

# 企业级网络设计与高可用性配置

## 一、课程设计目的

《路由与交换技术》是信息工程学院网络工程专业专业的必修课程，主要学习路由器与交换机的综合配置。在前阶段的学习中，进行了路由器和交换机的各个知识点的专项练习。本次课程设计的目的在于提升我们的动手实践能力，加强对专业理论知识的理解和实践技能的实际综合运用，以及掌握本次课程设计重点专业知识，加强路由与交换的实际动手能力。同时锻炼学生的分析问题、解决问题的能力，从而加深对这门课的理解，在理解相关设备的原理知识的同时又提高学生的实际操作能力。

## 二、课程设计内容

### （一）项目背景介绍

该拓扑可用于企业多部门网络，远程办公与分支机构互联，高可用性关键业务环境，教育与培训环境等应用场景。该拓扑网络实现了 VLAN 划分，实现不同部门或用户组的网络隔离，高可用性与冗余，VRRP 自动切换主备状态，MSTP 防止环路，远程访问与安全通信，VPN 隧道，telnet 远程登录，无线网络接入，AP 与 VLAN40，扩展性与可管理性，网络拓扑支持扩展，提供集中式管理能力。

### （二）网络设计实现内容

- 1.划分 VLAN 实现逻辑隔离，避免广播风暴
- 2.使用 STP 生成树协议避免环路
- 3.使用 VRRP 实现网络可用性冗余
- 4.Telnet 远程访问
- 5.无线接入

### （三）使用技术介绍

多区域 OSPF 将一个大型网络划分为多个区域，必须存在一个骨干区域编号为 Area 0。负责连接其他非骨干区域，承担区域间路由信息传输和汇总等功能。以提高网络的可扩展性、稳定性和管理效率。在多区域 OSPF 网络中，每个区域内，路由器会收集本区域内的链路状态信息，并通过洪泛的方式将这些信息传播给区域内的其他路由器。每个路由器根据收到的链路状态信息，使用 Dijkstra 算法计算出到达本区域

内各个网络的最短路径，并生成区域内的路由表 MSTP（Multiple Spanning Tree Protocol）是 STP（生成树协议）和 RSTP（快速生成树协议）的升级版，其核心目标是解决单生成树环境下的资源浪费问题，实现多实例化的生成树拓扑，进而支持流量负载均衡与冗余备份。

VRRP（Virtual Router Redundancy Protocol）的作用是解决局域网中网关单点故障问题，通过创建一个“虚拟路由器”，将多个物理路由器虚拟为一个逻辑网关，实现网关的冗余备份与透明切换

VPN：虚拟专用网，属于远程访问技术，利用公网架设专网。VPN 可实现用户在外地能利用 VPN 访问内网资源。GRE：通用路由封装，一种协议。对某些网络层协议数据包进行封装，使得这些被封装的数据包能够在 IPV4 网络中传输。其采用隧道（Tunnel：在路由器种表现为逻辑接口）技术，支持组播和广播。可以实现在因特网上传输企业内网数据。

AC+AP 三层旁路的集中式转发，是一种无线局域网（WLAN）部署方案，AC 与核心交换机通过三层网络连接（非直连），无需与 AP 在同一网段。采用集中式转发方式，AP 仅负责射频信号收发，所有数据流量经 AP 封装后通过隧道（如 CAPWAP 隧道）转发至 AC，由 AC 统一处理后再接入有线网络。

#### （四）网络设备选择

设计使用设备型号、数量如表 1 所示

表 1 设备型号表

设备型号	数量	说明
S5820V2-54QS-GE	2	汇聚层交换机
S5820V2-54QS-GE	2	接入层交换机
VSR-88	2	核心路由器
AC	1	无线接入控制器
AP	1	无线设备
网线	若干	网线
PC	5	模拟上网设备



设备名称	接口	IP 地址/掩码	线路类型
VRRP	VLAN10	192. 168. 10. 2/24	内网线路
	VLAN20	192. 168. 20. 2/24	内网线路
	VLAN30	192. 168. 30. 2/24	内网线路
	VLAN40	192. 168. 40. 2/24	内网线路
	VLAN10	192. 168. 10. 254/24	内网线路
	VLAN20	192. 168. 20. 254/24	内网线路
	VLAN30	192. 168. 30. 254/24	内网线路
	VLAN40	192. 168. 40. 254/24	内网线路
vlan10	G0/0/1	192. 168. 10. 101/24	PC 地址
vlan20	G0/0/1	192. 168. 20. 101/24	PC 地址

### (三) 写出各个设备的配置命令

#### 1. 配置交换机的 vlan。将对应端口划入 vlan，改 trunk 口。

S1 上:

```
[H3C]sysn S1 //将改设备命名为 S1
[S1]vlan 10 //创建 vlan
[S1-vlan10]port g1/0/11 //将端口加入 vlan
[S1-vlan10]qu //退出当前界面
[S1]vlan 20
[S1-vlan20]port g1/0/12
[S1-vlan20]qu
[S1]int ran g1/0/1 g1/0/2 //同时进入端口
[S1-if-range]port link-type trunk //将端口改为 trunk 模式
[S1-if-range]port trunk permit vlan 10 20 //trunk 模式允许 vlan 10 20 通过
[S1-if-range]qu
```

S2 上: 与 S1 类似, 划分 VLAN30, 40, 将端口 1,2 改 Trunk 允许 30,40 通过。

SW1 上: 创建 VLAN10,20,30,40, 端口 1,2 改 Trunk 允许所有 vlan 通过

```
[H3C]sysn SW1
[SW1]vlan 10
[SW1-vlan10]vlan 20
```

```
[SW1-vlan20]vlan 30
[SW1-vlan30]vlan 40
[SW1-vlan40]qu
[SW1]int ran g1/0/1 g1/0/2 g1/0/10
[SW1-if-range]port link-type trunk
[SW1-if-range]port trunk permit vlan all
```

SW2 上：与 SW1 类似，创建 VLAN10,20,30,40，端口 1,2 改 Trunk 允许所有 vlan 通过

## 2. 配置 MSTP。

S1, S2, SW1, SW2 上：

```
[SW1]stp global enable           //全局启用生成树协议
[SW1]stp mode mstp              //配置为多生成树协议
[SW1]stp region-configuration   //进入 MSTP 区域配置
[SW1-mst-region]region-name hcl //MSTP 名称为 hcl
[SW1-mst-region]instance 10 vlan 10 30 //将 vlan 10 30 映射到 MSTP 的实例
```

10 上

```
[SW1-mst-region]instance 20 vlan 20 40
[SW1-mst-region]qu
```

SW1 上：

```
[SW1]stp instance 10 priority 8192 //将 MSTP 实例 10 的桥优先级设置
```

为 8192

```
[SW1]stp instance 20 priority 4096 //优先级越大越可能成为桥根
```

SW2 上

```
[SW2]stp instance 10 priority 4096
```

```
[SW2]stp instance 20 priority 8192
```

```
[SW2]
```

## 3. 配置 VRRP。

SW1 上：

```
[SW1]int vlan 10 //进入 vlan10
```

[SW1-Vlan-interface10]ip add 192.168.10.1 24 //给 vlan10 分配 IP  
地址

[SW1-Vlan-interface10]vrrp vrid 10 virtual-ip 192.168.10.254 //配置 VRRP 组 10  
的虚拟 IP

[SW1-Vlan-interface10]vrrp vrid 10 priority 150 //设置 VRRP 组 10  
的优先级为 150，默认为 100。

[SW1-Vlan-interface10]int vlan 20

[SW1-Vlan-interface20]ip add 192.168.20.1 24

[SW1-Vlan-interface20]vrrp vrid 20 virtual-ip 192.168.20.254

[SW1-Vlan-interface20]int vlan 30

[SW1-Vlan-interface30]ip add 192.168.30.1 24

[SW1-Vlan-interface30]vrrp vrid 30 virtual-ip 192.168.30.254

[SW1-Vlan-interface30]vrrp vrid 30 priority 150

[SW1-Vlan-interface30]int vlan 40

[SW1-Vlan-interface40]ip add 192.168.40.1 24

[SW1-Vlan-interface40]vrrp vrid 40 virtual-ip 192.168.40.254

SW2 上

[SW2]int vlan 10

[SW2-Vlan-interface10]ip add 192.168.10.2 24

[SW2-Vlan-interface10]vrrp vrid 10 virtual-ip 192.168.10.254

[SW2-Vlan-interface10]int vlan 20

[SW2-Vlan-interface20]ip add 192.168.20.2 24

[SW2-Vlan-interface20]vrrp vrid 20 virtual-ip 192.168.20.254

[SW2-Vlan-interface20]vrrp vrid 20 priority 150

[SW2-Vlan-interface20]int vlan 30

[SW2-Vlan-interface30]ip add 192.168.30.2 24

[SW2-Vlan-interface30]vrrp vrid 30 virtual-ip 192.168.30.254

[SW2-Vlan-interface30]int vlan 40

[SW2-Vlan-interface40]ip add 192.168.40.2 24

```
[SW2-Vlan-interface40]vrrp vrid 40 virtual-ip 192.168.40.254
```

```
[SW2-Vlan-interface40]vrrp vrid 40 priority 150
```

```
[SW2-Vlan-interface40]qu
```

#### 4. 配置链路聚会:

SW1 上

```
[SW1]int Bridge-Aggregation 1 // 创建名为 Bridge-
```

Aggregation 1 的链路聚合端口

```
[SW1-Bridge-Aggregation1]qu
```

```
[SW1]int range g1/0/10 g1/0/11
```

```
[SW1-if-range]port link-aggregation group 1 //将当前端口添加到链
```

路聚合组 1 中

```
[SW1]int Bridge-Aggregation 1
```

```
[SW1-Bridge-Aggregation1]port link-type trunk
```

```
Configuring GigabitEthernet1/0/10 done.
```

```
Configuring GigabitEthernet1/0/11 done.
```

```
[SW1-Bridge-Aggregation1]port trunk permit vlan all
```

SW2 上, 与 SW1 相同

#### 5. 配置三层交换机的路由:

SW1 上

```
[SW1]int g1/0/24
```

```
[SW1-GigabitEthernet1/0/24]port link-mode route //将端口改为路由模式
```

(三层端口)

```
[SW1-GigabitEthernet1/0/24]ip add 20.20.20.1 24
```

```
[SW1-GigabitEthernet1/0/24]qu
```

```
[SW1]ospf 1 //启用 OSPF 协议
```

```
[SW1-ospf-1]area 1 //进入区域 1
```

```
[SW1-ospf-1-area-0.0.0.1]network 20.20.20.0 0.0.0.255 // 在区域里宣称
```

20.20.20.0

```
[SW1-ospf-1-area-0.0.0.1]network 192.168.0.0 0.0.255.255
```

```

[SW1-ospf-1-area-0.0.0.1]qu
[SW1-ospf-1]
SW2 上
[SW2]int g1/0/23
[SW2-GigabitEthernet1/0/23]port link-mode route
[SW2-GigabitEthernet1/0/23]ip add 30.30.30.1 24
[SW2-GigabitEthernet1/0/23]qu
[SW2]ospf 1
[SW2-ospf-1]area 1
[SW2-ospf-1-area-0.0.0.1]network 30.30.30.0 0.0.0.255
[SW2-ospf-1-area-0.0.0.1]network 192.168.0.0 0.0.255.255
[SW2-ospf-1-area-0.0.0.1]qu
[SW2-ospf-1]

```

## 6. 配置 vlan30 和 vlan40 的 DHCP

```

[SW2]dhcp enable //在 SW2 上启用 DHCP 服务
[SW2]dhcp server ip-pool vlan30 //创建名为 vlan30 的 DHCP
地址池。
[SW2-dhcp-pool-vlan30]network 192.168.30.0 24 //定义 vlan30 所属的网络范
围
[SW2-dhcp-pool-vlan30]gateway-list 192.168.30.254 //定义 vlan30 的默认网关
[SW2-dhcp-pool-vlan30]qu
[SW2]dhcp server forbidden-ip 192.168.30.1 192.168.30.100 //禁止分配 IP 地
址范围
[SW2]dhcp server ip-pool vlan40
[SW2-dhcp-pool-vlan40]network 192.168.40.0 24
[SW2-dhcp-pool-vlan40]gateway-list 192.168.40.254
[SW2-dhcp-pool-vlan40]qu
[SW2]dhcp server forbidden-ip 192.168.40.1 192.168.40.100
[SW2]

```



## 7. 配置 AC+AP:

SW2 上

```
[SW2]int g1/0/3
```

```
[SW2-GigabitEthernet1/0/3]port link-type trunk
```

```
[SW2-GigabitEthernet1/0/3]port trunk permit vlan all
```

```
[SW2-GigabitEthernet1/0/3]qu
```

S2 上

```
[S2]int g1/0/3
```

```
[S2-GigabitEthernet1/0/3]port link-type trunk
```

```
[S2-GigabitEthernet1/0/3]port trunk permit vlan all
```

```
[S2-GigabitEthernet1/0/3]qu
```

```
[S2]int g1/0/3
```

```
[S2-GigabitEthernet1/0/3]port trunk pvid vlan 30 //设置该端口的默认 VLAN
```

为 30

```
[S2-GigabitEthernet1/0/3]qu
```

```
[S2]
```

AC 上

```
<H3C>sys
```

```
[H3C]sysn AC
```

```
[AC]vlan 30
```

```
[AC-vlan30]vlan 40
```

```
[AC-vlan40]int vlan 30
```

```
[AC-Vlan-interface30]ip add 192.168.30.3 24
```

```
[AC-Vlan-interface30]int vlan 40
```

```
[AC-Vlan-interface40]ip add 192.168.40.3 24
```

```
[AC-Vlan-interface40]qu
```

```
[AC]int g1/0/0
```

```
[AC-GigabitEthernet1/0/0]port link-type trunk
```

```
[AC-GigabitEthernet1/0/0]port trunk permit vlan all
```

```

[AC-GigabitEthernet1/0/0]
[AC]wlan auto-ap enable //启用 AP 自动发现功能
[AC]wlan auto-ap persistent all //发现的 AP 保持持久化
[AC]wlan service-template 1 //创建一个“1”的 WLAN 服务模
版
[AC-wlan-st-1]ssid 1 //配置无线网络名称“1”
[AC-wlan-st-1]service-template enable //启用服务模板
[AC-wlan-st-1]quit
[AC]wlan ap aaf0-925c-1d00 //进入 AP 视图
[AC-wlan-ap-aaf0-925c-1d00]radio 1 //进入第一个无线电接口
[AC-wlan-ap-aaf0-925c-1d00-radio-1]radio enable //启用该接口
[AC-wlan-ap-aaf0-925c-1d00-radio-1]service-template 1 vlan 40 //将服务模板 1
应用到接口 1

```

## 8. 配置外网，R1，R2，R3.

```

<H3C>sys
System View: return to User View with Ctrl+Z.
[H3C]sysn R1
[R1]int g0/0/0
[R1-GigabitEthernet0/0/0]ip add 20.20.20.2 24
[R1-GigabitEthernet0/0/0]int g0/0/1
[R1-GigabitEthernet0/0/1]ip add 30.30.30.2 24
[R1-GigabitEthernet0/0/1]qu
[R1]int s0/0/3
[R1-Serial0/0/3]ip add 100.0.0.1 24
[R1-Serial0/0/3]baud 9600 //设置通信速率为 9600
[R1-Serial0/0/3]qu
[R1]ospf 1
[R1-ospf-1]area 1
[R1-ospf-1-area-0.0.0.1]network 20.20.20.0 0.0.0.255

```

[R1-ospf-1-area-0.0.0.1]network 30.30.30.0 0.0.0.255

[R1-ospf-1-area-0.0.0.1]qu

[R1-ospf-1]area 0

[R1-ospf-1-area-0.0.0.0]network 100.0.0.0 0.0.0.255

[R1-ospf-1-area-0.0.0.0]qu

[R1-ospf-1]qu

R2 上

<H3C>sys

[H3C]sysn R2

[R2]int s0/0/3

[R2-Serial0/0/3]ip add 100.0.0.2 24

[R2-Serial0/0/3]ospf 1

[R2-ospf-1]area 0

[R2-ospf-1-area-0.0.0.0]network 100.0.0.0 0.0.0.255

[R2-ospf-1-area-0.0.0.0]qu

[R2-ospf-1]qu

[R2]

[R2]int s0/0/4

[R2-Serial0/0/4]ip add 200.0.0.1 24

[R2-Serial0/0/4]baud 9600

[R2-Serial0/0/4]ospf 1

[R2-ospf-1]area 2

[R2-ospf-1-area-0.0.0.2]network 200.0.0.0 0.0.0.255

[R2-ospf-1-area-0.0.0.2]qu

[R2-ospf-1]

R3 上

<H3C>sys

System View: return to User View with Ctrl+Z.

[H3C]sysn R3

```

[R3]int s0/0/3
[R3-Serial0/0/3]ip add 200.0.0.2 24
[R3-Serial0/0/3]baud 9600
[R3]int g0/0/0
[R3-GigabitEthernet0/0/0]ip add 192.168.100.254 24
[R3-GigabitEthernet0/0/0]qu
[R3]ospf 1
[R3-ospf-1]area 2
[R3-ospf-1-area-0.0.0.2]network 200.0.0.0 0.0.0.255
[R3-ospf-1-area-0.0.0.2]network 192.168.100.0 0.0.0.255
[R3-ospf-1-area-0.0.0.2]qu
[R3-ospf-1]

```

## 9. 配置 GRE+VPN

R1 上

```

[R1]acl basic 2000 //基本访问控制列表
[R1-acl-ipv4-basic-2000]rule permit source any //允许所有源 IP 地址通过
[R1-acl-ipv4-basic-2000]qu
[R1]nat address-group 1 //创建一个 NAT 地址组，编号 1
[R1-address-group-1]add 100.0.0.10 100.0.0.100 //在地址组中添加地址范围
[R1-address-group-1]qu
[R1]int s0/0/3
[R1-Serial0/0/3]nat outbound 2000 address-group 1 //启用 NAT 出站规则，使用
ACL2000 匹配流量，并使用地址组 1 转换
[R1-Serial0/0/3]qu
[R1]
[R1]int tunnel 0 mode gre //进入 Tunnel 0 配置，并设置模
式为 GRE
[R1-Tunnel0]ip add 1.1.1.1 30
[R1-Tunnel0]source 100.0.0.1 //配置 Tunnel 源地址为 100.0.0.1

```

[R1-Tunnel0]destination 200.0.0.2 // 配置 Tunnel 目的地址为  
200.0.0.2

[R1-Tunnel0]keepalive //隧道保活

[R1-Tunnel0]qu

[R1]ip route-static 192.168.100.0 24 tunnel 0 //目标网络为 100.0 的通过  
Tunnel0

R3 上:

[R3]acl basic 2000

[R3-acl-ipv4-basic-2000]rule permit source any

[R3-acl-ipv4-basic-2000]qu

[R3]int s0/0/3

[R3-Serial0/0/3]nat outbound 2000 //没有地址组，将使用默认  
PAT 转换

[R3-Serial0/0/3]qu

[R3]

[R3]int tunnel 0 mode gre

[R3-Tunnel0]ip add 2.2.2.2 30

[R3-Tunnel0]source 200.0.0.2

[R3-Tunnel0]des

[R3-Tunnel0]destination 100.0.0.1

[R3-Tunnel0]keep

[R3-Tunnel0]keepalive

[R3]qu

[R3]ip route-static 192.168.0.0 16 tunnel 0

## 10. 配置 Telnet:

[R1]telnet server enable //启用 telnet 服务器

[R1]local-user admin class manage //创建一个名为 admin 的管  
理类用户

New local user added.

```
[R1-luser-manage-admin]password simple abcde12345 //为用户设置密码
```

```
[R1-luser-manage-admin]authorization-attribute user-role network-admin//赋予网络管理权限
```

```
[R1-luser-manage-admin]service-type telnet //用户可以使用 telnet 登录设备
```

```
[R1-luser-manage-admin]qu
```

```
[R1]line vty 0 4 //进入虚拟终端 VTY，用于远程登录
```

```
[R1-line-vty0-4]authentication-mode scheme //VTY 线路认证模式为 scheme
```

```
[R1-line-vty0-4]user-role level-15 //为 VTY 线路用户分配 15 级权限
```

```
[R1-line-vty0-4]qu
```

## 四、课程设计测试与结果分析

### （一）列出阶段性测试

#### 1. 三层 VLAN 仿真测试

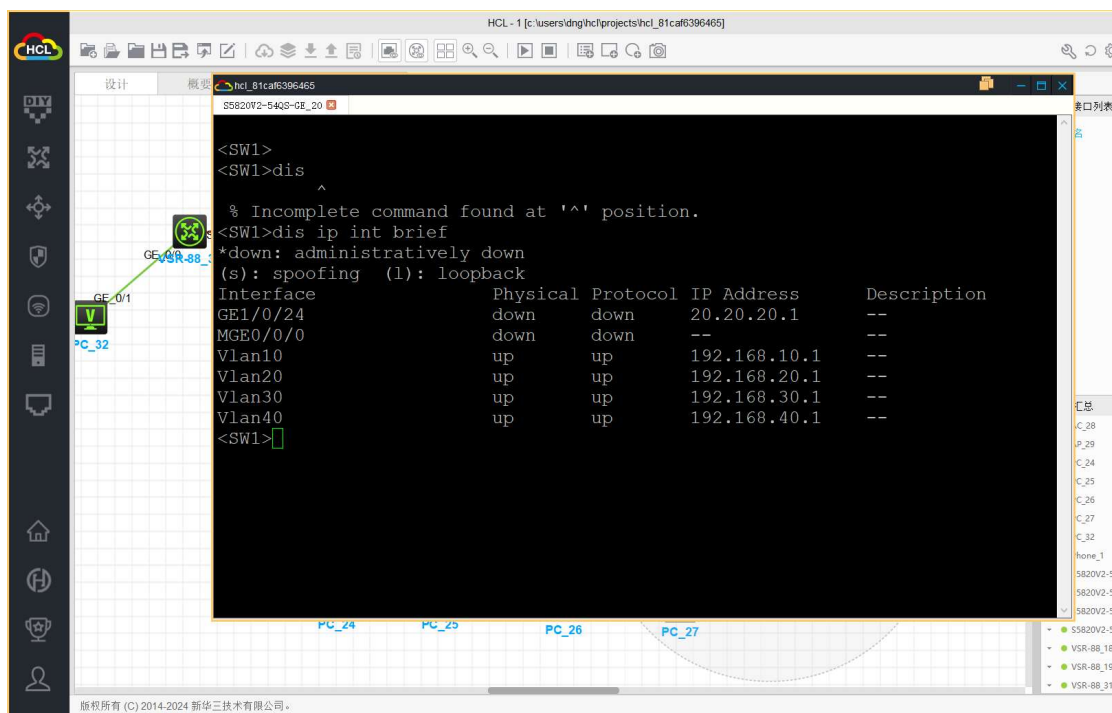


图 1 SW1 的 IP 地址分配

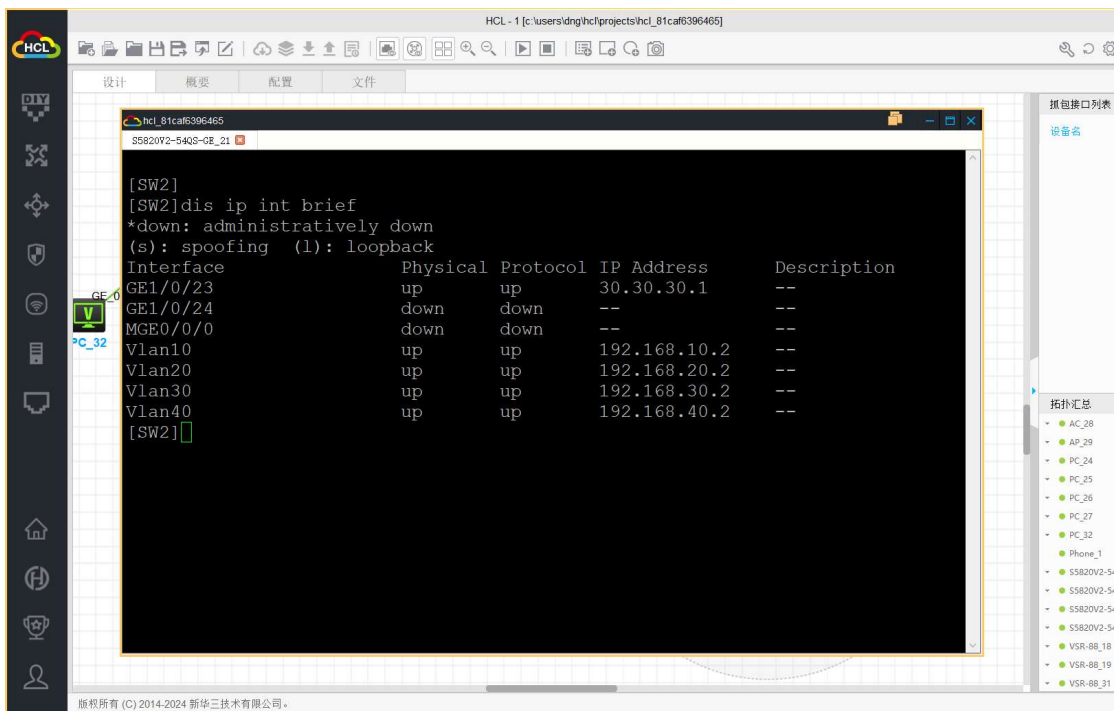


图 2 SW2 的 IP 地址分配

## 2. MSTP 仿真测试

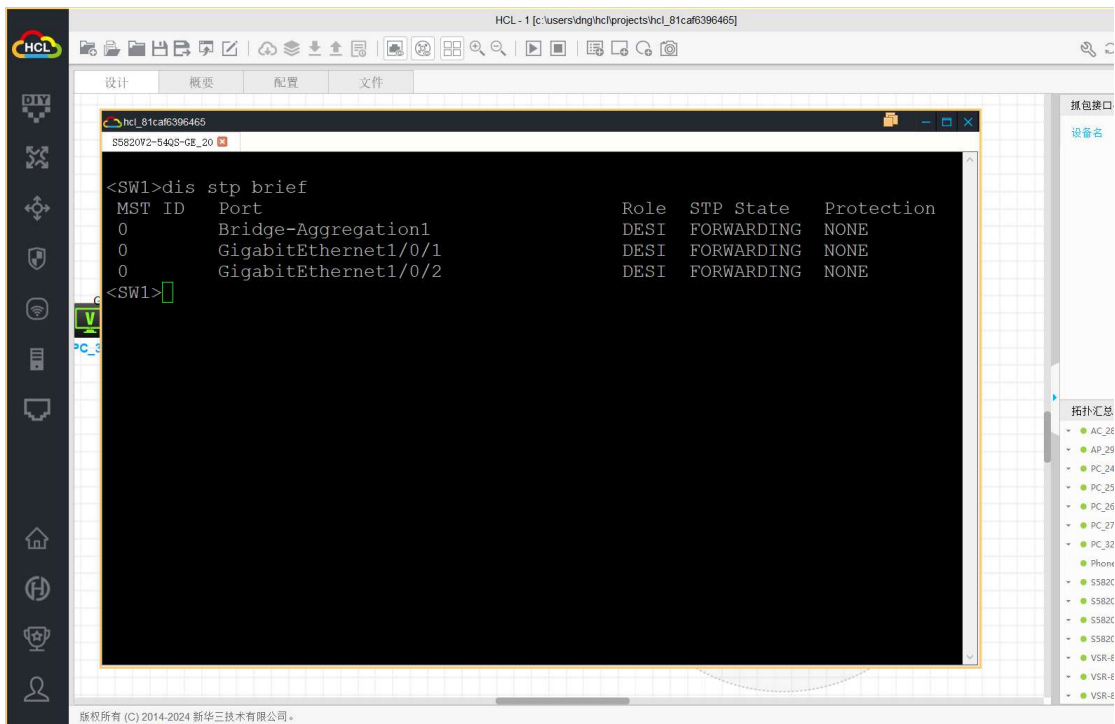


图 3 SW1 的生成树状态

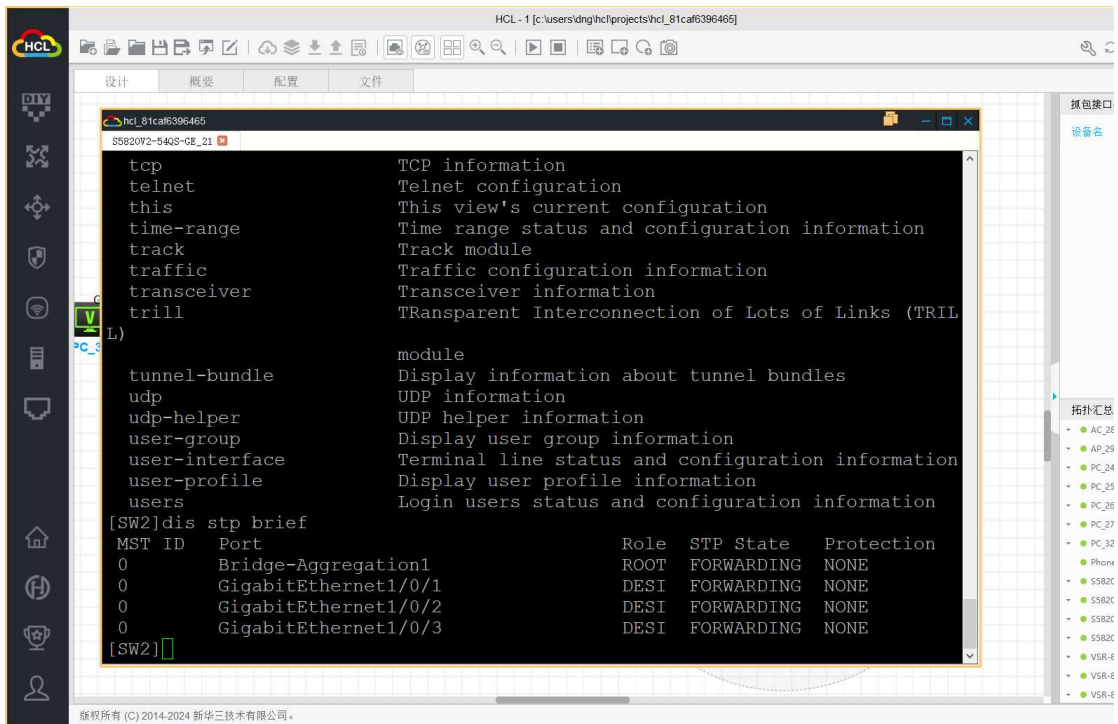


图 4 SW2 的生成树状态

### 3. VRRP 仿真测试

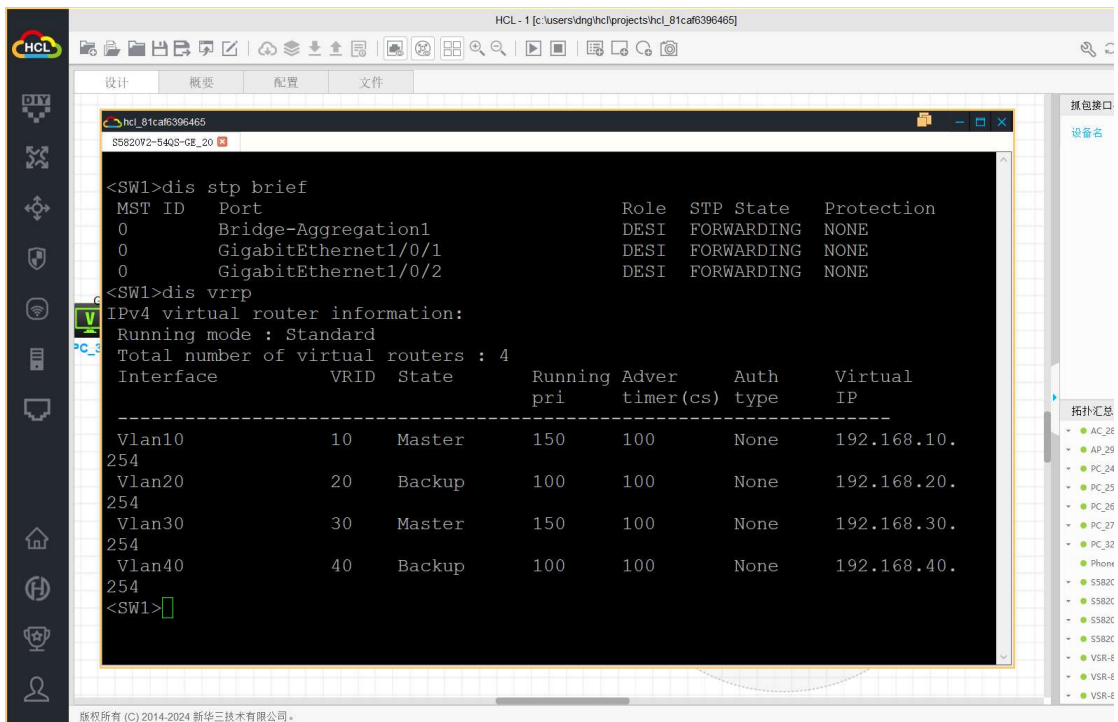


图 5 查看 SW1VRRP 信息



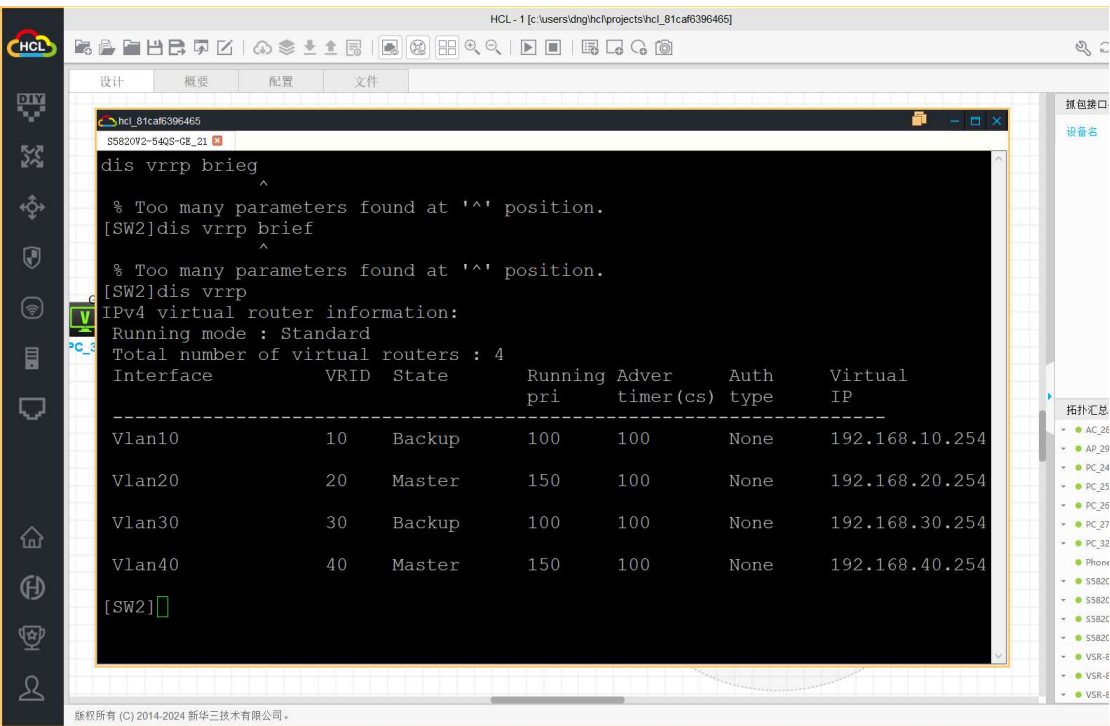


图 6 查看 SW2VRRP 信息

4. GRE VPN 隧道仿真测试

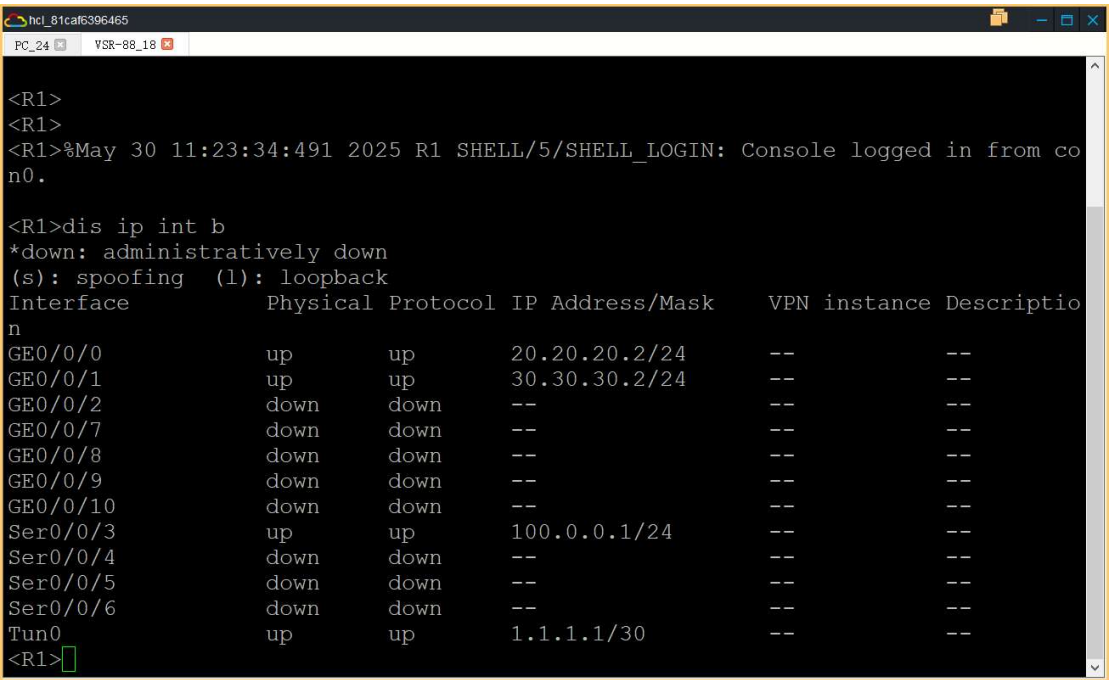


图 7R1 各接口配置

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31

<R3>
<R3>
<R3>%May 30 11:27:09:354 2025 R3 SHELL/5/SHELL_LOGIN: Console logged in from co
n0.

<R3>dis ip int b
*down: administratively down
(s): spoofing (1): loopback
Interface          Physical Protocol IP Address/Mask    VPN instance Descriptio
n
GE0/0/0            up        up        192.168.100.254/24 --          --
GE0/0/1            down      down      --              --          --
GE0/0/2            down      down      --              --          --
GE0/0/7            down      down      --              --          --
GE0/0/8            down      down      --              --          --
GE0/0/9            down      down      --              --          --
GE0/0/10           down      down      --              --          --
Ser0/0/3           up        up        200.0.0.2/24      --          --
Ser0/0/4           down      down      --              --          --
Ser0/0/5           down      down      --              --          --
Ser0/0/6           down      down      --              --          --
Tun0               up        up        2.2.2.2/30        --          --
<R3>
```

图 8 R3 各接口配置

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32

Total sessions found: 0
<R1>dis int tunnel 0
Tunnel0
Interface index: 132
Current state: UP
Line protocol state: UP
Description: Tunnel0 Interface
Bandwidth: 64 kbps
Maximum transmission unit: 1476
Internet address: 1.1.1.1/30 (Primary)
Tunnel source 100.0.0.1, destination 200.0.0.2
Tunnel keepalive enabled, Period(10 s), Retries(3)
Tunnel TTL 255
Tunnel protocol/transport GRE/IP
  GRE key disabled
  Checksumming of GRE packets disabled
Output queue - Urgent queuing: Size/Length/Discards 0/100/0
Output queue - Protocol queuing: Size/Length/Discards 0/500/0
Output queue - FIFO queuing: Size/Length/Discards 0/75/0
Last clearing of counters: Never
Traffic statistic: Not include Inter-frame Gaps and Preambles
Last 300 seconds input rate: 7 bytes/sec, 56 bits/sec, 0 packets/sec
Last 300 seconds output rate: 4 bytes/sec, 32 bits/sec, 0 packets/sec
Input: 761 packets, 27384 bytes, 0 drops
Output: 386 packets, 18528 bytes, 0 drops
---- More ----
```

图 9 查看 R1 的隧道信息

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32
Total sessions found: 1
<R3>dis int tunnel 0
Tunnel0
Interface index: 132
Current state: UP
Line protocol state: UP
Description: Tunnel0 Interface
Bandwidth: 64 kbps
Maximum transmission unit: 1476
Internet address: 2.2.2.2/30 (Primary)
Tunnel source 200.0.0.2, destination 100.0.0.1
Tunnel keepalive enabled, Period(10 s), Retries(3)
Tunnel TTL 255
Tunnel protocol/transport GRE/IP
  GRE key disabled
  Checksumming of GRE packets disabled
Output queue - Urgent queuing: Size/Length/Discards 0/100/0
Output queue - Protocol queuing: Size/Length/Discards 0/500/0
Output queue - FIFO queuing: Size/Length/Discards 0/75/0
Last clearing of counters: Never
Traffic statistic: Not include Inter-frame Gaps and Preambles
Last 300 seconds input rate: 7 bytes/sec, 56 bits/sec, 0 packets/sec
Last 300 seconds output rate: 4 bytes/sec, 32 bits/sec, 0 packets/sec
Input: 763 packets, 27480 bytes, 0 drops
Output: 381 packets, 18288 bytes, 0 drops
---- More ----
```

图 10 查看 R3 的隧道信息

## 5. NAT (Easy-ip) 地址转换仿真测试

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32
56 bytes from 192.168.10.101: icmp_seq=1 ttl=250 time=10.000 ms
56 bytes from 192.168.10.101: icmp_seq=2 ttl=250 time=8.000 ms
56 bytes from 192.168.10.101: icmp_seq=3 ttl=250 time=12.000 ms
56 bytes from 192.168.10.101: icmp_seq=4 ttl=250 time=10.000 ms

--- Ping statistics for 192.168.10.101 ---
5 packet(s) transmitted, 5 packet(s) received, 0.0% packet loss
round-trip min/avg/max/std-dev = 8.000/12.600/23.000/5.352 ms
<H3C>%May 30 11:27:20:401 2025 H3C PING/6/PING_STATISTICS: Ping statistics for
192.168.10.101: 5 packet(s) transmitted, 5 packet(s) received, 0.0% packet loss
, round-trip min/avg/max/std-dev = 8.000/12.600/23.000/5.352 ms.
ping 192.168.10.101
Ping 192.168.10.101 (192.168.10.101): 56 data bytes, press CTRL_C to break
56 bytes from 192.168.10.101: icmp_seq=0 ttl=250 time=13.000 ms
56 bytes from 192.168.10.101: icmp_seq=1 ttl=250 time=10.000 ms
56 bytes from 192.168.10.101: icmp_seq=2 ttl=250 time=24.000 ms
56 bytes from 192.168.10.101: icmp_seq=3 ttl=250 time=8.000 ms
56 bytes from 192.168.10.101: icmp_seq=4 ttl=250 time=24.000 ms

--- Ping statistics for 192.168.10.101 ---
5 packet(s) transmitted, 5 packet(s) received, 0.0% packet loss
round-trip min/avg/max/std-dev = 8.000/15.800/24.000/6.882 ms
<H3C>%May 30 11:30:40:329 2025 H3C PING/6/PING_STATISTICS: Ping statistics for
192.168.10.101: 5 packet(s) transmitted, 5 packet(s) received, 0.0% packet loss
, round-trip min/avg/max/std-dev = 8.000/15.800/24.000/6.882 ms.
```

图 11 分部 pingPC1

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32
Line protocol state: UP
Description: Tunnel0 Interface
Bandwidth: 64 kbps
Maximum transmission unit: 1476
Internet address: 2.2.2.2/30 (Primary)
Tunnel source 200.0.0.2, destination 100.0.0.1
Tunnel keepalive enabled, Period(10 s), Retries(3)
Tunnel TTL 255
Tunnel protocol/transport GRE/IP
  GRE key disabled
  Checksumming of GRE packets disabled
Output queue - Urgent queuing: Size/Length/Discards 0/100/0
Output queue - Protocol queuing: Size/Length/Discards 0/500/0
Output queue - FIFO queuing: Size/Length/Discards 0/75/0
Last clearing of counters: Never
Traffic statistic: Not include Inter-frame Gaps and Preambles
Last 300 seconds input rate: 7 bytes/sec, 56 bits/sec, 0 packets/sec
Last 300 seconds output rate: 4 bytes/sec, 32 bits/sec, 0 packets/sec
Input: 763 packets, 27480 bytes, 0 drops
Output: 381 packets, 18288 bytes, 0 drops
<R3>dis nat session brief
Slot 0:
Protocol    Source IP/port      Destination IP/port  Global IP/port
ICMP        192.168.100.101/180  192.168.10.101/2048  200.0.0.2/0
Total sessions found: 1
<R3>
```

图 12R3 查看 nat 状态

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32
Inactive<H3C>%May 30 11:31:35:405 2025 H3C SHELL/5/SHELL_LOGIN: Console logged
in from con0.

<H3C>ping 192.168.100.101
Ping 192.168.100.101 (192.168.100.101): 56 data bytes, press CTRL_C to break
56 bytes from 192.168.100.101: icmp_seq=0 ttl=251 time=22.895 ms
56 bytes from 192.168.100.101: icmp_seq=1 ttl=251 time=10.832 ms
56 bytes from 192.168.100.101: icmp_seq=2 ttl=251 time=30.072 ms
56 bytes from 192.168.100.101: icmp_seq=3 ttl=251 time=11.170 ms
56 bytes from 192.168.100.101: icmp_seq=4 ttl=251 time=38.813 ms

--- Ping statistics for 192.168.100.101 ---
5 packet(s) transmitted, 5 packet(s) received, 0.0% packet loss
round-trip min/avg/max/std-dev = 10.832/22.756/38.813/10.842 ms
<H3C>%May 30 11:31:49:051 2025 H3C PING/6/PING_STATISTICS: Ping statistics for
192.168.100.101: 5 packet(s) transmitted, 5 packet(s) received, 0.0% packet los
s, round-trip min/avg/max/std-dev = 10.832/22.756/38.813/10.842 ms.

```

图 13PC1ping 分部



```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32
Tunnel keepalive enabled, Period(10 s), Retries(3)
Tunnel TTL 255
Tunnel protocol/transport GRE/IP
  GRE key disabled
  Checksumming of GRE packets disabled
Output queue - Urgent queuing: Size/Length/Discards 0/100/0
Output queue - Protocol queuing: Size/Length/Discards 0/500/0
Output queue - FIFO queuing: Size/Length/Discards 0/75/0
Last clearing of counters: Never
Traffic statistic: Not include Inter-frame Gaps and Preambles
Last 300 seconds input rate: 7 bytes/sec, 56 bits/sec, 0 packets/sec
Last 300 seconds output rate: 4 bytes/sec, 32 bits/sec, 0 packets/sec
Input: 761 packets, 27384 bytes, 0 drops
Output: 386 packets, 18528 bytes, 0 drops
<R1>dis nat session b
Slot 0:
Total sessions found: 0
<R1>dis nat session b
Slot 0:
Total sessions found: 0
<R1>dis nat session b
Slot 0:
Total sessions found: 1
Table:
Protocol    Source IP/port      Destination IP/port  Global IP/port
ICMP        192.168.10.101/232  192.168.100.101/2048 100.0.0.81/0
<R1>
```

图 14 查看 R1nat 状态

## 6. DHCP 仿真测试

```
hcl_81caf6396465
PC_24 VSR-88_18 VSR-88_31 PC_32 S5820V2-54QS-GE_21
[SW2]dis dhcp server
^
% Incomplete command found at '^' position.
[SW2]dis dhcp server ?
  conflict      Information about IP address conflicts
  database      DHCP database information
  expired       Lease expiration information
  free-ip       IP addresses not in use
  ip-in-use     Addresses assigned
  pool          DHCP pool information
  statistics    DHCP server statistics

[SW2]dis dhcp server pool
Pool name: vlan30
  Network: 192.168.30.0 mask 255.255.255.0
  expired day 1 hour 0 minute 0 second 0
  reserve expired-ip enable
  reserve expired-ip mode client-id time 4294967295 limit 256000
  gateway-list 192.168.30.254
Pool name: vlan40
  Network: 192.168.40.0 mask 255.255.255.0
  expired day 1 hour 0 minute 0 second 0
  reserve expired-ip enable
  reserve expired-ip mode client-id time 4294967295 limit 256000
  gateway-list 192.168.40.254
[SW2]
```

图 15 查看 SW2 dhcp 地址池

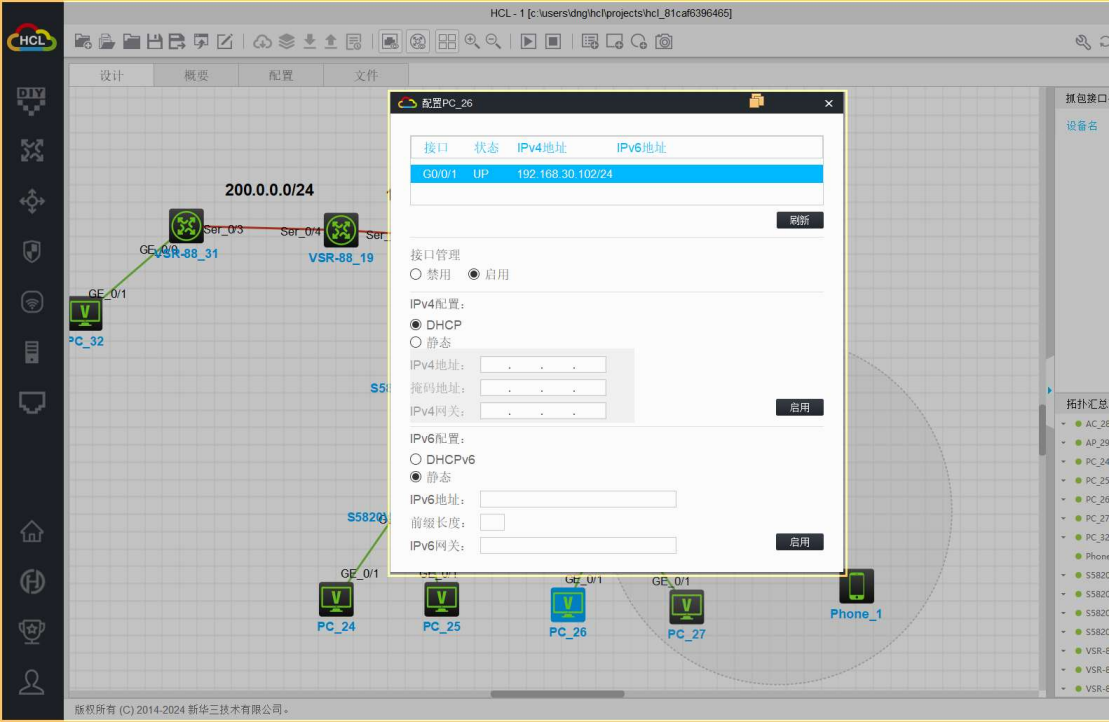


图 16VLAN30 自动获取 IP

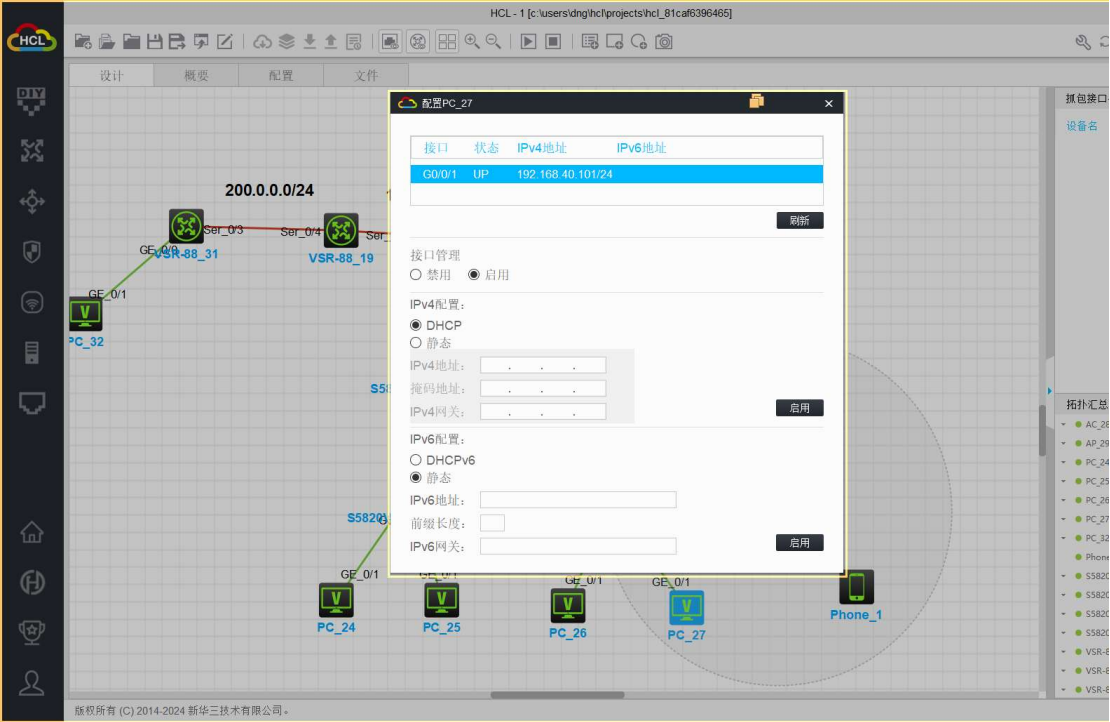


图 17VLAN40 自动获取 IP

## 7. Telnet 仿真测试

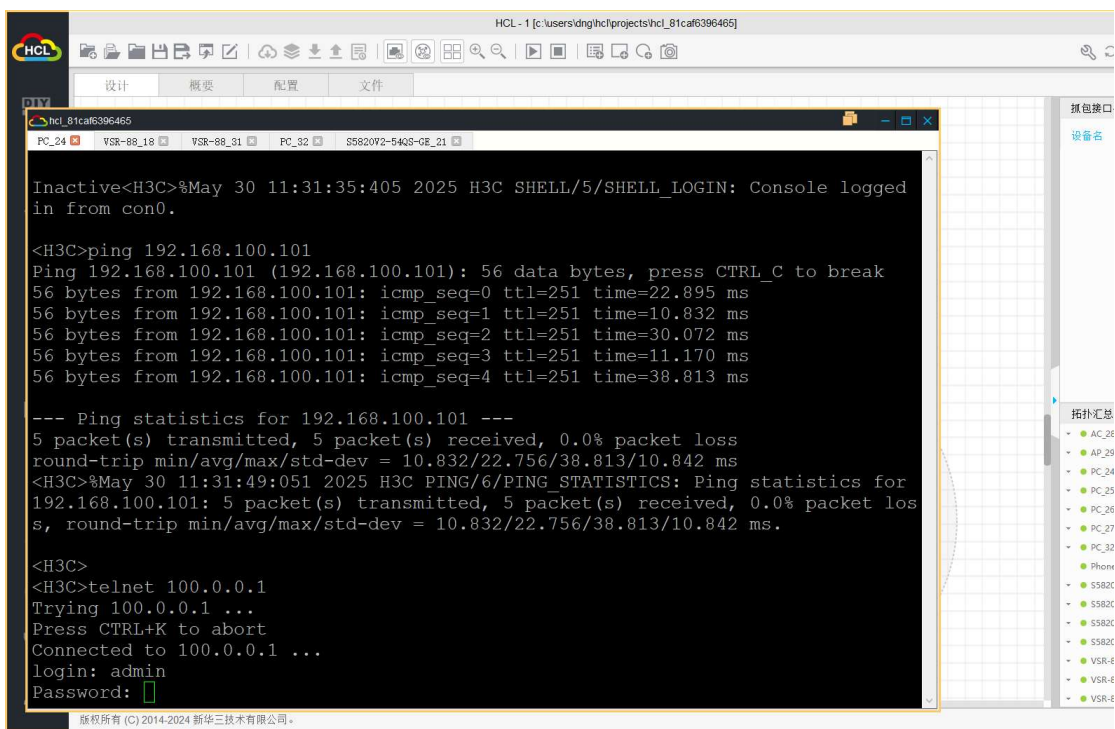


图 18PC1 远程登录 R1

## 8. 连通性测试

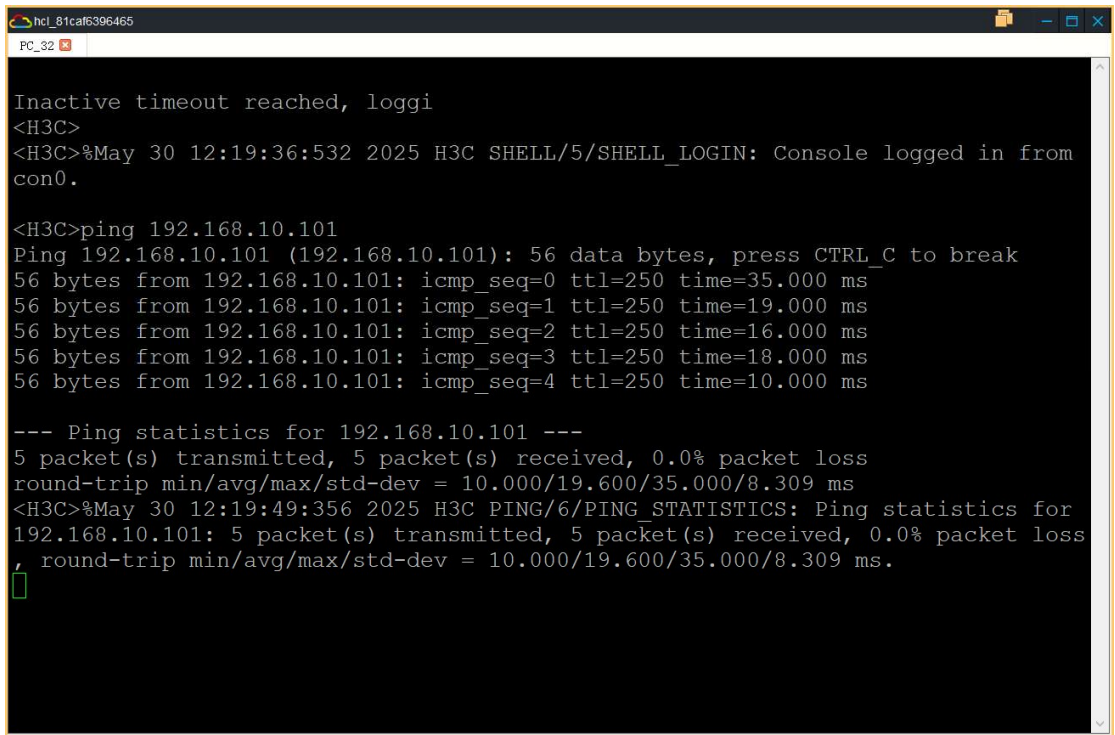


图 19 分部与总部通信

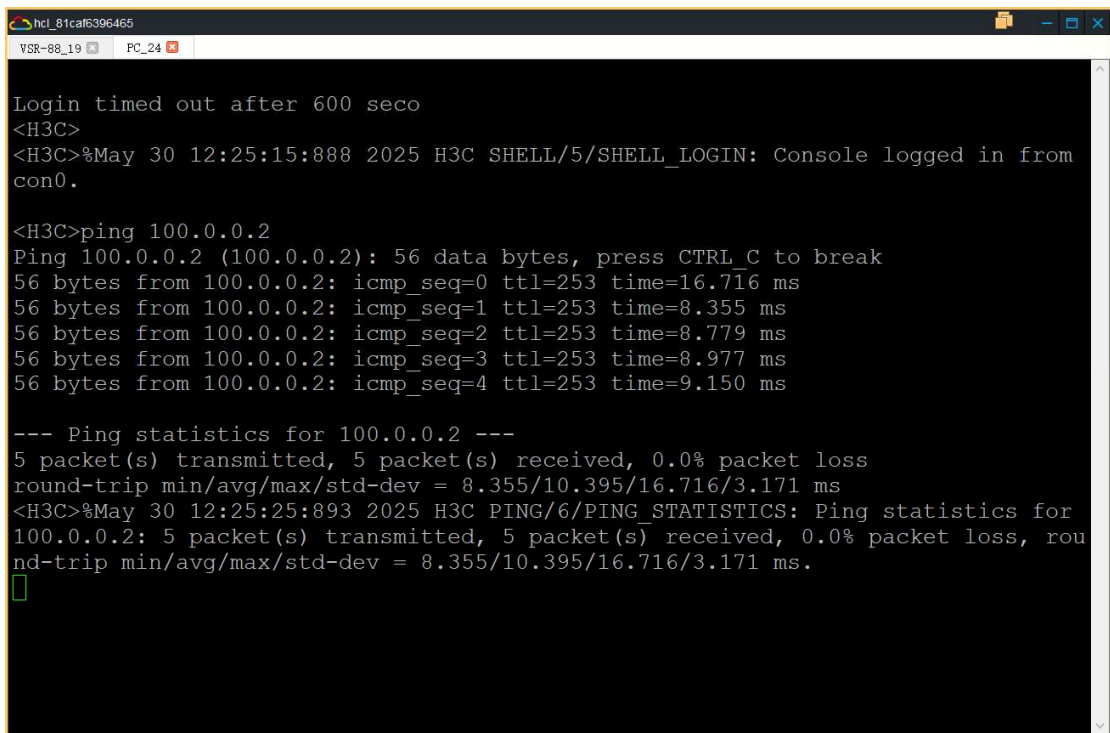


图 20 总部与外网通信

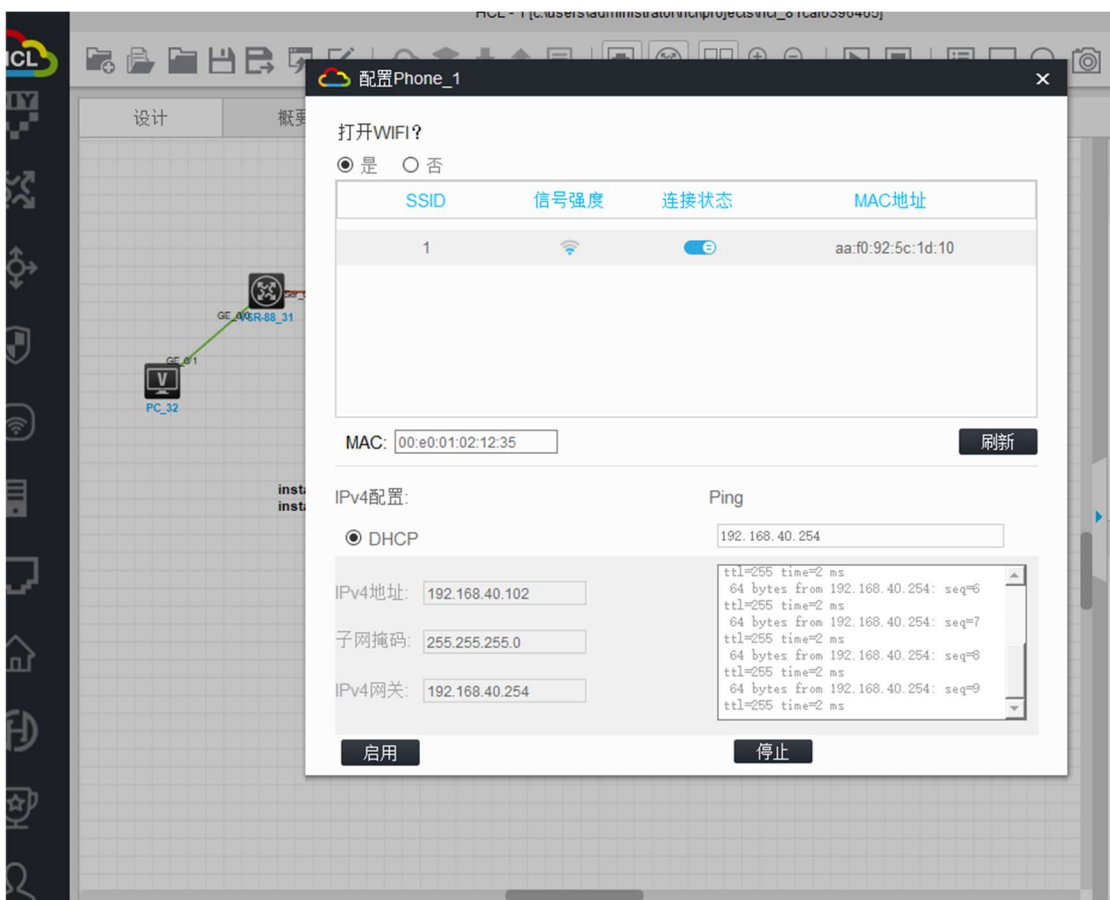


图 21 无线设备通信