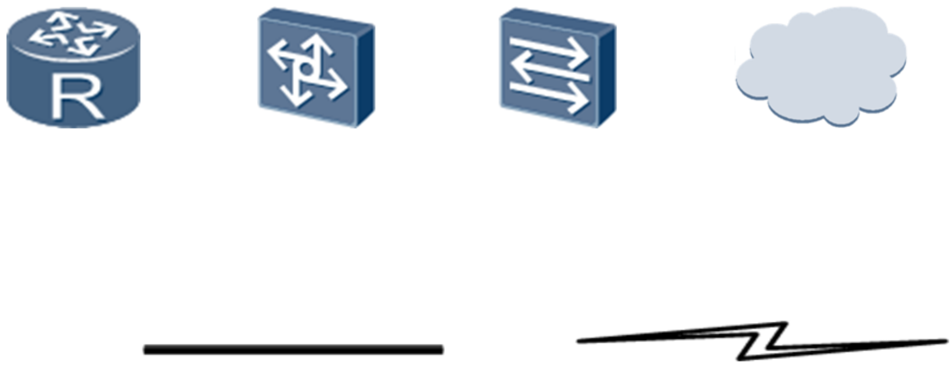
路由交换
实验指导书

HUAWEI

华为技术有限公司

本书常用图标



实验环境说明

组网介绍

本实验环境面向准备HCNA-HNTD考试的网络工程师，内容由HCNA-HNTD的VRP基础操作、路由协议原理、以太网交换技术、广域网技术、网络安全技术等部分的实验组成。

实验设备包括路由器3台，交换机4台。每套实验环境适用于2名学员同时上机操作。

设备介绍

为了满足HCNA-HNTD实验需要，建议每套实验环境采用以下配置：

设备名称、型号与版本的对应关系如下：

设备名称	设备型号	软件版本
R1	AR 2220	Version 5.120 (V200R003C00SPC200)
R2	AR 2220	Version 5.120 (V200R003C00SPC200)
R3	AR 2220	Version 5.120 (V200R003C00SPC200)
S1	S5700-28C-EI-24S	Version 5.70 (V100R006C00SPC800)
S2	S5700-28C-EI-24S	Version 5.70 (V100R006C00SPC800)
S3	S3700-28TP-EI-AC	Version 5.70 (V100R006C00SPC800)
S4	S3700-28TP-EI-AC	Version 5.70 (V100R006C00SPC800)

目录

实验一 使用eNSP搭建基础网络

实验 1-1 搭建基础 IP 网络

学习目标

- 掌握eNSP模拟器的基本设置方法
- 掌握使用eNSP搭建简单的端到端网络的方法
- 掌握在eNSP中使用Wireshark捕获IP报文的方法

场景

在本实验中，您将熟悉华为eNSP模拟器的基本使用，并使用模拟器自带的抓包软件捕获网络中的报文，以便更好地理解IP网络的工作原理。

操作步骤

.步骤一 启动 eNSP

本步骤介绍eNSP模拟器的启动与初始化界面。通过模拟器的使用将能够帮助您快速学习与掌握TCP/IP的原理知识，熟悉网络中的各种操作。

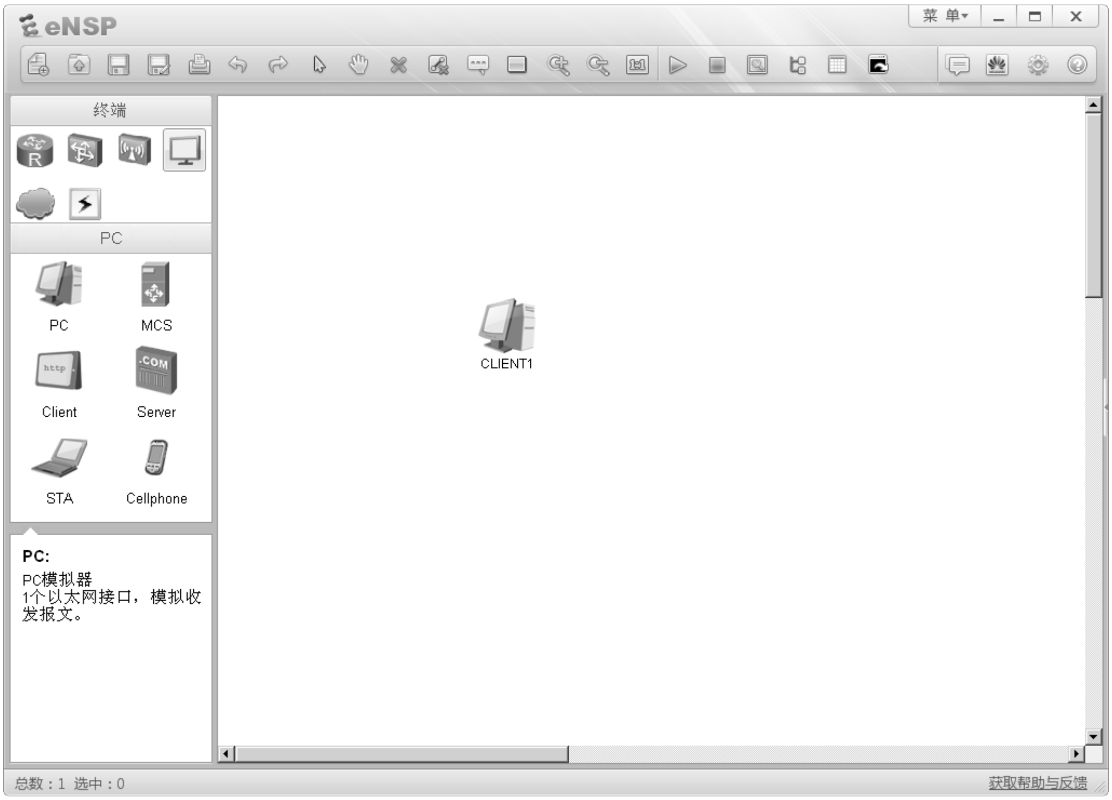
开启eNSP后，您将看到如下界面。左侧面板中的图标代表eNSP所支持的各种产品及设备。中间面板则包含多种网络场景的样例。

单击窗口左上角的“新建”图标，创建一个新的实验场景。

您可以在弹出的空白界面上搭建网络拓扑图，练习组网，分析网络行为。在本示例中，您需要使用两台终端系统建立一个简单的端到端网络。

.步骤二　建立拓扑

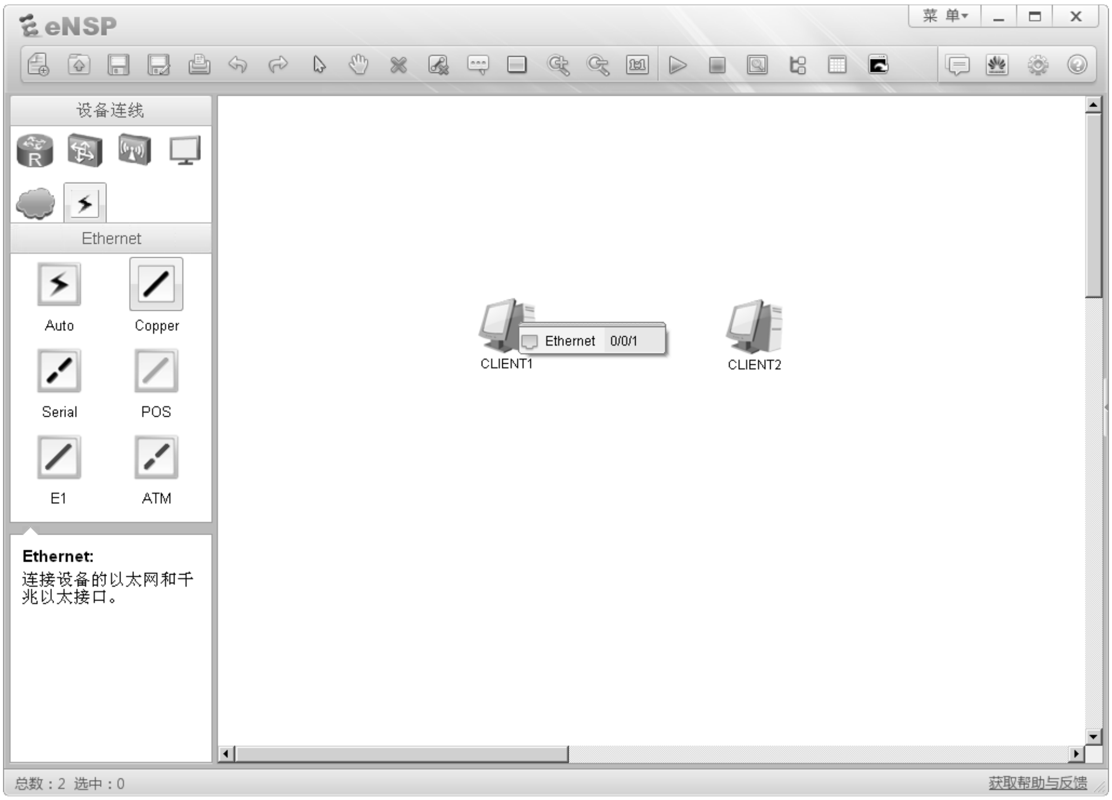
在左侧面板顶部，单击“终端”图标。在显示的终端设备中，选中“PC”图标，把图标拖动到空白界面上。



使用相同步骤，再拖动一个PC图标到空白界面上，建立一个端到端网络拓扑。PC设备模拟的是终端主机，可以再现真实的操作场景。

.步骤三　建立一条物理连接

在左侧面板顶部，单击“设备连线”图标。在显示的媒介中，选择“Copper (Ethernet)”图标。单击图标后，光标代表一个连接器。单击客户端设备，会显示该模拟设备包含的所有端口。单击“Ethernet 0/0/1”选项，连接此端口。

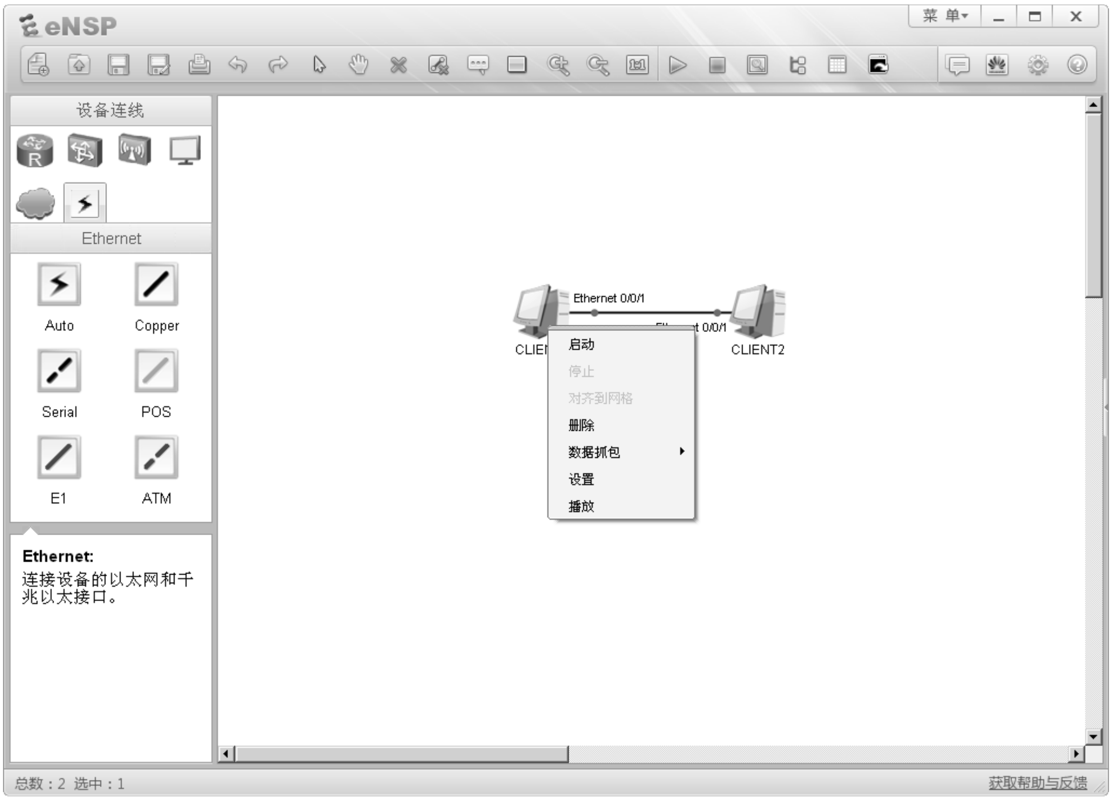


单击另外一台设备并选择“Ethernet 0/0/1”端口作为该连接的终点，此时，两台设备间的连接完成。

可以观察到，在已建立的端到端网络中，连线的两端显示的是两个红点，表示该连线连接的两个端口都处于Down状态。

.步骤四　进入终端系统配置界面

右击一台终端设备，在弹出的属性菜单中选择“设置”选项，查看该设备的系统配置信息。



弹出的设置属性窗口包含“基础配置”、“命令行”、“组播”、与“UDP发包工具”四个标签页，分别用于不同需求的配置。

.步骤五　配置终端系统

选择“基础配置”标签页，在“主机名”文本框中输入主机名称。在“IPv4配置”区域，单击“静态”选项按钮。在“IP地址”文本框中输入IP地址。建议按照下图所示配置IP地址及子网掩码。配置完成后，单击窗口右下角的“应用”按钮。再单击“CLIENT1”窗口右上角的关闭该窗口。

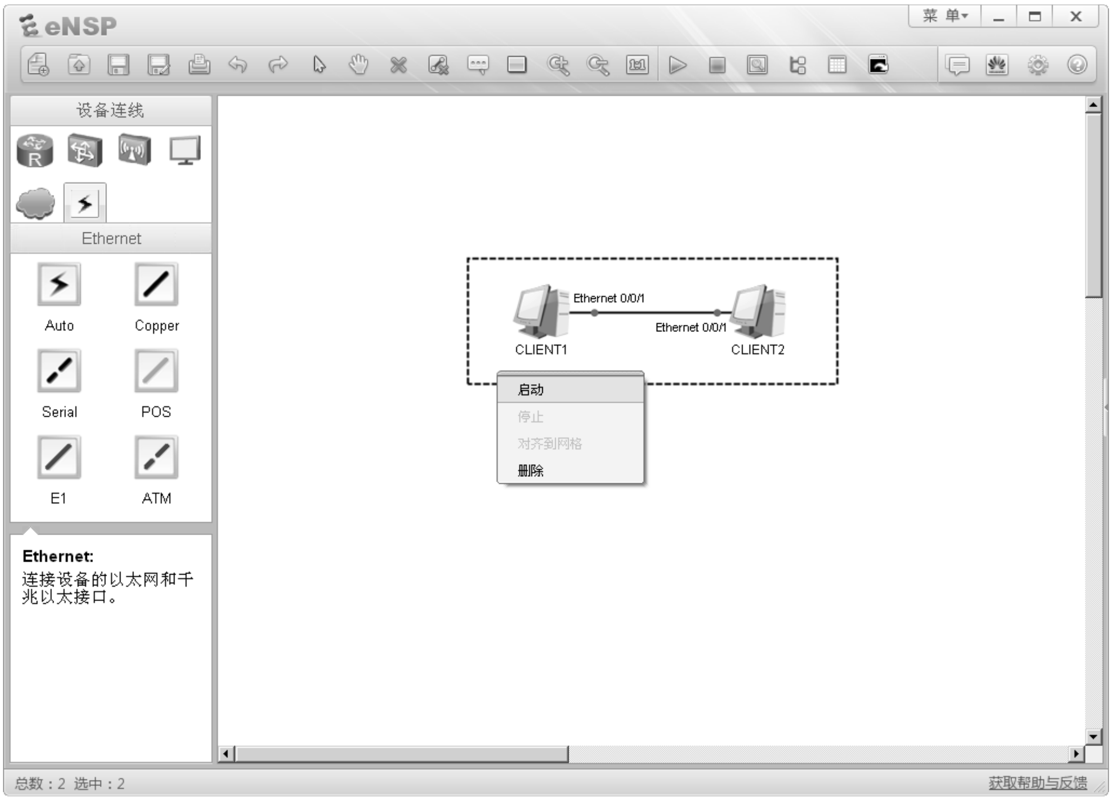
使用相同步骤配置CLIENT2。建议将CLIENT2的IP地址配置为192.168.1.2，子网掩码配置为255.255.255.0。

完成基础配置后，两台终端系统可以成功建立端到端通信。

.步骤六　启动终端系统设备

可以使用以下两种方法启动设备：

- 右击一台设备，在弹出的菜单中，选择“启动”选项，启动该设备。
- 拖动光标选中多台设备（如下图），通过右击显示菜单，选择“启动”选项，启动所有设备。

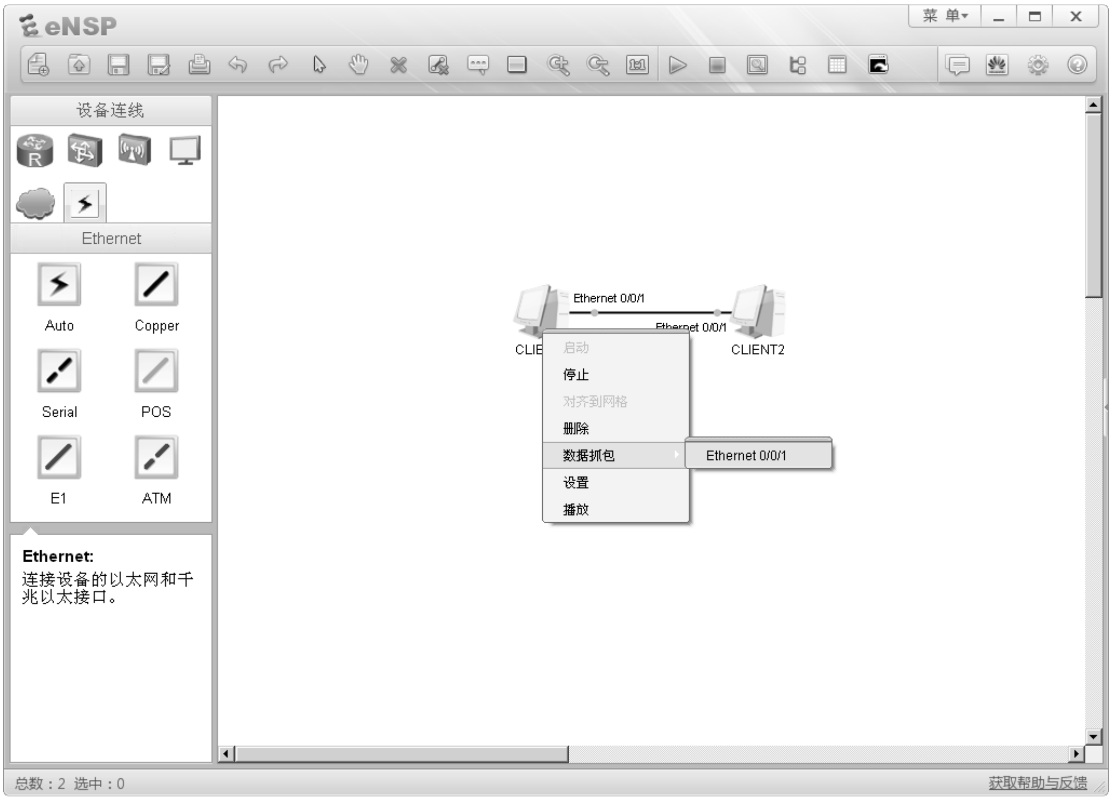


设备启动后，线缆上的红点将变为绿色，表示该连接为Up状态。

当网络拓扑中的设备变为可操作状态后，您可以监控物理链接中的接口状态与介质传输中的数据流。

.步骤七　捕获接口报文

选中设备并右击，在显示的菜单中单击“数据抓包”选项后，会显示设备上可用于抓包的接口列表。从列表中选择需要被监控的接口。



接口选择完成后，Wireshark抓包工具会自动激活，捕获选中接口所收发的所有报文。如需监控更多接口，重复上述步骤，选择不同接口即可，Wireshark将会为每个接口激活不同实例来捕获数据包。

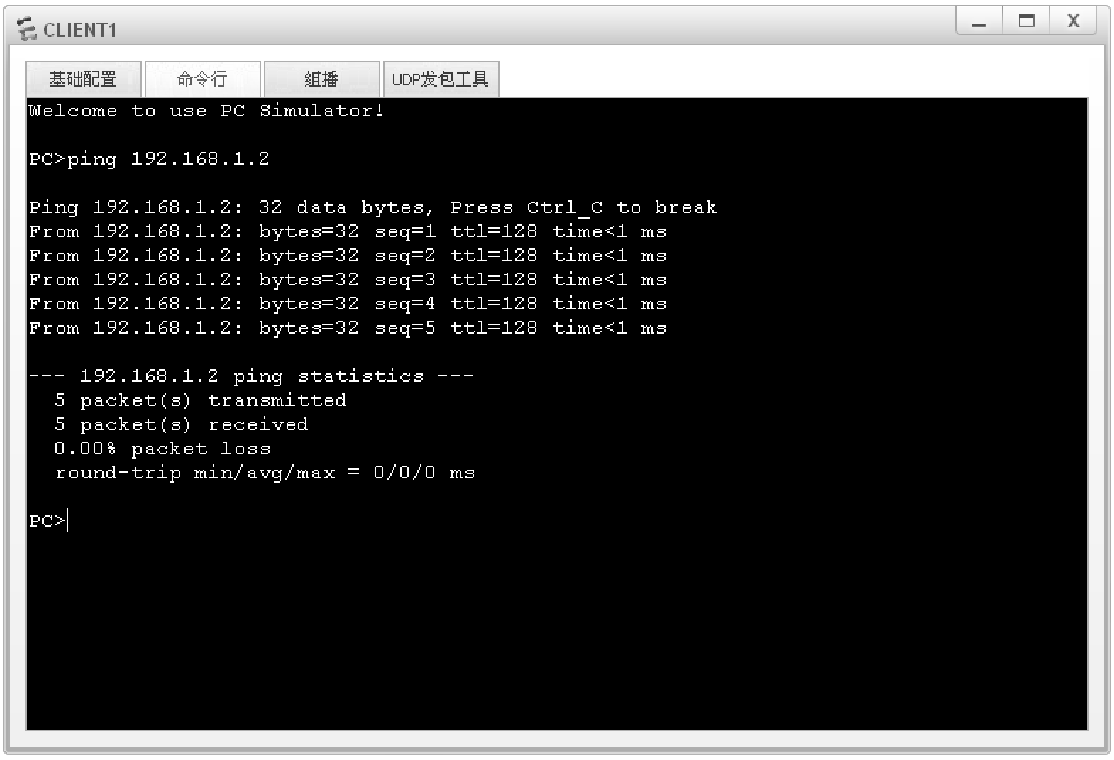
根据被监控设备的状态，Wireshark可捕获选中接口上产生的所有流量，生成抓包结果。在本实例的端到端组网中，需要先通过配置来产生一些流量，再观察抓包结果。

.步骤八　生成接口流量

可以使用以下两种方法打开命令行界面：

- 双击设备图标，在弹出的窗口中选择“命令行”标签页。
- 右击设备图标，在弹出的属性菜单中，选择“设置”选项，然后在弹出的窗口中选择“命令行” 标签页。

产生流量最简单的方法是使用ping命令发送ICMP报文。在命令行界面输入ping <*ip address*>命令，其中<*ip address*>设置为对端设备的IP地址。

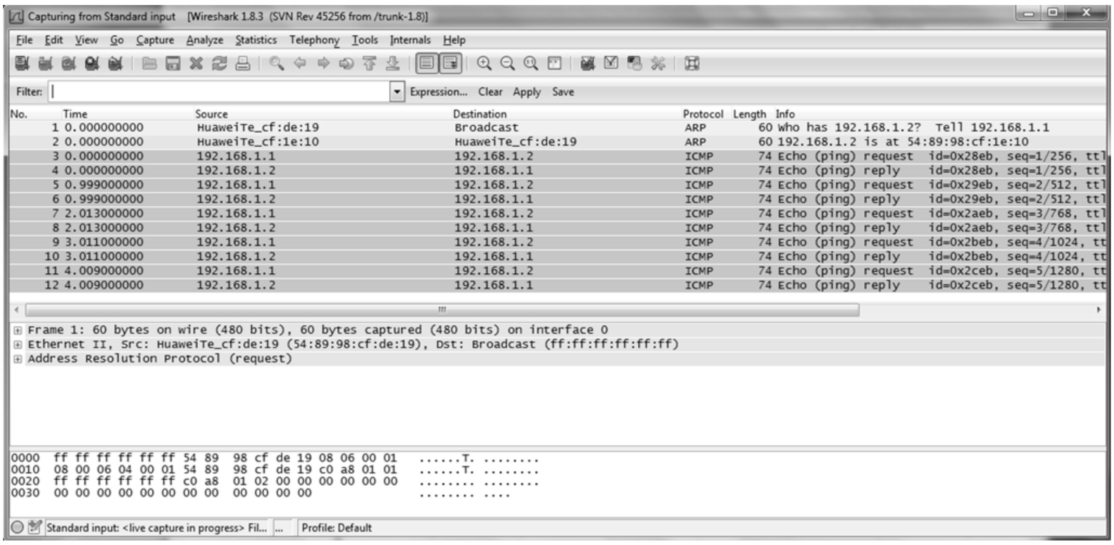


生成的流量会在该界面的回显信息中显示，包含发送的报文和接收的报文。

生成流量之后，通过Wireshark捕获报文并生成抓包结果。您可以在抓包结果中查看到IP网络的协议的工作过程，以及报文中所基于OSI参考模型各层的详细内容。

.步骤九　观察捕获的报文

查看Wireshark所抓取到的报文的结果。



Wireshark程序包含许多针对所捕获报文的管理功能。其中一个比较常见的功能是过滤功能，可用来显示某种特定报文或协议的抓包结果。在菜单栏下面的“Filter”文本框里输入过滤条件，就可以使用该功能。最简单的的过滤方法是在文本框中先输入协议名称（小写字母），再按回车键。在本示例中，Wireshark抓取了ICMP与ARP两种协议的报文。在“Filter”文本框中输入icmp或arp再按回车键后，在回显中就将只显示ICMP或ARP报文的捕获结果。

Wireshark界面包含三个面板，分别显示的是数据包列表、每个数据包的内容明细以及数据包对应的16进制的数据格式。报文内容明细对于理解协议报文格式十分重要，同时也显示了基于OSI参考模型的各层协议的详细信息。

实验二 设备基础配置

实验 2-1 设备基础配置

学习目标

- 掌握设备系统参数的配置方法，包括设备名称、系统时间及系统时区
- 掌握Console口空闲超时时长的配置方法
- 掌握登录信息的配置方法
- 掌握登录密码的配置方法
- 掌握保存配置文件的方法
- 掌握配置路由器接口IP地址的方法
- 掌握测试两台直连路由器连通性的方法
- 掌握重启设备的方法

拓扑图

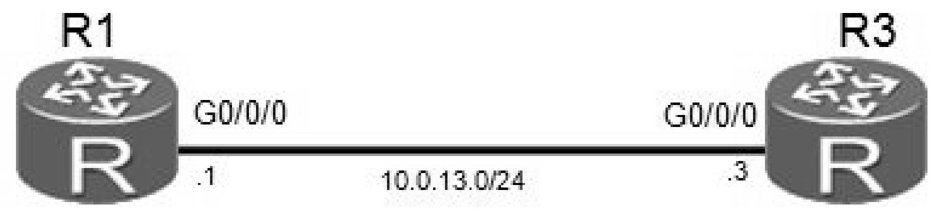


图2.1 设备基础配置拓扑图

场景

您是公司的网络管理员，现在公司购买了两台华为AR G3系列路由器。路由器在使用之前，需要先配置路由器的设备名称、系统时间及登录密码等管理信息。

操作步骤

.步骤一　查看系统信息

执行**display version**命令，查看路由器的软件版本与硬件信息。

```
<Huawei>display version
Huawei Versatile Routing Platform Software
VRP (R) software, Version 5.120 (AR2200 V200R003C00SPC200)
Copyright (C) 2011-2013 HUAWEI TECH CO., LTD
Huawei AR2220 Router uptime is 0 week, 3 days, 21 hours, 43 minutes
BKP 0 version information:
......output omitted......
```

命令回显信息中包含了VRP版本，设备型号和启动时间等信息。

.步骤二　修改系统时间

VRP系统会自动保存时间，但如果时间不正确，可以在用户视图下执行**clock timezone**命令和**clock datetime**命令修改系统时间。

```
<Huawei>clock timezone Local add 08:00:00
<Huawei>clock datetime 12:00:00 2013-09-15
```

您可以修改Local字段为当前地区的时区名称。如果当前时区位于UTC+0时区的西部，需要把add字段修改为minus。

执行**display clock**命令查看生效的新系统时间。

```
<Huawei>display clock
2013-09-15 12:00:21
Sunday
Time Zone(Default Zone Name) : UTC+00:00
```

.步骤三　帮助功能和命令自动补全功能

在系统中输入命令时，问号是通配符，Tab键是自动联想并补全命令的快捷键。

```
<Huawei>display ?
    Cellular                Cellular interface
    aaa                         AAA
```

```
 •access-user              User access
 accounting-scheme     Accounting scheme
 acl                       <Group> acl command group
 actual                    Current actual
 adp-ipv4              Ipv4 information
 adp-mpls              Adp-mpls module
 alarm                 Alarm
 antenna                   Current antenna that outputting radio
 anti-attack               Specify anti-attack configurations
 ap                        <Group> ap command group
 ap-auth-mode          Display AP authentication mode
......output omit......
```

在输入信息后输入“？”可查看以输入字母开头的命令。如输入“dis？”，设备将输出所有以dis开头的命令。

在输入的信息后增加空格，再输入“？”，这时设备将尝试识别输入的信息所对应的命令，然后输出该命令的其他参数。例如输入“dis ？”，如果只有display命令是以dis开头的，那么设备将输出display命令的参数；如果以dis开头的命令还有其他的，设备将报错。

另外可以使用键盘上Tab键补全命令，比如键入“dis”后，按键盘“Tab”键可以将命令补全为“display”。如有多个以“dis”开头的命令存在，则在多个命令之间循环切换。

命令在不发生歧义的情况下可以使用简写，如“display”可以简写为“dis”或“disp”等，“interface”可以简写为“int”或“inter”等。

.步骤四 进入系统视图

使用**system-view**命令可以进入系统视图，这样才可以配置接口、协议等内容。

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

.步骤五 修改设备名称

配置设备时，为了便于区分，往往给设备定义不同的名称。如下我们依照实验拓扑图，修改设备名称。

修改R1路由器的设备名称为R1。

```
[Huawei]sysname R1
[R1]
```

修改R3路由器的设备名称为R3。

```
[Huawei]sysname R3
[R3]
```

.步骤六　配置登录信息

配置登陆标语信息来进行提示或进行登陆警告。执行**header shell information**命令配置登录信息。

```
[R1]header shell information "Welcome to the Huawei certification lab."
```

退出路由器命令行界面，再重新登录命令行界面，查看登录信息是否已经修改。

```
[R1]quit
<R1>quit
  Configuration console exit, please press any key to log on
Welcome to the Huawei certification lab.
<R1>
```

.步骤七　配置 Console 口参数

默认情况下，通过Console口登陆无密码，任何人都可以直接连接到设备，进行配置。

为避免由此带来的风险，可以将Console接口登录方式配置为密码认证方式，密码为明文形式的“huawei”。

空闲时间指的是经过没有任何操作的一定时间后，会自动退出该配置界面，再次登陆会根据系统要求，提示输入密码进行验证。

设置空闲超时时间为20分钟，默认为10分钟。

```
[R1]user-interface console 0
[R1-ui-console0]authentication-mode password
[R1-ui-console0]set authentication password cipher huawei
[R1-ui-console0]idle-timeout 20 0
```

执行**display this**命令查看配置结果。

```
[R1-ui-console0]display this
```

```
[V200R003C01SPC200]
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$fIn'6>NZ6*~as(#J:WU%,#72Uy8cVlN^NXkT51E ^RX;>#75,%$%$
 idle-timeout 20 0
```

退出系统，并使用新配置的密码登录系统。需要注意的是，在路由器第一次初始化启动时，也需要配置密码。

```
[R1-ui-console0]return
<R1>quit

  Configuration console exit, please press any key to log on
Welcome to Huawei certification lab
<R1>
```

.步骤八　配置接口 IP 地址和描述信息

配置R1上GigabitEthernet 0/0/0接口的IP地址。使用点分十进制格式（如255.255.255.0）或根据子网掩码前缀长度配置子网掩码。

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.13.1 24
[R1-GigabitEthernet0/0/0]description This interface connects to R3-G0/0/0
```

在当前接口视图下，执行**display this**命令查看配置结果。

```
[R1-GigabitEthernet0/0/0]display this
[V200R003C00SPC200]
#
interface GigabitEthernet0/0/0
 description This interface connects to R3-G0/0/0
 ip address 10.0.13.1 255.255.255.0
#
Return
```

执行**display interface**命令查看接口信息。

```
[R1]display interface GigabitEthernet0/0/0
GigabitEthernet0/0/0 current state : UP
```

```
Line protocol current state : UP
Last line protocol up time : 2013-10-08 04:13:09
Description:This interface connects to R3-G0/0/0
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 10.0.13.1/24
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 5489-9876-830b
Last physical up time :   2013-10-08 03:24:01
Last physical down time   :   2013-10-08 03:25:29
Current system time: 2013-10-08 04:15:30
Port Mode: FORCE COPPER
Speed :  100,  Loopback: NONE
Duplex: FULL,  Negotiation: ENABLE
Mdi   : AUTO
Last 300 seconds input rate 2296 bits/sec, 1 packets/sec
Last 300 seconds output rate 88 bits/sec, 0 packets/sec
Input peak rate 7392 bits/sec,Record time: 2013-10-08 04:08:41
Output peak rate 1120 bits/sec,Record time: 2013-10-08 03:27:56
Input:  3192 packets, 895019 bytes
  Unicast:             0,      Multicast:              1592
  Broadcast:           1600,   Jumbo:                  0
  Discard:             0,      Total Error:            0
  CRC:                 0,      Giants:                 0
  Jabbers:             0,      Throttles:              0
  Runts:                   0,      Symbols:                0
  Ignoreds:                0,      Frames:                 0
Output:  181 packets, 63244 bytes
  Unicast:             0,      Multicast:              0
  Broadcast:           181,    Jumbo:                  0
  Discard:             0,      Total Error:            0
  Collisions:          0,      ExcessiveCollisions:    0
  Late Collisions:         0,      Deferreds:              0
    Input bandwidth utilization threshold : 100.00%
    Output bandwidth utilization threshold: 100.00%
    Input bandwidth utilization  : 0.01%
    Output bandwidth utilization :    0%
```

从命令回显信息中可以看到，接口的物理状态与协议状态均为Up，表示对应的物理层与数据链路层均可用。

配置 R3 上 GigabitEthernet 0/0/0 接口的 IP 地址与描述信息。

```
[R3]interface GigabitEthernet 0/0/0

[R3-GigabitEthernet0/0/0]ip address 10.0.13.3 255.255.255.0
[R3-GigabitEthernet0/0/0]description This interface connects to R1-G0/0/0
```

配置完成后，通过执行ping命令测试R1和R3间的连通性。

```
<R1>ping 10.0.13.3

  PING 10.0.13.3: 56  data bytes, press CTRL_C to break

    Reply from 10.0.13.3: bytes=56 Sequence=1 ttl=255 time=35 ms

    Reply from 10.0.13.3: bytes=56 Sequence=2 ttl=255 time=32 ms

    Reply from 10.0.13.3: bytes=56 Sequence=3 ttl=255 time=32 ms

    Reply from 10.0.13.3: bytes=56 Sequence=4 ttl=255 time=32 ms

    Reply from 10.0.13.3: bytes=56 Sequence=5 ttl=255 time=32 ms

  --- 10.0.13.3 ping statistics ---

    5 packet(s) transmitted

    5 packet(s) received

    0.00% packet loss

round-trip min/avg/max = 32/32/35 ms
```

.步骤九　查看当前设备上存储的文件列表

在用户视图下执行**dir**命令，查看当前目录下的文件列表。

```
<R1>dir

Directory of sd1:/

  Idx  Attr    Size(Byte)  Date        Time(LMT)   FileName

    0  -rw-     1,738,816  Mar 14 2013 11:50:24    web.zip

    1  -rw-    68,288,896  Mar 14 2013 14:17:58
  ar2220-v200r003c00spc200.cc

    2  -rw-         739Mar 14 2013 16:01:17    vrpcfg.zip

1,927,476 KB total (1,856,548 KB free)


<R3>dir

Directory of sd1:/

  Idx  Attr    Size(Byte)  Date        Time(LMT)   FileName

    0  -rw-    1,738,816   Mar 14 2013 11:50:58    web.zip

    1  -rw-    68,288,896  Mar 14 2013 14:19:02
  ar2220-v200r003c00spc200.cc

    2  -rw-         739Mar 14 2013 16:03:04    vrpcfg.zip

1,927,476 KB total (1,855,076 KB free)
```

.步骤十　管理设备配置文件

执行**display saved-configuration**命令查看保存的配置文件。

```
<R1>display saved-configuration
  There is no correct configuration file in FLASH
```

系统中没有已保存的配置文件。执行**save**命令保存当前配置文件。

```
<R1>save
  The current configuration will be written to the device.
  Are you sure to continue? (y/n)[n]:y
  It will take several minutes to save configuration file, please wait...........
  Configuration file had been saved successfully
  Note: The configuration file will take effect after being activated
```

重新执行**display saved-configuration**命令查看已保存的配置信息。

```
<R1>display saved-configuration
[V200R003C00SPC200]
#
 sysname R1
 header shell information "Welcome to Huawei certification lab"
#
 board add 0/1 1SA
 board add 0/2 1SA
……output omit……
```

执行**display current-configuration**命令查看当前配置信息。

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
 header shell information "Welcome to Huawei certification lab"
#
 board add 0/1 1SA
 board add 0/2 1SA
 board add 0/3 2FE
```

```
……output omit……
```

一台路由器可以存储多个配置文件。执行**display startup**命令查看下次启动时使用的配置文件。

```
<R3>display startup
MainBoard:
  Startup system software:
   sd1:/ar2220-v200r003c00spc200.cc
  Next startup system software:
   sd1:/ar2220-v200r003c00spc200.cc
  Backup system software for next startup:   null
  Startup saved-configuration file:          null
  Next startup saved-configuration file:  sd1:/vrpcfg.zip
  Startup license file:                      null
  Next startup license file:             null
  Startup patch package:                 null
  Next startup patch package:            null
  Startup voice-files:                       null
  Next startup voice-files:                  null
```

删除闪存中的配置文件。

```
<R1>reset saved-configuration
This will delete the configuration in the flash memory.
The device configurations will be erased to reconfigure.
Are you sure? (y/n)[n]:y
 Clear the configuration in the device successfully.

<R3>reset saved-configuration
This will delete the configuration in the flash memory.
The device configurations will be erased to reconfigure.
Are you sure? (y/n)[n]:y
 Clear the configuration in the device successfully.
```

.步骤十一　重启设备

执行**reboot**命令重启路由器。

```
<R1>reboot
Info: The system is now comparing the configuration, please wait.
```

```
Warning: All the configuration will be saved to the next startup configuration. Continue ? [y/n]:n

System will reboot! Continue ? [y/n]:y

Info: system is rebooting ,please wait...


<R3>reboot

Info: The system is now comparing the configuration, please wait.

Warning: All the configuration will be saved to the next startup configuration. Continue ? [y/n]:n

System will reboot! Continue ? [y/n]:y
```

系统提示是否保存当前配置，可根据实验要求决定是否保存当前配置。如果无法确定是否保存，则不保存当前配置。

配置文件

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
 header shell information "Welcome to Huawei certification lab"
#
interface GigabitEthernet0/0/0
 description This interface connects to R3-G0/0/0
 ip address 10.0.13.1 255.255.255.0
#
user-interface con 0
 authentication-mode password
 set authentication password cipher %$%$4D0K*-E"t/I7[{HD~kgW,%dgkQQ!&|;XTDq9SFQJ.27M%dj,%$%$
 idle-timeout 20 0
#
return


[R3]dispay current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface GigabitEthernet0/0/0
```

```
 description This interface connect to R1-G0/0/0
 ip address 10.0.13.3 255.255.255.0
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$M8\HO3:72:ERQ8JLoHU8,%t+lE:$9=a7"8%yMoARB]$B%t.,%$%$
user-interface vty 0 4
#
return
```

实验三 链路聚合与VLAN

实验 3-1 链路聚合

学习目标

- 掌握接口速率和双工模式的配置方法
- 掌握使用手动模式配置链路聚合的方法
- 掌握使用静态LACP模式配置链路聚合的方法
- 掌握在静态LACP模式下配置接口优先级的方法

拓扑图

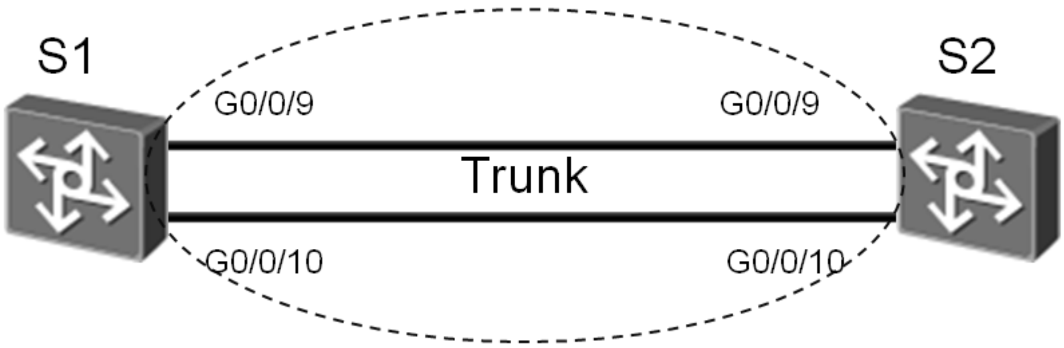


图3.1 以太网链路聚合拓扑图

场景

您是公司的网络管理员。现在公司购买了两台华为的S5700系列的交换机，为了提高交换机之间链路带宽以及可靠性，您需要在交换机上配置链路聚合功能。

操作步骤

步骤一. 以太网交换机基础配置

华为交换机接口默认开启了自协商功能。在本任务中，需要手动配置S1与

S2上G0/0/9和G0/0/10接口的速率及双工模式。

首先修改交换机的设备名称，然后查看S1上G0/0/9和G0/0/10接口的详细信息。

```
<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%
```

在修改接口的速率和双工模式之前应先关闭接口的自协商功能，然后将S1上的G0/0/9和G0/0/10接口的速率配置为100 Mbit/s，工作模式配置为全双工模式。

```
[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
```

同样的方法将S2上的G0/0/9和G0/0/10接口的速率配置为100 Mbit/s，工作模式配置为全双工模式。

```
<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
```

验证S1上的G0/0/9和G0/0/10接口的速率和工作模式已配置成功。

```
[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……
```

步骤二. 配置手动模式的链路聚合

在S1和S2上创建Eth-Trunk 1，然后将G0/0/9和G0/0/10接口加入Eth-Trunk 1(注意 :将接口加入Eth-Trunk前需确认成员接口下没有任何配置)。

```
[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
```

验证Eth-Trunk的配置结果。

```
[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
```

回显信息中灰色阴影标注的部分表明Eth-Trunk工作正常，成员接口都已正

确加入。

步骤三.　配置静态 LACP 模式的链路聚合

删除S1和S2上的G0/0/9和G0/0/10接口下的配置。

```
[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
```

创建Eth-Trunk 1并配置该Eth-Trunk为静态LACP模式。然后将G0/0/9和G0/0/10接口加入Eth-Trunk 1。

```
[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
```

查看交换机上Eth-Trunk的信息，查看链路是否协商成功。

```
[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
```

在S1上配置LACP的系统优先级为100，使其成为LACP主动端。

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

配置接口的优先级确定活动链路。

```
[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
```

验证Eth-Trunk的配置结果。

```
[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
```

配置文件

```
[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
```

实验 3-2 VLAN 配置

学习目标

- 掌握VLAN的创建方法
- 掌握Access和Trunk类型接口的配置方法
- 掌握Hybird接口的配置
- 掌握将接口与VLAN关联的配置方法

拓扑图

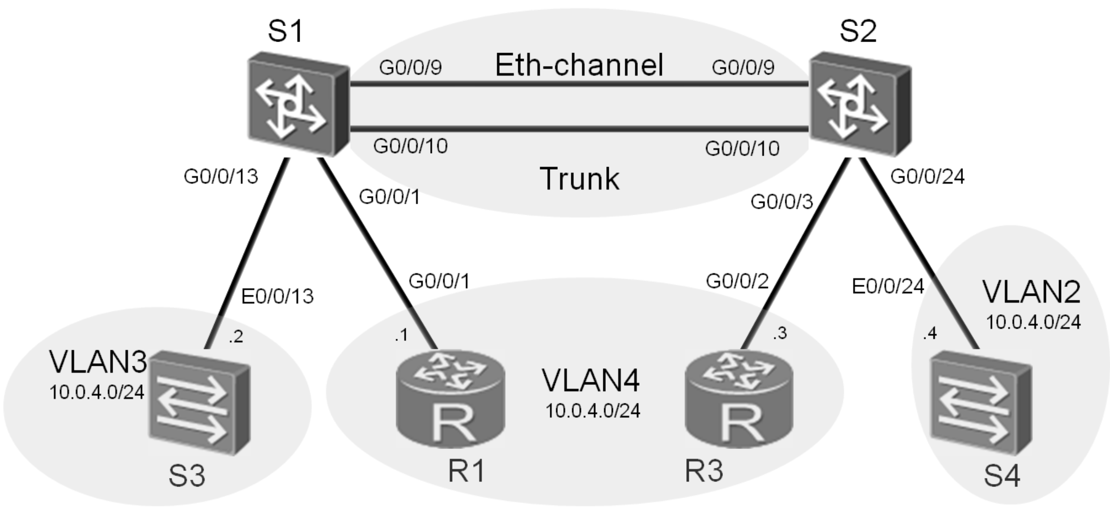


图3.2 VLAN配置实验拓扑图

场景

目前，公司网络内的所有主机都处在同一个广播域，网络中充斥着大量的广播流量。作为网络管理员，您需要将网络划分成多个VLAN来控制广播流量的泛滥。本实验中，您需要在交换机S1和S2上进行VLAN配置。

操作步骤

步骤一. 实验环境准备

如果本任务中您使用的是空配置设备，那么请从步骤1开始配置。如果使用的设备包含上一个实验的配置，请直接从步骤2开始配置。

在S1和S2上创建Eth-Trunk 1并配置该Eth-Trunk为静态LACP模式。然后将G0/0/9和G0/0/10接口加入Eth-Trunk 1。

```
<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
```

```
<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
```

步骤二. 关闭不相关接口，并配置 Trunk

为了确保测试结果的准确性，需要关闭S3上的E0/0/1和E0/0/23端口以及S4上的E0/0/14端口。

```
<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
```

交换机端口的类型默认为Hybrid端口。将Eth-Trunk 1的端口类型配置为Trunk，并允许所有VLAN的报文通过该端口。

```
[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
```

步骤三.　创建 VLAN

本实验中将S3、R1、R3和S4设备作为客户端主机。在S1和S2上分别创建VLAN，并使用两种不同方式将端口加入到已创建VLAN中。将所有连接客户端的端口类型配置为Access。

在S1上，将端口G0/0/13和G0/0/1分别加入到VLAN 3和VLAN 4。

在S2上，将端口G0/0/2和G0/0/24分别加入VLAN 4和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
```

确认S1和S2上已成功创建VLAN，且已将相应端口划分到对应的VLAN中。

```
<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…
```

回显信息中灰色阴影标注的部分表明接口已经加入到各个对应VLAN中，并且Eth-Trunk 1端口允许所有VLAN的报文通过。

步骤四. 为客户端配置 IP 地址

分别为主机R1、S3、R3和S4配置IP地址。由于无法直接为交换机的物理接口分配IP地址，因此将S3和S4的本地管理接口VLANIF 1作为用户接口，配置IP地址。

```
<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
```

步骤五. 检测设备连通性，验证 VLAN 配置结果

执行**ping**命令。同属VLAN 4中的R1和R3能够相互通信。其他不同VLAN间的设备无法通信。

```
[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
```

同样，还可以检测R1和S3以及R3和S4之间的连通性。此处不再赘述。

步骤六. 配置 Hybrid 端口

配置端口的类型为Hybrid，可以实现端口为来自不同VLAN报文打上标签或去除标签的功能。本任务中，需要通过配置Hybrid端口来允许VLAN 2和VLAN 4之间可以互相通信。

将S1上的G0/0/1端口和S2上的G0/0/3和G0/0/24端口的类型配置为Hybrid。同时，配置这些端口发送数据帧时能够删除VLAN 2和VLAN 4的标签。

```
[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
```

执行**port hybrid pvid vlan**命令，可以配置端口收到数据帧时需要给数据帧添加的VLAN标签。同时**port hybrid untagged vlan**命令可以配置该端口在向主机转发数据帧之前，删除相应的VLAN标签。

执行**ping**命令。测试VLAN 3中的R1与R3是否还能通信。

```
<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
```

执行**ping**命令，测试VLAN 2中的S4能否与VLAN 4中的R1通信。

```
<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
```

通过配置Hybrid端口，使VLAN 2内的主机能够接收来自VLAN 4的报文，反之亦然。而没有配置Hybrid端口的VLAN 3中地址为10.0.4.2的主机仍无法与其他VLAN主机通信。

配置文件

```
[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
```

实验 3-3 VLAN 单臂路由

学习目标

- 掌握用于VLAN间路由的Trunk接口的配置方法
- 掌握在单个物理接口上配置多个子接口的方法
- 掌握在VLAN间实现ARP通信的配置方法

拓扑图

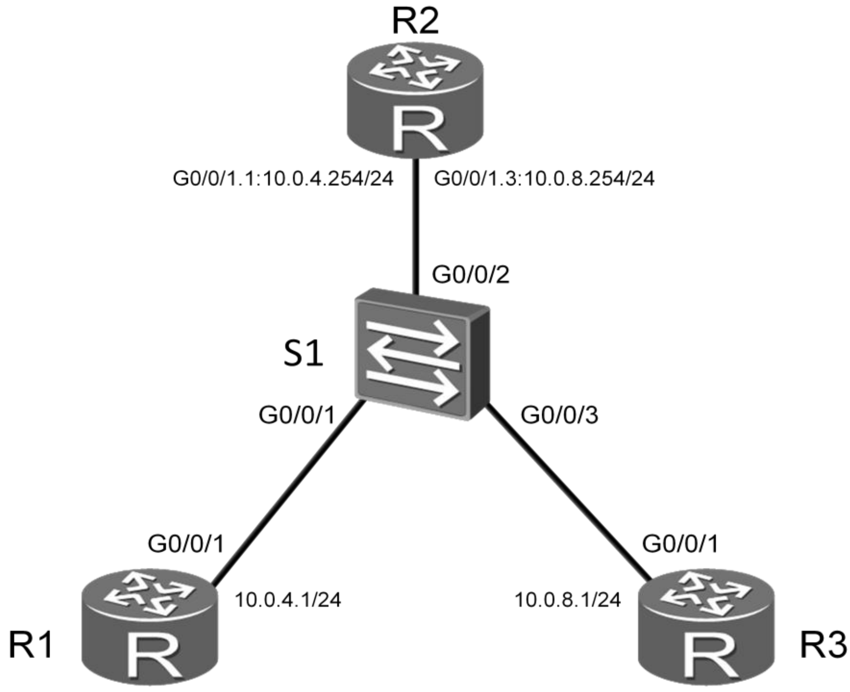


图3.3 单臂路由实验拓扑图

场景

企业内部网络通常会通过划分不同的VLAN来隔离不同部门之间的二层通信，并保证各部门间的信息安全。但是由于业务需要，部分部门之间需要实现跨VLAN通信，网络管理员决定借助路由器，通过配置单臂路由实现R1与R3之间跨VLAN通信需求。

操作步骤

步骤一.　实验环境准备

如果本任务中您使用的是空配置设备，需要从步骤1开始配置，然后跳过步骤2。如果使用的设备包含上一个实验的配置，请直接从步骤2开始配置。

配置R1、R3和S1的设备名称，并按照拓扑图配置R1的G0/0/1接口的IP地址。

```
<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
```

步骤二.　清除设备上原有的配置

删除R3的G0/0/2接口IP地址，清除交换机上GVRP的配置并关闭无关端口。

```
[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
```

步骤三. 为 R3 配置 IP 地址

按照拓扑图配置R3上的G0/0/1接口的IP地址。

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

步骤四. 创建 VLAN

在S1上创建VLAN 4和VLAN 8，将端口G0/0/1加入到VLAN 4中，将端口G0/0/3加入到VLAN 8中。

```
[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
```

将S1连接路由器的G0/0/2端口配置为Trunk接口，并允许VLAN 4和VLAN 8的报文通过。

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

步骤五. 配置 R2 上的子接口实现 VLAN 间路由

由于路由器只有一个实际的物理接口与交换机S1相连，而实际上不同部门属于不同VLAN和不同网段，所以在路由器上配置不同的逻辑子接口来扮演不同的网关角色，在R2上配置子接口G0/0/1.1和G0/0/1.3，并作为VLAN 4和VLAN 8的网关。

```
<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
```

在R1和R3上各配置一条默认路由指向各自的网关。

```
[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
```

配置完成后，检测R1与R3间的连通性。

```
<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
```

配置文件

```
[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]display 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
```

实验 3-4 配置三层交换

学习目标

- 掌握通过三层交换机实现VLAN间通信的配置方法
- 掌握通过以太网Trunk链路实现VLAN间通信的配置方法
- 掌握在不同VLAN间配置动态路由协议OSPF的方法

拓扑图

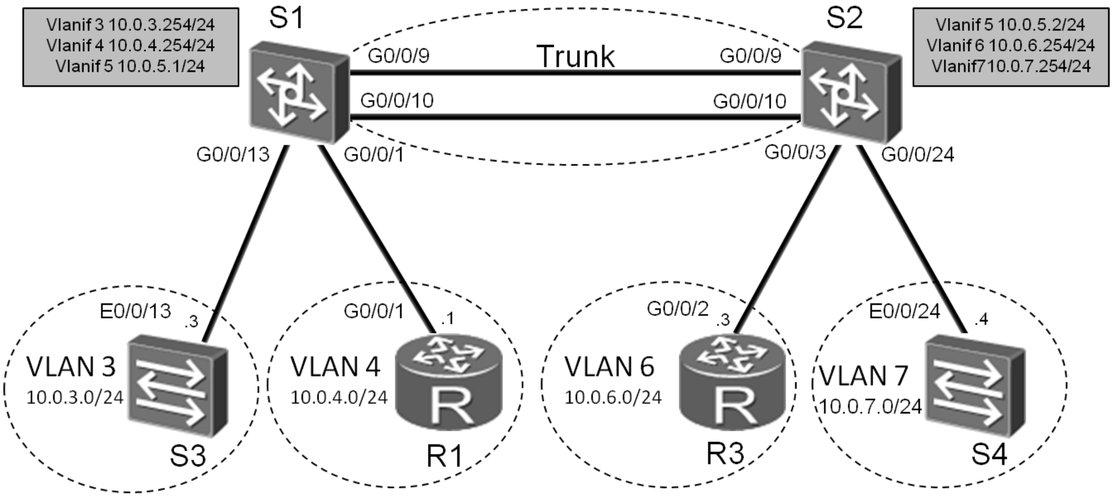


图3.4 三层交换实验拓扑图

场景

在企业网络中，通过使用三层交换机可以简便的实现VLAN间通信。作为企业的网络管理员，您需要在三层交换机配置VLANIF接口的三层功能，使得如上所示拓扑图中的网络能够实现VLAN间通信。此外，为了使S1和S2所连接的不同网络能够进行三层通信，还需要配置路由协议。

操作步骤

步骤一. 实验环境准备

如果本任务中您使用的是空配置设备，需要从步骤1开始，然后跳过步骤2。

如果使用的设备包含上一个实验的配置，请直接从步骤2开始配置。

将R1上的G0/0/1接口的IP地址配置为10.0.4.1/24，在S1和S2之间配置Eth-Trunk，并关闭S3和S4上的无关端口。

```
<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
```

步骤二.　清除设备上原有的配置

清除设备上的VLAN路由和子接口配置。

```
[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
```

重新打开S1和S2间的Eth-Trunk接口。

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

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

步骤三. 在 S1 和 S2 批量创建 VLAN 3 到 VLAN 7

```
[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.
```

确认VLAN已成功创建。

```
[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)
```

步骤四.　配置 Eth-Trunk 链路

将S1上的G0/0/1和0/0/13端口分别加入VLAN 4和VLAN 3。将S2上的G0/0/3和G0/0/24端口分别加入VLAN 6和VLAN 7。

```
[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
```

配置完成后，执行**display vlan**命令查看VLAN以及成员端口信息。

```
<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)
```

步骤五. 配置 VLANIF 三层接口

分别为S1上的VLANIF 3、VLANIF 4和VLANIF 5以及S2上的VLANIF 5、VLANIF 6和VLANIF 7配置IP地址。

```
[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
```

步骤六. 为 R1、R3、S3 和 S4 配置 IP 地址和缺省路由

本实验中，R1、R3、S3和S4模拟客户端主机，四台设备都需要配置一个用户IP地址，其中S3和S4使用VLANIF 1接口配置IP地址，然后将S3的E0/0/13端口和S4的E0/0/24端口加入到VLAN 1中。R1的地址应配置为10.0.4.1/24。最后为每台设备配置一条缺省静态路由指向网关。

```
[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
```

步骤七. 检测 VLAN 3 和 VLAN 4 间的连通性

检测R1和S3之间的连通性。

```
<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
```

检测R1和R3之间的连通性。

```
<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
```

回显信息表明R1和R3无法互相通信。执行**tracert**命令，查找通信失败的原因。

```
[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  *  *  *
```

由显示信息可以看出，R1向目的地址10.0.6.3发送了数据报文，但是数据报文仅能到达地址为10.0.4.254的网关设备。

在网关设备S1上查看是否拥有到达目的网络的路由条目。

```
[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
```

由显示信息可以看出，由于网段10.0.6.0/24并非S1直连网段，且S1上也并未配置任何静态路由或用动态路由协议获取该网段路由信息，因而S1没有通往该网段的路由条目，S1就无法将数据包正确转发到该网段。

步骤八.　在 S1 和 S2 上配置 OSPF 协议

```
[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
```

配置完成后，待OSPF收敛完成，再查看S1的路由表。

```
[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
```

可以观察到S1已经通过OSPF学习到了10.0.6.0/24和10.0.7.0/24这两条路由。再次检测R1和R3间的连通性。

```
[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
```

配置文件

```
[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
```

实验四 生成树配置

实验 4-1 配置 RSTP

学习目标

- 掌握启用和禁用RSTP的配置方法
- 掌握边缘端口的配置方法
- 掌握RSTP BPDU保护功能的配置方法
- 掌握RSTP环路保护功能的配置方法

拓扑图

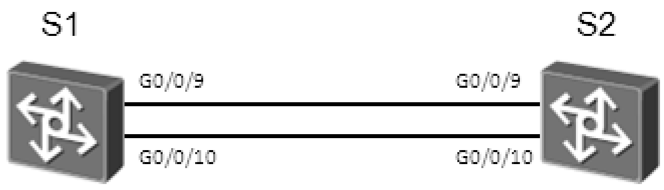


图4.1 配置RSTP实验拓扑图

场景

公司的网络使用了两层网络结构，核心层和接入层，并采用了冗余设计。您是公司的网络管理员，需要通过使用RSTP来避免网络中产生二层环路问题。本实验中，还将通过配置RSTP的一些特性来加快RSTP收敛速度，并配置相关保护功能。

操作步骤

.步骤一 实验环境准备

如果本实验中您使用的是空配置设备，需要从步骤1开始，并跳过步骤2。如

果使用的设备包含上一个实验的配置，请直接从步骤2开始。

为了保证实验结果的准确性，必须先关闭无关的端口。

在实验配置之前，先关闭S3上的E0/0/1、E0/0/13、E0/0/23端口，以及S4上的E0/0/14和E0/0/24端口，确保设备空配置启动。如果STP被禁用，则需执行**stp enable**命令启用STP。

```
<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S1

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S2

<Quidway>system-view
[Quidway]sysname S3
[S3]interface Ethernet 0/0/1
[S3-Ethernet0/0/1]shutdown
[S3-Ethernet0/0/1]quit
[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]shutdown
[S3-Ethernet0/0/13]quit
[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
[S4-Ethernet0/0/14]quit
[S4]interface Ethernet 0/0/24
[S4-Ethernet0/0/24]shutdown
```

.步骤二 清除设备上已有的配置

清除S1上配置的STP优先级和开销，清除S2上配置的STP优先级。

```
[S1]undo stp priority
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]undo stp cost
```

```
[S2]undo stp priority
```

.步骤三 配置 RSTP 并验证 RSTP 配置

执行**stp mode rstp**命令配置S1和S2的STP模式为RSTP。

```
[S1]stp mode rstp
```

```
[S2]stp mode rstp
```

执行**display stp**命令查看RSTP的简要信息。

```
[S1]display  stp
-------[CIST Global Info][Mode RSTP]-------
CIST Bridge         :32768.4c1f-cc45-aace
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :32768.4c1f-cc45-aacc / 20000
CIST RegRoot/IRPC   :32768.4c1f-cc45-aace / 0
CIST RootPortId     :128.9
BPDU-Protection     :Disabled
TC or TCN received  :28
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:11m:1s
……output omitted……
```

```
[S2]display  stp
-------[CIST Global Info][Mode RSTP]-------
CIST Bridge         :32768.4c1f-cc45-aacc
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :32768.4c1f-cc45-aacc / 0
CIST RegRoot/IRPC   :32768.4c1f-cc45-aacc / 0
CIST RootPortId     :0.0
BPDU-Protection     :Disabled
TC or TCN received  :14
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
```

```
Time since last TC  :0 days 0h:12m:23s
……output omitted……
```

.步骤四 配置边缘端口

配置连接用户终端的端口为边缘端口。边缘端口可以不通过RSTP计算直接由Discarding状态转变为Forwarding状态。在本示例中，S1和S2上的G0/0/4端口都连接的是一台路由器，可以配置为边缘端口，以加快RSTP收敛速度。

```
[S1]interface GigabitEthernet 0/0/4
[S1-GigabitEthernet0/0/4]stp edged-port enable

[S2]interface GigabitEthernet 0/0/4
[S2-GigabitEthernet0/0/4]stp edged-port enable
```

.步骤五 配置 BPDU 保护功能

边缘端口直接与用户终端相连，正常情况下不会收到BPDU报文。但如果攻击者向交换机的边缘端口发送伪造的BPDU报文，交换机会自动将边缘端口设置为非边缘端口，并重新进行生成树计算，从而引起网络震荡。在交换机上配置BPDU保护功能，可以防止该类攻击。

执行**stp bpdu-protection**命令，在S1和S2上配置BPDU保护功能。

```
[S1]stp bpdu-protection

[S2]stp bpdu-protection
```

执行**display stp brief**命令查看端口上配置的保护功能。

```
<S1>display  stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/4         DESI  FORWARDING      BPDU
   0    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/10        ALTE  DISCARDING      NONE

<S2>display  stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/4         DESI  FORWARDING      BPDU
   0    GigabitEthernet0/0/9         DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
```

配置完成后，从上述回显的灰色部分可以看出，S1和S2上的G0/0/4端口已经配置BPDU保护功能。

.步骤六　配置环路保护功能

在运行RSTP协议的网络中，交换机依靠不断接收来自上游设备的BPDU报文维持根端口和Alternate端口的状态。如果由于链路拥塞或者单向链路故障导致交换机收不到来自上游设备的BPDU报文，交换机会重新选择根端口。原先的根端口会转变为指定端口，而原先的阻塞端口会迁移到转发状态，从而会引起网络环路。可以在交换机上配置环路保护功能，避免此种情况发生。

首先在S1上查看端口角色。

```
[S1]display  stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/4         DESI  FORWARDING      BPDU
   0    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/10        ALTE  DISCARDING      NONE
```

可以看到S1上的G0/0/9和G0/0/10端口分别为根端口和Alternate端口。在这两个端口上配置环路保护功能。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]stp loop-protection
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]stp loop-protection
```

执行**display stp brief**命令查看端口上配置的保护功能。

```
<S1>display  stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/4         DESI  FORWARDING      BPDU
   0    GigabitEthernet0/0/9         ROOT  FORWARDING      LOOP
   0    GigabitEthernet0/0/10        ALTE  DISCARDING      LOOP
```

因为S2是根桥，S2上的所有端口都是指定端口，无需配置环路保护功能。配置完成后，如果您把S1配置为根桥，可以使用相同的步骤在S2的根端口和Alternate端口上配置环路保护功能。

配置文件

```
<S1>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 stp mode rstp
 stp bpdu-protection
#
interface GigabitEthernet0/0/4
 stp edged-port enable
#
interface GigabitEthernet0/0/9
 stp loop-protection
#
interface GigabitEthernet0/0/10
 stp loop-protection
#
user-interface con 0
user-interface vty 0 4
#
return

<S2>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 stp mode rstp
 stp bpdu-protection
#
interface GigabitEthernet0/0/4
 stp edged-port enable
#
user-interface con 0
user-interface vty 0 4
#
```

```
return

<S3>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
interface Ethernet0/0/1
 shutdown
#
interface Ethernet0/0/13
 shutdown
#
interface Ethernet0/0/23
 shutdown
#
user-interface con 0
user-interface vty 0 4
#
return

<S4>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
interface Ethernet0/0/14
 shutdown
#
interface Ethernet0/0/24
 shutdown
#
user-interface con 0
user-interface vty 0 4
#
return
```

实验 4-2 配置 MSTP

学习目标

- 了解MSTP的应用场景。
- 理解MSTP与STP、RSTP的差异。
- 理解MSTP区域、实例的概念。
- 掌握MST实例定义的方法。
- 掌握MSTP配置的方法。
- 掌握查询MSTP状态的方法。
- 理解MSTP端口的角色和状态。
- 掌握查询MSTP端口角色和状态的方法。

拓扑图

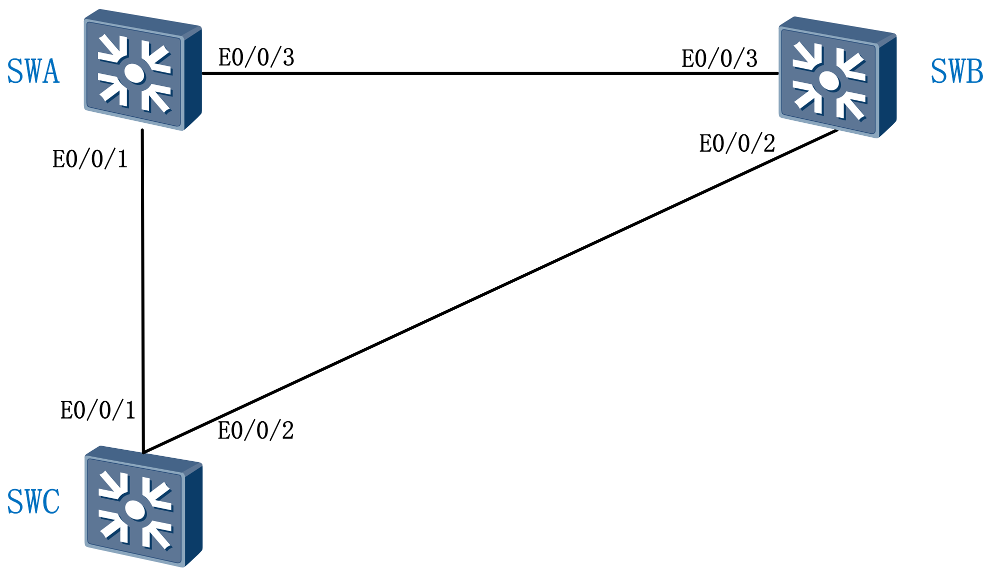


图4.2 配置MSTP实验拓扑图

假设 SWA 和 SWB 是核心交换机，SWC 是接入层交换机。我们在这个实验里新建 vlan10 和 vlan20，使他们属于不同的实例。对于实例 1 来说，SWA 为根桥，对于实例 2 来说，SWB 为根桥，从而实现上行流量的负载分担。

表 **错误！文档中没有指定样式的文字。**-1 Vlan 映射关系及桥优先级列表

实例编号（MST ID）	Vlan ID	SWA 优先级	SWB 优先级	SWC 优先级
0（默认）	1	32768	32768	32768
1	10	4096	8192	32768
2	20	8192	4096	32768

操作步骤

.步骤一　配置准备工作

首先在各交换机上创建 Vlan 10 和 Vlan 20，然后将各交换机之间的互联接口配置为 Trunk 接口，并允许所有 vlan 通过。

```
<SWA>system-view
Enter system view, return user view with Ctrl+Z.
[SWA]interface Ethernet 0/0/3
[SWA-Ethernet0/0/3]port link-type trunk
[SWA-Ethernet0/0/3]port trunk allow-pass vlan all
[SWA-Ethernet0/0/3]quit
[SWA]interface Ethernet 0/0/1
[SWA-Ethernet0/0/1]port link-type trunk
[SWA-Ethernet0/0/1]port trunk allow-pass vlan all
[SWA-Ethernet0/0/1]quit
[SWA]vlan 10
[SWA-vlan10]quit
[SWA]vlan 20
[SWA-vlan20]quit
```

在 SWB 和 SWC 上对应的接口做相同的配置。

.步骤二　使能 MSTP

若生成树协议还未开启，先使用下面的命令开启生成树协议。

```
[SWA]stp enable
Warning: The global STP state will be changed. Continue? [Y/N]y
Info: This operation may take a few seconds. Please wait for a
moment.....done.
[SWA]
```

在 SWB 和 SWC 上做相同的检查，默认情况下，交换机开启的就是 MSTP。

.步骤三　配置 MST 域

我们首先创建不同的 instance，然后把相应的 Vlan 映射到不同 instance；下面以 SWA 为例讲述配置过程，SWB 和 SWC 的配置与 SWA 相同。

```
<SWA>system-view
Enter system view, return user view with Ctrl+Z.
[SWA]stp region-configuration
[SWA-mst-region]region-name huawei
[SWA-mst-region]instance 1 vlan 10
[SWA-mst-region]instance 2 vlan 20
```

```
[SWA-mst-region]active region-configuration
[SWA-mst-region]quit
```

在这里我们创建的 MST 域的名称是“huawei”，并创建了 2 个 instance，然后把 vlan 10 映射到 instance 1，把 vlan 20 映射到 instance 2。由于修改域配置会引起生成树重新计算，所以每次完成变更以后并不会立刻生效，必须运行 active region-configuration 使刚才做的配置生效。

在这个域中的每台交换机必须有相同的映射关系，否则可能造成部分 vlan 不能互通。

.步骤四　配置实例优先级

对于 instance 1 来说，我们希望 SWA 是根桥，SWB 是备用的根桥，所以在 instance 1 中，SWA 的优先级最高，SWB 次之，在 instance 2 中，优先级正好相反。SWC 是接入层交换机，我们不希望它成为根桥，所以保持其默认的的桥优先级不变。实例的优先级是在全局模式下配置的。

```
[SWA]stp instance 1 priority 4096
[SWA]stp instance 2 priority 8192
```

对于 SWB 来说，也手工指定两个实例的优先级：

```
[SWB]stp instance 1 priority 8192
[SWB]stp instance 2 priority 4096
```

.步骤五　结果验证

我们首先查看 SWC 的端口状态：

```
<SWC>display stp brief
 MSTID    Port                Role  STP State     Protection
0      Ethernet0/0/1       ROOT  FORWARDING     NONE
0      Ethernet0/0/2       ALTE  DISCARDING     NONE
1      Ethernet0/0/1       ROOT  FORWARDING     NONE
1      Ethernet0/0/2       ALTE  DISCARDING     NONE
2      Ethernet0/0/1       ALTE  DISCARDING     NONE
2      Ethernet0/0/2       ROOT  FORWARDING     NONE
```

第一列 MST ID 就是 instance 的编号。我们可以看到，对于 instance 1 来说，E0/0/1 为根端口，因为 instance 1 的根桥是 SWA，E0/0/1 是到达根桥路径开销最小端口，所以被选举为根端口；而对于 instance 2 来说，根桥是 SWB，所以 E0/0/2 被选举为根端口。根据上面的结果，我们可得知，SWC 通过 E0/0/1 把 Vlan10 的数据转发到核心交换机，通过 E0/0/2 把 Vlan20 的数据转发到核心层；最终通过 MSTP 实现了负载分担。可通过下面的命令查看每个 instance 的详细信息。

```
 <SWC>display stp instance 1
-------[MSTI 1 Global Info]-------
MSTI Bridge ID      :32768.0025-9e74-a09c
MSTI RegRoot/IRPC    :4096.0018-82d4-1521 / 199999
MSTI RootPortId     :128.1
Master Bridge       :32768.0018-82d4-1521
Cost to Master      :199999
TC received        :5
TC count per hello  :0
<SWC>display stp instance 2
```

```
-------[MSTI 2 Global Info]-------
MSTI Bridge ID      :32768.0025-9e74-a09c
MSTI RegRoot/IRPC   :4096.0025-9e74-a097 / 199999
MSTI RootPortId     :128.2
Master Bridge       :32768.0018-82d4-1521
Cost to Master      :199999
TC received        :8
TC count per hello  :0
```

配置参考

SWA 相关配置

```
#
 vlan batch 10 20
#
 stp instance 1 priority 4096
 stp instance 2 priority 8192
 stp enable
#
stp region-configuration
  region-name huawei
  instance 1 vlan 10
  instance 2 vlan 20
  active region-configuration
#
```

SWB 相关配置

```
#
 vlan batch 10 20
#
 stp instance 1 priority 8192
 stp instance 2 priority 4096
 stp enable
#
stp region-configuration
  region-name huawei
  instance 1 vlan 10
  instance 2 vlan 20
  active region-configuration
```

SWC 相关配置

```
vlan batch 10 20
#
stp enable
#
stp region-configuration
  region-name huawei
  instance 1 vlan 10
  instance 2 vlan 20
  active region-configuration
```

实验五 路由配置

实验 5-1 配置静态路由和缺省路由

学习目标

- 掌握静态路由的配置方法
- 掌握测试静态路由连通性的方法
- 掌握通过配置缺省路由实现本地网络与外部网络间的访问
- 掌握静态备份路由的配置方法

拓扑图

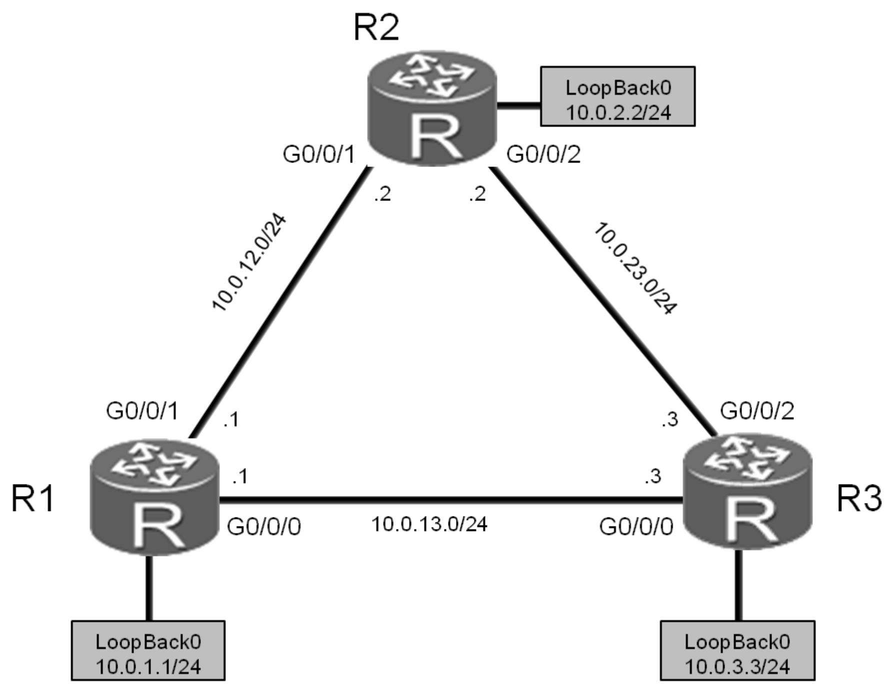


图4.1 静态路由和缺省路由实验拓扑图

场景

您是公司的网络管理员。现在公司有一个总部与两个分支机构。其中R1为总部路由器，R2、R3为分支机构，总部与分支机构间通过以太网实现互连，且当

前公司网络中没有配置任何路由协议。

由于网络的规模比较小，您可以配置通过静态路由和缺省路由来实现网络互通。IP编址信息如拓扑图所示。

操作步骤

.步骤一 基础配置和 IP 编址

在R1、R2和R3上配置设备名称和IP地址。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.13.1 24
[R1-GigabitEthernet0/0/0]quit
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.12.1 24
[R1-GigabitEthernet0/0/1]quit
[R1]interface LoopBack 0
[R1-LoopBack0]ip address 10.0.1.1 24
```

执行**display current-configuration**命令，检查配置情况。

```
<R1>display ip interface brief
Interface                     IP Address/Mask     Physical   Protocol
......output omitted......
GigabitEthernet0/0/0         10.0.13.1/24         up         up
GigabitEthernet0/0/1         10.0.12.1/24         up         up
GigabitEthernet0/0/2         unassigned           up         down
LoopBack0                    10.0.1.1/24          up         up(s)
......output omitted......

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ip address 10.0.12.2 24
[R2-GigabitEthernet0/0/1]quit
```

```
[R2]interface GigabitEthernet0/0/2
[R2-GigabitEthernet0/0/2]ip add 10.0.23.2 24
[R2-GigabitEthernet0/0/2]quit
[R2]interface LoopBack0
[R2-LoopBack0]ip address 10.0.2.2 24

<R2>display ip interface brief
Interface                     IP Address/Mask     Physical   Protocol
......output omitted......
GigabitEthernet0/0/0         unassigned          up        down
GigabitEthernet0/0/1         10.0.12.2/24        up        up
GigabitEthernet0/0/2         10.0.23.2/24        up        up
LoopBack0                    10.0.2.2/24         up        up(s)
......output omitted......

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ip address 10.0.13.3 24
[R3-GigabitEthernet0/0/0]quit
[R3]interface GigabitEthernet0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.23.3 24
[R3-GigabitEthernet0/0/2]quit
[R3]interface LoopBack 0
[R3-LoopBack0]ip address 10.0.3.3 24

<R3>display ip interface brief
Interface                     IP Address/Mask     Physical   Protocol
......output omitted......
GigabitEthernet0/0/0         10.0.13.3/24        up        up
GigabitEthernet0/0/1         unassigned          up        down
GigabitEthernet0/0/2         10.0.23.3/24        up        up
LoopBack0                    10.0.3.3/24         up        up(s)
......output omitted......
```

执行**ping**命令，检测R1与其它设备间的连通性。

```
<R1>ping 10.0.12.2
```

```
  PING 10.0.12.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.12.2: bytes=56 Sequence=1 ttl=255 time=30 ms
    Reply from 10.0.12.2: bytes=56 Sequence=2 ttl=255 time=30 ms
    Reply from 10.0.12.2: bytes=56 Sequence=3 ttl=255 time=30 ms
    Reply from 10.0.12.2: bytes=56 Sequence=4 ttl=255 time=30 ms
    Reply from 10.0.12.2: bytes=56 Sequence=5 ttl=255 time=30 ms
  --- 10.0.12.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 30/30/30 ms

<R1>ping 10.0.13.3
  PING 10.0.13.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.13.3: bytes=56 Sequence=1 ttl=255 time=6 ms
    Reply from 10.0.13.3: bytes=56 Sequence=2 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=3 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=4 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=5 ttl=255 time=2 ms
  --- 10.0.13.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/2/6 ms
```

执行**ping**命令，检测R2与其它设备间的连通性。

```
<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=31 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=255 time=31 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=31 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 = 31/35/41 ms
```

.步骤二 测试R2到目的网络10.0.13.0/24、10.0.3.0/24的连通性

```
<R2>ping 10.0.13.3
  PING 10.0.13.3: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
  --- 10.0.13.3 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss

<R2>ping 10.0.3.3
  PING 10.0.3.3: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
  --- 10.0.3.3 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
100.00% packet loss
```

R2如果要与10.0.3.0/24网络通信，需要R2上有去往该网段的路由信息，并且R3上也需要有到R2相应接口所在IP网段的路由信息。

上述检测结果表明，R2不能与10.0.3.3和10.0.13.3网络通信。

执行**display ip routing-table**命令，查看R2上的路由表。可以发现路由表中没有到这两个网段的路由信息。

```
<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
      10.0.2.0/24       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
      10.0.12.0/24      Direct  0    0    D   10.0.12.2       GigabitEthernet0/0/1
      10.0.12.2/32      Direct  0    0    D   127.0.0.1       GigabitEthernet0/0/1
      10.0.12.255/32    Direct  0    0    D   127.0.0.1       GigabitEthernet0/0/1
      10.0.23.0/24      Direct  0    0    D   10.0.23.2       GigabitEthernet0/0/2
      10.0.23.2/32      Direct  0    0    D   127.0.0.1       GigabitEthernet0/0/2
      10.0.23.255/32    Direct  0    0    D   127.0.0.1       GigabitEthernet0/0/2
      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
```

.步骤三　在 R2 上配置静态路由

配置目的地址为10.0.13.0/24和10.0.3.0/24的静态路由，路由的下一跳配置为R3的G0/0/0接口IP地址10.0.23.3。默认静态路由优先级为60，无需额外配置路由优先级信息。

```
[R2]ip route-static 10.0.13.0 24 10.0.23.3
[R2]ip route-static 10.0.3.0 24 10.0.23.3
```

注意：在**ip route-static**命令中，24代表子网掩码长度，也可以写成完整的掩码形式如255.255.255.0。

```
<R2>display ip routing-table

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

Destination/Mask    Proto   Pre  Cost  Flags NextHop         Interface
    10.0.3.0/24     Static  60   0      RD  10.0.23.3       GigabitEthernet0/0/2
    10.0.12.0/24    Direct  0    0      D   10.0.12.2       GigabitEthernet0/0/1
    10.0.12.2/32    Direct  0    0      D   127.0.0.1       GigabitEthernet0/0/1
    10.0.12.255/32  Direct  0    0      D   127.0.0.1       GigabitEthernet0/0/1
    10.0.13.0/24    Static  60   0      RD  10.0.23.3       GigabitEthernet0/0/2
    10.0.23.0/24    Direct  0    0      D   10.0.23.2       GigabitEthernet0/0/2
    10.0.23.2/32    Direct  0    0      D   127.0.0.1       GigabitEthernet0/0/2
```

.步骤四　配置备份静态路由

R2与网络10.0.13.3和10.0.3.3之间交互的数据通过R2与R3间的链路传输。如果R2和R3间的链路发生故障，R2将不能与网络10.0.13.3和10.0.3.3通信。

但是根据拓扑图可以看出，当R2和R3间的链路发生故障时，R2还可以通过R1与R3通信。所以可以通过配置一条备份静态路由实现路由的冗余备份。正常情况下，备份静态路由不生效。当R2和R3间的链路发生故障时，才使用备份静态路由传输数据。

配置备份静态路由时，需要修改备份静态路由的优先级，确保只有主链路故障时才使用备份路由。本任务中，需要将备份静态路由的优先级修改为80。

```
[R1]ip route-static 10.0.3.0 24 10.0.13.3


[R2]ip route-static 10.0.13.0 255.255.255.0 10.0.12.1 preference 80
[R2]ip route-static 10.0.3.0 24 10.0.12.1 preference 80


[R3]ip route-static 10.0.12.0 24 10.0.13.1
```

.步骤五　验证静态路由

在R2的路由表中，查看当前的静态路由配置。

```
<R2>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 15      Routes : 15
  Destination/Mask  Proto   Pre  Cost  Flags NextHop     Interface
       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
       10.0.3.0/24    Static  60   0   RD  10.0.23.3   GigabitEthernet0/0/2
      10.0.12.0/24    Direct  0    0    D  10.0.12.2   GigabitEthernet0/0/1
      10.0.12.2/32    Direct  0    0    D  127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32    Direct  0    0    D  127.0.0.1   GigabitEthernet0/0/1
      10.0.13.0/24    Static  60   0    RD 10.0.23.3   GigabitEthernet0/0/2
      10.0.23.0/24    Direct  0    0    D  10.0.23.2   GigabitEthernet0/0/2
      10.0.23.2/32    Direct  0    0    D  127.0.0.1   GigabitEthernet0/0/2
    10.0.23.255/32    Direct  0    0    D  127.0.0.1   GigabitEthernet0/0/2
       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
```

路由表中包含两条静态路由。其中，Protocol字段的值是Static，表明该路由是静态路由。Preference字段的值是60，表明该路由使用的是默认优先级。

在R2和R3之间链路正常时，R2与网络10.0.13.3和10.0.3.3之间交互的数据通过R2与R3间的链路传输。执行**tracert**命令，可以查看数据的传输路径。

```
<R2>tracert 10.0.13.3
 traceroute to  10.0.13.3(10.0.13.3), max hops: 30 ,packet length: 40,
 press CTRL_C to break
 1 10.0.23.3 40 ms  31 ms  30 ms

<R2>tracert 10.0.3.3
 traceroute to  10.0.3.3(10.0.3.3), max hops: 30 ,packet length: 40,
 press CTRL_C to break
 1 10.0.23.3 40 ms  30 ms  30 ms
```

命令的回显信息证实R2将数据直接发送给R3，未经过其他设备。

.步骤六　验证备份静态路由

关闭R2上的G0/0/2接口，模拟R2与R3间的链路发生故障，然后查看IP路由表的变化。

```
[R2]intface GigabitEthernet0/0/2
[R2-GigabitEthernet0/0/2]shutdown
[R2-GigabitEthernet0/0/2]quit
```

注意与关闭接口之前的路由表情况作对比。

```
<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
10.0.2.0/24       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
10.0.3.0/24        Static  80   0        D   10.0.12.2     GigabitEthernet0/0/1
10.0.12.0/24       Direct  0    0        D   10.0.12.2     GigabitEthernet0/0/1
10.0.12.2/32       Direct  0    0        D   127.0.0.1     GigabitEthernet0/0/1
10.0.12.255/32     Direct  0    0        D   127.0.0.1     GigabitEthernet0/0/1
10.0.13.0/24       Static  80   0        D   10.0.12.2     GigabitEthernet0/0/1
127.0.0.0/8        Direct  0    0        D   127.0.0.1     InLoopBack0
127.0.0.1/32       Direct  0    0        D   127.0.0.1     InLoopBack0
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
```

在R2的路由表中，灰色所标记出的两条路由的下一跳和优先级均已发生变化。

检测R2到目的地址10.0.13.3以及R3上的10.0.3.3的连通性。

```
<R2>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=255 time=3 ms
    Reply from 10.0.3.3: bytes=56 Sequence=2 ttl=255 time=2 ms
    Reply from 10.0.3.3: bytes=56 Sequence=3 ttl=255 time=2 ms
    Reply from 10.0.3.3: bytes=56 Sequence=4 ttl=255 time=2 ms
    Reply from 10.0.3.3: bytes=56 Sequence=5 ttl=255 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 = 2/2/3 ms

<R2>ping 10.0.13.3
  PING 10.0.13.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.13.3: bytes=56 Sequence=1 ttl=255 time=3 ms
    Reply from 10.0.13.3: bytes=56 Sequence=2 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=3 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=4 ttl=255 time=2 ms
    Reply from 10.0.13.3: bytes=56 Sequence=5 ttl=255 time=2 ms
  --- 10.0.13.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
```

```
round-trip min/avg/max = 2/2/3 ms
```

网络并未因为R2与R3之间的链路被关闭而中断。

执行**tracert**命令，查看数据包的转发路径。

```
<R2>tracert 10.0.13.3

 traceroute to  10.0.13.3(10.0.13.3), max hops: 30 ,packet length: 40,press
CTRL_C to break

 1 10.0.12.1 40 ms  21 ms  21 ms

 2 10.0.13.3 30 ms  21 ms  21 ms


<R2>tracert 10.0.3.3

 traceroute to  10.0.3.3(10.0.3.3), max hops: 30 ,packet length: 40,press
CTRL_C to break

 1 10.0.12.1 40 ms  21 ms  21 ms

 2 10.0.13.3 30 ms  21 ms  21 ms
```

命令的回显信息表明，R2发送的数据经过R1抵达R3设备。

.步骤七　配置缺省路由实现网络的互通

打开R2上在步骤6中关闭的接口。

```
[R2]intface GigabitEthernet 0/0/2

[R2-GigabitEthernet0/0/2]undo shutdown
```

验证从R1到10.0.23.3网络的连通性。

```
[R1]ping 10.0.23.3

  PING 10.0.23.3: 56  data bytes, press CTRL_C to break

    Request time out

    Request time out

    Request time out

    Request time out

    Request time out

  --- 10.0.23.3 ping statistics ---

    5 packet(s) transmitted

    0 packet(s) received

100.00% packet loss
```

因为R1上没有去往10.0.23.0网段的路由信息，所以报文无法到达R3。

```
<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
    10.0.3.0/24   Static  60   0       RD  10.0.13.3   GigabitEthernet0/0/0
    10.0.12.0/24  Direct  0    0       D   10.0.12.1   GigabitEthernet0/0/1
    10.0.12.1/32  Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32 Direct 0    0       D   127.0.0.1   GigabitEthernet0/0/1
    10.0.13.0/24   Direct 0    0       D   10.0.13.1   GigabitEthernet0/0/0
    10.0.13.1/32   Direct 0    0       D   127.0.0.1   GigabitEthernet0/0/0
    10.0.13.255/32 Direct 0    0       D   127.0.0.1   GigabitEthernet0/0/0
    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
```

可以在R1上配置一条下一跳为10.0.13.3的缺省路由来实现网络的连通。

```
[R1]ip route-static 0.0.0.0 0.0.0.0 10.0.13.3
```

配置完成后，检测R1和10.0.23.3网络间的连通性。

```
<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=255 time=3 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=255 time=2 ms
    Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=255 time=2 ms
    Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=255 time=2 ms
    Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=255 time=2 ms
  --- 10.0.23.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
```

```
round-trip min/avg/max = 2/2/3 ms
```

R1通过缺省路由实现了与网段10.0.23.3间的通信。

.步骤八　配置备份缺省路由

当R1与R3间的链路发生故障时，R1可以使用备份缺省路由通过R2实现与10.0.23.3和10.0.3.3网络间通信。

配置两条备份路由，确保数据来回的双向都有路由。

```
[R1]ip route-static 0.0.0.0 0.0.0.0 10.0.12.2 preference 80


[R3]ip route-static 10.0.12.0 24 10.0.23.2 preference 80
```

.步骤九　验证备份缺省路由

查看链路正常时R1上的路由条目。

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 15      Routes : 15
Destination/Mask    Proto   Pre  Cost Flags NextHop       Interface
    0.0.0.0/0      Static  60   0       RD  10.0.13.3   GigabitEthernet0/0/0
    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
    10.0.3.0/24    Static  60   0       RD  10.0.13.3   GigabitEthernet0/0/0
    10.0.12.0/24  Direct  0    0       D   10.0.12.1   GigabitEthernet0/0/1
    10.0.12.1/32  Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32 Direct  0    0      D   127.0.0.1   GigabitEthernet0/0/1
    10.0.13.0/24   Direct  0    0      D   10.0.13.1   GigabitEthernet0/0/0
    10.0.13.1/32   Direct  0    0      D   127.0.0.1   GigabitEthernet0/0/0
    10.0.13.255/32 Direct  0    0      D   127.0.0.1   GigabitEthernet0/0/0
    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
```

关闭R1与R3上的G0/0/0接口模拟链路故障，然后查看R1的路由表。比较关闭接口前后的路由表变化情况。

```
[R1]interface GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]shutdown
[R1-GigabitEthernet0/0/0]quit

[R3]interface GigabitEthernet0/0/0
[R3-GigabitEthernet0/0/0]shutdown
[R3-GigabitEthernet0/0/0]quit

<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 11       Routes : 11
Destination/Mask    Proto   Pre  Cost  Flags NextHop    Interface
    0.0.0.0/0     Static  80   0       RD  10.0.12.2   GigabitEthernet0/0/1
    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
    10.0.12.0/24  Direct  0    0       D   10.0.12.1   GigabitEthernet0/0/1
    10.0.12.1/32  Direct  0    0       D   127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32 Direct  0    0      D   127.0.0.1   GigabitEthernet0/0/1
    127.0.0.0/8    Direct  0    0      D   127.0.0.1   InLoopBack0
    127.0.0.1/32   Direct  0    0      D   127.0.0.1   InLoopBack0
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
```

上述路由表中，缺省路由0.0.0.0的Preference值为80，表明备用的缺省路由已生效。

```
<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=76 ms
    Reply from 10.0.23.3: bytes=56 Sequence=2 ttl=254 time=250 ms
    Reply from 10.0.23.3: bytes=56 Sequence=3 ttl=254 time=76 ms
    Reply from 10.0.23.3: bytes=56 Sequence=4 ttl=254 time=76 ms
```

```
  Reply from 10.0.23.3: bytes=56 Sequence=5 ttl=254 time=76 ms
 --- 10.0.23.3 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 76/110/250 ms
```

网络并未因为R1与R3之间的链路被关闭而中断。执行**tracert**命令，查看数据包的转发路径。

```
<R1>tracert 10.0.23.3
traceroute to  10.0.23.3(10.0.23.2), max hops: 30 ,packet length: 40,press
CTRL_C to break
 1 10.0.12.2 30 ms  26 ms  26 ms
 2 10.0.23.3 60 ms  53 ms  56 ms
```

结果显示报文通过R2（10.0.12.2）到达R3（10.0.23.3）。

配置文件

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
interface GigabitEthernet0/0/0
 shutdown
 ip address 10.0.13.1 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 10.0.12.1 255.255.255.0
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
ip route-static 0.0.0.0 0.0.0.0 10.0.13.3
ip route-static 0.0.0.0 0.0.0.0 10.0.12.2 preference 80
ip route-static 10.0.3.0 255.255.255.0 10.0.13.3
ip route-static 10.0.12.0 255.255.255.0 10.0.23.2 preference 80
#
```

```
user-interface con 0

 authentication-mode password

 set authentication password
cipher %$%$+L'YR&IZt'4,)>-*#lH",}%K-oJ_M9+'lOU~bD (\WTqB}%N,%$%$

user-interface vty 0 4

#

return


<R2>display current-configuration

[V200R003C00SPC200]

#

 sysname R2

interface GigabitEthernet0/0/1

 ip address 10.0.12.2 255.255.255.0

#

interface GigabitEthernet0/0/2

 ip address 10.0.23.2 255.255.255.0

#

interface LoopBack0

 ip address 10.0.2.2 255.255.255.0

#

ip route-static 10.0.3.0 255.255.255.0 10.0.23.3

ip route-static 10.0.3.0 255.255.255.0 10.0.12.1 preference 80

ip route-static 10.0.13.0 255.255.255.0 10.0.23.3

ip route-static 10.0.13.0 255.255.255.0 10.0.12.1 preference 80

#

user-interface con 0

 authentication-mode password

 set authentication password
cipher %$%$1=cd%b%/O%Id-8X:by1N,+s}'4wD6TvO<I|/pd# #44C@+s#,%$%$

user-interface vty 0 4

#

return


<R3>display current-configuration

[V200R003C00SPC200]

#

 sysname R3

#
```

```
interface GigabitEthernet0/0/0
 shutdown
 ip address 10.0.13.3 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.0.23.3 255.255.255.0
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
ip route-static 10.0.12.0 255.255.255.0 10.0.13.1
ip route-static 10.0.12.0 255.255.255.0 10.0.23.2 preference 80
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$ksXDMg7Ry6yUU:63:DQ),#/sQg"@*S\U#.s.bHW xQ,y%#/v,%$%$
user-interface vty 0 4
#
return
```

实验 5-2 OSPF 单区域配置

学习目标

- 掌握OSPF中Router ID的配置方法
- 掌握OSPF的配置方法
- 掌握通过display命令查看OSPF运行状态的方法
- 掌握使用OSPF发布缺省路由的方法
- 掌握修改OSPF hello和dead时间的配置方法
- 理解多路访问网络中的DR或BDR选举
- 掌握OSPF路由优先级的修改方法

拓扑图

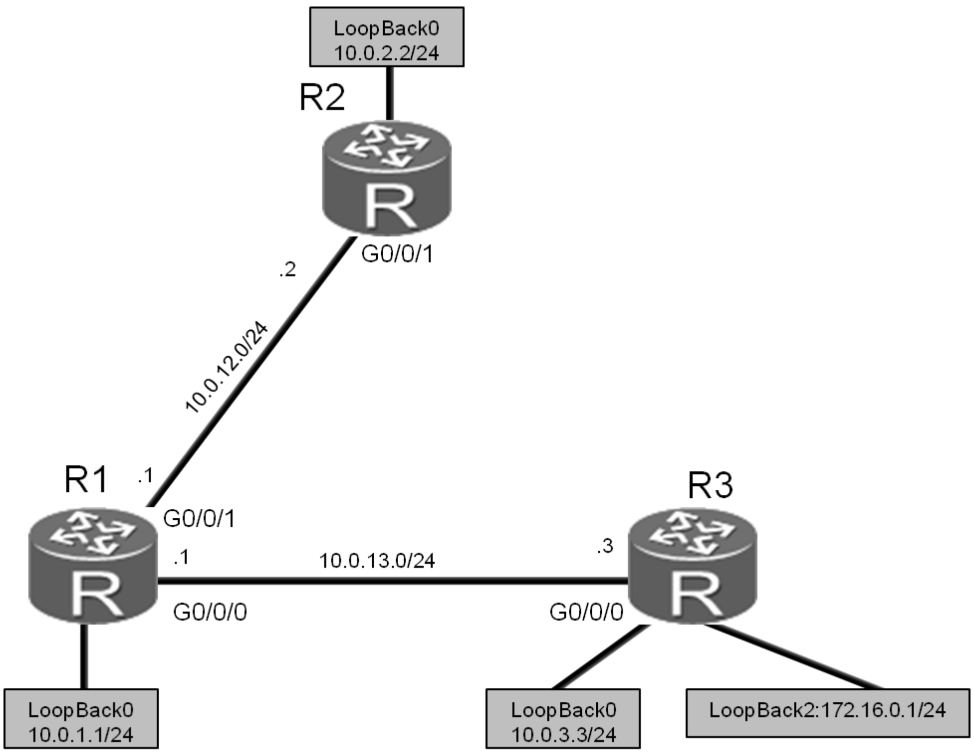


图4.4 OSPF单域配置实验拓扑图

场景

您是公司的网络管理员。现在公司网络中需要使用OSPF协议来进行路由信息的传递。规划网络中所有路由器属于OSPF的区域0。实际使用中需要向OSPF发布默认路由，此外您也希望通过这次部署了解DR/BDR选举的机制。

操作步骤

.步骤一　实验环境准备

如果本任务中您使用的是空配置设备，需要从步骤1开始配置，然后跳过步骤2。如果使用的设备包含上一个实验的配置，请直接从步骤2开始配置。

基本配置以及IP编址。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet 0/0/1]ip address 10.0.12.1 24
[R1-GigabitEthernet 0/0/1]quit
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ip address 10.0.13.1 24
[R1-GigabitEthernet0/0/0]quit
[R1]interface LoopBack 0
[R1-LoopBack0]ip address 10.0.1.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet 0/0/1]ip address 10.0.12.2 24
[R2-GigabitEthernet 0/0/1]quit
[R2]interface LoopBack 0
[R2-LoopBack0]ip address 10.0.2.2 24

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

```
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ip address 10.0.13.3 24
[R3-GigabitEthernet0/0/0]quit
[R3]interface LoopBack 0
[R3-LoopBack0]ip address 10.0.3.3 24
[R3-LoopBack0]quit
[R3]interface LoopBack 2
[R3-LoopBack2]ip address 172.16.0.1 24
```

.步骤二　清除设备上原有的配置

打开必要的接口，关闭无关接口。

```
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]undo shutdown
[R1-GigabitEthernet0/0/1]quit

[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]undo rip summary-address 172.16.0.0 255.255.0.0
[R2-GigabitEthernet0/0/0]shutdown

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]undo shutdown
[R3-GigabitEthernet0/0/0]quit
[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]shutdown
[R3-GigabitEthernet0/0/1]quit
[R3]undo interface LoopBack 3
Info: This operation may take a few seconds. Please wait for a
moment...succeeded.
[R3]undo interface LoopBack 4
Info: This operation may take a few seconds. Please wait for a
moment...succeeded.
[R3]undo interface LoopBack 5
Info: This operation may take a few seconds. Please wait for a
moment...succeeded.
```

删除设备上的RIP认证配置和RIP进程1。

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]undo rip authentication-mode
```

```
[R1-GigabitEthernet0/0/0]quit
[R1]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R2]interface GigabitEthernet 0/0/0
[R2-GigabitEthernet0/0/0]undo rip authentication-mode
[R2-GigabitEthernet0/0/0]quit
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]undo rip authentication-mode
[R2-GigabitEthernet0/0/1]quit
[R2]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R3]interface GigabitEthernet 0/0/1
[R3-GigabitEthernet0/0/1]undo rip authentication-mode
[R3-GigabitEthernet0/0/1]quit
[R3]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y
```

.步骤三　配置 OSPF

将R1的Router ID配置为10.0.1.1（逻辑接口Loopback 0的地址），开启OSPF进程1（缺省进程），并将网段10.0.1.0/24、10.0.12.0/24和10.0.13.0/24发布到OSPF区域0。

```
[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
[R1-ospf-1-area-0.0.0.0]network 10.0.12.0 0.0.0.255
```

注意：同一个路由器可以开启多个OSPF进程，默认进程号为1，由于进程号只具有本地意义，所以同一路由域的不同路由器可以使用相同或不同的OSPF进程号。另外**network**命令后面需使用反掩码。

将R2的Router ID配置为10.0.2.2，开启OSPF进程1，并将网段10.0.12.0/24和10.0.2.0/24发布到OSPF区域0。

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

```
[R2-ospf-1-area-0.0.0.0]network 10.0.12.0 0.0.0.255

…output omitted…

Nov 30 2013 09:41:39+00:00 R2 %%01OSPF/4/NBR_CHANGE_E(l)[5]:Neighbor changes
event: neighbor status changed. (ProcessId=1, NeighborAddress=10.0.12.1,
NeighborEvent=LoadingDone, NeighborPreviousState=Loading,
NeighborCurrentState=Full)
```

当回显信息中包含“NeighborCurrentState=Full”信息时，表明邻接关系已经建立。

将R3的Router ID配置为10.0.3.3，开启OSPF进程1，并将网段10.0.3.0/24和10.0.13.0/24发布到OSPF区域0。

```
[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

…output omitted…

Nov 30 2013 16:05:34+00:00 R3 %%01OSPF/4/NBR_CHANGE_E(l)[5]:Neighbor changes
event: neighbor status changed. (ProcessId=1, NeighborAddress=10.0.13.1,
NeighborEvent=LoadingDone, NeighborPreviousState=Loading,
NeighborCurrentState=Full)
```

.步骤四　验证 OSPF 配置

待OSPF收敛完成后，查看R1、R2和R3上的路由表。

```
<R1>display ip routing-table

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

------------------------------------------------------------------------------

Routing Tables: Public

        Destinations : 15       Routes : 15

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   1       D   10.0.12.2    GigabitEthernet0/0/1

    10.0.3.3/32    OSPF   10   1       D   10.0.13.3    GigabitEthernet0/0/0

    10.0.12.0/24   Direct 0    0       D   10.0.12.1    GigabitEthernet0/0/1

    10.0.12.1/32   Direct 0    0       D   127.0.0.1    GigabitEthernet0/0/1

    10.0.12.255/32 Direct 0    0       D   127.0.0.1    GigabitEthernet0/0/1

    10.0.13.0/24   Direct 0    0       D   10.0.13.1    GigabitEthernet0/0/0

    10.0.13.1/32   Direct 0    0       D   127.0.0.1    GigabitEthernet0/0/0

    10.0.13.255/32 Direct 0    0       D   127.0.0.1    GigabitEthernet0/0/0
```

```
    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 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
    10.0.1.1/32    OSPF   10   1        D   10.0.12.1    GigabitEthernet0/0/1
    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   2        D   10.0.12.1    GigabitEthernet0/0/1
    10.0.12.0/24   Direct  0    0       D   10.0.12.2    GigabitEthernet0/0/1
    10.0.12.2/32   Direct  0    0       D   127.0.0.1    GigabitEthernet0/0/1
    10.0.12.255/32 Direct  0    0       D   127.0.0.1    GigabitEthernet0/0/1
    10.0.13.0/24   OSPF    10   2       D   10.0.12.1    GigabitEthernet0/0/1
    127.0.0.0/8    Direct  0    0       D   127.0.0.1    InLoopBack0
    127.0.0.1/32   Direct  0    0       D   127.0.0.1    InLoopBack0
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 : 16      Routes : 16
Destination/Mask    Proto   Pre  Cost Flags NextHop        Interface
    10.0.1.1/32    OSPF   10   1        D   10.0.13.1    GigabitEthernet0/0/0
    10.0.2.2/32    OSPF   10   2        D   10.0.13.1    GigabitEthernet0/0/0
    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
    10.0.12.0/24   OSPF   10   2        D   10.0.13.1    GigabitEthernet0/0/0
    10.0.13.0/24   Direct 0    0        D   10.0.13.3    GigabitEthernet0/0/0
```

```
    10.0.13.3/32    Direct 0    0       D   127.0.0.1    GigabitEthernet0/0/0
    10.0.13.255/32 Direct 0     0       D   127.0.0.1    GigabitEthernet0/0/0
    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
    172.16.0.0/24  Direct 0     0       D   172.16.0.1  LoopBack2
    172.16.0.1/32  Direct 0     0       D   127.0.0.1    LoopBack2
    172.16.0.255/32 Direct    0    0       D   127.0.0.1    LoopBack2
255.255.255.255/32  Direct    0    0       D   127.0.0.1    InLoopBack0
```

检测R2和R1（10.0.1.1）以及R2和R3（10.0.3.3）间的连通性。

```
<R2>ping 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=37 ms
    Reply from 10.0.1.1: bytes=56 Sequence=2 ttl=255 time=42 ms
    Reply from 10.0.1.1: bytes=56 Sequence=3 ttl=255 time=42 ms
    Reply from 10.0.1.1: bytes=56 Sequence=4 ttl=255 time=45 ms
    Reply from 10.0.1.1: bytes=56 Sequence=5 ttl=255 time=42 ms
  --- 10.0.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 37/41/45 ms

<R2>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=254 time=42 ms
    Reply from 10.0.3.3: bytes=56 Sequence=3 ttl=254 time=42 ms
    Reply from 10.0.3.3: bytes=56 Sequence=4 ttl=254 time=42 ms
    Reply from 10.0.3.3: bytes=56 Sequence=5 ttl=254 time=42 ms
  --- 10.0.3.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 37/41/42 ms
```

执行**display ospf peer**命令，查看OSPF邻居状态。

```
<R1>display ospf peer
        OSPF Process 1 with Router ID 10.0.1.1
               Neighbors
 Area 0.0.0.0 interface 10.0.12.1(GigabitEthernet0/0/1)'s neighbors
 Router ID: 10.0.2.2        Address: 10.0.12.2
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.12.1  BDR: 10.0.12.2  MTU: 0
   Dead timer due in 32  sec
   Retrans timer interval: 5
   Neighbor is up for 00:47:59
   Authentication Sequence: [ 0 ]
               Neighbors
 Area 0.0.0.0 interface 10.0.13.1(GigabitEthernet0/0/0)'s neighbors
 Router ID: 10.0.3.3        Address: 10.0.13.3
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.13.1  BDR: 10.0.13.3  MTU: 0
   Dead timer due in 34  sec
   Retrans timer interval: 5
   Neighbor is up for 00:41:44
   Authentication Sequence: [ 0 ]
```

display ospf peer命令显示所有OSPF邻居的详细信息。本任务中，10.0.13.0网段上R1是DR。由于DR选举是非抢占模式，如果OSPF进程不重启，R3将不会取代R1的DR角色。

执行**display ospf peer brief**命令，可以查看简要的OSPF邻居信息。

```
<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          GigabitEthernet0/0/0               10.0.3.3        Full
 0.0.0.0          GigabitEthernet0/0/1               10.0.2.2        Full
 ----------------------------------------------------------------------------

<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         GigabitEthernet0/0/1             10.0.1.1         Full
 ----------------------------------------------------------------------------

<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          GigabitEthernet0/0/0            10.0.1.1         Full
 ----------------------------------------------------------------------------
```

.步骤五　修改 OSPF hello 和 dead 时间参数

在R1上执行**display ospf interface GigabitEthernet 0/0/0**命令，查看OSPF默认的hello和dead时间。

```
<R1>display ospf interface GigabitEthernet 0/0/0
        OSPF Process 1 with Router ID 10.0.1.1
               Interfaces
 Interface: 10.0.13.1 (GigabitEthernet0/0/0)
 Cost: 1      State: DR       Type: Broadcast    MTU: 1500
 Priority: 1
 Designated Router: 10.0.13.1
 Backup Designated Router: 10.0.13.3
 Timers: Hello 10 , Dead 40 , Poll  120 , Retransmit 5 , Transmit Delay 1
```

在R1的GE0/0/0接口执行**ospf timer**命令，将OSPF hello和dead时间分别修改为15秒和60秒。

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ospf timer hello 15
[R1-GigabitEthernet0/0/0]ospf timer dead 60
Nov 30 2013 16:58:39+00:00 R1 %%01OSPF/3/NBR_DOWN_REASON(l)[1]:Neighbor
state leaves full or changed to Down. (ProcessId=1, NeighborRouterId=10.0.3.3,
NeighborAreaId=0,
NeighborInterface=GigabitEthernet0/0/0,NeighborDownImmediate
```

```
reason=Neighbor Down Due to Inactivity, NeighborDownPrimeReason=Interface Parameter Mismatch, NeighborChangeTime=2013-11-30 16:58:39)


<R1>display ospf interface GigabitEthernet 0/0/0
        OSPF Process 1 with Router ID 10.0.1.1
               Interfaces
 Interface: 10.0.13.1 (GigabitEthernet0/0/0)
 Cost: 1      State: DR       Type: Broadcast    MTU: 1500
 Priority: 1
 Designated Router: 10.0.13.1
 Backup Designated Router: 10.0.13.3
 Timers: Hello 15 , Dead 60 , Poll  120 , Retransmit 5 , Transmit Delay 1
```

在R1上查看OSPF邻居状态。

```
<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         GigabitEthernet0/0/1             10.0.2.2        Full

----------------------------------------------------------------------------
```

上述回显信息表明，R1只有一个邻居，那就是R2。因为R1和R3上的OSPF hello和dead时间取值不同，所以R1无法与R3建立OSPF邻居关系。

在R3的GE0/0/0接口执行**ospf timer**命令，将OSPF hello和dead时间分别修改为15秒和60秒。

```
[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ospf timer hello 15
[R3-GigabitEthernet0/0/0]ospf timer dead 60
…output omitted…
Nov 30 2013 17:03:33+00:00 R3 %%01OSPF/4/NBR_CHANGE_E(l)[4]:Neighbor changes event: neighbor status changed. (ProcessId=1, NeighborAddress=10.0.13.1, NeighborEvent=LoadingDone, NeighborPreviousState=Loading, NeighborCurrentState=Full)


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

```
Interface: 10.0.13.3 (GigabitEthernet0/0/0)
Cost: 1      State: DR       Type: Broadcast    MTU: 1500
Priority: 1
Designated Router: 10.0.13.3
Backup Designated Router: 10.0.13.1
Timers: Hello 15 , Dead 60 , Poll  120 , Retransmit 5 , Transmit Delay 1
```

再次在R1上查看OSPF邻居状态。

```
<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          GigabitEthernet0/0/0           10.0.3.3         Full
 0.0.0.0          GigabitEthernet0/0/1           10.0.2.2         Full
------------------------------------------------------------------------
```

.步骤六 OSPF 缺省路由发布及验证

在R3上配置缺省路由并发布到OSPF域内。

```
[R3]ip route-static 0.0.0.0 0.0.0.0 LoopBack 2
[R3]ospf 1
[R3-ospf-1]default-route-advertise
```

查看R1和R2的路由表。可以看到，R1和R2均已经学习到了R3发布的缺省路由。

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------
Routing Tables: Public
       Destinations : 16      Routes : 16

Destination/Mask    Proto   Pre  Cost Flags    NextHop     Interface
    0.0.0.0/0       O_ASE   150  1       D   10.0.13.3   GigabitEthernet0/0/0
    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   1        D   10.0.12.2   GigabitEthernet0/0/1
    10.0.3.3/32    OSPF   10   1        D   10.0.13.3   GigabitEthernet0/0/0
    10.0.12.0/24   Direct 0    0        D   10.0.12.1   GigabitEthernet0/0/1
    10.0.12.1/32   Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32 Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/1
    10.0.13.0/24   Direct 0    0        D   10.0.13.1   GigabitEthernet0/0/0
    10.0.13.1/32   Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/0
    10.0.13.255/32 Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/0
    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 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
    0.0.0.0/0      O_ASE   150  1        D   10.0.12.1   GigabitEthernet0/0/1
    10.0.1.1/32    OSPF1  0    1        D   10.0.12.1   GigabitEthernet0/0/1
    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   2        D   10.0.12.1   GigabitEthernet0/0/1
    10.0.12.0/24   Direct 0    0        D   10.0.12.2   GigabitEthernet0/0/1
    10.0.12.2/32   Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/1
    10.0.12.255/32 Direct 0    0        D   127.0.0.1   GigabitEthernet0/0/1
    10.0.13.0/24   OSPF   10   2        D   10.0.12.1   GigabitEthernet0/0/1
    127.0.0.0/8    Direct 0    0        D   127.0.0.1   InLoopBack0
    127.0.0.1/32   Direct 0    0        D   127.0.0.1   InLoopBack0
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 : 17       Routes : 17
Destination/Mask    Proto   Pre  Cost Flags   NextHop      Interface
    0.0.0.0/0       Static  60   0      D   172.16.0.1   LoopBack2
    10.0.1.1/32     OSPF    10   1      D   10.0.13.1    GigabitEthernet0/0/0
    10.0.2.2/32     OSPF    10   2      D   10.0.13.1    GigabitEthernet0/0/0
    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
    10.0.12.0/24    OSPF    10   2      D   10.0.13.1    GigabitEthernet0/0/0
    10.0.13.0/24    Direct  0    0      D   10.0.13.3    GigabitEthernet0/0/0
    10.0.13.3/32    Direct  0    0      D   127.0.0.1    GigabitEthernet0/0/0
    10.0.13.255/32  Direct  0    0      D   127.0.0.1    GigabitEthernet0/0/0
    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
    172.16.0.0/24   Direct  0    0      D   172.16.0.1   LoopBack2
    172.16.0.1/32   Direct  0    0      D   127.0.0.1    LoopBack2
    172.16.0.255/32 Direct0      0      D   127.0.0.1    LoopBack2
255.255.255.255/32  Direct0      0      D   127.0.0.1    InLoopBack0
```

使用**ping**命令，检测R2与172.16.0.1/24网段之间的连通性。

```
<R2>ping 172.16.0.1
  PING 172.16.0.1: 56  data bytes, press CTRL_C to break
    Reply from 172.16.0.1: bytes=56 Sequence=1 ttl=254 time=47 ms
    Reply from 172.16.0.1: bytes=56 Sequence=2 ttl=254 time=37 ms
    Reply from 172.16.0.1: bytes=56 Sequence=3 ttl=254 time=37 ms
    Reply from 172.16.0.1: bytes=56 Sequence=4 ttl=254 time=37 ms
    Reply from 172.16.0.1: bytes=56 Sequence=5 ttl=254 time=37 ms
  --- 172.16.0.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 37/39/47 ms
```

.步骤七　控制 OSPF DR/BDR 的选举

执行**display ospf peer**命令，查看R1和R3的DR/BDR角色。

```
<R1>display ospf peer 10.0.3.3
```

```
        OSPF Process 1 with Router ID 10.0.1.1
               Neighbors
 Area 0.0.0.0 interface 10.0.13.1(GigabitEthernet0/0/0)'s neighbors
 Router ID: 10.0.3.3       Address: 10.0.13.3
   State: Full  Mode:Nbr is  Master  Priority: 1
   DR: 10.0.13.3  BDR: 10.0.13.1  MTU: 0
   Dead timer due in 49  sec
   Retrans timer interval: 5
   Neighbor is up for 00:17:40
   Authentication Sequence: [ 0 ]
```

上述回显信息表明，由于默认路由器优先级（数值为1）相同，但R3的Router ID 10.0.3.3大于R1的Router ID 10.0.1.1，所以R3为DR，R1为BDR。

执行**ospf dr-priority**命令，修改R1和R3的DR优先级。

```
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]ospf dr-priority 200

[R3]interface GigabitEthernet 0/0/0
[R3-GigabitEthernet0/0/0]ospf dr-priority 100
```

默认情况下，DR/BDR的选举采用的是非抢占模式。路由器优先级修改后，不会自动重新选举DR。因此，需要重置R1和R3间的OSPF邻居关系。

先关闭然后再打开R1和R3上的Gigabit Ethernet 0/0/0接口，重置R1和R3间的OSPF邻居关系。

```
[R3]interface GigabitEthernet0/0/0
[R3-GigabitEthernet0/0/0]shutdown

[R1]interface GigabitEthernet0/0/0
[R1-GigabitEthernet0/0/0]shutdown

[R1-GigabitEthernet0/0/0]undo shutdown

[R3-GigabitEthernet0/0/0]undo shutdown
```

执行**display ospf peer**命令，查看R1和R3的DR/BDR角色。

```
[R1]display ospf peer 10.0.3.3
        OSPF Process 1 with Router ID 10.0.1.1
```

```
               Neighbors
 Area 0.0.0.0 interface 10.0.13.1(GigabitEthernet0/0/0)'s neighbors
 Router ID: 10.0.3.3       Address: 10.0.13.3
   State: Full  Mode:Nbr is  Master  Priority: 100
   DR: 10.0.13.1  BDR: 10.0.13.3  MTU: 0
   Dead timer due in 52  sec
   Retrans timer interval: 5
   Neighbor is up for 00:00:25
   Authentication Sequence: [ 0 ]
```

上述信息表明，R1的DR优先级高于R3，因此R1被选举为DR，而R3成为了BDR。

配置文件

```
<R1>display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
interface GigabitEthernet0/0/0
 ip address 10.0.13.1 255.255.255.0
 ospf dr-priority 200
 ospf timer hello 15
#
interface GigabitEthernet0/0/1
 ip address 10.0.12.1 255.255.255.0
#
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 10.0.12.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
user-interface con 0
 authentication-mode password
```

```
 set authentication password
cipher %$%$+L'YR&IZt'4,)>-*#lH",}%K-oJ_M9+'lOU~bD (\WTqB}%N,%$%$
user-interface vty 0 4
#
return

<R2>display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
interface GigabitEthernet0/0/1
 ip address 10.0.12.2 255.255.255.0
#
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
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$1=cd%b%/O%Id-8X:by1N,+s}'4wD6TvO<I|/pd# #44C@+s#,%$%$
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 dr-priority 100
 ospf timer hello 15
```

```
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
interface LoopBack2
 ip address 172.16.0.1 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 default-route-advertise
 area 0.0.0.0
  network 10.0.3.0 0.0.0.255
  network 10.0.13.0 0.0.0.255
#
ip route-static 0.0.0.0 0.0.0.0 LoopBack2
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$ksXDMg7Ry6yUU:63:DQ),#/sQg"@*S\U#.s.bHW xQ,y%#/v,%$%$
user-interface vty 0 4
#
return
```

实验六 VRRP技术原理与配置

实验 6-1 VRRP 基本配置

学习目标

- 了解VRRP的应用场景。
- 理解VRRP工作原理。
- 理解VRRP的Master和Backup角色。
- 掌握VRRP的配置方法。
- 掌握查看VRRP状态的方法。

拓扑图

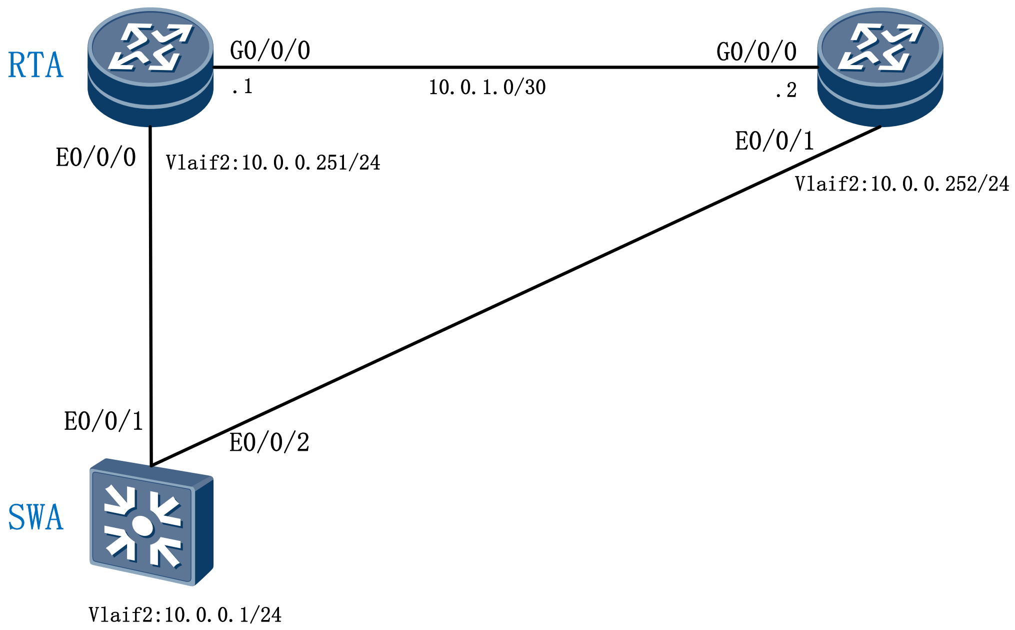


图 6.1 VRRP 基本配置组网

在本实验中，我们假定 RTA 和 RTB 是核心层交换机，SWA 为接入层交换机，在 RTA 和 RTB 上运行 VRRP 用于对接入设备的网关进行备份。

操作步骤

.步骤一　基础配置

更改设备名称，配置路由器各接口IP地址，由于路由器下联接口为二层接口，因此需要在路由器上启用Vlanif，本实验中我们使用VLAN2：10.0.0.0/24如图所示配置各Vlanif的IP地址，并且需要将RTA和RTB的下联接口配置为Trunk类型并允许Vlan2通过。

```
<RTA>sys
Enter system view, return user view with Ctrl+Z.
[RTA]vlan 2
[RTA-vlan2]quit
[RTA]interface Vlanif 2
[RTA-Vlanif2]ip address 10.0.0.251 24
[RTA-Vlanif2]quit
[RTA]interface GigabitEthernet 0/0/0
[RTA-GigabitEthernet0/0/0]ip address 10.0.1.1 24
[RTA-GigabitEthernet0/0/0]quit
[RTA]interface Ethernet 0/0/0
[RTA-Ethernet0/0/0]port link-type trunk
[RTA-Ethernet0/0/0]port trunk allow-pass vlan 2
[RTA-Ethernet0/0/0]quit

<RTB>sys
Enter system view, return user view with Ctrl+Z.
[RTB]vlan 2
[RTB-vlan2]quit
[RTB]interface Vlanif 2
[RTB-Vlanif2]ip address 10.0.0.252 24
[RTB-Vlanif2]quit
[RTB]interface GigabitEthernet 0/0/0
[RTB-GigabitEthernet0/0/0]ip address 10.0.1.2 24
[RTB-GigabitEthernet0/0/0]quit
[RTB]interface Ethernet 0/0/1
[RTB-Ethernet0/0/1]port link-type trunk
[RTB-Ethernet0/0/1]port trunk allow-pass vlan 2
[RTB-Ethernet0/0/1]quit
```

SWA的配置，创建Vlanif2并配置IP地址，并设置相应端口为Trunk类型允许Vlan2通过。

```
<SWA>sys
Enter system view, return user view with Ctrl+Z.
[SWA]vlan 2
[SWA-vlan2]quit
[SWA]interface Vlanif 2
[SWA-Vlanif2]ip address 10.0.0.1 255.255.255.0
[SWA-Vlanif2]quit
[SWA]interface Ethernet 0/0/1
[SWA-Ethernet0/0/1]port link-type trunk
[SWA-Ethernet0/0/1]port trunk allow-pass vlan 2
[SWA-Ethernet0/0/1]quit
[SWA]interface Ethernet 0/0/2
[SWA-Ethernet0/0/2]port link-type trunk
[SWA-Ethernet0/0/2]port trunk allow-pass vlan 2
[SWA-Ethernet0/0/2]quit
```

.步骤二　配置 VRRP

我们首先在RTA上配置VRRP组，设置组地址为10.0.0.254，并修改优先级为150，这样可以保证RTA成为Master路由器。

```
[RTA]interface Vlanif 2
[RTA-Vlanif2]vrrp vrid 1 virtual-ip 10.0.0.254
[RTA-Vlanif2]vrrp vrid 1 priority 150
```

在RTB上，我们配置与RTA相同的VRRP组，并保持默认的优先级100不变。

```
[RTB]interface Vlanif 2
[RTB-Vlanif2]vrrp vrid 1 virtual-ip 10.0.0.254
```

结果验证

验证 VRRP 状态

首先在RTA上查看VRRP的状态，我们可以看到RTA现在处于Master状态。

```
<RTA>dispaly vrrp
  Vlanif2 | Virtual Router 1
```

```
    State : Master
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.251
    PriorityRun : 150
    PriorityConfig : 150
    MasterPriority : 150
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Config track link-bfd down-number : 0
```

而此时RTB处于backup状态。

```
<RTB>display vrrp
  Vlanif2 | Virtual Router 1
    State : Backup
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.251
    PriorityRun : 100
    PriorityConfig : 100
    MasterPriority : 150
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Config track link-bfd down-number : 0
```

我们在SWA上ping虚地址，能访问到VRRP虚拟路由器的地址。

```
<SWA>ping 10.0.0.254
  PING 10.0.0.254: 56  data bytes, press CTRL_C to break
Reply from 10.0.0.254: bytes=56 Sequence=1 ttl=255 time=28 ms
Reply from 10.0.0.254: bytes=56 Sequence=2 ttl=254 time=1 ms
Reply from 10.0.0.254: bytes=56 Sequence=3 ttl=254 time=1 ms
Reply from 10.0.0.254: bytes=56 Sequence=4 ttl=254 time=1 ms
```

```
Reply from 10.0.0.254: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 10.0.0.254 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 1/6/28 ms
```

故障切换

我们通过关闭Vlanif接口的方式来模拟故障：

```
[RTA]interface vlanif 2
[RTA-Vlanif2]shutdown

<RTB>display vrrp
  Vlanif2 | Virtual Router 1
    State : Master
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.252
    PriorityRun : 100
    PriorityConfig : 100
    MasterPriority : 100
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Config track link-bfd down-number : 0
```

注意到当RTA上Vlanif 2关闭时，RTB成了这个VRRP组的Master路由器；当RTA重新开启Vlanif 2时，RTB又切换回backup状态。

```
[RTA-Vlanif2]undo shutdown

<RTB>display vrrp
  Vlanif2 | Virtual Router 1
    State : Backup
    Virtual IP : 10.0.0.254
```

```
   Master IP : 10.0.0.251
   PriorityRun : 100
   PriorityConfig : 100
   MasterPriority : 150
   Preempt : YES   Delay time : 0
   TimerRun : 1
   TimerConfig : 1
   Auth type : NONE
   Virtual MAC :  0000-5e00-0101
   Check TTL : YES
   Config type : normal-vrrp
   Config track link-bfd down-number : 0
```

配置参考

RTA 相关配置：

```
#
vlan batch 2
#
interface Vlanif2
 ip address 10.0.0.251 255.255.255.0
 vrrp vrid 1 virtual-ip 10.0.0.254
 vrrp vrid 1 priority 150
#
interface Ethernet0/0/0
 port link-type trunk
 port trunk allow-pass vlan 2
 stp disable
#
 interface GigabitEthernet0/0/0
 ip address 10.0.1.1 255.255.255.0
#
```

RTB 相关配置：

```
#
vlan batch 2
#
interface Vlanif2
```

```
 ip address 10.0.0.252 255.255.255.0
 vrrp vrid 1 virtual-ip 10.0.0.254
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2
#
interface GigabitEthernet0/0/0
 ip address 10.0.1.2 255.255.255.0
#
```

SWA 的配置：

```
vlan batch 2
#
interface Vlanif2
 ip address 10.0.0.1 255.255.255.0
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2
#
interface Ethernet0/0/2
 port link-type trunk
 port trunk allow-pass vlan 2
#
```

实验 6-2 VRRP 跟踪上行端口配置

学习目标

- 了解VRRP跟踪上行端口的应用场景。
- 理解VRRP跟踪端口的工作原理。
- 掌握VRRP跟踪端口的配置方法。

拓扑图

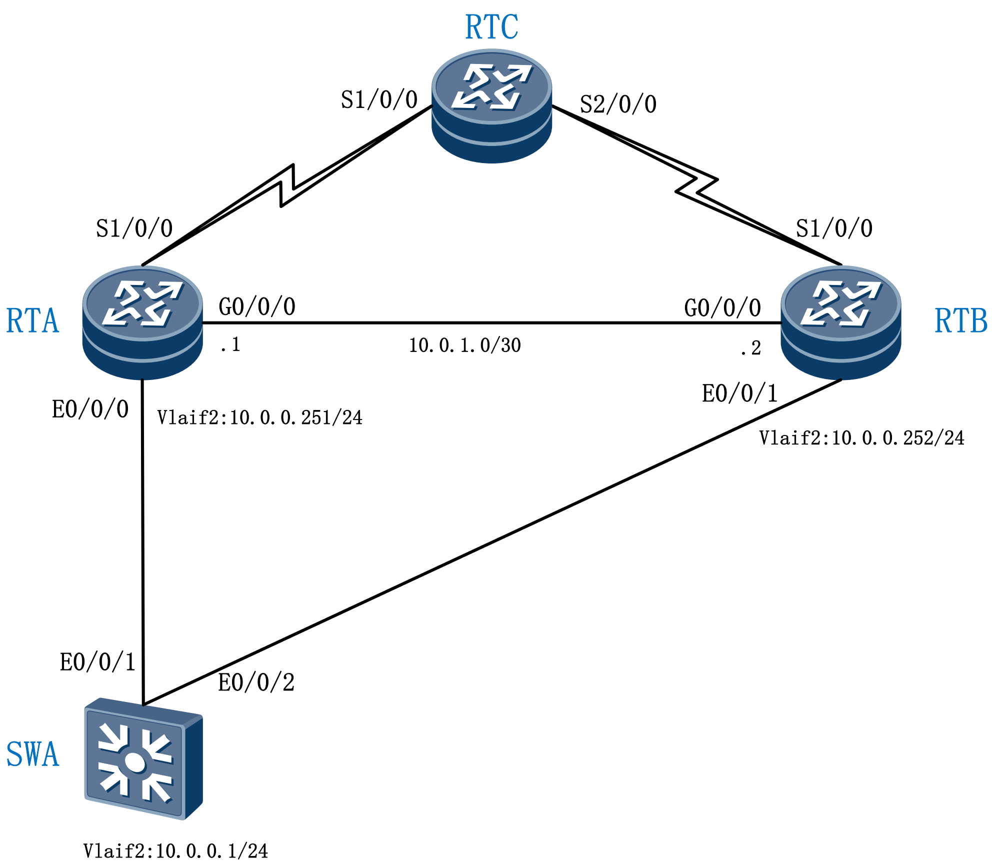


图 6.2 VRRP 跟踪上行端口配置组网

如图所示构建实验拓扑，本实验与上一实验具有延续性，即在前一的实验的基础上增加跟踪上行接口的配置。

操作步骤

.步骤一　基础配置

与前一实验相同，请参考前一章节实验。RTA和RTB与RTC之间相连的链路无需配置。

```
<RTA>sys
Enter system view, return user view with Ctrl+Z.
[RTA]vlan 2
[RTA-vlan2]quit
[RTA]interface Vlanif 2
[RTA-Vlanif2]ip address 10.0.0.251 24
[RTA-Vlanif2]quit
[RTA]interface GigabitEthernet 0/0/0
[RTA-GigabitEthernet0/0/0]ip address 10.0.1.1 24
[RTA-GigabitEthernet0/0/0]quit
[RTA]interface Ethernet 0/0/0
[RTA-Ethernet0/0/0]port link-type trunk
[RTA-Ethernet0/0/0]port trunk allow-pass vlan 2
[RTA-Ethernet0/0/0]quit
[RTA]interface Vlanif 2
[RTA-Vlanif2]vrrp vrid 1 virtual-ip 10.0.0.254
[RTA-Vlanif2]vrrp vrid 1 priority 150

<RTB>sys
Enter system view, return user view with Ctrl+Z.
[RTB]vlan 2
[RTB-vlan2]quit
[RTB]interface Vlanif 2
[RTB-Vlanif2]ip address 10.0.0.252 24
[RTB-Vlanif2]quit
[RTB]interface GigabitEthernet 0/0/0
[RTB-GigabitEthernet0/0/0]ip address 10.0.1.2 24
[RTB-GigabitEthernet0/0/0]quit
[RTB]interface Ethernet 0/0/1
[RTB-Ethernet0/0/1]port link-type trunk
[RTB-Ethernet0/0/1]port trunk allow-pass vlan 2
```

```
[RTB-Ethernet0/0/1]quit
[RTB]interface Vlanif 2
[RTB-Vlanif2]vrrp vrid 1 virtual-ip 10.0.0.254
```

```
<SWA>sys
Enter system view, return user view with Ctrl+Z.
[SWA]vlan 2
[SWA-vlan2]quit
[SWA]interface Vlanif 2
[SWA-Vlanif2]ip address 10.0.0.1 255.255.255.0
[SWA-Vlanif2]quit
[SWA]interface Ethernet 0/0/1
[SWA-Ethernet0/0/1]port link-type trunk
[SWA-Ethernet0/0/1]port trunk allow-pass vlan 2
[SWA-Ethernet0/0/1]quit
[SWA]interface Ethernet 0/0/2
[SWA-Ethernet0/0/2]port link-type trunk
[SWA-Ethernet0/0/2]port trunk allow-pass vlan 2
[SWA-Ethernet0/0/2]quit
```

.步骤二　跟踪上行端口

由于前面的配置中RTA的优先级为150，所以正常情况下由RTA担当Master角色，我们在RTA上配置跟踪上行接口，所跟踪的接口为RTA连接到路由器RTC的S1/0/0，当S0/0/1故障时，RTA的优先级降低100。

```
[RTA]interface Vlanif 2
[RTA-Vlanif2]vrrp vrid 1 track interface Serial 1/0/0 reduced 100
```

结果验证

验证跟踪上行端口

我们首先观察上行接口正常情况下的输出，此时RTA的PriorityRun和PriorityConfig是一样的，均为150。

```
<RTA>display vrrp
  Vlanif2 | Virtual Router 1
```

```
    State : Master
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.251
    PriorityRun : 150
    PriorityConfig : 150
    MasterPriority : 150
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Track IF : GigabitEthernet1/0/0  Priority reduced : 100
    IF state : UP
    Config track link-bfd down-number : 0
```

然后我们关闭RTA的上行接口，我们观察到RTA的PriorityRun降到了50，此时RTA变成Backup状态，RTB成为了新的Master。

```
<RTA>sys
Enter system view, return user view with Ctrl+Z.
[RTA]interface GigabitEthernet 1/0/0
[RTA-GigabitEthernet1/0/0]shutdown
[RTA-GigabitEthernet1/0/0]return
<RTA>display vrrp
  Vlanif2 | Virtual Router 1
    State : Backup
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.252
    PriorityRun : 50
    PriorityConfig : 150
    MasterPriority : 100
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
```

```
    Track IF : GigabitEthernet1/0/0  Priority reduced : 100
    IF state : DOWN
    Config track link-bfd down-number : 0

<RTB>display vrrp
  Vlanif2 | Virtual Router 1
    State : Master
    Virtual IP : 10.0.0.254
    Master IP : 10.0.0.252
    PriorityRun : 100
    PriorityConfig : 100
    MasterPriority : 100
    Preempt : YES   Delay time : 0
    TimerRun : 1
    TimerConfig : 1
    Auth type : NONE
    Virtual MAC :  0000-5e00-0101
    Check TTL : YES
    Config type : normal-vrrp
    Config track link-bfd down-number : 0
```

配置参考

RTA相关配置：

```
#
vlan batch 2
#
interface Vlanif2
 ip address 10.0.0.251 255.255.255.0
 vrrp vrid 1 virtual-ip 10.0.0.254
 vrrp vrid 1 priority 150
vrrp vrid 1 track interface Serial1/0/0 reduced 100
#
interface Ethernet0/0/0
 port link-type trunk
 port trunk allow-pass vlan 2
 stp disable
```

```
#
interface GigabitEthernet0/0/0
 ip address 10.0.1.1 255.255.255.0
#
```

RTB相关配置：

```
#
vlan batch 2
#
interface Vlanif2
 ip address 10.0.0.252 255.255.255.0
 vrrp vrid 1 virtual-ip 10.0.0.254
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2
#
interface GigabitEthernet0/0/0
 ip address 10.0.1.2 255.255.255.0
#
```

SWA的配置：

```
vlan batch 2
#
interface Vlanif2
 ip address 10.0.0.1 255.255.255.0
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2
#
interface Ethernet0/0/2
 port link-type trunk
 port trunk allow-pass vlan 2
#
```