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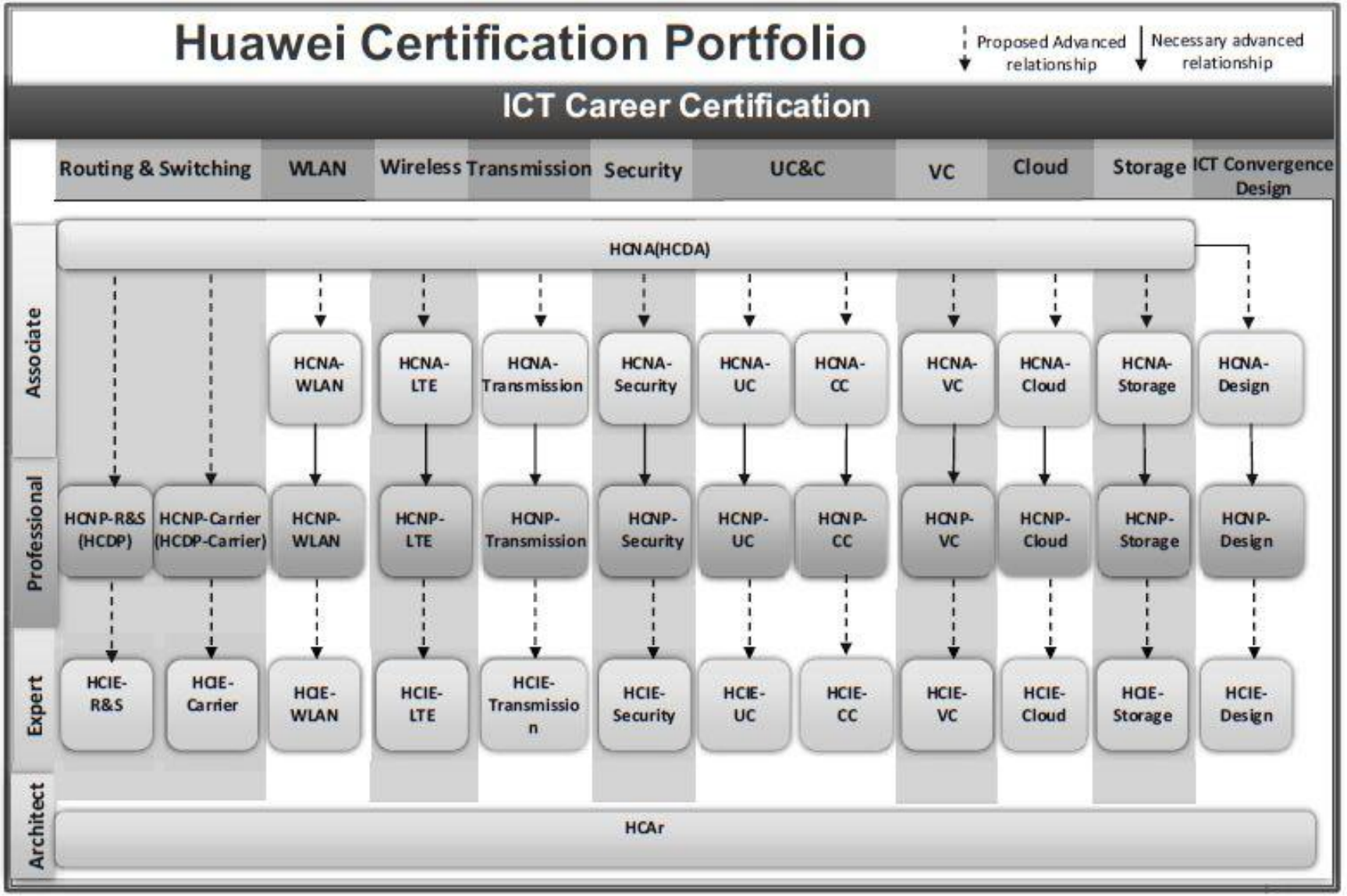
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HCNP-LTE
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HCIE-WLAN
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HCIE-Security
HCIE-UC
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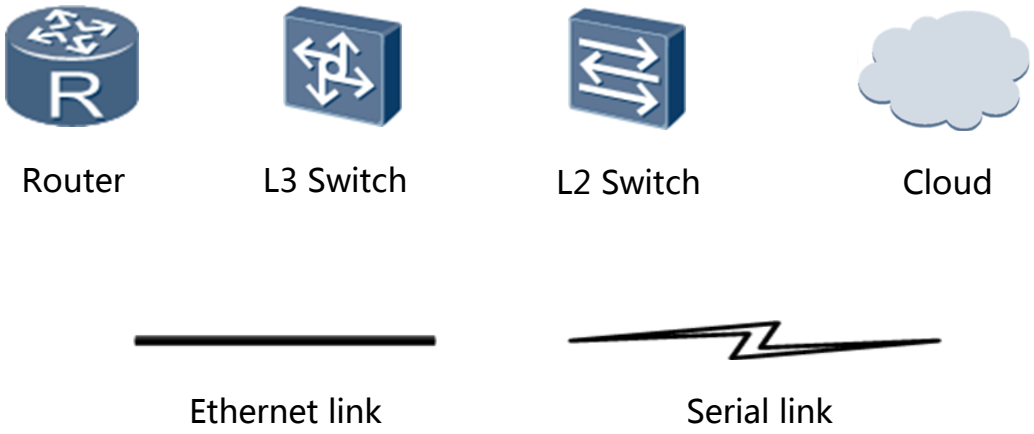


Lab Environment Specification

In order to ensure that that the configuration given in this lab is supported on all devices, it is recommended that the following device models and VRP versions be used:

Identifier	Device Model	VRP version
R1	AR 2220	Version 5.120 (AR2200 V200R003C00SPC200)
R2	AR 2220	Version 5.120 (AR2200 V200R003C00SPC200)
R3	AR 2220	Version 5.120 (AR2200 V200R003C00SPC200)
S1	S5700-28C-EI-24S	Version 5.70 (S5700 V100R006C00SPC800)
S2	S5700-28C-EI-24S	Version 5.70 (S5700 V100R006C00SPC800)
S3	S3700-28TP-EI-AC	Version 5.70 (S3700 V100R006C00SPC800)
S4	S3700-28TP-EI-AC	Version 5.70 (S3700 V100R006C00SPC800)

CONTENTS

Module 1 Ethernet and VLAN

Lab 1-1 Ethernet Interface and Link Configuration

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Manually set the line rate and duplex mode on an interface.
- Configuration of manual mode link aggregation.
- Configuration of link aggregation using static LACP mode.
- Management of the priority of interfaces in static LACP mode.

Topology

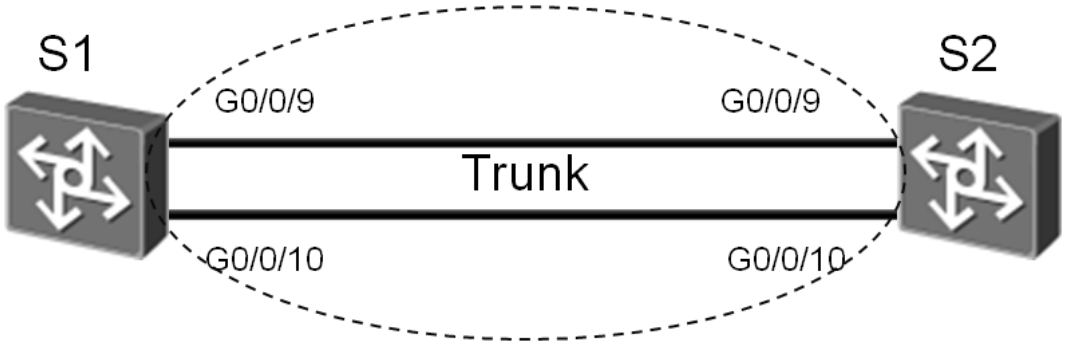


Figure 1.1 Ethernet link aggregation topology

Scenario

As a network administrator of an existing enterprise network, it has been requested that the connections between the switches be used more effectively by preparing the switches to support link aggregation before establishing manual link aggregation, for which the media between the switches are to be configured as member links.

Tasks

Step 1 **Perform basic configuration on the Ethernet switches.**

Auto-negotiation is enabled on Huawei switch interfaces by default. The rate and duplex mode of G0/0/9 and G0/0/10 on S1 and S2 are to be set manually.

Change the system name and view detailed information for G0/0/9 and G0/0/10 on S1.

```
<Quidway>system-view
[Quidway]sysname S1
[S1]display interface GigabitEthernet 0/0/9
GigabitEthernet0/0/9 current state : UP
Line protocol current state : UP
Description:HUAWEI, Quidway Series, GigabitEthernet0/0/9 Interface
Switch Port,PVID :    1,The Maximum Frame Length is 1600
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 0018-82e1-aea6
Port Mode: COMMON COPPER
Speed : 1000,  Loopback: NONE
Duplex: FULL,  Negotiation: ENABLE
Mdi   : AUTO
Last 300 seconds input rate 752 bits/sec, 0 packets/sec
Last 300 seconds output rate 720 bits/sec, 0 packets/sec
Input peak rate 1057259144 bits/sec,Record time: 2008-10-01 00:08:58
Output peak rate 1057267232 bits/sec,Record time: 2008-10-01 00:08:58
Input:  11655141 packets, 960068100 bytes
Unicast         :                70,Multicast          :           5011357
Broadcast       :           6643714,Jumbo              :                 0
CRC             :                 0,Giants             :                 0
Jabbers         :                 0,Throttles          :                 0
Runts           :                 0,DropEvents         :                 0
Alignments      :                 0,Symbols            :                 0
Ignoreds        :                 0,Frames             :                 0
Discard         :                69,Total Error        :                 0
Output: 11652169 packets, 959869843 bytes
Unicast         :               345,Multicast          :           5009016
Broadcast       :           6642808,Jumbo              :                 0
Collisions      :                 0,Deferreds          :                 0
Late Collisions :                 0,ExcessiveCollisions:                 0
Buffers Purged  :                 0
Discard         :                 5,Total Error        :                 0
```

```
    Input bandwidth utilization threshold : 100.00%
    Output bandwidth utilization threshold: 100.00%
    Input bandwidth utilization   : 0.01%
    Output bandwidth utilization  : 0.00%

[S1]display interface GigabitEthernet 0/0/10
GigabitEthernet0/0/10 current state : UP
Line protocol current state : UP
Description:HUAWEI, Quidway Series, GigabitEthernet0/0/10 Interface
Switch Port,PVID :    1,The Maximum Frame Length is 1600
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 0018-82e1-aea6
Port Mode: COMMON COPPER
Speed : 1000,  Loopback: NONE
Duplex: FULL,  Negotiation: ENABLE
Mdi   : AUTO
Last 300 seconds input rate 1312 bits/sec, 0 packets/sec
Last 300 seconds output rate 72 bits/sec, 0 packets/sec
Input peak rate 1057256792 bits/sec,Record time: 2008-10-01 00:08:58
Output peak rate 1057267296 bits/sec,Record time: 2008-10-01 00:08:58
Input:  11651829 packets, 959852817 bytes
Unicast         :               115,Multicast          :           5009062
Broadcast       :           6642648,Jumbo              :                 0
CRC             :                 3,Giants             :                 0
Jabbers         :                 0,Throttles          :                 0
Runts           :                 0,DropEvents         :                 0
Alignments      :                 0,Symbols            :                 4
Ignoreds        :                 0,Frames             :                 0
Discard         :               218,Total Error        :                 7
Output: 11655280 packets, 960072712 bytes
Unicast         :               245,Multicast          :           5011284
Broadcast       :           6643751,Jumbo              :                 0
Collisions      :                 0,Deferreds          :                 0
Late Collisions :                 0,ExcessiveCollisions:                 0
Buffers Purged  :                 0
Discard         :               107,Total Error        :                 0
    Input bandwidth utilization threshold : 100.00%
    Output bandwidth utilization threshold: 100.00%
    Input bandwidth utilization   : 0.01%
    Output bandwidth utilization  : 0.00%
```

Set the rate of G0/0/9 and G0/0/10 on S1 to 100 Mbit/s and configure them to work in full duplex mode. Before changing the interface rate and duplex mode, disable auto-negotiation.

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]undo negotiation auto
[S1-GigabitEthernet0/0/9]speed 100
[S1-GigabitEthernet0/0/9]duplex full
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]undo negotiation auto
[S1-GigabitEthernet0/0/10]speed 100
[S1-GigabitEthernet0/0/10]duplex full
```

Set the rate of G0/0/9 and G0/0/10 on S2 to 100 Mbit/s and configure them to work in full duplex mode.

```
<Quidway>system-view
[Quidway]sysname S2
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]undo negotiation auto
[S2-GigabitEthernet0/0/9]speed 100
[S2-GigabitEthernet0/0/9]duplex full
[S2-GigabitEthernet0/0/9]quit
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]undo negotiation auto
[S2-GigabitEthernet0/0/10]speed 100
[S2-GigabitEthernet0/0/10]duplex full
```

Confirm that the rate and duplex mode of G0/0/9 and G0/0/10 have been set on S1.

```
[S1]display interface GigabitEthernet 0/0/9
GigabitEthernet0/0/9 current state : UP
Line protocol current state : UP
Description:HUAWEI, Quidway Series, GigabitEthernet0/0/9 Interface
Switch Port,PVID :    1,The Maximum Frame Length is 1600
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 0018-82e1-aea6
Port Mode: COMMON COPPER
Speed :  100,  Loopback: NONE
Duplex: FULL,  Negotiation: DISABLE
Mdi   : AUTO
……output omitted……
```

```
[S1]display interface GigabitEthernet 0/0/10
GigabitEthernet0/0/10 current state : UP
Line protocol current state : UP
Description:HUAWEI, Quidway Series, GigabitEthernet0/0/10 Interface
Switch Port,PVID :    1,The Maximum Frame Length is 1600
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 0018-82e1-aea6
Port Mode: COMMON COPPER
Speed :  100,  Loopback: NONE
Duplex: FULL,  Negotiation: DISABLE
Mdi   : AUTO
……output omitted……
```

Step 2 **Configure manual link aggregation.**

Create Eth-Trunk 1 on S1 and S2. Delete the default configuration from G0/0/9 and G0/0/10 on S1 and S2, and then add G0/0/9 and G0/0/10 to Eth-Trunk 1.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]quit
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]eth-trunk 1
[S1-GigabitEthernet0/0/9]quit
[S1-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]eth-trunk 1

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]quit
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]eth-trunk 1
[S2-GigabitEthernet0/0/9]quit
[S2-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]eth-trunk 1
```

Verify the Eth-Trunk configuration.

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
WorkingMode: NORMAL        Hash arithmetic: According to SA-XOR-DA
Least Active-linknumber: 1  Max Bandwidth-affected-linknumber: 8
Operate status: up         Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
PortName                      Status     Weight
GigabitEthernet0/0/9            Up          1
```

```
GigabitEthernet0/0/10        Up          1

[S2]display eth-trunk 1
Eth-Trunk1's state information is:
WorkingMode: NORMAL        Hash arithmetic: According to SA-XOR-DA
Least Active-linknumber: 1  Max Bandwidth-affected-linknumber: 8
Operate status: up         Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
PortName                    Status      Weight
GigabitEthernet0/0/9         Up          1
GigabitEthernet0/0/10        Up          1
```

The greyed lines in the preceding information indicate that the Eth-Trunk works properly.

Step 3 **Configuring Link Aggregation in Static LACP Mode**

Delete the configurations from G0/0/9 and G0/0/10 on S1 and S2.

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]undo eth-trunk
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]undo eth-trunk

[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]undo eth-trunk
[S2-GigabitEthernet0/0/9]quit
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]undo eth-trunk
```

Create Eth-Trunk 1 and set the load balancing mode of the Eth-Trunk to static LACP mode.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]mode lacp-static
[S1-Eth-Trunk1]quit
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]eth-trunk 1
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]eth-trunk 1
```

```
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]mode lacp-static
[S2-Eth-Trunk1]quit
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]eth-trunk 1
[S2-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]eth-trunk 1
```

Verify that the LACP-static mode has been enabled on the two links.

```
[S1]display eth-trunk
Eth-Trunk1's state information is:
Local:
LAG ID: 1                         WorkingMode: STATIC
Preempt Delay: Disabled           Hash arithmetic: According to SA-XOR-DA
System Priority: 32768            System ID: 4c1f-cc45-aace
Least Active-linknumber: 1        Max Active-linknumber: 8
Operate status: up                Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
ActorPortName           Status  PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9    Selected 100M    32768   9      289     10111100  1
GigabitEthernet0/0/10   Selected 100M    32768   10     289     10111100  1
Partner:
--------------------------------------------------------------------------------
ActorPortName          SysPri   SystemID       PortPri PortNo PortKey PortState
GigabitEthernet0/0/9   32768    4c1f-cc45-aacc  32768   9     289     10111100
GigabitEthernet0/0/10  32768    4c1f-cc45-aacc  32768   10    289     10111100
```

Set the system priority on S1 to 100 to ensure S1 remains the Actor.

```
[S1]lacp  priority 100
```

Set the priority of the interface and determine active links on S1.

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]lacp priority 100
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]lacp priority 100
```

Verify the Eth-Trunk configuration.

```
[S1]display  eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay: Disabled         Hash arithmetic: According to SA-XOR-DA
System Priority: 100            System ID: 4c1f-cc45-aace
Least Active-linknumber: 1      Max Active-linknumber: 8
Operate status: up         Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
ActorPortName           Status  PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9    Selected 100M    100     9       289     10111100  1
GigabitEthernet0/0/10   Selected 100M    100     10      289     10111100  1
Partner:
--------------------------------------------------------------------------------
ActorPortName          SysPri   SystemID       PortPri PortNo PortKey PortState
GigabitEthernet0/0/9   32768    4c1f-cc45-aacc  32768   9      289     10111100
GigabitEthernet0/0/10  32768    4c1f-cc45-aacc  32768   10     289     10111100

[S2]display  eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay: Disabled         Hash arithmetic: According to SA-XOR-DA
System Priority: 32768          System ID: 4c1f-cc45-aacc
Least Active-linknumber: 1      Max Active-linknumber: 8
Operate status: up              Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
ActorPortName           Status  PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9    Selected 100M    32768   9      289     10111100  1
GigabitEthernet0/0/10   Selected 100M    32768   10     289     10111100  1
Partner:
--------------------------------------------------------------------------------
ActorPortName          SysPri   SystemID        PortPri PortNo PortKey PortState
GigabitEthernet0/0/9   100      4c1f-cc45-aace  100     9      289     10111100
GigabitEthernet0/0/10  100      4c1f-cc45-aace  100     10     289     10111100
```

Final Configuration

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
```

```
 sysname S1
#
 lacp priority 100
#
interface Eth-Trunk1
 mode lacp-static
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
return

[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
interface Eth-Trunk1
 mode lacp-static
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 undo negotiation auto
 speed 100
#
return
```

Lab 1-2 VLAN Configuration

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Assign port interfaces to become access and trunk ports.
- Create VLANs.
- Configure VLAN tagging over ports using the hybrid port link type.
- Configure the default VLAN for an interface using the Port VLAN ID.

Topology

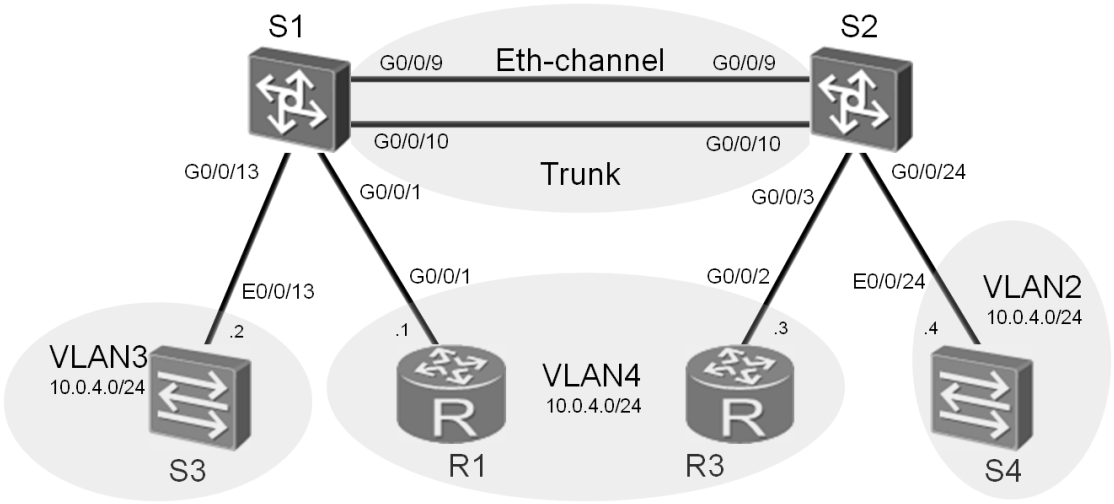


Figure 1.2 VLAN topology

Scenario

The enterprise network currently operates in a single broadcast domain resulting in a large amount of traffic being flooded to all network nodes. It is required that the administrator attempt to control the flow of traffic at the link layer by implementing VLAN solutions. The VLAN solutions are to be applied to switches S1 and S2.

Tasks

Step 1 Preparing the environment.

If you are starting this section with a non-configured device, begin here and then move to step 2. For those continuing from previous labs, begin at step 2.

Establish an Eth-trunk link between S1 and S2.

```
<Quidway>system-view
[Quidway]sysname S1
[S1]interface Eth-trunk 1
[S1-Eth-Trunk1]mode lacp-static
[S1-Eth-Trunk1]quit
[S1]interface GigabitEthernet0/0/9
[S1-Gigabitethernet0/0/9]eth-trunk 1
[S1-Gigabitethernet0/0/9]interface GigabitEthernet0/0/10
[S1-Gigabitethernet0/0/10]eth-trunk 1
```

On S2, add interfaces to an Eth-Trunk using the Eth-Trunk view.

```
<Quidway>system-view
[Quidway]sysname S2
[S2]interface eth-trunk 1
[S2-Eth-Trunk1]mode lacp-static
[S2-Eth-Trunk1]trunkport GigabitEthernet 0/0/9
[S2-Eth-Trunk1]trunkport GigabitEthernet 0/0/10
```

Step 2 Disable unused interfaces and establish a VLAN trunk.

Unused interfaces must be disabled to ensure test result accuracy. In this lab, interfaces Ethernet 0/0/1 and Ethernet 0/0/23 on S3 and Ethernet0/0/14 on S4 need to be shut down.

```
<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S3
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]shutdown
[S3-Ethernet0/0/1]quit
[S3]interface Ethernet 0/0/23
[S3-Ethernet0/0/23]shutdown
```

```
<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S4
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]shutdown
```

The link type of a switch port interface is hybrid by default. Configure the port link-type for Eth-Trunk 1 to become a trunk port. Additionally, allow all VLANS to be permitted over the trunk port.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]port link-type trunk
[S1-Eth-Trunk1]port trunk allow-pass vlan all

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]port link-type trunk
[S2-Eth-Trunk1]port trunk allow-pass vlan all
```

Step 3 **Configure VLANs.**

Use S3, R1, R3, and S4 as non-VLAN aware hosts. There are two methods to create VLANs, and two methods to bind interfaces to the created VLANs, S1 and S2 are used to demonstrate the two methods. All interfaces associated with hosts should be configured as access ports.

On S1, associate interface Gigabit Ethernet 0/0/13 with VLAN 3, and interface Gigabit Ethernet 0/0/1 with VLAN 4.

On S2, associate interface Gigabit Ethernet 0/0/2 with VLAN4, and Gigabit Ethernet 0/0/24 with VLAN 2.

```
[S1]interface GigabitEthernet0/0/13
[S1-GigabitEthernet0/0/13]port link-type access
[S1-GigabitEthernet0/0/13]quit
[S1]interface GigabitEthernet0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]quit
[S1]vlan 2
[S1-vlan2]vlan 3
[S1-vlan3]port GigabitEthernet0/0/13
[S1-vlan3]vlan 4
[S1-vlan4]port GigabitEthernet0/0/1
```

```
[S2]vlan batch 2 to 4
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]port link-type access
[S2-GigabitEthernet0/0/3]port default vlan 4
[S2-GigabitEthernet0/0/3]quit
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port link-type access
[S2-GigabitEthernet0/0/24]port default vlan 2
```

Verify that the VLAN configuration has been correctly applied to S1 and S2.

```
<S1>display vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type       Ports
--------------------------------------------------------------------------------
1    common     UT:GE0/0/2(U)  GE0/0/3(U)      GE0/0/4(U)      GE0/0/5(U)
                GE0/0/6(D)     GE0/0/7(D)      GE0/0/8(D)      GE0/0/11(D)
                GE0/0/12(D)    GE0/0/14(D)     GE0/0/15(D)     GE0/0/16(D)
                GE0/0/17(D)    GE0/0/18(D)     GE0/0/19(D)     GE0/0/20(D)
                GE0/0/21(U)    GE0/0/22(U)     GE0/0/23(U)     GE0/0/24(D)
                Eth-Trunk1(U)
2    common  TG:Eth-Trunk1(U)
3    common  UT:GE0/0/13(U)
             TG:Eth-Trunk1(U)
4    common  UT:GE0/0/1(U)
             TG:Eth-Trunk1(U)
…output omitted…
```

```
<S2>display vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type       Ports
--------------------------------------------------------------------------------
1    common     UT:GE0/0/1(U)  GE0/0/2(U)      GE0/0/4(U)      GE0/0/5(U)
                GE0/0/6(D)      GE0/0/7(D)      GE0/0/8(D)      GE0/0/11(U)
                GE0/0/12(U)     GE0/0/13(U)     GE0/0/14(D)     GE0/0/15(D)
                GE0/0/16(D)     GE0/0/17(D)     GE0/0/18(D)     GE0/0/19(D)
                GE0/0/20(D)     GE0/0/21(D)     GE0/0/22(D)     GE0/0/23(D)
                Eth-Trunk1(U)
2    common  UT:GE0/0/24(U)
             TG:Eth-Trunk1(U)
3    common  TG:Eth-Trunk1(U)
4    common  UT:GE0/0/3(U)
             TG:Eth-Trunk1(U)
…output omitted…
```

The highlighted entries confirm the binding of the interfaces to each created VLAN. All VLANs are permitted over the trunk (TG) port Eth-Trunk 1.

Step 4 **Configure IP addressing for each VLAN.**

Configure IP addresses on hosts, R1, S3, R3, and S4 as part of the respective VLANs. Physical port interfaces on switches cannot be configured with IP addresses, therefore configure the native management interface Vlanif1 with the IP address for the switch.

```
<Huawei>system-view
[Huawei]sysname R1
[R1]interface GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.4.1 24

[S3]interface vlanif 1
[S3-vlanif1]ip address 10.0.4.2 24
```

```
<Huawei>system-view
[Huawei]sysname R3
[R3]interface GigabitEthernet0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.4.3 24

[S4]interface vlanif 1
[S4-vlanif1]ip address 10.0.4.4 24
```

Step 5 **Verify the configuration, by checking the connectivity.**

Use the **ping** command. R1 and R3 in VLAN 4 should be able to communicate with one another. Devices in other VLANs should be unable to communicate.

```
[R1]ping 10.0.4.3
  PING 10.0.4.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.3: bytes=56 Sequence=1 ttl=255 time=6 ms
    Reply from 10.0.4.3: bytes=56 Sequence=2 ttl=255 time=2 ms
    Reply from 10.0.4.3: bytes=56 Sequence=3 ttl=255 time=2 ms
    Reply from 10.0.4.3: bytes=56 Sequence=4 ttl=255 time=2 ms
    Reply from 10.0.4.3: bytes=56 Sequence=5 ttl=255 time=2 ms

  --- 10.0.4.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 2/2/6 ms

[R1]ping 10.0.4.4
  PING 10.0.4.4: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out

  --- 10.0.4.4 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

You may wish to also try between R1 and S3, and between R3 and S4.

Step 6 **Configure a hybrid interface.**

Use the hybrid port link type to allow VLAN tagging to be closely managed at a port interface level. We shall use hybrid ports to allow tagged frames from VLAN 4 to be received by VLAN 2 and vice versa.

Set the port link type of port interface Gigabit Ethernet 0/0/1 of port S1 and the interfaces Gigabit Ethernet 0/0/3 and 0/0/24 of S2 as hybrid ports. Additionally set the hybrid ports to untag all frames associated with VLAN 2 and 4.

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]undo port default vlan
[S1-GigabitEthernet0/0/1]port link-type hybrid
[S1-GigabitEthernet0/0/1]port hybrid untagged vlan 2 4
[S1-GigabitEthernet0/0/1]port hybrid pvid vlan 4

[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]undo port default vlan
[S2-GigabitEthernet0/0/3]port link-type hybrid
[S2-GigabitEthernet0/0/3]port hybrid untagged vlan 2 4
[S2-GigabitEthernet0/0/3]port hybrid pvid vlan 4
[S2-GigabitEthernet0/0/3]quit
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]undo port default vlan
[S2-GigabitEthernet0/0/24]port link-type hybrid
[S2-GigabitEthernet0/0/24]port hybrid untagged vlan 2 4
[S2-GigabitEthernet0/0/24]port hybrid pvid vlan 2
```

The **port hybrid pvid vlan** command will ensure frames received from the host are tagged with the appropriate VLAN tag. Frames received from VLAN 2 or 4 will be untagged at the interface before being forwarded to the host.

Use the ping command to verify that R3 in VLAN 4 is still reachable.

```
<R1>ping 10.0.4.3
  PING 10.0.4.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.3: bytes=56 Sequence=1 ttl=255 time=1 ms
    Reply from 10.0.4.3: bytes=56 Sequence=2 ttl=255 time=1 ms
    Reply from 10.0.4.3: bytes=56 Sequence=3 ttl=255 time=1 ms
    Reply from 10.0.4.3: bytes=56 Sequence=4 ttl=255 time=10 ms
    Reply from 10.0.4.3: bytes=56 Sequence=5 ttl=255 time=1 ms
```

```
  --- 10.0.4.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 1/2/10 ms
```

Use the ping command to test whether S4 in VLAN 2 is now reachable from R1 in VLAN 4.

```
<R1>ping 10.0.4.4
  PING 10.0.4.4: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.4: bytes=56 Sequence=1 ttl=255 time=41 ms
    Reply from 10.0.4.4: bytes=56 Sequence=2 ttl=254 time=2 ms
    Reply from 10.0.4.4: bytes=56 Sequence=3 ttl=254 time=3 ms
    Reply from 10.0.4.4: bytes=56 Sequence=4 ttl=254 time=2 ms
    Reply from 10.0.4.4: bytes=56 Sequence=5 ttl=254 time=2 ms

  --- 10.0.4.4 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/10/41 ms
```

In using the hybrid port link type, frames originating from VLAN 4 are now able to be received by VLAN 2 and vice versa, whilst still being unable to reach the host address of 10.0.4.2 in VLAN 3.

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
interface GigabitEthernet0/0/1
 ip address 10.0.4.1 255.255.255.0
#
return

[S3]display current-configuration
#
```

```
!Software Version V100R006C00SPC800
 sysname S3
#
interface Vlanif1
 ip address 10.0.4.2 255.255.255.0
#
interface Ethernet0/0/1
 shutdown
#
interface Ethernet0/0/23
 shutdown
#
return

[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 2 to 4
#
 lacp priority 100
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/1
 port hybrid pvid vlan 4
 port hybrid untagged vlan 2 4
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
```

```
#
interface GigabitEthernet0/0/13
 port link-type access
 port default vlan 3
#
return

[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 2 4
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/3
 port hybrid pvid vlan 4
 port hybrid untagged vlan 2 4
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/24
 port hybrid pvid vlan 2
 port hybrid untagged vlan 2 4
#
interface NULL0
#
user-interface con 0
user-interface vty 0 4
#
return
```

```
[R3]display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface GigabitEthernet0/0/2
 ip address 10.0.4.3 255.255.255.0
#
return

[S4]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
interface Vlanif1
 ip address 10.0.4.4 255.255.255.0
#
interface Ethernet0/0/14
 shutdown
#
return
```

Lab 1-3 GVRP Configuration

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of GVRP.
- Setting of the GVRP registration mode.

Topology

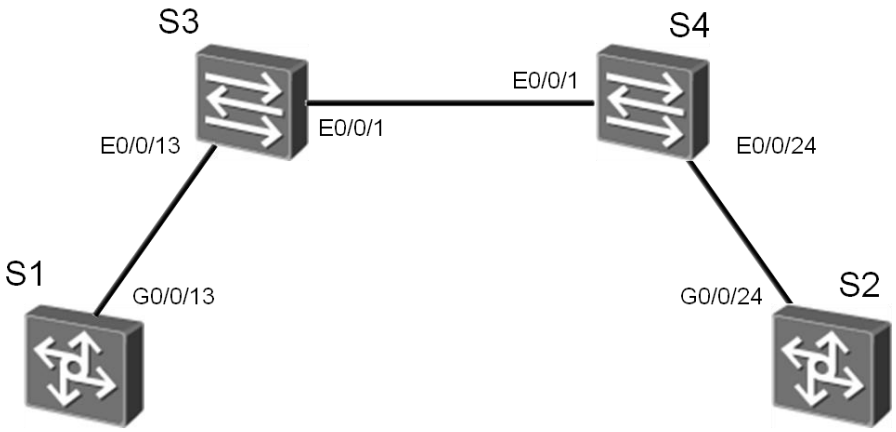


Figure 1.3 GVRP topology

Scenario

The enterprise network contains multiple switches which are expected to be regularly managed. VLANs are required to be applied and removed as necessary on all switches however this tends to be a laborious task for the administrator and often configuration mistakes occur due to human error. The administrator wishes to simplify the VLAN management process and has requested that GVRP be enabled on all switchs and the registration mode on the interfaces be set.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Quidway>system-view
[Quidway]sysname S1
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]shutdown
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]shutdown

<Quidway>system-view
[Quidway]sysname S2
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]shutdown
[S2-GigabitEthernet0/0/9]quit
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]shutdown

<Quidway>system-view
[Quidway]sysname S3
[S3-Ethernet0/0/23]shutdown

<Quidway>system-view
[Quidway]sysname S4
[S4-Ethernet0/0/14]shutdown
```

Step 2 Clean up the previous configuration

Remove the unsed VLANs and disable the Eth-Trunk interface on S1 and S2. Remove Vlanif1 on S3 and S4 and bring up interface Ethernet 0/0/1 on S3.

```
[S1]undo vlan batch 2 to 4
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]shutdown
```

```
[S2]undo vlan batch 2 to 4
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]shutdown
[S2-Eth-Trunk1]quit
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]undo port hybrid vlan 2 4

[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]undo shutdown
[S3-Ethernet0/0/1]quit
[S3]undo interface Vlanif 1
Info: This operation may take a few seconds. Please wait for a moment...succeeded.

[S4]undo interface Vlanif 1
Info: This operation may take a few seconds. Please wait for a moment...succeeded.
```

Step 3 **Configure trunk links between the switches.**

```
[S1]interface GigabitEthernet 0/0/13
[S1-Gigabitethernet0/0/13]port link-type trunk
[S1-Gigabitethernet0/0/13]port trunk allow-pass vlan all

[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]port link-type trunk
[S3-Ethernet0/0/13]port trunk  allow-pass vlan  all
[S3-Ethernet0/0/13]quit
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]port link-type trunk
[S3-Ethernet0/0/1]port trunk allow-pass vlan all

[S2]interface GigabitEthernet 0/0/24
[S2-Gigabitethernet0/0/24]port link-type trunk
[S2-Gigabitethernet0/0/24]port trunk allow-pass vlan all

[S4]interface Ethernet 0/0/24
[S4-Ethernet0/0/24]port link-type trunk
[S4-Ethernet0/0/24]port trunk allow-pass vlan all
[S4-Ethernet0/0/24]quit
[S4]interface Ethernet 0/0/1
[S4-Ethernet0/0/1]port link-type trunk
[S4-Ethernet0/0/1]port trunk  allow-pass  vlan  all
```

Step 1 **Enable GVRP globally, and on all relevant interfaces.**

```
[S1]gvrp
[S1]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]gvrp

[S3]gvrp
[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]gvrp
[S3-Ethernet0/0/13]quit
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]gvrp

[S2]gvrp
[S2]interface GigabitEthernet 0/0/24
[S2-Gigabitethernet0/0/24]gvrp

[S4]gvrp
[S4]interface Ethernet0/0/24
[S4-Ethernet0/0/24]gvrp
[S4-Ethernet0/0/24]quit
[S4]interface Ethernet 0/0/1
[S4-Ethernet0/0/1]gvrp
```

Create VLAN 100 on S1, VLAN 200 on S2 and VLAN 2 on S1, S2, S3 and S4.

```
[S1]vlan batch 2 100
[S2]vlan batch 2 200
[S3]vlan 2
[S4]vlan 2
```

Run the **display gvrp statistics** command on S3 and S4 to view the GVRP statistics.

```
[S3]display  gvrp statistics
  GVRP statistics on port Ethernet0/0/1
    GVRP status                         : Enabled
    GVRP registrations failed           : 0
    GVRP last PDU origin                : 5489-98ec-f012
    GVRP registration type              : Normal

  GVRP statistics on port Ethernet0/0/13
    GVRP status                         : Enabled
```

```
   GVRP registrations failed          : 0
   GVRP last PDU origin               : 4c1f-cc45-aace
  GVRP registration type              : Normal

[S4]display  gvrp statistics
    GVRP statistics on port Ethernet0/0/1
     GVRP status                      : Enabled
     GVRP registrations failed        : 0
     GVRP last PDU origin             : 781d-ba99-d977
     GVRP registration type           : Normal

    GVRP statistics on port Ethernet0/0/24
     GVRP status                      : Enabled
     GVRP registrations failed        : 0
     GVRP last PDU origin             : 4c1f-cc45-aacc
     GVRP registration type           : Normal
```

The registration type is set as normal by default. Use the **display vlan** command to verify the VLAN configuration on S3 and S4.

```
[S3]display  vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(U)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(D)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/1(U)  Eth0/0/13(U)
100  dynamic TG:Eth0/0/13(U)
200  dynamic TG:Eth0/0/1(U)
…output omitted…
```

```
[S4]display  vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(D)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(U)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/1(U)  Eth0/0/24(U)
100  dynamic TG:Eth0/0/1(U)
200  dynamic TG:Eth0/0/24(U)
…output omitted…
```

S3 and S4 are learning VLAN 100 and VLAN 200 dynamically, but only in one direction. VLAN 2 has been statically defined. Create VLAN 200 on S1 and VLAN 100 on S2 to enable 2-way propagation.

```
[S1]vlan 200
[S2]vlan 100
```

Run the **display vlan** command to verify the configuration.

```
[S3]display vlan
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(U)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(D)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/1(U)  Eth0/0/13(U)
100  dynamic TG:Eth0/0/1(U)  Eth0/0/13(U)
200  dynamic TG:Eth0/0/1(U)  Eth0/0/13(U)
…output omitted…
```

```
[S4]display vlan
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(D)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(U)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/1(U)  Eth0/0/24(U)
100  dynamic TG:Eth0/0/1(U)  Eth0/0/24(U)
200  dynamic TG:Eth0/0/1(U)  Eth0/0/24(U)
…output omitted…
```

The highlighted entries indicate the interfaces that have been added to VLAN100 and VLAN200 on both S3 and S4.

Step 2 **Change the registration type for the interfaces**

Change the registration type of Ethernet 0/0/1 on S3 to fixed. The same steps can be performed on Ethernet 0/0/1 of S4.

```
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]gvrp registration fixed
```

Run the **display gvrp statistics** command on S3 and S4 to view the changes.

```
[S3]display gvrp statistics interface Ethernet 0/0/1
  GVRP statistics on port Ethernet0/0/1
    GVRP status                     : Enabled
    GVRP registrations failed       : 12
    GVRP last PDU origin            : 5489-98ec-f012
    GVRP registration type          : Fixed
```

The GVRP registration type is verified as fixed on Ethernet 0/0/1 interface. Dynamic VLANs are not allowed to register on this interface.

Run the **display vlan** command to view the effect of the fixed registration type.

```
[S3]display vlan
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(U)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(D)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/1(U)  Eth0/0/13(U)
100  dynamic TG:Eth0/0/13(U)
200  dynamic TG:Eth0/0/13(U)
```

The highlighted entries show that interface Ethernet 0/0/1 is not in registering dynamic VLANs 100 and 200.

Configure interface Ethernet 0/0/1 of S3 to use the forbidden registration type. The same steps can be performed on Ethernet 0/0/1 of S4.

```
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]gvrp registration forbidden
```

Run the **display gvrp statistics** command to view the changes to GVRP.

```
[S3]display gvrp statistics interface Ethernet 0/0/1

  GVRP statistics on port Ethernet0/0/1
    GVRP status                     : Enabled
    GVRP registrations failed       : 18
    GVRP last PDU origin            : 5489-98ec-f012
    GVRP registration type          : Forbidden
```

The GVRP registration type is set to forbidden on the Ethernet 0/0/1 interface.

Run the **display vlan** command to view the effect of the forbidden registration.

```
[S3]display vlan
The total number of vlans is : 4
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(U)  Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
             Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)
             Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
             Eth0/0/13(U)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
             Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
             Eth0/0/21(D)    Eth0/0/22(D)    Eth0/0/23(D)    Eth0/0/24(D)
             GE0/0/1(D)      GE0/0/2(D)      GE0/0/3(D)      GE0/0/4(D)
2    common  TG:Eth0/0/13(U)
100  dynamic TG:Eth0/0/13(U)
200  dynamic TG:Eth0/0/13(U)
```

Forbidden mode only allows VLAN1 pass over interface Ethernet 0/0/1, all other VLANS are restricted.

Final Configuration

```
[S1]dis current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 2 100 200
#
 gvrp
#
interface Eth-Trunk1
 shutdown
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/1
 port hybrid untagged vlan 2 4
#
interface GigabitEthernet0/0/9
 shutdown
```

```
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 shutdown
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/13
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
#
return

[S2]dis current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 2 100 200
#
 gvrp
#
interface Eth-Trunk1
 shutdown
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/3
 port hybrid untagged vlan 2 4
#
interface GigabitEthernet0/0/9
 shutdown
 eth-trunk 1
 undo negotiation auto
 speed 100
#
```

```
interface GigabitEthernet0/0/10
 shutdown
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
#
return

[S3]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
 vlan batch 2
#
 gvrp
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
 gvrp registration forbidden
#
interface Ethernet0/0/13
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
#
interface Ethernet0/0/23
 shutdown
#
return

[S4]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
```

```
 vlan batch 2
#
 gvrp
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
 gvrp registration forbidden
#
interface Ethernet0/0/14
 shutdown
#
interface Ethernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 gvrp
#
return
```

Lab 1-4 VLAN Routing

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Establishment of a trunk inteface for VLAN routing.
- Configuration of sub-interfaces on a single physical interface.
- Enabling of ARP messages to be broadcast between VLANS.

Topology

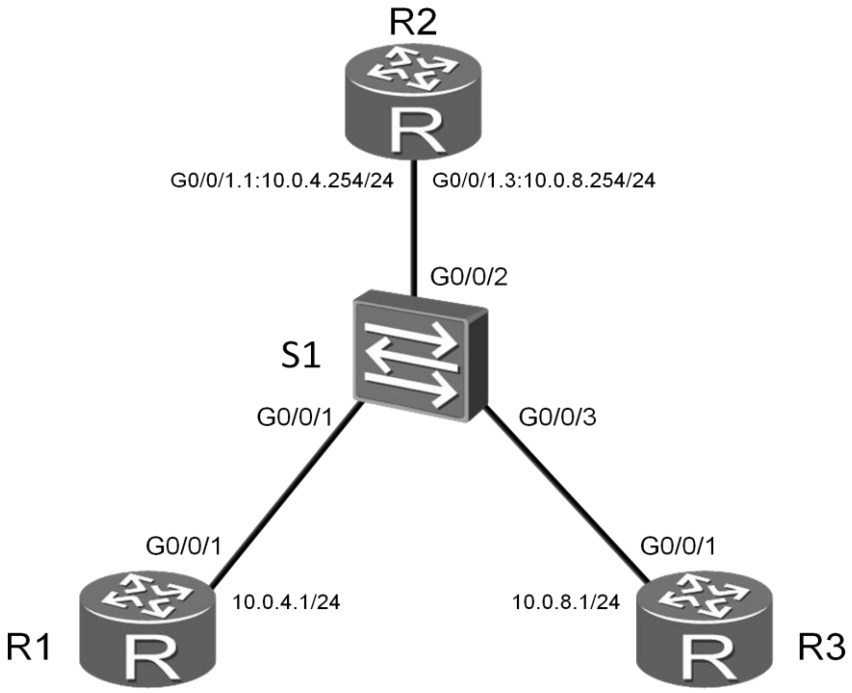


Figure 1.4 VLAN routing topology using a layer 2 switch.

Scenario

The implementation of VLANs in the enterprise network has resulted in groups of users being isolated from other users that are part of different subnets. As the network administrator you have been given the task to ensure that the broadcast domains are maintained whilst allowing communication between the disparate users.

Tasks

Step 1 **Preparing the environment.**

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

Configure the system name for R1, R3 and S1. Configure the IP address 10.0.4.1/24 on interface Gigabit Ethernet 0/0/1.

```
<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]ip address 10.0.4.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3

<Quidway>system-view
[Quidway]sysname S1
```

Step 2 **Clean up the previous configuration**

Remove the IP address 10.0.4.3 from R3, and disable the swich interfaces between S1 and S3 and S2 and S4 respectively.

```
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]undo ip address


[S1]undo gvrp
Warning: All information about the GVRP will be deleted . Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]undo port trunk allow-pass vlan 2 to 4094
[S1-GigabitEthernet0/0/13]shutdown
[S1-GigabitEthernet0/0/13]quit
[S1]interface GigabitEthernet 0/0/1
```

```
[S1-GigabitEthernet0/0/1]undo port hybrid vlan 2 4
[S1-GigabitEthernet0/0/1]quit
[S1]undo vlan batch 2 100 200
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.

[S2]undo gvrp
Warning: All information about the GVRP will be deleted . Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]undo port trunk allow-pass vlan 2 to 4094
[S2-GigabitEthernet0/0/24]shutdown
[S2-GigabitEthernet0/0/24]quit
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]undo port hybrid vlan 2 4
[S2-GigabitEthernet0/0/3]quit
[S2]undo vlan batch 2 100 200
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.

[S3]undo gvrp
Warning: All information about the GVRP will be deleted . Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]undo port trunk allow-pass vlan 2 to 4094
[S3-Ethernet0/0/13]port link-type hybrid
[S3-Ethernet0/0/13]quit
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]undo port trunk allow-pass vlan 2 to 4094
[S3-Ethernet0/0/1]quit
[S3]undo vlan 2

[S4]undo gvrp
Warning: All information about the GVRP will be deleted . Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S4]interface Ethernet 0/0/24
[S4-Ethernet0/0/24]undo port trunk allow-pass vlan 2 to 4094
[S4-Ethernet0/0/24]port link-type hybrid
[S4-Ethernet0/0/24]quit
[S4]interface Ethernet 0/0/1
[S4-Ethernet0/0/1]undo port trunk allow-pass vlan 2 to 4094
[S4-Ethernet0/0/1]quit
[S4]undo vlan 2
```

Step 3 **Configure an IP address for R3**

Configure an IP address in the 10.0.8.0/24 network range on R1 interface Gigabit Ethetnet 0/0/1

```
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]ip address 10.0.8.1 24
```

Step 4 **Establish two VLANs**

Create VLANs 4 and 8 on S1, configure interface Gigabit Ethernet 0/0/1 to belong to VLAN 4, and interface Gigabit Ethernet 0/0/3 to belong to VLAN 8.

```
[S1]vlan batch 4 8
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 4
[S1-GigabitEthernet0/0/1]quit
[S1]interface GigabitEthernet0/0/3
[S1-GigabitEthernet0/0/3]port link-type access
[S1-GigabitEthernet0/0/3]port default vlan 8
[S1-GigabitEthernet0/0/3]quit
```

Set interface Gigabit Ethernet 0/0/2 as a trunk link for VLANs 4 and 8.

```
[S1]interface GigabitEthernet0/0/2
[S1-GigabitEthernet0/0/2]port link-type trunk
[S1-GigabitEthernet0/0/2]port trunk allow-pass vlan 4 8
```

Step 5 **Configure VLAN routing through the sub-interface of R2**

Configure sub-interfaces GigabitEthernet0/0/1.1 and GigabitEthernet0/0/1.3, to act as the gateway of VLAN 4, and act as the gateway of VLAN 8.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface GigabitEthernet0/0/1.1
[R2-GigabitEthernet0/0/1.1]ip address 10.0.4.254 24
[R2-GigabitEthernet0/0/1.1]dot1q termination vid 4
```

```
[R2-GigabitEthernet0/0/1.1]arp broadcast enable
[R2-GigabitEthernet0/0/1.1]quit
[R2]interface GigabitEthernet0/0/1.3
[R2-GigabitEthernet0/0/1.3]ip address 10.0.8.254 24
[R2-GigabitEthernet0/0/1.3]dot1q termination vid 8
[R2-GigabitEthernet0/0/1.3]arp broadcast enable
```

Test connectivity between R1 and R3.

```
<R1>ping 10.0.8.1
  PING 10.0.8.1: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out

  --- 10.0.8.1 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

Configure a default route on R1 and R3.

```
[R1]ip route-static 0.0.0.0 0.0.0.0 10.0.4.254

[R3]ip route-static 0.0.0.0 0.0.0.0 10.0.8.254
```

Test connectivity between R1 and R3 again.

```
<R1>ping 10.0.8.1
  PING 10.0.8.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.8.1: bytes=56 Sequence=1 ttl=254 time=10 ms
    Reply from 10.0.8.1: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 10.0.8.1: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 10.0.8.1: bytes=56 Sequence=4 ttl=254 time=10 ms
    Reply from 10.0.8.1: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 10.0.8.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 1/4/10 ms
```

```
[R2]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 10      Routes : 10

Destination/Mask Proto Pre  Cost Flags  NextHop     Interface

10.0.4.0/24      Direct  0    0       D   10.0.4.254  GigabitEthernet0/0/1.1
 10.0.4.254/32   Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1.1
 10.0.4.255/32   Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1.1
 10.0.8.0/24     Direct  0    0       D   10.0.8.254  GigabitEthernet0/0/1.3
 10.0.8.254/32   Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1.3
 10.0.8.255/32   Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1.3
 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
```

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
interface GigabitEthernet0/0/1
 ip address 10.0.4.1 255.255.255.0
#
ip route-static 0.0.0.0 0.0.0.0 10.0.4.254
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return
```

```
[R2]display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
interface GigabitEthernet0/0/1
#
interface GigabitEthernet0/0/1.1
 dot1q termination vid 4
 ip address 10.0.4.254 255.255.255.0
 arp broadcast enable
#
interface GigabitEthernet0/0/1.3
 dot1q termination vid 8
 ip address 10.0.8.254 255.255.255.0
 arp broadcast enable
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


[R3]dis current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface GigabitEthernet0/0/1
 ip address 10.0.8.1 255.255.255.0
#
ip route-static 0.0.0.0 0.0.0.0 10.0.8.254
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return
```

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 4 8
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 4
#
interface GigabitEthernet0/0/2
 port link-type trunk
 port trunk allow-pass vlan 4 8
#
interface GigabitEthernet0/0/3
 port link-type access
 port default vlan 8
#
user-interface con 0
user-interface vty 0 4
#
return
```

Lab 1-5 Configuring Layer 3 Switching

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of VLAN interfaces.
- Establishment of VLAN routing on a single switch
- Perform VLAN routing over an Ethernet Trunk link.
- Perform dynamic routing between VLAN interfaces using OSPF.

Topology

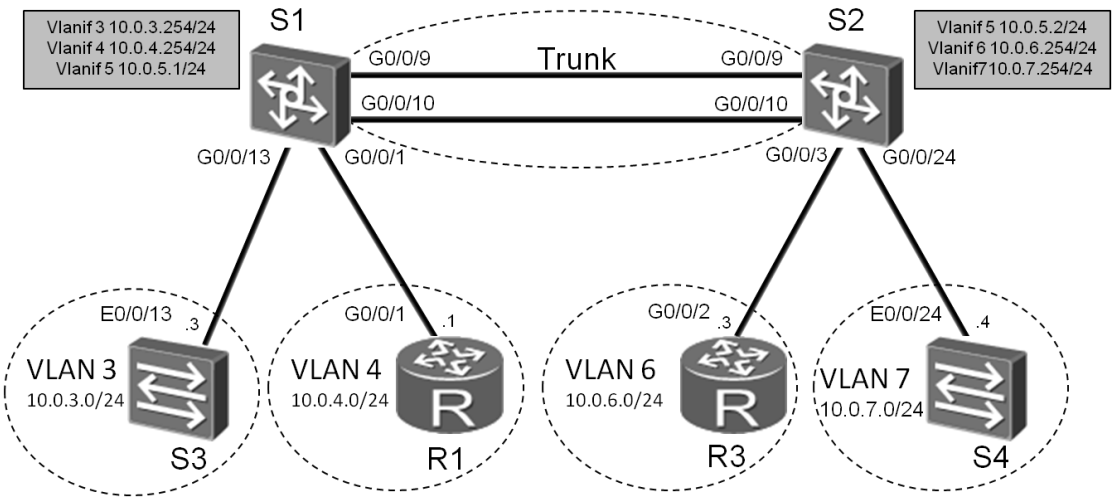


Figure 5.5 Layer 3 switching topology

Scenario

The introduction of layer three switches into the enterprise network opened up opportunities for streamlining the current VLAN routing configuration. The network administrator has been given the task to implement VLAN routing using only the layer three switches to support communication between the VLANs in the network as displayed in the topology. VLANs should be capable of inter VLAN communication. Additionally S1 and S2 are expected to communicate over a Layer 3 for which routing protocol support is required.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

Configure R1 with the address 10.0.4.1/24 on interface Gigabit Ethernet 0/0/1. Establish an Eth-Trunk beween S1 an S2. Disable any unnecessary interfaces on S1 and S2 to S3 and S4.

```
<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]ip address 10.0.4.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3

<Quidway>system-view
[Quidway]sysname S1
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]mode lacp-static
[S1-Eth-Trunk1]port link-type trunk
[S1-Eth-Trunk1]port trunk allow-pass vlan all
[S1-Eth-Trunk1]quit
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]eth-trunk 1
[S1-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]eth-trunk 1

<Quidway>system-view
[Quidway]sysname S2
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]mode lacp-static
[S2-Eth-Trunk1]port link-type trunk
[S2-Eth-Trunk1]port trunk allow-pass vlan all
[S2-Eth-Trunk1]quit
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]eth-trunk 1
```

```
[S2-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]eth-trunk 1

<Quidway>system-view
[Quidway]sysname S3
[S3]interface Ethernet 0/0/23
[S3-Ethernet0/0/23]shutdown

<Quidway>system-view
[Quidway]sysname S4
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]shutdown
```

Step 2 **Clean up the previous configuration**

Remove the VLAN routing configuration and sub-interfaces on the devices.

```
[R1]undo ip route-static 0.0.0.0 0

[R2]undo interface GigabitEthernet 0/0/1.1
[R2]undo interface GigabitEthernet 0/0/1.3

[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]undo ip address
[R3-GigabitEthernet0/0/1]quit
[R3]undo ip route-static 0.0.0.0 0

[S1]undo vlan batch 4 8
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface GigabitEthernet 0/0/2
[S1-GigabitEthernet0/0/2]undo port trunk allow-pass vlan 4 8
[S1-GigabitEthernet0/0/2]quit
[S1]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]undo shutdown

[S2]interface GigabitEthernet0/0/24
[S2-GigabitEthernet0/0/24]undo shutdown
```

Re-enable the Eth-Trunk interface between S1 and S2

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]undo shutdown

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]undo shutdown
```

Step 3 **Configure VLAN 3 through to VLAN 7 for S1 and S2.**

```
[S1]vlan batch 3 to 7
Info: This operation may take a few seconds. Please wait for a moment...done.

[S2]vlan batch 3 to 7
Info: This operation may take a few seconds. Please wait for a moment...done.
```

Verify that the VLANs have been created.

```
[S1]display vlan
The total number of vlans is : 6
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)     GE0/0/2(D)     GE0/0/3(U)     GE0/0/4(U)
             GE0/0/5(U)     GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)
             GE0/0/11(D)    GE0/0/12(D)    GE0/0/13(D)    GE0/0/14(D)
             GE0/0/15(D)    GE0/0/16(D)    GE0/0/17(D)    GE0/0/18(D)
             GE0/0/19(D)    GE0/0/20(D)    GE0/0/21(U)    GE0/0/22(U)
             GE0/0/23(U)    GE0/0/24(D)    Eth-Trunk1(U)
3    common  TG:Eth-Trunk1(U)
4    common  TG:Eth-Trunk1(U)
5    common  TG:Eth-Trunk1(U)
6    common  TG:Eth-Trunk1(U)
7    common  TG:Eth-Trunk1(U)
…output omitted…
```

```
[S2]display vlan
The total number of vlans is : 6
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)     GE0/0/2(D)     GE0/0/3(U)     GE0/0/4(U)
             GE0/0/5(U)     GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)
             GE0/0/11(U)    GE0/0/12(U)    GE0/0/13(U)    GE0/0/14(D)
             GE0/0/15(D)    GE0/0/16(D)    GE0/0/17(D)    GE0/0/18(D)
             GE0/0/19(D)    GE0/0/20(D)    GE0/0/21(D)    GE0/0/22(D)
             GE0/0/23(D)    GE0/0/24(D)    Eth-Trunk1(U)
3    common  TG:Eth-Trunk1(U)
4    common  TG:Eth-Trunk1(U)
5    common  TG:Eth-Trunk1(U)
6    common  TG:Eth-Trunk1(U)
7    common  TG:Eth-Trunk1(U)
```

Step 4 **Set the Eth-Trunk link between S1 and S2 with PVID 5.**

Add interfaces Gigabit Ethernet 0/0/1 and 0/0/13 of S1 to VLAN 4 and VLAN 3 respectively. For S2, add interfaces Gigabit Ethernet 0/0/3 and G0/0/24 to VLAN 6 and VLAN 7 respectively.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]port trunk pvid vlan 5
[S1-Eth-Trunk1]quit
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 4
[S1-GigabitEthernet0/0/1]quit
[S1]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]port link-type access
[S1-GigabitEthernet0/0/13]port default vlan 3

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]port trunk pvid vlan 5
[S2-Eth-Trunk1]quit
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]port link-type access
[S2-GigabitEthernet0/0/3]port default vlan 6
[S2-GigabitEthernet0/0/3]quit
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port link-type access
[S2-GigabitEthernet0/0/24]port default vlan 7
```

```
<S1>display vlan
The total number of vlans is : 6
…output omitted…
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:GE0/0/2(D)     GE0/0/3(U)     GE0/0/4(U)     GE0/0/5(U)
               GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)     GE0/0/11(D)
               GE0/0/12(D)    GE0/0/14(D)    GE0/0/15(D)    GE0/0/16(D)
               GE0/0/17(D)    GE0/0/18(D)    GE0/0/19(D)    GE0/0/20(D)
               GE0/0/21(U)    GE0/0/22(U)    GE0/0/23(U)    GE0/0/24(D)
             Eth-Trunk1(U)
3    common  UT:GE0/0/13(U)
             TG:Eth-Trunk1(U)
4    common  UT:GE0/0/1(U)
             TG:Eth-Trunk1(U)
5    common  TG:Eth-Trunk1(U)
6    common  TG:Eth-Trunk1(U)
7    common  TG:Eth-Trunk1(U)
…output omitted…

<S2>display vlan
The total number of vlans is : 6
…output omitted…

VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)     GE0/0/2(D)     GE0/0/4(U)     GE0/0/5(U)
               GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)     GE0/0/11(U)
               GE0/0/12(U)    GE0/0/13(U)    GE0/0/14(D)    GE0/0/15(D)
               GE0/0/16(D)    GE0/0/17(D)    GE0/0/18(D)    GE0/0/19(D)
               GE0/0/20(D)    GE0/0/21(D)    GE0/0/22(D)    GE0/0/23(D)
               Eth-Trunk1(U)
3    common  TG:Eth-Trunk1(U)
4    common  TG:Eth-Trunk1(U)
5    common  TG:Eth-Trunk1(U)
6    common  UT:GE0/0/3(U)
             TG:Eth-Trunk1(U)
7    common  UT:GE0/0/24(U)
             TG:Eth-Trunk1(U)
```

Step 5 **Configure gateway addresses for VLANs on S1 and S2.**

Configure IP addresses for Vlanif3, Vlanif4, and Vlanif5 on S1, and for Vlanif5, Vlanif6, and Vlanif7 on S2.

```
[S1]interface Vlanif 3
[S1-Vlanif3]ip address 10.0.3.254 24
[S1-Vlanif3]interface Vlanif 4
[S1-Vlanif4]ip address 10.0.4.254 24
[S1-Vlanif4]interface Vlanif 5
[S1-Vlanif5]ip address 10.0.5.1 24

[S2]interface Vlanif 5
[S2-Vlanif5]ip address 10.0.5.2 24
[S2-Vlanif5]interface Vlanif 6
[S2-Vlanif6]ip address 10.0.6.254 24
[S2-Vlanif6]interface Vlanif 7
[S2-Vlanif7]ip address 10.0.7.254 24
```

Step 6 **IP addressing and default routes for R1, R3, S3 and S4.**

IP addresses on a switch much be assigned to a Vlanif, where Vlanif1 is a common (untagged) Vlanif. Interfaces Ethernet 0/0/13 of S3 and Ethernet 0/0/24 of S4 should be associated with the common VLAN1. R1 should already be configured with the address 10.0.4.1/24.

```
[R1]ip route-static 0.0.0.0 0.0.0.0 10.0.4.254

[S3]interface Vlanif 1
[S3-Vlanif1]ip address 10.0.3.3 24
[S3-Vlanif1]quit
[S3]ip route-static 0.0.0.0 0.0.0.0 10.0.3.254

[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.6.3 24
[R3-GigabitEthernet0/0/2]quit
[R3]ip route-static 0.0.0.0 0.0.0.0 10.0.6.254

[S4]interface Vlanif 1
[S4-Vlanif1]ip address 10.0.7.4 24
[S4-Vlanif1]quit
[S4]ip route-static 0.0.0.0 0.0.0.0 10.0.7.254
```

Step 7 **Test connectivity between VLAN 3 and VLAN 4.**

Test connectivity between S3 and R1.

```
<R1>ping 10.0.3.3
  PING 10.0.3.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.3.3: bytes=56 Sequence=1 ttl=254 time=37 ms
    Reply from 10.0.3.3: bytes=56 Sequence=2 ttl=253 time=2 ms
    Reply from 10.0.3.3: bytes=56 Sequence=3 ttl=253 time=10 ms
    Reply from 10.0.3.3: bytes=56 Sequence=4 ttl=253 time=3 ms
    Reply from 10.0.3.3: bytes=56 Sequence=5 ttl=253 time=2 ms

  --- 10.0.3.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/10/37 ms
```

Test connectivity between R3 and R1.

```
<R1>ping 10.0.6.3
  PING 10.0.6.3: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out

  --- 10.0.6.3 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

The connectivity between R1 and R3 fails. Use the **tracert** command to troubleshoot the fault:

```
[R1]tracert 10.0.6.3
    traceroute to 10.0.6.3(10.0.6.3), max hops: 30 ,packet length: 40,press CTRL_C
    to break
 1 10.0.4.254 17 ms  4 ms  4 ms
 2  *  *  *
```

According to the command output, R1 has sent data packets to the destination address 10.0.6.3, but the gateway at 10.0.4.254 responds that the network is unreachable.

Check whether the network is unreachable on the gateway (S1).

```
[S1]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
       Destinations : 8       Routes : 8

    Destination/Mask    Proto  Pre  Cost      Flags NextHop     Interface

    10.0.3.0/24         Direct  0    0           D   10.0.3.254  Vlanif3
    10.0.3.254/32       Direct  0    0           D   127.0.0.1   InLoopBack0
    10.0.4.0/24         Direct  0    0           D   10.0.4.254  Vlanif4
    10.0.4.254/32       Direct  0    0           D   127.0.0.1   InLoopBack0
    10.0.5.0/24         Direct  0    0           D   10.0.5.1    Vlanif5
    10.0.5.1/32         Direct  0    0           D   127.0.0.1   InLoopBack0
    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
```

According to the command output, S1 does not have a route to the network segment 10.0.6.0 because the network segment is not directly connected to S1. In addition, no static route or dynamic routing protocol has been configured to advertise the routes.

Step 8 **Enable OSPF on S1 and S2.**

```
[S1]ospf
[S1-ospf-1]area 0
[S1-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255

[S2]ospf
[S2-ospf-1]area 0
[S2-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

After the configuration, wait until S1 and S2 exchange OSPF routes and complete the link state database, then view the resulting routing table of S1.

```
[S1]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
       Destinations : 10      Routes : 10

Destination/Mask    Proto  Pre  Cost      Flags NextHop         Interface

    10.0.3.0/24     Direct 0    0           D   10.0.3.254      Vlanif3
    10.0.3.254/32   Direct 0    0           D   127.0.0.1       InLoopBack0
    10.0.4.0/24     Direct 0    0           D   10.0.4.254      Vlanif4
    10.0.4.254/32   Direct 0    0           D   127.0.0.1       InLoopBack0
    10.0.5.0/24     Direct 0    0           D   10.0.5.1        Vlanif5
    10.0.5.1/32     Direct 0    0           D   127.0.0.1       InLoopBack0
    10.0.6.0/24     OSPF   10   2           D   10.0.5.2        Vlanif5
    10.0.7.0/24     OSPF   10   2           D   10.0.5.2        Vlanif5
    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
```

S1 has learned two routes using OSPF. Test connectivity between R1 and R3.

```
[R1]ping 10.0.6.3
  PING 10.0.6.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.6.3: bytes=56 Sequence=1 ttl=253 time=11 ms
    Reply from 10.0.6.3: bytes=56 Sequence=2 ttl=253 time=1 ms
    Reply from 10.0.6.3: bytes=56 Sequence=3 ttl=253 time=10 ms
    Reply from 10.0.6.3: bytes=56 Sequence=4 ttl=253 time=1 ms
    Reply from 10.0.6.3: bytes=56 Sequence=5 ttl=253 time=1 ms

  --- 10.0.6.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 1/4/11 ms
```

```
[R1]ping 10.0.7.4
  PING 10.0.7.4: 56  data bytes, press CTRL_C to break
    Reply from 10.0.7.4: bytes=56 Sequence=1 ttl=253 time=30 ms
    Reply from 10.0.7.4: bytes=56 Sequence=2 ttl=252 time=2 ms
    Reply from 10.0.7.4: bytes=56 Sequence=3 ttl=252 time=3 ms
    Reply from 10.0.7.4: bytes=56 Sequence=4 ttl=252 time=2 ms
    Reply from 10.0.7.4: bytes=56 Sequence=5 ttl=252 time=2 ms

  --- 10.0.7.4 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/7/30 ms
```

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
interface GigabitEthernet0/0/1
 ip address 10.0.4.1 255.255.255.0
#
ip route-static 0.0.0.0 0.0.0.0 10.0.4.254
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return


[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 3 to 7
#
```

```
interface Vlanif3
 ip address 10.0.3.254 255.255.255.0
#
interface Vlanif4
 ip address 10.0.4.254 255.255.255.0
#
interface Vlanif5
 ip address 10.0.5.1 255.255.255.0
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 4
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 lacp priority 100
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/13
 port link-type access
 port default vlan 3
#
ospf 1
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
user-interface vty 0 4
#
return
```

```
[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 3 to 7
#
interface Vlanif5
 ip address 10.0.5.2 255.255.255.0
#
interface Vlanif6
 ip address 10.0.6.254 255.255.255.0
#
interface Vlanif7
 ip address 10.0.7.254 255.255.255.0
#
interface Eth-Trunk1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 mode lacp-static
#
interface GigabitEthernet0/0/3
 port link-type access
 port default vlan 6
#
interface GigabitEthernet0/0/9
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 undo negotiation auto
 speed 100
#
interface GigabitEthernet0/0/24
 port link-type access
 port default vlan 7
#
ospf 1
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
```

```
#
user-interface con 0
user-interface vty 0 4
#
return

[S3]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
interface Vlanif1
 ip address 10.0.3.3 255.255.255.0
#
interface Ethernet0/0/23
 shutdown
#
 ip route-static 0.0.0.0 0.0.0.0 10.0.3.254
#
user-interface con 0
user-interface vty 0 4
#
return


[S4]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
 undo http server enable
#
 drop illegal-mac alarm
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password simple admin
 local-user admin service-type http
#
```

```
interface Vlanif1
 ip address 10.0.7.4 255.255.255.0
#
interface Ethernet0/0/14
 shutdown
#
 ip route-static 0.0.0.0 0.0.0.0 10.0.7.254
#
user-interface con 0
user-interface vty 0 4
#
return
```

Module 2 Enterprise WAN Configuration

Lab 2-1 HDLC and PPP Configuration

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Establish HDLC encapsulation as the serial link layer protocol.
- Change the DCE clock baud rate on a serial link.
- Establish PPP encapsulation as the serial link layer protocol.
- Implementation of PAP authentication on the PPP link.
- Implementation of CHAP authentication on the PPP link.

Topology

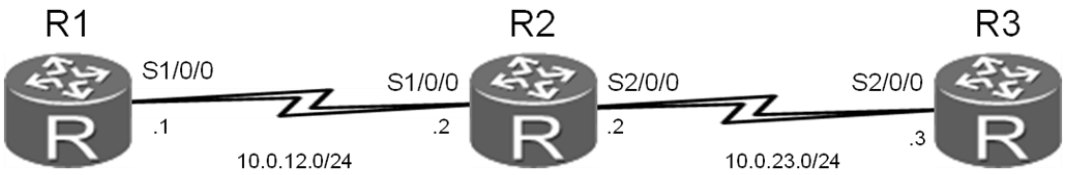


Figure 2.1 HDLC and PPP configuration topology

Scenario

As an expanding enterprise business, multiple branch offices have been established and are to be part of the company's administrative domain. WAN solutions are required and as the network administrator the company you have been tasked with establishing HDLC and PPP solutions at the edge router to be carried over some service provider network, possibly MPLS, however the details of this have not been revealed to you since the service provider network remains outside of the scope of your task. R2 is an edge router located in the HQ, and R1 and R3 are located in branch offices. The HQ and branches need to be established as a single administrative domain. Use HDLC and PPP on the WAN links, and establish authentication as a simple security measure.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1

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

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
```

Step 2 Clean up the previous configuration

Remove the static routes to R2 and disable the Ethernet interfaces to avoid creating alternative routes. Remove any unnecessary VLAN configuration.

```
[R1]undo ip route-static 0.0.0.0 0
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]shutdown

[R3]undo ip route-static 0.0.0.0 0
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]shutdown

[S1]undo interface Vlanif 3
[S1]undo interface Vlanif 5
[S1]undo vlan batch 3 5 to 7
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]undo port default vlan
[S1-GigabitEthernet0/0/1]quit
[S1]undo ospf 1
```

```
[S2]undo interface Vlanif 5
[S2]undo interface Vlanif 7
[S2]undo vlan batch 3 to 5 7
Warning: The configurations of the VLAN will be deleted. Continue?[Y/N]:y
Info: This operation may take a few seconds. Please wait for a moment...done.
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]undo port default vlan
[S2-GigabitEthernet0/0/3]quit
[S2]undo ospf 1

[S3]undo interface Vlanif 1

[S4]undo interface Vlanif 1
```

Step 3 **Configure serial interface IP addressing for R1, R2 & R3**

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ip address 10.0.12.1 24

[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ip address 10.0.12.2 24
[R2-Serial1/0/0]quit
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]ip address 10.0.23.2 24

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]ip address 10.0.23.3 24
```

Step 4 **Enable the HDLC protocol on the serial interfaces.**

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]link-protocol hdlc
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y

[R2]interface Serial 1/0/0
[R2-Serial1/0/0]link-protocol hdlc
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R2-Serial1/0/0]quit
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]link-protocol hdlc
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
```

```
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]link-protocol hdlc
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
```

After HDLC is enabled on the serial interfaces, view the serial interface status. The displayed information for R1 should be used as an example.

```
[R1]display interface Serial1/0/0
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-10 11:25:08
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.12.1/24
Link layer protocol is nonstandard HDLC
Last physical up time   : 2013-12-10 11:23:55
Last physical down time : 2013-12-10 11:23:55
Current system time: 2013-12-10 11:25:46
Physical layer is synchronous, Baudrate is 64000 bps
Interface is DCE, Cable type is V24, Clock mode is DCECLK
Last 300 seconds input rate 3 bytes/sec 24 bits/sec 0 packets/sec
Last 300 seconds output rate 3 bytes/sec 24 bits/sec 0 packets/sec

Input: 100418 packets, 1606804 bytes
  Broadcast:            0,  Multicast:              0
  Errors:               0,  Runts:                  0
  Giants:               0,  CRC:                    0

  Alignments:           0,  Overruns:               0
  Dribbles:             0,  Aborts:                 0
  No Buffers:           0,  Frame Error:            0

Output: 100418 packets, 1606830 bytes
  Total Error:          0,  Overruns:               0
  Collisions:           0,  Deferred:               0
  No Buffers:           0
DCD=UP DTR=UP DSR=UP RTS=UP CTS=UP
    Input bandwidth utilization  : 0.06%
    Output bandwidth utilization : 0.06%
```

Test connectivity of the directly connected link after verifying that the physical status and protocol status of the interface are Up.

```
<R2>ping 10.0.12.1
 PING 10.0.12.1: 56  data bytes, press CTRL_C to break
   Reply from 10.0.12.1: bytes=56 Sequence=1 ttl=255 time=44 ms
   Reply from 10.0.12.1: bytes=56 Sequence=2 ttl=255 time=39 ms
   Reply from 10.0.12.1: bytes=56 Sequence=3 ttl=255 time=39 ms
   Reply from 10.0.12.1: bytes=56 Sequence=4 ttl=255 time=40 ms
   Reply from 10.0.12.1: bytes=56 Sequence=5 ttl=255 time=39 ms

 --- 10.0.12.1 ping statistics ---
   5 packet(s) transmitted
   5 packet(s) received
   0.00% packet loss
   round-trip min/avg/max = 39/40/44 ms

[R2]ping 10.0.23.3
 PING 10.0.23.3: 56  data bytes, press CTRL_C to break
   Reply from 10.0.23.3: bytes=56 Sequence=1 ttl=255 time=44 ms
   Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=255 time=39 ms
   Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=255 time=39 ms
   Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=255 time=40 ms
   Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=255 time=39 ms

 --- 10.0.23.3 ping statistics ---
   5 packet(s) transmitted
   5 packet(s) received
   0.00% packet loss
   round-trip min/avg/max = 39/40/44 ms
```

Step 5 **Configure RIPv2.**

Enable the RIP routing protocol to advertise the remote networks of R1 & R3

```
[R1]rip
[R1-rip-1]version 2
[R1-rip-1]network 10.0.0.0

[R2]rip
[R2-rip-1]version 2
[R2-rip-1]network 10.0.0.0
```

```
[R3]rip
[R3-rip-1]version 2
[R3-rip-1]network 10.0.0.0
```

After the configuration is complete, check that all the routes have been learned. Verify that corresponding routes are learned by RIP.

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 8        Routes : 8

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.12.0/24    Direct  0    0           D   10.0.12.1       Serial1/0/0
    10.0.12.1/32    Direct  0    0           D   127.0.0.1       Serial1/0/0
    10.0.12.255/32  Direct  0    0           D   127.0.0.1       Serial1/0/0
    10.0.23.0/24    RIP     100  1           D   10.0.12.2       Serial1/0/0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

On R1, run the **ping** command to test connectivity between R1 and R3.

```
<R1>ping 10.0.23.3
  PING 10.0.23.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.23.3: bytes=56 Sequence=1 ttl=254 time=44 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=254 time=39 ms
    Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=254 time=39 ms
    Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=254 time=40 ms
    Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=254 time=39 ms

  --- 10.0.23.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 39/40/44 ms
```

Step 6 **Manage the serial connection**

View the type of the cable connected to the serial interface, interface status, and clock frequency, and change the clock frequency.

```
<R1>display interface Serial1/0/0
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-10 11:25:08
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.12.1/24
Link layer protocol is nonstandard HDLC
Last physical up time   : 2013-12-10 11:23:55
Last physical down time : 2013-12-10 11:23:55
Current system time: 2013-12-10 11:51:12
Physical layer is synchronous, Baudrate is 64000 bps
Interface is DCE, Cable type is V24, Clock mode is DCECLK
Last 300 seconds input rate 6 bytes/sec 48 bits/sec 0 packets/sec
Last 300 seconds output rate 4 bytes/sec 32 bits/sec 0 packets/sec
…output omitted…
```

The preceding information shows that S1/0/0 on R1 connects to a DCE cable and the clock frequency is 64000 bit/s. The DCE controls the clock frequency and bandwidth.

Change the clock frequency on the link between R1 and R2 to 128000 bit/s. This operation must be performed on the DCE, R1.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]baudrate 128000
```

After the configuration is complete, view the serial interface status.

```
<R1>display interface Serial1/0/0
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-10 11:25:08
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.12.1/24
Link layer protocol is nonstandard HDLC
Last physical up time   : 2013-12-10 11:23:55
Last physical down time : 2013-12-10 11:23:55
```

```
Current system time: 2013-12-10 11:54:19
Physical layer is synchronous, Baudrate is 128000 bps
Interface is DCE, Cable type is V24, Clock mode is DCECLK
Last 300 seconds input rate 6 bytes/sec 48 bits/sec 0 packets/sec
Last 300 seconds output rate 4 bytes/sec 32 bits/sec 0 packets/sec
…output omitted…
```

Step 7 **Configure PPP on the serial interfaces.**

Configure PPP between R1 and R2, as well as R2 and R3. Both ends of the link must use the same encapsulation mode. If different encapsulation modes are used, interfaces may display as 'Down'.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]link-protocol ppp
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y

[R2]interface Serial 1/0/0
[R2-Serial1/0/0]link-protocol ppp
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y

[R2-Serial1/0/0]quit
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]link-protocol ppp
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]link-protocol ppp
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
```

After the configuration is complete, test link connectivity.

```
<R2>ping 10.0.12.1
  PING 10.0.12.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.12.1: bytes=56 Sequence=1 ttl=255 time=22 ms
    Reply from 10.0.12.1: bytes=56 Sequence=2 ttl=255 time=27 ms
    Reply from 10.0.12.1: bytes=56 Sequence=3 ttl=255 time=27 ms
    Reply from 10.0.12.1: bytes=56 Sequence=4 ttl=255 time=27 ms
    Reply from 10.0.12.1: bytes=56 Sequence=5 ttl=255 time=27 ms

  --- 10.0.12.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 22/26/27 ms
```

```
<R2>ping 10.0.23.3
  PING 10.0.23.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.23.3: bytes=56 Sequence=1 ttl=255 time=35 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=255 time=40 ms
    Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=255 time=40 ms
    Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=255 time=40 ms
    Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=255 time=40 ms

  --- 10.0.23.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 35/39/40 ms
```

If the **ping** operation fails, check the interface status and whether the link layer protocol type is correct.

```
<R1>display interface Serial1/0/0
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-10 12:35:41
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.12.1/24
Link layer protocol is PPP
LCP opened, IPCP opened
Last physical up time   : 2013-12-10 11:57:20
Last physical down time : 2013-12-10 11:57:19
Current system time: 2013-12-10 13:38:03
Physical layer is synchronous, Baudrate is 128000 bps
Interface is DCE, Cable type is V24, Clock mode is DCECLK
Last 300 seconds input rate 7 bytes/sec 56 bits/sec 0 packets/sec
Last 300 seconds output rate 4 bytes/sec 32 bits/sec 0 packets/sec
…output omitted…
```

Step 8 **Check routing entry changes.**

After PPP configuration is complete, routers establish connections at the data link layer. The local device sends a route to the peer device. The route contains the interface IP address and a 32-bit mask.

The following information uses R2 as an example, for which the routes to R1 and R3 can be seen.

```
[R2]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 12        Routes : 12

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.12.0/24  Direct  0    0           D   10.0.12.2       Serial1/0/0
        10.0.12.1/32  Direct  0    0           D   10.0.12.1       Serial1/0/0
        10.0.12.2/32  Direct  0    0           D   127.0.0.1       Serial1/0/0
        10.0.12.255/32  Direct  0    0           D   127.0.0.1       Serial1/0/0
        10.0.23.0/24  Direct  0    0           D   10.0.23.2       Serial2/0/0
        10.0.23.2/32  Direct  0    0           D   127.0.0.1       Serial2/0/0
        10.0.23.3/32  Direct  0    0           D   10.0.23.3       Serial2/0/0
        10.0.23.255/32  Direct  0    0           D   127.0.0.1       Serial2/0/0
        127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
        127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

Think about the origin and functions of the two routes. Check the following items:

If HDLC encapsulation is used, do these two routes exist?

Can R1 and R2 communicate using HDLC or PPP when the IP addresses of S1/0/0 interfaces on R1 and R2 are located on different network segments?

Step 9 **Enable PAP authentication between R1 and R2.**

Configure PAP authentication with R1 as the PPP PAP authenticator.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ppp authentication-mode pap
[R1-Serial1/0/0]quit
[R1]aaa
[R1-aaa]local-user huawei password cipher huawei

 info: A new user added
[R1-aaa]local-user huawei service-type ppp
```

Configure PAP authentication with R2 acting as the PAP authenticated device.

```
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ppp pap local-user huawei password cipher huawei
```

After R2 sends an authentication request to R1, R1 sends a response message to R2, requesting R2 to use PAP authentication following which R2 will send its password to R1.

After the configuration is complete, test connectivity between R1 and R2.

```
<R1>debugging ppp pap packet
<R1>terminal debugging
<R1>display debugging
PPP PAP packets debugging switch is on
<R1>system-view
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]shutdown
[R1-Serial1/0/0]undo shutdown

Dec 10 2013 14:44:22.440.1+00:00 R1 PPP/7/debug2:
  PPP Packet:
      Serial1/0/0 Input  PAP(c023) Pkt, Len 22
      State ServerListen, code Request(01), id 1, len 18
      Host Len:  6  Name:huawei
[R1-Serial1/0/0]
Dec 10 2013 14:44:22.440.2+00:00 R1 PPP/7/debug2:
  PPP Packet:
      Serial1/0/0 Output PAP(c023) Pkt, Len 52
      State WaitAAA, code Ack(02), id 1, len 48
      Msg Len: 43  Msg:Welcome to use Quidway ROUTER, Huawei Tech.

[R1-Serial1/0/0]return
<R1>undo debugging all
Info: All possible debugging has been turned off
```

Step 10 **Enable CHAP authentication between R2 and R3.**

Configure R3 as the authenticator. After R2 sends an authentication request to R3, R3 sends a response message to R2, requesting R2 to use CHAP authentication following which a challenge is sent to R3.

```
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]ppp authentication-mode chap
[R3-Serial2/0/0]quit
[R3]aaa
[R3-aaa]local-user huawei password cipher huawei
 info: A new user added
[R3-aaa]local-user huawei service-type ppp
[R3-aaa]quit
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]shutdown
[R3-Serial2/0/0]undo shutdown
```

On R3, the following information is displayed.

```
Dec 10 2013 15:06:00+00:00 R3 %%01PPP/4/PEERNOCHAP(l)[5]:On the interface
Serial2/0/0, authentication failed and PPP link was closed because CHAP was
disabled on the peer.
[R3-Serial2/0/0]
Dec 10 2013 15:06:00+00:00 R3 %%01PPP/4/RESULTERR(l)[6]:On the interface
Serial2/0/0, LCP negotiation failed because the result cannot be accepted.
```

The highlighted output indicates that authentication is unable to initialize.

Configure R2 as the CHAP client.

```
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]ppp chap user huawei
[R2-Serial2/0/0]ppp chap password cipher huawei
```

After the configuration is complete, the interface changes to an Up state. The ping command output is as follows:

```
<R2>ping 10.0.23.3
  PING 10.0.23.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.23.3: bytes=56 Sequence=1 ttl=255 time=35 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=255 time=41 ms
    Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=255 time=41 ms
    Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=255 time=41 ms
    Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=255 time=41 ms

  --- 10.0.23.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 35/39/41 ms
```

Step 11 **PPP CHAP debugging**

Run the debug command to view negotiation of the PPP connection between R2 and R3. The PPP connection is established using CHAP. Disable interface Serial 2/0/0 on R2, run the debug command, and enable Serial 2/0/0 on R2.

```
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]shutdown
```

Run the **debugging ppp chap all** and the **terminal debugging** commands to display the debugging information.

```
[R2-Serial2/0/0]return
<R2>debugging ppp chap all
<R2>terminal debugging
Info: Current terminal debugging is on.
<R2>display debugging
PPP CHAP packets debugging switch is on
PPP CHAP events debugging switch is on
PPP CHAP errors debugging switch is on
PPP CHAP state change debugging switch is on
```

Force CHAP authentication to initialize on S2/0/0 of R2.

```
<R2>system-view
Enter system view, return user view with Ctrl+Z.
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]undo shutdown
```

The following debugging information is displayed:

```
Dec 10 2013 09:10:38.700.1+00:00 R2 PPP/7/debug2:
  PPP State Change:
     Serial2/0/0 CHAP : Initial --> ListenChallenge
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.710.1+00:00 R2 PPP/7/debug2:
  PPP Packet:
     Serial2/0/0 Input  CHAP(c223) Pkt, Len 25
     State ListenChallenge, code Challenge(01), id 1, len 21
     Value_Size:  16  Value: fc 9b 56 e1 53 e3 a6 26 1b 54 e5 e2 a1 ed 90 87
     Name:
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.710.2+00:00 R2 PPP/7/debug2:
  PPP Event:
```

```
     Serial2/0/0 CHAP Receive Challenge Event
     state ListenChallenge
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.710.3+00:00 R2 PPP/7/debug2:
  PPP Packet:
     Serial2/0/0 Output CHAP(c223) Pkt, Len 31
     State ListenChallenge, code Response(02), id 1, len 27
     Value_Size:  16  Value: f9 54  1 69 30 59 a0 af 52 a1 1d de 85 77 27 6b
     Name: huawei
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.710.4+00:00 R2 PPP/7/debug2:
  PPP State Change:
     Serial2/0/0 CHAP : ListenChallenge --> SendResponse
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.720.1+00:00 R2 PPP/7/debug2:
  PPP Packet:
     Serial2/0/0 Input  CHAP(c223) Pkt, Len 20
     State SendResponse, code SUCCESS(03), id 1, len 16
     Message: Welcome to .
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.720.2+00:00 R2 PPP/7/debug2:
  PPP Event:
     Serial2/0/0 CHAP Receive Success Event
     state SendResponse
[R2-Serial2/0/0]
Dec 10 2013 09:10:38.720.3+00:00 R2 PPP/7/debug2:
  PPP State Change:
     Serial2/0/0 CHAP : SendResponse --> ClientSuccess
```

The highlighted debugging information shows the key CHAP behavior. Disable the debugging process.

```
[R2-Serial2/0/0]return
<R2>undo debugging all
Info: All possible debugging has been turned off
```

Additional Exercises: Analyzing and Verifying

Why is the PPP Challenge Handshake Authentication Protocol (CHAP) more secure than the PPP Password Authentication Protocol (PAP)?

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$B:%I)Io0H8)[%SB[idM3C/!#%$%$
 local-user huawei service-type ppp
#
interface Serial1/0/0
 link-protocol ppp
 ppp authentication-mode pap
 ip address 10.0.12.1 255.255.255.0
 baudrate 128000
#
rip 1
 version 2
 network 10.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return


[R2]display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
```

```
interface Serial1/0/0
 link-protocol ppp
 ppp pap local-user huawei password cipher %$%$u[hr6d<JVHR@->T7xr1<$.iv%$%$
 ip address 10.0.12.2 255.255.255.0
#
interface Serial2/0/0
 link-protocol ppp
 ppp chap user huawei
 ppp chap password cipher %$%$e{5h)gh"/Uz0mUC%vEx3$4<m%$%$
 ip address 10.0.23.2 255.255.255.0
#
rip 1
 version 2
 network 10.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


[R3]display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$fZsyUk1=O=>:L4'ytgR~D*Im%$%$
 local-user huawei service-type ppp
#
interface Serial2/0/0
 link-protocol ppp
 ppp authentication-mode chap
```

```
 ip address 10.0.23.3 255.255.255.0
#
rip 1
 version 2
 network 10.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return
```

Lab 2-2 Configuring Frame Relay at the Customer Edge

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of frame relay interfaces on the customer edge.
- Establishment of RIP in a hub and spoke network.
- Establishment of OSPF in a hub and spoke (NBMA) network.
- Configuration of frame relay interfaces when using the OSPF point-to-multipoint network type.

Topology

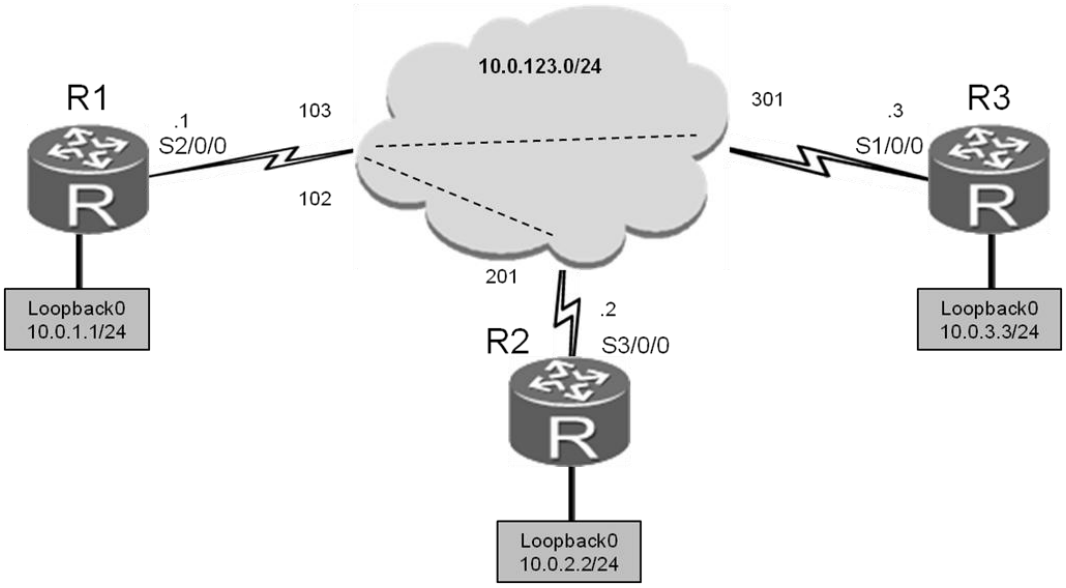


Figure 2.2 Lab topology for frame relay configuration

Scenario

The enterprise network has existing frame relay virtual circuits between the HQ and some branch offices. A recent change in equipment requires that these frame relay VC be re-established. The virtual circuits had been provided by the service provider at the time the service was first implemented and it is the task of the administrator to implement the frame relay configuration on the edge routers for the HQ and branch offices. The administrator must configure frame relay on the WAN links and perform mapping between the local DLCI and IP addresses.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1

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

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
```

Step 2 Clean up the previous configuration.

Disable the serial interfaces used for establishing the HDLC & PPP networks.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]shutdown

[R2]interface Serial 1/0/0
[R2-Serial1/0/0]shutdown
[R2-Serial1/0/0]interface Serial 2/0/0
[R2-Serial2/0/0]shutdown

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]shutdown
```

Step 3 Establish frame relay encapsulation.

Set basic parameters, including IP addresses. Manually define the mapping between the peer and DLCI. The inverse ARP function should be disabled. Ensure that the broadcast parameter is used in the fr map command to allow the network on the loopback interface to be advertised using RIP.

```
[R1]interface Serial 2/0/0
[R1-Serial2/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R1-Serial2/0/0]ip address 10.0.123.1 24
[R1-Serial2/0/0]undo fr inarp
[R1-Serial2/0/0]fr map ip 10.0.123.2 102 broadcast
[R1-Serial2/0/0]fr map ip 10.0.123.3 103 broadcast
[R1-Serial2/0/0]interface loopback 0
[R1-LoopBack0]ip address 10.0.1.1 24

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R2-Serial3/0/0]ip address 10.0.123.2 24
[R2-Serial3/0/0]undo fr inarp
[R2-Serial3/0/0]fr map ip 10.0.123.1 201 broadcast
[R2-Serial3/0/0]interface loopback 0
[R2-LoopBack0]ip address 10.0.2.2 24

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R3-Serial1/0/0]ip address 10.0.123.3 24
[R3-Serial1/0/0]undo fr inarp
[R3-Serial1/0/0]fr map ip 10.0.123.1 301 broadcast
[R3-Serial1/0/0]interface loopback 0
[R3-LoopBack0]ip address 10.0.3.3 24
```

After the IP addresses are configured, test network connectivity.

```
<R1>ping 10.0.123.2
  PING 10.0.123.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.123.2: bytes=56 Sequence=1 ttl=255 time=64 ms
    Reply from 10.0.123.2: bytes=56 Sequence=2 ttl=255 time=59 ms
    Reply from 10.0.123.2: bytes=56 Sequence=3 ttl=255 time=59 ms
    Reply from 10.0.123.2: bytes=56 Sequence=4 ttl=255 time=59 ms
    Reply from 10.0.123.2: bytes=56 Sequence=5 ttl=255 time=59 ms

  --- 10.0.123.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 59/60/64 ms
```

```
<R1>ping 10.0.123.3
  PING 10.0.123.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.123.3: bytes=56 Sequence=1 ttl=255 time=64 ms
    Reply from 10.0.123.3: bytes=56 Sequence=2 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=3 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=4 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=5 ttl=255 time=59 ms

  --- 10.0.123.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 59/60/64 ms
```

Run the following commands to view the FR encapsulation information for the R1 interfaces.

```
<R1>display fr interface Serial 2/0/0
Serial2/0/0, DTE, physical up, protocol up

<R1>display fr lmi-info interface Serial 2/0/0
Frame relay LMI statistics for interface Serial2/0/0 (DTE, Q933)
  T391DTE = 10 (hold timer 10)
  N391DTE = 6, N392DTE = 3, N393DTE = 4
  out status enquiry = 180, in status = 178
  status timeout = 0, discarded messages = 0

<R1>display fr map-info interface Serial 2/0/0
Map Statistics for interface Serial2/0/0 (DTE)
  DLCI = 102, IP 10.0.123.2, Serial2/0/0
    create time = 2011/11/16 09:28:49, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 103, IP 10.0.123.3, Serial2/0/0
    create time = 2011/11/16 09:28:56, status = ACTIVE
    encapsulation = ietf, vlink = 2, broadcast
```

Step 4 **Configure RIPv2 between R1, R2, and R3.**

Configure RIPv2 on R1, R2 and R3. If you are continuing from the previous HDLC/PPP lab, the RIP routes for network 10.0.0.0 may have already been configured, however the automatic summary must still be disabled to uniquely identify the routes of the peers.

In addition, split horizon is disabled by default on frame relay networks, and so It is not necessary for the split horizon parameters to be modified in this exercise.

```
[R1]rip 1
[R1-rip-1]version 2
[R1-rip-1]network 10.0.0.0
[R1-rip-1]undo summary

[R2]rip 1
[R2-rip-1]version 2
[R2-rip-1]network 10.0.0.0
[R2-rip-1]undo summary

[R3]rip 1
[R3-rip-1]version 2
[R3-rip-1]network 10.0.0.0
[R3-rip-1]undo summary
```

View the routing tables on R1, R2, and R3 to check the learned routes.

```
<R1>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
        Destinations : 2        Routes : 2

RIP routing table status : <Active>
        Destinations : 2        Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.2.0/24  RIP    100  1           D   10.0.123.2      Serial2/0/0
      10.0.3.0/24  RIP    100  1           D   10.0.123.3      Serial2/0/0

RIP routing table status : <Inactive>
        Destinations : 0        Routes : 0
```

```
<R2>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
       Destinations : 2        Routes : 2

RIP routing table status : <Active>
       Destinations : 2        Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.0/24  RIP    100  1         D   10.0.123.1      Serial3/0/0
      10.0.3.0/24  RIP    100  2         D   10.0.123.1      Serial3/0/0

RIP routing table status : <Inactive>
       Destinations : 0        Routes : 0

[R3]display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
       Destinations : 2        Routes : 2

RIP routing table status : <Active>
       Destinations : 2        Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.0/24  RIP    100  1         D   10.0.123.1      Serial1/0/0
      10.0.2.0/24  RIP    100  2         D   10.0.123.1      Serial1/0/0

RIP routing table status : <Inactive>
       Destinations : 0        Routes : 0
```

Verify that the 10.0.3.0 network of R3 is capable of reaching the 10.0.1.0 network of R1.

```
[R3]ping -a 10.0.3.3 10.0.1.1
  PING 10.0.1.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.1: bytes=56 Sequence=1 ttl=255 time=68 ms
    Reply from 10.0.1.1: bytes=56 Sequence=2 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=3 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=4 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=5 ttl=255 time=63 ms

  --- 10.0.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 63/64/68 ms
```

Perform the same test to network 10.0.2.2 of R2 from network 10.0.3.3 of R3.

```
<R3>ping -a 10.0.3.3 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=110 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=101 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 101/102/110 ms
```

The RIP routing protocol has enabled a route between the loopback interfaces of R2 and R3 to be established via R1.

Attempt the same procedure to network 10.0.2.2 of R2 from the S2/0/0 (10.0.123.3) interface of R3.

```
[R3]ping 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

The preceding test results indicate that R3 is unable to communicate with R2 (and vice versa) when the serial interface is the source. Check the routes to find out why R3 and R2 are disconnected. The procedure for diagnosing this fault is as follows:

View the R3 routing table and check whether any route is destined for the IP address 10.0.2.2.

If there is such a route, find out the next hop IP address of this route. Then check whether R3 can reach the next hop and whether there is mapping between the layer-3 IP addresses and layer-2 PVCs.

If R3 can reach the next hop and there is mapping between Layer-3 IP addresses and Layer-2 PVCs, check the devices on the route to determine whether there is any route that can reach IP address 10.0.2.2, whether the next hop of this route is reachable, and whether there is mapping between Layer-3 IP addresses and Layer-2 PVCs.

If there is a route that can reach IP address 10.0.2.2 and there is mapping between Layer-3 IP addresses and Layer-2 PVCs, check R2 to determine whether there is any route that reaches the destination IP address of the response packets and whether the next hop of this route is reachable.

If the next hop of this route is unreachable and the destination IP address of the response packets is 10.0.123.3, R2 has the route that reaches this address but there is no mapping between Layer-3 IP addresses and Layer-2 PVCs.

The following is the output of the commands used in the preceding fault diagnosis procedure.

```
<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 13        Routes : 13

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     RIP     100  1           D   10.0.123.1      Serial1/0/0
    10.0.2.0/24     RIP     100  2           D   10.0.123.1      Serial1/0/0
    10.0.3.0/24     Direct  0    0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.3.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.123.0/24   Direct  0    0           D   10.0.123.3      Serial1/0/0
    10.0.123.1/32   Direct  0    0           D   10.0.123.1      Serial1/0/0
    10.0.123.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       InLoopBack0
    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

<R3>display fr map-info interface Serial 1/0/0
Map Statistics for interface Serial1/0/0 (DTE)
  DLCI = 301, IP 10.0.123.1, Serial1/0/0
    create time = 2011/11/16 09:22:30, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast

<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 14        Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.2.0/24     RIP     100  1           D   10.0.123.2      Serial2/0/0
    10.0.3.0/24     RIP     100  1           D   10.0.123.3      Serial2/0/0
    10.0.123.0/24   Direct  0    0           D   10.0.123.1      Serial2/0/0
    10.0.123.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
    10.0.123.2/32   Direct  0   0           D   10.0.123.2      Serial2/0/0
    10.0.123.3/32   Direct  0   0           D   10.0.123.3      Serial2/0/0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       InLoopBack0
    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 fr map-info interface Serial 2/0/0
Map Statistics for interface Serial2/0/0 (DTE)
  DLCI = 102, IP 10.0.123.2, Serial2/0/0
    create time = 2011/11/16 09:28:49, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 103, IP 10.0.123.3, Serial2/0/0
    create time = 2011/11/16 09:28:56, status = ACTIVE
    encapsulation = ietf, vlink = 2, broadcast

<R2>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 13      Routes : 13

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     RIP     100 1           D   10.0.123.1      Serial3/0/0
    10.0.2.0/24     Direct  0   0           D   10.0.2.2        LoopBack0
    10.0.2.2/32     Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.2.255/32   Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.3.0/24     RIP     100 2           D   10.0.123.1      Serial3/0/0
    10.0.123.0/24   Direct  0   0           D   10.0.123.2      Serial3/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial3/0/0
    10.0.123.2/32   Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       InLoopBack0
    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
```

```
<R2>display fr map-info interface Serial 3/0/0
Map Statistics for interface Serial3/0/0 (DTE)
  DLCI = 201, IP 10.0.123.1, Serial3/0/0
    create time = 2011/11/16 09:21:10, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
```

The conclusion is that there is no PVC that allows R2 to reach IP address 10.0.123.3.

Step 5 **Modify network parameters to enable the connection between R2 and R3.**

The fault diagnosis results from step 2 indicate that communication fails since there is no virtual circuit between the frame relay interfaces on R2 and R3. In order to resolve this, configure a frame relay PVC between the interfaces on R2 and R3.

```
[R2]interface Serial 3/0/0
[R2-Serial3/0/0]fr map ip 10.0.123.3 201

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]fr map ip 10.0.123.2 301
```

After the mapping has been configured between IP addresses and PVCs, check the IP address-PVC mapping tables on R2 and R3 and detect network connectivity.

```
<R3>display fr lmi-info inter Serial 1/0/0
Frame relay LMI statistics for interface Serial1/0/0 (DTE, Q933)
  T391DTE = 10 (hold timer 10)
  N391DTE = 6, N392DTE = 3, N393DTE = 4
  out status enquiry = 326, in status = 324
  status timeout = 0, discarded messages = 0

<R3>display fr map-info interface Serial 1/0/0
Map Statistics for interface Serial1/0/0 (DTE)
  DLCI = 301, IP 10.0.123.1, Serial1/0/0
    create time = 2011/11/16 09:22:30, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 301, IP 10.0.123.2, Serial1/0/0
    create time = 2011/11/16 09:55:23, status = ACTIVE
    encapsulation = ietf, vlink = 2
```

```
<R3>ping 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=118 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=123 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 118/122/123 ms
```

Step 6 **Configure OSPF between R1 and R2.**

Delete the RIP configurations referenced in step 2 and the frame relay mapping between R2 and R3 that was established during step 3.

```
[R1]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]undo fr map ip 10.0.123.3 201
[R2-Serial3/0/0]quit
[R2]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]undo fr map ip 10.0.123.2 301
[R3-Serial1/0/0]quit
[R3]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y
[R3]
```

Configure single-area OSPF on R1, R2, and R3.

```
[R1]ospf 1 router-id 10.0.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

```
[R2]ospf 1 router-id 10.0.2.2
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255

[R3]ospf 1 router-id 10.0.3.3
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

After the basic parameters are set, OSPF cannot establish neighbor adjacencies. When using frame relay for data link layer encapsulation, OSPF will set the network type to NBMA by default. As a result, OSPF does not support broadcasts, and therefore cannot automatically discover neighbors.

```
<R3>display ospf interface Serial 1/0/0 verbose
        OSPF Process 1 with Router ID 10.0.3.3
               Interfaces

 Interface: 10.0.123.3 (Serial1/0/0)
 Cost: 1562    State: DR       Type: NBMA      MTU: 1500
 Priority: 1
 Designated Router: 10.0.123.3
 Backup Designated Router: 0.0.0.0
 Timers: Hello 30 , Dead 120 , Poll  120 , Retransmit 5 , Transmit Delay 1
  IO Statistics
            Type        Input     Output
            Hello           0          0
   DB Description           0          0
   Link-State Req           0          0
Link-State Update           0          0
   Link-State Ack           0          0
 OpaqueId: 0   PrevState: Waiting
```

Step 7 **Configuring the NBMA environment.**

While R3 is the DR, R2 is unable to establish a full adjacency with the DR since R3 is not reachable via the PVC between R2 and R1. Therefore the DR must be set on R1. Additionally OSPF hello messages are unicast in an NBMA network. Peers must be manually specified to allow hello packet forwarding.

```
[R1]ospf
[R1-ospf-1]peer 10.0.123.2
[R1-ospf-1]peer 10.0.123.3
[R1-ospf-1]interface Serial 2/0/0
[R1-Serial2/0/0]ospf dr-priority 255

[R2]ospf
[R2-ospf-1]peer 10.0.123.1

[R3]ospf
[R3-ospf-1]peer 10.0.123.1
```

Optionally the DR priority for R2 and R3 can be set to 0 to force their exemption from any DR election.

```
<R1>display ospf interface Serial 2/0/0 verbose
        OSPF Process 1 with Router ID 10.0.1.1
               Interfaces

Interface: 10.0.123.1 (Serial2/0/0)
 Cost: 1562    State: DR       Type: NBMA     MTU: 1500
 Priority: 255
 Designated Router: 10.0.123.1
 Backup Designated Router: 10.0.123.3
 Timers: Hello 30 , Dead 120 , Poll  120 , Retransmit 5 , Transmit Delay 1
  IO Statistics
             Type       Input     Output
            Hello       32          32
   DB Description       8           29
   Link-State Req       3           2
Link-State Update       16          30
   Link-State Ack       20          9
 OpaqueId: 0   PrevState: BDR
 Effective cost: 1562, enabled by OSPF Protocol
```

If R1 is not the designated router, reset the ospf process on all routers using the following command and reattempt the above display command

```
<R1>reset ospf process graceful-restart
```

Display the routing table to confirm that OSPF has been established over the frame relay network.

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 14        Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.0/24   Direct  0    0           D   10.0.1.1        LoopBack0
      10.0.1.1/32   Direct  0    0           D   127.0.0.1       LoopBack0
      10.0.1.255/32 Direct  0    0           D   127.0.0.1       LoopBack0
      10.0.2.2/32   OSPF    10   1562        D   10.0.123.2      Serial2/0/0
      10.0.3.3/32   OSPF    10   1562        D   10.0.123.3      Serial2/0/0
      10.0.123.0/24 Direct  0    0           D   10.0.123.1      Serial2/0/0
      10.0.123.1/32 Direct  0    0           D   127.0.0.1       Serial2/0/0
      10.0.123.2/32 Direct  0    0           D   10.0.123.2      Serial2/0/0
      10.0.123.3/32 Direct  0    0           D   10.0.123.3      Serial2/0/0
      10.0.123.255/32 Direct  0    0           D   127.0.0.1       Serial2/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R1>ping -a 10.0.1.1 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=255 time=60 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=255 time=60 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 51/54/60 ms
```

Attempts to establish a connection between 10.0.2.2 and 10.0.3.3 when using the NBMA network type will fail unless a virtual circuit (PVC) is established between R2 and R3. Alternatively the point-to-multipoint network type can be applied.

Step 8 **Setting the OSPF network type to point-to-multipoint.**

OSPF configuration can also use the point-to-multipoint OSPF network type over frame relay networks. First remove the manual peering and change the network type to point-to-multipoint.

```
[R1]ospf
[R1-ospf-1]undo peer 10.0.123.2
[R1-ospf-1]undo peer 10.0.123.3

[R2]ospf
[R2-ospf-1]undo peer 10.0.123.1

[R3]ospf
[R3-ospf-1]undo peer 10.0.123.1
```

Establish the Point-to-multipoint network type.

```
[R1]interface Serial 2/0/0
[R1-Serial2/0/0]ospf network-type p2mp

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]ospf network-type p2mp

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]ospf network-type p2mp
```

After setting the OSPF network type, wait until the neighbor relationship is established, then check the neighbor relationship and route information.

```
<R1>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.1.1
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          Serial2/0/0                    10.0.2.2        Full
 0.0.0.0          Serial2/0/0                    10.0.3.3        Full
 ----------------------------------------------------------------------------
```

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 14        Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.2.2/32     OSPF    10   1562        D   10.0.123.2      Serial2/0/0
    10.0.3.3/32     OSPF    10   1562        D   10.0.123.3      Serial2/0/0
    10.0.123.0/24   Direct  0    0           D   10.0.123.1      Serial2/0/0
    10.0.123.1/32   Direct  0    0           D   127.0.0.1       Serial2/0/0
    10.0.123.2/32   Direct  0    0           D   10.0.123.2      Serial2/0/0
    10.0.123.3/32   Direct  0    0           D   10.0.123.3      Serial2/0/0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       Serial2/0/0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R2>display ospf peer brief

         OSPF Process 1 with Router ID 10.0.2.2
                 Peer Statistic Information
 ------------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          Serial3/0/0                    10.0.1.1        Full
 ------------------------------------------------------------------------------

<R2>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 14        Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.1/32     OSPF    10   1562        D   10.0.123.1      Serial3/0/0
    10.0.2.0/24     Direct  0    0           D   10.0.2.2        LoopBack0
    10.0.2.2/32     Direct  0    0           D   127.0.0.1       LoopBack0
```

```
    10.0.2.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.3.3/32     OSPF    10  3124        D   10.0.123.1      Serial3/0/0
    10.0.123.0/24   Direct  0   0           D   10.0.123.2      Serial3/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial3/0/0
    10.0.123.2/32   Direct  0   0           D   127.0.0.1       Serial3/0/0
    10.0.123.3/32   OSPF    10  3124        D   10.0.123.1      Serial3/0/0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       Serial3/0/0
    127.0.0.0/8     Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0   0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0

<R3>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.3.3
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id         Interface                       Neighbor id     State
 0.0.0.0         Serial1/0/0                      10.0.1.1       Full
 ----------------------------------------------------------------------------

<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14       Routes : 14

Destination/Mask    Proto   Pre Cost      Flags NextHop         Interface

    10.0.1.1/32     OSPF    10  1562        D   10.0.123.1      Serial1/0/0
    10.0.2.2/32     OSPF    10  3124        D   10.0.123.1      Serial1/0/0
    10.0.3.0/24     Direct  0   0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.3.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.123.0/24   Direct  0   0           D   10.0.123.3      Serial1/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial1/0/0
    10.0.123.2/32   OSPF    10  3124        D   10.0.123.1      Serial1/0/0
    10.0.123.3/32   Direct  0   0           D   127.0.0.1       Serial1/0/0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       Serial1/0/0
    127.0.0.0/8     Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0   0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
```

Perform a network connectivity test on R3 from the source 10.0.3.3.

```
<R3>ping -a 10.0.3.3 10.0.1.1
  PING 10.0.1.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.1: bytes=56 Sequence=1 ttl=255 time=60 ms
    Reply from 10.0.1.1: bytes=56 Sequence=2 ttl=255 time=51 ms
    Reply from 10.0.1.1: bytes=56 Sequence=3 ttl=255 time=50 ms
    Reply from 10.0.1.1: bytes=56 Sequence=4 ttl=255 time=60 ms
    Reply from 10.0.1.1: bytes=56 Sequence=5 ttl=255 time=51 ms

  --- 10.0.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 50/54/60 ms

<R3>ping -a 10.0.3.3 10.0.123.2
    PING 10.0.123.2: 56  data bytes, press CTRL_C to break
      Reply from 10.0.123.2: bytes=56 Sequence=1 ttl=254 time=110 ms
      Reply from 10.0.123.2: bytes=56 Sequence=2 ttl=254 time=101 ms
      Reply from 10.0.123.2: bytes=56 Sequence=3 ttl=254 time=101 ms
      Reply from 10.0.123.2: bytes=56 Sequence=4 ttl=254 time=110 ms
      Reply from 10.0.123.2: bytes=56 Sequence=5 ttl=254 time=101 ms

    --- 10.0.123.2 ping statistics ---
      5 packet(s) transmitted
      5 packet(s) received
      0.00% packet loss
      round-trip min/avg/max = 101/104/110 ms

<R3>ping -a 10.0.3.3 10.0.2.2
     PING 10.0.2.2: 56  data bytes, press CTRL_C to break
       Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=102 ms
       Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=101 ms
       Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=110 ms
       Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=101 ms
       Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=102 ms

     --- 10.0.2.2 ping statistics ---
       5 packet(s) transmitted
       5 packet(s) received
       0.00% packet loss
       round-trip min/avg/max = 101/103/110 ms
```

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
 interface Serial2/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.2 102 broadcast
 fr map ip 10.0.123.3 103 broadcast
 ip address 10.0.123.1 255.255.255.0
 ospf network-type p2mp
 ospf dr-priority 255
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return

[R2]display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
interface Serial3/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.1 201 broadcast
 ip address 10.0.123.2 255.255.255.0
 ospf network-type p2mp
```

```
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.0
#
ospf 1 router-id 10.0.2.2
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return

[R3]display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface Serial1/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.1 301 broadcast
 ip address 10.0.123.3 255.255.255.0
 ospf network-type p2mp
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return
```

Lab 2-3 PPPoE Client Session Establishment

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of a Dialer interface for PPPoE
- Authentication of a client over PPPoE.

Topology

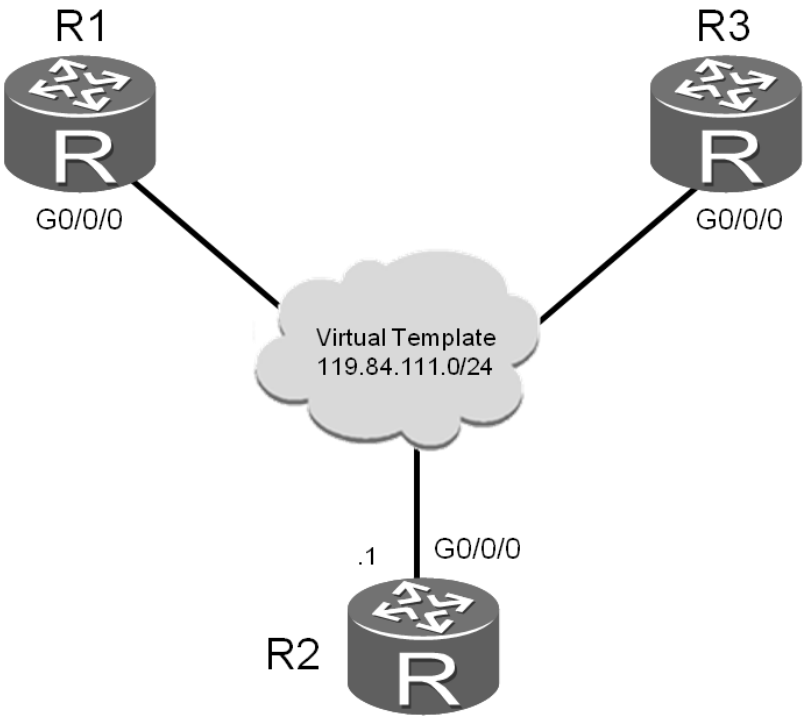


Figure 2.3 PPPoE Server and Client Topology

Scenario

The enterprise subscribes to a (typically high speed) DSL service from the service provider over which WAN services are supported. R1 and R3 are enterprise edge routers of different offices, and establish a connection to the service provider through the PPPoE server (R2). The enterprise is required to establish a PPPoE dialer on the edge routers to allow hosts in the local area network to access external resources transparently via the service provider network over PPPoE.

Tasks

Step 1 Preparing the environment.

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1

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

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
```

Step 2 Clean up the previous configuration

Disable the serial interfaces to avoid routing over the frame relay network.

```
[R1]interface Serial 2/0/0
[R1-Serial2/0/0]shutdown

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]shutdown
```

Step 3 Configure PPPoE Server.

The PPPoE server is not part of the enterprise network, however it is required to allow the enterprise edge routers R1 and R3 to be authenticated.

```
[R2]ip pool pool1
Info: It's successful to create an IP address pool.
[R2-ip-pool-pool1]network 119.84.111.0 mask 255.255.255.0
[R2-ip-pool-pool1]gateway-list 119.84.111.254
[R2-ip-pool-pool1]quit
[R2]interface Virtual-Template 1
[R2-Virtual-Template1]ppp authentication-mode chap
```

```
[R2-Virtual-Template1]ip address 119.84.111.254 255.255.255.0
[R2-Virtual-Template1]remote address pool pool1
[R2-Virtual-Template1]quit
```

Bind the Virtual Template to interface Gigabit Ethernet 0/0/0.

```
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]pppoe-server bind virtual-template 1
[R2-GigabitEthernet0/0/0]quit
```

Configure a PPPoE authenticated user.

```
[R2]aaa
[R2-aaa]local-user huawei1 password cipher huawei
Info: Add a new user.
[R2-aaa]local-user huawei1 service-type ppp
[R2-aaa]local-user huawei2 password cipher huawei
Info: Add a new user.
[R2-aaa]local-user huawei2 service-type ppp
[R2-aaa]quit
```

Step 4 **Configure PPPoE Client.**

Configure R1 as a PPPoE client, for which the dialer interface needs to be created, and PPP authentication enabled. The PPP authenticated username and password should match that configured on the PPPoE server.

```
[R1]dialer-rule
[R1-dialer-rule]dialer-rule 1 ip permit
[R1-dialer-rule]quit
[R1]interface Dialer 1
[R1-Dialer1]dialer user user1
[R1-Dialer1]dialer-group 1
[R1-Dialer1]dialer bundle 1
[R1-Dialer1]ppp chap user huawei1
[R1-Dialer1]ppp chap password cipher huawei
[R1-Dialer1]dialer timer idle 300
[R1-Dialer1]dialer queue-length 8
[R1-Dialer1]ip address ppp-negotiate
[R1-Dialer1]quit
```

Bind the PPPoE Dialer to the outbound interface

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]pppoe-client dial-bundle-number 1
[R1-GigabitEthernet0/0/0]quit
```

Configure a default static route to the PPPoE server

```
[R1]ip route-static 0.0.0.0 0.0.0.0 Dialer 1
```

Configure R3 as a PPPoE client, for which the dialer interface needs to be created, and PPP authentication enabled. The PPP authenticated username and password should match that configured on the PPPoE server.

```
[R3]dialer-rule
[R3-dialer-rule]dialer-rule 1 ip permit
[R3-dialer-rule]quit
[R3]interface Dialer 1
[R3-Dialer1]dialer user user2
[R3-Dialer1]dialer-group 1
[R3-Dialer1]dialer bundle 1
[R3-Dialer1]ppp chap user huawei2
[R3-Dialer1]ppp chap password cipher huawei
[R3-Dialer1]dialer timer idle 300
[R3-Dialer1]dialer queue-length 8
[R3-Dialer1]ip address ppp-negotiate
[R3-Dialer1]quit
```

Bind the PPPoE Dialer to the outbound interface

```
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]pppoe-client dial-bundle-number 1
[R3-GigabitEthernet0/0/0]quit
```

Configure a default static route to the PPPoE server

```
[R3]ip route-static 0.0.0.0 0.0.0.0 Dialer 1
```

Step 5 **Verify the configuration results**

Execute the command **display pppoe-server session all** command to view the status and configuration information.

```
<R2>display pppoe-server session all
SID Intf                    State   OIntf       RemMAC          LocMAC
1   Virtual-Template1:0     UP      GE0/0/0     00e0.fc03.d0ae  00e0.fc03.7516
2   Virtual-Template1:1     UP      GE0/0/0     00e0.fc03.aedd  00e0.fc03.7516
```

According to displayed information, the session state is normal.

```
<R2>display virtual-access
Virtual-Template1:0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-12 04:15:54
Description:HUAWEI, AR Series, Virtual-Template1:0 Interface
Route Port,The Maximum Transmit Unit is 1492, Hold timer is 10(sec)
Link layer protocol is PPP
LCP opened, IPCP opened
Current system time: 2013-12-12 04:53:01
    Input bandwidth utilization  :  0%
    Output bandwidth utilization :  0%

Virtual-Template1:1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-12 04:23:13
Description:HUAWEI, AR Series, Virtual-Template1:1 Interface
Route Port,The Maximum Transmit Unit is 1492, Hold timer is 10(sec)
Link layer protocol is PPP
LCP opened, IPCP opened
Current system time: 2013-12-12 04:53:01
    Input bandwidth utilization  :  0%
    Output bandwidth utilization :  0%
```

Check the dialer interface of R1 and R3, and ensure both can obtain an IP address from the PPPoE server.

```
<R1>display ip interface brief
    *down: administratively down
    ^down: standby
    (l): loopback
    (s): spoofing
    The number of interface that is UP in Physical is 7
    The number of interface that is DOWN in Physical is 4
    The number of interface that is UP in Protocol is 5
    The number of interface that is DOWN in Protocol is 6

Interface                IP Address/Mask     Physical    Protocol
Cellular0/0/0            unassigned          down        down
Cellular0/0/1            unassigned          down        down
Dialer1                  119.84.111.253/32   up          up(s)
GigabitEthernet0/0/0     unassigned          up          down
…output omitted…
```

```
<R3>display ip interface brief
…output omitted…
Interface                IP Address/Mask     Physical   Protocol
Cellular0/0/0            unassigned              down       down
Cellular0/0/1            unassigned              down       down
Dialer1                  119.84.111.252/32       up         up(s)
GigabitEthernet0/0/0     unassigned              up         down
…output omitted…
```

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$B:%I)Io0H8)[%SB[idM3C/!#%$%$
 local-user huawei service-type ppp
#
interface Dialer1
 link-protocol ppp
 ppp chap user huawei1
 ppp chap password cipher %$%$A8E~UjX}@;bhCL*C4w#<%"Ba%$%$
 ip address ppp-negotiate
 dialer user user1
 dialer bundle 1
 dialer queue-length 8
 dialer timer idle 300
 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 Dialer1
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return


[R2]dis current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
ip pool pool1
 gateway-list 119.84.111.254
 network 119.84.111.0 mask 255.255.255.0
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei1 password cipher %$%$MjCY6,a82N4W`]F]3LMAKG9+%$%$
 local-user huawei1 service-type ppp
 local-user huawei2 password cipher %$%$Ctq55RX:]R,8Jc13{|,)KH!m%$%$
 local-user huawei2 service-type ppp
#
interface Virtual-Template1
 ppp authentication-mode chap
 remote address pool pool1
 ip address 119.84.111.254 255.255.255.0
#
interface GigabitEthernet0/0/0
 pppoe-server bind Virtual-Template 1
#
```

```
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


[R3]display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$fZsyUk1=O=>:L4'ytgR~D*Im%$%$
 local-user huawei service-type ppp
#
interface Dialer1
 link-protocol ppp
 ppp chap user huawei2
 ppp chap password cipher %$%$0f8(;^]1NS:q;SPo8TyP%.Ei%$%$
 ip address ppp-negotiate
 dialer user user2
 dialer bundle 1
 dialer queue-length 8
 dialer timer idle 300
 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 Dialer1
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return
```

Module 3 Implementing IP Security

Lab 3-1 Filtering Enterprise Data with Access Control Lists.

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Establishment of a basic ACL to implement source based filtering.
- Establishment of an advanced ACL to implement enhanced filtering.

Topology

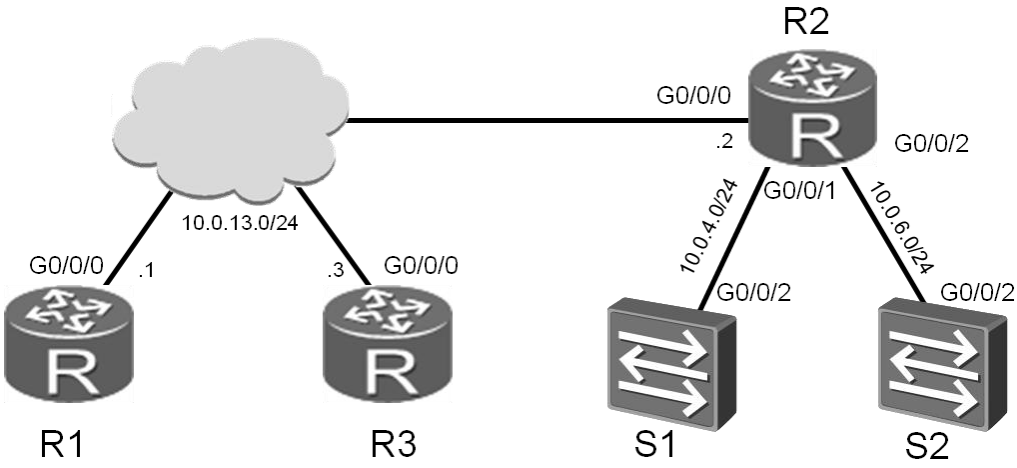


Figure 3.1 Filtering enterprise network data with Access Control Lists

Scenario

Assume that you are a network administrator of a company that has three networks belonging to three sites. R2 is deployed at the border of the network for the main site, while R1 and R3 are deployed at the boundary of the remaining sites. The routers are interconnected over a private WAN connection. The company needs to control the access of employees to telnet and FTP services. Only site R1 has permission to access the telnet server in the main site. Only site R3 has permission to access the FTP server.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
[Huawei]sysname R1
[Huawei]sysname R2
[Huawei]sysname R3

[Huawei]sysname S1
[S1]vlan 4
[S1-vlan4]quit
[S1]interface vlanif 4
[S1-Vlanif4]ip address 10.0.4.254 24

[Huawei]sysname S2
[S2]vlan 6
[S2-vlan6]quit
[S2]interface vlanif 6
[S2-Vlanif6]ip address 10.0.6.254 24
```

Step 2 Clean up the previous configuration

Remove the current network being advertised in OSPF, the PPPoE dialer interfaces, as well as the PPPoE server virtual template configuration from R2.

```
[R1]ospf
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]undo network 10.0.0.0 0.255.255.255
[R1]undo ip route-static 0.0.0.0 0
[R1-GigabitEthernet0/0/0]undo pppoe-client dial-bundle-number 1
[R1]interface Dialer 1
[R1-Dialer1]undo dialer user
[R1]undo interface Dialer 1
[R1]dialer-rule
[R1-dialer-rule]undo dialer-rule 1

[R2]ospf
```

```
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]undo network 10.0.0.0 0.255.255.255
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]undo pppoe-server bind
[R2]undo interface Virtual-Template 1
[R2]undo ip pool pool1
[R2]aaa
[R2-aaa]undo local-user huawei1
[R2-aaa]undo local-user huawei2

[R3]ospf
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]undo network 10.0.0.0 0.255.255.255
[R3]undo ip route-static 0.0.0.0 0
[R3-GigabitEthernet0/0/0]undo pppoe-client dial-bundle-number 1
[R3]interface Dialer 1
[R3-Dialer1]undo dialer user
[R3]undo interface Dialer 1
[R3]dialer-rule
[R3-dialer-rule]undo dialer-rule 1
```

Step 3 **Configure IP addressing**

Configure addressing for the 10.0.13.0/24. 10.0.4.0/24 and 10.0.6.0/24 networks as shown in the topology of figure 7.1.

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.13.1 24

[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ip address 10.0.13.2 24
[R2-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ip address 10.0.4.2 24
[R2-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ip address 10.0.6.2 24

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ip address 10.0.13.3 24
```

Establish VLAN trunks on S1 and S2. The port link type should already be configured for interface GigabitEthernet 0/0/2 on S1.

```
[S1]interface GigabitEthernet 0/0/2
[S1-GigabitEthernet0/0/2]port link-type trunk
[S1-GigabitEthernet0/0/2]port trunk allow-pass vlan all
[S1-GigabitEthernet0/0/2]port trunk pvid vlan 4
[S1-GigabitEthernet0/0/2]quit

[S2]interface GigabitEthernet 0/0/2
[S2-GigabitEthernet0/0/2]port link-type trunk
[S2-GigabitEthernet0/0/2]port trunk allow-pass vlan all
[S2-GigabitEthernet0/0/2]port trunk pvid vlan 6
[S2-GigabitEthernet0/0/2]quit
```

Step 4 **Configure OSPF to enable internetwork communication**

Configure OSPF for R1, R2, and R3. Ensure that all are part of the same OSPF area and advertise the networks that have been created.

```
[R1]ospf
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.13.0 0.0.0.255

[R2]ospf
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.13.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network 10.0.4.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network 10.0.6.0 0.0.0.255

[R3]ospf
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.0.13.0 0.0.0.255
```

Configure a static route on S1 and S2, the nexthop as the private network's gateway.

```
[S1]ip route-static 0.0.0.0 0.0.0.0 10.0.4.2
[S2]ip route-static 0.0.0.0 0.0.0.0 10.0.6.2
```

Verify that a path exists from R1 and R3 to S1 and S2.

```
<R1>ping 10.0.4.254
  PING 10.0.4.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.254: bytes=56 Sequence=1 ttl=253 time=2 ms
    Reply from 10.0.4.254: bytes=56 Sequence=2 ttl=253 time=10 ms
    Reply from 10.0.4.254: bytes=56 Sequence=3 ttl=253 time=1 ms
    Reply from 10.0.4.254: bytes=56 Sequence=4 ttl=253 time=2 ms
    Reply from 10.0.4.254: bytes=56 Sequence=5 ttl=253 time=2 ms

  --- 10.0.4.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 1/3/10 ms

<R1>ping 10.0.6.254
  PING 10.0.6.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.6.254: bytes=56 Sequence=1 ttl=253 time=10 ms
    Reply from 10.0.6.254: bytes=56 Sequence=2 ttl=253 time=2 ms
    Reply from 10.0.6.254: bytes=56 Sequence=3 ttl=253 time=2 ms
    Reply from 10.0.6.254: bytes=56 Sequence=4 ttl=253 time=10 ms
    Reply from 10.0.6.254: bytes=56 Sequence=5 ttl=253 time=2 ms

  --- 10.0.6.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/5/10 ms

<R3>ping 10.0.4.254
  PING 10.0.4.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.254: bytes=56 Sequence=1 ttl=253 time=10 ms
    Reply from 10.0.4.254: bytes=56 Sequence=2 ttl=253 time=2 ms
    Reply from 10.0.4.254: bytes=56 Sequence=3 ttl=253 time=2 ms
    Reply from 10.0.4.254: bytes=56 Sequence=4 ttl=253 time=10 ms
    Reply from 10.0.4.254: bytes=56 Sequence=5 ttl=253 time=2 ms

  --- 10.0.4.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 2/5/10 ms
```

```
<R3>ping 10.0.6.254
  PING 10.0.6.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.6.254: bytes=56 Sequence=1 ttl=253 time=10 ms
    Reply from 10.0.6.254: bytes=56 Sequence=2 ttl=253 time=2 ms
    Reply from 10.0.6.254: bytes=56 Sequence=3 ttl=253 time=2 ms
    Reply from 10.0.6.254: bytes=56 Sequence=4 ttl=253 time=10 ms
    Reply from 10.0.6.254: bytes=56 Sequence=5 ttl=253 time=2 ms

  --- 10.0.6.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/5/10 ms
```

Step 5 **Configure Filters using Access Control Lists**

Configure S1 as a telnet server.

```
[S1]user-interface vty 0 4
[S1-ui-vty0-4]authentication-mode password
[S1-ui-vty0-4]set authentication password cipher huawei
```

Configure S2 as an FTP server.

```
[S2]ftp server enable
[S2]aaa
[S2-aaa]local-user huawei password cipher huawei
[S2-aaa]local-user huawei service-type ftp
[S2-aaa]local-user huawei ftp-directory flash:
```

Configure an access control list on R2 to allow R1 to access the telnet server, and R3 to access the FTP server.

```
[R2]acl 3000
[R2-acl-adv-3000]rule 5 permit tcp source 10.0.13.1 0.0.0.0 destination
10.0.4.254 0.0.0.0 destination-port eq 23
[R2-acl-adv-3000]rule 10 permit tcp source 10.0.13.3 0.0.0.0 destination
10.0.6.254 0.0.0.0 destination-port range 20 21
[R2-acl-adv-3000]rule 15 deny ip source any
[R2-acl-adv-3000]quit
```

Apply the ACL to the Gigabit Ethernet 0/0/0 interface of R2.

```
[R2]interface GigabitEthernet0/0/0
[R2-GigabitEthernet0/0/0]traffic-filter inbound acl 3000
```

Verify the results of the access control list on the network.

```
<R1>telnet 10.0.4.254
  Press CTRL_] to quit telnet mode
  Trying 10.0.4.254 ...
  Connected to 10.0.4.254 ...

Login authentication



Password:
Info: The max number of VTY users is 5, and the number
     of current VTY users on line is 1.
<S1>
```

Note: use the **quit** command to exit the telnet session

```
<R1>ftp 10.0.6.254
Trying 10.0.6.254 ...
Press CTRL+K to abort
Error: Failed to connect to the remote host.
```

Note: The FTP connection may take a while to respond (approx 60 seconds).

```
<R3>telnet 10.0.4.254
  Press CTRL_] to quit telnet mode
  Trying 10.0.4.254 ...
  Error: Can't connect to the remote host

<R3>ftp 10.0.6.254
Trying 10.0.6.254 ...
Press CTRL+K to abort
Connected to 10.0.6.254.
220 FTP service ready.
User(10.0.6.254:(none)):huawei
331 Password required for huawei.
Enter password:
230 User logged in.
[R3-ftp]
```

Note: The **bye** command can be used to close the FTP connection

Additional Exercises: Analyzing and Verifying

FTP requires two ports to be defined in the access control list, why is this?

Should basic ACL and advanced ACL be deployed near the source network or target network, and why?

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$B:%I)Io0H8)[%SB[idM3C/!#%$%$
 local-user huawei service-type ppp
#
interface GigabitEthernet0/0/0
 ip address 10.0.13.1 255.255.255.0
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return
```

```
<R2>display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
acl number 3000
 rule 5 permit tcp source 10.0.13.1 0 destination 10.0.4.254 0 destination-port
eq telnet
 rule 10 permit tcp source 10.0.13.3 0 destination 10.0.6.254 0 destination-port
range ftp-data ftp
 rule 15 deny ip
#
interface GigabitEthernet0/0/0
 ip address 10.0.13.2 255.255.255.0
 traffic-filter inbound acl 3000
#
interface GigabitEthernet0/0/1
 ip address 10.0.4.2 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.0.6.2 255.255.255.0
#
ospf 1 router-id 10.0.2.2
 area 0.0.0.0
  network 10.0.4.0 0.0.0.255
  network 10.0.6.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface GigabitEthernet0/0/0
```

```
 ip address 10.0.13.3 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return


<S1>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 4
#
interface Vlanif4
 ip address 10.0.4.254 255.255.255.0
#
interface GigabitEthernet0/0/2
 port link-type trunk
 port trunk pvid vlan 4
 port trunk allow-pass vlan 2 to 4094
#
ip route-static 0.0.0.0 0.0.0.0 10.0.4.2
#
user-interface con 0
user-interface vty 0 4
 set authentication password cipher N`C55QK<`=/Q=^Q`MAF4<1!!
#
return
```

```
<S2>dis current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 FTP server enable
#
 vlan batch 6
#
aaa
 authentication-scheme default
 authorization-scheme default
 accounting-scheme default
 domain default
 domain default_admin
 local-user admin password simple admin
 local-user admin service-type http
 local-user huawei password cipher N`C55QK<`=/Q=^Q`MAF4<1!!
 local-user huawei ftp-directory flash:
 local-user huawei service-type ftp
#
interface Vlanif6
 ip address 10.0.6.254 255.255.255.0
#
interface GigabitEthernet0/0/2
 port link-type trunk
 port trunk pvid vlan 6
 port trunk allow-pass vlan 2 to 4094
#
ip route-static 0.0.0.0 0.0.0.0 10.0.6.2
#
user-interface con 0
user-interface vty 0 4
#
return
```

Lab 3-2 Network Address Translation

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Translation of addresses between networks (NAT).
- Configuration of Easy IP.

Topology

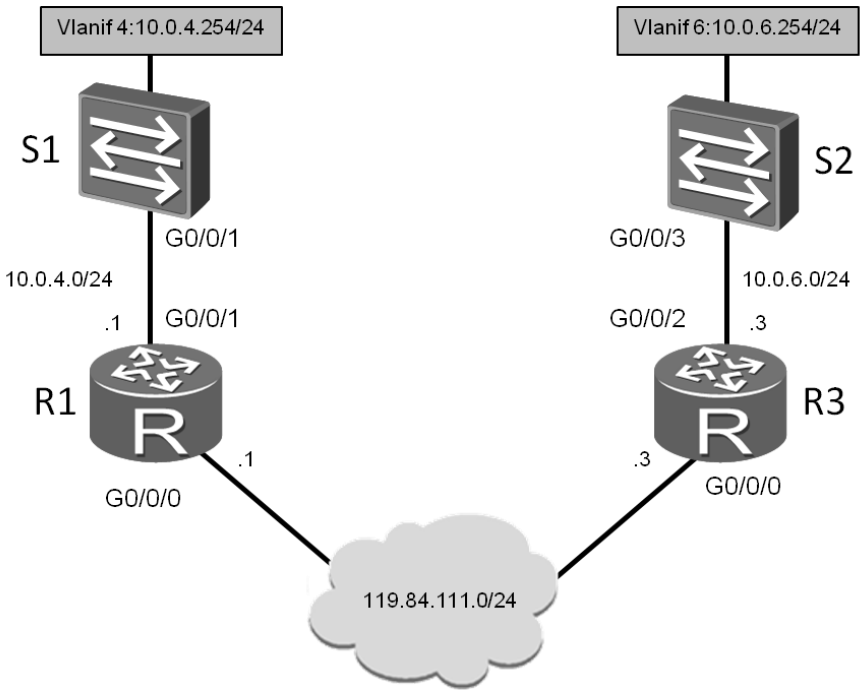


Figure 3.2 Network Address Translation Topology

Scenario

In order to conserve addressing the offices of the enterprise network have implemented private addressing internally. Users however require a means to be routed between these private networks and the public network domain. R1 and R3 represent edge routers of the enterprise branch offices ,the branch network need access to the public network. The administrator of the network is requested to configure dynamic NAT solutions on the in order to allow R1 to perform address translation. An easyIP NAT solution is to be applied to R3.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
[Huawei]sysname R1
[R1]inter GigabitEthernet0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.4.1 24

[Huawei]sysname R3
[R3]interface GigabitEthernet0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.6.3 24

[Huawei]sysname S1
[S1]vlan 4
[S1-vlan3]quit
[S1]interface vlanif 4
[S1-Vlanif4]ip address 10.0.4.254 24
[S1-Vlanif4]quit

[Huawei]sysname S2
[S2]vlan 6
[S2-vlan6]quit
[S2]interface vlanif 6
[S2-Vlanif6]ip address 10.0.6.254 24
[S2-Vlanif6]quit
```

Step 2 Clean up the previous configuration

Re-establish the connection to S1 and S2 via Gigabit Ethernet 0/0/1 on R1 and Gigabit Ethernet 0/0/2 on R3. Remove OSPF from all routers.

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]undo ip address
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]undo shutdown
[R1]undo ospf 1
Warning: The OSPF process will be deleted. Continue? [Y/N]:y
```

```
[R2]undo ospf 1
Warning: The OSPF process will be deleted. Continue? [Y/N]:y

[R3-GigabitEthernet0/0/0]undo ip address
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]undo shutdown
[R3]undo ospf 1
Warning: The OSPF process will be deleted. Continue? [Y/N]:y
```

Remove the static routes pointing to R2 on S1 and S2.

```
[S1]undo ip route-static 0.0.0.0 0.0.0.0

[S2]undo ip route-static 0.0.0.0 0.0.0.0
```

Step 3 **Implement VLAN configuration for S1 and S2**

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type trunk
[S1-GigabitEthernet0/0/1]port trunk pvid vlan 4
[S1-GigabitEthernet0/0/1]port trunk allow-pass vlan all
[S1-GigabitEthernet0/0/1]quit

[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]port link-type trunk
[S2-GigabitEthernet0/0/3]port trunk pvid vlan 6
[S2-GigabitEthernet0/0/3]port trunk allow-pass vlan all

[R1]interface GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]ip address 119.84.111.1 24

[R3]interface GigabitEthernet0/0/0
[R3-GigabitEthernet0/0/0]ip address 119.84.111.3 24
```

Verify that R1 is able to reach both S1 and R3.

```
<R1>ping 10.0.4.254
  PING 10.0.4.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.4.254: bytes=56 Sequence=1 ttl=255 time=23 ms
    Reply from 10.0.4.254: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 10.0.4.254: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 10.0.4.254: bytes=56 Sequence=4 ttl=254 time=10 ms
    Reply from 10.0.4.254: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 10.0.4.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 1/7/23 ms

<R1>ping 119.84.111.3
  PING 119.84.111.3: 56  data bytes, press CTRL_C to break
    Reply from 119.84.111.3: bytes=56 Sequence=1 ttl=255 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=2 ttl=255 time=10 ms
    Reply from 119.84.111.3: bytes=56 Sequence=3 ttl=255 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=4 ttl=255 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=5 ttl=255 time=10 ms

  --- 119.84.111.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 1/4/10 ms
```

Step 4 **Configure Access Control Lists for R1 and R3**

Configure an advanced ACL on R1 and select the data flow with the source of S1, the destination of R3, and destined for the telnet service port.

```
[R1]acl 3000
[R1-acl-adv-3000]rule 5 permit tcp source 10.0.4.254 0.0.0.0 destination
119.84.111.3 0.0.0.0 destination-port eq 23
[R1-acl-adv-3000]rule 10 permit ip source 10.0.4.0 0.0.0.255 destination any
[R1-acl-adv-3000]rule 15 deny ip
```

Configure a basic ACL on R3 and select the data flow whose source IP address is 10.0.6.0/24.

```
[R3]acl 2000
[R3-acl-basic-2000]rule permit source 10.0.6.0 0.0.0.255
```

Step 5 **Configure Dynamic NAT**

Configure static route on S1 and S2,the nexthop as the private network's gateway.

```
[S1]ip route-static 0.0.0.0 0.0.0.0 10.0.4.1
[S2]ip route-static 0.0.0.0 0.0.0.0 10.0.6.3
```

Configure dynamic NAT on the GigabitEthernet0/0/0 interface of R1.

```
[R1]nat address-group 1 119.84.111.240 119.84.111.243
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]nat outbound 3000 address-group 1
```

Configure R3 as the telnet server.

```
[R3]user-interface vty 0 4
[R3-ui-vty0-4]authentication-mode password
[R3-ui-vty0-4]set authentication password cipher huawei
[R3-ui-vty0-4]quit
```

Verify the address group has been configured correctly

```
<R1>display nat address-group
     NAT Address-Group Information:
     --------------------------------------
     Index   Start-address      End-address
     --------------------------------------
     1      119.84.111.240   119.84.111.243
     --------------------------------------
     Total : 1
```

Test connectivity to the gateway of the remote peer from the internal network.

```
<S1>ping 119.84.111.3
  PING 119.84.111.3: 56  data bytes, press CTRL_C to break
    Request time out
    Reply from 119.84.111.3: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=4 ttl=254 time=1 ms
    Reply from 119.84.111.3: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 119.84.111.3 ping statistics ---
    5 packet(s) transmitted
    4 packet(s) received
    20.00% packet loss
    round-trip min/avg/max = 1/1/1 ms
```

Establish a telnet connection to the public address of the remote peer.

```
<S1>telnet 119.84.111.3
Trying 119.84.111.3 ...
Press CTRL+K to abort
Connected to 119.84.111.3 ...

Login authentication

Password:
<R3>
```

Do not exit the telnet session, instead open a second session window to R1 and view the results of the ACL and NAT session translation.

```
<R1>display acl 3000
Advanced ACL 3000, 2 rules
Acl's step is 5
rule 5 permit tcp source 10.0.4.254 0 destination 119.84.111.3 0 destination-port
eq telnet (1 matches)
rule 10 permit ip source 10.0.4.0 0.0.0.255 (1 matches)
rule 15 deny ip

<R1>display nat session all
  NAT Session Table Information:

    Protocol               : ICMP(1)
    SrcAddr   Vpn          : 10.0.4.254
    DestAddr  Vpn          : 119.84.111.3
    Type Code IcmpId       : 8   0   44003
    NAT-Info
      New SrcAddr          : 119.84.111.242
      New DestAddr         : ----
      New IcmpId           : 10247

    Protocol               : TCP(6)
    SrcAddr Port Vpn       : 10.0.4.254     49646
    DestAddr Port Vpn      : 119.84.111.3    23
    NAT-Info
      New SrcAddr          : 119.84.111.242
      New SrcPort          : 10249
      New DestAddr         : ----
      New DestPort         : ----

  Total : 2
```

The ICMP session has a lifetime of only 20 seconds and therefore may not appear to be present when displaying the NAT session results. The following command can be used in this case to extend the period over which the ICMP results are maintained:

```
[R1]firewall-nat session icmp aging-time 300
```

Configure easyIP on the Gigabit Ethernet 0/0/0 interface of R3, associating the easyIP configuration with ACL 2000 that had been configured earlier.

```
[R3-GigabitEthernet0/0/0]nat outbound 2000
```

Test the connectivity from S2 to R1 via R3.

```
<S2>ping 119.84.111.1
  PING 119.84.111.1: 56  data bytes, press CTRL_C to break
    Reply from 119.84.111.1: bytes=56 Sequence=1 ttl=254 time=1 ms
    Reply from 119.84.111.1: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 119.84.111.1: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 119.84.111.1: bytes=56 Sequence=4 ttl=254 time=1 ms
    Reply from 119.84.111.1: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 119.84.111.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 1/1/1 ms

<R3>display acl 2000
Basic ACL 2000, 1 rule
Acl's step is 5
 rule 5 permit source 10.0.6.0 0.0.0.255 (1 matches)

<R3>display nat outbound acl 2000
 NAT Outbound Information:
--------------------------------------------------------------------------
Interface               Acl    Address-group/IP/Interface     Type
--------------------------------------------------------------------------
GigabitEthernet0/0/0   2000                   119.84.111.3   easyip
--------------------------------------------------------------------------
  Total : 1
```

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
firewall-nat session icmp aging-time 300
#
acl number 3000
 rule 5 permit tcp source 10.0.4.254 0 destination 119.84.111.3 0 destination-port
eq telnet
 rule 10 permit ip source 10.0.4.0 0.0.0.255
 rule 15 deny ip
#
 nat address-group 1 119.84.111.240 119.84.111.243
#
interface GigabitEthernet0/0/0
 ip address 119.84.111.1 255.255.255.0
 nat outbound 3000 address-group 1
#
interface GigabitEthernet0/0/1
 ip address 10.0.4.1 255.255.255.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return


<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
acl number 2000
 rule 5 permit source 10.0.6.0 0.0.0.255
#
interface GigabitEthernet0/0/0
```

```
 ip address 119.84.111.3 255.255.255.0
 nat outbound 2000
#
interface GigabitEthernet0/0/2
 ip address 10.0.6.3 255.255.255.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode password
 set authentication password
cipher %$%$7ml|,!ccE$SQ~CZ{GtaE%hO>v}~bVk18p5qq<:UPtI:9hOA%%$%$
#
return


<S1>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 4
#
interface Vlanif4
 ip address 10.0.4.254 255.255.255.0
#
interface GigabitEthernet0/0/1
 port link-type trunk
 port trunk pvid vlan 4
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/2
 port link-type trunk
 port trunk pvid vlan 4
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/14
 shutdown
#
 ip route-static 0.0.0.0 0.0.0.0 10.0.4.1
#
```

```
user-interface con 0
user-interface vty 0 4
 set authentication password cipher N`C55QK<`=/Q=^Q`MAF4<1!!
#
return


<S2>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 6
#
interface Vlanif6
 ip address 10.0.6.254 255.255.255.0
#
interface GigabitEthernet0/0/2
 port link-type trunk
 port trunk pvid vlan 6
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/3
 port link-type trunk
 port trunk pvid vlan 6
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/23
 shutdown
#
 ip route-static 0.0.0.0 0.0.0.0 10.0.6.3
#
user-interface con 0
user-interface vty 0 4
#
return
```

Lab 3-3 Establishing Local AAA solutions

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of local AAA for which authentication and authorization schemes are to be used.
- Establishment of a domain named huawei
- Implementation of privilege levels for authenticated users.

Topology

Figure 3-3 AAA configuration

Scenario

R1 and R3 have been deployed on the network and are to provide remote authentication services using AAA. The company requires that both routers are made part of the huawei domain and that the telnet service is made available to users, with limited privileges given once authenticated.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
[Huawei]sysname R1
[R1]interface GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]ip address 119.84.111.1 24

[Huawei]sysname R3
[R3]inter GigabitEthernet0/0/0
[R3-GigabitEthernet0/0/0]ip address 119.84.111.3 24
```

Step 2 Clean up the previous configuration

Remove the previous NAT and ACL configuration from R1 and R3.

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]undo nat outbound 3000 address-group 1
[R1-GigabitEthernet0/0/0]quit
[R1]undo nat address-group 1
[R1]undo acl 3000

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]undo nat outbound 2000
[R3-GigabitEthernet0/0/0]quit
[R3]undo acl 2000
```

Step 3 Verify connectivity between R1 and R3

```
<R1>ping 119.84.111.3
  PING 119.84.111.3: 56  data bytes, press CTRL_C to break
    Reply from 119.84.111.3: bytes=56 Sequence=1 ttl=255 time=70 ms
    Reply from 119.84.111.3: bytes=56 Sequence=2 ttl=255 time=20 ms
    Reply from 119.84.111.3: bytes=56 Sequence=3 ttl=255 time=10 ms
    Reply from 119.84.111.3: bytes=56 Sequence=4 ttl=255 time=20 ms
    Reply from 119.84.111.3: bytes=56 Sequence=5 ttl=255 time=10 ms
```

```
  --- 119.84.111.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 10/26/70 ms
```

Step 4 **Perform AAA configuration on R1**

Configure an authentication-scheme and authorization-scheme on R1. The configuration for R3 can be found at step 5.

```
[R1]aaa
[R1-aaa]authentication-scheme auth1
Info: Create a new authentication scheme.
[R1-aaa-authen-auth1]authentication-mode local
[R1-aaa-authen-auth1]quit
[R1-aaa]authorization-scheme auth2
Info: Create a new authorization scheme.
[R1-aaa-author-auth2]authorization-mode local
[R1-aaa-author-auth2]quit
```

Configure the domain **huawei** on R1, then create a user and apply the user to this domain.

```
[R1-aaa]domain huawei
[R1-aaa-domain-huawei]authentication-scheme auth1
[R1-aaa-domain-huawei]authorization-scheme auth2
[R1-aaa-domain-huawei]quit
[R1-aaa]local-user user1@huawei password cipher huawei
[R1-aaa]local-user user1@huawei service-type telnet
[R1-aaa]local-user user1@huawei privilege level 0
```

Configure R1 as the telnet server, using AAA authentication mode.

```
[R1]user-interface vty 0 4
[R1-ui-vty0-4]authentication-mode aaa
```

Verify whether the telnet service on R1 has been established successfully.

```
<R3>telnet 119.84.111.1
  Press CTRL_] to quit telnet mode
  Trying 119.84.111.1 ...
  Connected to 119.84.111.1 ...

Login authentication

Username:user1@huawei
Password:
<R1>system-view
    ^
Error: Unrecognized command found at '^' position.
<R1>quit
```

Operations are restricted as user privileges are limited to privilege level 0 for user1@huawei.

Step 5 **Perform AAA configuration on R3**

```
[R3]aaa
[R3-aaa]authentication-scheme auth1
Info: Create a new authentication scheme.
[R3-aaa-authen-auth1]authentication-mode local
[R3-aaa-authen-auth1]quit
[R3-aaa]authorization-scheme auth2
Info: Create a new authorization scheme.
[R3-aaa-author-auth2]authorization-mode local
[R3-aaa-author-auth2]quit
```

Configure the domain **huawei** on R3, then create a user and apply the user to this domain.

```
[R3-aaa]domain huawei
[R3-aaa-domain-huawei]authentication-scheme auth1
[R3-aaa-domain-huawei]authorization-scheme auth2
[R3-aaa-domain-huawei]quit
[R3-aaa]local-user user3@huawei password cipher huawei
[R3-aaa]local-user user3@huawei service-type telnet
[R3-aaa]local-user user3@huawei privilege level 0
```

Configure the telnet service on R3 to use AAA authentication mode.

```
[R3]user-interface vty 0 4
[R3-ui-vty0-4]authentication-mode aaa
```

Verify the results of implementing AAA on the vty interface.

.

```
<R1>telnet 119.84.111.3
  Press CTRL_] to quit telnet mode
  Trying 119.84.111.1 ...
  Connected to 119.84.111.1 ...

Login authentication

Username:user3@huawei
Password:
<R3>system-view
    ^
Error: Unrecognized command found at '^' position.
<R3>
```

Operations are restricted as user privileges are set to privilege level 0 for user3@huawei.

Step 6 **Observe the results of the AAA configuration**

```
<R1>display domain name huawei

  Domain-name                    : huawei
  Domain-state                   : Active
  Authentication-scheme-name     : auth1
  Accounting-scheme-name         : default
  Authorization-scheme-name : auth2
  Service-scheme-name            : -
  RADIUS-server-template         : -
  HWTACACS-server-template       : -
  User-group                     : -
```

```
<R1>display local-user username user1@huawei
  The contents of local user(s):
  Password              : ****************
  State                 : active
  Service-type-mask     : T
  Privilege level       : 0
  Ftp-directory         : -
  Access-limit          : -
  Accessed-num          : 0
  Idle-timeout          : -
  User-group            : -

<R3>display domain name huawei

  Domain-name                   : huawei
  Domain-state                  : Active
  Authentication-scheme-name    : auth1
  Accounting-scheme-name        : default
  Authorization-scheme-name     : auth2
  Service-scheme-name           : -
  RADIUS-server-template        : -
  HWTACACS-server-template      : -
  User-group                    : -

<R3>display local-user username user3@huawei
  The contents of local user(s):
  Password              : ****************
  State                 : active
  Service-type-mask     : T
  Privilege level       : 0
  Ftp-directory         : -
  Access-limit          : -
  Accessed-num          : 0
  Idle-timeout          : -
  User-group            : -
```

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
aaa
 authentication-scheme default
 authentication-scheme auth1
 authorization-scheme default
 authorization-scheme auth2
 accounting-scheme default
 domain default
 domain default_admin
 domain huawei
  authentication-scheme auth1
  authorization-scheme auth2
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$B:%I)Io0H8)[%SB[idM3C/!#%$%$
 local-user huawei service-type ppp
 local-user user1@huawei password cipher %$%$^L*5IP'0^A!;R)R*L=LFcXgv%$%$
 local-user user1@huawei privilege level 0
 local-user user1@huawei service-type telnet
#
interface GigabitEthernet0/0/0
 ip address 119.84.111.1 255.255.255.0
 nat outbound 3000 address-group 1  //may remain from previous labs
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

```
<R3>dis current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
aaa
 authentication-scheme default
 authentication-scheme auth1
 authorization-scheme default
 authorization-scheme auth2
 accounting-scheme default
 domain default
 domain default_admin
 domain huawei
  authentication-scheme auth1
  authorization-scheme auth2
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$fZsyUk1=O=>:L4'ytgR~D*Im%$%$
 local-user huawei service-type ppp
 local-user user3@huawei password cipher %$%$WQt.;bEsR<8fz3LCiPY,che_%$%$
 local-user user3@huawei privilege level 0
 local-user user3@huawei service-type telnet
#
interface GigabitEthernet0/0/0
 ip address 119.84.111.3 255.255.255.0
 nat outbound 2000  //may remain from previous labs
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

Lab 3-4 Securing Traffic with IPsec VPN

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of an IPsec proposal using an esp transform set.
- Configuration of an ACL used to determine interesting traffic.
- Configuration of an IPsec policy
- The binding of an IPsec policy to an interface.

Topology

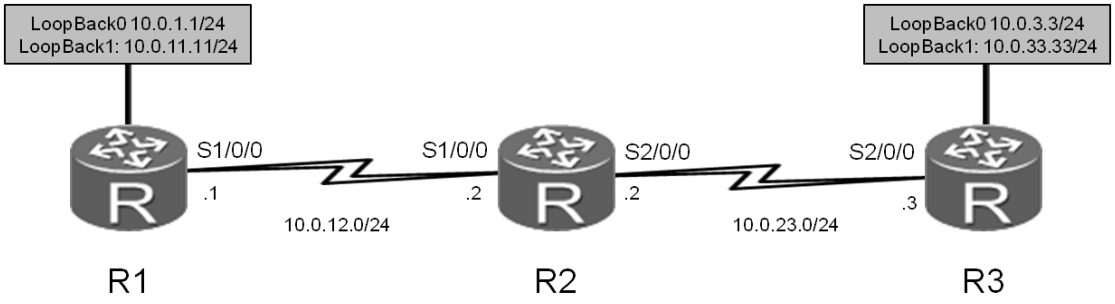


Figure 3.4 IPsec VPN topology

Scenario

In the interests of protecting both the integrity and confidentiality of company data, it is required that the communication between the offices of the enterprise secure specific private data as it is transmitted over the public network infrastructure. As the network administrator of the company, the task has been assigned to implement IPsec VPN solutions between the HQ edge router (R1) and the branch office (R3). Currently only select departments within the HQ require secured communication over the public network (R2). The administrator should establish IPsec using tunnel mode between the two offices for all traffic originating from the department.

Tasks

Step 1 **Preparing the environment.**

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
[Huawei]sysname R1
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ip address 10.0.12.1 24
[R1-Serial1/0/0]interface loopback 0
[R1-LoopBack0]ip address 10.0.1.1 24

<Huawei>system-view
[Huawei]sysname R2
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ip address 10.0.12.2 24
[R2-Serial1/0/0]interface serial 2/0/0
[R2-Serial2/0/0]ip address 10.0.23.2 24
[R2-Serial2/0/0]interface loopback 0
[R2-LoopBack0]ip address 10.0.2.2 24

<Huawei>system-view
[Huawei]sysname R3
[R3]interface Serial  2/0/0
[R3-Serial2/0/0]ip address 10.0.23.3 24
[R3-Serial2/0/0]interface loopback 0
[R3-LoopBack0]ip address 10.0.3.3 24
```

Step 2 **Clean up the previous configuration.**

Remove the addressing for the Gigabit Ethernet 0/0/0 interface on R1 & R3, and disable the interfaces as shown to prevent alternative routes.

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]undo ip address
[R1-GigabitEthernet0/0/0]quit
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]shutdown
[R1-GigabitEthernet0/0/1]quit
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]undo shutdown
```

```
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]undo shutdown
[R2]interface Serial 2/0/0
[R2-Serial2/0/0]undo shutdown

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]undo ip address
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]shutdown
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]undo shutdown
```

Step 3 **Establish additional logical interfaces.**

```
[R1-LoopBack0]interface loopback 1
[R1-LoopBack1]ip address 10.0.11.11 24

[R3-LoopBack0]interface loopback 1
[R3-LoopBack1]ip address 10.0.33.33 24
```

Step 4 **Configure OSPF.**

Use the IP address of Loopback 0 as the router ID, use the default OSPF process (1), and specify the public network segments 10.0.12.0/24, and 10.0.23.0/24 as part of OSPF area 0.

```
[R1]ospf router-id 10.0.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.12.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 10.0.1.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 10.0.11.0 0.0.0.255

[R2]ospf router-id  10.0.2.2
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.2.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network  10.0.12.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network  10.0.23.0 0.0.0.255

[R3]ospf router-id  10.0.3.3
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network  10.0.23.0 0.0.0.255
```

```
[R3-ospf-1-area-0.0.0.0]network  10.0.3.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]network  10.0.33.0 0.0.0.255
```

After OSPF route convergence is complete, view the configuration.

```
<R2>display ospf peer brief
        OSPF Process 1 with Router ID 10.0.2.2
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          Serial1/0/0                    10.0.1.1        Full
 0.0.0.0          Serial2/0/0                    10.0.3.3        Full
 ----------------------------------------------------------------------------

<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 17       Routes : 17

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.2.2/32     OSPF    10   781         D   10.0.12.2       Serial1/0/0
    10.0.3.3/32     OSPF    10   2343        D   10.0.12.2       Serial1/0/0
    10.0.11.0/24    Direct  0    0           D   10.0.11.11      LoopBack1
    10.0.11.11/32   Direct  0    0           D   127.0.0.1       LoopBack1
    10.0.11.255/32  Direct  0    0           D   127.0.0.1       LoopBack1
    10.0.12.0/24    Direct  0    0           D   10.0.12.1       Serial1/0/0
    10.0.12.1/32    Direct  0    0           D   127.0.0.1       Serial1/0/0
    10.0.12.2/32    Direct  0    0           D   10.0.12.2       Serial1/0/0
    10.0.12.255/32  Direct  0    0           D   127.0.0.1       Serial1/0/0
    10.0.23.0/24    OSPF    10   2343        D   10.0.12.2       Serial1/0/0
    10.0.33.33/32   OSPF    10   2343        D   10.0.12.2       Serial1/0/0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

If the baudrate is maintained as 128000 from lab 6-1, the OSPF cost will be set as shown, and thus may vary due to the the metric calculation used by OSPF.

```
<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 17        Routes : 17

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.1/32   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.2.2/32   OSPF    10   1562        D   10.0.23.2       Serial2/0/0
      10.0.3.0/24   Direct  0    0           D   10.0.3.3        LoopBack0
      10.0.3.3/32   Direct  0    0           D   127.0.0.1       LoopBack0
      10.0.3.255/32 Direct  0    0           D   127.0.0.1       LoopBack0
      10.0.11.11/32 OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.12.0/24  OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.23.0/24  Direct  0    0           D   10.0.23.3       Serial2/0/0
      10.0.23.2/32  Direct  0    0           D   10.0.23.2       Serial2/0/0
      10.0.23.3/32  Direct  0    0           D   127.0.0.1       Serial2/0/0
      10.0.23.255/32 Direct 0    0           D   127.0.0.1       Serial2/0/0
      10.0.33.0/24  Direct  0    0           D   10.0.33.33      LoopBack1
      10.0.33.33/32 Direct  0    0           D   127.0.0.1       LoopBack1
      10.0.33.255/32 Direct 0    0           D   127.0.0.1       LoopBack1
      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
```

Step 5 **Configure the ACL to define interesting traffic**

An advanced ACL is created to identify interesting traffic for which the IPsec VPN will be applied. The advanced ACL is capable of filtering based on specific parameters for selective traffic filtering.

```
[R1]acl 3001
[R1-acl-adv-3001]rule 5 permit ip source 10.0.1.0 0.0.0.255 destination 10.0.3.0
0.0.0.255

[R3]acl 3001
[R3-acl-adv-3001]rule 5 permit ip source 10.0.3.0 0.0.0.255 destination 10.0.1.0
0.0.0.255
```

Step 6 **Configure IPsec VPN Proposal**

Create an IPsec proposal and enter the IPsec proposal view to specify the security protocols to be used. Ensure both peers use the same protocols.

```
[R1]ipsec proposal tran1
[R1-ipsec-proposal-tran1]esp authentication-algorithm sha1
[R1-ipsec-proposal-tran1]esp encryption-algorithm 3des

[R3]ipsec proposal tran1
[R3-ipsec-proposal-tran1]esp authentication-algorithm sha1
[R3-ipsec-proposal-tran1]esp encryption-algorithm 3des
```

Run the **display ipsec proposal** command to verify the configuration.

```
[R1]display ipsec proposal

Number of proposals: 1

IPSec proposal name :   tran1
 Encapsulation mode :   Tunnel
 Transform          :   esp-new
 ESP protocol       :   Authentication SHA1-HMAC-96
                        Encryption    3DES

[R3]display ipsec proposal

Number of proposals: 1

IPSec proposal name :   tran1
 Encapsulation mode :   Tunnel
 Transform          :   esp-new
 ESP protocol       :   Authentication SHA1-HMAC-96
                        Encryption    3DES
```

Step 7 **IPsec Policy Creation**

Create an IPsec policy and define the parameters for establishing the SA.

```
[R1]ipsec  policy P1 10 manual
[R1-ipsec-policy-manual-P1-10]security acl 3001
[R1-ipsec-policy-manual-P1-10]proposal tran1
[R1-ipsec-policy-manual-P1-10]tunnel remote 10.0.23.3
```

```
[R1-ipsec-policy-manual-P1-10]tunnel local 10.0.12.1
[R1-ipsec-policy-manual-P1-10]sa spi outbound esp 54321
[R1-ipsec-policy-manual-P1-10]sa spi inbound esp 12345
[R1-ipsec-policy-manual-P1-10]sa string-key outbound esp simple huawei
[R1-ipsec-policy-manual-P1-10]sa string-key inbound esp simple huawei

[R3]ipsec  policy P1 10 manual
[R3-ipsec-policy-manual-P1-10]security acl 3001
[R3-ipsec-policy-manual-P1-10]proposal tran1
[R3-ipsec-policy-manual-P1-10]tunnel remote 10.0.12.1
[R3-ipsec-policy-manual-P1-10]tunnel local 10.0.23.3
[R3-ipsec-policy-manual-P1-10]sa spi outbound esp 12345
[R3-ipsec-policy-manual-P1-10]sa spi inbound esp 54321
[R3-ipsec-policy-manual-P1-10]sa string-key outbound esp simple huawei
[R3-ipsec-policy-manual-P1-10]sa string-key inbound esp simple huawei
```

Run the **display ipsec policy** command to verify the configuration.

```
<R1>display ipsec policy

==========================================
IPSec policy group: "P1"
Using interface:
==========================================

    Sequence number: 10
    Security data flow: 3001
    Tunnel local  address: 10.0.12.1
    Tunnel remote address: 10.0.23.3
    Qos pre-classify: Disable
    Proposal name:tran1
    Inbound AH setting:
      AH SPI:
      AH string-key:
      AH authentication hex key:
    Inbound ESP setting:
      ESP SPI: 12345 (0x3039)
      ESP string-key: huawei
      ESP encryption hex key:
      ESP authentication hex key:
    Outbound AH setting:
      AH SPI:
      AH string-key:
```

```
    AH authentication hex key:
  Outbound ESP setting:
    ESP SPI: 54321 (0xd431)
    ESP string-key: huawei
    ESP encryption hex key:
    ESP authentication hex key:

<R3>display ipsec policy

==============================================
IPSec policy group: "P1"
Using interface:
==============================================

  Sequence number: 10
  Security data flow: 3001
  Tunnel local  address: 10.0.23.3
  Tunnel remote address: 10.0.12.1
  Qos pre-classify: Disable
  Proposal name:tran1
  Inbound AH setting:
    AH SPI:
    AH string-key:
    AH authentication hex key:
  Inbound ESP setting:
    ESP SPI: 54321 (0xd431)
    ESP string-key: huawei
    ESP encryption hex key:
    ESP authentication hex key:
  Outbound AH setting:
    AH SPI:
    AH string-key:
    AH authentication hex key:
  Outbound ESP setting:
    ESP SPI: 12345 (0x3039)
    ESP string-key: huawei
    ESP encryption hex key:
    ESP authentication hex key:
```

Step 8 **Applying IPsec Policies to Interfaces**

Apply the policy to the physical interface upon which traffic will be subjected to IPsec processing.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ipsec policy P1

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]ipsec policy P1
```

Step 9 **Test connectivity between the IP networks.**

Observe and verity that non-interesting traffic bypasses the IPsec processing.

```
<R1>ping -a 10.0.11.11 10.0.33.33
  PING 10.0.33.33: 56  data bytes, press CTRL_C to break
    Reply from 10.0.33.33: bytes=56 Sequence=1 ttl=254 time=60 ms
    Reply from 10.0.33.33: bytes=56 Sequence=2 ttl=254 time=50 ms
    Reply from 10.0.33.33: bytes=56 Sequence=3 ttl=254 time=50 ms
    Reply from 10.0.33.33: bytes=56 Sequence=4 ttl=254 time=60 ms
    Reply from 10.0.33.33: bytes=56 Sequence=5 ttl=254 time=50 ms
  --- 10.0.33.33 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 50/54/60 ms

<R1>display ipsec statistics esp
 Inpacket count             : 0
 Inpacket auth count        : 0
 Inpacket decap count       : 0
 Outpacket count            : 0
 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
```

Observe that only the interesting traffic will be secured by the IPsec VPN.

```
<R1>ping -a 10.0.1.1 10.0.3.3
  PING 10.0.3.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.3.3: bytes=56 Sequence=1 ttl=255 time=80 ms
    Reply from 10.0.3.3: bytes=56 Sequence=2 ttl=255 time=77 ms
    Reply from 10.0.3.3: bytes=56 Sequence=3 ttl=255 time=77 ms
    Reply from 10.0.3.3: bytes=56 Sequence=4 ttl=255 time=80 ms
    Reply from 10.0.3.3: bytes=56 Sequence=5 ttl=255 time=77 ms
  --- 10.0.3.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 77/78/80 ms

<R1>display ipsec statistics esp
 Inpacket count             : 5
 Inpacket auth count        : 0
 Inpacket decap count       : 0
 Outpacket count            : 5
 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
```

Step 10 **Redefine interesting traffic**

Change the ACL to define OSPF traffic as interesting traffic.

```
[R1]acl 3001
[R1-acl-adv-3001]rule 5 permit ospf source  any  destination any

[R3]acl 3001
[R3-acl-adv-3001]rule 5 permit ospf source  any  destination any
```

```
<R1>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.1.1
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id         Interface                     Neighbor id     State
 0.0.0.0         Serial1/0/0                    10.0.2.2        Init
 ----------------------------------------------------------------------------

<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14      Routes : 14

Destination/Mask    Proto   Pre Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0   0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.1.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.11.0/24    Direct  0   0           D   10.0.11.11      LoopBack1
    10.0.11.11/32   Direct  0   0           D   127.0.0.1       LoopBack1
    10.0.11.255/32  Direct  0   0           D   127.0.0.1       LoopBack1
    10.0.12.0/24    Direct  0   0           D   10.0.12.1       Serial1/0/0
    10.0.12.1/32    Direct  0   0           D   127.0.0.1       Serial1/0/0
    10.0.12.2/32    Direct  0   0           D   10.0.12.2       Serial1/0/0
    10.0.12.255/32  Direct  0   0           D   127.0.0.1       Serial1/0/0
    127.0.0.0/8     Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0   0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0

<R3>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.3.3
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id         Interface                     Neighbor id     State
 0.0.0.0         Serial2/0/0                    10.0.2.2        Init
 ----------------------------------------------------------------------------
```

```
<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 14        Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.3.0/24     Direct  0    0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.3.255/32   Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.23.0/24    Direct  0    0           D   10.0.23.3       Serial2/0/0
    10.0.23.2/32    Direct  0    0           D   10.0.23.2       Serial2/0/0
    10.0.23.3/32    Direct  0    0           D   127.0.0.1       Serial2/0/0
    10.0.23.255/32  Direct  0    0           D   127.0.0.1       Serial2/0/0
    10.0.33.0/24    Direct  0    0           D   10.0.33.33      LoopBack1
    10.0.33.33/32   Direct  0    0           D   127.0.0.1       LoopBack1
    10.0.33.255/32  Direct  0    0           D   127.0.0.1       LoopBack1
    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
```

OSPF hello messages fail to be encapsulated using IPsec, causing the link state to fail, returning OSPF to an Init state and effectively breaking the established OSPF adjacent relationship of R1 and R3 with R2. Lab 7-5 will introduce solutions to the problem of dynamic routing over IPsec VPN.

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
acl number 3001
 rule 5 permit ospf
#
ipsec proposal tran1
 esp authentication-algorithm sha1
 esp encryption-algorithm 3des
```

```
#
ipsec policy P1 10 manual
 security acl 3001
 proposal tran1
 tunnel local 10.0.12.1
 tunnel remote 10.0.23.3
 sa spi inbound esp 12345
 sa string-key inbound esp simple huawei
 sa spi outbound esp 54321
 sa string-key outbound esp simple huawei
#
interface Serial1/0/0
 link-protocol ppp
 ppp authentication-mode pap
 ip address 10.0.12.1 255.255.255.0
 ipsec policy P1
 baudrate 128000
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
interface LoopBack1
 ip address 10.0.11.11 255.255.255.0
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.1.0 0.0.0.255
  network 10.0.11.0 0.0.0.255
  network 10.0.12.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

```
<R2>display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
interface Serial1/0/0
 link-protocol ppp
 ppp pap local-user huawei password cipher %$%$u[hr6d<JVHR@->T7xr1<$.iv%$%$
 ip address 10.0.12.2 255.255.255.0
#
interface Serial2/0/0
 link-protocol ppp
 ppp chap user huawei
 ppp chap password cipher %$%$e{5h)gh"/Uz0mUC%vEx3$4<m%$%$
 ip address 10.0.23.2 255.255.255.0
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.0
#
ospf 1 router-id 10.0.2.2
 area 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
acl number 3001
 rule 5 permit ospf
#
ipsec proposal tran1
 esp authentication-algorithm sha1
```

```
 esp encryption-algorithm 3des
#
ipsec policy P1 10 manual
 security acl 3001
 proposal tran1
 tunnel local 10.0.23.3
 tunnel remote 10.0.12.1
 sa spi inbound esp 54321
 sa string-key inbound esp simple huawei
 sa spi outbound esp 12345
 sa string-key outbound esp simple huawei
#
interface Serial2/0/0
 link-protocol ppp
 ppp authentication-mode chap
 ip address 10.0.23.3 255.255.255.0
 ipsec policy P1
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
interface LoopBack1
 ip address 10.0.33.33 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.3.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
  network 10.0.33.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

Lab 3-5 Supporting Dynamic Routing with GRE

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of an ACL to support GRE encapsulation
- Establishment of a tunnel interface for GRE
- Implementation of the GRE keepalive feature.

Topology

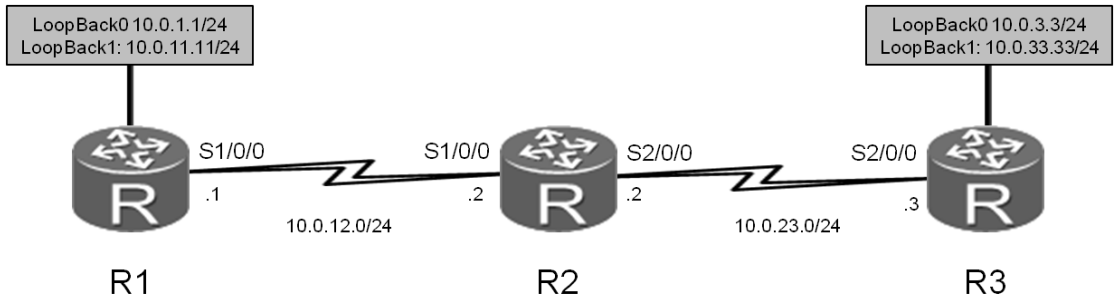


Figure 3.5 Dynamic routing with GRE topology

Scenario

A requirement has been made to allow networks from other offices to be advertised to the HQ. Following the implementation of IPsec VPN solutions, it was discovered that this was not possible. After some consultation the administrator has been advised to implement a GRE solution over the existing IPsec network to enable the enterprise offices to truly operate as a single administrative domain.

Tasks

Note: It is a prerequisite that lab 3-4 be completed before attempting this lab.

Step 1 Set GRE traffic as the interesting traffic

Reconfigure the access control list establish GRE encapsulation over IPsec.

```
[R1]acl 3001
[R1-acl-adv-3001]rule 5 permit gre source 10.0.12.1 0 destination 10.0.23.3 0

[R3]acl 3001
[R3-acl-adv-3001]rule 5 permit gre source 10.0.23.3 0 destination 10.0.12.1 0
```

Step 2 Configure a tunnel interface.

Create a tunnel interface and specify GRE as the encapsulation type. Set the tunnel source address or source interface, and set the tunnel destination address.

```
[R1]interface Tunnel 0/0/1
[R1-Tunnel0/0/1]ip address 100.1.1.1 24
[R1-Tunnel0/0/1]tunnel-protocol gre
[R1-Tunnel0/0/1]source 10.0.12.1
[R1-Tunnel0/0/1]destination 10.0.23.3

[R3]interface Tunnel 0/0/1
[R3-Tunnel0/0/1]ip address 100.1.1.2 24
[R3-Tunnel0/0/1]tunnel-protocol gre
[R3-Tunnel0/0/1]source 10.0.23.3
[R3-Tunnel0/0/1]destination 10.0.12.1
```

Step 3 Configure a second OSPF process to route the tunnel.

Add the tunnel interface network to OSPF 1 process, and create a second OSPF instance of the link state database (process 2) for the 10.0.12.0 and 10.0.23.0 networks, be sure to remove these networks from OSPF 1.

```
[R1]ospf 1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 100.1.1.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]undo network 10.0.12.0 0.0.0.255
[R1]ospf 2 router-id 10.0.1.1
[R1-ospf-2]area 0
[R1-ospf-2-area-0.0.0.0]network 10.0.12.0 0.0.0.255

[R3]ospf 1
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 100.1.1.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]undo network 10.0.23.0 0.0.0.255
[R3]ospf 2 router-id 10.0.3.3
[R3-ospf-2]area 0
[R3-ospf-2-area-0.0.0.0]network 10.0.23.0 0.0.0.255
```

OSPF LSDB are significant only to the local router, therefore allowing routes from OSPF LSDB 2 of R1 and R3 to reach OSPF LSDB 1 of R2.

Run the **display interface Tunnel 0/0/1** command to verify the configuration.

```
<R1>display interface Tunnel 0/0/1
Tunnel0/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-17 17:10:16
Description:HUAWEI, AR Series, Tunnel0/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 100.1.1.1/24
Encapsulation is TUNNEL, loopback not set
Tunnel source 10.0.12.1 (Serial1/0/0), destination 10.0.23.3
Tunnel protocol/transport GRE/IP, key disabled
keepalive disabled
Checksumming of packets disabled
Current system time: 2013-12-17 17:35:39
    Last 300 seconds input rate 0 bytes/sec, 0 packets/sec
    Last 300 seconds output rate 9 bytes/sec, 0 packets/sec
    Realtime 0 seconds input rate 0 bytes/sec, 0 packets/sec
    Realtime 0 seconds output rate 0 bytes/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 drops
    145 packets output, 14320 bytes, 0 drops
    Input bandwidth utilization  : --
    Output bandwidth utilization : --
```

```
<R3>display interface Tunnel 0/0/1
Tunnel0/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-17 17:10:40
Description:HUAWEI, AR Series, Tunnel0/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 100.1.1.2/24
Encapsulation is TUNNEL, loopback not set
Tunnel source 10.0.23.3 (Serial2/0/0), destination 10.0.12.1
Tunnel protocol/transport GRE/IP, key disabled
keepalive disabled
Checksumming of packets disabled
Current system time: 2013-12-17 17:36:44
    Last 300 seconds input rate 0 bytes/sec, 0 packets/sec
    Last 300 seconds output rate 9 bytes/sec, 0 packets/sec
    Realtime 0 seconds input rate 0 bytes/sec, 0 packets/sec
    Realtime 0 seconds output rate 0 bytes/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 drops
    162 packets output, 14420 bytes, 15 drops
    Input bandwidth utilization  : --
    Output bandwidth utilization : --
```

Step 4 **Verify that the routes are being carried via GRE**

Run the **display ip routing-table** command to check the IPv4 routing table.

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 21        Routes : 21

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.1.0/24  Direct  0    0           D   10.0.1.1        LoopBack0
        10.0.1.1/32  Direct  0    0           D   127.0.0.1       LoopBack0
      10.0.1.255/32  Direct  0    0           D   127.0.0.1       LoopBack0
        10.0.2.2/32  OSPF    10   781         D   10.0.12.2       Serial1/0/0
        10.0.3.3/32  OSPF    10   1562        D   100.1.1.2       Tunnel0/0/1
       10.0.11.0/24  Direct  0    0           D   10.0.11.11      LoopBack1
      10.0.11.11/32  Direct  0    0           D   127.0.0.1       LoopBack1
    10.0.11.255/32  Direct  0    0           D   127.0.0.1       LoopBack1
```

```
    10.0.12.0/24    Direct  0   0           D   10.0.12.1       Serial1/0/0
    10.0.12.1/32    Direct  0   0           D   127.0.0.1       Serial1/0/0
    10.0.12.2/32    Direct  0   0           D   10.0.12.2       Serial1/0/0
    10.0.12.255/32  Direct  0   0           D   127.0.0.1       Serial1/0/0
    10.0.23.0/24    OSPF    10  2343        D   10.0.12.2       Serial1/0/0
    10.0.33.33/32   OSPF    10  1562        D   100.1.1.2       Tunnel0/0/1
    100.1.1.0/24    Direct  0   0           D   100.1.1.1       Tunnel0/0/1
    100.1.1.1/32    Direct  0   0           D   127.0.0.1       Tunnel0/0/1
    100.1.1.255/32  Direct  0   0           D   127.0.0.1       Tunnel0/0/1
    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

<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 21       Routes : 21

Destination/Mask    Proto   Pre Cost      Flags NextHop         Interface

    10.0.1.1/32     OSPF    10  1562        D   100.1.1.1       Tunnel0/0/1
    10.0.2.2/32     OSPF    10  1562        D   10.0.23.2       Serial2/0/0
    10.0.3.0/24     Direct  0   0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.3.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.11.11/32   OSPF    10  1562        D   100.1.1.1       Tunnel0/0/1
    10.0.12.0/24    OSPF    10  3124        D   10.0.23.2       Serial2/0/0
    10.0.23.0/24    Direct  0   0           D   10.0.23.3       Serial2/0/0
    10.0.23.2/32    Direct  0   0           D   10.0.23.2       Serial2/0/0
    10.0.23.3/32    Direct  0   0           D   127.0.0.1       Serial2/0/0
    10.0.23.255/32  Direct  0   0           D   127.0.0.1       Serial2/0/0
    10.0.33.0/24    Direct  0   0           D   10.0.33.33      LoopBack1
    10.0.33.33/32   Direct  0   0           D   127.0.0.1       LoopBack1
    10.0.33.255/32  Direct  0   0           D   127.0.0.1       LoopBack1
    100.1.1.0/24    Direct  0   0           D   100.1.1.2       Tunnel0/0/1
    100.1.1.2/32    Direct  0   0           D   127.0.0.1       Tunnel0/0/1
    100.1.1.255/32  Direct  0   0           D   127.0.0.1       Tunnel0/0/1
    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
```

After a GRE tunnel is set up, the router can exchange OSPF packets through the GRE tunnel. Clear the IPsec statistics and test the connection

```
<R1>reset ipsec statistics esp
[R1]ping -a 10.0.1.1 10.0.3.3
  PING 10.0.3.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.3.3: bytes=56 Sequence=1 ttl=255 time=69 ms
    Reply from 10.0.3.3: bytes=56 Sequence=2 ttl=255 time=70 ms
    Reply from 10.0.3.3: bytes=56 Sequence=3 ttl=255 time=68 ms
    Reply from 10.0.3.3: bytes=56 Sequence=4 ttl=255 time=68 ms
    Reply from 10.0.3.3: bytes=56 Sequence=5 ttl=255 time=68 ms

  --- 10.0.3.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 68/68/70 ms

<R1>display ipsec statistics esp
 Inpacket count              : 8
 Inpacket auth count         : 0
 Inpacket decap count        : 0
 Outpacket count             : 8
 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
```

GRE encapsulates all OSPF traffic including the hello packets over IPsec, the gradual increment of the IPsec esp statistics verifies this.

Step 5 **Implement the keepalive feature on the GRE tunnel.**

```
[R1]interface Tunnel 0/0/1
[R1-Tunnel0/0/1]keepalive period 3
```

Verify that the keepalive feature has been enabled on the tunnel interface.

```
<R1>display interface Tunnel 0/0/1
Tunnel0/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2013-12-18 09:50:21
Description:HUAWEI, AR Series, Tunnel0/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 100.1.1.1/24
Encapsulation is TUNNEL, loopback not set
Tunnel source 10.0.12.1 (Serial1/0/0), destination 10.0.23.3
Tunnel protocol/transport GRE/IP, key disabled
keepalive enable period 3 retry-times 3
Checksumming of packets disabled
Current system time: 2013-12-18 11:05:49
    Last 300 seconds input rate 0 bytes/sec, 0 packets/sec
    Last 300 seconds output rate 8 bytes/sec, 0 packets/sec
    Realtime 0 seconds input rate 0 bytes/sec, 0 packets/sec
    Realtime 0 seconds output rate 0 bytes/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 drops
    503 packets output, 47444 bytes, 0 drops
    Input bandwidth utilization  : --
    Output bandwidth utilization : --
```

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
acl number 3001
 rule 5 permit gre source 10.0.12.1 0 destination 10.0.23.3 0
#
ipsec proposal tran1
 esp authentication-algorithm sha1
 esp encryption-algorithm 3des
#
ipsec policy P1 10 manual
 security acl 3001
 proposal tran1
```

```
 tunnel local 10.0.12.1
 tunnel remote 10.0.23.3
 sa spi inbound esp 12345
 sa string-key inbound esp simple huawei
 sa spi outbound esp 54321
 sa string-key outbound esp simple huawei
#
interface Serial1/0/0
 link-protocol ppp
 ppp authentication-mode pap
 ip address 10.0.12.1 255.255.255.0
 ipsec policy P1
 baudrate 128000
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
interface LoopBack1
 ip address 10.0.11.11 255.255.255.0
#
interface Tunnel0/0/1
 ip address 100.1.1.1 255.255.255.0
 tunnel-protocol gre
 keepalive period 3
 source 10.0.12.1
 destination 10.0.23.3
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.1.0 0.0.0.255
  network 10.0.11.0 0.0.0.255
  network 100.1.1.0 0.0.0.255
#
ospf 2 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.12.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
 authentication-mode aaa
```

```
#
return


<R2>display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
interface Serial1/0/0
 link-protocol ppp
 ppp pap local-user huawei password cipher %$%$u[hr6d<JVHR@->T7xr1<$.iv%$%$
 ip address 10.0.12.2 255.255.255.0
#
interface Serial2/0/0
 link-protocol ppp
 ppp chap user huawei
 ppp chap password cipher %$%$e{5h)gh"/Uz0mUC%vEx3$4<m%$%$
 ip address 10.0.23.2 255.255.255.0
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.0
#
ospf 1 router-id 10.0.2.2
 area 0.0.0.0
  network 10.0.2.0 0.0.0.255
  network 10.0.12.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return


<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
```

```
acl number 3001
 rule 5 permit gre source 10.0.23.3 0 destination 10.0.12.1 0
#
ipsec proposal tran1
 esp authentication-algorithm sha1
 esp encryption-algorithm 3des
#
ipsec policy P1 10 manual
 security acl 3001
 proposal tran1
 tunnel local 10.0.23.3
 tunnel remote 10.0.12.1
 sa spi inbound esp 54321
 sa string-key inbound esp simple huawei
 sa spi outbound esp 12345
 sa string-key outbound esp simple huawei
#
interface Serial2/0/0
 link-protocol ppp
 ppp authentication-mode chap
 ip address 10.0.23.3 255.255.255.0
 ipsec policy P1
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
interface LoopBack1
 ip address 10.0.33.33 255.255.255.0
#
interface Tunnel0/0/1
 ip address 100.1.1.2 255.255.255.0
 tunnel-protocol gre
 source 10.0.23.3
 destination 10.0.12.1
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.3.0 0.0.0.255
  network 10.0.33.0 0.0.0.255
  network 100.1.1.0 0.0.0.255
#
ospf 2 router-id 10.0.3.3
 area 0.0.0.0
```

```
  network 10.0.23.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

Module 4 Managing Enterprise Networks

Lab 4-1 Managing Networks with SNMP

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of an SNMP agent for a network element.
- Configuration of SNMP agent traps.
- Application of the NMS in managing network elements.

Topology

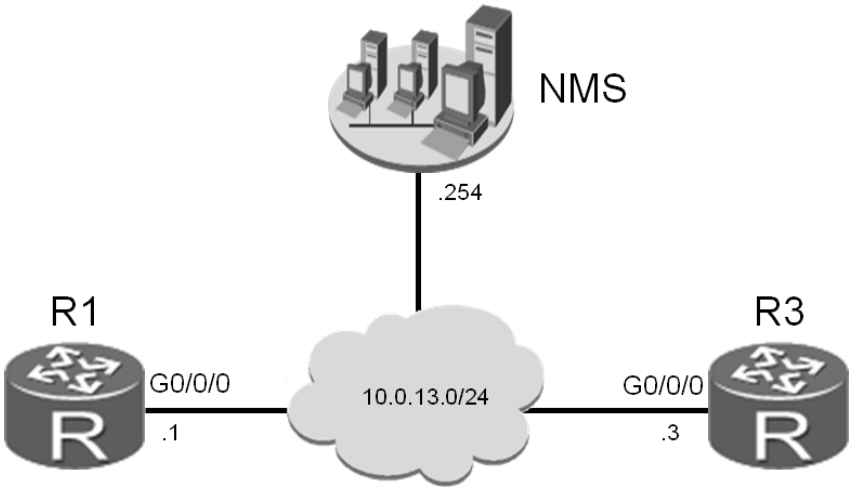


Figure 4.1 Network management with SNMP topology

Scenario

With the continued growth of the enterprise network it has become apparent that new measures need to be taken to manage and monitor the health of the network so as to minimize network downtime. The network administrator has decided that an NMS solution should be deployed, with tests performed to observe the basic capability of the NMS solution to monitor devices, before deploying the solution in the enterprise network.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
[Huawei]sysname R1
[R1]interface LoopBack 0
[R1-LoopBack0]ip address 10.0.1.1 24

<Huawei>system-view
[Huawei]sysname R3
[R3]interface LoopBack 0
[R3-LoopBack0]ip address 10.0.3.3 24
```

Step 2 Clean up the previous configuration

Disable the unused serial interfaces and remove the OSPF processes from all routers.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]shutdown
[R1-Serial1/0/0]quit
[R1]undo ospf 1
Warning: The OSPF process will be deleted. Continue? [Y/N]:y
[R1]undo ospf 2
Warning: The OSPF process will be deleted. Continue? [Y/N]:y

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]shutdown
[R3-Serial2/0/0]quit
[R3]undo ospf 1
Warning: The OSPF process will be deleted. Continue? [Y/N]:y
[R3]undo ospf 2
Warning: The OSPF process will be deleted. Continue? [Y/N]:y
```

Step 3 **Estabish routes between hosts and the NMS.**

Configure the IP address and route on the router, make sure the route between the device and the NMS is reachable.

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.13.1 24

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ip address 10.0.13.3 24

[R1]ospf
[R1]ospf 1 router-id 10.0.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.1.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 10.0.13.0 0.0.0.255

[R3]ospf 1 router-id 10.0.3.3
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.0.3.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]network 10.0.13.0 0.0.0.255
```

Test the network connectivity.

```
[R1]ping 10.0.13.254
  PING 10.0.13.254: 56  data bytes, press CTRL_C to break
    Reply from 10.0.13.254: bytes=56 Sequence=1 ttl=128 time=1 ms
    Reply from 10.0.13.254: bytes=56 Sequence=2 ttl=128 time=1 ms
    Reply from 10.0.13.254: bytes=56 Sequence=3 ttl=128 time=10 ms
    Reply from 10.0.13.254: bytes=56 Sequence=4 ttl=128 time=1 ms
    Reply from 10.0.13.254: bytes=56 Sequence=5 ttl=128 time=1 ms

  --- 10.0.13.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
     round-trip min/avg/max = 1/2/10 ms
```

Step 4 **Configure SNMP on R1.**

Enable the SNMP agent and confige the version SNMPv2c on the R1.

```
[R1]snmp-agent
[R1]snmp-agent sys-info version v2c
```

Configure SNMP read and write community

```
[R1]snmp-agent community read public
[R1]snmp-agent community write private
```

Enable the trap function of R1. Configure contact information about the device administrator.

```
[R1]snmp-agent trap enable
Info: All switches of SNMP trap/notification will be open. Continue? [Y/N]:y
[R1]snmp-agent trap queue-size 200
[R1]snmp-agent trap life 60
[R1]snmp-agent target-host trap-hostname NMS address 10.0.13.254 trap-paramsname
public
[R1]snmp-agent target-host trap-paramsname public v2c securityname public
[R1]snmp-agent sys-info contact Call the operator at 010-12345678
```

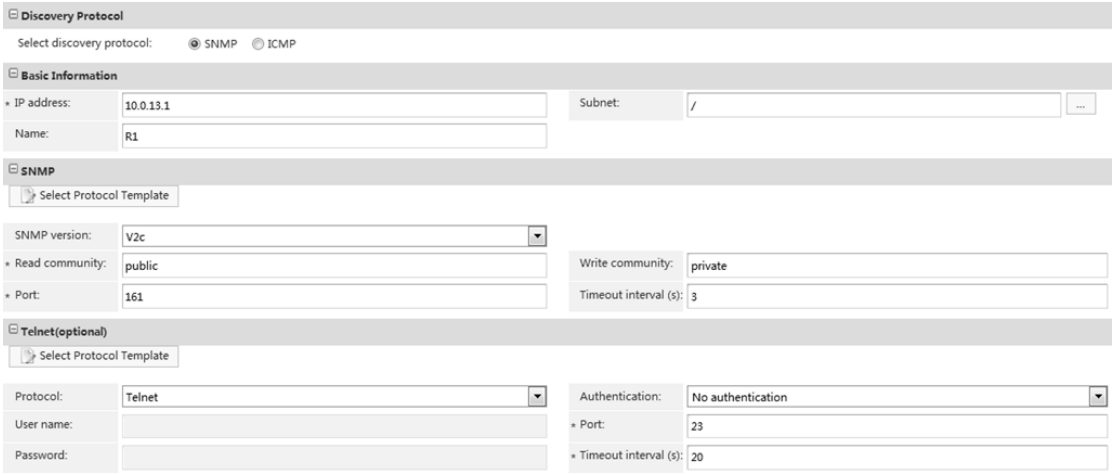
After the configuration is complete, run the following commands to verify that the configuration has taken effect.

```
<R1>display snmp-agent sys-info
   The contact person for this managed node:
          Call the operator at 010-12345678

   The physical location of this node:
          Shenzhen China

   SNMP version running in the system:
          SNMPv2c

<R1>display snmp-agent community write
   Community name: %$%$ZR)y~^VY9I"~n`=b`KR1(OX%%$%$
   Storage type: nonVolatile
   View name: ViewDefault
```

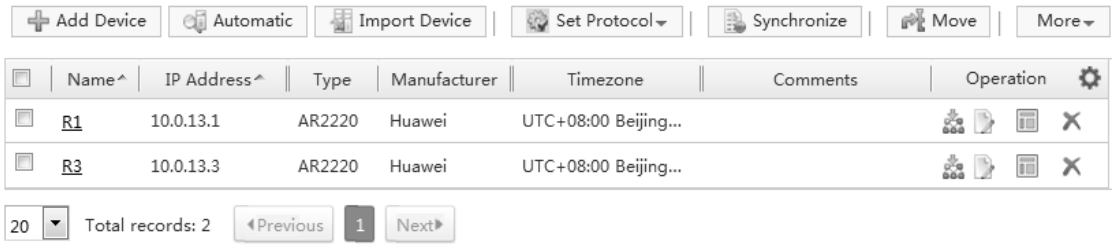
```
<R1>display snmp-agent target-host
   Traphost list:
   Target host name: NMS
   Traphost address: 10.0.13.254
   Traphost portnumber: 162
   Target host parameter: public

   Total number is 1

   Parameter list trap target host:
   Parameter name of the target host: public
   Message mode of the target host: SNMPV2C
   Trap version of the target host: v2c
   Security name of the target host: public

   Total number is 1
```

Step 5 **Configure Network Elements on the NMS**

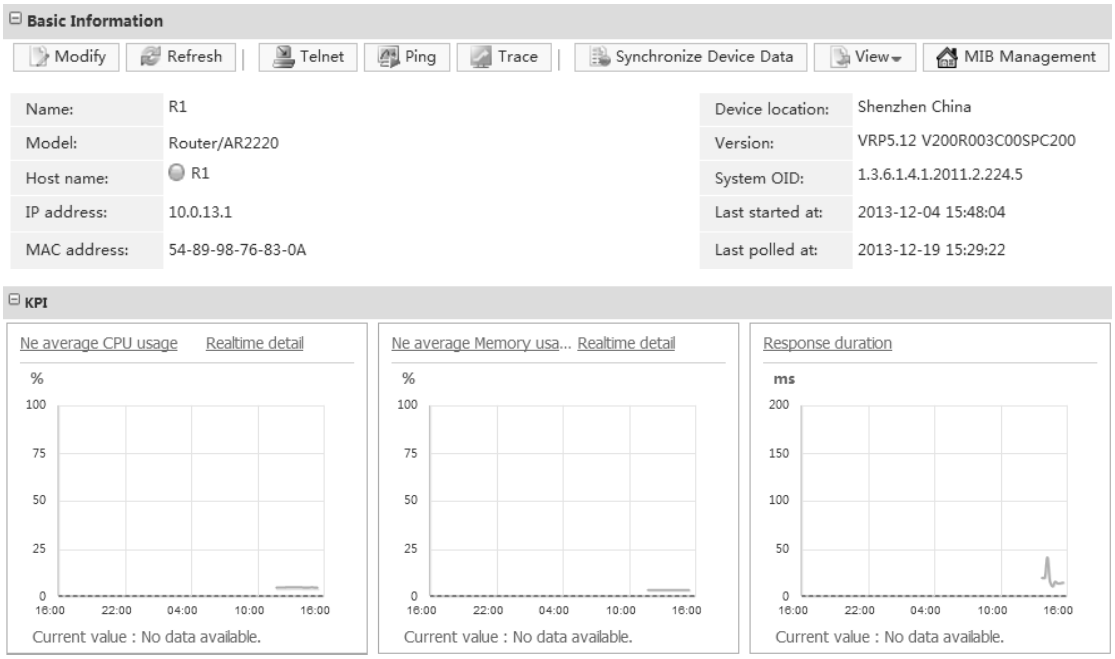
Under the Resource > Add Device > Single path, add the Network Element (NE) R1 and R3 to the NMS, and configure the SNMP parameters as shown.



Verify that the Network Elements have been added to the NMS under the Resource > Resource Management > Equipment Resources > NE Resources path.



Click on the resource name R1 and R3 to view the basic information.



Select the Interface Manager option under Device Config in the resource menu to the left of the screen. The given output represents a scenario in which all labs throughout the lab guide have been completed in succession, thus producing multiple addresses.

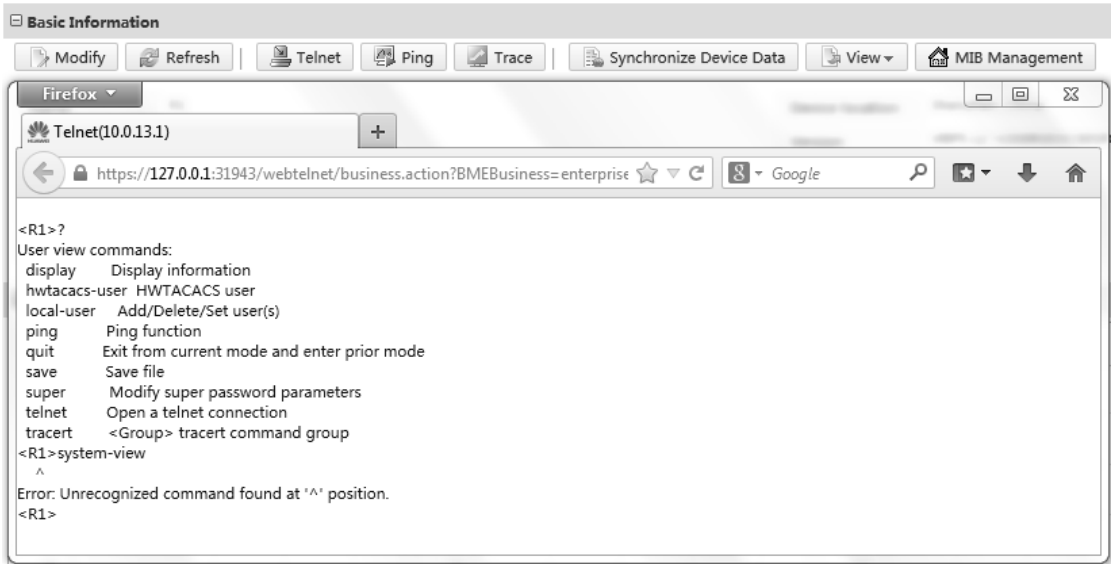
Index	Name	Alias	Operational Status	Admin Status	IP Address	Rate (bit/s)	Operation
1	InLoopBack0	HUAWEI, AR Series,...	up	up	127.0.0.1	0	
2	NULL0	HUAWEI, AR Series,...	up	up		0	
3	GigabitEthernet0/0/0	HUAWEI, AR Series,...	up	up	10.0.13.1	100M	
4	GigabitEthernet0/0/1	HUAWEI, AR Series,...	up	up	10.0.4.1	1000M	
5	GigabitEthernet0/0/2	HUAWEI, AR Series,...	up	up		1000M	
6	Cellular0/0/0	HUAWEI, AR Series,...	down	up		10M	
7	Cellular0/0/1	HUAWEI, AR Series,...	down	up		10M	
8	Serial1/0/0	HUAWEI, AR Series,...	down	down	10.0.12.1	128K	
9	Serial3/0/0	HUAWEI, AR Series,...	up	up		64K	
10	Serial2/0/0	HUAWEI, AR Series,...	down	down	10.0.123.1	64K	
12	LoopBack0	HUAWEI, AR Series,...	up	up	10.0.1.1	0	
13	LoopBack1	HUAWEI, AR Series,...	up	up	10.0.11.11	0	
23	Tunnel0/0/1	HUAWEI, AR Series,...	down	up	100.1.1.1	64K	

Select the Telnet Parameters option under Protocol Parameters of the resource menu, to configure the telnet parameters for accessing each network element from the NMS. If the AAA local user authentication of lab 7-3 has been maintained in the current configuration, it can be applied as shown. Note: the password is huawei.

Optionally, if the AAA authentication is not present on the VTY interface of R1 and/or R3, a simple telnet authentication process can be applied as follows before registering the telnet parameters in the NMS.

```
[R1]user-interface vty 0 4
[R1-ui-vty0-4]authentication-mode password
[R1-ui-vty0-4]set authentication password cipher huawei
[R1-ui-vty0-4]user privilege level 0
```

The telnet feature in the Basic Information panel of the resource menu grants remote management of the NE via the NMS, however privileges currently prevent configuration.



If the AAA configuration has been maintained from lab 7-3, first increase the privilege from level 0 to level 3.

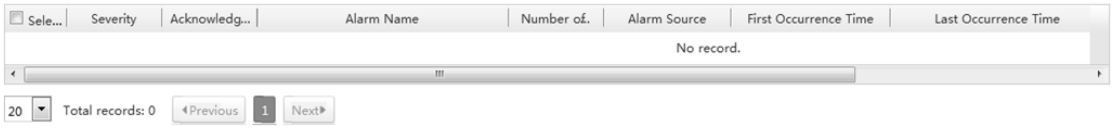
```
[R1]aaa
[R1-aaa]local-user user1@huawei privilege level 3
```

Alternatively, if the simple telnet authentication process has been used, change the privilege on the VTY user interface.

```
[R1-ui-vty0-4]user privilege level 3
```

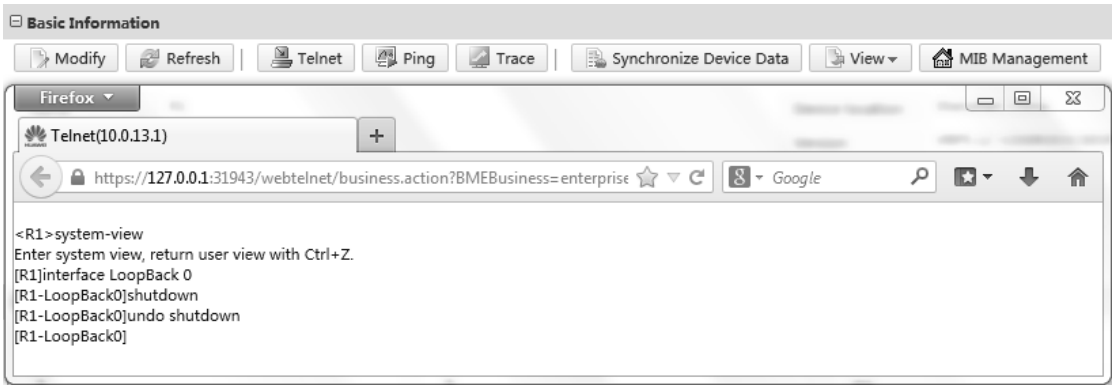
Step 6 **Manage Basic NMS Trap Functions**

Changes that occur to the NE can be monitored in the NMS using traps which trigger alarms. Select the Alarm List from the view panel from the resource menu .



Currently no alarms are recorded. Access the NE through the telnet feature in the NMS and shut down the loopback 0 interface to trigger alarms on the NMS.

```
[R1]interface LoopBack 0
[R1-LoopBack0]shutdown
[R1-LoopBack0]undo shutdown
```



Verify that the relevant alarms have been generated in the Alarm List for the resource, once the interface state has been changed.

Sele...	Severity	Acknowledg...	Alarm Name	Number of...	Alarm Source	First Occurrence Time	Last Occurrence Time
	Major		OSPF Interface State Changed	2	R1	2013-12-19 17:35:34	2013-12-19 17:35:55
	Critical		Link Down	1	R1	2013-12-19 17:35:38	2013-12-19 17:35:38

Additional Exercises: Analyzing and Verifying

If the interface of R1 that is linked to the NMS is down, will the failure be detected by the NMS?

Final Configuration

```
<R1>dis current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
 snmp-agent local-engineid 800007DB0354899876830A
 snmp-agent community read %$%$><Oc4D:9(4}bjw"Bu'd7(ONp%$%$
 snmp-agent community write %$%$ZR)y~^VY9I"~n`=b`KR1(OX%%$%$
 snmp-agent sys-info contact Call the operator at 010-12345678
 snmp-agent sys-info version v2c
 snmp-agent target-host trap-hostname NMS address 10.0.13.254 udp-port 162
trap-paramsname public
 snmp-agent target-host trap-paramsname public v2c securityname public
 snmp-agent trap enable
 snmp-agent trap queue-size 200
 snmp-agent trap life 60
 snmp-agent
#
aaa
 authentication-scheme default
 authentication-scheme auth1
 authorization-scheme default
 authorization-scheme auth2
 accounting-scheme default
 domain default
 domain default_admin
 domain huawei
```

```
  authentication-scheme auth1
  authorization-scheme auth2
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$B:%I)Io0H8)[%SB[idM3C/!#%$%$
 local-user huawei service-type ppp
 local-user user1@huawei password cipher %$%$^L*5IP'0^A!;R)R*L=LFcXgv%$%$
 local-user user1@huawei privilege level 3
 local-user user1@huawei service-type telnet
#
interface GigabitEthernet0/0/0
 ip address 10.0.13.1 255.255.255.0
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.1.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return


<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
 snmp-agent local-engineid 800007DB03548998768222
 snmp-agent community read %$%$I^)/SB#f|Q#U\*Fd^xVX(bwT%$%$
 snmp-agent community write %$%$,CnkQV6[!*c.&0/wn>HU(b{n%$%$
 snmp-agent sys-info contact Call the operator at 010-12345678
 snmp-agent sys-info version v2c
 snmp-agent target-host trap-hostname NMS address 10.0.13.254 udp-port 162
trap-paramsname public
```

```
 snmp-agent target-host trap-paramsname public v2c securityname public
 snmp-agent trap enable
 snmp-agent trap queue-size 200
 snmp-agent trap life 60
 snmp-agent
#
aaa
 authentication-scheme default
 authentication-scheme auth1
 authorization-scheme default
 authorization-scheme auth2
 accounting-scheme default
 domain default
 domain default_admin
 domain huawei
  authentication-scheme auth1
  authorization-scheme auth2
 local-user admin password cipher %$%$=i~>Xp&aY+*2cEVcS-A23Uwe%$%$
 local-user admin service-type http
 local-user huawei password cipher %$%$fZsyUk1=O=>:L4'ytgR~D*Im%$%$
 local-user huawei service-type ppp
 local-user user3@huawei password cipher %$%$WQt.;bEsR<8fz3LCiPY,che_%$%$
 local-user user3@huawei privilege level 3
 local-user user3@huawei service-type telnet
#
interface GigabitEthernet0/0/0
 ip address 10.0.13.3 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.3.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

Module 5 Establishing IPv6 Networks

Lab 5-1 Implementing IPv6 Networks and Solutions

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of basic IPv6 addressing.
- Configuration of the OSPFv3 routing protocol.
- Configuration of DHCPv6 server functions.
- Verification of the results using IPv6 display commands.

Topology

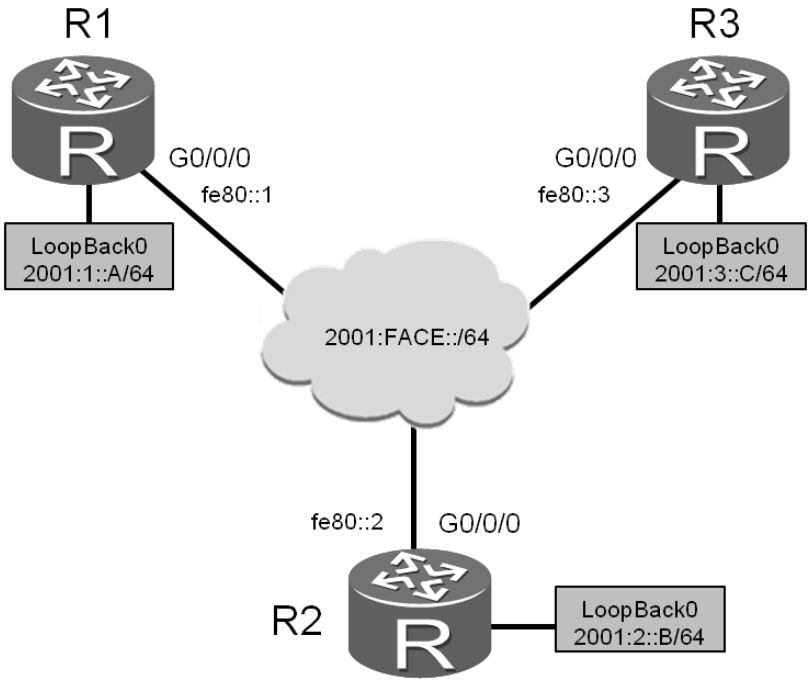


Figure 5-1 IPv6 topology

Scenario

In line with plans for deployment of solutions for next generation networks, it has been decided that the enterprise network should implement an IPv6 design to the existing infrastructure. As the administrator you have been tasked with the job of implementing the addressing scheme and routing for IPv6, as well as providing stateful addressing solutions for IPv6.

Tasks

Step 1 Preparing the environment

If you are starting this section with a non-configured device, begin here and then move to step 2. For those continuing from previous labs, begin at step 2.

```
<huawei>system-view
[huawei]sysname R1

<huawei>system-view
[huawei]sysname R2

<huawei>system-view
[huawei]sysname R3
```

Step 2 Configure IPv6 addressing

Establish IPv6 global unicast addressing on the loopback interfaces and manually configure link local addressing on interface Gigabit Ethernet 0/0/0 of all routers.

```
[R1]ipv6
[R1]interface loopback 0
[R1-LoopBack0]ipv6 enable
[R1-LoopBack0]ipv6 address 2001:1::A 64
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ipv6 enable
[R1-GigabitEthernet0/0/0]ipv6 address fe80::1 link-local
```

```
[R2]ipv6
[R2]interface loopback 0
[R2-LoopBack0]ipv6 enable
[R2-LoopBack0]ipv6 address 2001:2::B 64
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ipv6 enable
[R2-GigabitEthernet0/0/0]ipv6 address fe80::2 link-local


[R3]ipv6
[R3]interface loopback 0
[R3-LoopBack0]ipv6 enable
[R3-LoopBack0]ipv6 address 2001:3::C 64
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ipv6 enable
[R3-GigabitEthernet0/0/0]ipv6 address fe80::3 link-local


<R1>display ipv6 interface GigabitEthernet 0/0/0
GigabitEthernet0/0/0 current state : UP
IPv6 protocol current state : UP
IPv6 is enabled, link-local address is FE80::1
  No global unicast address configured
  Joined group address(es):
    FF02::1:FF00:1
    FF02::2
    FF02::1
  MTU is 1500 bytes
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
  ND retransmit interval is 1000 milliseconds
  Hosts use stateless autoconfig for addresses
```

IPv6 interfaces become part of various multicast groups for support of stateless address auto-configuration (SLAAC). The Network Discovery (ND) Duplicate Address Detection (DAD) verifies the link local address is unique.

Step 3 **Configure OSPFv3.**

Enable the OSPFv3 process and specify its router ID on R1, R2 and R3. OSPFv3 must then be enabled on the interface.

```
[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 loopback 0
[R1-LoopBack0]ospfv3 1 area 0

[R2]ospfv3 1
[R2-ospfv3-1]router-id 2.2.2.2
[R2-ospfv3-1]quit
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ospfv3 1 area 0
[R2-GigabitEthernet0/0/0]quit
[R2]interface loopback 0
[R2-LoopBack0]ospfv3 1 area 0

[R3]ospfv3 1
[R3-ospfv3-1]router-id 3.3.3.3
[R3-ospfv3-1]quit
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ospfv3 1 area 0
[R3-GigabitEthernet0/0/0]quit
[R3]interface loopback 0
[R3-LoopBack0]ospfv3 1 area 0
```

Run the **display ospfv3 peer** command on R1 and R3 to verify the OSPFv3 peering has 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/Backup     00:00:30    GE0/0/0           0
3.3.3.3     1       Full/DROther    00:00:40    GE0/0/0           0
```

```
<R3>display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID Pri     State           Dead Time   Interface   Instance ID
1.1.1.1     1       Full/DR         00:00:32    GE0/0/0           0
2.2.2.2     1       Full/Backup     00:00:38    GE0/0/0           0
```

If 1.1.1.1 is not currently the DR, the following command can be used to reset the OSPFv3 process

```
<R1>reset ospfv3 1 graceful-restart
```

Test connectivity to the peer link local address and the global unicast address of interface LoopBack 0.

```
<R1>ping ipv6 fe80::3 -i GigabitEthernet 0/0/0
  PING fe80::3 : 56  data bytes, press CTRL_C to break
    Reply from FE80::3
    bytes=56 Sequence=1 hop limit=64  time = 2 ms
    Reply from FE80::3
    bytes=56 Sequence=2 hop limit=64  time = 2 ms
    Reply from FE80::3
    bytes=56 Sequence=3 hop limit=64  time = 11 ms
    Reply from FE80::3
    bytes=56 Sequence=4 hop limit=64  time = 2 ms
    Reply from FE80::3
    bytes=56 Sequence=5 hop limit=64  time = 2 ms

  --- fe80::3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/3/11 ms

<R1>ping ipv6 2001:3::C
  PING 2001:3::C : 56  data bytes, press CTRL_C to break
    Reply from 2001:3::C
    bytes=56 Sequence=1 hop limit=64  time = 11 ms
    Reply from 2001:3::C
    bytes=56 Sequence=2 hop limit=64  time = 6 ms
    Reply from 2001:3::C
    bytes=56 Sequence=3 hop limit=64  time = 2 ms
    Reply from 2001:3::C
```

```
  bytes=56 Sequence=4 hop limit=64  time = 2 ms
  Reply from 2001:3::C
  bytes=56 Sequence=5 hop limit=64  time = 6 ms

--- 2001:3::C ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 2/5/11 ms
```

Step 4 **Configure DHCPv6 to distribute IPv6 addresses.**

Enable the DHCPv6 Server function on R2 so that devices can be assigned IPv6 addresses using DHCPv6.

```
[R2]dhcp enable
[R2]dhcpv6 pool pool1
[R2-dhcpv6-pool-pool1]address prefix 2001:FACE::/64
[R2-dhcpv6-pool-pool1]dns-server 2001:444e:5300::1
[R2-dhcpv6-pool-pool1]excluded-address 2001:FACE::1
[R2-dhcpv6-pool-pool1]quit
```

Configure IPv6 functions on the GigabitEthernet 0/0/0 interface.
Enable the DHCPv6 server function on the interface.

```
[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]ipv6 address 2001:FACE::1 64
[R2-GigabitEthernet0/0/0]dhcpv6 server pool1
```

Enable the DHCPv6 client function on R1 and R3 so that devices can obtain IPv6 addresses using DHCPv6.

```
[R1]dhcp enable
[R1]interface gigabitethernet 0/0/0
[R1-GigabitEthernet0/0/0]ipv6 address auto dhcp

[R3]dhcp enable
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ipv6 address auto dhcp
```

Run the **display dhcpv6 pool** command on R2 to check information about the DHCPv6 address pool.

```
<R2>display dhcpv6 pool
DHCPv6 pool: pool1
  Address prefix: 2001:FACE::/64
    Lifetime valid 172800 seconds, preferred 86400 seconds
    2 in use, 0 conflicts
  Excluded-address 2001:FACE::1
  1 excluded addresses
  Information refresh time: 86400
  DNS server address: 2001:444E:5300::1
  Conflict-address expire-time: 172800
  Active normal clients: 2
```

Run the **display ipv6 interface brief** command on R1 and R3 to check the IPv6 address information.

```
[R1]display ipv6 interface brief
*down: administratively down
(l): loopback
(s): spoofing
Interface                   Physical            Protocol
GigabitEthernet0/0/0           up                  up
[IPv6 Address] 2001:FACE::2
LoopBack0                      up                  up(s)
[IPv6 Address] 2001:1::A

[R3]display ipv6 interface brief
*down: administratively down
(l): loopback
(s): spoofing
Interface                   Physical            Protocol
GigabitEthernet0/0/0           up                  up
[IPv6 Address] 2001:FACE::3
LoopBack0                      up                  up(s)
[IPv6 Address] 2001:3::C
```

Final Configuration

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
ipv6
#
dhcp enable
#
ospfv3 1
 router-id 1.1.1.1
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.13.1 255.255.255.0
 ipv6 address FE80::1 link-local
 ospfv3 1 area 0.0.0.0
 ipv6 address auto dhcp
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.1.1 255.255.255.0
 ipv6 address 2001:1::A/64
 ospfv3 1 area 0.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

```
<R2>display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
ipv6
#
dhcp enable
#
dhcpv6 pool pool1
 address prefix 2001:FACE::/64
 excluded-address 2001:FACE::1
 dns-server 2001:444E:5300::1
#
ospfv3 1
 router-id 2.2.2.2
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.13.2 255.255.255.0
 ipv6 address 2001:FACE::1/64
 ipv6 address FE80::2 link-local
 ospfv3 1 area 0.0.0.0
 traffic-filter inbound acl 3000
 dhcpv6 server pool1
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.2.2 255.255.255.0
 ipv6 address 2001:2::B/64
 ospfv3 1 area 0.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return
```

```
<R3>display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
ipv6
#
dhcp enable
#
ospfv3 1
 router-id 3.3.3.3
#
interface GigabitEthernet0/0/0
 ipv6 enable
 ip address 10.0.13.3 255.255.255.0
 ipv6 address FE80::3 link-local
 ospfv3 1 area 0.0.0.0
 ipv6 address auto dhcp
#
interface LoopBack0
 ipv6 enable
 ip address 10.0.3.3 255.255.255.0
 ipv6 address 2001:3::C/64
 ospfv3 1 area 0.0.0.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
 authentication-mode aaa
#
return
```

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