-route ospfv3 1
 #
#
ospfv3 1
 router-id 5.5.5.5
 filter-policy 2000 export
 import-route isis 1
#
interface GigabitEthernet0/0/1
 ipv6 enable
```

```
 ipv6 address 2056::5/64
 isis ipv6 enable 1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2015::5/64
 ospfv3 1 area 0.0.0.1
#
return
[R5]
```

6.4.6 R6's Configuration

```
#
 sysname R6
#
ipv6
#
isis 1
 network-entity 10.0000.0000.0006.00
 #
 ipv6 enable topology standard
 ipv6 default-route-advertise always level-1
 #
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2004::1/64
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2056::6/64
 isis ipv6 enable 1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2067::6/64
 isis ipv6 enable 1
```

```
#
return
<R6>
```

6.4.7 R7's Configuration

```
#
 sysname R7
#
ipv6
#
isis 1
 is-level level-1
 network-entity 10.0000.0000.0007.00
 #
 ipv6 enable topology standard
 ipv6 import-route direct level-1
 #
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2004::1/64
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2005::1/64
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2067::7/64
 isis ipv6 enable 1
#
return
<R7>
```

7 Dual IS-IS Configuration

7.1 Introduction

7.1.1 About This Lab

Intermediate System-to-Intermediate System (IS-IS) is the mainstream Interior Gateway Protocol (IGP) deployed on global IP networks. With the wide application of IPv6 networks, IS-IS is becoming more and more popular thanks to its strong scalability brought by the type-length-value (TLV) structure it uses. In this lab, you will learn how to configure the area-based deployment of dual IS-IS, and on that basis, the related filtering policies and route leaking technologies.

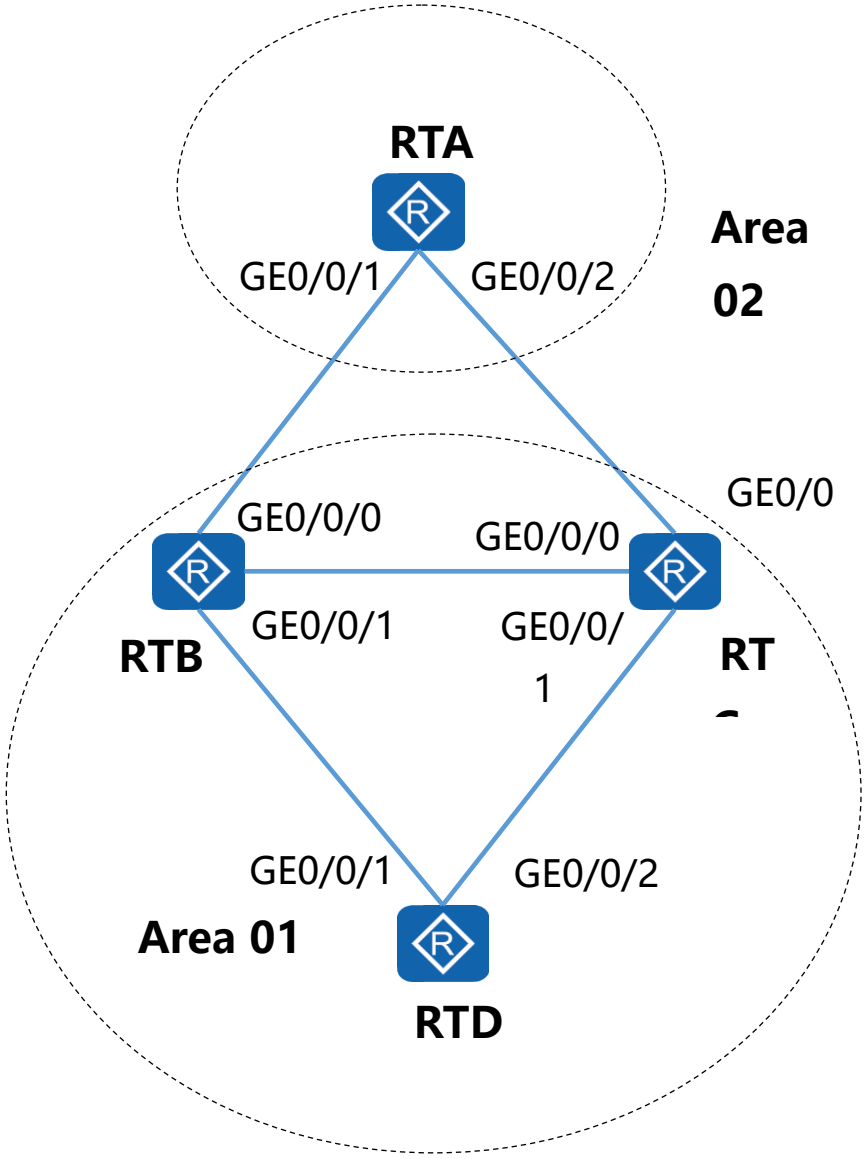
7.1.2 Objectives

Upon completion of this task, you will be able to:

- Conduct area-based deployment of dual IS-IS.
- Deploy IS-IS filtering policies.
- Grasp IS-IS route leaking technologies.
- Conduct routine O&M of IS-IS.

7.1.3 Networking Topology

Figure 7-1 Dual IS-IS Networking Topology



7.1.4 Networking Design

Dual IS-IS runs on RTA, RTB, RTC and RTD. RTA is in Area 02; RTB, RTC and RTD are in Area 01. RTA is a Level-2 router; RTB and RTC are Level-1-2 routers; RTD is a Level-1 router. The four routers need to communicate with each other through both IPv4 and IPv6 routes. IS-IS route leaking is configured on RTB and RTC. Two routes are available in the routing table of RTA: 100.1.1.1/32 and 200.1.1.1/32. A policy needs to be deployed to enable RTA to advertise only route 200.1.1.1/32.

Table 7-1 Planning of network element interconnection addresses

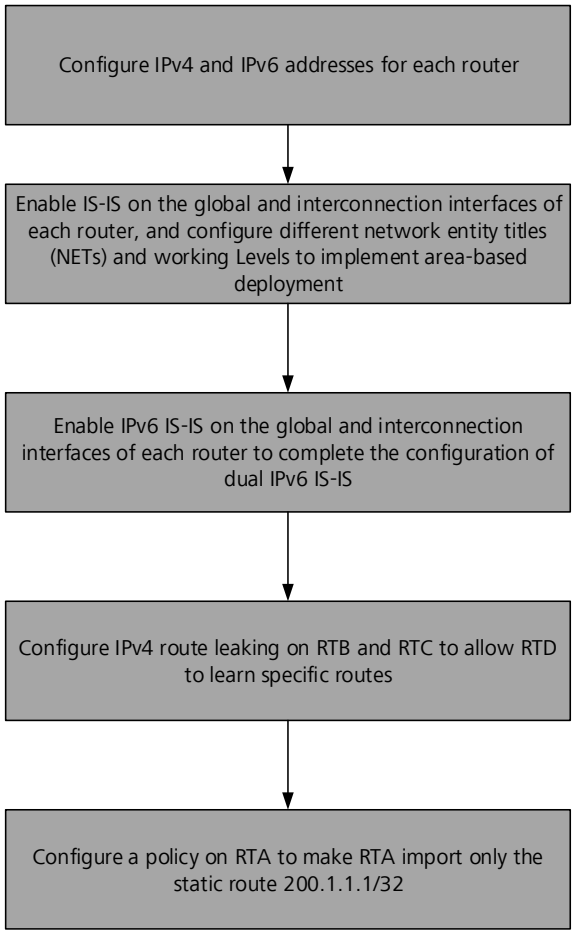
Network Element	Port	IPv4 Address	IPv6 Address
RTA	GE0/0/1	10.1.1.1/30	2000::1/64
	GE0/0/2	10.1.2.1/30	2001::1/64
RTB	GE0/0/0	10.1.1.2/30	2000::2/64
	GE0/0/1	10.2.1.1/30	2003::1/64
	GE0/0/2	10.1.3.1/30	2002::1/64
RTC	GE0/0/0	10.1.3.2/30	2002::2/64
	GE0/0/1	10.2.2.1/30	2004::1/64
	GE0/0/2	10.1.2.2/30	2001::1/64
RTD	GE0/0/1	10.2.1.2/30	2003::2/64
	GE0/0/2	10.2.2.2/30	2004::2/64

Table 7-2 Planning of network element management address

Network Element	Interface	IPv4 Address	IPv6 Address
RTA	Loopback0	1.1.1.1/32	1111::1/128
RTB	Loopback0	2.2.2.2/32	2222::2/128
RTC	Loopback0	3.3.3.3/32	3333::3/128
RTD	Loopback0	4.4.4.4/32	4444::4/128

7.2 Lab Configuration

7.2.1 Configuration Roadmap



7.2.2 Configuration Procedure

Step 1. **Configure IPv4 and IPv6 addresses on RTA, RTB, RTC and RTD.**

Configure IPv4 and IPv6 addresses on RTA.

```
<Huawei>system-view
[Huawei]sysname RTA
[RTA]ipv6
[RTA]interface GigabitEthernet 0/0/1
[RTA-GigabitEthernet0/0/1]ip address 10.1.1.1 255.255.255.252
[RTA-GigabitEthernet0/0/1]ipv6 enable
[RTA-GigabitEthernet0/0/1]ipv6 address 2000::1/64
```

```
[RTA-GigabitEthernet0/0/1]quit
[RTA]interface GigabitEthernet 0/0/2
[RTA-GigabitEthernet0/0/2]ip address 10.1.2.1 24
[RTA-GigabitEthernet0/0/2]ipv6 enable
[RTA-GigabitEthernet0/0/2]ipv6 address 2001::1/64
[RTA-GigabitEthernet0/0/2]quit
[RTA]interface LoopBack 0
[RTA-LoopBack0]ip address 1.1.1.1 32
[RTA-LoopBack0]ipv6 enable
[RTA-LoopBack0]ipv6 address 1111::1/128
[RTA-LoopBack0]quit
```

Configure IPv4 and IPv6 addresses on RTB.

```
<Huawei>system-view
[Huawei]sysname RTB
[RTB]ipv6
[RTB]interface GigabitEthernet 0/0/0
[RTB-GigabitEthernet0/0/0]ip address 10.1.1.2 30
[RTB-GigabitEthernet0/0/0]ipv6 enable
[RTB-GigabitEthernet0/0/0]ipv6 address 2000::2/64
[RTB-GigabitEthernet0/0/0]quit
[RTB]interface GigabitEthernet 0/0/1
[RTB-GigabitEthernet0/0/1]ip address 10.2.1.1 24
[RTB-GigabitEthernet0/0/1]ipv6 enable
[RTB-GigabitEthernet0/0/1]ipv6 address 2003::1/64
[RTB-GigabitEthernet0/0/1]quit
[RTB]interface LoopBack 0
[RTB-LoopBack0]ip address 2.2.2.2 32
[RTB-LoopBack0]ipv6 enable
[RTB-LoopBack0]ipv6 address 2222::2/128
```

Configure IPv4 and IPv6 addresses on RTC.

```
<Huawei>system-view
[Huawei]sysname RTC
[RTC]ipv6
[RTC]interface GigabitEthernet 0/0/0
[RTC-GigabitEthernet0/0/0]ip address 10.1.3.2 30
[RTC-GigabitEthernet0/0/0]ipv6 enable
[RTC-GigabitEthernet0/0/0]ipv6 address 2002::2/64
[RTC-GigabitEthernet0/0/0] quit
```

```
[RTC]interface GigabitEthernet 0/0/1
[RTC-GigabitEthernet0/0/1]ip address 10.1.3.2 30
[RTC-GigabitEthernet0/0/1]ipv6 enable
[RTC-GigabitEthernet0/0/1]ipv6 address 2002::2/64
[RTC-GigabitEthernet0/0/1]quit
[RTC]interface LoopBack 0
[RTC-LoopBack0]ip address 3.3.3.3 32
[RTC-LoopBack0]ipv6 enable
[RTC-LoopBack0]ipv6 address 3333::3/128
[RTC-LoopBack0]quit
```

Configure IPv4 and IPv6 addresses on RTD.

```
<Huawei>system-view
[Huawei]sysname RTD
[RTD]ipv6
[RTD]interface GigabitEthernet 0/0/1
[RTD-GigabitEthernet0/0/1]ip address 10.2.1.2 30
[RTD-GigabitEthernet0/0/1]ipv6 enable
[RTD-GigabitEthernet0/0/1]ipv6 address 2003::2/64
[RTD-GigabitEthernet0/0/1]quit
[RTD]interface GigabitEthernet 0/0/2
[RTD-GigabitEthernet0/0/2]ip address 10.2.2.2 30
[RTD-GigabitEthernet0/0/2]ipv6 enable
[RTD-GigabitEthernet0/0/2]ipv6 address 2004::2/64
[RTD-GigabitEthernet0/0/2]quit
```

Step 2. **Configure dual IS-IS on RTA, RTB, RTC and RTD to ensure that devices can communicate with each other through both IPv4 and IPv6 routes.**

Configure dual IS-IS on RTA.

```
[RTA]isis 1
[RTA-isis-1]network-entity 02.0000.0000.0001.00
[RTA-isis-1]is-level level-2
[RTA-isis-1]ipv6 enable topology ipv6
[RTA-isis-1]qut
[RTA]interface GigabitEthernet 0/0/1
[RTA-GigabitEthernet0/0/1]isis enable 1
[RTA-GigabitEthernet0/0/1]isis circuit-level level-2
[RTA-GigabitEthernet0/0/1]isis ipv6 enable 1
[RTA-GigabitEthernet0/0/1]quit
```

```
[RTA]interface GigabitEthernet 0/0/2
[RTA-GigabitEthernet0/0/2]isis enable 1
[RTA-GigabitEthernet0/0/2]isis circuit-level level-2
[RTA-GigabitEthernet0/0/2]isis ipv6 enable 1
[RTA-GigabitEthernet0/0/2]quit
[RTA]interface LoopBack 0
[RTA-LoopBack0]isis enable 1
[RTA-LoopBack0]isis circuit-level level-2
[RTA-LoopBack0]isis ipv6 enable 1
[RTA-LoopBack0]quit
```

Configure dual IS-IS on RTB.

```
[RTB]isis 1
[RTB-isis-1]network-entity 01.0000.0000.0002.00
[RTB-isis-1]ipv6 enable topology ipv6
[RTB-isis-1]quit
[RTB]interface GigabitEthernet 0/0/0
[RTB-GigabitEthernet0/0/0]isis enable 1
[RTB-GigabitEthernet0/0/0]isis circuit-level level-2
[RTB-GigabitEthernet0/0/0]isis ipv6 enable 1
[RTB-GigabitEthernet0/0/0]quit
[RTB]interface GigabitEthernet 0/0/1
[RTB-GigabitEthernet0/0/1]isis enable 1
[RTB-GigabitEthernet0/0/1]isis circuit-level level-1
[RTB-GigabitEthernet0/0/1]isis ipv6 enable 1
[RTB-GigabitEthernet0/0/1]quit
[RTB]interface GigabitEthernet 0/0/2
[RTB-GigabitEthernet0/0/2]isis enable 1
[RTB-GigabitEthernet0/0/2]isis ipv6 enable 1
[RTB-GigabitEthernet0/0/2]quit
[RTB]interface LoopBack 0
[RTB-LoopBack0]isis enable 1
[RTB-LoopBack0]isis circuit-level level-2
[RTB-LoopBack0]isis ipv6 enable 1
[RTB-LoopBack0]quit
```

Configure dual IS-IS on RTC.

```
[RTC]isis 1
[RTC-isis-1]network-entity 01.0000.0000.0003.00
[RTC-isis-1]ipv6 enable topology ipv6
```

```
[RTC-isis-1]quit
[RTC]interface GigabitEthernet 0/0/0
[RTC-GigabitEthernet0/0/0]isis enable 1
[RTC-GigabitEthernet0/0/0]isis ipv6 enable 1
[RTC-GigabitEthernet0/0/0]quit
[RTC]interface GigabitEthernet 0/0/1
[RTC-GigabitEthernet0/0/1]isis enable 1
[RTC-GigabitEthernet0/0/1]isis circuit-level level-1
[RTC-GigabitEthernet0/0/1]isis ipv6 enable 1
[RTC-GigabitEthernet0/0/1]quit
[RTC]interface GigabitEthernet 0/0/2
[RTC-GigabitEthernet0/0/2]isis enable 1
[RTC-GigabitEthernet0/0/2]isis circuit-level level-2
[RTC-GigabitEthernet0/0/2]isis ipv6 enable 1
[RTC-GigabitEthernet0/0/2]quit
[RTC]interface LoopBack 0
[RTC-LoopBack0]isis enable 1
[RTC-LoopBack0]isis circuit-level level-2
[RTC-LoopBack0]isis ipv6 enable 1
RTC-LoopBack0]quit
```

Configure dual IS-IS on RTD.

```
[RTD]isis 1
[RTD-isis-1]network-entity 01.0000.0000.0004.00
[RTD-isis-1]is-level level-1
[RTD-isis-1]ipv6 enable topology ipv6
[RTD-isis-1]quit
[RTD]interface GigabitEthernet 0/0/1
[RTD-GigabitEthernet0/0/1]isis enable 1
[RTD-GigabitEthernet0/0/1]isis circuit-level level-1
[RTD-GigabitEthernet0/0/1]isis ipv6 enable 1
[RTD-GigabitEthernet0/0/1]quit
[RTD]interface GigabitEthernet 0/0/2
[RTD-GigabitEthernet0/0/2]isis enable 1
[RTD-GigabitEthernet0/0/2]isis circuit-level level-1
[RTD-GigabitEthernet0/0/2]isis ipv6 enable 1
[RTD-GigabitEthernet0/0/2]quit
[RTD]interface LoopBack 0
[RTD-LoopBack0]isis enable 1
[RTD-LoopBack0]isis circuit-level level-1
[RTD-LoopBack0]isis ipv6 enable 1
```

```
[RTD-LoopBack0]quit
```

Step 3. **Configure route leaking on RTB and RTC.**

Configure IS-IS route leaking on RTB.

```
[RTB]isis 1
[RTB-isis-1]import-route isis level-2 into level-1
```

Configure IS-IS route leaking on RTC.

```
[RTC]isis 1
[RTC-isis-1]import-route isis level-2 into level-1
```

Step 4. **Configure a route filtering policy on RTA to ensure that only the static route 200.1.1.1 is imported.**

Configure two static routes on RTA.

```
[RTA]ip route-static 100.1.1.1 255.255.255.255 NULL0
[RTA]ip route-static 200.1.1.1 255.255.255.255 NULL0
```

Configure the routing policy on RTA.

```
[RTA]ip ip-prefix 200 index 10 permit 200.1.1.1 32
[RTA]route-policy 200 permit node 10
[RTA-route-policy]if-match ip-prefix 200
[RTA-route-policy]quit
```

Import a static route on RTA and invoke the routing policy.

```
[RTA]isis 1
[RTA-isis-1]import-route static route-policy 200
#
```

7.3 Verification

After the preceding configurations are complete and the network topology becomes stable, perform the following operations to verify the configuration.

Run the **display isis peer** command on RTA to check the neighbor status. The command output is as follows:

```
[RTA]dis isis peer
                    Peer information for ISIS(1)

  System Id     Interface          Circuit Id         State HoldTime Type     PRI
------------------------------------------------------------------------------
0000.0000.0002* GE0/0/1            0000.0000.0002.01 Up    8s       L2       64
0000.0000.0003* GE0/0/2            0000.0000.0001.02 Up    22s      L2       64
Total Peer(s): 2
```

Perform the same operations on RTB, RTC and RTD. All neighbor status is Up.

Run the **dis ip routing-table protocol isis** command on RTD. The command output is as follows:

```
<RTD>dis ip routing-table protocol isis
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : ISIS
         Destinations : 8        Routes : 12

ISIS routing table status : <Active>
         Destinations : 8        Routes : 12

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        0.0.0.0/0   ISIS-L1 15   10         D   10.2.2.1        GigabitEthernet0/0/2
                    ISIS-L1 15   10         D   10.2.1.1        GigabitEthernet0/0/1
        1.1.1.1/32  ISIS-L1 15   20         D   10.2.2.1        GigabitEthernet0/0/2
                    ISIS-L1 15   20         D   10.2.1.1        GigabitEthernet0/0/1
        2.2.2.2/32  ISIS-L1 15   10         D   10.2.1.1        GigabitEthernet0/0/1
        3.3.3.3/32  ISIS-L1 15   10         D   10.2.2.1        GigabitEthernet0/0/2
        10.1.1.0/30 ISIS-L1 15   20         D   10.2.1.1        GigabitEthernet0/0/1
        10.1.2.0/30 ISIS-L1 15   20         D   10.2.2.1        GigabitEthernet0/0/2
        10.1.3.0/30 ISIS-L1 15   20         D   10.2.2.1        GigabitEthernet0/0/2
                    ISIS-L1 15   20         D   10.2.1.1        GigabitEthernet0/0/1
      200.1.1.1/32 ISIS-L1 15    84         D   10.2.2.1        GigabitEthernet0/0/2
                   ISIS-L1 15    84         D   10.2.1.1        GigabitEthernet0/0/1

ISIS routing table status : <Inactive>
```

Destinations : 0 Routes : 0

The routing table of RTD shows that only the route 200.1.1.1 is learned.

Run the **dis ipv6 routing-table protocol isis** command on RTD. The command output is as follows:

<RTD>dis ipv6 routing-table protocol isis

Public Routing Table : ISIS

Summary Count : 4

ISIS Routing Table's Status : < Active >

Summary Count : 4

Destination : :: **PrefixLength : 0**

NextHop : FE80::2E0:FCFF:FE37:2098 **Preference : 15**

Cost : 10 **Protocol : ISIS-L1**

RelayNextHop : :: **TunnelID : 0x0**

Interface : GigabitEthernet0/0/2 **Flags : D**

Destination : :: PrefixLength : 0

NextHop : FE80::2E0:FCFF:FEF1:59A Preference : 15

Cost : 10 Protocol : ISIS-L1

RelayNextHop : :: TunnelID : 0x0

Interface : GigabitEthernet0/0/1 Flags : D

Destination : 2002:: PrefixLength : 64

NextHop : FE80::2E0:FCFF:FE37:2098 Preference : 15

Cost : 20 Protocol : ISIS-L1

RelayNextHop : :: TunnelID : 0x0

Interface : GigabitEthernet0/0/2 Flags : D

```
Destination    : 2002::                        PrefixLength : 64
NextHop        : FE80::2E0:FCFF:FEF1:59A       Preference   : 15
Cost           : 20                            Protocol     : ISIS-L1
RelayNextHop : ::                              TunnelID     : 0x0
Interface      : GigabitEthernet0/0/1          Flags        : D

ISIS Routing Table's Status : < Inactive >
Summary Count : 0
```

The routing table of RTD shows that only the default route ::/0 is learned.

Run the **display isis lsdb 0000.0000.0002.00-00 verbose** command on RTD. The command output is as follows:

```
<RTD>display isis lsdb 0000.0000.0002.00-00 verbose

                    Database information for ISIS(1)
                    --------------------------------

                      Level-1 Link State Database

LSPID                 Seq Num     Checksum    Holdtime       Length    ATT/P/OL
-------------------------------------------------------------------------------
0000.0000.0002.00-00  0x00000021  0x53d8      746            284       1/0/0
  SOURCE          0000.0000.0002.00
  NLPID           IPV4
  NLPID           IPV6
  AREA ADDR       01
  INTF ADDR       2.2.2.2
  INTF ADDR       10.1.1.2
  INTF ADDR       10.1.3.1
  INTF ADDR       10.2.1.1
  INTF ADDR V6 2222::2
  INTF ADDR V6 2000::2
  INTF ADDR V6 2002::1
  INTF ADDR V6 2003::1
  Topology        Standard, IPV6(ATT)
  NBR   ID        0000.0000.0002.03   COST: 10
  NBR   ID        0000.0000.0002.02   COST: 10
 +MT NBR ID       0000.0000.0002.03   COST: 10          MT: 2 (IPV6)
 +MT NBR ID       0000.0000.0002.02   COST: 10          MT: 2 (IPV6)
```

```
IP-Internal    2.2.2.2          255.255.255.255    COST: 0
IP-Internal    10.1.1.0         255.255.255.252    COST: 10
IP-Internal    10.1.3.0         255.255.255.252    COST: 10
IP-Internal*   1.1.1.1          255.255.255.255    COST: 10
IP-Internal    10.2.1.0         255.255.255.252    COST: 10
IP-External*   200.1.1.1        255.255.255.255    COST: 74
IPV6           2002::/64                           COST: 10          MT: 2
IPV6           2003::/64                           COST: 10          MT: 2

Total LSP(s): 1
     *(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
               ATT-Attached, P-Partition, OL-Overload
```

Only the route information of 200.1.1.1 is found in the LSP of RTD.

7.4 Reference Configuration

7.4.1 RTA's Configuration

```
#
 sysname RTA
#
ipv6
#
isis 1
 is-level level-2
 network-entity 02.0000.0000.0001.00
 import-route static route-policy 200
 #
 ipv6 enable topology ipv6
 #
#
interface GigabitEthernet0/0/0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.1.1.1 255.255.255.252
 ipv6 address 2000::1/64
 isis enable 1
 isis ipv6 enable 1
```

```
 isis circuit-level level-2
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ip address 10.1.2.1 255.255.255.252
 ipv6 address 2001::1/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
interface NULL0
#
interface LoopBack0
 ipv6 enable
 ip address 1.1.1.1 255.255.255.255
 ipv6 address 1111::1/128
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
route-policy 200 permit node 10
 if-match ip-prefix 200
#
ip ip-prefix 200 index 10 permit 200.1.1.1 32
#
ip route-static 100.1.1.1 255.255.255.255 NULL0
ip route-static 200.1.1.1 255.255.255.255 NULL0
#
return
```

7.4.2 RTB's Configuration

```
#
 sysname RTB
#
ipv6
#
isis 1
 network-entity 01.0000.0000.0002.00
 import-route isis level-2 into level-1
 #
 ipv6 enable topology ipv6
```

```
 #
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.1.1.2 255.255.255.252
 ipv6 address 2000::2/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.2.1.1 255.255.255.252
 ipv6 address 2003::1/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ip address 10.1.3.1 255.255.255.252
 ipv6 address 2002::1/64
 isis enable 1
 isis ipv6 enable 1
#
interface NULL0
#
interface LoopBack0
 ipv6 enable
 ip address 2.2.2.2 255.255.255.255
 ipv6 address 2222::2/128
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
return
```

7.4.3 RTC's Configuration

```
#
 sysname RTC
#
```

```
isis 1
 network-entity 01.0000.0000.0003.00
 import-route isis level-2 into level-1
 #
 ipv6 enable topology ipv6
 #
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.1.3.2 255.255.255.252
 ipv6 address 2002::2/64
 isis enable 1
 isis ipv6 enable 1
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.2.2.1 255.255.255.252
 ipv6 address 2004::1/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ip address 10.1.2.2 255.255.255.252
 ipv6 address 2001::2/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
interface NULL0
#
interface LoopBack0
 ipv6 enable
 ip address 3.3.3.3 255.255.255.255
 ipv6 address 3333::3/128
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-2
#
return
```

7.4.4 RTD's Configuration

```
#
 sysname RTD
#
isis 1
 is-level level-1
 network-entity 01.0000.0000.0004.00
 #
 ipv6 enable topology ipv6
 #
#
interface GigabitEthernet0/0/0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.2.1.2 255.255.255.252
 ipv6 address 2003::2/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-1
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ip address 10.2.2.2 255.255.255.252
 ipv6 address 2004::2/64
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-1
#
interface NULL0
#
interface LoopBack0
 ipv6 enable
 ip address 4.4.4.4 255.255.255.255
 ipv6 address 4444::4/128
 isis enable 1
 isis ipv6 enable 1
 isis circuit-level level-1
#
return
```

7.5 Quiz

According to the preceding configuration, how do we configure IPv6 route leaking?

8 BGP Basic Configuration

8.1 Introduction

8.1.1 About This Lab

In this lab, you will learn how to configure BGP peer relationships and BGP attributes, understand how to use AS_Path filters, master the basic configuration of BGP.

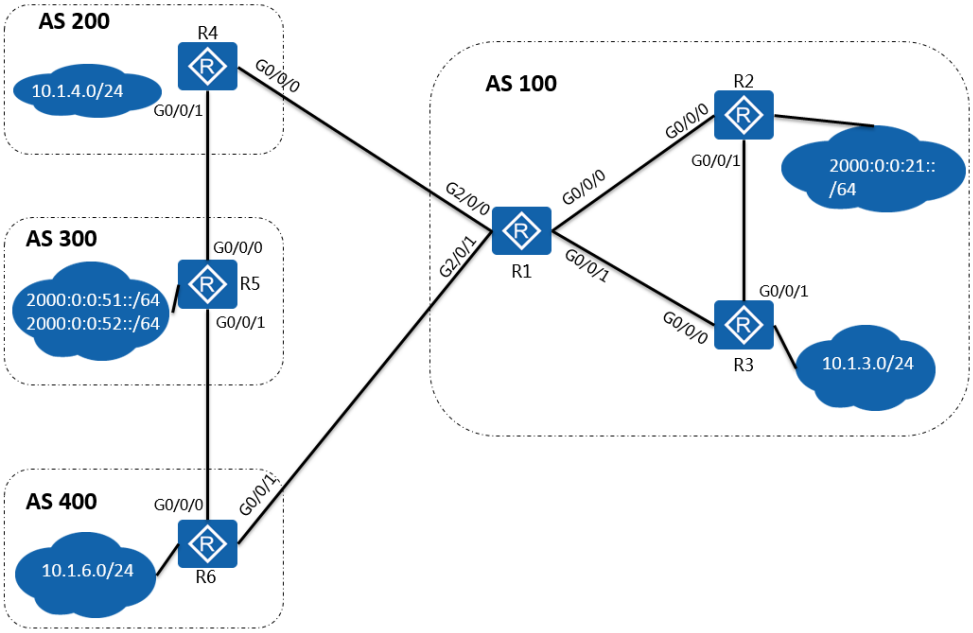
8.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand how to configure IBGP and EBGP peers (IPv4 and IPv6).
- Master the methods of changing the update source address, changing the next hop, and configuring EBGP multi-hop.
- Grasp the method of configuring BGP authentication.
- Understand the usage of AS_Path_filters.
- Understand the usage of IP-Prefix and Route-Policy.
- Understand the usage of common BGP attributes.

8.1.3 Networking Topology

Figure 8-1 BGP networking topology



8.1.4 Networking Design

The link R1-R3-R5 is preferred for the communication between PC1 and PC2.

Table 8-1 Device port parameter design

Device	Interface	Interface Address
R1	GE0/0/0	IPv4:10.0.12.1/24 IPv6:2000::1201/120
	GE0/0/1	IPv4:10.0.13.1/24 IPv6:2000::1301/120
	GE2/0/0	IPv4:10.0.14.1/24 IPv6:2000::1401/120
	GE2/0/1	IPv4:10.0.16.1/24 IPv6:2000::1601/120
	LoopBack 0	IPv4:10.0.1.1/32

Device	Interface	Interface Address
		IPv6:2000::1/128
R2	GE0/0/0	IPv4:10.0.12.2/24 IPv6:2000::1202/120
	GE0/0/1	IPv4:10.0.23.2/24 IPv6:2000::2302/120
	LoopBack 0	IPv4:10.0.2.2/32 IPv6:2000::2/128
	Vlanif1	IPv6:2000:0:0:21::1/64
R3	GE0/0/0	IPv4:10.0.13.3/24 IPv6:2000::1303/120
	GE0/0/1	IPv4:10.0.23.3/24 IPv6:2000::2303/120
	LoopBack 0	IPv4:10.0.3.3/32 IPv6:2000::3/128
	Vlanif1	IPv4:10.1.3.1/24
R4	GE0/0/0	IPv4:10.0.14.4/24 IPv6:2000::1404/120
	GE0/0/1	IPv4:10.0.45.4/24 IPv6:2000::4504/120
	LoopBack 0	IPv4:10.0.4.4/32 IPv6:2000::4/128
	Vlanif1	IPv4:10.1.4.1/24
R5	GE0/0/0	IPv4:10.0.45.5/24 IPv6:2000::4505/120
	GE0/0/1	IPv4:10.0.56.5/24 IPv6:2000::5605/120

Device	Interface	Interface Address
	LoopBack 0	IPv4:10.0.5.5/32 IPv6:2000::5/128
	Vlanif1	IPv6:2000:0:0:51::1/64
	Vlanif2	IPv6:2000:0:0:52::1/64
R6	GE0/0/0	IPv4:10.0.56.6/24 IPv6:2000::5606/120
	GE0/0/1	IPv4:10.0.16.6/24 IPv6:2000::1606/120
	LoopBack 0	IPv4:10.0.6.6/32 IPv6:2000::6/128
	Vlanif1	IPv4:10.1.6.1/24

8.2 Lab Procedure

8.2.1 Configuration Roadmap

1. Assign IPv4 and IPv6 addresses to interfaces on each device.
2. Use OSPFv2 and OSPFv3 as IGP in AS 100.
3. Establish IBGP or EBGP peer relationships between directly connected routers. Use loopback interface IP addresses as update source addresses to establish IBGP peer relationships between routers in AS 100. R1 and R4 use loopback interfaces to establish EBGP peer relationships using static routes. (The configuration of IPv6 BGP peer relationships is the same as above.)
4. Advertise the network segments of all the loopback 0 interfaces and those shown in the topology to BGP so that loopback interfaces on all routers can directly communicate with each other.
5. Filter routes. AS 100 does not advertise the routes learned from AS 200 to AS 400, and vice versa.

6. Route selection: Routers in AS 100 preferentially select paths passing through AS 200 to access 2000:0:0:51::1/64, and select paths passing through AS 400 to access 2000:0:0:51::2/64.

8.2.2 Configuration Procedure and Verification

Step 1 Configure IP addresses for device interfaces.

Configure IPv4 and IPv6 addresses for each device based on the plan. The configuration of GE0/0/0 on R1 is used as an example.

Configure an IP address on R1.

```
<Huawei>sys
[Huawei]sysname R1
[R1]ipv6
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.12.1 24
[R1-GigabitEthernet0/0/0]ipv6 enable
[R1-GigabitEthernet0/0/0]ipv6 address 2000::1201 120
```

Step 2 Configure an IGP.

Configure OSPF. The configuration of R1 is used as an example.

Configure OSPF on R1.

```
[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 10.1.13.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 10.0.1.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]quit
[R1-ospf-1]quit
[R1]ospfv3 1
[R1-ospfv3-1]quit
[R1]inter GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ospfv3 1 area 0
```

Verify the configuration.

Display the IPv4 neighbor relationship.

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

```
 OSPF Process 1 with Router ID 10.0.12.1
  Neighbors

 Area 0.0.0.0 interface 10.0.12.1(GigabitEthernet0/0/0)'s neighbors
 Router ID: 10.0.12.2          Address: 10.0.12.2
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.12.2  BDR: 10.0.12.1  MTU: 0
   Dead timer due in 38  sec
   Retrans timer interval: 5
   Neighbor is up for 00:04:00
   Authentication Sequence: [ 0 ]

   Neighbors

 Area 0.0.0.0 interface 10.0.13.1(GigabitEthernet0/0/1)'s neighbors
 Router ID: 10.0.13.3          Address: 10.0.13.3
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.13.3  BDR: 10.0.13.1  MTU: 0
   Dead timer due in 40  sec
   Retrans timer interval: 5
   Neighbor is up for 00:04:05
Authentication Sequence: [ 0 ]
```

Display information about the IPv4 OSPF routing table.

```
[R1]display ip routing-table protocol ospf
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : OSPF
         Destinations : 3        Routes : 4

OSPF routing table status : <Active>
         Destinations : 3        Routes : 4

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.2.2/32  OSPF    10   1           D   10.0.12.2       GigabitEthernet0/0/0
        10.0.3.3/32  OSPF    10   1           D   10.0.13.3       GigabitEthernet0/0/1
       10.0.23.0/24  OSPF    10   2           D   10.0.13.3       GigabitEthernet0/0/1
                     OSPF    10   2           D   10.0.12.2       GigabitEthernet0/0/0

OSPF routing table status : <Inactive>
```

```
Destinations : 0        Routes : 0
```

Display information about IPv6 neighbor relationships.

```
[R1]display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID     Pri   State            Dead Time Interface          Instance ID
10.0.2.2          1   Full/DR          00:00:38  GE0/0/0                  0
10.0.3.3          1   Full/DR          00:00:37  GE0/0/1                  0
```

Display information about the IPv6 OSPFv3 routing table (only the key part is displayed in this example).

```
[R1]display ipv6 routing-table protocol ospfv3
Public Routing Table : OSPFv3
Summary Count : 7

OSPFv3 Routing Table's Status : < Active >
Summary Count : 4

 Destination  : 2000::2                        PrefixLength : 128
 NextHop      : FE80::2E0:FCFF:FECE:2A8B       Preference   : 10
 Cost         : 1                              Protocol     : OSPFv3
 RelayNextHop : ::                             TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/0           Flags        : D

 Destination  : 2000::3                        PrefixLength : 128
 NextHop      : FE80::2E0:FCFF:FEBC:4266       Preference   : 10
 Cost         : 1                              Protocol     : OSPFv3
 RelayNextHop : ::                             TunnelID     : 0x0
 Interface    : GigabitEthernet0/0/1           Flags        : D
```

Step 3 Configure BGP peer relationships.

Configure BGP peer relationships. Use loopback 0 to establish IBGP peer relationships between routers in AS 100. Establish EBGP peer relationships between R1 and R4 using loopback 0. For other routers, use the interfaces directly connecting them to establish EBGP peer relationships. The following uses R1 and R4 as an example.

Configure BGP on R1.

```
[R1]ip route-static 10.0.4.4 255.255.255.255 10.0.14.4
```

```
[R1]ipv6 route-static 2000::4 128 2000::1404
[R1]bgp 100
[R1-bgp]router-id 10.0.1.1
[R1-bgp]peer 10.0.4.4 as-number 200
[R1-bgp]peer 10.0.4.4 ebgp-max-hop 2
[R1-bgp]peer 10.0.4.4 connect-interface LoopBack0
[R1-bgp]peer 2000::4 as-number 200
[R1-bgp]peer 2000::4 ebgp-max-hop 2
[R1-bgp]peer 2000::4 connect-interface LoopBack0
[R1-bgp]ipv6-family unicast
[R1-bgp-af-ipv6]peer 2000::4 enable
```

Configure BGP routes on R4.

```
[R4]ip route-static 10.0.1.1 255.255.255.255 10.0.14.1
[R4]ipv6 route-static 2000::1 128 2000::1401
[R4]bgp 200
[R4-bgp]router-id 10.0.4.4
[R4-bgp]peer 10.0.1.1 as-number 100
[R4-bgp]peer 10.0.1.1 ebgp-max-hop 2
[R4-bgp]peer 10.0.1.1 connect-interface LoopBack0
[R4-bgp] peer 2000::1 as-number 100
[R4-bgp] peer 2000::1 ebgp-max-hop 2
[R4-bgp]peer 2000::1 connect-interface LoopBack0
[R4-bgp]ipv6-family unicast
[R4-bgp-af-ipv6]peer 2000::1 enable
```

Verify the configuration.

Display information about BGP peer relationships.

```
[R1]display bgp peer
 BGP local router ID : 10.0.1.1
 Local AS number : 100
 Total number of peers : 4
Peers in established state : 4

  Peer            V     AS  MsgRcvd  MsgSent  OutQ  Up/Down       State     Pre fRcv
  10.0.2.2        4    100       33       34     0 00:31:50        Established     0
  10.0.3.3        4    100       33       34     0 00:31:50        Established     0
  10.0.4.4        4    200       35       36     0 00:32:21        Established     1
  10.0.16.6       4    400       35       36     0 00:32:21        Established     1
```

```
[R1]display bgp ipv6 peer
 BGP local router ID : 10.0.1.1
 Local AS number : 100
 Total number of peers : 4       Peers in established state : 4

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State Pre  fRcv

  2000::2         4         100       34       35     0 00:32:21   Established   0
  2000::3         4         100       34       35     0 00:32:20   Established   0
  2000::4         4         200       35       37     0 00:32:40   Established   1
  2000::1606 4              400       35       35     0 00:32:52   Established   1
```

Step 4 Import loopback and some direct routes to BGP.

The configuration on R1 is used as an example.

Import routes to R1.

```
[R1]bgp 100
[R1-bgp]network 10.0.1.1 32
[R1-bgp]ipv6-family unicast
[R1-bgp-af-ipv6]network 2000::1 128
```

Verify the configuration.

Check the routing table of R1.

```
[R1]display bgp routing-table
BGP Local router ID is 10.0.1.1
 Status codes: * - valid, > - best, d - damped,
               h - history,   i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

 Total Number of Routes: 9
      Network            NextHop            MED        LocPrf     PrefVal Path/Ogn

*>    10.0.1.1/32        0.0.0.0            0                     0       i
 i    10.0.2.2/32        10.0.2.2           0          100        0       i
 i    10.0.3.3/32        10.0.3.3           0          100        0       i
*>    10.0.4.4/32        10.0.16.6                             0       400 300 200i
                         10.0.4.4           0                  0       200i
*>    10.0.5.5/32        10.0.4.4                              0       200 300i
*                        10.0.16.6                             0       400 300i
*>    10.0.6.6/32        10.0.16.6          0                  0       400i
```

```
 *                    10.0.4.4                              0          200 300 400i
[R1]display bgp ipv6 routing-table
 BGP Local router ID is 10.0.1.1
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

 Total Number of Routes: 13
 *>  Network  : 2000::1                        PrefixLen : 128
     NextHop  : ::                             LocPrf    :
     MED      : 0                              PrefVal   : 0
     Label    :
     Path/Ogn : i
    i Network  : 2000::2                       PrefixLen : 128
     NextHop  : 2000::2                        LocPrf    : 100
     MED      : 0                              PrefVal   : 0
     Label    :
     Path/Ogn : i
    i Network  : 2000::3                       PrefixLen : 128
     NextHop  : 2000::3                        LocPrf    : 100
     MED      : 0                              PrefVal   : 0
     Label    :
     Path/Ogn : i
 *>  Network  : 2000::4                        PrefixLen : 128
     NextHop  : 2000::1606                     LocPrf    :
     MED      :                                PrefVal   : 0
     Label    :
     Path/Ogn : 400 300 200  i

     NextHop  : 2000::4                        LocPrf    :
     MED      : 0                              PrefVal   : 0
     Label    :
     Path/Ogn : 200  i
 *>  Network  : 2000::5                        PrefixLen : 128
     NextHop  : 2000::4                        LocPrf    :
     MED      :                                PrefVal   : 0
     Label    :
     Path/Ogn : 200 300  i
 *
     NextHop  : 2000::1606                     LocPrf    :
     MED      :                                PrefVal   : 0
     Label    :
     Path/Ogn : 400 300  i
```

```
*>   Network  : 2000::6                          PrefixLen : 128
     NextHop  : 2000::1606                       LocPrf    :
     MED      : 0                           PrefVal   : 0
     Label    :
     Path/Ogn : 400   i
*>i Network  : 2000:0:0:21::          PrefixLen : 64
     NextHop  : 2000::2                          LocPrf    : 100
     MED      : 0                           PrefVal   : 0
     Label    :
     Path/Ogn : i
*>   Network  : 2000:0:0:51::              PrefixLen : 64
     NextHop  : 2000::4                          LocPrf    :
     MED      :                             PrefVal   : 0
     Label    :
     Path/Ogn : 200 300   i
*
     NextHop  : 2000::1606                 LocPrf    :
     MED      :                             PrefVal   : 0
     Label    :
     Path/Ogn : 400 300   i
*>   Network  : 2000:0:0:52::              PrefixLen : 64
     NextHop  : 2000::4                          LocPrf    :
     MED      :                                  PrefVal   : 0
     Label    :
     Path/Ogn : 200 300   i
*
     NextHop  : 2000::1606                       LocPrf    :
     MED      :                             PrefVal   : 0
     Label    :
     Path/Ogn : 400 300   i
```

Problem 1: Check the routing table of R2. It is found that the BGP routes outside the AS are invalid. How to solve this problem?

```
[R2]display bgp routing-table
 BGP Local router ID is 10.0.2.2
 Status codes: * - valid, > - best, d - damped,
               h - history,   i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

 Total Number of Routes: 9
```

```
      Network            NextHop          MED        LocPrf     PrefVal Path/Ogn

 i    10.0.1.1/32        10.0.1.1         0          100        0       i
*>    10.0.2.2/32        0.0.0.0          0                     0       i
 i    10.0.3.3/32        10.0.3.3         0          100        0       i
 i    10.0.4.4/32        10.0.16.6                   100        0       400 300 200i
 i    10.0.5.5/32        10.0.4.4                    100        0       200 300i
 i    10.0.6.6/32        10.0.16.6        0          100        0       400i
*>i   10.1.3.0/24        10.0.3.3         0          100        0       i
 i    10.1.4.0/24        10.0.4.4         0          100        0       200i
 i    10.1.6.0/24        10.0.16.6        0          100        0       400i
```

Problem 2: Check the routing tables of R4, R5 and R6. It is found that the IP addresses (including IPv6 addresses) of loopback 0 interfaces on R2 and R3 are not learned by R4, R5 and R6. Why? How can I solve this problem?

Step 5 Filter routes.

Assume that AS 100 is the network of company A, and AS 200 and AS 400 are networks of different carriers. Company A requires that only the traffic destined to its network passes through AS 100. In this case, BGP routes need to be filtered.

Configure a route filtering policy on R1. The following example rejects the IPv4 routes that are learnt from AS 400 and then advertised from AS 400 to AS 200.

```
[R1]ip as-path-filter from_as_400 deny  _400_
[R1]ip as-path-filter from_as_400 permit .*
[R1]bgp 100
[R1-bgp]peer 10.0.4.4 as-path-filter from_as_400 export
```

Verify the configuration.

Before the configuration:

```
<R4>dis bgp routing-table
 BGP Local router ID is 10.0.4.4
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

 Total Number of Routes: 10
      Network            NextHop        MED        LocPrf     PrefVal Path/Ogn
```

```
*>    10.0.1.1/32        10.0.45.5                          0        300 400 100i
                         10.0.1.1   0                  0        100i
*>    10.0.4.4/32        0.0.0.0    0                  0        i
*>    10.0.5.5/32        10.0.45.5  0                  0        300i
*>    10.0.6.6/32        10.0.1.1                           0        100 400i
*                        10.0.45.5                          0        300 400i
*>    10.1.3.0/24        10.0.1.1                           0        100i
*>    10.1.4.0/24   0.0.0.0          0                  0        i
*>    10.1.6.0/24        10.0.1.1                           0        100 400i
*                        10.0.45.5                          0        300 400i
```

After the configuration:

```
<R4>display bgp routing-table
 BGP Local router ID is 10.0.4.4
 Status codes: * - valid, > - best, d - damped,
               h - history,   i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

 Total Number of Routes: 9
      Network            NextHop        MED        LocPrf     PrefVal Path/Ogn

*>    10.0.1.1/32   10.0.45.5                          0        300 400 100i
                         10.0.1.1        0                  0        100i
*>    10.0.4.4/32        0.0.0.0              0            0        i
*>    10.0.5.5/32        10.0.45.5            0            0        300i
*>    10.0.6.6/32        10.0.45.5                         0        300 400i
*>    10.1.3.0/24     10.0.1.1                             0        100i
*                        10.0.45.5                         0        300 400 100i
*>    10.1.4.0/24     0.0.0.0              0            0        i
*>    10.1.6.0/24        10.0.45.5                         0        300 400i
```

Step 6 Select routes.

Routers in AS 100 need to access 2000:0:0:51::/64 through AS 200 and access 2000:0:0:52::/64 through AS 400. The following example configures a route-policy that allows routers in AS 100 to access 2000:0:0:51::/64 through AS 200 on R1.

Configure a routing policy on R1.

```
[R1]ip ipv6-prefix R4_import permit 2000:0:0:51:: 64
[R1]route-policy R4_import permit node 10
[R1-route-policy]if-match ipv6 address prefix-list R4_import
```

```
[R1-route-policy]apply local-preference 150
[R1-route-policy]quit
[R1]route-policy R4_import permit node 20
[R1-route-policy]quit
[R1]bgp 100
[R1-bgp]ipv6-family unicast
[R1-bgp-af-ipv6] peer 2000::4 route-policy R4_import import
```

Verify the configuration.

```
[R1]display bgp ipv6 routing-table
 BGP Local router ID is 10.0.1.1
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete
*>  Network  : 2000:0:0:51::                    PrefixLen : 64
     NextHop  : 2000::4                        LocPrf    : 150
     MED      :                                PrefVal   : 0
     Label    :
     Path/Ogn : 200 300  i
*>  Network  : 2000:0:0:52::                    PrefixLen : 64
     NextHop  : 2000::1606                     LocPrf    : 200
     MED      :                                PrefVal   : 0
     Label    :
     Path/Ogn : 400 300  i
```

Problem 1: Can other attributes be used to fulfill this requirement?

Problem 2: Check whether 2000:0:0:52:: /64 in AS 300 can access 2000:0:0:21::/64 in AS 100. How to solve this problem?

```
<R2>tracert ipv6 -a 2000:0:0:21::1 2000:0:0:52::1
 traceroute to 2000:0:0:52::1  30 hops max,60 bytes packet

 1 2000::1201       40 ms  30 ms  30 ms
 2 2000::1606       40 ms  30 ms  40 ms
 3 2000:0:0:52::1   80 ms  60 ms  40 ms

<R5>tracert ipv6 -a  2000:0:0:52::1 2000:0:0:21::1
 traceroute to 2000:0:0:21::1  30 hops max,60 bytes packet

 1 2000::4504       30 ms  40 ms  30 ms
```

```
 2 2000::1601        20 ms    30 ms    40 ms
 3 2000:0:0:21::1    60 ms    40 ms    40 ms
```

8.3 Reference Configuration

8.3.1 R1's Configuration

```
#
 sysname R1
#
 board add 0/2 4GET
#
ipv6
#
ospfv3 1
 router-id 10.0.1.1
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.12.1 255.255.255.0
 ipv6 address 2000::1201/120
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.13.1 255.255.255.0
 ipv6 address 2000::1301/120
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet2/0/0
 ipv6 enable
 ip address 10.0.14.1 255.255.255.0
 ipv6 address 2000::1401/120
#
interface GigabitEthernet2/0/1
 ipv6 enable
 ip address 10.0.16.1 255.255.255.0
 ipv6 address 2000::1601/120
#
interface LoopBack0
```

```
 ipv6 enable
 ip address 10.0.1.1 255.255.255.255
 ipv6 address 2000::1/128
 ospfv3 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.1.1
 peer 10.0.2.2 as-number 100
 peer 10.0.2.2 connect-interface LoopBack0
 peer 10.0.3.3 as-number 100
 peer 10.0.3.3 connect-interface LoopBack0
 peer 10.0.4.4 as-number 200
 peer 10.0.4.4 ebgp-max-hop 2
 peer 10.0.4.4 connect-interface LoopBack0
 peer 10.0.16.6 as-number 400
 peer 2000::2 as-number 100
 peer 2000::2 connect-interface LoopBack0
 peer 2000::3 as-number 100
 peer 2000::3 connect-interface LoopBack0
 peer 2000::4 as-number 200
 peer 2000::4 ebgp-max-hop 2
 peer 2000::4 connect-interface LoopBack0
 peer 2000::1606 as-number 400
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.1.1 255.255.255.255
  network 10.0.2.2 255.255.255.255
  network 10.0.3.3 255.255.255.255
  peer 10.0.2.2 enable
  peer 10.0.2.2 next-hop-local
  peer 10.0.3.3 enable
  peer 10.0.3.3 next-hop-local
  peer 10.0.4.4 enable
  peer 10.0.4.4 as-path-filter from_as_400 export
  peer 10.0.16.6 enable
  peer 10.0.16.6 as-path-filter from_as_200 export
 #
 ipv6-family unicast
  undo synchronization
  network 2000::1 128
  network 2000::2 128
  network 2000::3 128
```

```
  peer 2000::2 enable
  peer 2000::2 next-hop-local
  peer 2000::3 enable
  peer 2000::3 next-hop-local
  peer 2000::4 enable
  peer 2000::4 route-policy R4_import import
  peer 2000::1606 enable
  peer 2000::1606 route-policy R5_import import
#
ospf 1
 area 0.0.0.0
  network 10.0.1.1 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
route-policy R4_import permit node 10
 if-match ipv6 address prefix-list R4_import
 apply local-preference 150
 apply cost 10
#
route-policy R4_import permit node 20
#
route-policy R5_import permit node 10
 if-match ipv6 address prefix-list R5_import
 apply local-preference 200
#
route-policy R5_import permit node 20
#
ip as-path-filter from_as_200 deny _200_
ip as-path-filter from_as_200 permit .*
ip as-path-filter from_as_400 deny _400_
ip as-path-filter from_as_400 permit .*
#
ip route-static 10.0.4.4 255.255.255.255 10.0.14.4
#
ipv6 route-static 2000::4 128 2000::1404
#
ip ipv6-prefix R4_import index 20 permit 2000:0:0:51:: 64
ip ipv6-prefix R5_import index 10 permit 1000:0:0:52:: 64
#
return
```

8.3.2 R2's Configuration

```
#
 sysname R2
#
 ipv6
#
ospfv3 1
 router-id 10.0.2.2
#
interface Vlanif1
 ipv6 enable
 ipv6 address 2000:0:0:21::1/64
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.12.2 255.255.255.0
 ipv6 address 2000::1202/120
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.23.2 255.255.255.0
 ipv6 address 2000::2302/120
 ospfv3 1 area 0.0.0.0
#
interface NULL0
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.2.2 255.255.255.255
 ipv6 address 2000::2/128
 ospfv3 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.2.2
 peer 10.0.1.1 as-number 100
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.3.3 as-number 100
 peer 10.0.3.3 connect-interface LoopBack0
 peer 2000::1 as-number 100
 peer 2000::1 connect-interface LoopBack0
```

```
 peer 2000::3 as-number 100
 peer 2000::3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.2.2 255.255.255.255
  peer 10.0.1.1 enable
  peer 10.0.3.3 enable
 #
 ipv6-family unicast
  undo synchronization
  network 2000::2 128
  network 2000:0:0:21:: 64
  peer 2000::1 enable
  peer 2000::3 enable
#
ospf 1
 area 0.0.0.0
  network 10.0.2.2 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
#
route-policy R5_import permit node 10
 if-match ipv6 address prefix-list R5_import
 apply local-preference 200
#
route-policy R5_import permit node 20
#
ip ipv6-prefix R5_import index 10 permit 1000:0:0:52:: 64
#
return
```

8.3.3 R3's Configuration

```
#
 sysname R3
#
ipv6
#
ospfv3 1
 router-id 10.0.3.3
#
```

```
interface Vlanif1
 ip address 10.1.3.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.13.3 255.255.255.0
 ipv6 address 2000::1303/120
 ospfv3 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.23.3 255.255.255.0
 ipv6 address 2000::2303/120
 ospfv3 1 area 0.0.0.0
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.3.3 255.255.255.255
 ipv6 address 2000::3/128
 ospfv3 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.3.3
 peer 10.0.1.1 as-number 100
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.2.2 as-number 100
 peer 10.0.2.2 connect-interface LoopBack0
 peer 2000::1 as-number 100
 peer 2000::1 connect-interface LoopBack0
 peer 2000::2 as-number 100
 peer 2000::2 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.3.3 255.255.255.255
  network 10.1.3.0 255.255.255.0
  peer 10.0.1.1 enable
  peer 10.0.2.2 enable
 #
 ipv6-family unicast
  undo synchronization
  network 2000::3 128
  peer 2000::1 enable
```

```
  peer 2000::2 enable
#
ospf 1
 area 0.0.0.0
  network 10.0.3.3 0.0.0.0
  network 10.0.13.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
#
Return
```

8.3.4 R4's Configuration

```
#
 sysname R4
#
ipv6
#
interface Vlanif1
 ip address 10.1.4.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.14.4 255.255.255.0
 ipv6 address 2000::1404/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.45.4 255.255.255.0
 ipv6 address 2000::4504/120
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.4.4 255.255.255.255
 ipv6 address 2000::4/128
#
bgp 200
 router-id 10.0.4.4
 peer 10.0.1.1 as-number 100
 peer 10.0.1.1 ebgp-max-hop 2
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.45.5 as-number 300
 peer 2000::1 as-number 100
```

```
 peer 2000::1 ebgp-max-hop 2
 peer 2000::1 connect-interface LoopBack0
 peer 2000::4505 as-number 300
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.4.4 255.255.255.255
  network 10.1.4.0 255.255.255.0
  peer 10.0.1.1 enable
  peer 10.0.1.1 route-policy test import
  peer 10.0.45.5 enable
 #
 ipv6-family unicast
  undo synchronization
  network 2000::4 128
  peer 2000::1 enable
  peer 2000::4505 enable
#
route-policy test permit node 10
 if-match ip-prefix test
#
ip route-static 10.0.1.1 255.255.255.255 10.0.14.1
#
ipv6 route-static 2000::1 128 2000::1401
#
return
```

8.3.5 R5's Configuration

```
#
 sysname R5
#
ipv6
#
vlan batch 2
#
interface Vlanif1
 ipv6 enable
 ipv6 address 2000:0:0:51::1/64
#
interface Vlanif2
 ipv6 enable
```

```
 ipv6 address 2000:0:0:52::1/64
#
interface Ethernet0/0/0
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.45.5 255.255.255.0
 ipv6 address 2000::4505/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.56.5 255.255.255.0
 ipv6 address 2000::5605/120
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.5.5 255.255.255.255
 ipv6 address 2000::5/128
#
bgp 300
 router-id 10.0.5.5
 peer 10.0.45.4 as-number 200
 peer 10.0.56.6 as-number 400
 peer 2000::4504 as-number 200
 peer 2000::5606 as-number 400
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.5.5 255.255.255.255
  peer 10.0.45.4 enable
  peer 10.0.56.6 enable
 #
 ipv6-family unicast
  undo synchronization
  network 2000::5 128
  network 2000:0:0:51:: 64
  network 2000:0:0:52:: 64
  peer 2000::4504 enable
  peer 2000::5606 enable
#
Return
```

8.3.6 R6's Configuration

```
#
 sysname R6
#
ipv6
#
interface Vlanif1
 ip address 10.1.6.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.56.6 255.255.255.0
 ipv6 address 2000::5606/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.16.6 255.255.255.0
 ipv6 address 2000::1606/120
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.6.6 255.255.255.255
 ipv6 address 2000::6/128
#
bgp 400
 router-id 10.0.6.6
 peer 10.0.16.1 as-number 100
 peer 10.0.56.5 as-number 300
 peer 2000::1601 as-number 100
 peer 2000::5605 as-number 300
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.0.0
  network 10.0.6.6 255.255.255.255
  network 10.1.6.0 255.255.255.0
  peer 10.0.16.1 enable
  peer 10.0.56.5 enable
 #
 ipv6-family unicast
  undo synchronization
```

```
  network 2000::6 128
  peer 2000::1601 enable
  peer 2000::5605 enable
#
return
```

9 Advanced BGP Configuration

9.1 Introduction

9.1.1 About This Lab

In this lab, you will be able to learn how to configure and use BGP tools and familiarize yourself with common BGP usage scenarios and usage of functions and attributes.

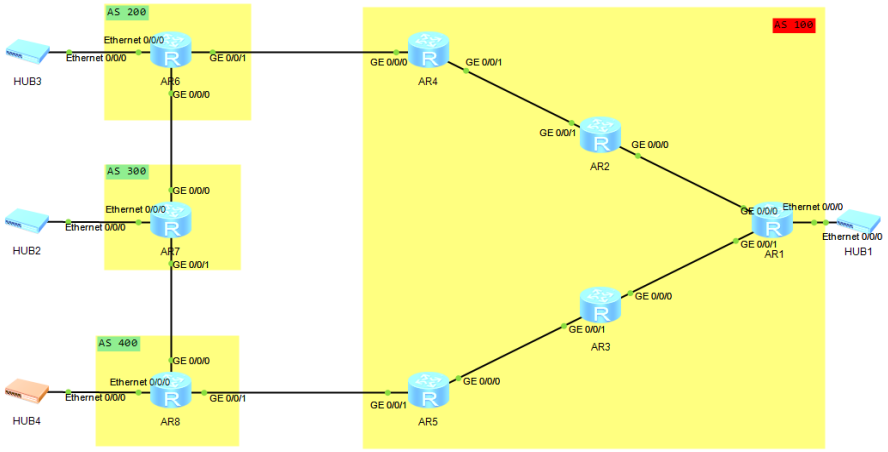
9.1.2 Objectives

Upon completion of this task, you will be able to:

- Grasp the principles and methods of route summarization.
- Master the principles and configuration of route reflectors.
- Configure BGP authentication.
- Understand the principles and usage of community attributes and Community-Filter.
- Configure BGP load balancing.
- Understand the usage of common BGP attributes.

9.1.3 Networking Typology

Figure 9-1 Advanced BGP networking topology



9.1.4 Networking Design

Table 9-1 Device and interface parameter plan

Device Name	Interface Name	Interface Address and Mask
R1	GE 0/0/0	IPv4: 10.0.12.1/24 IPv6: 2000::1201/120
	GE 0/0/1	IPv4: 10.0.13.1/24 IPv6: 2000::1301/120
	LoopBack 0	IPv4: 10.0.1.1/32 IPv6: 2000::1/128
	Vlanif1	IPv4: 221.12.128.1/24
	Vlanif2	IPv4: 115.192.0.1/24
	Vlanif3	IPv4: 10.1.1.1/24 IPv6: 2000:0:0:11::1/64

Device Name	Interface Name	Interface Address and Mask
R2	GE 0/0/0	IPv4: 10.0.12.2/24 IPv6: 2000::1202/120
	GE 0/0/1	IPv4: 10.0.24.2/24 IPv6: 2000::2402/120
	LoopBack 0	IPv4: 10.0.2.2/32 IPv6: 2000::2/128
R3	GE 0/0/0	IPv4: 10.0.13.3/24 IPv6: 2000::1303/120
	GE 0/0/1	IPv4: 10.0.35.3/24 IPv6: 2000::3503/120
	LoopBack 0	IPv4: 10.0.3.3/32 IPv6: 2000::3/128
R4	GE 0/0/0	IPv4: 10.0.46.4/24 IPv6: 2000::4604/120
	GE 0/0/1	IPv4: 10.0.24.4/24 IPv6: 2000::2404/120
	LoopBack 0	IPv4: 10.0.4.4/32 IPv6: 2000::4/128
R5	GE 0/0/0	IPv4: 10.0.35.5/24 IPv6: 2000::3505/120
	GE 0/0/1	IPv4: 10.0.58.5/24 IPv6: 2000::5805/120
	LoopBack 0	IPv4: 10.0.5.5/32 IPv6: 2000::5/128
R6	GE 0/0/0	IPv4: 10.0.67.6/24 IPv6: 2000::6706/120

Device Name	Interface Name	Interface Address and Mask
	GE 0/0/1	IPv4: 10.0.46.6/24 IPv6: 2000::4606/120
	LoopBack 0	IPv4: 10.0.6.6/32 IPv6: 2000::6/128
	Vlanif1	IPv4: 10.1.6.1/24
R7	GE 0/0/0	IPv4: 10.0.67.7/24 IPv6: 2000::6707/120
	GE 0/0/1	IPv4: 10.0.78.7/24 IPv6: 2000::7807/120
	LoopBack 0	IPv4: 10.0.7.7/32 IPv6: 2000::7/128
	Vlanif1	IPv4: 10.1.7.1/24
	Vlanif2	IPv6: 2000:0:0:70::1
	Vlanif3	IPv6: 2000:0:0:71::1
	Vlanif4	IPv6: 2000:0:0:72::1
	Vlanif5	IPv6: 2000:0:0:73::1
R8	GE 0/0/0	IPv4: 10.0.78.8/24 IPv6: 2000::7808/120
	GE 0/0/1	IPv4: 10.0.58.8/24 IPv6: 2000::5808/120
	LoopBack 0	IPv4: 10.0.8.8/32 IPv6: 2000::8/128
	Vlanif1	IPv4: 10.1.8.1/24

9.2 Lab Configuration

9.2.1 Configuration Roadmap

The configuration roadmap is as follows:

1. Assign IPv4 and IPv6 addresses to interfaces on each device.
2. Use OSPFv2 and OSPFv3 as IGP in AS 100.
3. Establish IBGP or EBGP peer relationships between directly connected routers. Use loopback interfaces to establish IBGP peer relationships and direct interfaces to establish EBGP peer relationships. Configure two egress routers R4 and R5 in AS 100 to authenticate peers.
4. Configure R2 and R3 as RRs of R4 and R5, respectively, and as clients of R1.
5. Configure all devices to advertise routes of all directly connected network segments to BGP. AS 200 and AS 400 belong to different ISPs, and 221.12.128.1/24 and 115.192.0.0/24 belong to two ISPs. In this situation, to enable users out of ISP networks to access a server on an ISP network, the following requirements must be met:
   1. The route destined for 221.12.128.1/24 is advertised only to AS 200.
   2. The route destined for 115.192.0.0/24 is advertised only to AS 400.

   In addition, to prevent traffic between ISPs from passing through AS 100, devices in AS 100 can learn routes from AS 200 and AS 400 but are disabled from advertising these routes to AS 400 and AS 200, respectively. (This restriction applies only to IPv4 routes.)

   NOTE

   This restriction is implemented using the community attribute.
6. Allow devices in AS 100 to access four network segments: 2000:0:0:70:: /64, 2000:0:0:71:: /64, 2000:0:0:72:: /64, and 2000:0:0:73:: /64. In addition, prevent network loops and minimize the impact that any network segment flapping poses on the entire network as much as possible.
7. Efficiently use link bandwidth resources when R1 accesses 10.1.7.0/24 through the network segment 10.1.1.0/24, and configure link redundancy on R1.

9.2.2 Configuration Procedure and Verification

Step 1 Assign an IP address to each interface on each device.

Configure IPv4 and IPv6 addresses for each device based on the plan. The configuration of the interface on R1 is used as an example.

Assign IP addresses to R1.

```
<Huawei>sys
[Huawei]sysname R1
[R1]ipv6
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.12.1 24
[R1-GigabitEthernet0/0/0]ipv6 enable
[R1-GigabitEthernet0/0/0]ipv6 address 2000::1201 120
```

Step 2 Configure an IGP.

Configure OSPF. The configuration of R1 is used as an example.

Configure OSPF on R1.

```
[R1]ospf 1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]quit
[R1-ospf-1]quit
[R1]ospfv3 1
[R1-ospfv3-1]router-id 10.0.1.1
[R1-ospfv3-1]quit
[R1]interface LoopBack 0
[R1-LoopBack0]ospf en area 0
[R1-LoopBack0]ospfv3 1 area 0
[R1-LoopBack0]quit
[R1GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]ospfv3 1 area 0
[R1-GigabitEthernet0/0/0]ospf enable area 0
[R1-GigabitEthernet0/0/0]quit
[R1] GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]ospf en area 0
[R1-GigabitEthernet0/0/1]ospfv3 1 area 0
```

```
[R1-GigabitEthernet0/0/1]quit
```

Verify the configuration.

Display the IPv4 neighbor relationship.

```
[R1]display ospf peer

 OSPF Process 1 with Router ID 10.0.1.1
          Neighbors

 Area 0.0.0.0 interface 10.0.12.1(GigabitEthernet0/0/0)'s neighbors
 Router ID: 10.0.2.2             Address: 10.0.12.2
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.12.1  BDR: 10.0.12.2  MTU: 0
   Dead timer due in 36  sec
   Retrans timer interval: 5
   Neighbor is up for 00:08:49
   Authentication Sequence: [ 0 ]

          Neighbors

 Area 0.0.0.0 interface 10.0.13.1(GigabitEthernet0/0/1)'s neighbors
 Router ID: 10.0.3.3             Address: 10.0.13.3
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.13.1  BDR: 10.0.13.3  MTU: 0
   Dead timer due in 32  sec
   Retrans timer interval: 5
   Neighbor is up for 00:06:27
   Authentication Sequence: [ 0 ]
```

Display information about the IPv4 OSPF routing table.

```
[R1]display ip routing-table protocol ospf
```

Route Flags: R - relay, D - download to fib

Public routing table : OSPF

Destinations : 8 Routes : 8

OSPF routing table status : <Active>

Destinations : 8 Routes : 8

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.2.2/32	OSPF	10	1	D	10.0.12.2	GigabitEthernet 0/0/0
10.0.3.3/32	OSPF	10	1	D	10.0.13.3	GigabitEthernet 0/0/1
10.0.4.4/32	OSPF	10	2	D	10.0.12.2	GigabitEthernet 0/0/0
10.0.5.5/32	OSPF	10	2	D	10.0.13.3	GigabitEthernet 0/0/1
10.0.24.0/24	OSPF	10	2	D	10.0.12.2	GigabitEthernet 0/0/0
10.0.35.0/24	OSPF	10	2	D	10.0.13.3	GigabitEthernet 0/0/1
10.0.46.0/24	OSPF	10	3	D	10.0.12.2	GigabitEthernet 0/0/0
10.0.58.0/24	OSPF	10	3	D	10.0.13.3	GigabitEthernet 0/0/1

OSPF routing table status : <Inactive>

Destinations : 0 Routes : 0

Display information about the IPv6 neighbor relationship.

[R1]display ospfv3 peer

OSPFv3 Process (1)

OSPFv3 Area (0.0.0.0)

Neighbor ID	Pri	State	Dead Time	Interface	Instance ID
10.0.2.2	1	Full/Backup	00:00:35	GE0/0/0	0
10.0.3.3	1	Full/Backup	00:00:38	GE0/0/1	0

Display information about the IPv6 OSPFv3 neighbor routing table (key information is provided only).

[R1]display ipv6 routing-table protocol ospfv3

Public Routing Table : OSPFv3

Summary Count : 11

OSPFv3 Routing Table's Status : < Active >

Summary Count : 8

```
 Destination   : 2000::2                       PrefixLength : 128
 NextHop       : FE80::2E0:FCFF:FED3:22C2      Preference   : 10
 Cost          : 1                             Protocol     : OSPFv3
 RelayNextHop : ::                             TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/0          Flags        : D

 Destination   : 2000::3                       PrefixLength : 128
 NextHop       : FE80::2E0:FCFF:FEF1:7B55      Preference   : 10
 Cost          : 1                             Protocol     : OSPFv3
 RelayNextHop : ::                             TunnelID     : 0x0
 Interface     : GigabitEthernet0/0/1          Flags        : D

 Destination   : 2000::4                       PrefixLength : 128
 NextHop       : FE80::2E0:FCFF:FED3:22C2      Preference   : 10
 Cost          : 2                             Protocol     : OSPFv3
```

RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/0 Flags : D

Destination : 2000::5 PrefixLength : 128
NextHop : FE80::2E0:FCFF:FEF1:7B55 Preference : 10
Cost : 2 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/1 Flags : D

Destination : 2000::2400 PrefixLength : 120
NextHop : FE80::2E0:FCFF:FED3:22C2 Preference : 10
Cost : 2 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/0 Flags : D

Destination : 2000::3500 PrefixLength : 120
NextHop : FE80::2E0:FCFF:FEF1:7B55 Preference : 10
Cost : 2 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/1 Flags : D

Destination : 2000::4600 PrefixLength : 120
NextHop : FE80::2E0:FCFF:FED3:22C2 Preference : 10
Cost : 3 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/0 Flags : D

Destination : 2000::5800 PrefixLength : 120
NextHop : FE80::2E0:FCFF:FEF1:7B55 Preference : 10
Cost : 3 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : GigabitEthernet0/0/1 Flags : D

Step 3 Configure BGP peer relationships.

In AS 100, use the LoopBack0 address to establish IBGP peer relationships and direct interface addresses to establish EBGP peer relationships. In addition, enable R4 and R5 to authenticate their EBGP peers. The configurations of R4 and R6 are used as an example.

Configure BGP peer relationships on R4.

```
[R4] bgp 100
[R4-bgp]router-id 10.0.4.4
[R4-bgp]peer 10.0.46.6 as-number 200
[R4-bgp] peer 10.0.46.6 password cipher huawei
[R4-bgp]peer 2000::4606 as-number 200
[R4-bgp] peer 2000::4606 password cipher huawei
[R4-bgp]ipv6-family unicast
[R4-bgp-af-ipv6]peer 2000::4606 enable
```

Configure BGP peer relationships on R6.

```
[R6]bgp 200
[R6-bgp]router-id 10.0.6.6
[R6-bgp]peer 10.0.46.4 as-number 100
[R6-bgp]peer 10.0.46.4 password cipher huawei
[R6-bgp]peer 2000::4604 as-number 100
[R6-bgp]peer 2000::4604 password cipher huawei
[R6-bgp]ipv6-family unicast
[R6-bgp-af-ipv6]peer 2000::4604 enable
```

Verify the configuration.

Display information about BGP peer relationships.

```
[R4]display bgp peer

 BGP local router ID : 10.0.4.4
 Local AS number : 100
```

```
 Total number of peers : 2                    Peers in established state :
2

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down
State Pre
fRcv

  10.0.2.2        4         100       27       27     0 00:24:16 Established
   1
  10.0.46.6       4         200        3        4     0 00:00:53 Established
   0
[R4]display bgp ipv6 peer

 BGP local router ID : 10.0.4.4
 Local AS number : 100
 Total number of peers : 2                    Peers in established state :
2

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down
State Pre
fRcv

  2000::2         4         100       27       26     0 00:24:41 Established
   1
  2000::4606      4         200        8        9     0 00:06:22 Established
   0
```

Step 4 Configure a reflector.

To ensure that BGP routes can be advertised within AS 100, configure R4 as R2's client, R5 as R3's client, and R1 as the reflector of R2 and R3. The configuration of R1 is used as an example.

Configure the client on R1.

```
[R1]bgp 100
```

[R1-bgp]peer 10.0.2.2 reflect-client

[R1-bgp]peer 10.0.3.3 reflect-client

[R1-bgp]ipv6-family unicast

[R1-bgp-af-ipv6]peer 2000::2 reflect-client

[R1-bgp-af-ipv6]peer 2000::3 reflect-client

Verify the configuration.

Display information about the BGP peer table of R1 (key information is provided only).

[R1]display bgp peer 10.0.2.2 verbose

```
  BGP Peer is 10.0.2.2,  remote AS 100
  Type: IBGP link
  BGP version 4, Remote router ID 10.0.2.2
  Authentication type configured: None
Last keepalive received: 2018/09/29 19:43:36 UTC-08:00
Last keepalive sent    : 2018/09/29 19:43:37 UTC-08:00
Last update    received: 2018/09/29 19:12:36 UTC-08:00
Last update    sent    : 2018/09/29 19:41:15 UTC-08:00
Minimum route advertisement interval is 15 seconds
Optional capabilities:
Route refresh capability has been enabled
4-byte-as capability has been enabled
It's route-reflector-client
Connect-interface has been configured
Peer Preferred Value: 0
Routing policy configured:
No routing policy is configured
```

[R1]dis bgp peer 10.0.3.3 verbose

```
  BGP Peer is 10.0.3.3,  remote AS 100
```

```
  Type: IBGP link
  BGP version 4, Remote router ID 10.0.3.3
Authentication type configured: None
 Last keepalive received: 2018/09/29 19:46:05 UTC-08:00
 Last keepalive sent      : 2018/09/29 19:46:06 UTC-08:00
 Last update      received: 2018/09/29 19:12:05 UTC-08:00
 Last update      sent      : 2018/09/29 19:41:20 UTC-08:00
 Minimum route advertisement interval is 15 seconds
 Optional capabilities:
 Route refresh capability has been enabled
 4-byte-as capability has been enabled
 It's route-reflector-client
 Connect-interface has been configured
 Peer Preferred Value: 0
 Routing policy configured:
 No routing policy is configure
```

Step 5 Import routes into BGP and filter out routes using community attributes.

To simplify the configuration, properly plan the configuration in advance. For example, the community attribute value of 100:200 indicates that the route is not advertised to AS 200, and the community attribute value of 100:400 indicates that the route is not advertised to AS 400.

Configure a route-policy on R1 to add a community attribute to the routes destined for 221.12.128.1/24 and 115.192.0.0/24 when importing these routes.

```
[R1]ip ip-prefix not_to_200 permit 115.192.0.0 24
[R1]ip ip-prefix not_to_400 permit 221.12.128.0 24
[R1]route-policy add_community permit node 10
Info: New Sequence of this List.
[R1-route-policy]if-match ip-prefix not_to_200
[R1-route-policy]apply community 100:200 additive
[R1-route-policy]quit
[R1]route-policy add_community permit node 20
```

```
Info: New Sequence of this List.
[R1-route-policy]if-match ip-prefix not_to_400
[R1-route-policy]apply community 100:400
[R1-route-policy]quit
[R1]route-policy add_community permit node 30
Info: New Sequence of this List.
[R1-route-policy]quit
[R1]bgp 100
[R1-bgp]peer 10.0.2.2 advertise-community
[R1-bgp]peer 10.0.3.3 advertise-community
[R1-bgp]network 115.192.0.0 24 route-policy add_community
[R1-bgp]network 221.12.128.0 24 route-policy add_community
[R1-bgp]network 10.0.1.1 32
[R1-bgp]ipv6-family unicast
[R1-bgp-af-ipv6]network 2000:0:0:11::1 64
```

Configure a route-policy on R4.

```
[R4]route-policy add_community permit node 10
[R4-route-policy] apply community 100:400
[R4-route-policy]quit
[R4]ip community-filter 10 deny 100:200
[R4]route-policy filter deny node 10
[R4-route-policy]if-match community-filter 10
[R4-route-policy]quit
[R4]route-policy filter permit node 20
[R4-route-policy]quit
[R4]bgp 100
[R4-bgp]peer 10.0.46.6 route-policy add_community import
[R4-bgp]peer 10.0.46.6 route-policy filter export
```

Verify the configuration.

[R6]display bgp routing-table

BGP Local router ID is 10.0.6.6
Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 7

	Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>	10.0.4.4/32	10.0.46.4	0	0		100i
*>	10.0.7.7/32	10.0.67.7	0	0		300i
*>	10.1.1.0/24	10.0.46.4		0		100i
*>	10.1.6.0/24	0.0.0.0	0	0		i
*>	10.1.8.0/24	10.0.67.7		0		300 400i
*>	115.192.0.0/24	10.0.67.7		0		300 400 100i
*>	221.12.128.0	10.0.46.4		0		100i

[R8]display bgp routing-table

BGP Local router ID is 10.0.8.8
Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 8

	Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>	10.0.4.4/32	10.0.78.7		0		300 200 100i

```
 *>   10.0.7.7/32        10.0.78.7        0                0      300i
 *>   10.1.1.0/24        10.0.58.5                         0      100i
 *                       10.0.78.7                         0      300 200 10
0i
 *>   10.1.6.0/24        10.0.78.7                         0      300 200i
 *>   10.1.8.0/24        0.0.0.0          0                0      i
 *>   115.192.0.0/24     10.0.58.5                         0      100i
 *>   221.12.128.0       10.0.78.7                         0      300 200 10
0i
```

Step 6 Configure route summarization and path selection.

On R4 and R5, summarize four specific routes to a route destined for 2000:0:0:70:: /62. To prevent loops and allow traffic to preferentially pass through AS 200, disable the advertisement of specific routes and modify attributes. The configuration of R4 is used as an example.

Configure R4.

```
[R4]ip ipv6-prefix aggregation permit 2000:0:0:72:: 62
[R4]route-policy aggregation permit node 10
[R4-route-policy]if-match ipv6 address prefix-list aggregation
[R4-route-policy]apply local-preference 200
[R4-route-policy]quit
[R4]route-policy aggregation permit node 20
[R4-route-policy]quit
[R4]bgp 100
[R4-bgp]ipv6-family unicast
[R4-bgp-af-ipv6]aggregate 2000:0:0:70:: 62 as-set detail-suppressed attribute-po
licy aggregation
```

Verify the configuration.

```
[R1]display bgp ipv6 routing-table
```

```
BGP Local router ID is 10.0.1.1
Status codes: * - valid, > - best, d - damped,
              h - history,  i - internal, s - suppressed, S - Stale
              Origin : i - IGP, e - EGP, ? - incomplete


Total Number of Routes: 4
  i Network  : 2000::2                          PrefixLen : 128
    NextHop  : 2000::2                          LocPrf    : 100
    MED      : 0                                PrefVal   : 0
    Label    :
    Path/Ogn : i
  i Network  : 2000::3                          PrefixLen : 128
    NextHop  : 2000::3                          LocPrf    : 100
    MED      : 0                                PrefVal   : 0
    Label    :
    Path/Ogn : i
*>  Network  : 2000:0:0:11::                    PrefixLen : 64
    NextHop  : ::                               LocPrf    :
    MED      : 0                                PrefVal   : 0
    Label    :
    Path/Ogn : i
*>i Network  : 2000:0:0:70::                    PrefixLen : 62
    NextHop  : 2000::4                          LocPrf    : 200
    MED      :                                  PrefVal   : 0
    Label    :
    Path/Ogn : 200 300  i
```

Step 7 Configure load balancing.

Configure IBGP peer load balancing on R1. In addition, because the AS_Path attributes of the two routes destined for 10.1.7.0/24 are different, disable R1 from comparing the AS_Path attributes of the two routes, which prevents a load balancing failure.

```
[R1]bgp 100
[R1-bgp]maximum load-balancing ibgp 2
[R1-bgp]load-balancing as-path-ignore
[R1-bgp]quit
```

Verify the configuration.

```
[R1]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 32        Routes : 34

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.1.7.0/24  IBGP    255  0           RD  10.0.46.6       GigabitEthernet
0/0/0
                     IBGP    255  0           RD  10.0.58.8       GigabitEthernet
0/0/1
        10.1.8.0/24  IBGP    255  0           RD  10.0.58.8       GigabitEthernet
0/0/1
        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
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
[R1]display bgp routing-table

 BGP Local router ID is 10.0.1.1
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete
```

Total Number of Routes: 12

*>i	10.0.7.7/32	10.0.46.6		100	0	200 300i
* i		10.0.58.8		100	0	400 300i
*>	10.1.1.0/24	0.0.0.0	0		0	i
*>i	10.1.6.0/24	10.0.46.6	0	100	0	200i
*>i	10.1.7.0/24	10.0.46.6		100	0	200 300i
* i		10.0.58.8		100	0	400 300i
*>i	10.1.8.0/24	10.0.58.8	0	100	0	400i
*>	115.192.0.0/24	0.0.0.0	0		0	i
*>	221.12.128.0	0.0.0.0	0		0	i

9.3 Reference Configuration

9.3.1 R1's Configuration

```
#
 sysname R1
#
ipv6
#
vlan batch 2 to 6
#
ospfv3 1
 router-id 10.0.1.1
#
firewall zone Local
 priority 15
#
interface Vlanif1
  ip address 221.12.128.1 255.255.255.0
```

```
#
interface Vlanif2
 ip address 115.192.0.1 255.255.255.0
#
interface Vlanif3
 ipv6 enable
 ip address 10.1.1.1 255.255.255.0
 ipv6 address 2000:0:0:11::1/64
#
interface Ethernet0/0/0
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.12.1 255.255.255.0
 ipv6 address 2000::1201/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.13.1 255.255.255.0
 ipv6 address 2000::1301/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.1.1 255.255.255.255
```

```
 ipv6 address 2000::1/32
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.1.1
 peer 10.0.2.2 as-number 100
 peer 10.0.2.2 connect-interface LoopBack0
 peer 10.0.3.3 as-number 100
 peer 10.0.3.3 connect-interface LoopBack0
 peer 2000::2 as-number 100
 peer 2000::2 connect-interface LoopBack0
 peer 2000::3 as-number 100
 peer 2000::3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.1.0 255.255.255.0
  network 10.0.1.1 255.255.255.255
  network 10.1.1.0 255.255.255.0
  network 115.192.0.0 255.255.255.0 route-policy add_community
  network 221.12.128.0 route-policy add_community
  maximum load-balancing ibgp 2
  load-balancing as-path-ignore
  peer 10.0.2.2 enable
  peer 10.0.2.2 reflect-client
  peer 10.0.2.2 advertise-community
  peer 10.0.3.3 enable
  peer 10.0.3.3 reflect-client
  peer 10.0.3.3 advertise-community
```

```
 #
 ipv6-family unicast
  undo synchronization
  network 2000:0:0:11:: 64
  peer 2000::2 enable
  peer 2000::2 reflect-client
  peer 2000::3 enable
  peer 2000::3 reflect-client
#
ospf 1
 area 0.0.0.0
#
route-policy add_community permit node 10
 if-match ip-prefix not_to_200
 apply community 100:200 additive
#
route-policy add_community permit node 20
 if-match ip-prefix not_to_400
 apply community 100:400
#
route-policy add_community permit node 30
#
ip ip-prefix not_to_200 index 10 permit 115.192.0.0 24
ip ip-prefix not_to_400 index 10 permit 221.12.128.0 24
#
return
```

9.3.2 R2's Configuration

```
#
 sysname R2
```

```
#
ipv6
#
ospfv3 1
 router-id 10.0.2.2
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.12.2 255.255.255.0
 ipv6 address 2000::1202/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.24.2 255.255.255.0
 ipv6 address 2000::2402/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.2.2 255.255.255.255
 ipv6 address 2000::2/128
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.2.2
 peer 10.0.1.1 as-number 100
```

```
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.4.4 as-number 100
 peer 10.0.4.4 connect-interface LoopBack0
 peer 2000::1 as-number 100
 peer 2000::1 connect-interface LoopBack0
 peer 2000::4 as-number 100
 peer 2000::4 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.2.2 255.255.255.255
  peer 10.0.1.1 enable
  peer 10.0.1.1 advertise-community
  peer 10.0.4.4 enable
  peer 10.0.4.4 reflect-client
  peer 10.0.4.4 advertise-community
 #
 ipv6-family unicast
  undo synchronization
  network 2000::2 128
  peer 2000::1 enable
  peer 2000::4 enable
  peer 2000::4 reflect-client
#
ospf 1
 area 0.0.0.0
#
route-policy filter deny node 10
 if-match community-filter 10
#
```

```
route-policy filter permit node 20
#
ip community-filter 10 permit 100:400
#
return
```

9.3.3 R3's Configuration

```
#
 sysname R3
#
 ipv6
#
 ospfv3 1
 router-id 10.0.3.3
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.13.3 255.255.255.0
 ipv6 address 2000::1303/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.35.3 255.255.255.0
 ipv6 address 2000::3503/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface LoopBack0
```

```
 ipv6 enable
 ip address 10.0.3.3 255.255.255.255
 ipv6 address 2000::3/128
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.3.3
 peer 10.0.1.1 as-number 100
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.5.5 as-number 100
 peer 10.0.5.5 connect-interface LoopBack0
 peer 2000::1 as-number 100
 peer 2000::1 connect-interface LoopBack0
 peer 2000::5 as-number 100
 peer 2000::5 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.3.3 255.255.255.255
  peer 10.0.1.1 enable
  peer 10.0.1.1 advertise-community
  peer 10.0.5.5 enable
  peer 10.0.5.5 reflect-client
  peer 10.0.5.5 advertise-community
 #
 ipv6-family unicast
  undo synchronization
  network 2000::3 128
  peer 2000::1 enable
```

```
  peer 2000::5 enable
  peer 2000::5 reflect-client
#
ospf 1
 area 0.0.0.0
#
return
```

9.3.4 R4's Configuration

```
 #
 sysname R4
#
ipv6
#
ospfv3 1
 router-id 10.0.4.4
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.46.4 255.255.255.0
 ipv6 address 2000::4604/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.24.4 255.255.255.0
 ipv6 address 2000::2404/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
```

```
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.4.4 255.255.255.255
 ipv6 address 2000::4/128
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
bgp 100
 router-id 10.0.4.4
 peer 10.0.2.2 as-number 100
 peer 10.0.2.2 connect-interface LoopBack0
 peer 10.0.46.6 as-number 200
 peer 10.0.46.6 password cipher huawei
 peer 2000::2 as-number 100
 peer 2000::2 connect-interface LoopBack0
 peer 2000::4606 as-number 200
 peer 2000::4606 password cipher huawei
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.4.4 255.255.255.255
  peer 10.0.2.2 enable
  peer 10.0.2.2 advertise-community
  peer 10.0.46.6 enable
  peer 10.0.46.6 route-policy add_community import
  peer 10.0.46.6 route-policy filter export
  peer 10.0.46.6 advertise-community
 #
 ipv6-family unicast
```

```
  undo synchronization
  aggregate 2000:0:0:70:: 62 as-set detail-suppressed attribute-policy aggregati
on
  peer 2000::2 enable
  peer 2000::4606 enable
#
ospf 1
 area 0.0.0.0
#
route-policy add_community permit node 10
 apply community 100:400
#
route-policy filter deny node 10
 if-match community-filter 10
#
route-policy filter permit node 20
#
route-policy aggregation permit node 10
 if-match ipv6 address prefix-list aggregation
 apply local-preference 200
#
route-policy aggregation permit node 20
#
ip community-filter 10 permit 100:200
#
ip ipv6-prefix aggregation index 10 permit 2000:0:0:70:: 62
#
return
```

9.3.5 R5's Configuration

```
#
 sysname R5
#
ipv6
#
ospfv3 1
 router-id 10.0.5.5
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.35.5 255.255.255.0
 ipv6 address 2000::3505/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.58.5 255.255.255.0
 ipv6 address 2000::5805/120
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.5.5 255.255.255.255
 ipv6 address 2000::5/128
 ospfv3 1 area 0.0.0.0
 ospf enable 1 area 0.0.0.0
#
```

```
bgp 100
 router-id 10.0.5.5
 peer 10.0.3.3 as-number 100
 peer 10.0.3.3 connect-interface LoopBack0
 peer 10.0.58.8 as-number 400
 peer 10.0.58.8 password cipher huawei
 peer 2000::3 as-number 100
 peer 2000::3 connect-interface LoopBack0
 peer 2000::5808 as-number 400
 peer 2000::5808 password cipher huawei
 #
 ipv4-family unicast
  undo synchronization
  peer 10.0.3.3 enable
  peer 10.0.3.3 advertise-community
  peer 10.0.58.8 enable
  peer 10.0.58.8 route-policy add_community import
  peer 10.0.58.8 route-policy filter export
 #
 ipv6-family unicast
  undo synchronization
  aggregate 2000:0:0:70:: 62 as-set detail-suppressed
  peer 2000::3 enable
  peer 2000::5808 enable
#
ospf 1
 area 0.0.0.0
#
route-policy add_community permit node 10
 apply community 100:200 additive
```

```
#
route-policy filter deny node 10
 if-match community-filter 10
#
route-policy filter permit node 20
#
ip community-filter 10 permit 100:400
#
return
```

9.3.6 R6's Configuration

```
#
 sysname R6
#
ipv6
#
interface Vlanif1
 ip address 10.1.6.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.67.6 255.255.255.0
 ipv6 address 2000::6706/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.46.6 255.255.255.0
 ipv6 address 2000::4606/120
#
```

```
interface LoopBack0
 ipv6 enable
 ip address 10.0.6.6 255.255.255.255
 ipv6 address 2000::6/128
#
bgp 200
 router-id 10.0.6.6
 peer 10.0.46.4 as-number 100
 peer 10.0.46.4 password cipher huawei
 peer 10.0.67.7 as-number 300
 peer 2000::4604 as-number 100
 peer 2000::4604 password cipher huawei
 peer 2000::6707 as-number 300
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.6.0 255.255.255.0
  peer 10.0.46.4 enable
  peer 10.0.67.7 enable
 #
 ipv6-family unicast
  undo synchronization
  peer 2000::4604 enable
  peer 2000::6707 enable
#
return
```

9.3.7 R7's Configuration

```
#
```

```
 sysname R7
#
ipv6
#
vlan batch 2 to 6
#
interface Vlanif1
 ip address 10.1.7.1 255.255.255.0
#
interface Vlanif2
 ipv6 enable
 ipv6 address 2000:0:0:70::1/64
#
interface Vlanif3
 ipv6 enable
 ipv6 address 2000:0:0:71::1/64
#
interface Vlanif4
 ipv6 enable
 ipv6 address 2000:0:0:72::1/64
#
interface Vlanif5
 ipv6 enable
 ipv6 address 2000:0:0:73::1/64
#
interface Ethernet0/0/0
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/0
```

```
 ipv6 enable
 ip address 10.0.67.7 255.255.255.0
 ipv6 address 2000::6707/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.78.7 255.255.255.0
 ipv6 address 2000::7807/120
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.7.7 255.255.255.255
 ipv6 address 2000::7/128
#
bgp 300
 router-id 10.0.7.7
 peer 10.0.67.6 as-number 200
 peer 10.0.78.8 as-number 400
 peer 2000::6706 as-number 200
 peer 2000::7808 as-number 400
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.7.7 255.255.255.255
  network 10.1.7.0 255.255.255.0
  peer 10.0.67.6 enable
  peer 10.0.78.8 enable
 #
 ipv6-family unicast
  undo synchronization
```

```
  network 2000::7 128
  network 2000:0:0:70:: 64
  network 2000:0:0:71:: 64
  network 2000:0:0:72:: 64
  network 2000:0:0:73:: 64
  peer 2000::6706 enable
  peer 2000::7808 enable
#
return
```

9.3.8 R8's Configuration

```
#
 sysname R8
#
ipv6
#
interface Vlanif1
 ip address 10.1.8.1 255.255.255.0
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.78.8 255.255.255.0
 ipv6 address 2000::7808/120
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ip address 10.0.58.8 255.255.255.0
 ipv6 address 2000::5808/120
#
interface NULL0
```

```
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.8.8 255.255.255.255
 ipv6 address 2000::8/128
#
bgp 400
 router-id 10.0.8.8
 peer 10.0.58.5 as-number 100
 peer 10.0.58.5 password cipher huawei
 peer 10.0.78.7 as-number 300
 peer 2000::5805 as-number 100
 peer 2000::5805 password cipher huawei
 peer 2000::7807 as-number 300
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.8.0 255.255.255.0
  peer 10.0.58.5 enable
  peer 10.0.78.7 enable
 #
 ipv6-family unicast
  undo synchronization
  peer 2000::5805 enable
  peer 2000::7807 enable
#
Return
```

9.4 Quiz

In Step 6, how can a device be allowed to implement route summarization only when a BGP route destined for 2000:0:0:70::60 exists?

10 Route Import and Control Configuration

10.1 Introduction

10.1.1 About This Lab

This guide describes how to configure ACLs and IP prefix lists as route filters, how to configure the route import function, and how to configure routing policies.

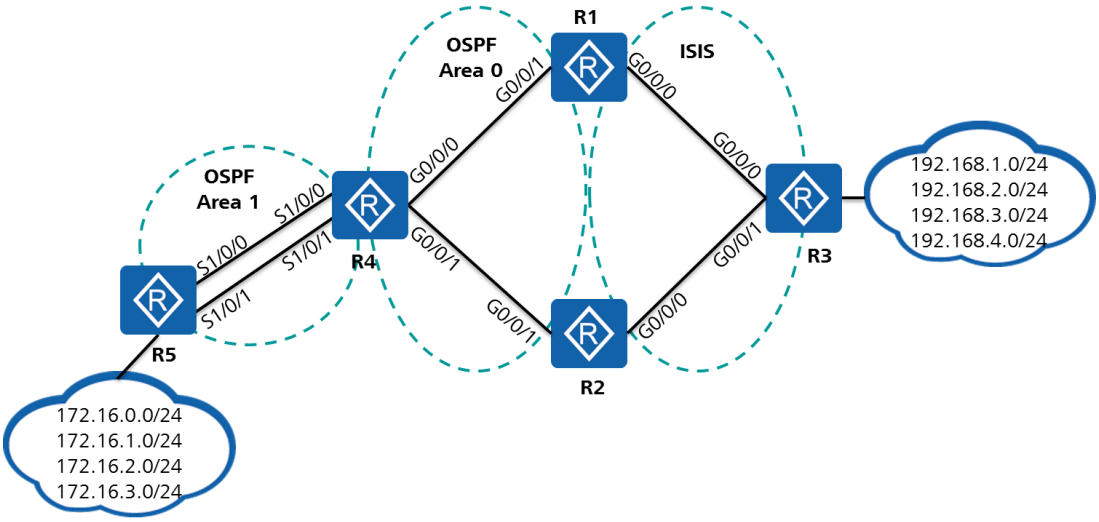
10.1.2 Objectives

Upon completion of this task, you will be able to

- Configure route filters.
- Configure routing policies.

10.1.3 Networking Topology

Figure 10-1 Route import and control networking topology



10.1.4 Networking Design

As shown in the networking topology of a company, OSPF is run on the headquarters network, while IS-IS is run on branch networks. The headquarters and branches have several service network segments. The network segments with IP addresses having an odd number in the third byte is used by service A, while those with IP addresses having an even number in the third byte is used by service B. Deploy the network based on the following requirements:

1. An OSPF network is built for the headquarters and an IS-IS network is built for branches according to the topology, and the number of routes that need to be maintained by the devices in the OSPF area 1 is minimized (but not through route summarization).
2. The network administrator imports IS-IS routes to OSPF on R1, imports OSPF routes to IS-IS on R2, and commissions the routes to ensure normal communication between service network segments.
3. To prevent network disconnection caused by a single point of failure between the headquarters and branch networks, the network administrator configures two-way route import on R1 and R2, and then commissions the routes to ensure normal communication between service network segments.
4. Services A and B on network segments of the headquarters network are transmitted over two different links for load balancing (instead of using routing policies).

Table 10-1 IP address planning

Device	Interface	IP Address	Subnet Mask
R1	G 0/0/0	13.1.1.1	255.255.255.252
	G 0/0/1	41.1.1.2	255.255.255.252
	Loopback 0	1.1.1.1	255.255.255.255
R2	G 0/0/0	23.1.1.1	255.255.255.252
	G 0/0/1	42.1.1.2	255.255.255.252
	Loopback 0	2.2.2.2	255.255.255.255
R3	G 0/0/0	13.1.1.2	255.255.255.252

	G 0/0/1	23.1.1.2	255.255.255.252
	Loopback 0	3.3.3.3	255.255.255.255
R4	G 0/0/0	41.1.1.1	255.255.255.252
	G 0/0/1	42.1.1.1	255.255.255.252
	S 1/0/0	54.1.1.2	255.255.255.252
	S 1/0/1	54.2.2.2	255.255.255.252
	Loopback 0	4.4.4.4	255.255.255.255
R5	S 1/0/0	54.1.1.1	255.255.255.252
	S 1/0/1	54.2.2.1	255.255.255.252
	Loopback 0	5.5.5.5	255.255.255.255

10.2 Lab Configuration

10.2.1 Configuration Roadmap

1. Assign IP addresses to interfaces.
2. Configure OSPF.
3. Configure IS-IS.
4. Perform configuration task 1.
5. Perform configuration task 2.
6. Perform configuration task 3.
7. Perform configuration task 4.

10.2.2 Configuration Procedure

Step 1 **Assign IP addresses to interfaces.**

Configure R5.

```
<Quidway>system-view
[Quidway]sysname R5
[R5]interface Serial 1/0/0
```

```
[R5-Serial1/0/0]ip address 54.1.1.1 30
[R5]interface Serial 1/0/1
[R5-Serial1/0/1]ip address 54.2.2.1 30
[R5]interface LoopBack 0
[R5-LoopBack0]ip address 5.5.5.5 32
[R5]interface LoopBack 1
[R5-LoopBack1]ip address 172.16.0.1 24
[R5]interface LoopBack 2
[R5-LoopBack2]ip address 172.16.1.1 24
[R5]interface LoopBack 3
[R5-LoopBack3]ip address 172.16.2.1 24
[R5]interface LoopBack 4
[R5-LoopBack4]ip address 172.16.3.1 24
```

Configure R4.

```
<Quidway>system-view
[Quidway]sysname R4
[R4]interface Serial 1/0/0
[R4-Serial1/0/0]ip address 54.1.1.2 30
[R4]interface Serial 1/0/1
[R4-Serial1/0/1]ip address 54.2.2.2 30
[R4]interface LoopBack 0
[R4-LoopBack0]ip address 4.4.4.4 32
[R4]interface GigabitEthernet 0/0/0
[R4-GigabitEthernet0/0/0]ip address 41.1.1.1 30
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ip address 42.1.1.1 30
```

Configure R1.

```
<Quidway>system-view
[Quidway]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 41.1.1.2 30
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 13.1.1.1 30
[R1]interface LoopBack 0
[R1-LoopBack0]ip address 1.1.1.1 32
```

Configure R2.

```
<Quidway>system-view
[Quidway]sysname R2
```

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ip address 42.1.1.2 30
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ip address 23.1.1.1 30
[R2]interface LoopBack 0
[R2-LoopBack0]ip address 2.2.2.2 32
```

Configure R3.

```
<Quidway>system-view
[Quidway]sysname R3
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ip address 23.1.1.2 30
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ip address 13.1.1.2 30
[R3]interface LoopBack 0
[R3-LoopBack0]ip address 3.3.3.3 32
[R3]interface LoopBack 1
[R3-LoopBack1]ip address 192.168.1.1 24
[R3]interface LoopBack 2
[R3-LoopBack2]ip address 192.168.2.1 24
[R3]interface LoopBack 3
[R3-LoopBack3]ip address 192.168.3.1 24
[R3]interface LoopBack 4
[R3-LoopBack4]ip address 192.168.4.1 24
```

Step 2 **Configure OSPF.**

Configure OSPF on R5.

```
[R5]ospf 1 router-id  5.5.5.5
[R5-ospf-1]area 1
[R5-ospf-1-area-0.0.0.1]network 5.5.5.5 0.0.0.0
[R5-ospf-1-area-0.0.0.1]network 54.1.1.0 0.0.0.3
[R5-ospf-1-area-0.0.0.1]network 54.2.2.0 0.0.0.3
[R5]ip ip-prefix r5 permit 172.16.0.0 16 greater-equal 24 less-equal 24
[R5]route-policy r5 permit node 10
[R5-route-policy]if-match ip-prefix r5
[R5]ospf 1
[R5-ospf-1]import-route direct route-policy r5
```

Configure OSPF on R4.

```
[R4]ospf 1 router-id  4.4.4.4
```

```
[R4-ospf-1]area 1
[R4-ospf-1-area-0.0.0.1]network 54.1.1.0 0.0.0.3
[R4-ospf-1-area-0.0.0.1]network 54.2.2.0 0.0.0.3
[R4-ospf-1]area 0
[R4-ospf-1-area-0.0.0.0]network 41.1.1.0 0.0.0.3
[R4-ospf-1-area-0.0.0.0]network 42.1.1.0 0.0.0.3
[R4-ospf-1-area-0.0.0.0]network 4.4.4.4 0.0.0.0
```

Configure OSPF on R1.

```
[R1]ospf 1 router-id  1.1.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]network 41.1.1.0 0.0.0.3
```

Configure OSPF on R2.

```
[R2]ospf 1 router-id  2.2.2.2
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[R2-ospf-1-area-0.0.0.0]network 42.1.1.0 0.0.0.3
```

Step 3 **Configure IS-IS.**

Configure IS-IS on R1.

```
[R1]isis 1
[R1-isis-1]network-entity 49.0010.0100.1001.00
[R1-isis-1]is-level level-2
[R1-isis-1]cost-style wide
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]isis enable 1
[R1]interface LoopBack 0
[R1-LoopBack0]isis enable 1
```

Configure IS-IS on R2.

```
[R2]isis 1
[R2-isis-1]network-entity 49.0020.0200.2002.00
[R2-isis-1]is-level level-2
[R2-isis-1]cost-style wide
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]isis enable 1
[R2]interface LoopBack 0
[R2-LoopBack0]isis enable 1
```

Configure IS-IS on R3.

```
[R3]isis 1
[R3-isis-1]network-entity 49.0030.0300.3003.00
[R3-isis-1]is-level level-2
[R3-isis-1]cost-style wide
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]isis enable 1
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]isis enable 1
[R3]interface LoopBack 0
[R3-LoopBack0]isis enable 1
[R3]interface LoopBack 1
[R3-LoopBack1]isis enable 1
[R3]interface LoopBack 2
[R3-LoopBack2]isis enable 1
[R3]interface LoopBack 3
[R3-LoopBack3]isis enable 1
[R3]interface LoopBack 4
[R3-LoopBack4]isis enable 1
```

Step 4 **Perform configuration task 1.**

Configure R4.

```
[R4]ospf 1
[R4-ospf-1]area 1
[R4-ospf-1-area-0.0.0.1]nssa no-summary
```

Configure R5.

```
[R5]ospf 1
[R5-ospf-1]area 1
[R5-ospf-1-area-0.0.0.1]nssa
```

Step 5 **Perform configuration task 2.**

Configure R1.

```
[R1]acl 2000
[R1-acl-basic-2000]rule   permit source 172.16.0.0 0.0.0.255
[R1-acl-basic-2000]rule   permit source 172.16.1.0 0.0.0.255
[R1-acl-basic-2000]rule   permit source 172.16.2.0 0.0.0.255
[R1-acl-basic-2000]rule   permit source 172.16.3.0 0.0.0.255
[R1]acl 2001
[R1-acl-basic-2001]rule permit source 192.168.1.0 0.0.0.255
```

```
[R1-acl-basic-2001]rule permit source 192.168.2.0 0.0.0.255
[R1-acl-basic-2001]rule permit source 192.168.3.0 0.0.0.255
[R1-acl-basic-2001]rule permit source 192.168.4.0 0.0.0.255
[R1]route-policy I2O permit node 10
[R1-route-policy]if-match acl 2001
[R1]ospf
[R1-ospf-1]import-route isis route-policy I2O
```

Configure R2.

```
[R2]acl 2000
[R2-acl-basic-2000]rule   permit source 172.16.0.0 0.0.0.255
[R2-acl-basic-2000]rule   permit source 172.16.1.0 0.0.0.255
[R2-acl-basic-2000]rule   permit source 172.16.2.0 0.0.0.255
[R2-acl-basic-2000]rule   permit source 172.16.3.0 0.0.0.255
[R2]acl 2001
[R2-acl-basic-2001]rule permit source 192.168.1.0 0.0.0.255
[R2-acl-basic-2001]rule permit source 192.168.2.0 0.0.0.255
[R2-acl-basic-2001]rule permit source 192.168.3.0 0.0.0.255
[R2-acl-basic-2001]rule permit source 192.168.4.0 0.0.0.255
[R2]route-policy O2I permit node 10
[R2-route-policy]if-match acl 2000
[R2]isis 1
[R2-isis-1]import-route ospf route-policy O2I
```

Configure R1.

```
[R1]route-policy ase permit node 10
[R1-route-policy]if-match acl 2000
[R1-route-policy]apply preference 13
[R1]ospf 1
[R1-ospf-1]preference ase route-policy ase 150
```

Step 6 **Perform configuration task 3.**

Configure R1.

```
[R1]route-policy I2O deny node 5
[R1-route-policy]if-match tag 100
[R1]route-policy I2O permit node 10
[R1-route-policy]apply tag 200
[R1]route-policy O2I deny node 5
[R1-route-policy]if-match tag 300
[R1]route-policy O2I permit node 10
```

```
[R1-route-policy]apply tag 400
[R1]isis 1
[R1-isis-1]import-route ospf route-policy O2I
```

Configure R2.

```
[R2]route-policy O2I deny node 5
[R2-route-policy]if-match tag 200
[R2]route-policy O2I permit node 10
[R2-route-policy]apply tag 100
[R2]route-policy I2O deny node 5
[R2-route-policy]if-match tag 400
[R2]route-policy I2O permit node 10
[R2-route-policy]apply tag 300
[R2]ospf 1
[R2-ospf-1]import-route isis route-policy I2O
```

Configure R2.

```
[R2]route-policy ase permit node 10
[R2-route-policy]if-match acl 2000
[R2-route-policy]apply preference 13
[R2]ospf 1
[R2-ospf-1]preference ase route-policy ase 150
```

Step 7 **Perform configuration task 4.**

Configure R5.

```
[R5]ip local policy-based-route test
[R5]acl 2000
[R5-acl-basic-2000]rule permit source 172.16.0.0 0.0.0.255
[R5-acl-basic-2000]rule permit source 172.16.2.0 0.0.0.255
[R5]acl 2001
[R5-acl-basic-2001]rule permit source 172.16.1.0 0.0.0.255
[R5-acl-basic-2001]rule permit source 172.16.3.0 0.0.0.255
[R5]policy-based-route test permit node 10
[R5-policy-based-route-test-10]if-match acl 2000
[R5-policy-based-route-test-10]apply output-interface Serial 1/0/0
[R5]policy-based-route test permit node 20
[R5-policy-based-route-test-20]if-match acl 2001
[R5-policy-based-route-test-20]apply output-interface Serial 1/0/1
```

10.3 Quiz

Are there any other methods to complete the tasks?

10.4 Reference Configuration

10.4.1 R1's Configuration

```
#
<R1>dis cur
#
sysname R1
#
acl number 2000
 rule 5 permit source 172.16.0.0 0.0.0.255
 rule 10 permit source 172.16.1.0 0.0.0.255
 rule 15 permit source 172.16.2.0 0.0.0.255
 rule 20 permit source 172.16.3.0 0.0.0.255
#
acl number 2001
 rule 5 permit source 192.168.1.0 0.0.0.255
 rule 10 permit source 192.168.2.0 0.0.0.255
 rule 15 permit source 192.168.3.0 0.0.0.255
 rule 20 permit source 192.168.4.0 0.0.0.255
#
isis 1
 is-level level-2
 cost-style wide
 network-entity 49.0010.0100.1001.00
 import-route ospf 1 route-policy O2I
#
interface GigabitEthernet0/0/0
 ip address 13.1.1.1 255.255.255.252
 isis enable 1
#
interface GigabitEthernet0/0/1
 ip address 41.1.1.2 255.255.255.252
```

```
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
 isis enable 1
#
ospf 1 router-id 1.1.1.1
 import-route isis 1 route-policy I2O
 preference ase route-policy ase 150
 area 0.0.0.0
  network 1.1.1.1 0.0.0.0
  network 41.1.1.0 0.0.0.3
#
route-policy I2O deny node 5
 if-match tag 100
#
route-policy I2O permit node 10
 if-match acl 2001
 apply tag 200
#
route-policy ase permit node 10
 if-match acl 2000
 apply preference 13
#
route-policy O2I deny node 5
 if-match tag 300
#
route-policy O2I permit node 10
 apply tag 400
#
return
```

10.4.2 R2's Configuration

```
<R2>dis cur
#
sysname R2
#
acl number 2000
 rule 5 permit source 172.16.0.0 0.0.0.255
```

```
 rule 10 permit source 172.16.1.0 0.0.0.255
 rule 15 permit source 172.16.2.0 0.0.0.255
 rule 20 permit source 172.16.3.0 0.0.0.255
#
acl number 2001
 rule 5 permit source 192.168.1.0 0.0.0.255
 rule 10 permit source 192.168.2.0 0.0.0.255
 rule 15 permit source 192.168.3.0 0.0.0.255
 rule 20 permit source 192.168.4.0 0.0.0.255
#
isis 1
 is-level level-2
 cost-style wide
 network-entity 49.0020.0200.2002.00
 import-route ospf 1 route-policy O2I
#
interface GigabitEthernet0/0/0
 ip address 23.1.1.1 255.255.255.252
 isis enable 1
#
interface GigabitEthernet0/0/1
 ip address 42.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
 isis enable 1
#
ospf 1 router-id 2.2.2.2
 import-route isis 1 route-policy I2O
 preference ase route-policy ase 150
 area 0.0.0.0
  network 2.2.2.2 0.0.0.0
  network 42.1.1.0 0.0.0.3
#
route-policy O2I deny node 5
 if-match tag 200
#
route-policy O2I permit node 10
```

```
 if-match acl 2000
 apply tag 100
#
route-policy I2O deny node 5
 if-match tag 400
#
route-policy I2O permit node 10
 apply tag 300
#
route-policy ase permit node 10
 if-match acl 2000
 apply preference 13
#
return
```

10.4.3 R3's Configuration

```
<R3>dis cur
#
sysname R3
#
isis 1
 is-level level-2
 cost-style wide
 network-entity 49.0030.0300.3003.00
#
interface GigabitEthernet0/0/0
 ip address 13.1.1.2 255.255.255.252
 isis enable 1
#
interface GigabitEthernet0/0/1
 ip address 23.1.1.2 255.255.255.252
 isis enable 1
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
 isis enable 1
#
interface LoopBack1
```

```
 ip address 192.168.1.1 255.255.255.0
 isis enable 1
#
interface LoopBack2
 ip address 192.168.2.1 255.255.255.0
 isis enable 1
#
interface LoopBack3
 ip address 192.168.3.1 255.255.255.0
 isis enable 1
#
interface LoopBack4
 ip address 192.168.4.1 255.255.255.0
 isis enable 1
#
return
```

10.4.4 R4's Configuration

```
<R4>dis cur
[V200R003C00]
#
 sysname R4
#
 board add 0/1 2SA
#
interface Serial1/0/0
 link-protocol ppp
 ip address 54.1.1.2 255.255.255.252
#
interface Serial1/0/1
 link-protocol ppp
 ip address 54.2.2.2 255.255.255.252
#
interface GigabitEthernet0/0/0
 ip address 41.1.1.1 255.255.255.252
#
interface GigabitEthernet0/0/1
 ip address 42.1.1.1 255.255.255.252
```

```
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 4.4.4.4 0.0.0.0
  network 41.1.1.0 0.0.0.3
  network 42.1.1.0 0.0.0.3
 area 0.0.0.1
  network 54.1.1.0 0.0.0.3
  network 54.2.2.0 0.0.0.3
  nssa no-summary
#
return
```

10.4.5 R5's Configuration

```
[R5]dis cur
[V200R003C00]
#
 sysname R5
#
 board add 0/1 2SA
#
ip local policy-based-route test
#
acl number 2000
 rule 5 permit source 172.16.0.0 0.0.0.255
 rule 10 permit source 172.16.2.0 0.0.0.255
acl number 2001
 rule 5 permit source 172.16.1.0 0.0.0.255
 rule 10 permit source 172.16.3.0 0.0.0.255
#
interface Serial1/0/0
 link-protocol ppp
 ip address 54.1.1.1 255.255.255.252
#
interface Serial1/0/1
```

```
 link-protocol ppp
 ip address 54.2.2.1 255.255.255.252
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
interface LoopBack1
 ip address 172.16.0.1 255.255.255.0
#
interface LoopBack2
 ip address 172.16.1.1 255.255.255.0
#
interface LoopBack3
 ip address 172.16.2.1 255.255.255.0
#
interface LoopBack4
 ip address 172.16.3.1 255.255.255.0
#
ospf 1 router-id 5.5.5.5
 import-route direct route-policy r5
 area 0.0.0.1
  network 5.5.5.5 0.0.0.0
  network 54.1.1.0 0.0.0.3
  network 54.2.2.0 0.0.0.3
  nssa
#
route-policy r5 permit node 10
 if-match ip-prefix r5
#
ip ip-prefix r5 index 10 permit 172.16.0.0 16 greater-equal 24 less-equal 24
#
policy-based-route test permit node 10
 if-match acl 2000
 apply output-interface Serial1/0/0
policy-based-route test permit node 20
 if-match acl 2001
 apply output-interface Serial1/0/1
#
```

return

11 SPT Switchover Configuration in a PIM-SM Domain

11.1 Introduction

11.1.1 About This Lab

Protocol Independent Multicast (PIM) implements multicast routing and data forwarding in an autonomous system (AS). Protocol Independent Multicast - Sparse Mode (PIM-SM) applies to a large-scale network with sparsely distributed group members. Key PIM-SM mechanisms include neighbor discovery, Assert, designated router (DR) election, rendezvous point (RP) discovery, Join, Prune, Register, and shortest path tree (SPT) switchover.

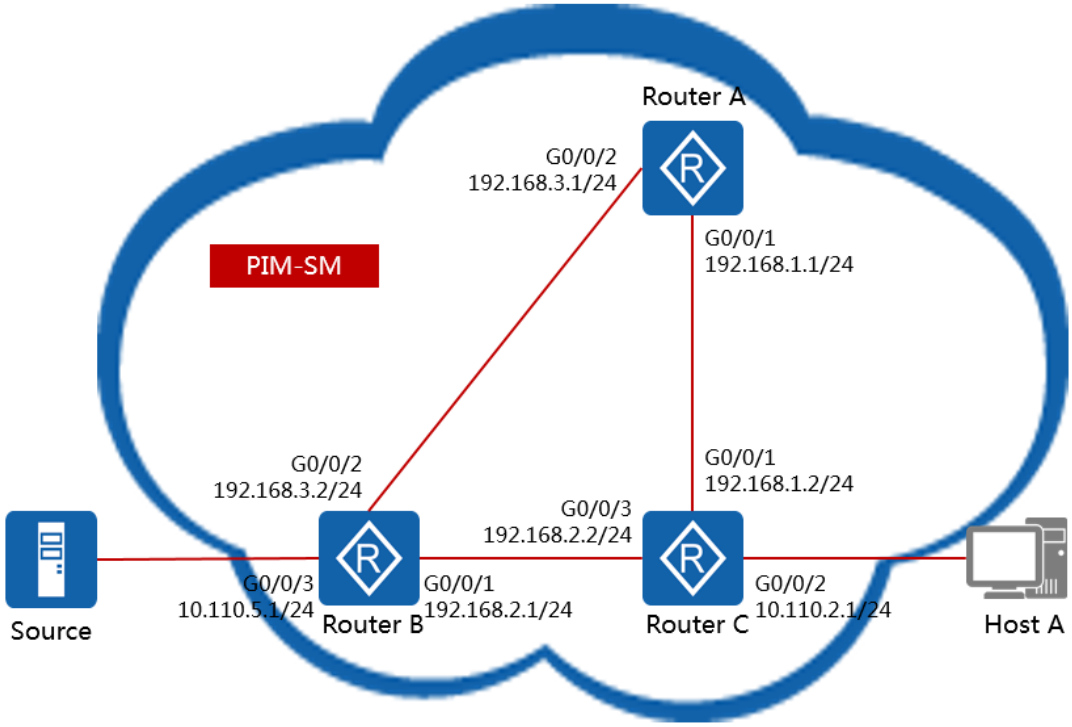
This chapter describes the basic configuration of PIM-SM. Upon completion of this task, you will be able to learn how to configure multicast routing protocols on Huawei devices.

11.1.2 Objectives

Upon completion of this task, you will be able to learn how to configure PIM-SM.

11.1.3 Networking Topology

Figure 11-1 Topology for configuring an SPT switchover in a PIM-SM domain



11.1.4 Networking Design

Receivers can receive the Video On Demand (VOD) information in multicast mode. The SM-single BootStrap router (BSR) administrative domain is adopted in the entire PIM network. By default, the DR on the receiver side and the RP perform an SPT switchover immediately after receiving the first multicast data packet, and choose the optimal path to receive information from the source. If a receiver wants to perform an SPT switchover after traffic reaches a specified threshold, you need to configure an SPT switchover.

As shown in the figure, it is required to perform proper configuration on routers. Host A on the network can receive multicast data from the RP (G0/0/1 of Router A). When the rate for forwarding multicast data reaches 1024 kbit/s, an SPT switchover is performed (After the SPT switchover, the path used by Host A to receive multicast data is Source-Router B-Router C-Host A).

Table 11-1 Device interface parameter design

Device	Interface	IP Address
Router A	G0/0/1	192.168.1.1/24

	G0/0/2	192.168.3.1/24
Router B	G0/0/1	192.168.2.1/24
	G0/0/2	192.168.3.2/24
	G0/0/3	10.110.5.1/24
Router C	G0/0/1	192.168.1.2/24
	G0/0/2	10.110.2.1/24
	G0/0/3	192.168.2.2/24

11.2 Configuration

11.2.1 Configuration Roadmap

1. Configure an IP address for each router interface and configure a unicast routing protocol.
2. Enable multicast on each router, PIM-SM on each interface, and IGMP on the interface connected to the host.
3. Configure the same static RP address on all the routers.
4. Configure the SPT switchover on Router C.

11.2.2 Configuration Procedure

Step 1 **Configure an IP address for each router interface and configure a unicast routing protocol.**

Configure an IP address and mask for each interface according to the plan, and configure OSPF on each router to ensure that the routers can communicate at the network-layer and can dynamically update routes through the unicast routing protocol.

Configure an IP address for each interface on each router.

```
[Huawei]sysname RouterA

[RouterA]interface GigabitEthernet 0/0/1
```

[RouterA-GigabitEthernet0/0/1]ip address 192.168.1.1 24

[RouterA-GigabitEthernet0/0/1]quit

[RouterA]interface GigabitEthernet 0/0/2

[RouterA-GigabitEthernet0/0/2]ip address 192.168.3.1 24

[RouterA-GigabitEthernet0/0/2]quit

[RouterA]

[Huawei]sysname RouterB

[RouterB]int GigabitEthernet 0/0/1

[RouterB-GigabitEthernet0/0/1]ip address 192.168.1.2 24

[RouterB-GigabitEthernet0/0/1]quit

[RouterB]int gi0/0/2

[RouterB-GigabitEthernet0/0/2]ip address 10.110.2.1 24

[RouterB-GigabitEthernet0/0/2]quit

[RouterB]interface gi0/0/3

[RouterB-GigabitEthernet0/0/3]ip address 192.168.2.2 24

[RouterB-GigabitEthernet0/0/3]quit

[RouterB]

<Huawei>sy

Enter system view, return user view with Ctrl+Z.

[Huawei]sysname RouterC

```
[RouterC]int gi0/0/1
[RouterC-GigabitEthernet0/0/1]ip address 192.168.1.2 24
[RouterC-GigabitEthernet0/0/1]quit
[RouterC]int gi0/0/2
[RouterC-GigabitEthernet0/0/2]ip address 10.110.2.1 24
[RouterC-GigabitEthernet0/0/2]quit
[RouterC]int gi0/0/3
[RouterC-GigabitEthernet0/0/3]ip address 192.168.2.2 24
[RouterC-GigabitEthernet0/0/3]quit
```

Configure OSPF.

```
[RouterA]ospf 1
[RouterA-ospf-1]area 0
[RouterA-ospf-1-area-0.0.0.0]network 192.168.1.1 0.0.0.0
[RouterA-ospf-1-area-0.0.0.0]network 192.168.3.1 0.0.0.0
[RouterA-ospf-1-area-0.0.0.0]quit
[RouterA-ospf-1]quit
[RouterA]
```

```
[RouterB]ospf 1
[RouterB-ospf-1]area 0
[RouterB-ospf-1-area-0.0.0.0]network 192.168.2.1 0.0.0.0
```

```
[RouterB-ospf-1-area-0.0.0.0]network 192.168.3.2 0.0.0.0

[RouterB-ospf-1-area-0.0.0.0]network 10.110.5.1 0.0.0.0

[RouterB-ospf-1-area-0.0.0.0]quit

[RouterB-ospf-1]quit

[RouterB]
```

```
[RouterC]ospf 1

[RouterC-ospf-1]area 0

[RouterC-ospf-1-area-0.0.0.0]network 192.168.1.2 0.0.0.0

[RouterC-ospf-1-area-0.0.0.0]network 192.168.2.2 0.0.0.0

[RouterC-ospf-1-area-0.0.0.0]network 10.110.2.1 0.0.0.0

[RouterC-ospf-1]quit

[RouterC]
```

Step 2 **Enable multicast.**

Enable multicast on each router, PIM-SM on each interface, and IGMP on Router C's interface connected to the host.

```
[RouterA]multicast routing-enable

[RouterA]interface GigabitEthernet 0/0/1

[RouterA-GigabitEthernet0/0/1]pim sm

[RouterA-GigabitEthernet0/0/1]quit
```

```
[RouterA]interface GigabitEthernet 0/0/2
```

[RouterA-GigabitEthernet0/0/2]pim sm

[RouterA-GigabitEthernet0/0/2]quit

[RouterA]

[RouterB]multicast routing-enable

[RouterB]int GigabitEthernet 0/0/1

[RouterB-GigabitEthernet0/0/1]pim sm

[RouterB-GigabitEthernet0/0/1]quit

[RouterB]interface GigabitEthernet 0/0/2

[RouterB-GigabitEthernet0/0/2]pim sm

[RouterB-GigabitEthernet0/0/2]quit

[RouterB]

[RouterB]interface GigabitEthernet 0/0/3

[RouterB-GigabitEthernet0/0/3]pim sm

[RouterB-GigabitEthernet0/0/3]igmp enable

[RouterB-GigabitEthernet0/0/3]quit

[RouterB]

[RouterC]multicast routing-enable

[RouterC]interface GigabitEthernet 0/0/1

[RouterC-GigabitEthernet0/0/1]pim sm

[RouterC-GigabitEthernet0/0/1]quit

```
[RouterC]interface GigabitEthernet 0/0/2
[RouterC-GigabitEthernet0/0/2]pim sm
[RouterC-GigabitEthernet0/0/2]igmp enable
[RouterC-GigabitEthernet0/0/2]quit
[RouterC]interface GigabitEthernet 0/0/3
[RouterC-GigabitEthernet0/0/3]pim sm
[RouterC-GigabitEthernet0/0/3]quit
[RouterC]
```

Display information about PIM interfaces.

```
<RouterA>display pim neighbor
 VPN-Instance: public net
 Total Number of Neighbors = 2

 Neighbor          Interface          Uptime    Expires  Dr-Priority  BFD-Session
 192.168.1.2       GE0/0/1            00:02:11 00:01:34 1            N
 192.168.3.2       GE0/0/2            00:48:56 00:01:19 1            N
<RouterA>
```

```
[RouterB]display pim neighbor
 VPN-Instance: public net
 Total Number of Neighbors = 2
```

Neighbor	Interface	Uptime	Expires	Dr-Priority	BFD-Session
192.168.2.2	GE0/0/1	00:02:06	00:01:39	1	N
192.168.3.1	GE0/0/2	00:49:06	00:01:33	1	N

[RouterB]

Step 3 **Configure a static RP.**

Configure a static RP on Router A, Router B, and Router C.

[RouterA]pim

[RouterA-pim]static-rp 192.168.1.1

[RouterA-pim]quit

[RouterA]

[RouterB]pim

[RouterB-pim]static-rp 192.168.1.1

[RouterB-pim]quit

[RouterB]

[RouterC]pim

[RouterC-pim]static-rp 192.168.1.1

[RouterC-pim]quit

[RouterC]

Configure a threshold of an SPT switchover.

Configure Router C to perform an SPT switchover when the rate of multicast data packets reaches 1024 kbit/s.

```
[RouterC]pim

[RouterC-pim]spt-switch-threshold 1024

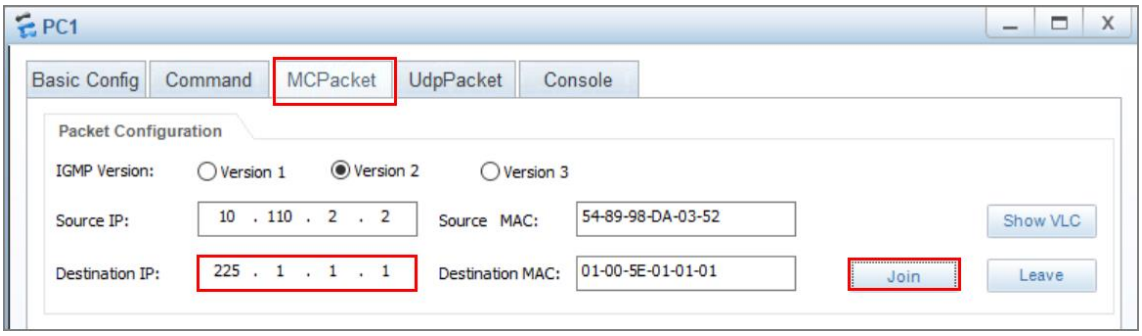
[RouterC-pim]quit

[RouterC]
```

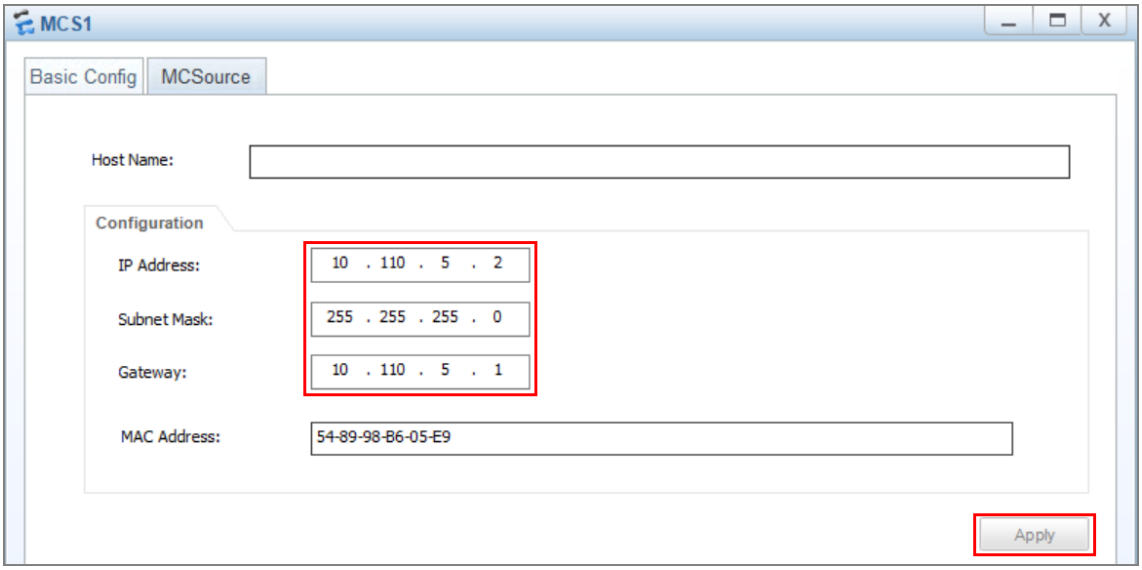
11.3 Verification

11.3.1 Verifying the Configuration

Set the IP address of the receiver.



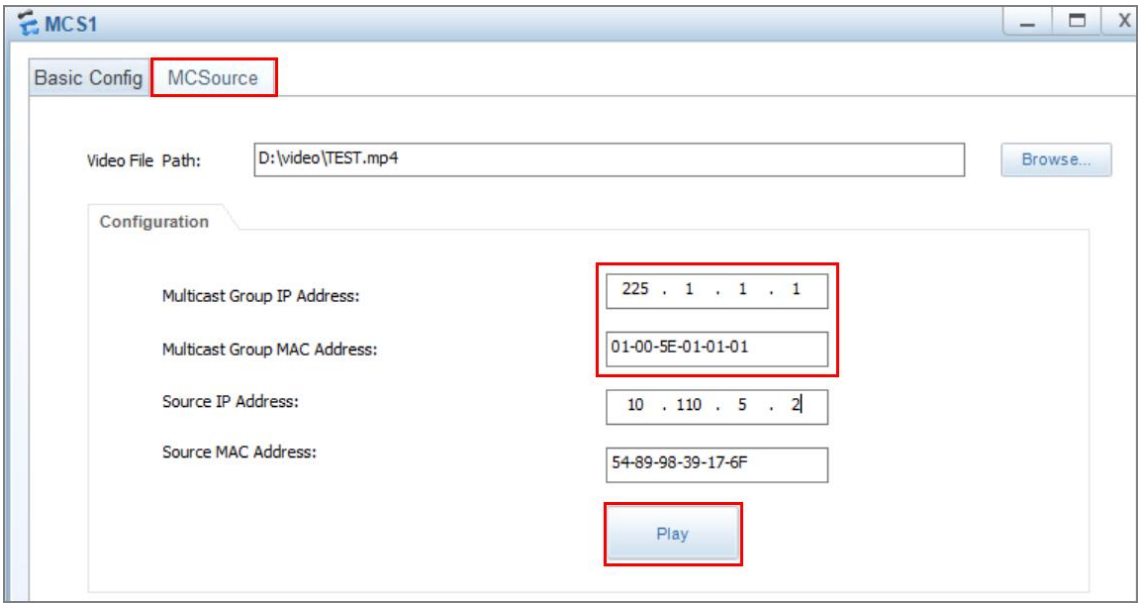
Set the IP address of the multicast source, and configure Router B as the gateway.



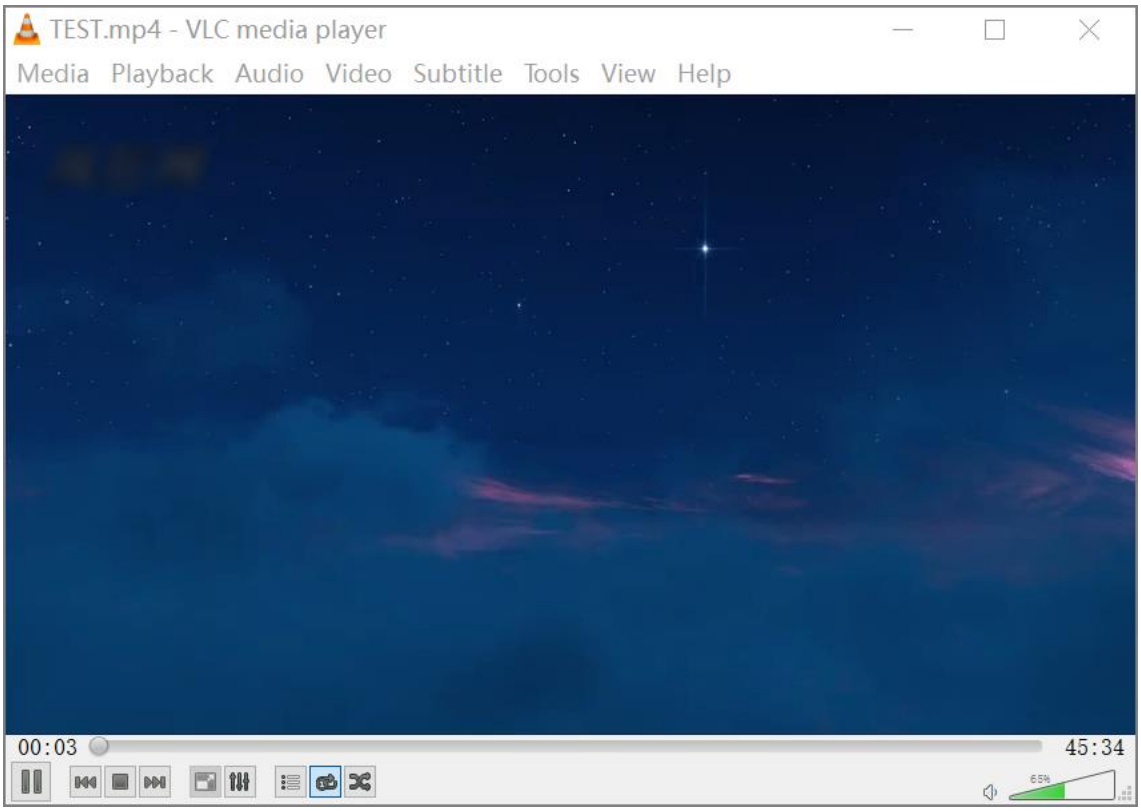
The source IP address and MAC address automatically match those in the basic configuration.

Set the multicast group IP address to 225.1.1.1, and then click the text box for **Multicast Group MAC Address** to automatically generate the multicast group MAC address.

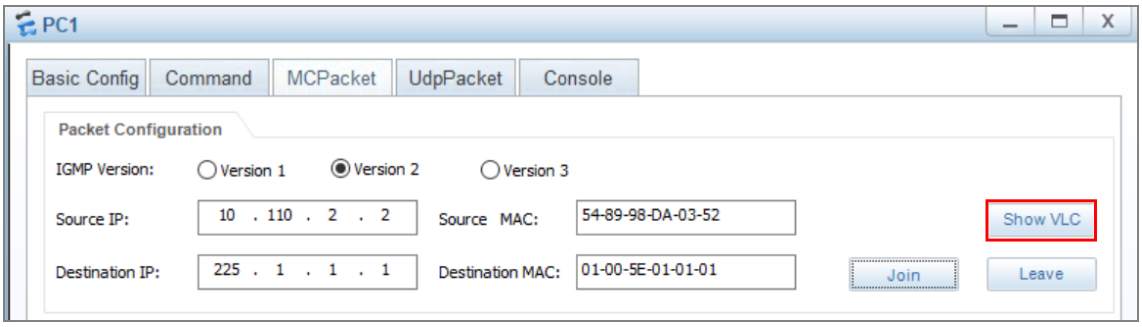
After the address configuration is complete, click **Browse**, select a video file in .mp4 format, and click **Play**, as shown in the following figure.

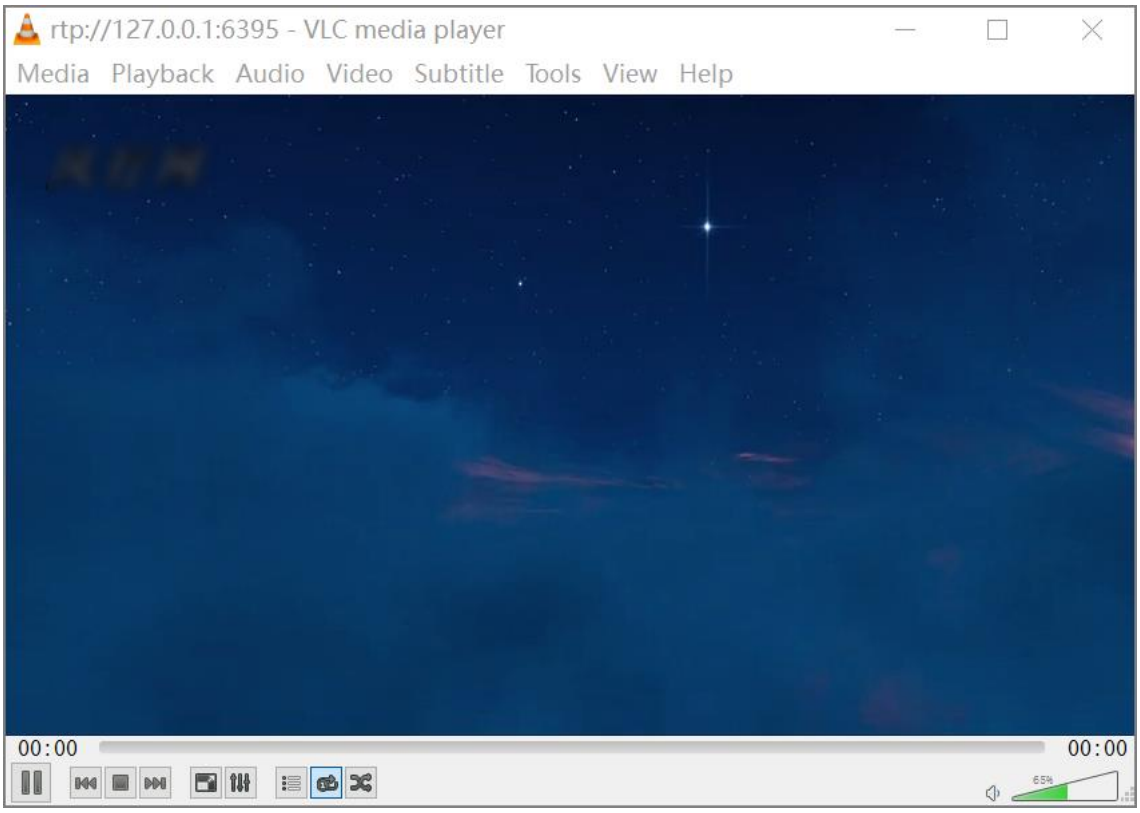


The multicast source starts to send data (that is, video traffic) to the multicast group.



Host A can receive data from the multicast source.





When the rate is lower than 1024 kbit/s (the video startup time is about 5s), run the **display pim routing-table** command on Router C to view the PIM routing table. The command output shows that the upstream neighbor is Router A.

```
<R3>display pim routing-table

 VPN-Instance: public net

 Total 1 (*, G) entry; 2 (S, G) entries



 (*, 225.1.1.1)

      RP: 192.168.1.1

      Protocol: pim-sm, Flag: WC

      UpTime: 00:05:15

      Upstream interface: GigabitEthernet0/0/1
```

Upstream neighbor: 192.168.1.1

RPF prime neighbor: 192.168.1.1

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: igmp, UpTime: 00:05:15, Expires: -

(10.110.5.1, 225.1.1.1)

RP: 192.168.1.1

Protocol: pim-sm, Flag: ACT

UpTime: 00:02:05

Upstream interface: GigabitEthernet0/0/1

Upstream neighbor: 192.168.1.1

RPF prime neighbor: 192.168.1.1

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: pim-sm, UpTime: 00:02:05, Expires: -

(192.168.2.2, 225.1.1.1)

RP: 192.168.1.1

Protocol: pim-sm, Flag: RPT SPT LOC ACT

```
    UpTime: 00:02:53
    Upstream interface: GigabitEthernet0/0/3
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/2
            Protocol: pim-sm, UpTime: 00:02:53, Expires: -
<R3>
```

When the rate is higher than 1024 kbit/s, run the **display pim routing-table** command on Router C to view the PIM routing table. The command output shows that the upstream neighbor is Router B, indicating that the SPT switchover succeeds.

```
<R3>display pim routing-table
 VPN-Instance: public net
 Total 1 (*, G) entry; 1 (S, G) entry


 (*, 225.1.1.1)
     RP: 192.168.1.1
     Protocol: pim-sm, Flag: WC
     UpTime: 00:08:48
     Upstream interface: GigabitEthernet0/0/1
         Upstream neighbor: 192.168.1.1
```

RPF prime neighbor: 192.168.1.1

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: igmp, UpTime: 00:08:48, Expires: -

(10.110.5.2, 225.1.1.1)

RP: 192.168.1.1

Protocol: pim-sm, Flag: RPT SPT ACT

UpTime: 00:00:44

Upstream interface: GigabitEthernet0/0/3

Upstream neighbor: 192.168.2.1

RPF prime neighbor: 192.168.2.1

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: pim-sm, UpTime: 00:00:44, Expires: -

<R3>

11.3.2 Router A's Configuration

#

```
sysname RouterA
#
multicast routing-enable
#
interface GigabitEthernet0/0/1
 ip address 192.168.1.1 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/2
 ip address 192.168.3.1 255.255.255.0
 pim sm
#
ospf 1
 area 0.0.0.0
  network 192.168.1.1 0.0.0.0
  network 192.168.3.1 0.0.0.0
#
pim
 static-rp 192.168.1.1
#
return
[RouterA]
```

11.3.3 Router B's Configuration

```
#
sysname RouterB
#
multicast routing-enable
#
interface GigabitEthernet0/0/1
 ip address 192.168.2.1 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/2
 ip address 192.168.3.2 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/3
 ip address 10.110.5.1 255.255.255.0
 pim sm
#
ospf 1
 area 0.0.0.0
  network 192.168.2.1 0.0.0.0
```

```
  network 192.168.3.2 0.0.0.0
  network 10.110.5.1 0.0.0.0
#
pim
 static-rp 192.168.1.1
 spt-switch-threshold 1024
#
return
<R2>
```

11.3.4 Router C's Configuration

```
#
sysname RouterC
#
multicast routing-enable
#
interface GigabitEthernet0/0/1
 ip address 192.168.1.2 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/2
 ip address 10.110.2.1 255.255.255.0
```

```
 pim sm
 igmp enable
#
interface GigabitEthernet0/0/3
 ip address 192.168.2.2 255.255.255.0
 pim sm
#
ospf 1
 area 0.0.0.0
  network 10.110.2.1 0.0.0.0
  network 192.168.2.2 0.0.0.0
  network 192.168.1.2 0.0.0.0
#
igmp
#
pim
 static-rp 192.168.1.1
 spt-switch-threshold 1024
#
return
<RouterC>
```

12 PIM-SSM Configuration

12.1 Introduction

12.1.1 About This Lab

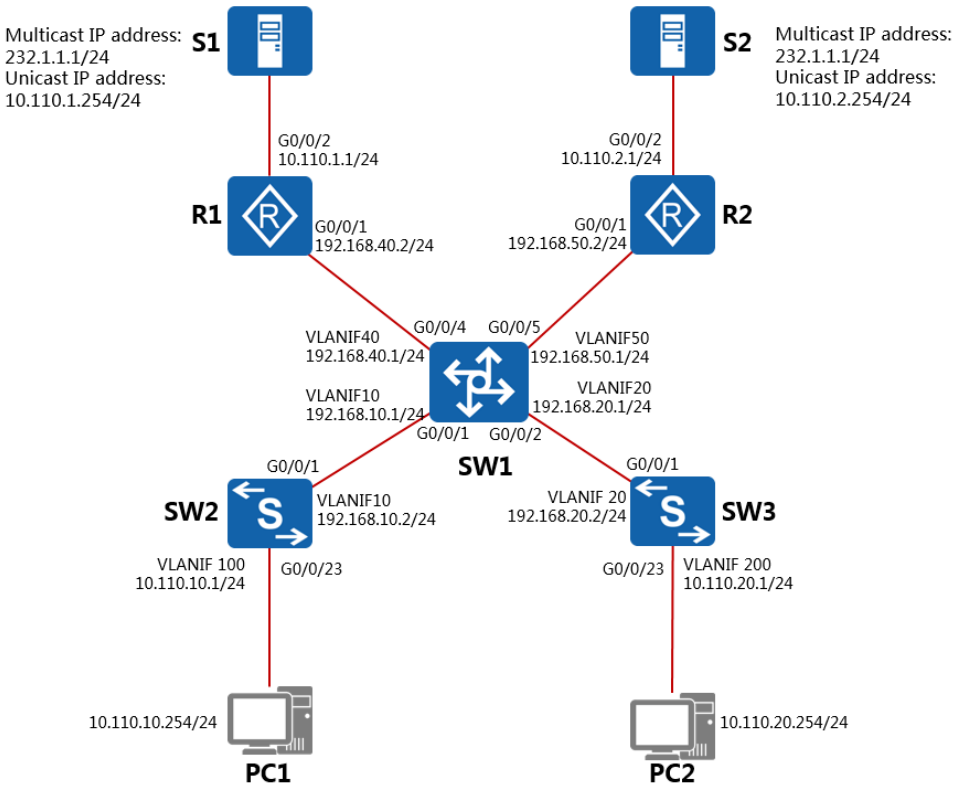
This chapter describes how to configure Protocol Independent Multicast - Source-Specific Multicast (PIM-SSM).

12.1.2 Objectives

Upon completion of this task, you will be able to learn how to configure PIM-SSM.

12.1.3 Networking Topology

Figure 12-1 Topology for configuring PIM-SSM



12.1.4 Networking Design

Configure PIM-SM on the routers to enable them to provide the SSM service for the user hosts PC1 and PC2 on the network. The hosts in a multicast group can then receive VOD information from specified sources to this group.

Enable OSPF on R1, R2, SW1, SW2, and SW3 to implement network-side interworking.

Configure the same multicast group IP address on S1 and S2. Run IGMPv3 on SW2 and SW3. Specify different sources for PC1 and PC2 so that they obtain traffic from the corresponding sources.

Table 12-1 Device interface parameter design

Device	Interface	IP Address
S1	Unicast address	10.110.1.254/24
	Multicast group address	232.1.1.1/24
S2	Unicast address	10.110.2.254/24
	Multicast group address	232.1.1.1/24
R1	G0/0/1	192.168.40.2/24
	G0/0/2	10.110.1.1/24
R2	G0/0/1	192.168.50.2/24
	G0/0/2	10.110.2.1/24
SW1	VLANIF10	192.168.10.1/24
	VLANIF20	192.168.20.1/24
	VLANIF40	192.168.40.1/24
	VLANIF50	192.168.50.1/24
SW2	VLANIF10	192.168.10.2/24
	VLANIF100	10.110.10.1/24

SW3	VLANIF20	192.168.30.2/24
	VLANIF200	192.168.20.1/24
PC1	Eth0/0/1	10.110.10.254/24
PC2	Eth0/0/1	10.110.20.254/24

12.2 Configuration

12.2.1 Configuration Roadmap

1. Configure an IP address for each router interface and configure a unicast routing protocol. PIM is an intra-domain multicast routing protocol that depends on unicast routing protocols.
2. Enable multicast on all multicast routers. Before configuring PIM-SM, you must enable multicast.
3. Enable PIM-SM on all interfaces of the multicast routers. You can configure other PIM-SM functions only after PIM-SM is enabled.
4. Enable IGMP on the interfaces connected to the hosts, and set the IGMP version to IGMPv3. A receiver can join and leave a multicast group of a specified source by sending IGMP messages. The leaf routers maintain the multicast member relationship through IGMP.
5. Set an SSM group address range on all routers, so that the multicast routers in the PIM-SM domain provide services for the multicast groups in the SSM group address range.

12.2.2 Configuration Procedure

Step 1 **Assign IP addresses to interfaces and configure a unicast routing protocol.**

Configure an IP address and mask for each interface according to the plan, and configure OSPF on each router to ensure that the routers can communicate at the network-layer and can dynamically update routes through the unicast routing protocol.

Configure R1.

```
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 192.168.40.2 24
[R1-GigabitEthernet0/0/1]quit
[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ip address 10.110.1.1 24
[R1-GigabitEthernet0/0/2]quit
[R1]interface  LoopBack 0
[R1-LoopBack0]ip address 1.1.1.1 32
[R1-LoopBack0]quit
[R1]
```

```
[R1]ospf 1 router-id 1.1.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]network 10.110.1.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]network 192.168.40.2 0.0.0.0
[R1-ospf-1-area-0.0.0.0]quit
```

Configure R2.

```
[R2]multicast routing-enable
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ip address 192.168.50.2 24
```

```
[R2-GigabitEthernet0/0/1]quit

[R2]interface GigabitEthernet 0/0/2

[R2-GigabitEthernet0/0/2]ip address 10.110.2.1 24

[R2-GigabitEthernet0/0/2]quit

[R2]interface  LoopBack 0

[R2-LoopBack0]ip address 2.2.2.2 32

[R2-LoopBack0]quit

[R2]
```

```
[R2]ospf 1 router-id 2.2.2.2

[R2-ospf-1]area 0

[R2-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0

[R2-ospf-1-area-0.0.0.0]network 10.110.2.1 0.0.0.0

[R2-ospf-1-area-0.0.0.0]network 192.168.50.2 0.0.0.0

[R2-ospf-1-area-0.0.0.0]quit
```

Configure SW1.

```
[SW1]vlan batch 10 20 40 50

[SW1]int vlan 10

[SW1-Vlanif10]ip address 192.168.10.1 24

[SW1-Vlanif10]quit

[SW1]int vlan 20
```

```
[SW1-Vlanif20]ip address 192.168.20.1 24

[SW1-Vlanif20]quit

[SW1]int vlan 40

[SW1-Vlanif40]ip address 192.168.40.1 24

[SW1-Vlanif40]quit

[SW1]int vlan 50

[SW1-Vlanif50]ip address 192.168.50.1 24

[SW1-Vlanif50]quit

[SW1]interface  LoopBack 0

[SW1-LoopBack0]ip address 10.10.10.10 32

[SW1-LoopBack0]quit

[SW1]


[SW1]ospf 1 router-id 10.10.10.10

[SW1-ospf-1]area 0

[SW1-ospf-1-area-0.0.0.0]network 10.10.10.10 0.0.0.0

[SW1-ospf-1-area-0.0.0.0]network 192.168.10.1 0.0.0.0

[SW1-ospf-1-area-0.0.0.0]network 192.168.20.1 0.0.0.0

[SW1-ospf-1-area-0.0.0.0]network 192.168.40.1 0.0.0.0

[SW1-ospf-1-area-0.0.0.0]network 192.168.50.1 0.0.0.0

[SW1-ospf-1-area-0.0.0.0]quit
```

Configure SW2.

```
[SW2]vlan batch 10 100

[SW2]int vlan 10

[SW2-Vlanif10]ip address 192.168.10.2 24

[SW2-Vlanif10]quit

[SW2]int vlan 100

[SW2-Vlanif100]ip address 10.110.10.1 24

[SW2-Vlanif100]quit

[SW2]interface  LoopBack 0

[SW2-LoopBack0]ip address 20.20.20.20 32

[SW2-LoopBack0]quit

[SW2]


[SW2]ospf 1 router-id 10.10.10.10

[SW2-ospf-1]area 0

[SW2-ospf-1-area-0.0.0.0]network 20.20.20.20 0.0.0.0

[SW2-ospf-1-area-0.0.0.0]network 192.168.10.2 0.0.0.0

[SW2-ospf-1-area-0.0.0.0]network 10.110.10.1 0.0.0.0

[SW2-ospf-1-area-0.0.0.0]quit
```

Configure SW3.

```
[SW3]vlan batch 20 200

[SW3]int vlan 20

[SW3-Vlanif20]ip address 192.168.20.2 24

[SW3-Vlanif20]quit

[SW3]int vlan 200

[SW3-Vlanif200]ip address 10.110.20.1 24

[SW3-Vlanif200]quit

[SW3]interface LoopBack 0

[SW3-LoopBack0]ip address 30.30.30.30 32

[SW3-LoopBack0]quit

[SW3]


[SW3]ospf 1 router-id 30.30.30.30

[SW3-ospf-1]area 0

[SW3-ospf-1-area-0.0.0.0]network 30.30.30.30 0.0.0.0

[SW3-ospf-1-area-0.0.0.0]network 192.168.20.2 0.0.0.0

[SW3-ospf-1-area-0.0.0.0]network 10.110.20.1 0.0.0.0

[SW3-ospf-1-area-0.0.0.0]quit
```

Check the OSPF neighbor relationship on SW1.

```
<SW1>display ospf peer brief
```

OSPF Process 1 with Router ID 192.168.10.1

Peer Statistic Information

Area Id	Interface	Neighbor id	State
0.0.0.0	Vlanif10	192.168.10.2	Full
0.0.0.0	Vlanif20	192.168.20.2	Full
0.0.0.0	Vlanif40	192.168.40.2	Full
0.0.0.0	Vlanif50	192.168.50.2	Full

<SW1>

Step 2 **Configure multicast and enable PIM-SM and IGMPv3.**

Enable multicast, and enable PIM-SM on all interfaces.

Configure R1.

```
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]pim sm
[R1-GigabitEthernet0/0/1]quit
[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]pim sm
[R1-GigabitEthernet0/0/2]quit
[R1]interface  LoopBack 0
[R1-LoopBack0]pim sm
[R1-LoopBack0]quit
```

```
[R1]
```

Configure R2.

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]pim sm
[R2-GigabitEthernet0/0/1]quit
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]pim sm
[R2-GigabitEthernet0/0/2]quit
[R2]interface  LoopBack 0
[R2-LoopBack0]pim sm
[R2-LoopBack0]quit
[R2]
```

Configure SW1.

```
[SW1]multicast routing-enable
[SW1]int vlan 10
[SW1-Vlanif10]pim sm
[SW1-Vlanif10]quit
[SW1]int vlan 20
[SW1-Vlanif20]pim sm
```

```
[SW1-Vlanif20]quit
[SW1]int vlan 40
[SW1-Vlanif40]pim sm
[SW1-Vlanif40]quit
[SW1]int vlan 50
[SW1-Vlanif50]pim sm
[SW1-Vlanif50]quit
[SW1]interface  LoopBack 0
[SW1-LoopBack0]pim sm
[SW1-LoopBack0]quit
[SW1]
```

Configure SW2.

```
[SW2]multicast routing-enable
[SW2]int vlan 10
[SW2-Vlanif10]pim sm
[SW2-Vlanif10]quit
[SW2]int vlan 100
[SW2-Vlanif100]pim sm
[SW2-Vlanif100]quit
[SW2]interface  LoopBack 0
[SW2-LoopBack0]pim sm
```

```
[SW2-LoopBack0]quit
[SW2]
```

Configure SW3.

```
[SW3]multicast routing-enable
[SW3]int vlan 20
[SW3-Vlanif20]pim sm
[SW3-Vlanif20]quit
[SW3]int vlan 200
[SW3-Vlanif200]pim sm
[SW3-Vlanif200]quit
[SW3]interface LoopBack 0
[SW3-LoopBack0]pim sm
[SW3-LoopBack0]quit
[SW3]
```

Enable IGMP on the interfaces connected to the hosts, and set the IGMP version to IGMPv3.

```
[SW2]interface Vlanif 100
[SW2-Vlanif100]igmp enable
[SW2-Vlanif100]igmp version 3
[SW2-Vlanif100]quit
```

```
[SW2]igmp
[SW2-igmp]version 3
[SW2-igmp]quit
[SW2]
```

```
[SW3]interface Vlanif 200
[SW3-Vlanif200]igmp enable
[SW3-Vlanif200]igmp version 3
[SW3-Vlanif200]quit
[SW3]igmp
[SW3-igmp]version 3
[SW3-igmp]quit
[SW3]
```

Step 3 **(Optional) Configure an SSM group address range.**

Set an SSM group address range to 232.1.1.0/24 on all routers.

```
[R1]acl 2000
[R1-acl-basic-2000]rule permit source 232.1.1.0 0.0.0.255
[R1-acl-basic-2000]quit
[R1]pim
[R1-pim]ssm-policy 2000
[R1-pim]quit
```

[R1]

[R2]acl 2000

[R2-acl-basic-2000]rule permit source 232.1.1.0 0.0.0.255

[R2-acl-basic-2000]quit

[R2]pim

[R2-pim]ssm-policy 2000

[R2-pim]quit

[R2]

[SW1]acl 2000

[SW1-acl-basic-2000]rule permit source 232.1.1.0 0.0.0.255

[SW1-acl-basic-2000]quit

[SW1]pim

[SW1-pim]ssm-policy 2000

[SW1-pim]quit

[SW1]

[SW2]acl 2000

[SW2-acl-basic-2000]rule permit source 232.1.1.0 0.0.0.255

[SW2-acl-basic-2000]quit

[SW2]pim

[SW2-pim]ssm-policy 2000

[SW2-pim]quit

[SW2]

[SW3]acl 2000

[SW3-acl-basic-2000]rule permit source 232.1.1.0 0.0.0.255

[SW3-acl-basic-2000]quit

[SW3]pim

[SW3-pim]ssm-policy 2000

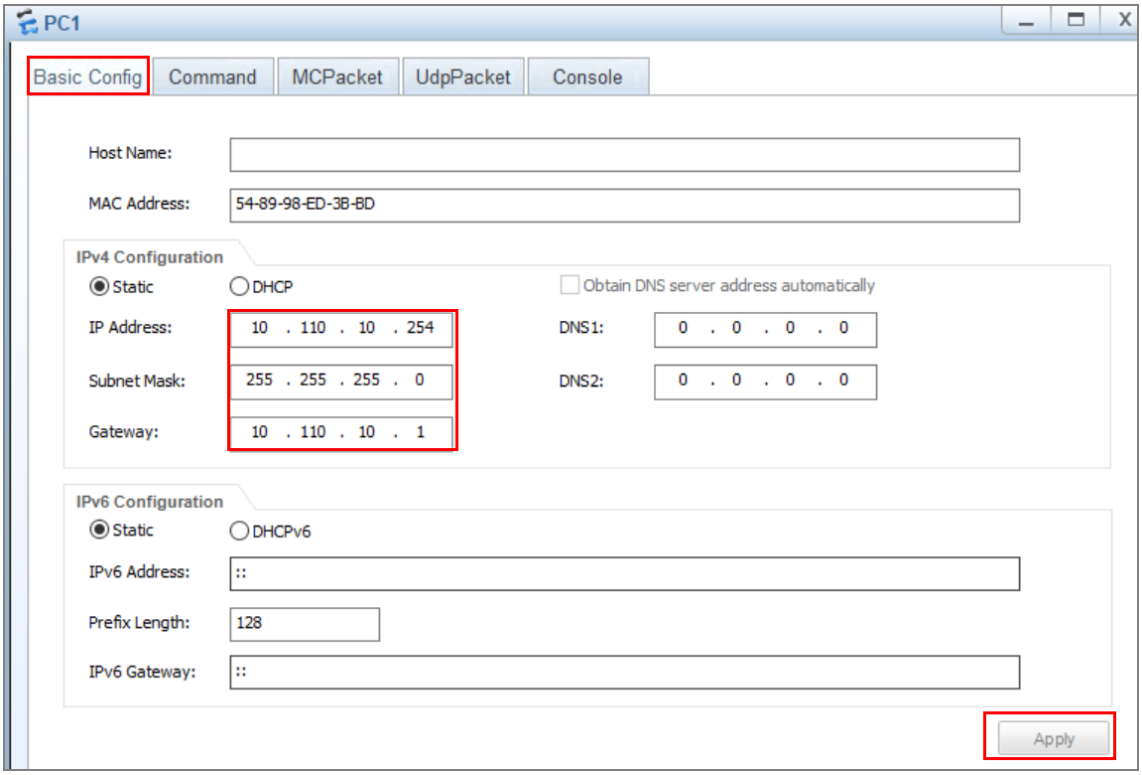
[SW3-pim]quit

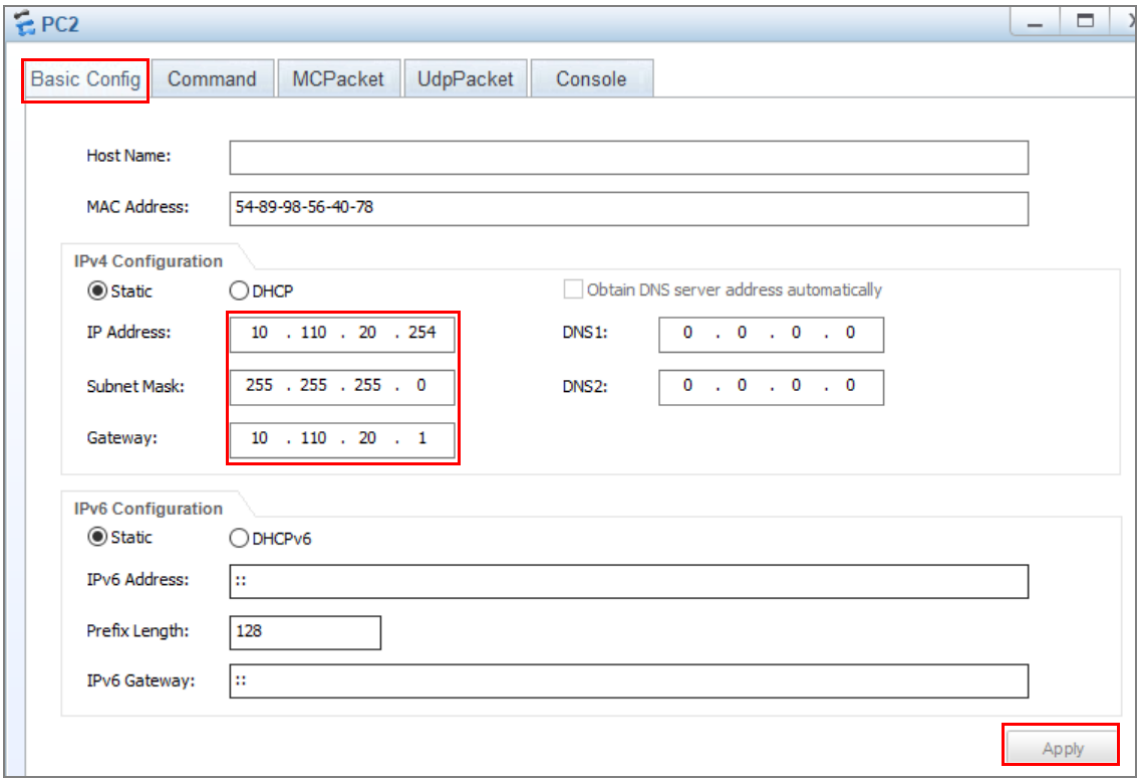
[SW3]

12.3 Verification

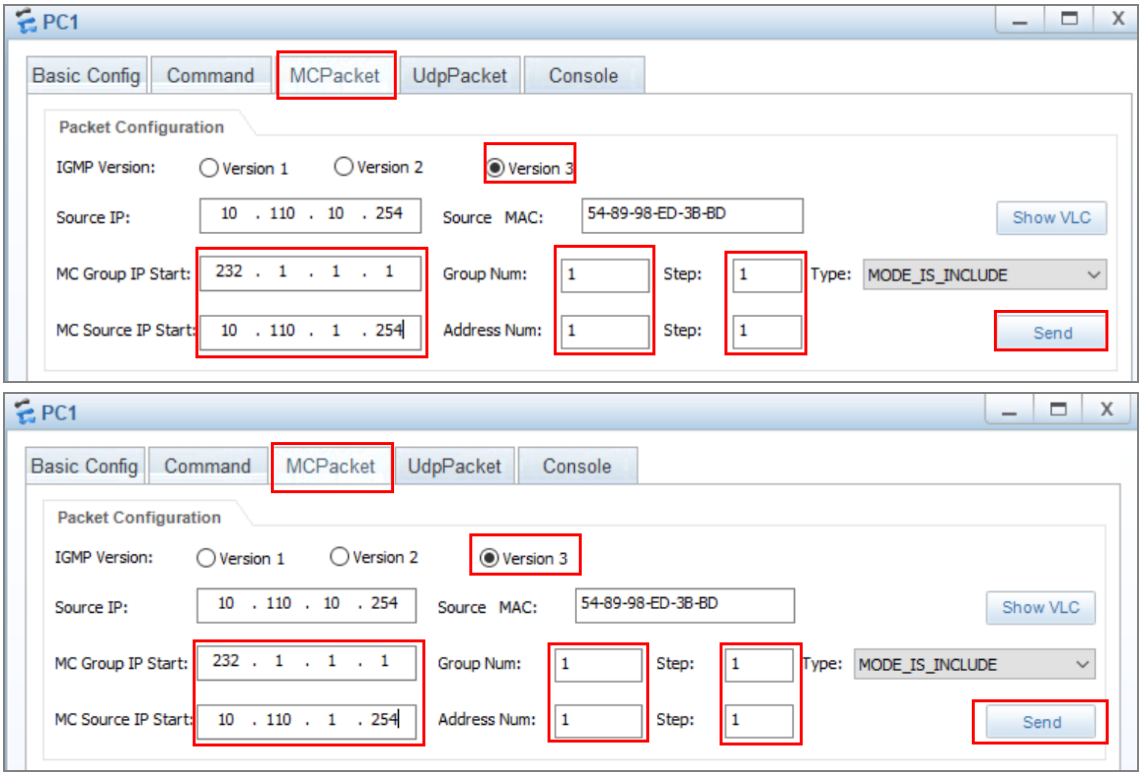
12.3.1 Verifying the Configuration

Set the IP addresses of PC1 and PC2.





Set the multicast group addresses of PC1 and PC2, and enable them to send messages to join the groups.



Display information about the IGMP groups on SW2 and SW3.

```
<SW2>display igmp group

Interface group report information

 Vlanif100(10.110.10.1):

   Total 1 IGMP Group reported

     Group Address      Last Reporter     Uptime         Expires

     232.1.1.1          10.110.10.254     00:00:32       off

<SW2>


<SW3>display igmp group

Interface group report information
```

```
Vlanif200(10.110.20.1):

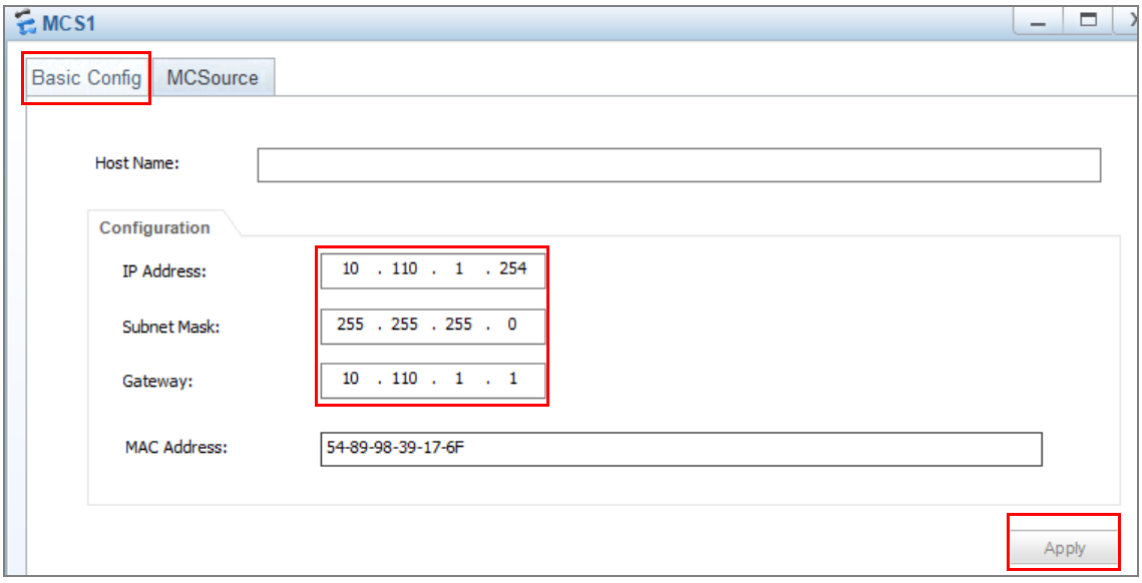
  Total 1 IGMP Group reported

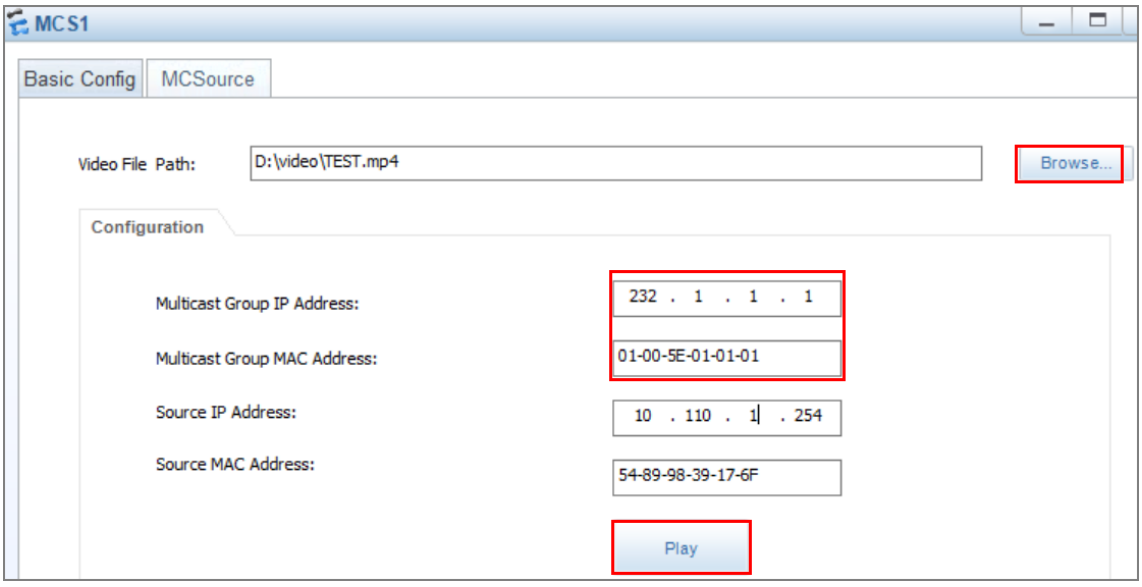
    Group Address      Last Reporter     Uptime       Expires

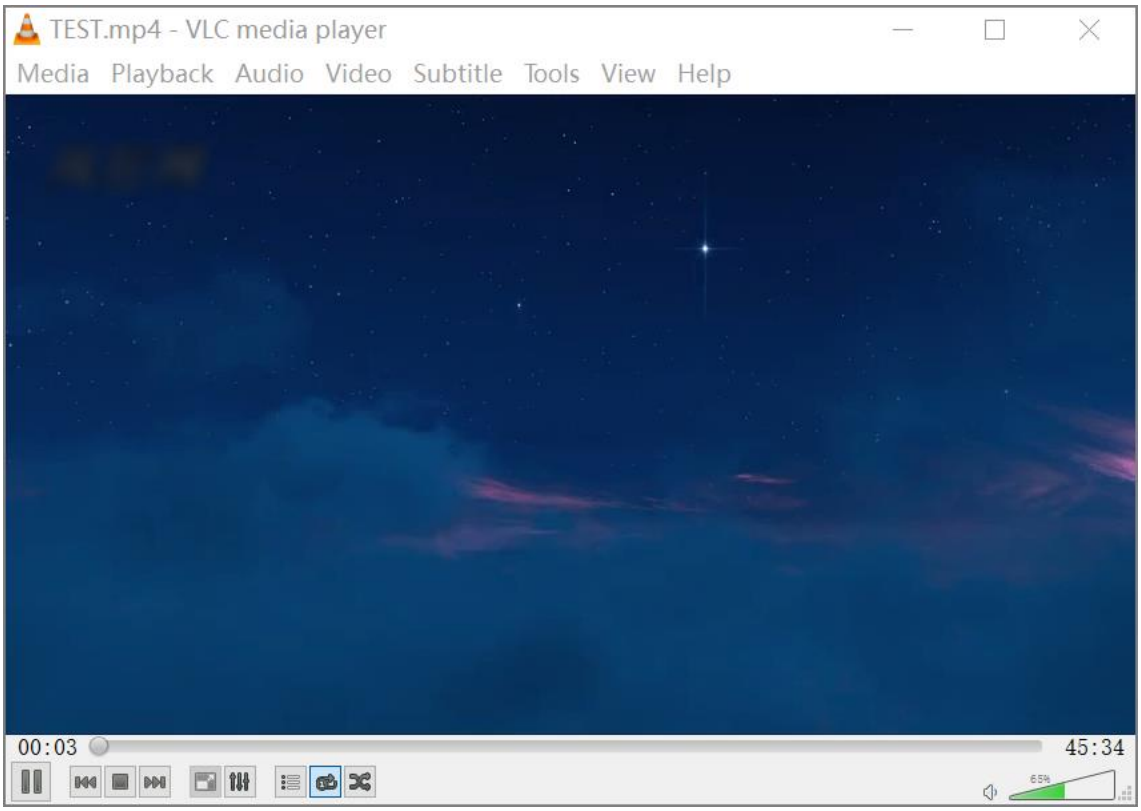
    232.1.1.1          10.110.20.254     00:05:30     off

<SW3>
```

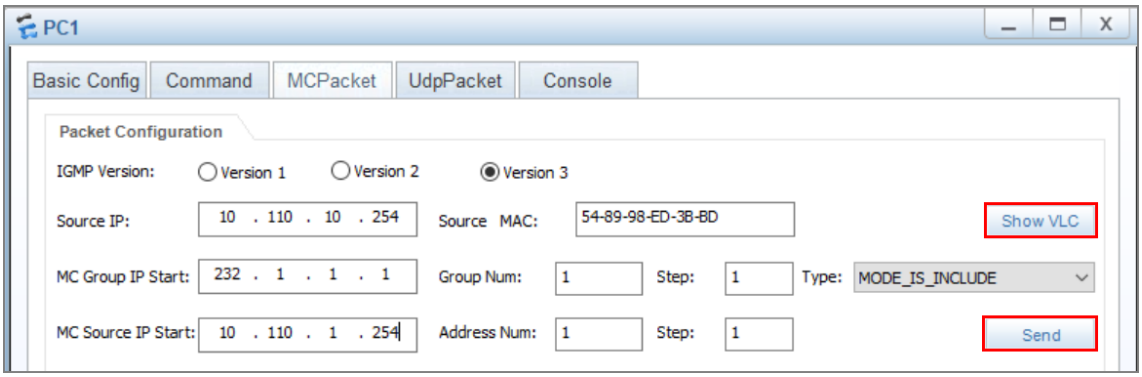
Set S1 parameters. Click **Play** to play a video. S1 starts to send UDP video data streams to the multicast group.

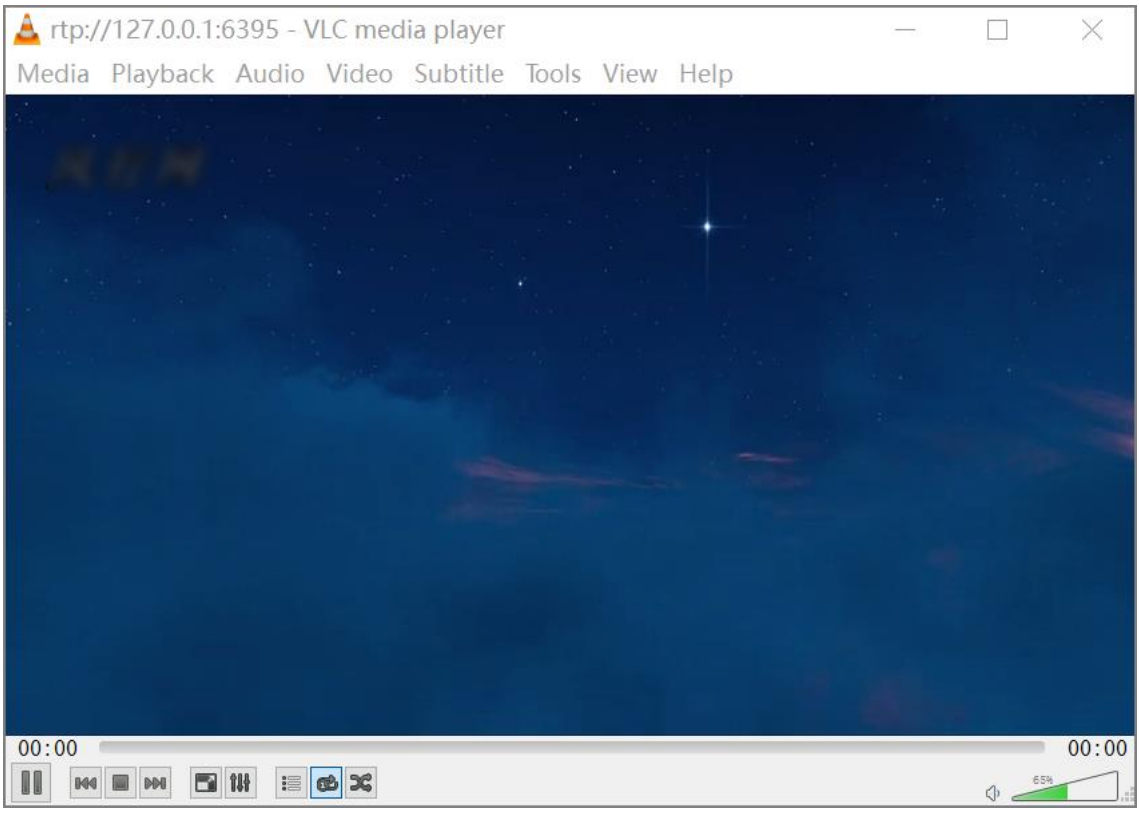




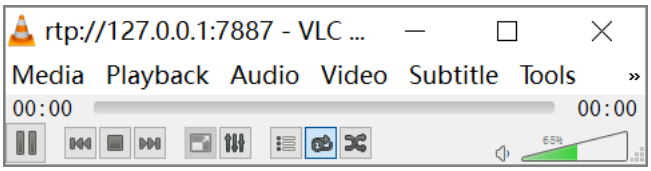


Start the VLC software on PC1. PC1 receives video data and plays the video from S1.

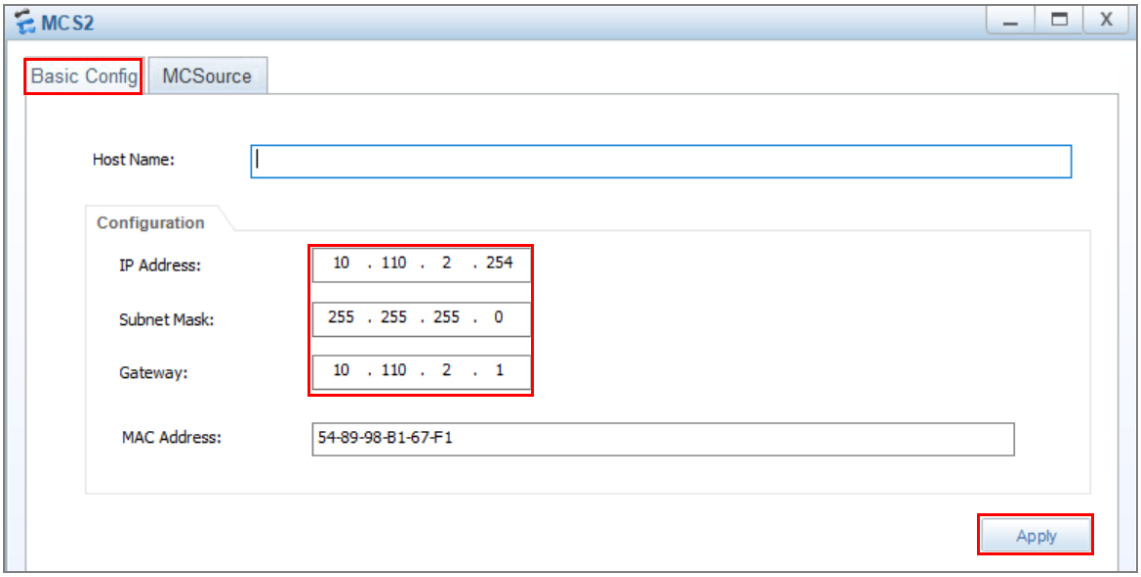


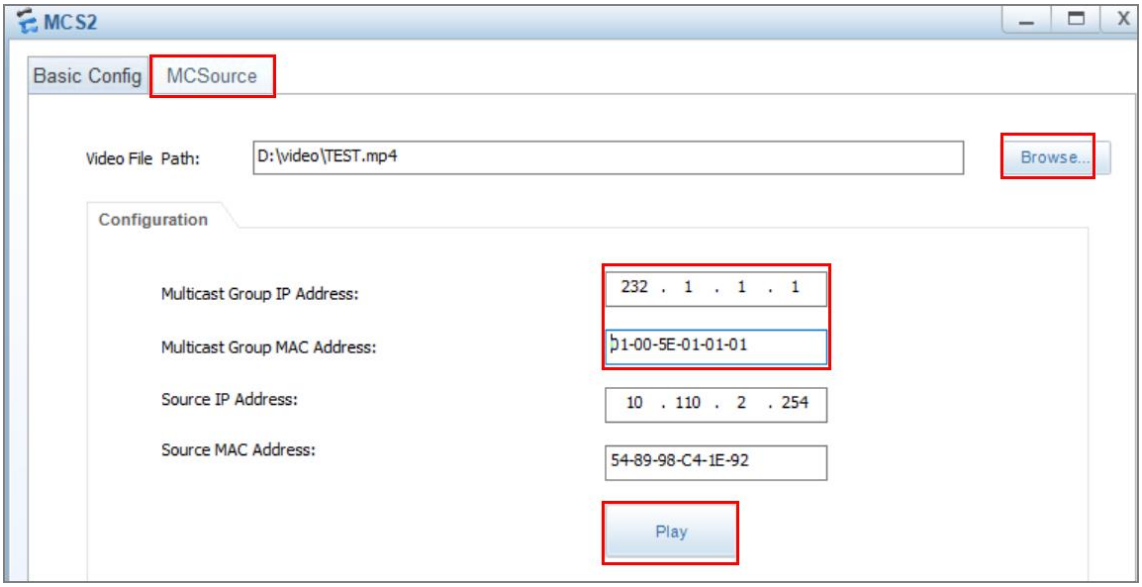


Start the VLC software on PC2 to attempt to obtain video data. No video data is obtained.

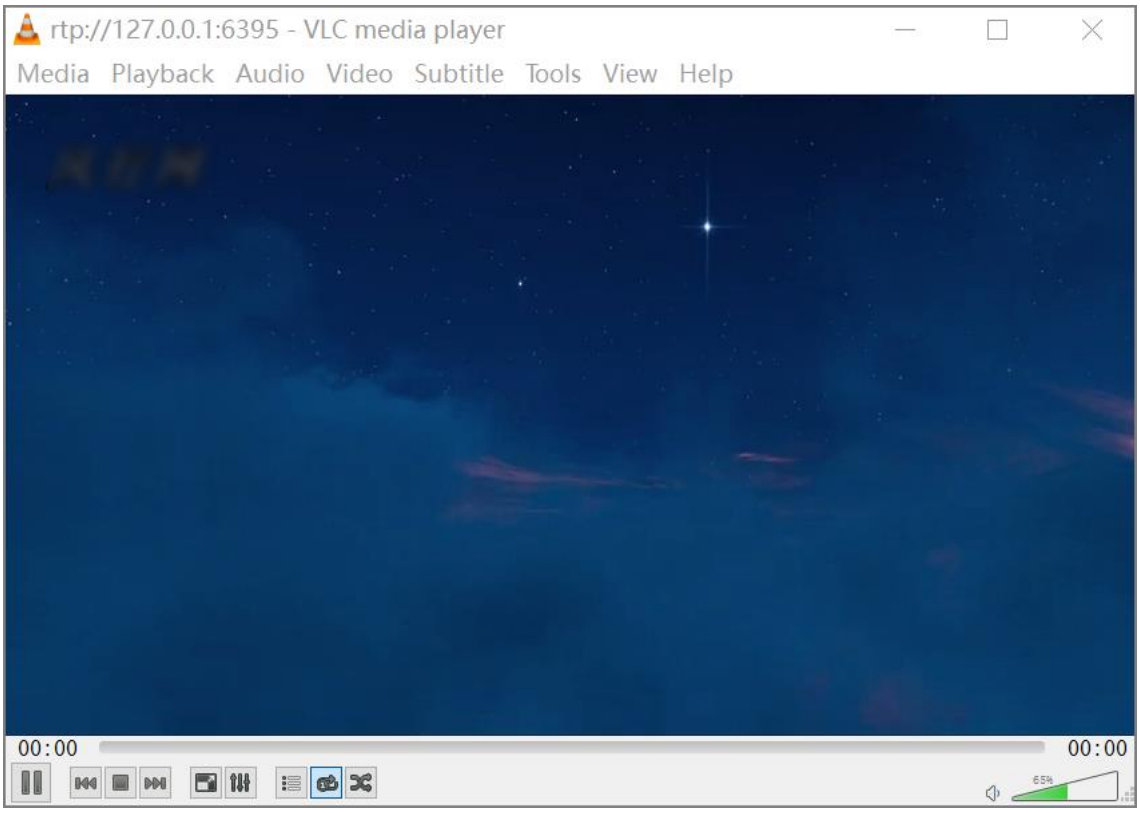


Set S2 parameters. Click **Play** to play a video.





PC2 obtains the video stream and starts to play the video of S2.



12.3.2 R1's Configuration

```
#
sysname R1
#
multicast routing-enable
#
acl number 2000
 rule 5 permit source 232.1.1.0 0.0.0.255
#
interface GigabitEthernet0/0/1
 ip address 192.168.40.2 255.255.255.0
```

```
 pim sm
#
interface GigabitEthernet0/0/2
 ip address 10.110.1.1 255.255.255.0
 pim sm
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
 pim sm
#
ospf 1
 area 0.0.0.0
  network 192.168.40.2 0.0.0.0
  network 10.110.1.1 0.0.0.0
  network 1.1.1.1 0.0.0.0
#
pim
#
return
<R1>
```

12.3.3 R2's Configuration

```
#
sysname R2
#
multicast routing-enable
#
acl number 2000
 rule 5 permit source 232.1.1.0 0.0.0.255
#
interface GigabitEthernet0/0/1
 ip address 192.168.50.2 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/2
 ip address 10.110.2.1 255.255.255.0
 pim sm
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
 pim sm
#
```

```
ospf 1
 area 0.0.0.0
  network 192.168.50.2 0.0.0.0
  network 10.110.2.1 0.0.0.0
  network 2.2.2.2 0.0.0.0
#
pim
ssm-policy 2000
#
return
<R2>
```

12.3.4 SW1's Configuration

```
#
sysname SW1
#
vlan batch 10 20 40 50
#
multicast routing-enable
#
acl number 2000
 rule 5 permit source 232.1.1.0 0.0.0.255
```

```
#
interface Vlanif10
 ip address 192.168.10.1 255.255.255.0
 pim sm
#
interface Vlanif20
 ip address 192.168.20.1 255.255.255.0
 pim sm
#
interface Vlanif40
 ip address 192.168.40.1 255.255.255.0
 pim sm
#
interface Vlanif50
 ip address 192.168.50.1 255.255.255.0
 pim sm
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 10
#
interface GigabitEthernet0/0/2
```

```
 port link-type access
 port default vlan 20
#
interface GigabitEthernet0/0/4
 port link-type access
 port default vlan 40
#
interface GigabitEthernet0/0/5
 port link-type access
 port default vlan 50
#
interface LoopBack0
 ip address 10.10.10.10 255.255.255.255
 pim sm
#
ospf 1
 area 0.0.0.0
  network 192.168.10.1 0.0.0.0
  network 192.168.20.1 0.0.0.0
  network 192.168.30.1 0.0.0.0
  network 192.168.40.1 0.0.0.0
  network 192.168.50.1 0.0.0.0
```

```
  network 10.10.10.10 0.0.0.0
#
pim
ssm-policy 2000
#
return
<SW1>
```

12.3.5 SW2's Configuration

```
#
sysname SW2
#
vlan batch 10 100
#
multicast routing-enable
#
acl number 2000
 rule 5 permit source 232.1.1.0 0.0.0.255
#
interface Vlanif10
 ip address 192.168.10.2 255.255.255.0
 pim sm
```

```
#
interface Vlanif100
 ip address 10.110.10.1 255.255.255.0
 pim sm
 igmp enable
 igmp version 3
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 10
#
interface GigabitEthernet0/0/23
 port link-type access
 port default vlan 100
#
interface LoopBack0
 ip address 20.20.20.20 255.255.255.255
 pim sm
#
ospf 1
 area 0.0.0.0
  network 20.20.20.20 0.0.0.0
```

```
  network 192.168.10.2 0.0.0.0
  network 10.110.10.1 0.0.0.0
#
igmp
 version 3
#
pim
ssm-policy 2000
#
return
<SW2>
```

12.3.6 SW3's Configuration

```
#
sysname SW3
#
vlan batch 20 200
#
multicast routing-enable
#
acl number 2000
 rule 5 permit source 232.1.1.0 0.0.0.255
```

```
#
interface Vlanif20
 ip address 192.168.20.2 255.255.255.0
 pim sm
#
interface Vlanif200
 ip address 10.110.20.1 255.255.255.0
 pim sm
 igmp enable
 igmp version 3
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 20
#
interface GigabitEthernet0/0/23
 port link-type access
 port default vlan 200
#
interface LoopBack0
 ip address 30.30.30.30 255.255.255.255
 pim sm
```

```
#
ospf 1
 area 0.0.0.0
  network 30.30.30.30 0.0.0.0
  network 192.168.20.2 0.0.0.0
  network 10.110.20.1 0.0.0.0
#
igmp
 version 3
#
pim
ssm-policy 2000
#
return
<SW3>
```

13 IPv6 PIM-ASM Configuration

13.1 Introduction

13.1.1 About This Lab

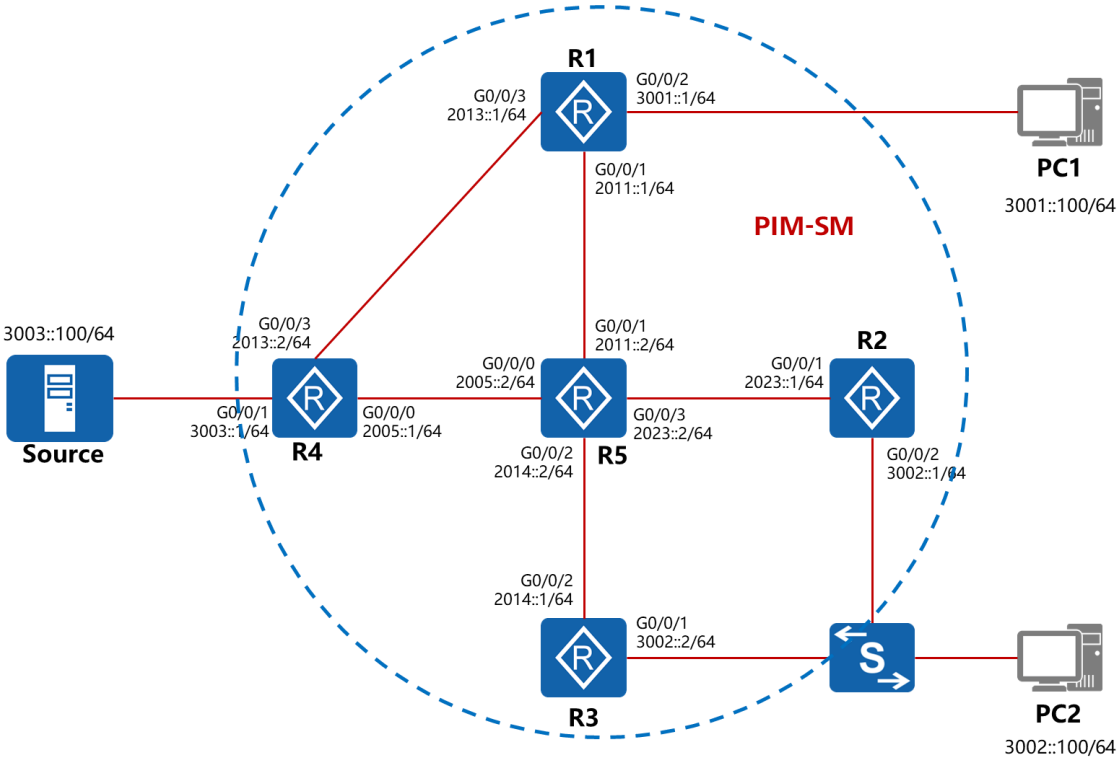
This chapter describes how to configure PIM-SM on an IPv6 network.

13.1.2 Objectives

Upon completion of this task, you will be able to learn how to configure PIM-SM on an IPv6 network.

13.1.3 Networking Topology

Figure 13-1 Topology for configuring IPv6 PIM-ASM



13.1.4 Networking Design

Configure IPv6 PIM-SM on the routers to enable them to provide multicast services for the user hosts PC1 and PC2 on the network. The hosts in a multicast group can then receive VOD information from specified sources to this group.

Enable IS-ISv6 on R1, R2, SW1, SW2, and SW3 to implement network-side interworking.

Table 13-1 Device interface parameter design

Device	Interface	IP Address
R1	G0/0/1	2011::1/64
	G0/0/2	3001::1/64
	G0/0/3	2013::1/64
R2	G0/0/1	2023::1/64
	G0/0/2	3002::1/64
R3	G0/0/1	3002::2/64
	G0/0/2	2014::1/64
R4	G0/0/0	2005::1/64
	G0/0/1	3003::1/64
	G0/0/3	2013::2/64
R5	G0/0/0	2005::2/64
	G0/0/1	2011::2/64
	G0/0/2	2014::2/64
	G0/0/3	2023::2/64
PC1	Eth0/0/1	3001::100/64
PC2	Eth0/0/1	3002::100/64
Source	Eth0/0/1	3003::100/64

Table 13-2 Routing protocol parameter plan

Protocol Type	Process ID	Device	Area or Router Level	Other Parameters:
IS-ISv6	100	R1	IS-level-1-2	network-entity 10.0000.0000.0001.00
		R2	IS-level-1-2	network-entity 10.0000.0000.0002.00
		R3	IS-level-1-2	network-entity 10.0000.0000.0003.00
		R4	IS-level-1-2	network-entity 10.0000.0000.0004.00
		R5	IS-level-2	network-entity 10.0000.0000.0005.00

13.2 Configuration

13.2.1 Configuration Roadmap

1. Configure IPv6 addresses for all devices so that the directly connected devices can communicate.
2. Configure IS-ISv6 on R1, R2, R3, R4 and R5 to ensure that the global network can communicate.
3. Enable IPv6 multicast on all multicast routers.
4. Enable IPv6 PIM-SM on all interfaces of the multicast routers. You can configure other IPv6 PIM-SM functions only after IPv6 PIM-SM is enabled.
5. Enable MLD on the router interfaces connected to the hosts and configure the interfaces to statically join a multicast group. A receiver joins and leaves a multicast group by sending MLD messages. The leaf routers maintain the multicast member relationship through MLD.

6. Configure a RP. In an IPv6 PIM-SM domain, a RP is essential in providing ASM services and helps forward multicast data. Configuring a router that has more multicast branches as a RP is recommended. For example, configure R5 as a RP on the network.

13.2.2 Configuration Procedure

Step 1 **Assign IPv6 addresses to interfaces and configure an IPv6 unicast routing protocol.**

Enable IPv6 on R1 and configure IPv6 addresses.

```
[R1]ipv6
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ipv6 enable
[R1-GigabitEthernet0/0/1]ipv6 address 2011::1 64
[R1-GigabitEthernet0/0/1]quit
[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ipv6 enable
[R1-GigabitEthernet0/0/2]ipv6 address 3001::1 64
[R1-GigabitEthernet0/0/2]quit
[R1]interface GigabitEthernet 0/0/3
[R1-GigabitEthernet0/0/3]ipv6 enable
[R1-GigabitEthernet0/0/3]ipv6 address 2013::1 64
[R1-GigabitEthernet0/0/3]quit
```

Enable IPv6 on R2 and configure IPv6 addresses.

```
[R2]ipv6
```

```
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ipv6 enable
[R2-GigabitEthernet0/0/1]ipv6 address 2023::1 64
[R2-GigabitEthernet0/0/1]quit
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ipv6 enable
[R2-GigabitEthernet0/0/2]ipv6 address 3002::1 64
[R2-GigabitEthernet0/0/2]quit
```

Enable IPv6 on R3 and configure IPv6 addresses.

```
[R3]ipv6
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ipv6 enable
[R3-GigabitEthernet0/0/1]ipv6 address 3002::2 64
[R3-GigabitEthernet0/0/1]quit
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ipv6 enable
[R3-GigabitEthernet0/0/2]ipv6 address 2014::1 64
[R3-GigabitEthernet0/0/2]quit
```

Enable IPv6 on R4 and configure IPv6 addresses.

```
[R4]ipv6
[R4]interface GigabitEthernet 0/0/0
[R4-GigabitEthernet0/0/0]ipv6 enable
[R4-GigabitEthernet0/0/0]ipv6 address 2005::1 64
[R4-GigabitEthernet0/0/0]quit
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ipv6 enable
[R4-GigabitEthernet0/0/1]ipv6 address 3003::1 64
[R4-GigabitEthernet0/0/1]quit
[R4]interface GigabitEthernet 0/0/3
[R4-GigabitEthernet0/0/3]ipv6 enable
[R4-GigabitEthernet0/0/3]ipv6 address 2013::2 64
[R4-GigabitEthernet0/0/3]quit
```

Enable IPv6 on R5 and configure IPv6 addresses.

```
[R5]ipv6
[R5]interface GigabitEthernet 0/0/0
[R5-GigabitEthernet0/0/0]ipv6 enable
[R5-GigabitEthernet0/0/0]ipv6 address 2005::2 64
[R5-GigabitEthernet0/0/0]quit
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1]ipv6 enable
[R5-GigabitEthernet0/0/1]ipv6 address 2011::2 64
```

```
[R5-GigabitEthernet0/0/1]quit
[R5]interface GigabitEthernet 0/0/2
[R5-GigabitEthernet0/0/2]ipv6 enable
[R5-GigabitEthernet0/0/2]ipv6 address 2014::2 64
[R5-GigabitEthernet0/0/2]quit
[R5]interface GigabitEthernet 0/0/3
[R5-GigabitEthernet0/0/3]ipv6 enable
[R5-GigabitEthernet0/0/3]ipv6 address 2023::2 64
[R5-GigabitEthernet0/0/3]quit
```

Step 2 **Configure IS-ISv6.**

Configure IS-ISv6 on R1.

```
[R1]isis 100
[R1-isis-100]ipv6 enable
[R1-isis-100]is-level level-1-2
[R1-isis-100]network-entity 10.0000.0000.0001.00
[R1-isis-100]quit

[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]isis ipv6 enable 100
[R1]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]isis ipv6 enable 100
```

[R1]interface GigabitEthernet 0/0/3

[R1-GigabitEthernet0/0/3]isis ipv6 enable 100

Configure IS-ISv6 on R2.

[R2]isis 100

[R2-isis-100]ipv6 enable

[R2-isis-100]is-level level-1-2

[R2-isis-100]network-entity 10.0000.0000.0002.00

[R2-isis-100]quit

[R2]interface GigabitEthernet 0/0/1

[R2-GigabitEthernet0/0/1]isis ipv6 enable 100

[R21]interface GigabitEthernet 0/0/2

[R2-GigabitEthernet0/0/2]isis ipv6 enable 100

Configure IS-ISv6 on R3.

[R3]isis 100

[R3-isis-100]ipv6 enable

[R3-isis-100]is-level level-1-2

[R3-isis-100]network-entity 10.0000.0000.0003.00

[R3-isis-100]quit

[R3]interface GigabitEthernet 0/0/1

[R3-GigabitEthernet0/0/1]isis ipv6 enable 100

[R31]interface GigabitEthernet 0/0/2

[R3-GigabitEthernet0/0/2]isis ipv6 enable 100

Configure IS-ISv6 on R4.

[R4]isis 100

[R4-isis-100]ipv6 enable

[R4-isis-100]is-level level-1-2

[R4-isis-100]network-entity 10.0000.0000.0002.00

[R4-isis-100]quit

[R4]interface GigabitEthernet 0/0/0

[R4-GigabitEthernet0/0/0]isis ipv6 enable 100

[R4]interface GigabitEthernet 0/0/1

[R4-GigabitEthernet0/0/1]isis ipv6 enable 100

[R4]interface GigabitEthernet 0/0/3

[R4-GigabitEthernet0/0/3]isis ipv6 enable 100

Configure IS-ISv6 on R5.

```
[R5]isis 100
[R5-isis-100]ipv6 enable
[R5-isis-100]is-level level-1-2
[R5-isis-100]network-entity 10.0000.0000.0002.00
[R5-isis-100]quit

[R5]interface GigabitEthernet 0/0/0
[R5-GigabitEthernet0/0/0]isis ipv6 enable 100
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1]isis ipv6 enable 100
[R5]interface GigabitEthernet 0/0/2
[R5-GigabitEthernet0/0/2]isis ipv6 enable 100
[R5]interface GigabitEthernet 0/0/3
[R5-GigabitEthernet0/0/3]isis ipv6 enable 100
```

Check the IS-ISv6 neighbor relationship status on R5. The command output shows that four IS-ISv6 neighbor relationships have been established.

```
[R5]display isis peer

                    Peer information for ISIS(100)

System Id     Interface          Circuit Id         State HoldTime Type     PRI
```

```
--------------------------------------------------------------------------------

0000.0000.0004  GE0/0/0          0000.0000.0005.01 Up    25s       L2        64

0000.0000.0003  GE0/0/2          0000.0000.0005.02 Up    27s       L2        64

0000.0000.0001  GE0/0/1          0000.0000.0001.01 Up    9s        L2        64

0000.0000.0002  GE0/0/3          0000.0000.0002.01 Up    8s        L2        64


Total Peer(s): 4

[R5]
```

Step 3 **Enable IPv6 multicast.**

Enable IPv6 multicast on all routers and IPv6 PIM-SM on all interfaces.

```
[R1]multicast ipv6 routing-enable

[R1]interface GigabitEthernet 0/0/1

[R1-GigabitEthernet0/0/1]pim ipv6 sm

[R1-GigabitEthernet0/0/1]quit

[R1]interface GigabitEthernet 0/0/2

[R1-GigabitEthernet0/0/2]pim ipv6 sm

[R1-GigabitEthernet0/0/2]quit

[R1]interface GigabitEthernet 0/0/3

[R1-GigabitEthernet0/0/3]pim ipv6 sm

[R1-GigabitEthernet0/0/3]quit
```

```
[R2]multicast ipv6 routing-enable
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]pim ipv6 sm
[R2-GigabitEthernet0/0/1]quit
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]pim ipv6 sm
[R2-GigabitEthernet0/0/2]quit

[R3]multicast ipv6 routing-enable
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]pim ipv6 sm
[R3-GigabitEthernet0/0/1]quit
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]pim ipv6 sm
[R3-GigabitEthernet0/0/2]quit

[R4]multicast ipv6 routing-enable
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]pim ipv6 sm
[R4-GigabitEthernet0/0/1]quit
[R4]interface GigabitEthernet 0/0/2
[R4-GigabitEthernet0/0/2]pim ipv6 sm
```

```
[R4-GigabitEthernet0/0/2]quit
[R4]interface GigabitEthernet 0/0/3
[R4-GigabitEthernet0/0/3]pim ipv6 sm
[R4-GigabitEthernet0/0/3]quit
```

```
[R5]multicast ipv6 routing-enable
[R5]interface GigabitEthernet 0/0/0
[R5-GigabitEthernet0/0/0]pim ipv6 sm
[R5-GigabitEthernet0/0/0]quit
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1]pim ipv6 sm
[R5-GigabitEthernet0/0/1]quit
[R5]interface GigabitEthernet 0/0/2
[R5-GigabitEthernet0/0/2]pim ipv6 sm
[R5-GigabitEthernet0/0/2]quit
[R5]interface GigabitEthernet 0/0/3
[R5-GigabitEthernet0/0/3]pim ipv6 sm
[R5-GigabitEthernet0/0/3]quit
```

Step 4 **Enable MLD on the interfaces connected to the hosts.**

Enable MLD on the interface connecting R1 to the user host, and configure GE 0/0/2 to forward packets from the multicast source 3003::100 to the multicast group FF1E::1.

```
[R1]interface GigabitEthernet 0/0/2
```

```
[R1-GigabitEthernet0/0/2]mld enable
[R1-GigabitEthernet0/0/2]mld static-group FF1E::1 source 3003::100
[R1-GigabitEthernet0/0/2]quit
```

Enable MLD on the interface connecting R2 to the user host, and configure GE 0/0/2 to forward packets from the multicast source 3003::100 to the multicast group FF1E::1.

```
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]mld enable
[R2-GigabitEthernet0/0/2]mld static-group FF1E::1 source 3003::100
[R2-GigabitEthernet0/0/2]quit
```

Enable MLD on the interface connecting R3 to the user host, and configure GE 0/0/2 to forward packets from the multicast source 3003::100 to the multicast group FF1E::1.

```
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]mld enable
[R3-GigabitEthernet0/0/1]mld static-group FF1E::1 source 3003::100
[R3-GigabitEthernet0/0/1]quit
```

Step 5 Configure a RP.

Configure a C-RP on R5 and specify the group address range served by the C-RP.

```
[R5]acl ipv6 2001
[R5-acl6-basic-2001]rule permit source ff1e:: 112
[R5-acl6-basic-2001]quit
```

```
[R5]pim-ipv6

[R5-pim6]c-rp 2005::2 group-policy 2001

[R5-pim6]c-bsr 2005::2

[R5-pim6]quit
```

13.3 Verification

13.3.1 Verifying the Configuration

Run the **display pim ipv6 interface** command to check the IPv6 PIM configuration and status. In this example, the IPv6 PIM information on R3 is displayed as follows:

```
<R3>display pim ipv6 interface

 VPN-Instance: public net

 Interface              State NbrCnt HelloInt    DR-Pri       DR-Address

 GE0/0/1                  up     1        30         1            FE80::5689:98FF

                                                                :FEEB:4AF2

 GE0/0/2                  up     1        30         1            FE80::5689:98FF

                                                                :FEAD:A41

<R3>
```

Run the **display pim ipv6 bsr-info** command to check information about the BSR selection on a router. For example, BSR information on R1 and R5 is displayed as follows (C-BSR information is also displayed on R5):

```
[R1]display pim ipv6 bsr-info

 VPN-Instance: public net

 Elected AdminScoped BSR Count: 0
```

Elected BSR Address: 2005::2

Priority: 0

Hash mask length: 126

State: Accept Preferred

Scope: Not scoped

Uptime: 01:16:31

Expires: 00:01:39

C-RP Count: 1

[R1]

[R5]display pim ipv6 bsr-info

VPN-Instance: public net

Elected AdminScoped BSR Count: 0

Elected BSR Address: 2005::2

Priority: 0

Hash mask length: 126

State: Elected

Scope: Not scoped

Uptime: 01:16:55

Next BSR message scheduled at: 00:00:05

C-RP Count: 1

Candidate AdminScoped BSR Count: 0

```
 Candidate BSR Address: 2005::2
      Priority: 0
      Hash mask length: 126
      State: Elected
      Scope: Not scoped
      Wait to be BSR: 0
[R5]
```

Run the **display pim ipv6 rp-info** command to check the RP information on a router. In this example, the RP information on R1 is displayed as follows:

```
[R1]display pim ipv6 rp-info
 VPN-Instance: public net
 PIM-SM BSR RP Number:1
 Group/MaskLen: FF1E::/64
      RP: 2005::2
      Priority: 192
      Uptime: 01:18:02
      Expires: 00:02:28
[R1]
```

Run the **display pim ipv6 routing-table** command to check the IPv6 PIM multicast routing table. The multicast source 3003::100/64 sends multicast packets to the multicast group FF1E::1/64.

```
<R1>display pim ipv6 routing-table
```

VPN-Instance: public net

Total 0 (*, G) entry; 1 (S, G) entry

(3003::100, FF1E::1)

RP: 2005::2

Protocol: pim-sm, Flag: SPT SG_RCVR

UpTime: 00:15:10

Upstream interface: GigabitEthernet0/0/3

Upstream neighbor: FE80::5689:98FF:FE8D:7266

RPF prime neighbor: FE80::5689:98FF:FE8D:7266

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: static, UpTime: 00:15:10, Expires: -

<R1>

<R2>display pim ipv6 routing-table

VPN-Instance: public net

Total 0 (*, G) entry; 1 (S, G) entry

(3002::100, FF1E::1)

RP: 2005::2

Protocol: pim-sm, Flag: SPT SG_RCVR

UpTime: 00:13:36

Upstream interface: GigabitEthernet0/0/1

Upstream neighbor: FE80::5689:98FF:FEAD:A42

RPF prime neighbor: FE80::5689:98FF:FEAD:A42

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: static, UpTime: 00:13:36, Expires: -

<R2>

<R3>display pim ipv6 routing-table

VPN-Instance: public net

Total 0 (*, G) entry; 1 (S, G) entry

(3003::100, FF1E::1)

RP: 2005::2

Protocol: pim-sm, Flag: SG_RCVR

UpTime: 00:13:44

Upstream interface: GigabitEthernet0/0/2

Upstream neighbor: FE80::5689:98FF:FEAD:A41

RPF prime neighbor: FE80::5689:98FF:FEAD:A41

Downstream interface(s) information: None

<R3>

[R4]display pim ipv6 routing-table

VPN-Instance: public net

Total 0 (*, G) entry; 1 (S, G) entry

(3003::100, FF1E::1)

RP: 2005::2

Protocol: pim-sm, Flag: SPT LOC

UpTime: 00:03:37

Upstream interface: GigabitEthernet0/0/1

Upstream neighbor: NULL

RPF prime neighbor: NULL

Downstream interface(s) information:

Total number of downstreams: 2

1: GigabitEthernet0/0/0

Protocol: pim-sm, UpTime: 00:01:27, Expires: 00:03:03

2: GigabitEthernet0/0/3

Protocol: pim-sm, UpTime: 00:03:37, Expires: 00:02:52

[R4]

<R5>display pim ipv6 routing-table

VPN-Instance: public net

Total 0 (*, G) entry; 1 (S, G) entry

(3003::100, FF1E::1)

RP: 2005::2 (local)

Protocol: pim-sm, Flag: SPT

UpTime: 00:01:45

Upstream interface: GigabitEthernet0/0/0

Upstream neighbor: FE80::5689:98FF:FE8D:7263

RPF prime neighbor: FE80::5689:98FF:FE8D:7263

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/3

Protocol: pim-sm, UpTime: 00:01:45, Expires: 00:02:45

<R5>

13.4 Reference Configuration

13.4.1 R1's Configuration

```
#
sysname R1
#
ipv6
#
multicast ipv6 routing-enable
#
acl ipv6 number 2001
 rule 5 permit source FF1E::/64
#
isis 100
 network-entity 10.0000.0000.0001.00
 #
 ipv6 enable topology standard
 #
#
interface GigabitEthernet0/0/1
 ipv6 enable
```

```
 ipv6 address 2011::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 3001::1/64
 isis ipv6 enable 100
 pim ipv6 sm
 mld enable
 mld static-group FF1E::1 source 3003::100
#
interface GigabitEthernet0/0/3
 ipv6 enable
 ipv6 address 2013::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
pim-ipv6
#
return
[R1]
```

13.4.2 R2's Configuration

```
#
sysname R2
#
ipv6
#
multicast ipv6 routing-enable
#
isis 100
 network-entity 10.0000.0000.0002.00
 #
 ipv6 enable topology standard
 #
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2023::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/2
 ipv6 enable
```

```
 ipv6 address 3002::1/64
 isis ipv6 enable 100
 pim ipv6 sm
 mld enable
 mld static-group FF1E::1 source 3003::100
#
pim-ipv6
#
return
[R2]
```

13.4.3 R3's Configuration

```
#
sysname R3
#
ipv6
#
multicast ipv6 routing-enable
#
isis 100
 network-entity 10.0000.0000.0003.00
 #
```

```
 ipv6 enable topology standard
 #
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 3002::2/64
 isis ipv6 enable 100
 pim ipv6 sm
 mld enable
 mld static-group FF1E::1 source 3003::100
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2014::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
pim-ipv6
#
return
[R3]
```

13.4.4 R4's Configuration

```
#
sysname R4
#
ipv6
#
multicast ipv6 routing-enable
#
isis 100
 network-entity 10.0000.0000.0004.00
 #
 ipv6 enable topology standard
 #
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2005::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/1
```

```
 ipv6 enable
 ipv6 address 3003::1/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/3
 ipv6 enable
 ipv6 address 2013::2/64
 isis ipv6 enable 100
 pim ipv6 sm
#
pim-ipv6
#
return
[R4]
```

13.4.5 R5's Configuration

```
#
sysname R5
#
ipv6
#
```

```
multicast ipv6 routing-enable
#
acl ipv6 number 2001
 rule 5 permit source FF1E::/112
#
isis 100
 is-level level-2
 network-entity 10.0000.0000.0005.00
 #
 ipv6 enable topology standard
 #
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ipv6 address 2005::2/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/1
 ipv6 enable
 ipv6 address 2011::2/64
 isis ipv6 enable 100
```

```
 pim ipv6 sm
#
interface GigabitEthernet0/0/2
 ipv6 enable
 ipv6 address 2014::2/64
 isis ipv6 enable 100
 pim ipv6 sm
#
interface GigabitEthernet0/0/3
 ipv6 enable
 ipv6 address 2023::2/64
 isis ipv6 enable 100
 pim ipv6 sm
#
pim-ipv6
 c-bsr 2005::2
 c-rp 2005::2 group-policy 2001
#
return
<R5>
```

14 Inter-AS MPLS BGP VPN Option A

14.1 Introduction

14.1.1 About This Lab

In this lab, you will learn how to configure the Inter-AS MPLS BGP VPN Option A solution.

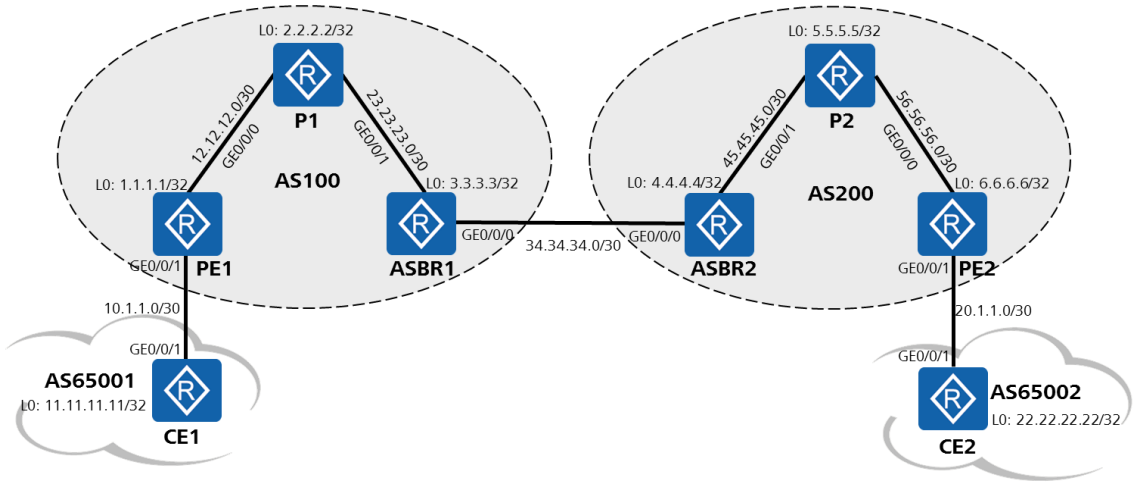
14.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand the fundamentals of Inter-AS MPLS BGP VPN Option A.
- Grasp the configuration roadmap and methods of Inter-AS MPLS BGP VPN Option A.

14.1.3 Networking Topology

Figure 14-1 Inter-AS MPLS BGP VPN Option A networking topology

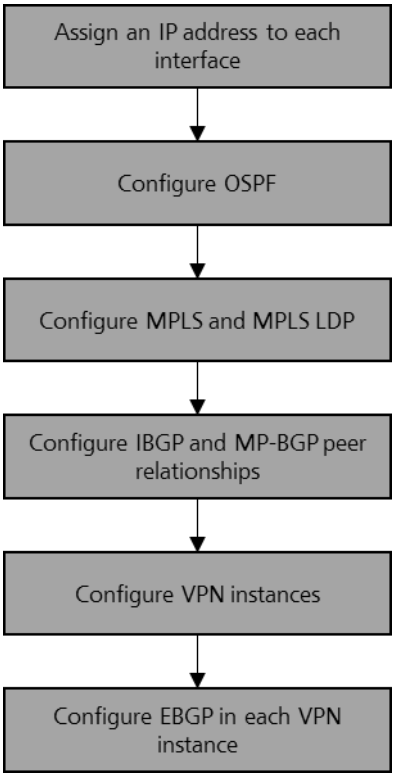


14.1.4 Networking Design

There are four ASs on the network shown in Figure 14-1. PE1, P1 and ASBR1 belong to AS100. PE2, P2 and ASBR2 belong to AS200. CE1 and CE2 belong to the same VPN. CE1 belongs to AS65001 and is connected to PE1 in AS100. CE2 belongs to AS65002 and is connected to PE2 in AS200. The IP addresses planned on each router are shown in Figure 14-1.

14.2 Lab Configuration

14.2.1 Configuration Roadmap



14.2.2 Configuration Procedure

Step 1 **Configure an IP address for each interface.**

CE1's configuration:

```
<Huawei>system-view
[Huawei]sysname CE1
```

```
[CE1]interface GigabitEthernet0/0/1
[CE1-GigabitEthernet0/0/1]ip address 10.1.1.1 30
[CE1-GigabitEthernet0/0/1]undo shutdown
[CE1-GigabitEthernet0/0/1]quit
[CE1]interface LoopBack 0
[CE1-LoopBack0]ip address 11.11.11.11 32
```

PE1's configuration:

```
<Huawei>system-view
[Huawei]sysname PE1
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]ip address 12.12.12.1 30
[PE1-GigabitEthernet0/0/0]undo shutdown
[PE1-GigabitEthernet0/0/0]quit
[PE1]interface loopback 0
[PE1-LoopBack0]ip address 1.1.1.1 32
[PE1-LoopBack0]quit
```

P1's configuration:

```
<Huawei>system-view
[Huawei]sysname P1
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]ip address 12.12.12.2 30
[P1-GigabitEthernet0/0/0]undo shutdown
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]ip address 23.23.23.1 30
[P1-GigabitEthernet0/0/1]undo shutdown
[P1-GigabitEthernet0/0/1]quit
[P1]interface loopback 0
[P1-LoopBack0]ip address 2.2.2.2 32
[P1-LoopBack0]quit
```

ASBR1's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR1
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]ip address 23.23.23.2 30
[ASBR1-GigabitEthernet0/0/1]undo shutdown
[ASBR1-GigabitEthernet0/0/1]quit
```

```
[ASBR1]interface loopback 0
[ASBR1-LoopBack0]ip address 3.3.3.3 32
[ASBR1-LoopBack0]quit
```

ASBR2's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR2
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]ip address 45.45.45.1 30
[ASBR2-GigabitEthernet0/0/1]undo shutdown
[ASBR2-GigabitEthernet0/0/1]quit
[ASBR2]interface loopback 0
[ASBR2-LoopBack0]ip address 4.4.4.4 32
[ASBR2-LoopBack0]quit
```

P2's configuration:

```
<Huawei>system-view
[Huawei]sysname P2
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]ip address 56.56.56.1 30
[P2-GigabitEthernet0/0/0]undo shutdown
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]ip address 45.45.45.2 30
[P2-GigabitEthernet0/0/1]undo shutdown
[P2-GigabitEthernet0/0/1]quit
[P2]interface loopback 0
[P2-LoopBack0]ip address 5.5.5.5 32
[P2-LoopBack0]quit
```

PE2's configuration:

```
<Huawei>system-view
[Huawei]sysname PE2
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]ip address 56.56.56.2 30
[PE2-GigabitEthernet0/0/0]undo shutdown
[PE2-GigabitEthernet0/0/0]quit
[PE2]interface loopback 0
[PE2-LoopBack0]ip address 6.6.6.6 32
[PE2-LoopBack0]quit
```

CE2's configuration:

```
<Huawei>system-view
[Huawei]sysname CE2
[CE2]interface GigabitEthernet0/0/1
[CE2-GigabitEthernet0/0/1]ip address 20.1.1.2 30
[CE2-GigabitEthernet0/0/1]undo shutdown
[CE2-GigabitEthernet0/0/1]quit
[CE2]interface loopback 0
[CE2-LoopBack0]ip address 22.22.22.22 32
```

Step 2 **Configure OSPF.**

PE1's configuration:

```
[PE1]ospf 1 router-id 1.1.1.1
[PE1-ospf-1]area 0
[PE1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[PE1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
```

P1's configuration:

```
[P1]ospf 1 router-id 2.2.2.2
[P1-ospf-1]area 0
[P1-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[P1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
```

ASBR1's configuration:

```
[ASBR1]ospf 1 router-id 3.3.3.3
[ASBR1-ospf-1]area 0
[ASBR1-ospf-1-area-0.0.0.0]network 3.3.3.3 0.0.0.0
[ASBR1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
```

ASBR2's configuration:

```
[ASBR2]ospf 1 router-id 4.4.4.4
[ASBR2-ospf-1]area 0
[ASBR2-ospf-1-area-0.0.0.0]network 4.4.4.4 0.0.0.0
[ASBR2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
```

P2's configuration:

```
[P2]ospf 1 router-id 5.5.5.5
[P2-ospf-1]area 0
[P2-ospf-1-area-0.0.0.0]network 5.5.5.5 0.0.0.0
```

```
[P2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
```

PE2's configuration:

```
[PE2]ospf 1 router-id 6.6.6.6
[PE2-ospf-1]area 0
[PE2-ospf-1-area-0.0.0.0]network 6.6.6.6 0.0.0.0
[PE2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
```

Step 3 **Enable MPLS and MPLS LDP.**

PE1's configuration:

```
<PE1>system-view
[PE1]mpls lsr-id 1.1.1.1
[PE1]mpls
[PE1-mpls]mpls ldp
[PE1-mpls-ldp]quit
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]mpls
[PE1-GigabitEthernet0/0/0]mpls ldp
[PE1-GigabitEthernet0/0/0]quit
```

P1's configuration:

```
<P1>system-view
[P1]mpls lsr-id 2.2.2.2
[P1]mpls
[P1-mpls]mpls ldp
[P1-mpls-ldp]quit
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]mpls
[P1-GigabitEthernet0/0/0]mpls ldp
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]mpls
[P1-GigabitEthernet0/0/1]mpls ldp
[P1-GigabitEthernet0/0/1]quit
```

ASBR1's configuration:

```
[ASBR1]mpls lsr-id 3.3.3.3
[ASBR1]mpls
[ASBR1-mpls]mpls ldp
```

[ASBR1-mpls-ldp]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]mpls
[ASBR1-GigabitEthernet0/0/1]mpls ldp
[ASBR1-GigabitEthernet0/0/1]quit

ASBR2's configuration:

[ASBR2]mpls lsr-id 4.4.4.4
[ASBR2]mpls
[ASBR2-mpls]mpls ldp
[ASBR2-mpls-ldp]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]mpls
[ASBR2-GigabitEthernet0/0/1]mpls ldp
[ASBR2-GigabitEthernet0/0/1]quit

P2's configuration:

<P2>system-view
[P2]mpls lsr-id 5.5.5.5
[P2]mpls
[P2-mpls]mpls ldp
[P2-mpls-ldp]quit
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]mpls
[P2-GigabitEthernet0/0/0]mpls ldp
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]mpls
[P2-GigabitEthernet0/0/1]mpls ldp
[P2-GigabitEthernet0/0/1]quit

PE2's configuration:

[PE2]mpls lsr-id 6.6.6.6
[PE2]mpls
[PE2-mpls]mpls ldp
[PE2-mpls-ldp]quit
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]mpls
[PE2-GigabitEthernet0/0/0]mpls ldp
[PE2-GigabitEthernet0/0/0]quit

Step 4 **Configure IBGP and MP-BGP peer relationships.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]peer 3.3.3.3 as-number 100
```

//Configure an IBGP peer relationship between PE1 and ASBR1.

```
[PE1-bgp]peer 3.3.3.3 connect-interface loopback 0
```

//Set the interface used to establish the peer relationship to Loopback 0.

```
[PE1-bgp]ipv4-family vpnv4
```

//Display the BGP VPNv4 view.

```
[PE1-bgp-af-vpnv4]peer 3.3.3.3 enable
```

//Enable the MP-IBGP peer relationship between PE1 and ASBR1.

```
[PE1-bgp-af-vpnv4]quit
```

ASBR1's configuration:

```
[ASBR1]bgp 100
[ASBR1-bgp]peer 1.1.1.1 as-number 100
[ASBR1-bgp]peer 1.1.1.1 connect-interface LoopBack 0
[ASBR1-bgp]ipv4-family vpnv4
[ASBR1-bgp-af-vpnv4]peer 1.1.1.1 enable
[ASBR1-bgp-af-vpnv4]quit
```

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]peer 4.4.4.4 as-number 200
[PE2-bgp]peer 4.4.4.4 connect-interface loopback 0
[PE2-bgp]ipv4-family vpnv4
[PE2-bgp-af-vpnv4]peer 4.4.4.4 enable
[PE2-bgp-af-vpnv4]quit
```

ASBR2's configuration:

```
[ASBR2]bgp 200
[ASBR2-bgp]peer 6.6.6.6 as-number 200
[ASBR2-bgp]peer 6.6.6.6 connect-interface loopback 0
[ASBR2-bgp]ipv4-family vpnv4
[ASBR2-bgp-af-vpnv4]peer 6.6.6.6 enable
[ASBR2-bgp-af-vpnv4]quit
```

Step 5 **Configure VPN instances.**

PE1's configuration:

[PE1]ip vpn-instance huawei

//Create a VPN instance.

[PE1-vpn-instance-huawei]route-distinguisher 100:1

//Configure an RD.

[PE1-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both

//Configure RTs.

[PE1-vpn-instance-huawei-af-ipv4]quit

[PE1-vpn-instance-huawei]quit

[PE1]interface GigabitEthernet0/0/1

[PE1-GigabitEthernet0/0/1]ip binding vpn-instance huawei

//Bind the AC interface to the VPN instance.

[PE1-GigabitEthernet0/0/1]ip address 10.1.1.2 30

[PE1-GigabitEthernet0/0/1]undo shutdown

[PE1-GigabitEthernet0/0/1]quit

ASBR1's configuration:

[ASBR1]ip vpn-instance huawei

[ASBR1-vpn-instance-huawei]route-distinguisher 100:1

[ASBR1-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both

[ASBR1-vpn-instance-huawei-af-ipv4]quit

[ASBR1-vpn-instance-huawei]quit

[ASBR1]interface GigabitEthernet0/0/0

[ASBR1-GigabitEthernet0/0/0]ip binding vpn-instance huawei

[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30

[ASBR1-GigabitEthernet0/0/0]undo shutdown

[ASBR1-GigabitEthernet0/0/0]quit

ASBR2's configuration:

[ASBR2]ip vpn-instance huawei

[ASBR2-vpn-instance-huawei]route-distinguisher 100:1

[ASBR2-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both

[ASBR2-vpn-instance-huawei-af-ipv4]quit

[ASBR2-vpn-instance-huawei]quit

[ASBR2]interface GigabitEthernet0/0/0

[ASBR2-GigabitEthernet0/0/0]ip binding vpn-instance huawei

[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30

[ASBR2-GigabitEthernet0/0/0]undo shutdown

[ASBR2-GigabitEthernet0/0/0]quit

PE2's configuration:

[PE2]ip vpn-instance huawei

[PE2-vpn-instance-huawei]route-distinguisher 100:1

[PE2-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both

[PE2-vpn-instance-huawei-af-ipv4]quit

[PE2-vpn-instance-huawei]quit

[PE2]interface GigabitEthernet0/0/1

[PE2-GigabitEthernet0/0/1]ip binding vpn-instance huawei

[PE2-GigabitEthernet0/0/1]ip address 20.1.1.1 30

[PE2-GigabitEthernet0/0/1]undo shutdown

[PE2-GigabitEthernet0/0/1]quit

Step 6 **Configure EBGP in each VPN instance.**

PE1's configuration:

[PE1]bgp 100

[PE1-bgp]ipv4-family vpn-instance huawei

[PE1-bgp-huawei]peer 10.1.1.1 as-number 65001

//Configures an EBGP peer relationship between PE1 and CE1.

CE1's configuration:

[CE1]bgp 65001

[CE1-bgp]peer 10.1.1.2 as-number 100

[CE1-bgp]network 11.11.11.11 32

ASBR1's configuration:

[ASBR1]bgp 100

[ASBR1-bgp]ipv4-family vpn-instance huawei

[ASBR1-bgp-huawei]peer 34.34.34.2 as-number 200

//Configure an EBGP peer relationship between ASBR1 and ASBR2.

ASBR2's configuration:

[ASBR2]bgp 200

[ASBR2-bgp]ipv4-family vpn-instance huawei

[ASBR2-bgp-huawei]peer 34.34.34.1 as-number 100

PE2's configuration:

[PE2]bgp 200

[PE2-bgp]ipv4-family vpn-instance huawei

[PE2-bgp-huawei]peer 20.1.1.2 as-number 65002

CE2's configuration:

```
[CE2]bgp 65002
[CE2-bgp]peer 20.1.1.1 as-number 200
[CE2-bgp]network 22.22.22.22 32
```

14.3 Verification

Run the **display bgp vpnv4 vpn-instance huawei peer** command to check the BGP peer status in each VPN instance. Take PE1 as an example, the information output is as follows:

```
[PE1]display bgp vpnv4 vpn-instance huawei peer
BGP local router ID : 12.12.12.1
Local AS number : 100
VPN-Instance huawei, Router ID 12.12.12.1:
Total number of peers : 1          Peers in established state : 1
 Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State Pre  fRcv
 10.1.1.1        4       65001       84       86     0 01:21:56    Established     1
```

After the preceding configuration is complete, CE1 and CE2 can learn the routes to each other's loopback interfaces. Run the **display ip routing-table** command to check for the routes. Take CE1 as an example, the information output is as follows:

```
[CE1]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

10.1.1.0/30         Direct  0    0           D   10.1.1.1        GigabitEthernet0/0/1
10.1.1.1/32         Direct  0    0           D   127.0.0.1       GigabitEthernet0/0/1
11.11.11.11/32      Direct  0    0           D   127.0.0.1       LoopBack0
22.22.22.22/32      EBGP    255  0           D   10.1.1.2        GigabitEthernet0/0/1
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
```

Run the **ping** command to test the connectivity. The following example uses CE1 to ping CE2's loopback interface:

```
[CE1]ping -a 11.11.11.11 22.22.22.22
```

```
PING 22.22.22.22: 56  data bytes, press CTRL_C to break
  Reply from 22.22.22.22: bytes=56 Sequence=1 ttl=251 time=210 ms
  Reply from 22.22.22.22: bytes=56 Sequence=2 ttl=251 time=150 ms
  Reply from 22.22.22.22: bytes=56 Sequence=3 ttl=251 time=220 ms
  Reply from 22.22.22.22: bytes=56 Sequence=4 ttl=251 time=200 ms
  Reply from 22.22.22.22: bytes=56 Sequence=5 ttl=251 time=170 ms
--- 22.22.22.22 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 150/190/220 ms
```

14.4 Reference Configuration

14.4.1 CE1's Configuration

```
[CE1]dis cur
#
sysname CE1
#
interface GigabitEthernet0/0/1
 ip address 10.1.1.1 255.255.255.252
#
#
interface LoopBack0
 ip address 11.11.11.11 255.255.255.255
#
bgp 65001
 peer 10.1.1.2 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 11.11.11.11 255.255.255.255
  peer 10.1.1.2 enable
#
return
```

14.4.2 PE1's Configuration

```
[PE1]dis cur
#
sysname PE1
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 1.1.1.1
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 10.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
#
bgp 100
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 3.3.3.3 enable
 #
 ipv4-family vpnv4
```

```
  policy vpn-target
  peer 3.3.3.3 enable
 #
 ipv4-family vpn-instance huawei
  peer 10.1.1.1 as-number 65001
#
ospf 1 router-id 1.1.1.1
 area 0.0.0.0
  network 1.1.1.1 0.0.0.0
  network 12.12.12.0 0.0.0.3
#
return
```

14.4.3 P1's Configuration

```
[P1]dis cur
#
sysname P1
#
mpls lsr-id 2.2.2.2
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.1 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
#
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
```

```
  network 2.2.2.2 0.0.0.0
  network 12.12.12.0 0.0.0.3
  network 23.23.23.0 0.0.0.3
#
return
```

14.4.4 ASBR1's Configuration

```
[ASBR1]dis cur
#
sysname ASBR1
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 3.3.3.3
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip binding vpn-instance huawei
 ip address 34.34.34.1 255.255.255.252
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.2 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
bgp 100
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
 #
```

```
 ipv4-family unicast
  undo synchronization
  peer 1.1.1.1 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 1.1.1.1 enable
 #
 ipv4-family vpn-instance huawei
  peer 34.34.34.2 as-number 200
#
ospf 1 router-id 3.3.3.3
 area 0.0.0.0
  network 3.3.3.3 0.0.0.0
  network 23.23.23.0 0.0.0.3
#
return
```

14.4.5 ASBR2's Configuration

```
[ASBR2]dis cur
#
sysname ASBR2
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 4.4.4.4
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip binding vpn-instance huawei
 ip address 34.34.34.2 255.255.255.252
#
```

```
interface GigabitEthernet0/0/1
 ip address 45.45.45.1 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
bgp 200
 peer 6.6.6.6 as-number 200
 peer 6.6.6.6 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 6.6.6.6 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 6.6.6.6 enable
 #
 ipv4-family vpn-instance huawei
  peer 34.34.34.1 as-number 100
#
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 4.4.4.4 0.0.0.0
  network 45.45.45.0 0.0.0.3
#
return
```

14.4.6 P2's Configuration

```
[P2]dis cur
#
sysname P2
#
mpls lsr-id 5.5.5.5
mpls
#
```

```
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.2 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
ospf 1 router-id 5.5.5.5
 area 0.0.0.0
  network 5.5.5.5 0.0.0.0
  network 45.45.45.0 0.0.0.3
  network 56.56.56.0 0.0.0.3
#
return
```

14.4.7 PE2's Configuration

```
[PE2]dis cur
#
sysname PE2
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 6.6.6.6
mpls
#
mpls ldp
```

```
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 20.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 6.6.6.6 255.255.255.255
#
bgp 200
 peer 4.4.4.4 as-number 200
 peer 4.4.4.4 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 4.4.4.4 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 4.4.4.4 enable
 #
 ipv4-family vpn-instance huawei
  peer 20.1.1.2 as-number 65002
#
ospf 1 router-id 6.6.6.6
 area 0.0.0.0
  network 6.6.6.6 0.0.0.0
  network 56.56.56.0 0.0.0.3
#
return
```

14.4.8 CE2's Configuration

```
[CE2]dis cur
#
```

```
sysname CE2
#
interface GigabitEthernet0/0/1
 ip address 20.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 22.22.22.22 255.255.255.255
#
bgp 65002
 peer 20.1.1.1 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 22.22.22.22 255.255.255.255
  peer 20.1.1.1 enable
#
return
```

14.5 Quiz

1. In the Inter-AS MPLS BGP VPN Option A solution, is it necessary to set the RTs of PEs in different ASs to be the same?
2. In the preceding verification, if CE1 does not use its source address when ping CE2's loopback interface, can the ping operation succeed?

15 Configuration for Inter-AS MPLS BGP VPN Option B

15.1 Introduction

15.1.1 About This Lab

In this lab, you will learn how to configure the Inter-AS MPLS BGP VPN Option B solution.

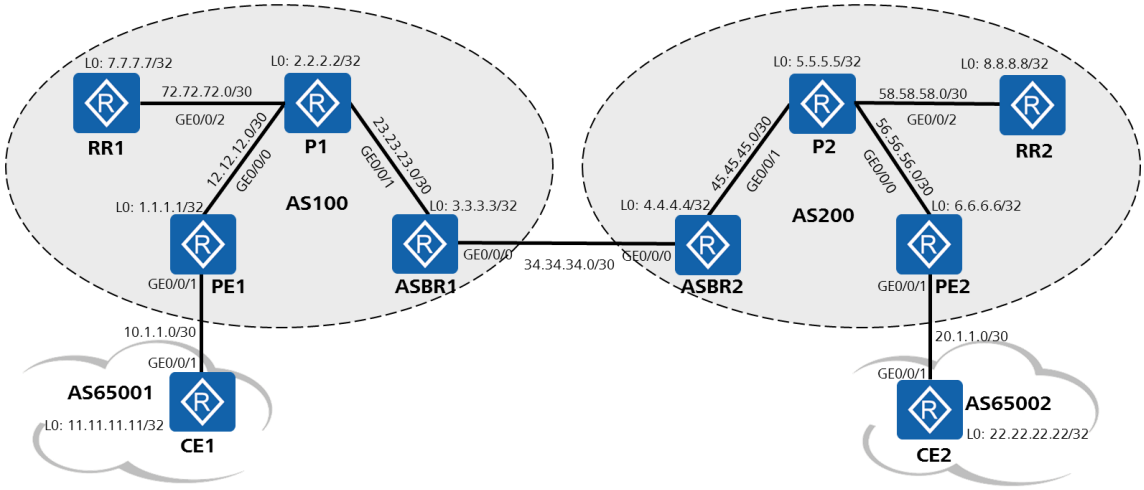
15.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand the fundamentals of Inter-AS MPLS BGP VPN Option B.
- Grasp the configuration roadmap and methods of Inter-AS MPLS BGP VPN Option B.

15.1.3 Networking Topology

Figure 15-1 Inter-AS MPLS BGP VPN Option B networking topology

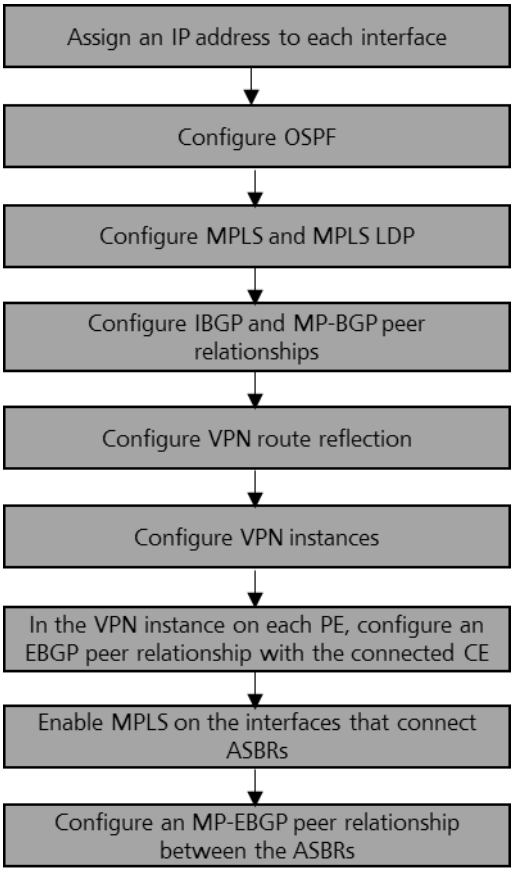


15.1.4 Networking Design

There are four ASs on the network shown in Figure 15-1. PE1, P1, RR1, and ASBR1 belong to AS100. PE2, P2, RR2, and ASBR2 belong to AS200. CE1 and CE2 belong to the same VPN. CE1 belongs to AS65001 and is connected to PE1 in AS100. CE2 belongs to AS65002 and is connected to PE2 in AS200. The IP addresses planned on each router are shown in Figure 15-1.

15.2 Lab Configuration

15.2.1 Configuration Roadmap



15.2.2 Configuration Procedure

Step 1 **Configure an IP address for each interface.**

CE1's configuration:

```
<Huawei>system-view
[Huawei]sysname CE1
[CE1]interface GigabitEthernet0/0/1
[CE1-GigabitEthernet0/0/1]ip address 10.1.1.1 30
[CE1-GigabitEthernet0/0/1]undo shutdown
[CE1-GigabitEthernet0/0/1]quit
[CE1]interface LoopBack 0
[CE1-LoopBack0]ip address 11.11.11.11 32
```

PE1's configuration:

```
<Huawei>system-view
[Huawei]sysname PE1
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]ip address 12.12.12.1 30
[PE1-GigabitEthernet0/0/0]undo shutdown
[PE1-GigabitEthernet0/0/0]quit
[PE1]interface loopback 0
[PE1-LoopBack0]ip address 1.1.1.1 32
[PE1-LoopBack0]quit
```

P1's configuration:

```
<Huawei>system-view
[Huawei]sysname P1
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]ip address 12.12.12.2 30
[P1-GigabitEthernet0/0/0]undo shutdown
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]ip address 23.23.23.1 30
[P1-GigabitEthernet0/0/1]undo shutdown
[P1-GigabitEthernet0/0/1]quit
[P1]interface GigabitEthernet0/0/2
[P1-GigabitEthernet0/0/2]ip address 72.72.72.2 30
[P1-GigabitEthernet0/0/2]undo shutdown
[P1-GigabitEthernet0/0/2]quit
[P1]interface loopback 0
[P1-LoopBack0]ip address 2.2.2.2 32
[P1-LoopBack0]quit
```

RR1's configuration:

```
<Huawei>system-view
[Huawei]sysname RR1
[RR1]interface GigabitEthernet0/0/2
[RR1-GigabitEthernet0/0/2]ip address 72.72.72.1 30
[RR1-GigabitEthernet0/0/2]undo shutdown
[RR1-GigabitEthernet0/0/2]quit
[RR1]interface LoopBack 0
[RR1-LoopBack0]ip address 7.7.7.7 32
```

ASBR1's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR1
[ASBR1]interface GigabitEthernet0/0/0
[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30
[ASBR1-GigabitEthernet0/0/0]undo shutdown
[ASBR1-GigabitEthernet0/0/0]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]ip address 23.23.23.2 30
[ASBR1-GigabitEthernet0/0/1]undo shutdown
[ASBR1-GigabitEthernet0/0/1]quit
[ASBR1]interface loopback 0
[ASBR1-LoopBack0]ip address 3.3.3.3 32
[ASBR1-LoopBack0]quit
```

ASBR2's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR2
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]undo shutdown
[ASBR2-GigabitEthernet0/0/0]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]ip address 45.45.45.1 30
[ASBR2-GigabitEthernet0/0/1]undo shutdown
[ASBR2-GigabitEthernet0/0/1]quit
[ASBR2]interface loopback 0
[ASBR2-LoopBack0]ip address 4.4.4.4 32
[ASBR2-LoopBack0]quit
```

P2's configuration:

```
<Huawei>system-view
[Huawei]sysname P2
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]ip address 56.56.56.1 30
[P2-GigabitEthernet0/0/0]undo shutdown
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]ip address 45.45.45.2 30
[P2-GigabitEthernet0/0/1]undo shutdown
[P2-GigabitEthernet0/0/1]quit
[P2]interface GigabitEthernet0/0/2
[P2-GigabitEthernet0/0/2]ip address 58.58.58.1 30
[P2-GigabitEthernet0/0/2]undo shutdown
[P2-GigabitEthernet0/0/2]quit
[P2]interface loopback 0
[P2-LoopBack0]ip address 5.5.5.5 32
[P2-LoopBack0]quit
```

PE2's configuration:

```
<Huawei>system-view
[Huawei]sysname PE2
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]ip address 56.56.56.2 30
[PE2-GigabitEthernet0/0/0]undo shutdown
[PE2-GigabitEthernet0/0/0]quit
[PE2]interface loopback 0
[PE2-LoopBack0]ip address 6.6.6.6 32
[PE2-LoopBack0]quit
```

RR2's configuration:

```
<Huawei>system-view
[Huawei]sysname RR2
[RR2]interface GigabitEthernet0/0/2
[RR2-GigabitEthernet0/0/2]ip address 58.58.58.2 30
[RR2-GigabitEthernet0/0/2]undo shutdown
[RR2-GigabitEthernet0/0/2]quit
[RR2]interface loopback 0
[RR2-LoopBack0]ip address 8.8.8.8 32
```

CE2's configuration:

```
<Huawei>system-view
[Huawei]sysname CE2
[CE2]interface GigabitEthernet0/0/1
[CE2-GigabitEthernet0/0/1]ip address 20.1.1.2 30
[CE2-GigabitEthernet0/0/1]undo shutdown
[CE2-GigabitEthernet0/0/1]quit
[CE2]interface loopback 0
[CE2-LoopBack0]ip address 22.22.22.22 32
```

Step 2 **Configure OSPF.**

PE1's configuration:

```
[PE1]ospf 1 router-id 1.1.1.1
[PE1-ospf-1]area 0
[PE1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[PE1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
```

P1's configuration:

```
[P1]ospf 1 router-id 2.2.2.2
[P1-ospf-1]area 0
[P1-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[P1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

RR1's configuration:

```
[RR1]ospf 1 router-id 7.7.7.7
[RR1-ospf-1]area 0
[RR1-ospf-1-area-0.0.0.0]network 7.7.7.7 0.0.0.0
[RR1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

ASBR1's configuration:

```
[ASBR1]ospf 1 router-id 3.3.3.3
[ASBR1-ospf-1]area 0
[ASBR1-ospf-1-area-0.0.0.0]network 3.3.3.3 0.0.0.0
[ASBR1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
```

ASBR2's configuration:

```
[ASBR2]ospf 1 router-id 4.4.4.4
[ASBR2-ospf-1]area 0
[ASBR2-ospf-1-area-0.0.0.0]network 4.4.4.4 0.0.0.0
[ASBR2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
```

P2's configuration:

```
[P2]ospf 1 router-id 5.5.5.5
[P2-ospf-1]area 0
[P2-ospf-1-area-0.0.0.0]network 5.5.5.5 0.0.0.0
[P2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

RR2's configuration:

```
[RR2]ospf 1 router-id 8.8.8.8
[RR2-ospf-1]area 0
[RR2-ospf-1-area-0.0.0.0]network 8.8.8.8 0.0.0.0
[RR2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

PE2's configuration:

```
[PE2]ospf 1 router-id 6.6.6.6
[PE2-ospf-1]area 0
[PE2-ospf-1-area-0.0.0.0]network 6.6.6.6 0.0.0.0
[PE2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
```

Step 3 **Enable MPLS and MPLS LDP.**

PE1's configuration:

```
<PE1>system-view
[PE1]mpls lsr-id 1.1.1.1
[PE1]mpls
[PE1-mpls]mpls ldp
[PE1-mpls-ldp]quit
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]mpls
[PE1-GigabitEthernet0/0/0]mpls ldp
[PE1-GigabitEthernet0/0/0]quit
```

P1's configuration:

```
<P1>system-view
[P1]mpls lsr-id 2.2.2.2
[P1]mpls
[P1-mpls]mpls ldp
[P1-mpls-ldp]quit
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]mpls
```

[P1-GigabitEthernet0/0/0]mpls ldp
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]mpls
[P1-GigabitEthernet0/0/1]mpls ldp
[P1-GigabitEthernet0/0/1]quit

ASBR1's configuration:

[ASBR1]mpls lsr-id 3.3.3.3
[ASBR1]mpls
[ASBR1-mpls]mpls ldp
[ASBR1-mpls-ldp]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]mpls
[ASBR1-GigabitEthernet0/0/1]mpls ldp
[ASBR1-GigabitEthernet0/0/1]quit

ASBR2's configuration:

[ASBR2]mpls lsr-id 4.4.4.4
[ASBR2]mpls
[ASBR2-mpls]mpls ldp
[ASBR2-mpls-ldp]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]mpls
[ASBR2-GigabitEthernet0/0/1]mpls ldp
[ASBR2-GigabitEthernet0/0/1]quit

P2's configuration:

<P2>system-view
[P2]mpls lsr-id 5.5.5.5
[P2]mpls
[P2-mpls]mpls ldp
[P2-mpls-ldp]quit
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]mpls
[P2-GigabitEthernet0/0/0]mpls ldp
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]mpls
[P2-GigabitEthernet0/0/1]mpls ldp

[P2-GigabitEthernet0/0/1]quit

PE2's configuration:

[PE2]mpls lsr-id 6.6.6.6

[PE2]mpls

[PE2-mpls]mpls ldp

[PE2-mpls-ldp]quit

[PE2]interface GigabitEthernet0/0/0

[PE2-GigabitEthernet0/0/0]mpls

[PE2-GigabitEthernet0/0/0]mpls ldp

[PE2-GigabitEthernet0/0/0]quit

Step 4 **Configure MP-IBGP peer relationships.**

PE1's configuration:

[PE1]bgp 100

[PE1-bgp]peer 7.7.7.7 as-number 100

//Configure an IBGP peer relationship between PE1 and RR1.

[PE1-bgp]peer 7.7.7.7 connect-interface loopback 0

//Set the interface used to establish the peer relationship to Loopback 0.

[PE1-bgp]ipv4-family vpnv4

//Enters the BGP VPNv4 view.

[PE1-bgp-af-vpnv4]peer 7.7.7.7 enable

//Enable the MP-IBGP peer relationship between PE1 and ASBR1.

[PE1-bgp-af-vpnv4]quit

ASBR1's configuration:

[ASBR1]bgp 100

[ASBR1-bgp]peer 7.7.7.7 as-number 100

[ASBR1-bgp]peer 7.7.7.7 connect-interface LoopBack 0

[ASBR1-bgp]ipv4-family vpnv4

[ASBR1-bgp-af-vpnv4]peer 7.7.7.7 enable

[ASBR1-bgp-af-vpnv4]quit

RR1's configuration:

[RR1]bgp 100

[RR1-bgp]peer 1.1.1.1 as-number 100

[RR1-bgp]peer 1.1.1.1 connect-interface LoopBack 0

[RR1-bgp]peer 3.3.3.3 as-number 100

[RR1-bgp]peer 3.3.3.3 connect-interface LoopBack 0

```
[RR1-bgp]ipv4-family vpnv4
[RR1-bgp-af-vpnv4]peer 1.1.1.1 enable
[RR1-bgp-af-vpnv4]peer 3.3.3.3 enable
[RR1-bgp-af-vpnv4]undo policy vpn-target
[RR1-bgp-af-vpnv4]quit
```

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]peer 8.8.8.8 as-number 200
[PE2-bgp]peer 8.8.8.8 connect-interface loopback 0
[PE2-bgp]ipv4-family vpnv4
[PE2-bgp-af-vpnv4]peer 8.8.8.8 enable
[PE2-bgp-af-vpnv4]quit
```

ASBR2's configuration:

```
[ASBR2]bgp 200
[ASBR2-bgp]peer 8.8.8.8 as-number 200
[ASBR2-bgp]peer 8.8.8.8 connect-interface loopback 0
[ASBR2-bgp]ipv4-family vpnv4
[ASBR2-bgp-af-vpnv4]peer 8.8.8.8 enable
[ASBR2-bgp-af-vpnv4]quit
```

RR2's configuration:

```
[RR2]bgp 200
[RR2-bgp]peer 4.4.4.4 as-number 200
[RR2-bgp]peer 4.4.4.4 connect-interface LoopBack 0
[RR2-bgp]peer 6.6.6.6 as-number 200
[RR2-bgp]peer 6.6.6.6 connect-interface LoopBack 0
[RR2-bgp]ipv4-family vpnv4
[RR2-bgp-af-vpnv4]peer 4.4.4.4 enable
[RR2-bgp-af-vpnv4]peer 6.6.6.6 enable
[RR2-bgp-af-vpnv4]undo policy vpn-target
[RR2-bgp-af-vpnv4]quit
```

Step 5 **Configure VPN route reflection.**

RR1's configuration:

```
[RR1]bgp 100
[RR1-bgp]ipv4-family vpnv4
[RR1-bgp-af-vpnv4]peer 1.1.1.1 reflect-client
[RR1-bgp-af-vpnv4]peer 3.3.3.3 reflect-client
```

RR2's configuration:

```
[RR2]bgp 200
[RR2-bgp]ipv4-family vpnv4
[RR2-bgp-af-vpnv4]peer 4.4.4.4 reflect-client
[RR2-bgp-af-vpnv4]peer 6.6.6.6 reflect-client
```

Step 6 **Configure VPN instances.**

PE1's configuration:

```
[PE1]ip vpn-instance huawei
//Create a VPN instance.
[PE1-vpn-instance-huawei]route-distinguisher 100:1
//Configure an RD.
[PE1-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both
//Configure RTs.
[PE1-vpn-instance-huawei-af-ipv4]quit
[PE1-vpn-instance-huawei]quit
[PE1]interface GigabitEthernet0/0/1
[PE1-GigabitEthernet0/0/1]ip binding vpn-instance huawei
//Binds the AC interface to the VPN instance.
[PE1-GigabitEthernet0/0/1]ip address 10.1.1.2 30
[PE1-GigabitEthernet0/0/1]undo shutdown
[PE1-GigabitEthernet0/0/1]quit
```

PE2's configuration:

```
[PE2]ip vpn-instance huawei
[PE2-vpn-instance-huawei]route-distinguisher 100:1
[PE2-vpn-instance-huawei-af-ipv4]vpn-target 100:1 both
[PE2-vpn-instance-huawei-af-ipv4]quit
[PE2-vpn-instance-huawei]quit
[PE2]interface GigabitEthernet0/0/1
[PE2-GigabitEthernet0/0/1]ip binding vpn-instance huawei
[PE2-GigabitEthernet0/0/1]ip address 20.1.1.1 30
[PE2-GigabitEthernet0/0/1]undo shutdown
[PE2-GigabitEthernet0/0/1]quit
```

Step 7 **In the VPN instance on each PE, configure an EBGP peer relationship with the connected CE.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]ipv4-family vpn-instance huawei
[PE1-bgp-huawei]peer 10.1.1.1 as-number 65001
```

//Configure an EBGP peer relationship between PE1 and CE1.

CE1's configuration:

```
[CE1]bgp 65001
[CE1-bgp]peer 10.1.1.2 as-number 100
[CE1-bgp]network 11.11.11.11 32
```

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]ipv4-family vpn-instance huawei
[PE2-bgp-huawei]peer 20.1.1.2 as-number 65002
```

CE2's configuration:

```
[CE2]bgp 65002
[CE2-bgp]peer 20.1.1.1 as-number 200
[CE2-bgp]network 22.22.22.22 32
```

Step 8 **Enable MPLS on the interfaces that connect ASBRs.**

ASBR1's configuration:

```
[ASBR1]interface GigabitEthernet0/0/0
[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30
[ASBR1-GigabitEthernet0/0/0]undo shutdown
[ASBR1-GigabitEthernet0/0/0]mpls
```

//Enable MPLS on the ASBR1 interface that connects to ASBR2.

ASBR2's configuration:

```
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]undo shutdown
[ASBR2-GigabitEthernet0/0/0]mpls
```

Step 9 **Configure an MP-EBGP peer relationship between the ASBRs.**

ASBR1's configuration:

```
[ASBR1]bgp 100
[ASBR1-bgp]peer 34.34.34.2 as-number 200
[ASBR1-bgp]ipv4-family vpnv4
[ASBR1-bgp-af-vpnv4]peer 34.34.34.2 enable
```

//Enable the MP-EBGP peer relationship between ASBR1 and ASBR2.

[ASBR1-bgp-af-vpnv4]undo policy vpn-target

//Disable ASBR1 from filtering the received VPNv4 routes based on VPN targets.

ASBR2's configuration:

[ASBR2]bgp 200

[ASBR2-bgp]peer 34.34.34.1 as-number 100

[ASBR2-bgp]ipv4-family vpnv4

[ASBR2-bgp-af-vpnv4]peer 34.34.34.1 enable

[ASBR2-bgp-af-vpnv4]undo policy vpn-target

15.3 Verification

Run the **display bgp vpnv4 vpn-instance huawei peer** command to check the BGP peer status in each VPN instance. Take PE1 as an example, the information output is as follows:

[PE1]dis bgp vpnv4 vpn-instance huawei peer

BGP local router ID : 12.12.12.1

Local AS number : 100

VPN-Instance huawei, Router ID 12.12.12.1:

Total number of peers : 1 Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pre fRcv
10.1.1.1	**4**	**65001**	**262**	**275**	**0**	**04:19:21**	**Established**	**1**

Run the **display bgp vpnv4 all routing-table** command to check whether each RR has received correct VPN routes. Take RR1 as an example, the information output is as follows:

[RR1]dis bgp vpnv4 all routing-table

BGP Local router ID is 72.72.72.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total number of routes from all PE: 2

Route Distinguisher: 100:1

	Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
***>i**	**11.11.11.11/32**	1.1.1.1	0	100	0	65001i
***>i**	**22.22.22.22/32**	3.3.3.3		100	0	200 65002i

After the preceding configuration is complete, CE1 and CE2 can learn the routes to each other's loopback interfaces. Run the **display ip routing-table** command to check for the routes. Take CE1 as an example, the information output is as follows:

```
[CE1]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.1.1.0/30  Direct  0    0           D   10.1.1.1        GigabitEthernet0/0/1
        10.1.1.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet0/0/1
    11.11.11.11/32  Direct  0    0           D   127.0.0.1       LoopBack0
    22.22.22.22/32  EBGP    255  0           D   10.1.1.2        GigabitEthernet0/0/1
       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
```

Run the **ping** command to test the connectivity. The following example uses CE1 to ping CE2's loopback interface:

```
[CE1]ping -a 11.11.11.11 22.22.22.22
  PING 22.22.22.22: 56  data bytes, press CTRL_C to break
    Reply from 22.22.22.22: bytes=56 Sequence=1 ttl=250 time=400 ms
    Reply from 22.22.22.22: bytes=56 Sequence=2 ttl=250 time=120 ms
    Reply from 22.22.22.22: bytes=56 Sequence=3 ttl=250 time=160 ms
    Reply from 22.22.22.22: bytes=56 Sequence=4 ttl=250 time=110 ms
    Reply from 22.22.22.22: bytes=56 Sequence=5 ttl=250 time=310 ms
  --- 22.22.22.22 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 110/220/400 ms
```

15.4 Reference Configuration

15.4.1 CE1's Configuration

```
[CE1]dis cur
#
```

```
sysname CE1
#
interface GigabitEthernet0/0/1
 ip address 10.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 11.11.11.11 255.255.255.255
#
bgp 65001
 peer 10.1.1.2 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 11.11.11.11 255.255.255.255
  peer 10.1.1.2 enable
#
Return
```

15.4.2 PE1's Configuration

```
[PE1]dis cur
#
sysname PE1
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 1.1.1.1
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.1 255.255.255.252
 mpls
 mpls ldp
```

```
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 10.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 7.7.7.7 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 7.7.7.7 enable
 #
 ipv4-family vpn-instance huawei
  peer 10.1.1.1 as-number 65001
#
ospf 1 router-id 1.1.1.1
 area 0.0.0.0
  network 1.1.1.1 0.0.0.0
  network 12.12.12.0 0.0.0.3
#
return
```

15.4.3 P1's Configuration

```
[P1]dis cur
#
sysname P1
#
mpls lsr-id 2.2.2.2
mpls
#
```

```
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 72.72.72.2 255.255.255.252
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
#
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
  network 2.2.2.2 0.0.0.0
  network 12.12.12.0 0.0.0.3
  network 23.23.23.0 0.0.0.3
  network 72.72.72.0 0.0.0.3
#
return
```

15.4.4 ASBR1's Configuration

```
[ASBR1]dis cur
#
sysname ASBR1
#
mpls lsr-id 3.3.3.3
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
```

```
 ip address 34.34.34.1 255.255.255.252
 mpls
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.2 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 connect-interface LoopBack0
 peer 34.34.34.2 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  peer 7.7.7.7 enable
  peer 34.34.34.2 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 7.7.7.7 enable
  peer 34.34.34.2 enable
#
ospf 1 router-id 3.3.3.3
 area 0.0.0.0
  network 3.3.3.3 0.0.0.0
  network 23.23.23.0 0.0.0.3
#
Return
```

15.4.5 RR1's Configuration

```
[RR1]dis cur
#
sysname RR1
#
```

```
interface GigabitEthernet0/0/2
 ip address 72.72.72.1 255.255.255.252
#
interface LoopBack0
 ip address 7.7.7.7 255.255.255.255
#
bgp 100
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 1.1.1.1 enable
  peer 3.3.3.3 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 1.1.1.1 enable
  peer 1.1.1.1 reflect-client
  peer 3.3.3.3 enable
  peer 3.3.3.3 reflect-client
#
ospf 1 router-id 7.7.7.7
 area 0.0.0.0
  network 7.7.7.7 0.0.0.0
  network 72.72.72.0 0.0.0.3
#
return
```

15.4.6 ASBR2's Configuration

```
[ASBR2]dis cur
#
sysname ASBR2
#
mpls lsr-id 4.4.4.4
mpls
```

```
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 34.34.34.2 255.255.255.252
 mpls
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.1 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 peer 34.34.34.1 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  peer 8.8.8.8 enable
  peer 34.34.34.1 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 8.8.8.8 enable
  peer 34.34.34.1 enable
#
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 4.4.4.4 0.0.0.0
  network 45.45.45.0 0.0.0.3
#
return
```

15.4.7 P2's Configuration

```
[P2]dis cur
#
sysname P2
#
mpls lsr-id 5.5.5.5
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 58.58.58.1 255.255.255.252
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
ospf 1 router-id 5.5.5.5
 area 0.0.0.0
  network 5.5.5.5 0.0.0.0
  network 45.45.45.0 0.0.0.3
  network 56.56.56.0 0.0.0.3
  network 58.58.58.0 0.0.0.3
#
Return
```

15.4.8 PE2's Configuration

```
[PE2]dis cur
```

```
#
sysname PE2
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 6.6.6.6
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 20.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 6.6.6.6 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 8.8.8.8 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 8.8.8.8 enable
 #
```

```
 ipv4-family vpn-instance huawei
  peer 20.1.1.2 as-number 65002
#
ospf 1 router-id 6.6.6.6
 area 0.0.0.0
  network 6.6.6.6 0.0.0.0
  network 56.56.56.0 0.0.0.3
#
return
```

15.4.9 RR2's Configuration

```
[RR2]dis cur
#
sysname RR2
#
interface GigabitEthernet0/0/2
 ip address 58.58.58.2 255.255.255.252
#
interface LoopBack0
 ip address 8.8.8.8 255.255.255.255
#
bgp 200
 peer 4.4.4.4 as-number 200
 peer 4.4.4.4 connect-interface LoopBack0
 peer 6.6.6.6 as-number 200
 peer 6.6.6.6 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 4.4.4.4 enable
  peer 6.6.6.6 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 4.4.4.4 enable
  peer 4.4.4.4 reflect-client
  peer 6.6.6.6 enable
  peer 6.6.6.6 reflect-client
```

```
#
ospf 1 router-id 8.8.8.8
 area 0.0.0.0
  network 8.8.8.8 0.0.0.0
  network 58.58.58.0 0.0.0.3
#
Return
```

15.4.10 CE2's Configuration

```
[CE2]dis cur
#
sysname CE2
#
interface GigabitEthernet0/0/1
 ip address 20.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 22.22.22.22 255.255.255.255
#
bgp 65002
 peer 20.1.1.1 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 22.22.22.22 255.255.255.255
  peer 20.1.1.1 enable
#
return
```

15.5 Quiz

In the Inter-AS MPLS BGP VPN Option B solution, what is the function of the **undo policy vpn-target** command?

16 Configuration for Inter-AS MPLS BGP VPN Option C Solution 1

16.1 Introduction

16.1.1 About This Lab

In this lab, you will learn how to configure the Inter-AS MPLS BGP VPN Option C solution 1.

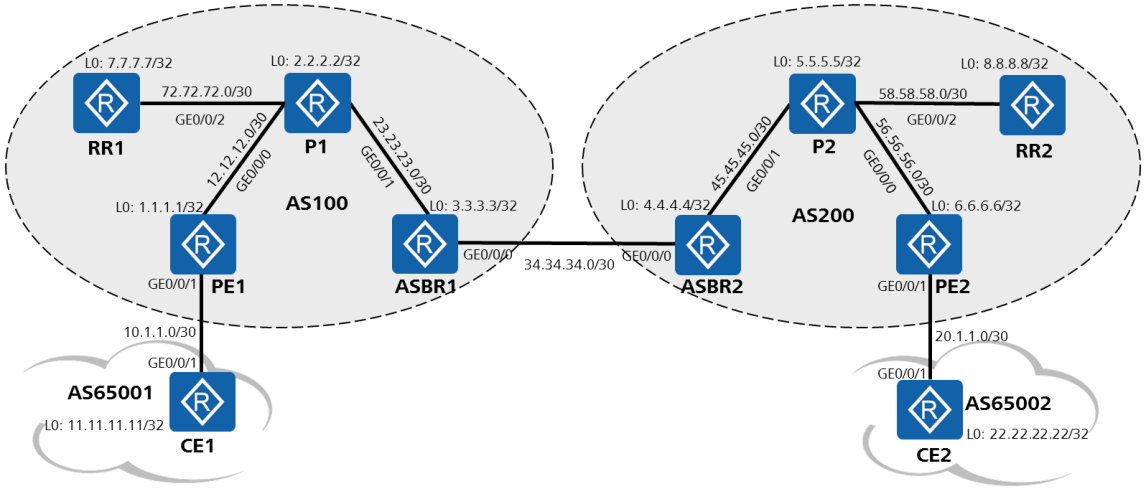
16.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand the fundamentals of Inter-AS MPLS BGP VPN Option C solution 1.
- Grasp the configuration roadmap and methods of Inter-AS MPLS BGP VPN Option C solution 1.

16.1.3 Networking Topology

Figure 16-1 Inter-AS MPLS BGP VPN Option C solution 1 networking topology

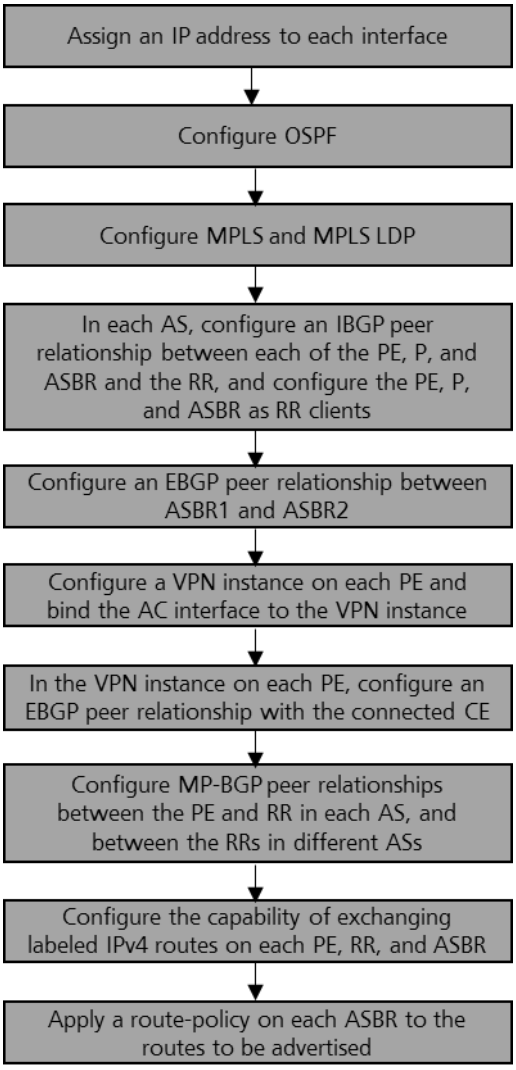


16.1.4 Networking Design

There are four ASs on the network shown in Figure 16-1. PE1, RR1, P1, and ASBR1 belong to AS100. PE2, RR2, P2, and ASBR2 belong to AS200. CE1 and CE2 belong to the same VPN. CE1 is connected to PE1 in AS 100, and CE2 is connected to PE2 in AS 200. The IP addresses planned on each router are shown in Figure 16-1.

16.2 Lab Configuration

16.2.1 Configuration Roadmap



16.2.2 Configuration Procedure

Step 1 **Configure an IP address for each interface.**

CE1's configuration:

```
<Huawei>system-view
[Huawei]sysname CE1
[CE1]interface GigabitEthernet0/0/1
[CE1-GigabitEthernet0/0/1]ip address 10.1.1.1 30
[CE1-GigabitEthernet0/0/1]undo shutdown
[CE1-GigabitEthernet0/0/1]quit
[CE1]interface LoopBack 0
[CE1-LoopBack0]ip address 11.11.11.11 32
```

PE1's configuration:

```
<Huawei>system-view
[Huawei]sysname PE1
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]ip address 12.12.12.1 30
[PE1-GigabitEthernet0/0/0]undo shutdown
[PE1-GigabitEthernet0/0/0]quit
[PE1]interface loopback 0
[PE1-LoopBack0]ip address 1.1.1.1 32
[PE1-LoopBack0]quit
```

P1's configuration:

```
<Huawei>system-view
[Huawei]sysname P1
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]ip address 12.12.12.2 30
[P1-GigabitEthernet0/0/0]undo shutdown
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]ip address 23.23.23.1 30
[P1-GigabitEthernet0/0/1]undo shutdown
[P1-GigabitEthernet0/0/1]quit
[P1]interface GigabitEthernet0/0/2
[P1-GigabitEthernet0/0/2]ip address 72.72.72.2 30
[P1-GigabitEthernet0/0/2]undo shutdown
[P1-GigabitEthernet0/0/2]quit
```

```
[P1]interface loopback 0
[P1-LoopBack0]ip address 2.2.2.2 32
[P1-LoopBack0]quit
```

RR1's configuration:

```
<Huawei>system-view
[Huawei]sysname RR1
[RR1]interface GigabitEthernet0/0/2
[RR1-GigabitEthernet0/0/2]ip address 72.72.72.1 30
[RR1-GigabitEthernet0/0/2]undo shutdown
[RR1-GigabitEthernet0/0/2]quit
[RR1]interface LoopBack 0
[RR1-LoopBack0]ip address 7.7.7.7 32
```

ASBR1's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR1
[ASBR1]interface GigabitEthernet0/0/0
[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30
[ASBR1-GigabitEthernet0/0/0]undo shutdown
[ASBR1-GigabitEthernet0/0/0]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]ip address 23.23.23.2 30
[ASBR1-GigabitEthernet0/0/1]undo shutdown
[ASBR1-GigabitEthernet0/0/1]quit
[ASBR1]interface loopback 0
[ASBR1-LoopBack0]ip address 3.3.3.3 32
[ASBR1-LoopBack0]quit
```

ASBR2's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR2
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]undo shutdown
[ASBR2-GigabitEthernet0/0/0]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]ip address 45.45.45.1 30
[ASBR2-GigabitEthernet0/0/1]undo shutdown
[ASBR2-GigabitEthernet0/0/1]quit
```

```
[ASBR2]interface loopback 0
[ASBR2-LoopBack0]ip address 4.4.4.4 32
[ASBR2-LoopBack0]quit
```

P2's configuration:

```
<Huawei>system-view
[Huawei]sysname P2
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]ip address 56.56.56.1 30
[P2-GigabitEthernet0/0/0]undo shutdown
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]ip address 45.45.45.2 30
[P2-GigabitEthernet0/0/1]undo shutdown
[P2-GigabitEthernet0/0/1]quit
[P2]interface GigabitEthernet0/0/2
[P2-GigabitEthernet0/0/2]ip address 58.58.58.1 30
[P2-GigabitEthernet0/0/2]undo shutdown
[P2-GigabitEthernet0/0/2]quit
[P2]interface loopback 0
[P2-LoopBack0]ip address 5.5.5.5 32
[P2-LoopBack0]quit
```

PE2's configuration:

```
<Huawei>system-view
[Huawei]sysname PE2
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]ip address 56.56.56.2 30
[PE2-GigabitEthernet0/0/0]undo shutdown
[PE2-GigabitEthernet0/0/0]quit
[PE2]interface loopback 0
[PE2-LoopBack0]ip address 6.6.6.6 32
[PE2-LoopBack0]quit
```

RR2's configuration:

```
<Huawei>system-view
[Huawei]sysname RR2
[RR2]interface GigabitEthernet0/0/2
[RR2-GigabitEthernet0/0/2]ip address 58.58.58.2 30
[RR2-GigabitEthernet0/0/2]undo shutdown
```

```
[RR2-GigabitEthernet0/0/2]quit
[RR2]interface loopback 0
[RR2-LoopBack0]ip address 8.8.8.8 32
```

CE2's configuration:

```
<Huawei>system-view
[Huawei]sysname CE2
[CE2]interface GigabitEthernet0/0/1
[CE2-GigabitEthernet0/0/1]ip address 20.1.1.2 30
[CE2-GigabitEthernet0/0/1]undo shutdown
[CE2-GigabitEthernet0/0/1]quit
[CE2]interface loopback 0
[CE2-LoopBack0]ip address 22.22.22.22 32
```

Step 2 **Configure OSPF.**

PE1's configuration:

```
[PE1]ospf 1 router-id 1.1.1.1
[PE1-ospf-1]area 0
[PE1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[PE1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
```

P1's configuration:

```
[P1]ospf 1 router-id 2.2.2.2
[P1-ospf-1]area 0
[P1-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[P1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

RR1's configuration:

```
[RR1]ospf 1 router-id 7.7.7.7
[RR1-ospf-1]area 0
[RR1-ospf-1-area-0.0.0.0]network 7.7.7.7 0.0.0.0
[RR1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

ASBR1's configuration:

```
[ASBR1]ospf 1 router-id 3.3.3.3
[ASBR1-ospf-1]area 0
[ASBR1-ospf-1-area-0.0.0.0]network 3.3.3.3 0.0.0.0
[ASBR1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
```

ASBR2's configuration:

```
[ASBR2]ospf 1 router-id 4.4.4.4
[ASBR2-ospf-1]area 0
[ASBR2-ospf-1-area-0.0.0.0]network 4.4.4.4 0.0.0.0
[ASBR2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
```

P2's configuration:

```
[P2]ospf 1 router-id 5.5.5.5
[P2-ospf-1]area 0
[P2-ospf-1-area-0.0.0.0]network 5.5.5.5 0.0.0.0
[P2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

RR2's configuration:

```
[RR2]ospf 1 router-id 8.8.8.8
[RR2-ospf-1]area 0
[RR2-ospf-1-area-0.0.0.0]network 8.8.8.8 0.0.0.0
[RR2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

PE2's configuration:

```
[PE2]ospf 1 router-id 6.6.6.6
[PE2-ospf-1]area 0
[PE2-ospf-1-area-0.0.0.0]network 6.6.6.6 0.0.0.0
[PE2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
```

Step 3 **Enable MPLS and MPLS LDP.**

PE1's configuration:

```
<PE1>system-view
[PE1]mpls lsr-id 1.1.1.1
[PE1]mpls
[PE1-mpls]mpls ldp
[PE1-mpls-ldp]quit
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]mpls
[PE1-GigabitEthernet0/0/0]mpls ldp
[PE1-GigabitEthernet0/0/0]quit
```

P1's configuration:

```
<P1>system-view
```

```
[P1]mpls lsr-id 2.2.2.2
[P1]mpls
[P1-mpls]mpls ldp
[P1-mpls-ldp]quit
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]mpls
[P1-GigabitEthernet0/0/0]mpls ldp
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]mpls
[P1-GigabitEthernet0/0/1]mpls ldp
[P1-GigabitEthernet0/0/1]quit
```

ASBR1's configuration:

```
[ASBR1]mpls lsr-id 3.3.3.3
[ASBR1]mpls
[ASBR1-mpls]mpls ldp
[ASBR1-mpls-ldp]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]mpls
[ASBR1-GigabitEthernet0/0/1]mpls ldp
[ASBR1-GigabitEthernet0/0/1]quit
```

ASBR2's configuration:

```
[ASBR2]mpls lsr-id 4.4.4.4
[ASBR2]mpls
[ASBR2-mpls]mpls ldp
[ASBR2-mpls-ldp]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]mpls
[ASBR2-GigabitEthernet0/0/1]mpls ldp
[ASBR2-GigabitEthernet0/0/1]quit
```

P2's configuration:

```
<P2>system-view
[P2]mpls lsr-id 5.5.5.5
[P2]mpls
[P2-mpls]mpls ldp
[P2-mpls-ldp]quit
[P2]interface GigabitEthernet0/0/0
```

```
[P2-GigabitEthernet0/0/0]mpls
[P2-GigabitEthernet0/0/0]mpls ldp
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]mpls
[P2-GigabitEthernet0/0/1]mpls ldp
[P2-GigabitEthernet0/0/1]quit
```

PE2's configuration:

```
[PE2]mpls lsr-id 6.6.6.6
[PE2]mpls
[PE2-mpls]mpls ldp
[PE2-mpls-ldp]quit
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]mpls
[PE2-GigabitEthernet0/0/0]mpls ldp
[PE2-GigabitEthernet0/0/0]quit
```

Step 4 **In each AS, configure an IBGP peer relationship between each of the PE, P, and ASBR and the RR, and configure the PE, P, and ASBR as RR clients.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]peer 7.7.7.7 as-number 100
```

//Configures an IBGP peer relationship between PE1 and RR1.

```
[PE1-bgp]peer 7.7.7.7 connect-interface loopback 0
```

//Sets the interface used to establish the peer relationship to Loopback 0.

P1's configuration:

```
[P1]bgp 100
[P1-bgp]peer 7.7.7.7 as-number 100
[P1-bgp]peer 7.7.7.7 connect-interface LoopBack 0
```

ASBR1's configuration:

```
[ASBR1]bgp 100
[ASBR1-bgp]peer 7.7.7.7 as-number 100
[ASBR1-bgp]peer 7.7.7.7 connect-interface LoopBack 0
```

RR1's configuration:

```
[RR1]bgp 100
[RR1-bgp]peer 1.1.1.1 as-number 100
```

[RR1-bgp]peer 1.1.1.1 connect-interface LoopBack 0

[RR1-bgp]peer 1.1.1.1 reflect-client

[RR1-bgp]peer 2.2.2.2 as-number 100

[RR1-bgp]peer 2.2.2.2 connect-interface LoopBack 0

[RR1-bgp]peer 2.2.2.2 reflect-client

[RR1-bgp]peer 3.3.3.3 as-number 100

[RR1-bgp]peer 3.3.3.3 connect-interface LoopBack 0

[RR1-bgp]peer 3.3.3.3 reflect-client

PE2's configuration:

[PE2]bgp 200

[PE2-bgp]peer 8.8.8.8 as-number 200

[PE2-bgp]peer 8.8.8.8 connect-interface loopback 0

P2's configuration:

[P2]bgp 200

[P2-bgp]peer 8.8.8.8 as-number 200

[P2-bgp]peer 8.8.8.8 connect-interface loopback 0

ASBR2's configuration:

[ASBR2]bgp 200

[ASBR2-bgp]peer 8.8.8.8 as-number 200

[ASBR2-bgp]peer 8.8.8.8 connect-interface loopback 0

RR2's configuration:

[RR2]bgp 200

[RR2-bgp]peer 4.4.4.4 as-number 200

[RR2-bgp]peer 4.4.4.4 connect-interface LoopBack 0

[RR2-bgp]peer 4.4.4.4 reflect-client

[RR2-bgp]peer 5.5.5.5 as-number 200

[RR2-bgp]peer 5.5.5.5 connect-interface LoopBack 0

[RR2-bgp]peer 5.5.5.5 reflect-client

[RR2-bgp]peer 6.6.6.6 as-number 200

[RR2-bgp]peer 6.6.6.6 connect-interface LoopBack 0

[RR2-bgp]peer 6.6.6.6 reflect-client

Step 5 **Configure an EBGP peer relationship between ASBR1 and ASBR2.**

ASBR1's configuration:

[ASBR1]bgp 100

[ASBR1-bgp]peer 34.34.34.2 as-number 200

ASBR2's configuration:

```
[ASBR2]bgp 200
[ASBR2-bgp]peer 34.34.34.1 as-number 100
```

Step 6 **Configure a VPN instance on each PE and bind the AC interface to the VPN instance.**

PE1's configuration:

```
[PE1]ip vpn-instance huawei
[PE1-vpn-instance-huawei]route-distinguisher 100:1
[PE1-vpn-instance-huawei]vpn-target 100:1 both
[PE1]interface GigabitEthernet0/0/1
[PE1-GigabitEthernet0/0/1]ip binding vpn-instance huawei
[PE1-GigabitEthernet0/0/1]ip address 10.1.1.2 30
[PE1-GigabitEthernet0/0/1]quit
```

PE2's configuration:

```
[PE2]ip vpn-instance huawei
[PE2-vpn-instance-huawei]route-distinguisher 100:1
[PE2-vpn-instance-huawei]vpn-target 100:1 both
[PE2]interface GigabitEthernet0/0/1
[PE2-GigabitEthernet0/0/1]ip binding vpn-instance huawei
[PE2-GigabitEthernet0/0/1]ip address 20.1.1.1 30
[PE2-GigabitEthernet0/0/1]quit
```

Step 7 **In the VPN instance on each PE, configure an EBGP peer relationship with the connected CE.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]ipv4-family vpn-instance huawei
[PE1-bgp-huawei]peer 10.1.1.1 as-number 65001
```

CE1's configuration:

```
[CE1]bgp 65001
[CE1-bgp]peer 10.1.1.2 as-number 100
[CE1-bgp]network 11.11.11.11 32
```

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]ipv4-family vpn-instance huawei
```

[PE2-bgp-huawei]peer 20.1.1.2 as-number 65002

CE2's configuration:

[CE2]bgp 65002

[CE2-bgp]peer 20.1.1.1 as-number 200

[CE2-bgp]network 22.22.22.22 32

Step 8 **Configure MP-BGP peer relationships between the PE and RR in each AS, and between the RRs in different ASs.**

PE1's configuration:

[PE1]bgp 100

[PE1-bgp]ipv4-family vpnv4

[PE1-bgp-af-vpnv4]peer 7.7.7.7 enable

RR1's configuration:

[RR1]bgp 100

[RR1-bgp]peer 8.8.8.8 as-number 200

[RR1-bgp]peer 8.8.8.8 connect-interface LoopBack 0

[RR1-bgp]peer 8.8.8.8 ebgp-max-hop 10

[RR1-bgp]ipv4-family vpnv4

[RR1-bgp-af-vpnv4]undo policy vpn-target

[RR1-bgp-af-vpnv4]peer 1.1.1.1 enable

[RR1-bgp-af-vpnv4]peer 1.1.1.1 reflect-client

[RR1-bgp-af-vpnv4]peer 1.1.1.1 next-hop-invariable

[RR1-bgp-af-vpnv4]peer 8.8.8.8 enable

[RR1-bgp-af-vpnv4]peer 8.8.8.8 next-hop-invariable

RR2's configuration:

[RR2]bgp 200

[RR2-bgp]peer 7.7.7.7 as-number 100

[RR2-bgp]peer 7.7.7.7 connect-interface LoopBack 0

[RR2-bgp]peer 7.7.7.7 ebgp-max-hop 10

[RR2-bgp]ipv4-family vpnv4

[RR2-bgp-af-vpnv4]undo policy vpn-target

[RR2-bgp-af-vpnv4]peer 6.6.6.6 enable

[RR2-bgp-af-vpnv4]peer 6.6.6.6 reflect-client

[RR2-bgp-af-vpnv4]peer 6.6.6.6 next-hop-invariable

[RR2-bgp-af-vpnv4]peer 7.7.7.7 enable

[RR2-bgp-af-vpnv4]peer 7.7.7.7 next-hop-invariable

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]ipv4-family vpnv4
[PE2-bgp-af-vpnv4]peer 8.8.8.8 enable
```

Step 9 **Configure the capability of exchanging labeled IPv4 routes on each PE, RR, and ASBR.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]peer 7.7.7.7 as-number 100
[PE1-bgp]peer 7.7.7.7 label-route-capability
```

RR1's configuration:

```
[RR1]bgp 100
[RR1-bgp]peer 1.1.1.1 as-number 100
[RR1-bgp]peer 1.1.1.1 label-route-capability
[RR1-bgp]peer 3.3.3.3 as-number 100
[RR1-bgp]peer 3.3.3.3 label-route-capability
```

ASBR1's configuration:

```
[ASBR1]bgp 100
[ASBR1-bgp]peer 7.7.7.7 as-number 100
[ASBR1-bgp]peer 7.7.7.7 label-route-capability
[ASBR1-bgp]peer 34.34.34.2 as-number 200
[ASBR1-bgp]peer 34.34.34.2 label-route-capability
```

ASBR2's configuration:

```
[ASBR2]bgp 200
[ASBR2-bgp]peer 8.8.8.8 as-number 100
[ASBR2-bgp]peer 8.8.8.8 label-route-capability
[ASBR2-bgp]peer 34.34.34.1 as-number 100
[ASBR2-bgp]peer 34.34.34.1 label-route-capability
```

RR2's configuration:

```
[RR2]bgp 200
[RR2-bgp]peer 4.4.4.4 as-number 200
[RR2-bgp]peer 4.4.4.4 label-route-capability
[RR2-bgp]peer 6.6.6.6 as-number 200
[RR2-bgp]peer 6.6.6.6 label-route-capability
```

PE2's configuration:

```
[PE2]bgp 200
```

[PE2-bgp]peer 8.8.8.8 as-number 200

[PE2-bgp]peer 8.8.8.8 label-route-capability

Step 10 **Configure a route-policy on each ASBR.**

ASBR1's configuration:

[ASBR1]interface GigabitEthernet0/0/0

[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30

[ASBR1-GigabitEthernet0/0/0]mpls

[ASBR1-GigabitEthernet0/0/0]quit

[ASBR1]route-policy policy1 permit node 10

[ASBR1-route-policy]apply mpls-label //Allocates labels to the routes that hit the filtering rule.

[ASBR1-route-policy]quit

[ASBR1]route-policy policy2 permit node 10

[ASBR1-route-policy]if-match mpls-label

[ASBR1-route-policy]apply mpls-label //Allocates new labels to the labeled routes.

[ASBR1-route-policy]quit

//Creates two route-policies on ASBR1.

[ASBR1]bgp 100

[ASBR1-bgp]peer 7.7.7.7 route-policy policy2 export

//On ASBR1, applies the export route-policy to the routes to be advertised to RR1. If the routes to be advertised to RR1 are labeled IPv4 routes, ASBR1 will assign new MPLS labels to these routes.

[ASBR1-bgp]peer 34.34.34.2 as-number 200

[ASBR1-bgp]peer 34.34.34.2 route-policy policy1 export

[ASBR1-bgp]peer 34.34.34.2 label-route-capability

[ASBR1-bgp]quit

//On ASBR1, applies the export route-policy to the routes to be advertised to ASBR2. When advertising the routes received from RR1 to ASBR2, ASBR1 will assign MPLS labels to the routes.

[ASBR1]bgp 100

[ASBR1-bgp]network 1.1.1.1 32

[ASBR1-bgp]network 7.7.7.7 32

//Configures ASBR1 to advertise routes destined for the loopback interfaces of PE1 and RR1 to ASBR2 so that ASBR2 can advertise the routes to RR2 and PE2.

[ASBR1-bgp]quit

ASBR2's configuration:

```
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]mpls
[ASBR2-GigabitEthernet0/0/0]quit
[ASBR2]route-policy policy1 permit node 10
[ASBR2-route-policy]apply mpls-label //Allocates labels to the routes that hit the filtering rule.
[ASBR2-route-policy]quit
[ASBR2]route-policy policy2 permit node 10
[ASBR2-route-policy]if-match mpls-label
[ASBR2-route-policy]apply mpls-label //Allocates new labels to the labeled routes.
[ASBR2-route-policy]quit
//Creates two route-policies on ASBR2.
[ASBR2]bgp 200
[ASBR2-bgp]peer 8.8.8.8 route-policy policy2 export
//On ASBR2, applies the export route-policy to the routes to be advertised to RR2. If the routes to be advertised to RR2 are labeled IPv4 routes, ASBR2 will assign new MPLS labels to these routes.
[ASBR2-bgp]peer 34.34.34.1 as-number 100
[ASBR2-bgp]peer 34.34.34.1 route-policy policy1 export
[ASBR2-bgp]peer 34.34.34.1 label-route-capability
[ASBR2-bgp]quit
//On ASBR2, applies the export route-policy to the routes to be advertised to ASBR1. When advertising the routes received from RR2 to ASBR1, ASBR2 will assign MPLS labels to the routes.
[ASBR2]bgp 200
[ASBR2-bgp]network 6.6.6.6 32
[ASBR2-bgp]network 8.8.8.8 32
//Configures ASBR2 to advertise routes destined for the loopback interfaces of PE2 and RR2 to ASBR1 so that ASBR2 can advertise the routes to RR1 and PE1.
[ASBR2-bgp]quit
```

16.3 Verification

Run the **display bgp peer** command to check the BGP peer status. The information output on RR1 as an example:

```
[RR1]dis bgp peer
 BGP local router ID : 72.72.72.1
 Local AS number : 100
 Total number of peers : 4          Peers in established state : 4

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State PrefRcv

  1.1.1.1         4         100      119      140     0 01:56:27 Established     0
  2.2.2.2         4         100      118      130     0 01:56:24 Established     0
  3.3.3.3         4         100      125      129     0 01:56:28 Established     2
  8.8.8.8         4         200      133      133     0 01:55:44 Established     0
```

Run the **display bgp vpnv4 all routing-table** command to check for BGP routes. The information output on PE1 as an example:

```
[PE1]dis bgp vpnv4 all routing-table
 BGP Local router ID is 12.12.12.1
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete
 Total number of routes from all PE: 2
 Route Distinguisher: 100:1
      Network            NextHop        MED        LocPrf    PrefVal Path/Ogn

 *>    11.11.11.11/32     10.1.1.1       0                    0       65001i
 *>i   22.22.22.22/32     6.6.6.6                  100        0       200 65002i

 VPN-Instance huawei, Router ID 12.12.12.1:

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

 *>    11.11.11.11/32     10.1.1.1         0          0          65001i
 *>i   22.22.22.22/32     6.6.6.6        100          0          200 65002i
```

After the preceding configuration is complete, CE1 and CE2 can learn the routes to each other's loopback interfaces. Run the **display ip routing-table** command to check for the routes. The information output on CE1 as an example:

```
<CE1>dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

10.1.1.0/30         Direct  0    0           D   10.1.1.1        GigabitEthernet0/0/1
10.1.1.1/32         Direct  0    0           D   127.0.0.1       GigabitEthernet0/0/1
11.11.11.11/32      Direct  0    0           D   127.0.0.1       LoopBack0
22.22.22.22/32      EBGP    255  0           D   10.1.1.2        GigabitEthernet0/0/1
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
```

Run the **ping** command to test the connectivity. The following example uses CE1 to ping CE2's loopback interface:

```
<CE1>ping -a 11.11.11.11 22.22.22.22
  PING 22.22.22.22: 56  data bytes, press CTRL_C to break
    Reply from 22.22.22.22: bytes=56 Sequence=1 ttl=250 time=250 ms
    Reply from 22.22.22.22: bytes=56 Sequence=2 ttl=250 time=170 ms
    Reply from 22.22.22.22: bytes=56 Sequence=3 ttl=250 time=200 ms
    Reply from 22.22.22.22: bytes=56 Sequence=4 ttl=250 time=180 ms
    Reply from 22.22.22.22: bytes=56 Sequence=5 ttl=250 time=180 ms

  --- 22.22.22.22 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 170/196/250 ms
```

16.4 Reference Configuration

16.4.1 CE1's Configuration

```
[CE1]dis cur
#
sysname CE1
#
interface GigabitEthernet0/0/1
 ip address 10.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 11.11.11.11 255.255.255.255
#
bgp 65001
 peer 10.1.1.2 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 11.11.11.11 255.255.255.255
  peer 10.1.1.2 enable
#
return
```

16.4.2 PE1's Configuration

```
[PE1]dis cur
#
sysname PE1
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
```

```
mpls lsr-id 1.1.1.1
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 10.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 7.7.7.7 enable
  peer 7.7.7.7 label-route-capability
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 7.7.7.7 enable
 #
 ipv4-family vpn-instance huawei
  peer 10.1.1.1 as-number 65001
#
ospf 1 router-id 1.1.1.1
```

```
 area 0.0.0.0
  network 1.1.1.1 0.0.0.0
  network 12.12.12.0 0.0.0.3
#
return
```

16.4.3 P1's Configuration

```
<P1>dis cur
#
sysname P1
#
mpls lsr-id 2.2.2.2
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 72.72.72.2 255.255.255.252
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
```

```
 peer 7.7.7.7 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 7.7.7.7 enable
#
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
  network 2.2.2.2 0.0.0.0
  network 12.12.12.0 0.0.0.3
  network 23.23.23.0 0.0.0.3
  network 72.72.72.0 0.0.0.3
#
return
```

16.4.4 ASBR1's Configuration

```
[ASBR1]dis cur
#
sysname ASBR1
#
mpls lsr-id 3.3.3.3
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 34.34.34.1 255.255.255.252
 mpls
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.2 255.255.255.252
 mpls
 mpls ldp
#
```

```
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 connect-interface LoopBack0
 peer 34.34.34.2 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 1.1.1.1 255.255.255.255
  network 7.7.7.7 255.255.255.255
  peer 7.7.7.7 enable
  peer 7.7.7.7 route-policy policy2 export
  peer 7.7.7.7 label-route-capability
  peer 34.34.34.2 enable
  peer 34.34.34.2 route-policy policy1 export
  peer 34.34.34.2 label-route-capability
#
ospf 1 router-id 3.3.3.3
 area 0.0.0.0
  network 3.3.3.3 0.0.0.0
  network 23.23.23.0 0.0.0.3
#
route-policy policy1 permit node 10
 apply mpls-label
#
route-policy policy2 permit node 10
 if-match mpls-label
 apply mpls-label
#
return
```

16.4.5 RR1's Configuration

```
[RR1]dis cur
#
sysname RR1
#
interface GigabitEthernet0/0/2
 ip address 72.72.72.1 255.255.255.252
#
interface LoopBack0
 ip address 7.7.7.7 255.255.255.255
#
bgp 100
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
 peer 2.2.2.2 as-number 100
 peer 2.2.2.2 connect-interface LoopBack0
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 ebgp-max-hop 10
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 1.1.1.1 enable
  peer 1.1.1.1 reflect-client
  peer 1.1.1.1 label-route-capability
  peer 2.2.2.2 enable
  peer 2.2.2.2 reflect-client
  peer 3.3.3.3 enable
  peer 3.3.3.3 reflect-client
  peer 3.3.3.3 label-route-capability
  peer 8.8.8.8 enable
 #
```

```
 ipv4-family vpnv4
  undo policy vpn-target
  peer 1.1.1.1 enable
  peer 1.1.1.1 reflect-client
  peer 1.1.1.1 next-hop-invariable
  peer 8.8.8.8 enable
  peer 8.8.8.8 next-hop-invariable
#
ospf 1 router-id 7.7.7.7
 area 0.0.0.0
  network 7.7.7.7 0.0.0.0
  network 72.72.72.0 0.0.0.3
#
return
```

16.4.6 ASBR2's Configuration

```
[ASBR2]dis cur
#
sysname ASBR2
#
mpls lsr-id 4.4.4.4
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 34.34.34.2 255.255.255.252
 mpls
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.1 255.255.255.252
 mpls
 mpls ldp
#
```

```
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 peer 34.34.34.1 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 6.6.6.6 255.255.255.255
  network 8.8.8.8 255.255.255.255
  peer 8.8.8.8 enable
  peer 8.8.8.8 route-policy policy2 export
  peer 8.8.8.8 label-route-capability
  peer 34.34.34.1 enable
  peer 34.34.34.1 route-policy policy1 export
  peer 34.34.34.1 label-route-capability
#
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 4.4.4.4 0.0.0.0
  network 45.45.45.0 0.0.0.3
#
route-policy policy1 permit node 10
 apply mpls-label
#
route-policy policy2 permit node 10
 if-match mpls-label
 apply mpls-label
#
return
```

16.4.7 P2's Configuration

```
[P2]dis cur
#
sysname P2
#
mpls lsr-id 5.5.5.5
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 58.58.58.1 255.255.255.252
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 8.8.8.8 enable
#
```

```
ospf 1 router-id 5.5.5.5
 area 0.0.0.0
  network 5.5.5.5 0.0.0.0
  network 45.45.45.0 0.0.0.3
  network 56.56.56.0 0.0.0.3
  network 58.58.58.0 0.0.0.3
#
return
```

16.4.8 PE2's Configuration

```
[PE2]dis cur
#
sysname PE2
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 6.6.6.6
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 20.1.1.1 255.255.255.252
#
```

```
interface LoopBack0
 ip address 6.6.6.6 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 8.8.8.8 enable
  peer 8.8.8.8 label-route-capability
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 8.8.8.8 enable
 #
 ipv4-family vpn-instance huawei
  peer 20.1.1.2 as-number 65002
#
ospf 1 router-id 6.6.6.6
 area 0.0.0.0
  network 6.6.6.6 0.0.0.0
  network 56.56.56.0 0.0.0.3
#
return
```

16.4.9 RR2's Configuration

```
[RR2]dis cur
#
sysname RR2
#
interface GigabitEthernet0/0/2
 ip address 58.58.58.2 255.255.255.252
#
```

```
interface LoopBack0
 ip address 8.8.8.8 255.255.255.255
#
bgp 200
 peer 4.4.4.4 as-number 200
 peer 4.4.4.4 connect-interface LoopBack0
 peer 5.5.5.5 as-number 200
 peer 5.5.5.5 connect-interface LoopBack0
 peer 6.6.6.6 as-number 200
 peer 6.6.6.6 connect-interface LoopBack0
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 ebgp-max-hop 10
 peer 7.7.7.7 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 4.4.4.4 enable
  peer 4.4.4.4 reflect-client
  peer 4.4.4.4 label-route-capability
  peer 5.5.5.5 enable
  peer 5.5.5.5 reflect-client
  peer 6.6.6.6 enable
  peer 6.6.6.6 reflect-client
  peer 6.6.6.6 label-route-capability
  peer 7.7.7.7 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 6.6.6.6 enable
  peer 6.6.6.6 reflect-client
  peer 6.6.6.6 next-hop-invariable
  peer 7.7.7.7 enable
  peer 7.7.7.7 next-hop-invariable
#
```

```
ospf 1 router-id 8.8.8.8
 area 0.0.0.0
  network 8.8.8.8 0.0.0.0
  network 58.58.58.0 0.0.0.3
#
return
```

16.4.10 CE2's Configuration

```
[CE2]dis cur
#
sysname CE2
#
interface GigabitEthernet0/0/1
 ip address 20.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 22.22.22.22 255.255.255.255
#
bgp 65002
 peer 20.1.1.1 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 22.22.22.22 255.255.255.255
  peer 20.1.1.1 enable
#
return
```

16.5 Quiz

In Inter-AS MPLS BGP VPN Option C solution 1, what protocols are used to generate the three labels and what are their functions?

17 Configuration for Inter-AS MPLS BGP VPN Option C Solution 2

17.1 Introduction

17.1.1 About This Lab

In this lab, you will learn how to configure the Inter-AS MPLS BGP VPN Option C solution 2.

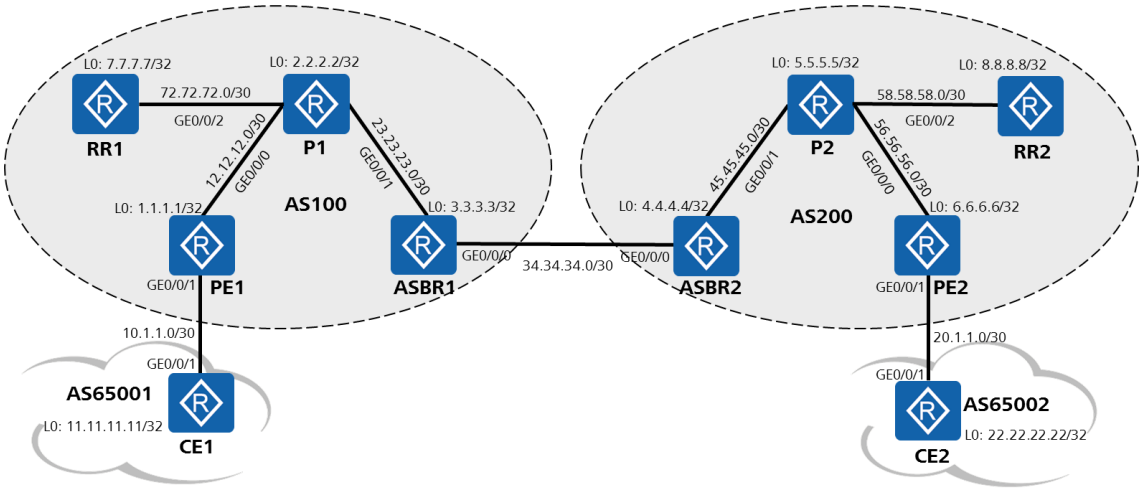
17.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand the fundamentals of Inter-AS MPLS BGP VPN Option C solution 2.
- Grasp the configuration roadmap and methods of Inter-AS MPLS BGP VPN Option C solution 2.

17.1.3 Networking Topology

Figure 17-1 Inter-AS MPLS BGP VPN Option C solution 2 networking topology

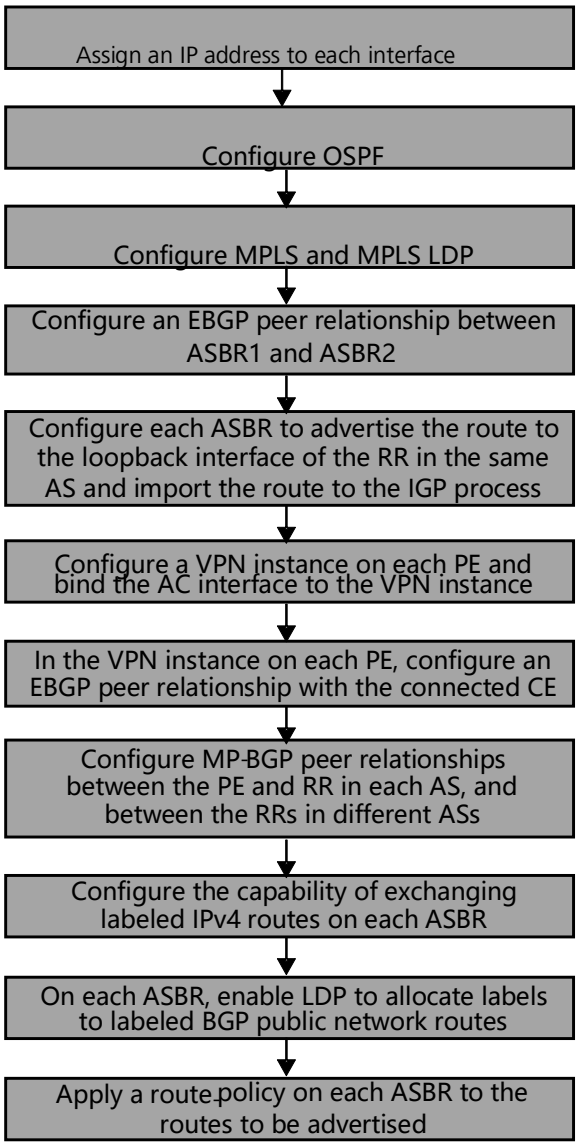


17.1.4 Networking Design

There are four ASs on the network shown in Figure 17-1. PE1, RR1, P1, and ASBR1 belong to AS100. PE2, RR2, P2, and ASBR2 belong to AS200. CE1 and CE2 belong to the same VPN. CE1 is connected to PE1 in AS 100, and CE2 is connected to PE2 in AS 200. The IP addresses planned on each router are shown in Figure 17-1.

17.2 Lab Configuration

17.2.1 Configuration Roadmap



17.2.2 Configuration Procedure

Step 1 **Configure an IP address for each interface.**

CE1's configuration:

```
<Huawei>system-view
[Huawei]sysname CE1
[CE1]interface GigabitEthernet0/0/1
[CE1-GigabitEthernet0/0/1]ip address 10.1.1.1 30
[CE1-GigabitEthernet0/0/1]undo shutdown
[CE1-GigabitEthernet0/0/1]quit
[CE1]interface LoopBack 0
[CE1-LoopBack0]ip address 11.11.11.11 32
```

PE1's configuration:

```
<Huawei>system-view
[Huawei]sysname PE1
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]ip address 12.12.12.1 30
[PE1-GigabitEthernet0/0/0]undo shutdown
[PE1-GigabitEthernet0/0/0]quit
[PE1]interface loopback 0
[PE1-LoopBack0]ip address 1.1.1.1 32
[PE1-LoopBack0]quit
```

P1's configuration:

```
<Huawei>system-view
[Huawei]sysname P1
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]ip address 12.12.12.2 30
[P1-GigabitEthernet0/0/0]undo shutdown
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]ip address 23.23.23.1 30
[P1-GigabitEthernet0/0/1]undo shutdown
[P1-GigabitEthernet0/0/1]quit
[P1]interface GigabitEthernet0/0/2
[P1-GigabitEthernet0/0/2]ip address 72.72.72.2 30
[P1-GigabitEthernet0/0/2]undo shutdown
[P1-GigabitEthernet0/0/2]quit
```

```
[P1]interface loopback 0
[P1-LoopBack0]ip address 2.2.2.2 32
[P1-LoopBack0]quit
```

RR1's configuration:

```
<Huawei>system-view
[Huawei]sysname RR1
[RR1]interface GigabitEthernet0/0/2
[RR1-GigabitEthernet0/0/2]ip address 72.72.72.1 30
[RR1-GigabitEthernet0/0/2]undo shutdown
[RR1-GigabitEthernet0/0/2]quit
[RR1]interface LoopBack 0
[RR1-LoopBack0]ip address 7.7.7.7 32
```

ASBR1's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR1
[ASBR1]interface GigabitEthernet0/0/0
[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30
[ASBR1-GigabitEthernet0/0/0]undo shutdown
[ASBR1-GigabitEthernet0/0/0]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]ip address 23.23.23.2 30
[ASBR1-GigabitEthernet0/0/1]undo shutdown
[ASBR1-GigabitEthernet0/0/1]quit
[ASBR1]interface loopback 0
[ASBR1-LoopBack0]ip address 3.3.3.3 32
[ASBR1-LoopBack0]quit
```

ASBR2's configuration:

```
<Huawei>system-view
[Huawei]sysname ASBR2
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]undo shutdown
[ASBR2-GigabitEthernet0/0/0]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]ip address 45.45.45.1 30
[ASBR2-GigabitEthernet0/0/1]undo shutdown
[ASBR2-GigabitEthernet0/0/1]quit
```

```
[ASBR2]interface loopback 0
[ASBR2-LoopBack0]ip address 4.4.4.4 32
[ASBR2-LoopBack0]quit
```

P2's configuration:

```
<Huawei>system-view
[Huawei]sysname P2
[P2]interface GigabitEthernet0/0/0
[P2-GigabitEthernet0/0/0]ip address 56.56.56.1 30
[P2-GigabitEthernet0/0/0]undo shutdown
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]ip address 45.45.45.2 30
[P2-GigabitEthernet0/0/1]undo shutdown
[P2-GigabitEthernet0/0/1]quit
[P2]interface GigabitEthernet0/0/2
[P2-GigabitEthernet0/0/2]ip address 58.58.58.1 30
[P2-GigabitEthernet0/0/2]undo shutdown
[P2-GigabitEthernet0/0/2]quit
[P2]interface loopback 0
[P2-LoopBack0]ip address 5.5.5.5 32
[P2-LoopBack0]quit
```

PE2's configuration:

```
<Huawei>system-view
[Huawei]sysname PE2
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]ip address 56.56.56.2 30
[PE2-GigabitEthernet0/0/0]undo shutdown
[PE2-GigabitEthernet0/0/0]quit
[PE2]interface loopback 0
[PE2-LoopBack0]ip address 6.6.6.6 32
[PE2-LoopBack0]quit
```

RR2's configuration:

```
<Huawei>system-view
[Huawei]sysname RR2
[RR2]interface GigabitEthernet0/0/2
[RR2-GigabitEthernet0/0/2]ip address 58.58.58.2 30
[RR2-GigabitEthernet0/0/2]undo shutdown
```

```
[RR2-GigabitEthernet0/0/2]quit
[RR2]interface loopback 0
[RR2-LoopBack0]ip address 8.8.8.8 32
```

CE2's configuration:

```
<Huawei>system-view
[Huawei]sysname CE2
[CE2]interface GigabitEthernet0/0/1
[CE2-GigabitEthernet0/0/1]ip address 20.1.1.2 30
[CE2-GigabitEthernet0/0/1]undo shutdown
[CE2-GigabitEthernet0/0/1]quit
[CE2]interface loopback 0
[CE2-LoopBack0]ip address 22.22.22.22 32
```

Step 2 **Configure OSPF.**

PE1's configuration:

```
[PE1]ospf 1 router-id 1.1.1.1
[PE1-ospf-1]area 0
[PE1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[PE1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
```

P1's configuration:

```
[P1]ospf 1 router-id 2.2.2.2
[P1-ospf-1]area 0
[P1-ospf-1-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[P1-ospf-1-area-0.0.0.0]network 12.12.12.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
[P1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

RR1's configuration:

```
[RR1]ospf 1 router-id 7.7.7.7
[RR1-ospf-1]area 0
[RR1-ospf-1-area-0.0.0.0]network 7.7.7.7 0.0.0.0
[RR1-ospf-1-area-0.0.0.0]network 72.72.72.0 0.0.0.3
```

ASBR1's configuration:

```
[ASBR1]ospf 1 router-id 3.3.3.3
[ASBR1-ospf-1]area 0
[ASBR1-ospf-1-area-0.0.0.0]network 3.3.3.3 0.0.0.0
[ASBR1-ospf-1-area-0.0.0.0]network 23.23.23.0 0.0.0.3
```

ASBR2's configuration:

```
[ASBR2]ospf 1 router-id 4.4.4.4
[ASBR2-ospf-1]area 0
[ASBR2-ospf-1-area-0.0.0.0]network 4.4.4.4 0.0.0.0
[ASBR2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
```

P2's configuration:

```
[P2]ospf 1 router-id 5.5.5.5
[P2-ospf-1]area 0
[P2-ospf-1-area-0.0.0.0]network 5.5.5.5 0.0.0.0
[P2-ospf-1-area-0.0.0.0]network 45.45.45.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
[P2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

RR2's configuration:

```
[RR2]ospf 1 router-id 8.8.8.8
[RR2-ospf-1]area 0
[RR2-ospf-1-area-0.0.0.0]network 8.8.8.8 0.0.0.0
[RR2-ospf-1-area-0.0.0.0]network 58.58.58.0 0.0.0.3
```

PE2's configuration:

```
[PE2]ospf 1 router-id 6.6.6.6
[PE2-ospf-1]area 0
[PE2-ospf-1-area-0.0.0.0]network 6.6.6.6 0.0.0.0
[PE2-ospf-1-area-0.0.0.0]network 56.56.56.0 0.0.0.3
```

Step 3 **Enable MPLS and MPLS LDP.**

PE1's configuration:

```
<PE1>system-view
[PE1]mpls lsr-id 1.1.1.1
[PE1]mpls
[PE1-mpls]mpls ldp
[PE1-mpls-ldp]quit
[PE1]interface GigabitEthernet0/0/0
[PE1-GigabitEthernet0/0/0]mpls
[PE1-GigabitEthernet0/0/0]mpls ldp
[PE1-GigabitEthernet0/0/0]quit
```

P1's configuration:

```
<P1>system-view
```

```
[P1]mpls lsr-id 2.2.2.2
[P1]mpls
[P1-mpls]mpls ldp
[P1-mpls-ldp]quit
[P1]interface GigabitEthernet0/0/0
[P1-GigabitEthernet0/0/0]mpls
[P1-GigabitEthernet0/0/0]mpls ldp
[P1-GigabitEthernet0/0/0]quit
[P1]interface GigabitEthernet0/0/1
[P1-GigabitEthernet0/0/1]mpls
[P1-GigabitEthernet0/0/1]mpls ldp
[P1-GigabitEthernet0/0/1]quit
```

ASBR1's configuration:

```
[ASBR1]mpls lsr-id 3.3.3.3
[ASBR1]mpls
[ASBR1-mpls]mpls ldp
[ASBR1-mpls-ldp]quit
[ASBR1]interface GigabitEthernet0/0/1
[ASBR1-GigabitEthernet0/0/1]mpls
[ASBR1-GigabitEthernet0/0/1]mpls ldp
[ASBR1-GigabitEthernet0/0/1]quit
```

ASBR2's configuration:

```
[ASBR2]mpls lsr-id 4.4.4.4
[ASBR2]mpls
[ASBR2-mpls]mpls ldp
[ASBR2-mpls-ldp]quit
[ASBR2]interface GigabitEthernet0/0/1
[ASBR2-GigabitEthernet0/0/1]mpls
[ASBR2-GigabitEthernet0/0/1]mpls ldp
[ASBR2-GigabitEthernet0/0/1]quit
```

P2's configuration:

```
<P2>system-view
[P2]mpls lsr-id 5.5.5.5
[P2]mpls
[P2-mpls]mpls ldp
[P2-mpls-ldp]quit
[P2]interface GigabitEthernet0/0/0
```

[P2-GigabitEthernet0/0/0]mpls
[P2-GigabitEthernet0/0/0]mpls ldp
[P2-GigabitEthernet0/0/0]quit
[P2]interface GigabitEthernet0/0/1
[P2-GigabitEthernet0/0/1]mpls
[P2-GigabitEthernet0/0/1]mpls ldp
[P2-GigabitEthernet0/0/1]quit

PE2's configuration:

[PE2]mpls lsr-id 6.6.6.6
[PE2]mpls
[PE2-mpls]mpls ldp
[PE2-mpls-ldp]quit
[PE2]interface GigabitEthernet0/0/0
[PE2-GigabitEthernet0/0/0]mpls
[PE2-GigabitEthernet0/0/0]mpls ldp
[PE2-GigabitEthernet0/0/0]quit

Step 4 **Configure an EBGP peer relationship between the ASBRs.**

ASBR1's configuration:

[ASBR1]bgp 100
[ASBR1-bgp]peer 34.34.34.2 as-number 200

ASBR2's configuration:

[ASBR2]bgp 200
[ASBR2-bgp]peer 34.34.34.1 as-number 100

Step 5 **Configure each ASBR to advertise the route to the loopback interface of the RR in the same AS and import the route to the IGP process.**

ASBR1's configuration:

[ASBR1]bgp 100
[ASBR1-bgp]network 7.7.7.7 32
[ASBR1]ospf
[ASBR1-ospf-1]import-route bgp

ASBR2's configuration:

[ASBR2]bgp 200
[ASBR2-bgp]network 8.8.8.8 32
[ASBR2]ospf
[ASBR2-ospf-1]import-route bgp

Step 6 **Configure a VPN instance on each PE and bind the AC interface to the VPN instance.**

PE1's configuration:

```
[PE1]ip vpn-instance huawei
[PE1-vpn-instance-huawei]route-distinguisher 100:1
[PE1-vpn-instance-huawei]vpn-target 100:1 both
[PE1]interface GigabitEthernet0/0/1
[PE1-GigabitEthernet0/0/1]ip binding vpn-instance huawei
[PE1-GigabitEthernet0/0/1]ip address 10.1.1.2 30
[PE1-GigabitEthernet0/0/1]quit
```

PE2's configuration:

```
[PE2]ip vpn-instance huawei
[PE2-vpn-instance-huawei]route-distinguisher 100:1
[PE2-vpn-instance-huawei]vpn-target 100:1 both
[PE2]interface GigabitEthernet0/0/1
[PE2-GigabitEthernet0/0/1]ip binding vpn-instance huawei
[PE2-GigabitEthernet0/0/1]ip address 20.1.1.1 30
[PE2-GigabitEthernet0/0/1]quit
```

Step 7 **In the VPN instance on each PE, configure an EBGP peer relationship with the connected CE.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]ipv4-family vpn-instance huawei
[PE1-bgp-huawei]peer 10.1.1.1 as-number 65001
```

CE1's configuration:

```
[CE1]bgp 65001
[CE1-bgp]peer 10.1.1.2 as-number 100
[CE1-bgp]network 11.11.11.11 32
```

PE2's configuration:

```
[PE2]bgp 200
[PE2-bgp]ipv4-family vpn-instance huawei
[PE2-bgp-huawei]peer 20.1.1.2 as-number 65002
```

CE2's configuration:

```
[CE2]bgp 65002
[CE2-bgp]peer 20.1.1.1 as-number 200
```

```
[CE2-bgp]network 22.22.22.22 32
```

Step 8 **Configure MP-BGP peer relationships between the PE and RR in each AS, and between the RRs in different ASs.**

PE1's configuration:

```
[PE1]bgp 100
[PE1-bgp]peer 7.7.7.7 as-number 100
[PE1-bgp]peer 7.7.7.7 connect-interface LoopBack 0
[PE1-bgp]ipv4-family vpnv4
[PE1-bgp-af-vpnv4]peer 7.7.7.7 enable
```

RR1's configuration:

```
[RR1]bgp 100
[RR1-bgp]peer 1.1.1.1 as-number 100
[RR1-bgp]peer 1.1.1.1 connect-interface LoopBack 0
[RR1-bgp]peer 8.8.8.8 as-number 200
[RR1-bgp]peer 8.8.8.8 connect-interface LoopBack 0
[RR1-bgp]peer 8.8.8.8 ebgp-max-hop 10
[RR1-bgp]ipv4-family vpnv4
[RR1-bgp-af-vpnv4]undo policy vpn-target
[RR1-bgp-af-vpnv4]peer  1.1.1.1 enable
[RR1-bgp-af-vpnv4]peer  1.1.1.1 reflect-client
[RR1-bgp-af-vpnv4]peer  1.1.1.1 next-hop-invariable
[RR1-bgp-af-vpnv4]peer  8.8.8.8 enable
[RR1-bgp-af-vpnv4]peer  8.8.8.8 next-hop-invariable
```

RR2's configuration:

```
[RR2]bgp 200
[RR2-bgp]peer 6.6.6.6 as-number 200
[RR2-bgp]peer 6.6.6.6 connect-interface LoopBack 0
[RR2-bgp]peer 7.7.7.7 as-number 100
[RR2-bgp]peer 7.7.7.7 connect-interface LoopBack 0
[RR2-bgp]peer 7.7.7.7 ebgp-max-hop 10
[RR2-bgp]ipv4-family vpnv4
[RR2-bgp-af-vpnv4]undo policy vpn-target
[RR2-bgp-af-vpnv4]peer  6.6.6.6 enable
[RR2-bgp-af-vpnv4]peer  6.6.6.6 reflect-client
[RR2-bgp-af-vpnv4]peer  6.6.6.6 next-hop-invariable
[RR2-bgp-af-vpnv4]peer  7.7.7.7 enable
```

[RR2-bgp-af-vpnv4]peer 7.7.7.7 next-hop-invariable

PE2's configuration:

[PE2]bgp 200

[PE2-bgp]peer 8.8.8.8 as-number 200

[PE2-bgp]peer 8.8.8.8 connect-interface LoopBack 0

[PE2-bgp]ipv4-family vpnv4

[PE2-bgp-af-vpnv4]peer 8.8.8.8 enable

Step 9 **Configure the capability of exchanging labeled IPv4 routes on each ASBR.**

ASBR1's configuration:

[ASBR1]bgp 100

[ASBR1-bgp]peer 34.34.34.2 as-number 200

[ASBR1-bgp]peer 34.34.34.2 label-route-capability

ASBR2's configuration:

[ASBR2]bgp 200

[ASBR2-bgp]peer 34.34.34.1 as-number 100

[ASBR2-bgp]peer 34.34.34.1 label-route-capability

Step 10 **On each ASBR, enable LDP to allocate labels to labeled BGP public network routes.**

ASBR1's configuration:

[ASBR1]mpls

[ASBR1-mpls]lsp-trigger bgp-label-route

ASBR2's configuration:

[ASBR2]mpls

[ASBR2-mpls]lsp-trigger bgp-label-route

Step 11 **Configure a route-policy on each ASBR.**

ASBR1's configuration:

[ASBR1]interface GigabitEthernet0/0/0

[ASBR1-GigabitEthernet0/0/0]ip address 34.34.34.1 30

[ASBR1-GigabitEthernet0/0/0]mpls

[ASBR1-GigabitEthernet0/0/0]quit

[ASBR1]route-policy policy1 permit node 10

[ASBR1-route-policy]apply mpls-label //Allocates labels to the routes that hit the filtering rule.

[ASBR1-route-policy]quit

```
[ASBR1]bgp 100
[ASBR1-bgp]peer 34.34.34.2 as-number 200
[ASBR1-bgp]peer 34.34.34.2 route-policy policy1 export
[ASBR1-bgp]network 1.1.1.1 32
```

ASBR2's configuration:

```
[ASBR2]interface GigabitEthernet0/0/0
[ASBR2-GigabitEthernet0/0/0]ip address 34.34.34.2 30
[ASBR2-GigabitEthernet0/0/0]mpls
[ASBR2-GigabitEthernet0/0/0]quit
[ASBR2]route-policy policy1 permit node 10
[ASBR2-route-policy]apply mpls-label //Allocates labels to the routes that hit the filtering rule.
[ASBR2-route-policy]quit
[ASBR2]bgp 200
[ASBR2-bgp]peer 34.34.34.1 as-number 100
[ASBR2-bgp]peer 34.34.34.1 route-policy policy1 export
[ASBR2-bgp]network 6.6.6.6 32
```

17.3 Verification

Run the **display ip routing-table** command on CE1 to check whether CE1 has learned the route from CE2.

```
[CE1]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

10.1.1.0/30         Direct  0    0           D   10.1.1.1        GigabitEthernet0/0/1
10.1.1.1/32         Direct  0    0           D   127.0.0.1       GigabitEthernet0/0/1
11.11.11.11/32      Direct  0    0           D   127.0.0.1       LoopBack0
22.22.22.22/32      EBGP    255  0           D   10.1.1.2        GigabitEthernet0/0/1
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
```

Run the **display bgp routing-table label** command on each ASBR to check label information of IPv4 routes.

```
[ASBR1]dis bgp routing-table label
 BGP Local router ID is 34.34.34.1
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete
 Total Number of Routes: 4
      Network            NextHop          In/Out Label

 *>   1.1.1.1            23.23.23.1       1024/NULL
 *>   6.6.6.6            34.34.34.2       NULL/1024
 *>   7.7.7.7            23.23.23.1       1025/NULL
 *>   8.8.8.8            34.34.34.2       NULL/1025
```

After the preceding configuration is complete, CE1 and CE2 can learn the routes to each other's loopback interfaces. Run the **display ip routing-table** command to check for the routes. The information output on CE1 as an example:

```
<CE1>dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 6        Routes : 6

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

10.1.1.0/30         Direct  0    0           D   10.1.1.1        GigabitEthernet0/0/1
10.1.1.1/32         Direct  0    0           D   127.0.0.1       GigabitEthernet0/0/1
11.11.11.11/32      Direct  0    0           D   127.0.0.1       LoopBack0
22.22.22.22/32      EBGP    255  0           D   10.1.1.2        GigabitEthernet0/0/1
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
```

Run the **display mpls lsp** command on each PE to check for the LDP LSP to the peer PE. The information output on PE1 as an example:

```
[PE1]dis mpls lsp
------------------------------------------------------------------------------
                LSP Information: BGP  LSP
------------------------------------------------------------------------------
 FEC                 In/Out Label  In/Out IF                    Vrf Name
 11.11.11.11/32      1028/NULL     -/-                          huawei
```

```
------------------------------------------------------------------------------
                LSP Information: LDP LSP
------------------------------------------------------------------------------
 FEC                 In/Out Label   In/Out IF                      Vrf Name
 2.2.2.2/32          NULL/3         -/GE0/0/0
 2.2.2.2/32          1024/3         -/GE0/0/0
 3.3.3.3/32          NULL/1026      -/GE0/0/0
 3.3.3.3/32          1025/1026      -/GE0/0/0
 6.6.6.6/32          NULL/1025      -/GE0/0/0
 6.6.6.6/32          1026/1025      -/GE0/0/0
 8.8.8.8/32          NULL/1024      -/GE0/0/0
 8.8.8.8/32          1027/1024      -/GE0/0/0
 1.1.1.1/32          3/NULL         -/-
```

17.4 Reference Configuration

17.4.1 CE1's Configuration

```
[CE1]dis cur
#
sysname CE1
#
interface GigabitEthernet0/0/1
 ip address 10.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 11.11.11.11 255.255.255.255
#
bgp 65001
 peer 10.1.1.2 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 11.11.11.11 255.255.255.255
  peer 10.1.1.2 enable
```

```
#
return
```

17.4.2 PE1's Configuration

```
[PE1]dis cur
#
sysname PE1
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 1.1.1.1
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 10.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
#
bgp 100
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 connect-interface LoopBack0
```

```
 #
 ipv4-family unicast
  undo synchronization
  peer 7.7.7.7 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 7.7.7.7 enable
 #
 ipv4-family vpn-instance huawei
  peer 10.1.1.1 as-number 65001
#
ospf 1 router-id 1.1.1.1
 area 0.0.0.0
  network 1.1.1.1 0.0.0.0
  network 12.12.12.0 0.0.0.3
#
return
```

17.4.3 P1's Configuration

```
[P1]dis cur
#
sysname P1
#
mpls lsr-id 2.2.2.2
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 12.12.12.2 255.255.255.252
 mpls
 mpls ldp
#
```

```
interface GigabitEthernet0/0/1
 ip address 23.23.23.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 72.72.72.2 255.255.255.252
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
#
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
  network 2.2.2.2 0.0.0.0
  network 12.12.12.0 0.0.0.3
  network 23.23.23.0 0.0.0.3
  network 72.72.72.0 0.0.0.3
#
return
```

17.4.4 ASBR1's Configuration

```
[ASBR1]dis cur
#
sysname ASBR1
#
mpls lsr-id 3.3.3.3
mpls
 lsp-trigger bgp-label-route
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 34.34.34.1 255.255.255.252
 mpls
```

```
#
interface GigabitEthernet0/0/1
 ip address 23.23.23.2 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
bgp 100
 peer 34.34.34.2 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 1.1.1.1 255.255.255.255
  network 7.7.7.7 255.255.255.255
  peer 34.34.34.2 enable
  peer 34.34.34.2 route-policy policy1 export
  peer 34.34.34.2 label-route-capability
#
ospf 1 router-id 3.3.3.3
 import-route bgp
 area 0.0.0.0
  network 3.3.3.3 0.0.0.0
  network 23.23.23.0 0.0.0.3
#
route-policy policy1 permit node 10
 apply mpls-label
#
return
```

17.4.5 RR1's Configuration

```
[RR1]dis cur
#
```

```
sysname RR1
#
interface GigabitEthernet0/0/2
 ip address 72.72.72.1 255.255.255.252
#
interface LoopBack0
 ip address 7.7.7.7 255.255.255.255
#
bgp 100
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 ebgp-max-hop 10
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 1.1.1.1 enable
  peer 8.8.8.8 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 1.1.1.1 enable
  peer 1.1.1.1 reflect-client
  peer 1.1.1.1 next-hop-invariable
  peer 8.8.8.8 enable
  peer 8.8.8.8 next-hop-invariable
#
ospf 1 router-id 7.7.7.7
 area 0.0.0.0
  network 7.7.7.7 0.0.0.0
  network 72.72.72.0 0.0.0.3
#
return
```

17.4.6 ASBR2's Configuration

```
[ASBR2]dis cur
#
sysname ASBR2
#
mpls lsr-id 4.4.4.4
mpls
 lsp-trigger bgp-label-route
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 34.34.34.2 255.255.255.252
 mpls
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.1 255.255.255.252
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
bgp 200
 peer 34.34.34.1 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 6.6.6.6 255.255.255.255
  network 8.8.8.8 255.255.255.255
  peer 34.34.34.1 enable
  peer 34.34.34.1 route-policy policy1 export
  peer 34.34.34.1 label-route-capability
#
```

```
ospf 1 router-id 4.4.4.4
 import-route bgp
 area 0.0.0.0
  network 4.4.4.4 0.0.0.0
  network 45.45.45.0 0.0.0.3
#
route-policy policy1 permit node 10
 apply mpls-label
#
return
```

17.4.7 P2's Configuration

```
[P2]dis cur
#
sysname P2
#
mpls lsr-id 5.5.5.5
mpls
 lsp-trigger bgp-label-route
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.1 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 45.45.45.2 255.255.255.252
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 58.58.58.1 255.255.255.252
```

```
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
ospf 1 router-id 5.5.5.5
 area 0.0.0.0
  network 5.5.5.5 0.0.0.0
  network 45.45.45.0 0.0.0.3
  network 56.56.56.0 0.0.0.3
  network 58.58.58.0 0.0.0.3
#
return
```

17.4.8 PE2's Configuration

```
[PE2]dis cur
#
sysname PE2
#
ip vpn-instance huawei
 ipv4-family
  route-distinguisher 100:1
  vpn-target 100:1 export-extcommunity
  vpn-target 100:1 import-extcommunity
#
mpls lsr-id 6.6.6.6
mpls
#
mpls ldp
#
interface GigabitEthernet0/0/0
 ip address 56.56.56.2 255.255.255.252
 mpls
 mpls ldp
#
```

```
interface GigabitEthernet0/0/1
 ip binding vpn-instance huawei
 ip address 20.1.1.1 255.255.255.252
#
interface LoopBack0
 ip address 6.6.6.6 255.255.255.255
#
bgp 200
 peer 8.8.8.8 as-number 200
 peer 8.8.8.8 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 8.8.8.8 enable
 #
 ipv4-family vpnv4
  policy vpn-target
  peer 8.8.8.8 enable
 #
 ipv4-family vpn-instance huawei
  peer 20.1.1.2 as-number 65002
#
ospf 1 router-id 6.6.6.6
 area 0.0.0.0
  network 6.6.6.6 0.0.0.0
  network 56.56.56.0 0.0.0.3
#
return
```

17.4.9 RR2's Configuration

```
[RR2]dis cur
#
sysname RR2
#
```

```
interface GigabitEthernet0/0/2
 ip address 58.58.58.2 255.255.255.252
#
interface LoopBack0
 ip address 8.8.8.8 255.255.255.255
#
bgp 200
 peer 6.6.6.6 as-number 200
 peer 6.6.6.6 connect-interface LoopBack0
 peer 7.7.7.7 as-number 100
 peer 7.7.7.7 ebgp-max-hop 10
 peer 7.7.7.7 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 6.6.6.6 enable
  peer 7.7.7.7 enable
 #
 ipv4-family vpnv4
  undo policy vpn-target
  peer 6.6.6.6 enable
  peer 6.6.6.6 reflect-client
  peer 6.6.6.6 next-hop-invariable
  peer 7.7.7.7 enable
  peer 7.7.7.7 next-hop-invariable
#
ospf 1 router-id 8.8.8.8
 area 0.0.0.0
  network 8.8.8.8 0.0.0.0
  network 58.58.58.0 0.0.0.3
#
return
```

17.4.10 CE2's Configuration

```
[CE2]dis cur
#
sysname CE2
#
interface GigabitEthernet0/0/1
 ip address 20.1.1.2 255.255.255.252
#
interface LoopBack0
 ip address 22.22.22.22 255.255.255.255
#
bgp 65002
 peer 20.1.1.1 as-number 200
 #
 ipv4-family unicast
  undo synchronization
  network 22.22.22.22 255.255.255.255
  peer 20.1.1.1 enable
#
return
```

17.5 Quiz

In Inter-AS MPLS BGP VPN Option C solution 2, how many labels are required for data forwarding, and what are the protocols that generate the labels?

18 IPSec VPN Configuration

18.1 Introduction

18.1.1 About This Lab

Internet Protocol Security (IPsec) is an easy-to-use secure network protocol suite that authenticates and encrypts the packets of data sent over an IP network. It protects TCP/IP communication against eavesdropping and tampering, thereby effectively defending against network attacks.

IPsec VPN ensures that remote P2P users can securely and efficiently communicate with each other and share internal network resources.

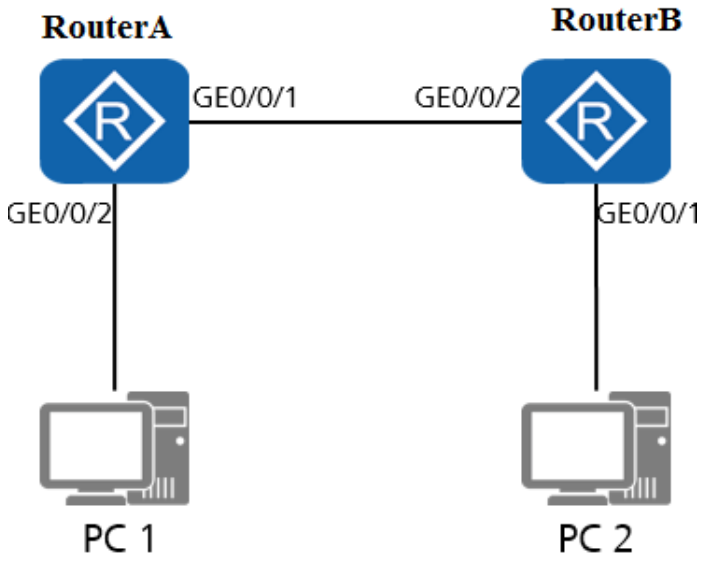
18.1.2 Objectives

Upon completion of this task, you will be able to understand:

How to configure an IPsec tunnel using IKE negotiation when the public IP addresses of the P2P devices at both ends are fixed.

18.1.3 Networking Topology

Figure 18-1 Networking topology for IPsec P2P configuration



18.1.4 Networking Design

PC1 represents an employee in the enterprise headquarters, and PC2 represents an employee in an enterprise branch. Configure RouterA and RouterB to allow PC1 to securely and efficiently communicate with PC2.

Table 18-1 Devices' interface parameter design

Device Name	eNSP Device	Interface	IP Address
RouterA	Router	G0/0/2	10.1.100.1/24
		G0/0/1	10.1.1.1/24
RouterB	Router	G0/0/1	10.1.200.1/24
		G0/0/2	10.1.1.2/24

18.2 Lab Configuration

18.2.1 Configuration Roadmap

1. Configure interface IP addresses.
2. Configure static routes.
3. Configure IPsec policies.

18.2.2 Configuration Procedure

Step 1 On RouterA and RouterB, configure IP address on each interface and a static route to implement communication between both ends.

Configure interface IP addresses on RouterA.

```
<Huawei>system-view
[Huawei]sysname RouterA
[RouterA]interface gigabitethernet 0/0/2
[RouterA-GigabitEthernet0/0/2]ip address 10.1.100.1 255.255.255.0
[RouterA-GigabitEthernet0/0/2]quit
[RouterA]interface gigabitethernet 0/0/1
[RouterA-GigabitEthernet0/0/1]ip address 10.1.1.1 255.255.255.0
[RouterA-GigabitEthernet0/0/1]quit
```

On RouterA, configure a static route destined to RouterB. This example assumes that the next hop address of the static route destined to RouterB is 10.1.1.2.

```
[RouterA]ip route-static 10.1.200.0 255.255.255.0 10.1.1.2
```

Configure interface IP addresses on RouterB.

```
<Huawei>system-view
[Huawei]sysname RouterB
[RouterB]interface gigabitethernet 0/0/2
[RouterB-GigabitEthernet0/0/2]ip address 10.1.1.2 255.255.255.0
[RouterB-GigabitEthernet0/0/2]quit
[RouterB]interface gigabitethernet 0/0/1
[RouterB-GigabitEthernet0/0/1]ip address 10.1.200.1 255.255.255.0
[RouterB-GigabitEthernet0/0/1]quit
```

On RouterB, configure a static route destined to RouterA. This example assumes that the next hop address of the static route destined to RouterA is 10.1.1.1.

```
[RouterB]ip route-static 10.1.100.0 255.255.255.0 10.1.1.1
```

Step 2 Configure ACLs on RouterA and RouterB to filter data flows.

Configure an ACL on RouterA to permit the data flow from subnet 10.1.100.0/24 to subnet 10.1.200.0/24.

```
[RouterA]acl number 3001
[RouterA-acl-adv-3001]rule permit ip source 10.1.100.0 0.0.0.255 destination
10.1.200.0 0.0.0.255
[RouterA-acl-adv-3101]quit
```

Configure an ACL on RouterB to permit the data flow from subnet 10.1.200.0/24 to subnet 10.1.100.0/24.

```
[RouterB]acl number 3001
[RouterB-acl-adv-3001]rule permit ip source 10.1.200.0 0.0.0.255 destination
10.1.100.0 0.0.0.255
[RouterB-acl-adv-3101]quit
```

Step 3 Configure an IPsec proposal on RouterA and RouterB.

Configure an IPsec proposal on RouterA.

```
[RouterA]ipsec proposal tran1
[RouterA-ipsec-proposal-tran1]esp authentication-algorithm sha2-256
[RouterA-ipsec-proposal-tran1]esp encryption-algorithm aes-128
[RouterA-ipsec-proposal-tran1]quit
```

Configure an IPsec proposal on RouterB.

```
[RouterB]ipsec proposal tran1
[RouterB-ipsec-proposal-tran1]esp authentication-algorithm sha2-256
[RouterB-ipsec-proposal-tran1]esp encryption-algorithm aes-128
[RouterB-ipsec-proposal-tran1]quit
```

To check the configured information, run the **display ipsec proposal** command on RouterA and RouterB.

Step 4 Configure RouterA and RouterB as IKE peers of each other.

Configure an IKE proposal on RouterA.

```
[RouterA]ike proposal 5
[RouterA-ike-proposal-5]encryption-algorithm aes-cbc-128
[RouterA-ike-proposal-5]authentication-algorithm sha1
```

```
[RouterA-ike-proposal-5]quit
```

On RouterA, configure an IKE peer, the pre-shared key, and the peer address.

```
[RouterA]ike peer spub v1
[RouterA-ike-peer-spub]ike-proposal 5
[RouterA-ike-peer-spub]pre-shared-key cipher huawei
[RouterA-ike-peer-spub]remote-address 10.1.1.2
[RouterA-ike-peer-spub]quit
```

Configure an IKE proposal on RouterB.

```
[RouterB]ike proposal 5
[RouterB-ike-proposal-5]encryption-algorithm aes-cbc-128
[RouterB-ike-proposal-5]authentication-algorithm sha1
[RouterB-ike-proposal-5]quit
```

On RouterB, configure an IKE peer, the pre-shared key, and the peer address.

```
[RouterB]ike peer spua v1
[RouterB-ike-peer-spua]ike-proposal 5
[RouterB-ike-peer-spua]pre-shared-key cipher huawei
[RouterB-ike-peer-spua]remote-address 10.1.1.1
[RouterB-ike-peer-spua]quit
```

Step 5 Configure an IPsec policy on RouterA and RouterB.

Configure an IPsec policy in dynamic IKE negotiation mode on RouterA.

```
[RouterA]ipsec policy map1 10 isakmp
[RouterA-ipsec-policy-isakmp-map1-10]ike-peer spub
[RouterA-ipsec-policy-isakmp-map1-10]proposal tran1
[RouterA-ipsec-policy-isakmp-map1-10]security acl 3001
[RouterA-ipsec-policy-isakmp-map1-10]quit
```

Configure an IPsec policy in dynamic IKE negotiation mode on RouterB.

```
[RouterB]ipsec policy use1 10 isakmp
[RouterB-ipsec-policy-isakmp-use1-10]ike-peer spua
[RouterB-ipsec-policy-isakmp-use1-10]proposal tran1
[RouterB-ipsec-policy-isakmp-use1-10]security acl 3001
[RouterB-ipsec-policy-isakmp-use1-10]quit
```

To check the configured information, run the **display ipsec policy** command on RouterA and RouterB.

Step 6 Apply the IPsec policy groups to the interconnected interfaces of RouterA and RouterB so that the IPsec function is enabled on the interfaces.

Apply the IPsec policy group to the interface of RouterA.

```
[RouterA]interface gigabitethernet 0/0/1
[RouterA-GigabitEthernet0/0/1]ipsec policy map1
[RouterA-GigabitEthernet0/0/1]quit
```

Apply the IPsec policy group to the interface of RouterB.

```
[RouterB]interface gigabitethernet 0/0/2
[RouterB-GigabitEthernet0/0/2]ipsec policy use1
[RouterB-GigabitEthernet0/0/2]quit
```

----End

18.3 Verification

18.3.1 Verifying the Configuration

Run the **display ike sa** command on RouterA. The information output is as follows:

```
<RouterA>display ike sa
    Conn-ID  Peer                VPN     Flag(s)                 Phase
  -------------------------------------------------------------
       3      10.1.1.2            0       RD                      2
  1      10.1.1.2            0       RD                      1

    Flag Description:
    RD--READY     ST--STAYALIVE     RL--REPLACED     FD--FADING
  TO--TIMEOUT
    HRT--HEARTBEAT     LKG--LAST KNOWN GOOD SEQ NO.     BCK--BACKED UP
```

Run the **display ipsec sa** command on RouterA and RouterB to check the configured information. The following example shows the information output on RouterA.

```
<RouterA>display ipsec sa

  ===============================
  Interface: GigabitEthernet0/0/1
```

```
      Path MTU: 1500
  ==============================

      ----------------------------
      IPSec policy name: "map1"
      Sequence number   : 10
      Acl Group         : 3001
      Acl rule          : 5
      Mode              : ISAKMP
      ----------------------------
        Connection ID     : 3
        Encapsulation mode: Tunnel
        Tunnel local      : 10.1.1.1
        Tunnel remote     : 10.1.1.2
        Flow source       : 10.1.100.0/255.255.255.0 0/0
        Flow destination  : 10.1.200.0/255.255.255.0 0/0
  Qos pre-classify   : Disable

      [Outbound ESP SAs]
        SPI: 1450485947 (0x5674a8bb)
        Proposal: ESP-ENCRYPT-AES-128 SHA2-256-128
        SA remaining key duration (bytes/sec): 1887436800/3411
   Max sent sequence-number: 0
   UDP encapsulation used for NAT traversal: N

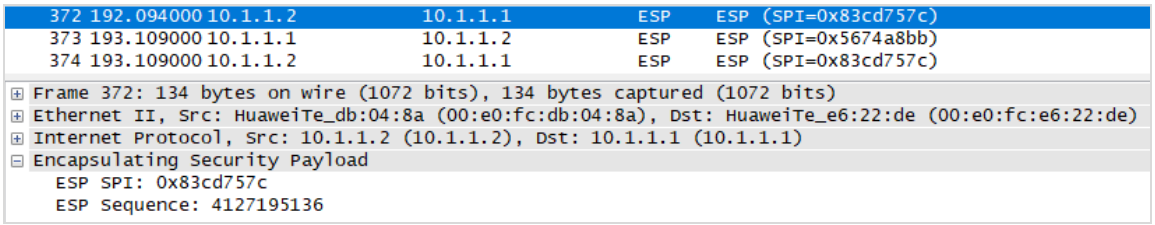
      [Inbound ESP SAs]
        SPI: 2211280252 (0x83cd757c)
        Proposal: ESP-ENCRYPT-AES-128 SHA2-256-128
        SA remaining key duration (bytes/sec): 1887436800/3411
        Max received sequence-number: 0
        Anti-replay window size: 32
        UDP encapsulation used for NAT traversal: N
```

18.3.2 Checking Information About Encrypted Packets

After the configuration is complete, PC2 can be pinged from PC1 using the **ping** command, and the data transmitted between them is encrypted. You can run the **display ipsec statistics esp** command to check packet statistics.

```
<RouterA>display ipsec statistics esp
 Inpacket count                : 23
 Inpacket auth count           : 0
 Inpacket decap count          : 0
 Outpacket count               : 24
 Outpacket auth count          : 0
 Outpacket encap count         : 0
 Inpacket drop count           : 0
 Outpacket drop count          : 0
 BadAuthLen count              : 0
 AuthFail count                : 0
 InSAAclCheckFail count        : 0
 PktDuplicateDrop count        : 0
 PktSeqNoTooSmallDrop count: 0
 PktInSAMissDrop count         : 0
```

Obtain packet headers. The result shows that the encrypted packet content is not displayed.



18.4 Reference Configuration

18.4.1 RouterA's Configuration

```
#
 sysname RouterA
#
```

```
acl number 3001
 rule 5 permit ip source 10.1.100.0 0.0.0.255 destination 10.1.200.0 0.0.0.255
#
ipsec proposal tran1
 esp authentication-algorithm sha2-256
 esp encryption-algorithm aes-128
#
ike proposal 5
 encryption-algorithm aes-cbc-128
#
ike peer spub v1
 pre-shared-key cipher huawei
 ike-proposal 5
 remote-address 10.1.1.2
#
ipsec policy map1 10 isakmp
 security acl 3001
 ike-peer spub
 proposal tran1
#
interface GigabitEthernet0/0/1
 ip address 10.1.1.1 255.255.255.0
 ipsec policy map1
#
interface GigabitEthernet0/0/2
 ip address 10.1.100.1 255.255.255.0
#
ip route-static 10.1.200.0 255.255.255.0 10.1.1.2
#
Return
```

18.4.2 RouterB's Configuration

```
#
 sysname RouterB
#
acl number 3001
```

```
 rule 5 permit ip source 10.1.200.0 0.0.0.255 destination 10.1.100.0 0.0.0.255
#
ipsec proposal tran1
 esp authentication-algorithm sha2-256
 esp encryption-algorithm aes-128
#
ike proposal 5
 encryption-algorithm aes-cbc-128
#
ike peer spua v1
 pre-shared-key cipher huawei
 ike-proposal 5
 remote-address 10.1.1.1
#
ipsec policy use1 10 isakmp
 security acl 3001
 ike-peer spua
 proposal tran1
#
interface GigabitEthernet0/0/1
 ip address 10.1.200.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.1.1.2 255.255.255.0
 ipsec policy use1
#
ip route-static 10.1.100.0 255.255.255.0 10.1.1.1
#
return
```

18.5 Quiz

What is the function of the preceding ACL configuration?

19 BFD Configuration

19.1 Introduction

19.1.1 About This Lab

In this lab, you will learn how to associate BFD with BGP and BFD with VRRP to learn about BFD functions and configuration methods.

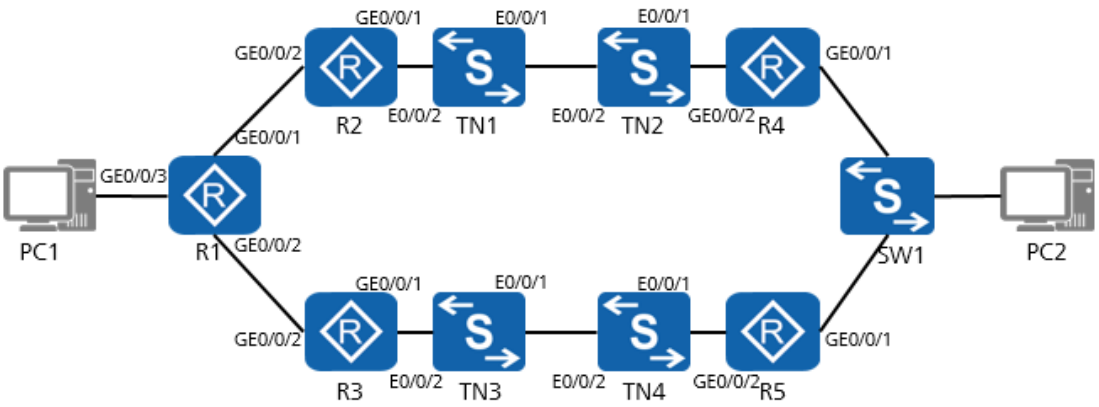
19.1.2 Objectives

Upon completion of this task, you will be able to:

- Understand the BFD working mechanism.
- Learn the application scenarios and configuration methods of BFD for BGP.
- Learn the application scenarios and configuration methods of BFD for VRRP.

19.1.3 Networking and Service Description

Figure 1-1 BFD networking topology



19.1.4 Networking Design

According to the preceding topology, PC1 and PC2 communicate with each other through two links. The transmission devices TN1 and TN2 exist between R2 and R4, and the transmission devices TN3 and TN4 exist between R3 and R5. The link R1-R3-R5 is preferred for the communication between PC1 and PC2.

Table 1-1 Device interface parameter design

Device	Interface	Interface Address
PC1	Eth0/0/1	10.1.100.100/24
PC2	Eth0/0/1	10.1.200.100/24 Gateway: 10.1.200.3
R1	GE0/0/1	10.1.12.1/24
	GE0/0/2	10.1.13.1/24
	GE0/0/3	10.1.100.1/24
	LoopBack 0	1.1.1.1/32
R2	GE0/0/1	10.1.24.1/24
	GE0/0/2	10.1.12.2/24
	LoopBack 0	2.2.2.2/32
R3	GE0/0/1	10.1.35.1/24
	GE0/0/2	10.1.13.2/24
	LoopBack 0	3.3.3.3/32
R4	GE0/0/1	10.1.200.1/24
	GE0/0/2	10.1.24.2/24
	LoopBack 0	4.4.4.4/32
R5	GE0/0/1	10.1.200.2/24
	GE0/0/2	10.1.35.2/24

	LoopBack 0	5.5.5.5/32

19.2 Configuration Procedure

19.2.1 Configuration Roadmap

2. Configure IP addresses for device interfaces.
3. Configure underlying OSPF routes.
4. Configure BGP routes and advertise terminal routes.
5. Configure VRRP.
6. Configure BFD for VRRP.
7. Configure BFD for BGP.

19.2.2 Configuration Procedure

Step 1 Configure IP addresses for device interfaces.

Configure IP addresses for each device and PC based on the plan. The configuration of the GE 0/0/1 interface on R1 is used as an example.

Configure an IP address on R1.

```
<Huawei>sys
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.1.12.1 24
```

Step 2 Configure a routing protocol.

Configure OSPF. The OSPF protocol is deployed between R1/R2/R3/R4/R5. Take R1 as an example.

Configure OSPF on R1.

```
[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 10.1.13.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 1.1.1.1 0.0.0.0
```

Configure BGP routes. PC1 and PC2 communicate with each other through R1-R3-R5. Configure R3 as the reflector and R1/R2/R4/R5 as the clients. R1, R4, and R5 advertise hosts' routes. R1 and R3 are used as an example.

Configure BGP on R3.

```
[R3]bgp 100
[R3-bgp]peer 1.1.1.1 as-number 100
[R3-bgp]peer 1.1.1.1 connect-interface LoopBack0
[R3-bgp]peer 1.1.1.1 reflect-client
[R3-bgp]peer 2.2.2.2 as-number 100
[R3-bgp]peer 2.2.2.2 connect-interface LoopBack0
[R3-bgp]peer 2.2.2.2 reflect-client
[R3-bgp]peer 4.4.4.4 as-number 100
[R3-bgp]peer 4.4.4.4 connect-interface LoopBack0
[R3-bgp]peer 4.4.4.4 reflect-client
[R3-bgp]peer 5.5.5.5 as-number 100
[R3-bgp]peer 5.5.5.5 connect-interface LoopBack0
[R3-bgp]peer 5.5.5.5 reflect-client
```

Configure BGP on R1.

```
[R1]bgp 100
[R1-bgp]peer 3.3.3.3 as-number 100
[R1-bgp]peer 3.3.3.3 connect-interface LoopBack0
[R1-bgp]network 10.1.100.0 255.255.255.0
```

Step 3 Configure VRRP.

Configure VRRP on R4/R5. R5 is the master device, R4 is the slave device, and the virtual IP address is 10.1.200.3.

Configure VRRP on R4.

```
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]vrrp vrid 1 virtual-ip 10.1.200.3
```

Configure VRRP on R5.

```
[R5]interface GigabitEthernet 0/0/1
[R5-GigabitEthernet0/0/1]vrrp vrid 1 virtual-ip 10.1.200.3
[R5-GigabitEthernet0/0/1]vrrp vrid 1 priority 120
```

Step 4 Configure BFD for VRRP.

Configure BFD to detect the upstream link R3-R5. The BFD session must be in static mode. When the TN3-TN4 link goes Down, services can be quickly switched to the backup device for forwarding, ensuring normal communication of between PC1 and PC2.

Configure BFD on R3.

```
[R3]bfd
[R3-bfd]quit
[R3]bfd vrrp bind peer-ip 10.1.35.2 interface GigabitEthernet0/0/1 source-ip 10.1.35.1 auto
```

Configure BFD on R5.

```
[R5]bfd
[R5-bfd]quit
[R5]bfd vrrp bind peer-ip 10.1.35.1 interface GigabitEthernet0/0/2 source-ip 10.1.35.2 auto
```

Associate BFD with VRRP on R5.

```
[R5]interface GigabitEthernet0/0/1
[R5-GigabitEthernet0/0/1]vrrp vrid 1 track bfd-session session-name vrrp reduced 30
```

Step 5 Configure BFD for BGP.

When the link R3-R5 goes Down, services can be quickly switched to the backup link R2-R4 to ensure available communication between PC1 and PC2.

Configure dynamic BFD on R3.

```
[R3]bgp 100
[R3-bgp]peer 5.5.5.5 bfd enable
```

Configure dynamic BFD on R5.

```
[R5]bgp 100
[R5-bgp]peer 3.3.3.3 bfd enable
```

19.3 Verification

19.3.1 Checking the BFD Session Information

Run the **display bfd session all** command on R3 and R5 to check the static BFD sessions and the BFD sessions dynamically generated by BGP.

```
[R3]display bfd session all
--------------------------------------------------------------------------------
Local Remote      PeerIpAddr      State     Type        InterfaceName
--------------------------------------------------------------------------------
```

```
8192   8192        10.1.35.2       Up         S_AUTO_IF    GigabitEthernet0/0/1
8193   8196        5.5.5.5         Up         D_IP_PEER          -
--------------------------------------------------------------------------------
      Total UP/DOWN Session Number : 2/0
```

19.3.2 Verifying the Association Between BFD and VRRP

When BFD sessions are not associated with VRRP, disconnect the link between TN3 and TN4. When the link is switched to R1-R2-R4, PC1 and PC2 cannot communicate with each other, and the master device is still R5.

Run the **display vrrp** command on R5.

```
[R5]display vrrp
  GigabitEthernet0/0/1 | Virtual Router 1
    State : Master
    Virtual IP : 10.1.200.3
    Master IP : 10.1.200.2
    PriorityRun : 120
    PriorityConfig : 120
    MasterPriority : 120
    Preempt : YES     Delay Time : 0 s
    TimerRun : 1 s
    TimerConfig : 1 s
    Auth type : NONE
    Virtual MAC : 0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Create time : 2018-08-07 13:51:53 UTC-08:00
    Last change time : 2018-08-07 14:18:22 UTC-08:00
```

When the association between the BFD sessions and VRRP is enabled, the link between TN3 and TN4 is disconnected. The master device is switched to R4, and PC1 and PC2 communicate with each other normally.

Check the BFD sessions on R5.

```
[R5]display bfd session all
--------------------------------------------------------------------------------
Local Remote      PeerIpAddr      State     Type        InterfaceName
--------------------------------------------------------------------------------
```

```
8192   0            10.1.35.1        Down       S_AUTO_IF    GigabitEthernet0/0/2
------------------------------------------------------------------------------
      Total UP/DOWN Session Number : 0/1
```

Run the **display vrrp** command on R5.

```
[R5-GigabitEthernet0/0/1]display vrrp
  GigabitEthernet0/0/1 | Virtual Router 1
    State : Backup
    Virtual IP : 10.1.200.3
    Master IP : 10.1.200.1
    PriorityRun : 90
    PriorityConfig : 120
    MasterPriority : 100
    Preempt : YES     Delay Time : 0 s
    TimerRun : 1 s
    TimerConfig : 1 s
    Auth type : NONE
    Virtual MAC : 0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Track BFD : vrrp    Priority reduced : 30
    BFD-session state : DOWN
    Create time : 2018-08-07 13:51:53 UTC-08:00
    Last change time : 2018-08-07 16:35:09 UTC-08:00
```

19.3.3 Verifying the Association Between BFD and BGP

When BFD is not enabled to detect the link between R3 and R5. If the link between TN3 and TN4 goes Down, It takes a long time to switch services to the backup link R1-R2-R4, and the BGP peer relationship between R3 and R5 does not change.

Ping PC2 from PC1.

```
PC>ping 10.1.200.100 -t

Ping 10.1.200.100: 32 data bytes, Press Ctrl_C to break
From 10.1.200.100: bytes=32 seq=1 ttl=125 time=140 ms
From 10.1.200.100: bytes=32 seq=2 ttl=125 time=157 ms
Request timeout!
Request timeout!
Request timeout!
```

```
Request timeout!
Request timeout!
Request timeout!
Request timeout!
...
From 10.1.200.100: bytes=32 seq=2 ttl=125 time=157 ms

--- 10.1.200.100 ping statistics ---
  66 packet(s) transmitted
  32 packet(s) received
  51.52% packet loss
  round-trip min/avg/max = 125/158/203 ms
```

Check the BGP peer information.

```
[R3]display bgp peer

 BGP local router ID : 10.1.35.1
 Local AS number : 100
 Total number of peers : 4      Peers in established state : 4
  Peer         V      AS   MsgRcvd   MsgSent   OutQ   Up/Down       State   PrefRcv

  1.1.1.1      4     100        54        59      0 00:51:12 Established     1
  2.2.2.2      4     100        53        59      0 00:51:12 Established     0
  4.4.4.4      4     100        54        59      0 00:51:12 Established     1
  5.5.5.5      4     100        13        15      0 00:10:38 Established     1
```

When BFD is enabled to detect the link between R3 and R5. If the link between TN3 and TN4 goes Down, Services can be quickly switched to the backup link R1-R2-R4, and the BGP peer relationship between R3 and R5 changes rapidly.

Check the BFD sessions on R3.

```
[R3]display bfd session all
--------------------------------------------------------------------------------
Local Remote      PeerIpAddr      State     Type           InterfaceName
--------------------------------------------------------------------------------
8192  0           10.1.35.2       Down      S_AUTO_IF      GigabitEthernet0/0/1
--------------------------------------------------------------------------------
      Total UP/DOWN Session Number : 0/1
```

Ping PC2 from PC1.

```
PC>ping 10.1.200.100 -t

Ping 10.1.200.100: 32 data bytes, Press Ctrl_C to break
From 10.1.200.100: bytes=32 seq=1 ttl=125 time=203 ms
From 10.1.200.100: bytes=32 seq=2 ttl=125 time=140 ms
Request timeout!
Request timeout!
From 10.1.200.100: bytes=32 seq=5 ttl=125 time=172 ms
From 10.1.200.100: bytes=32 seq=6 ttl=125 time=156 ms
From 10.1.200.100: bytes=32 seq=7 ttl=125 time=157 ms
From 10.1.200.100: bytes=32 seq=8 ttl=125 time=125 ms

--- 10.1.200.100 ping statistics ---
  9 packet(s) transmitted
  6 packet(s) received
  33.33% packet loss
  round-trip min/avg/max = 125/158/203 ms
```

Check the BGP peer information on R3.

```
<R3>display bgp peer

 BGP local router ID : 10.1.35.1
 Local AS number : 100
 Total number of peers : 4       Peers in established state : 3

  Peer            V          AS  MsgRcvd  MsgSent  OutQ  Up/Down       State PrefRcv

  1.1.1.1         4         100       38       42     0 00:35:43 Established     1
  2.2.2.2         4         100       37       42     0 00:35:43 Established     0
  4.4.4.4         4         100       38       42     0 00:35:43 Established     1
  5.5.5.5         4         100        0        0     0 00:01:02        Idle     0
```

19.4 Reference Configuration

19.4.1 R1's Configuration

```
#
sysname R1
```

```
#
interface GigabitEthernet0/0/1
 ip address 10.1.12.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.1.13.1 255.255.255.0
#
interface GigabitEthernet0/0/3
 ip address 10.1.100.1 255.255.255.0
#
interface LoopBack0
 ip address 1.1.1.1 255.255.255.255
#
bgp 100
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.100.0 255.255.255.0
  peer 3.3.3.3 enable
#
ospf 1
 area 0.0.0.0
  network 10.1.12.0 0.0.0.255
  network 10.1.13.0 0.0.0.255
  network 1.1.1.1 0.0.0.0
#
Return
```

19.4.2 R2's Configuration

```
#
sysname R2
#
interface GigabitEthernet0/0/1
 ip address 10.1.24.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.1.12.2 255.255.255.0
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.255
#
bgp 100
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 3.3.3.3 enable
#
ospf 1
 area 0.0.0.0
  network 10.1.12.0 0.0.0.255
  network 10.1.24.0 0.0.0.255
  network 2.2.2.2 0.0.0.0
#
Return
```

19.4.3 R3's Configuration

```
#
sysname R3
#
bfd
#
interface GigabitEthernet0/0/1
 ip address 10.1.35.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.1.13.2 255.255.255.0
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
bfd vrrp bind peer-ip 10.1.35.2 interface GigabitEthernet0/0/1 source-ip 10.1.35
.1 auto
 commit
#
bgp 100
 peer 1.1.1.1 as-number 100
 peer 1.1.1.1 connect-interface LoopBack0
 peer 2.2.2.2 as-number 100
 peer 2.2.2.2 connect-interface LoopBack0
 peer 4.4.4.4 as-number 100
 peer 4.4.4.4 connect-interface LoopBack0
 peer 5.5.5.5 as-number 100
 peer 5.5.5.5 connect-interface LoopBack0
 peer 5.5.5.5 bfd enable
 #
```

```
 ipv4-family unicast
  undo synchronization
  peer 1.1.1.1 enable
  peer 1.1.1.1 reflect-client
  peer 2.2.2.2 enable
  peer 2.2.2.2 reflect-client
  peer 4.4.4.4 enable
  peer 4.4.4.4 reflect-client
  peer 5.5.5.5 enable
  peer 5.5.5.5 reflect-client
#
ospf 1
 area 0.0.0.0
  network 10.1.13.0 0.0.0.255
  network 10.1.35.0 0.0.0.255
  network 3.3.3.3 0.0.0.0
#
Return
```

19.4.4 R4's Configuration

```
#
sysname R4
#
interface GigabitEthernet0/0/1
 ip address 10.1.200.1 255.255.255.0
 vrrp vrid 1 virtual-ip 10.1.200.3
#
interface GigabitEthernet0/0/2
 ip address 10.1.24.2 255.255.255.0
#
```

```
interface GigabitEthernet0/0/3
 ip address 10.1.45.1 255.255.255.0
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.255
#
bgp 100
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.200.0 255.255.255.0
  peer 3.3.3.3 enable
#
ospf 1
 area 0.0.0.0
  network 10.1.24.0 0.0.0.255
  network 10.1.45.0 0.0.0.255
  network 4.4.4.4 0.0.0.0
#
Return
```

19.4.5 R5's Configuration

```
#
sysname R5
#
bfd
#
interface GigabitEthernet0/0/1
```

```
 ip address 10.1.200.2 255.255.255.0
 vrrp vrid 1 virtual-ip 10.1.200.3
 vrrp vrid 1 priority 120
 vrrp vrid 1 track bfd-session session-name vrrp reduced 30
#
interface GigabitEthernet0/0/2
 ip address 10.1.35.2 255.255.255.0
#
interface GigabitEthernet0/0/3
 ip address 10.1.45.2 255.255.255.0
#
interface LoopBack0
 ip address 5.5.5.5 255.255.255.255
#
bfd vrrp bind peer-ip 10.1.35.1 interface GigabitEthernet0/0/2 source-ip 10.1.35
.2 auto
 commit
#
bgp 100
 peer 3.3.3.3 as-number 100
 peer 3.3.3.3 connect-interface LoopBack0
 peer 3.3.3.3 bfd enable
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.200.0 255.255.255.0
  peer 3.3.3.3 enable
#
ospf 1
 area 0.0.0.0
```

```
  network 10.1.35.0 0.0.0.255
  network 10.1.45.0 0.0.0.255
  network 5.5.5.5 0.0.0.0
#
return
```

19.5 Quiz

To prevent link bandwidth waste, load balancing is required between two links. How to implement load balancing? When one link is Down, how to quickly switch services to the other link?

20 QoS

20.1 Introduction

20.1.1 About This Lab

As networks rapidly develop, services on the Internet become increasingly diversified. Diversified services enrich users' lives but also increase the risk of traffic congestion on the Internet. To manage traffic congestion at a low cost, quality of service (QoS) is used to optimize resource allocation. This document describes the QoS MQC and queue bandwidth configuration.

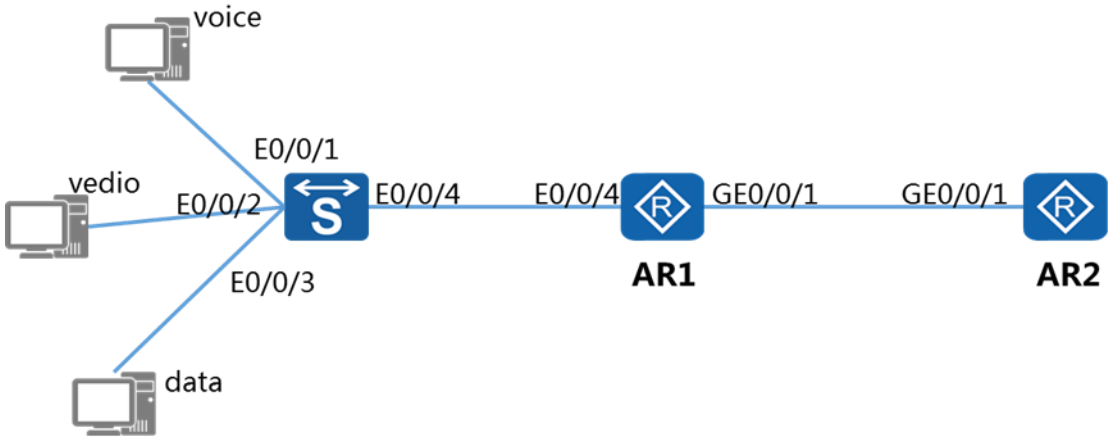
20.1.2 Objectives

Upon completion of this task, you will be able to understand:

- QoS MQC configuration
- QoS bandwidth configuration

20.1.3 Networking Topology

Figure 20-1 Networking topology for QoS configuration



20.1.4 Networking Design

AR1 represents a voice, video, and data service gateway. Mark the voice service as EF, video service as AF41, and data service as AF31 using MQC on AR1. The minimum EF bandwidth is 50%, the minimum AF41 bandwidth is 40%, and the minimum AF31 bandwidth is 5% of the available bandwidth of an interface.

Table 20-1 NE IP address design

NE	Physical Interface	IPv4 Address
AR1	GE0/0/1	51.1.1.1/30
	Vlanif10	192.168.10.1/24
	Vlanif20	192.168.20.1/24
	Vlanif30	192.168.30.1/24
AR2	GE0/0/1	51.1.1.2/30

20.2 Lab Configuration

20.2.1 Configuration Roadmap

1. Configure IPv4 addresses for ARs.
2. Configure MQC on the gateway router AR1 to mark queues for voice, video, and data services.
3. Configure queue scheduling to implement bandwidth allocation for EF, AF41, and AF31 queues.

20.2.2 Configuration Procedure

Step 1 Configure IP addresses for ARs.

Configure IP addresses for AR1.

```
<Huawei>system-view
[Huawei]sysname AR1
[AR1]vlan batch 10 20 30
```

```
[AR1]interface GigabitEthernet 0/0/1
[RTA-GigabitEthernet0/0/1]ip address 51.1.1.1 255.255.255.252
[RTA-GigabitEthernet0/0/1]quit
[AR1]interface Vlanif 10
[AR1-Vlanif10]ip address 192.168.10.1 24
[AR1-Vlanif10]quiti
[AR1]interface Vlanif 20
[AR1-Vlanif20]ip address 192.168.20.1 24
[AR1-Vlanif20]quit
[AR1]interface Vlanif 30
[AR1-Vlanif30]ip address 192.168.30.1 24
```

Configure IP addresses for AR2.

```
<Huawei>system-view
[Huawei]sysname AR2
[AR2]interface GigabitEthernet 0/0/1
[AR2-GigabitEthernet0/0/1]ip address 51.1.1.2 30
[AR2-GigabitEthernet0/0/1]quit
```

Step 2 Configure MQC on AR1 to mark voice, video, and data services as EF, AF41, and AF31 queues, respectively.

Configure ACLs.

```
[AR1]acl number 3002
[AR1-acl-adv-3002]rule permit ip source 192.168.10.0 0.0.0.255
[AR1-acl-adv-3002]quit
[AR1]acl number 3003
[AR1-acl-adv-3003]rule permit ip source 192.168.20.0 0.0.0.255
[AR1-acl-adv-3003]quit
[AR1]acl number 3004
[AR1-acl-adv-3004]rule permit ip source 192.168.30.0 0.0.0.255
```

Configure traffic classifiers to match the traffic with the three types of address segments.

```
[AR1]traffic classifier C1
[AR1-classifier-C1]if-match acl 3002
[AR1-classifier-C1]quit
[AR1]traffic classifier C2
[AR1-classifier-C2]if-match acl 3003
```

```
[AR1-classifier-C2]quit
[AR1]traffic classifier C3
[AR1-classifier-C3]if-match acl 3004
[AR1-classifier-C3]quit
```

Configure traffic behaviors to place matching traffic in the EF, AF41, and AF31 queues.

```
[AR1]traffic behavior b1
[AR1-behavior-b1]remark dscp ef
[AR1-behavior-b1]quit
[AR1]traffic behavior b2
[AR1-behavior-b2]remark dscp af41
[AR1-behavior-b2]quit
[AR1]traffic behavior b3
[AR1-behavior-b3]remark dscp af31
[AR1-behavior-b3]quit
```

Configure a traffic policy to associate the traffic classifiers with the traffic behaviors.

```
[AR1]traffic policy p1
[AR1-trafficpolicy-p1]classifier C1 behavior b1
[AR1-trafficpolicy-p1]classifier C2 behavior b2
[AR1-trafficpolicy-p1]classifier C3 behavior b3
[AR1-trafficpolicy-p1]quit
```

Step 3 Configure MQC on AR1 to allocate different bandwidths to different queues.

Configure traffic classifiers on AR1 to match different queues.

```
[AR1]traffic classifier voice
[AR1-classifier-voice]if-match dscp ef
[AR1-classifier-voice]quit
[AR1]traffic classifier video
[AR1-classifier-video]if-match dscp af41
[AR1-classifier-video]quit
[AR1]traffic classifier data
[AR1-classifier-data]if-match dscp af31
[AR1-classifier-data]quit
```

Configure traffic behaviors on AR1.

```
[AR1]traffic behavior voice
```

```
[AR1-behavior-voice]queue ef bandwidth pct 50
[AR1-behavior-voice]quit
[AR1]traffic behavior video
[AR1-behavior-video]queue af bandwidth pct 40
[AR1-behavior-video]quit
[AR1]traffic behavior data
[AR1-behavior-data]queue af bandwidth pct 5
[AR1-behavior-data]quit
```

Configure a traffic policy to associate the traffic classifiers with the traffic behaviors.

```
[AR1]traffic policy schedule
[AR1-trafficpolicy-schedule]classifier data behavior data
[AR1-trafficpolicy-schedule]classifier video behavior video
[AR1-trafficpolicy-schedule]classifier voice behavior voice
[AR1-trafficpolicy-schedule]quit
```

Step 4 Apply the MQC policies.

Apply the traffic policy named **p1** to incoming direction on Ethernet 0/0/4 on AR1.

```
[AR1]interface Ethernet 0/0/4
[AR1-Ethernet0/0/4]traffic-policy p1    inbound
```

Apply the traffic policy named **schedule** to outgoing direction on GE 0/0/1 on AR1.

```
[AR1]interface GigabitEthernet 0/0/1
[AR1-GigabitEthernet0/0/1]traffic-policy schedule outbound
```

Step 5 Configure VLANs on the switch.

```
<Huawei>system
[Huawei]sysname switch
[switch]vlan batch 10 20 30
[switch]interface Ethernet 0/0/1
[switch-Ethernet0/0/1]port link-type access
[switch-Ethernet0/0/1]port default vlan 10
[switch-Ethernet0/0/1]quit
                [switch]interface Ethernet 0/0/2
[switch-Ethernet0/0/2]port link-type access
[switch-Ethernet0/0/2]port default vlan 20
[switch-Ethernet0/0/2]quit
[switch]interface Ethernet 0/0/3
```

```
[switch-Ethernet0/0/3]port link-type access
[switch-Ethernet0/0/3]port default vlan 30
[switch-Ethernet0/0/3]quit
[switch]interface Ethernet 0/0/4
[switch-Ethernet0/0/4]port link-type trunk
[switch-Ethernet0/0/4]port trunk allow-pass vlan 10 20 30
[switch-Ethernet0/0/4]quit
```

----End

20.3 Verification

20.3.1 Verifying the Configuration

Run the following commands to verify the configuration when the network is stable.

Run the **display traffic policy user-defined** command on AR1 to view information about the configured policies. The command output is as follows:

```
[AR1]display traffic policy user-defined
 User Defined Traffic Policy Information:
 Policy: schedule
  Classifier: data
   Operator: OR
    Behavior: data
     Assured Forwarding:
       Bandwidth 5 (%)
       Drop Method: Tail
       Queue Length: 64 (Packets) 131072 (Bytes)

  Classifier: video
   Operator: OR
    Behavior: video
     Assured Forwarding:
       Bandwidth 40 (%)
       Drop Method: Tail
       Queue Length: 64 (Packets) 131072 (Bytes)

  Classifier: voice
```

```
    Operator: OR
     Behavior: voice
      Expedited Forwarding:
        Bandwidth 50 (%)
        Queue Length: 64 (Packets) 131072 (Bytes)
Policy: p1
  Classifier: C1
    Operator: OR
     Behavior: b1
      Marking:
        Remark DSCP ef

  Classifier: C2
    Operator: OR
     Behavior: b2
      Marking:
        Remark DSCP af41

  Classifier: C3
    Operator: OR
     Behavior: b3
      Marking:
        Remark DSCP af31
```

Run the **display traffic-policy applied-record** command on AR1 to view information about the applied policies. The command output is as follows:

```
AR1]display traffic-policy applied-record
-----------------------------------------------
  Policy Name:     p1
  Policy Index:    0
      Classifier:C1        Behavior:b1
      Classifier:C2        Behavior:b2
      Classifier:C3        Behavior:b3
-----------------------------------------------
 *interface Ethernet0/0/4
    traffic-policy p1 inbound
```

```
        slot 0      :   success
-------------------------------------------------
  Policy Name:     schedule
  Policy Index:    1
      Classifier:data        Behavior:data
      Classifier:video       Behavior:video
      Classifier:voice       Behavior:voice
-------------------------------------------------
 *interface GigabitEthernet0/0/1
    traffic-policy schedule outbound
        slot 0      :   success
-------------------------------------------------
```

20.4 Reference Configuration

20.4.1 AR1's Configuration

```
#
 sysname AR1
#
vlan batch 10 20 30
#
acl number 3002
 rule 5 permit ip source 192.168.10.0 0.0.0.255
acl number 3003
 rule 5 permit ip source 192.168.20.0 0.0.0.255
acl number 3004
 rule 5 permit ip source 192.168.30.0 0.0.0.255
#
traffic classifier video operator or
 if-match dscp af41
traffic classifier C3 operator or
 if-match acl 3004
traffic classifier C1 operator or
 if-match acl 3002
traffic classifier data operator or
 if-match dscp af31
```

```
traffic classifier C2 operator or
 if-match acl 3003
traffic classifier voice operator or
 if-match dscp ef
#
traffic behavior video
 queue af bandwidth pct 40
traffic behavior b2
 remark dscp af41
traffic behavior data
 queue af bandwidth pct 5
traffic behavior b3
 remark dscp af31
traffic behavior b1
 remark dscp ef
traffic behavior voice
 queue ef bandwidth pct 50
#
traffic policy schedule
 classifier data behavior data
 classifier video behavior video
 classifier voice behavior voice
traffic policy p1
 classifier C1 behavior b1
 classifier C2 behavior b2
 classifier C3 behavior b3
#
interface Vlanif10
 ip address 192.168.10.1 255.255.255.0
#
interface Vlanif20
 ip address 192.168.20.1 255.255.255.0
#
interface Vlanif30
 ip address 192.168.30.1 255.255.255.0
#
interface Ethernet0/0/4
```

```
 port link-type trunk
 port trunk allow-pass vlan 10 20 30
 traffic-policy p1 inbound
#
interface GigabitEthernet0/0/1
 ip address 51.1.1.1 255.255.255.252
 traffic-policy schedule outbound
#
```

20.4.2 AR2's Configuration

```
#
 sysname AR2
#
interface GigabitEthernet0/0/0
#
interface GigabitEthernet0/0/1
 ip address 51.1.1.2 255.255.255.252
#
interface GigabitEthernet0/0/2
#
user-interface con 0
 authentication-mode password
user-interface vty 0 4
user-interface vty 16 20
#
return
```

20.4.3 Switch's Configuration

```
#
sysname Huawei
#
vlan batch 10 20 30
#
interface Ethernet0/0/1
 port link-type access
 port default vlan 10
```

```
#
interface Ethernet0/0/2
 port link-type access
 port default vlan 20
#
interface Ethernet0/0/3
 port link-type access
 port default vlan 30
#
interface Ethernet0/0/4
 port link-type trunk
 port trunk allow-pass vlan 10 20 30
#
```

20.5 Quiz

Is there any other method for configuring queue rate limits?

Recommendations

- Huawei Learning Website
  - http://learning.huawei.com/en
- Huawei e-Learning
  - https://ilearningx.huawei.com/portal/#/portal/ebg/51
- Huawei Certification
  - http://support.huawei.com/learning/NavigationAction!createNavi?navId=_31&lang=en
- Find Training
  - http://support.huawei.com/learning/NavigationAction!createNavi?navId=_trainingsearch&lang=en

More Information

- Huawei learning APP

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