



南开大学
Nankai University

《计算机网络》实验报告

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实验名称: ensp 路由

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实验三：ensp 路由

1 实验 3.1 静态路由

1.1 实验目的

本实验旨在掌握静态路由协议，理解路由器工作原理，掌握路由器相关的配置、检测操作，并通过实际操作加深对网络基础知识的理解。

1.2 实验内容

实验内容包括以下几个方面：

- 华为网络设备常用配置命令；
- 华为网络模拟器 eNSP 的安装；
- IP 地址的配置；
- 静态路由的配置；
- 路由规划；
- 网络收敛的概念；
- 网络测试与排错操作。

1.3 实验原理、方法和手段

- 用路由器连接若干局域网，局域网之间建议采用 Ethernet 协议连接，局域网之间采用静态路由，从而使在不同局域网上的计算机能够交换信息。观察联通前后计算机和路由器路由表的变化情况。
- 通过 ping 其他主机，用 Wireshark 捕捉网络流量，找出与 ping 相关的 ARP 协议、ICMP 协议报文逐字节地进行剖析。

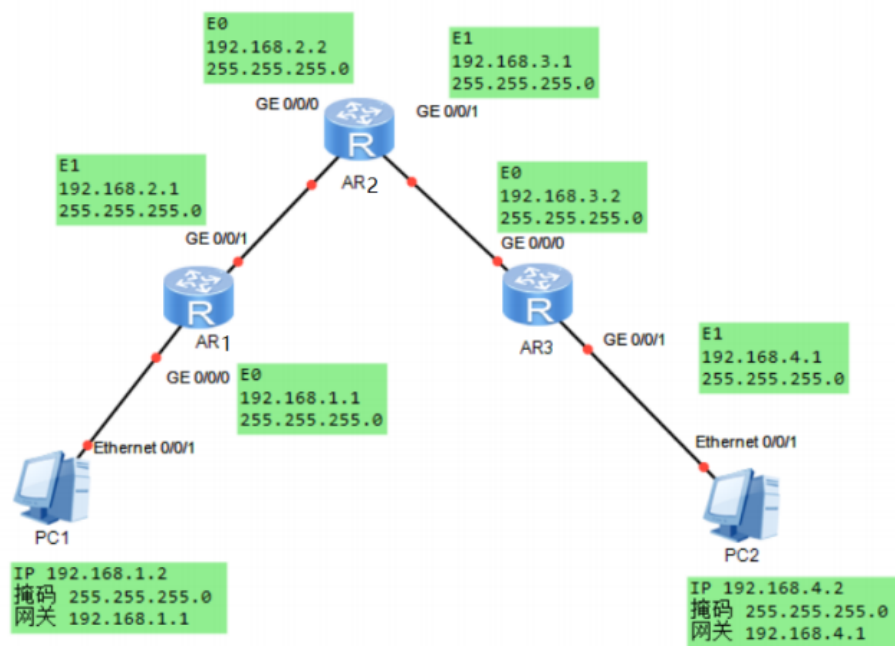


图 1: 实验拓扑图

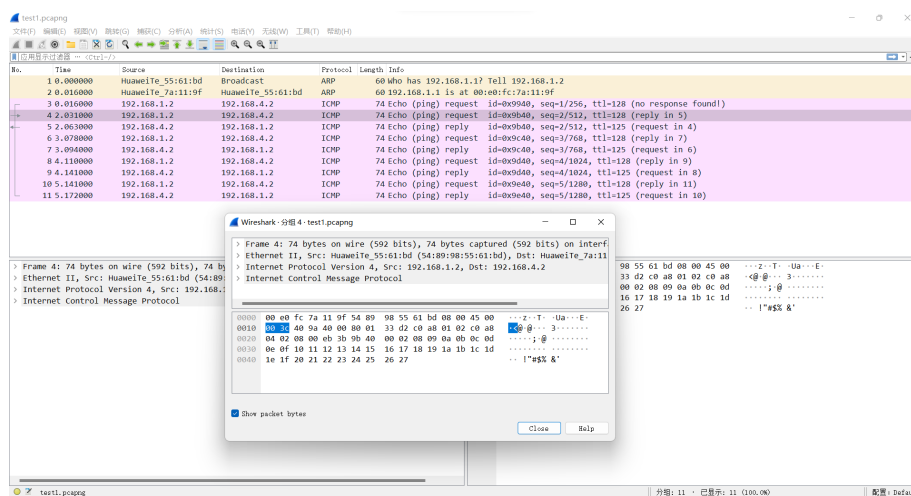


图 2: 数据包

```

0000  00 e0 fc 7a 11 9f 54 89 98 55 61 bd 08 00 45 00
0010  00 3c 40 9a 40 00 80 01 33 d2 c0 a8 01 02 c0 a8
0020  04 02 08 00 eb 3b 9b 40 00 02 08 09 0a 0b 0c 0d
0030  0e 0f 10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d
0040  1e 1f 20 21 22 23 24 25 26 27
  
```

前两行是十六进制表示的数据包的首部。每两个字符表示一个字节。第一行的 00 e0 fc

7a 11 9f 54 89 98 55 61 bd 08 00 是以太网帧的帧头，表示源 MAC 地址、目标 MAC 地址、以太网类型（IPv4）。第二行的 45 00 00 3c 40 9a 40 00 80 01 33 d2 c0 a8 01 02 是 IPv4 报头，包括版本、头部长度、服务类型、总长度、标识、标志、片偏移、生存时间、协议（ICMP）和校验和。第三行的 c0 a8 04 02 08 00 eb 3b 9b 40 00 02 08 09 0a 0b 是 IPv4 报头的其余部分，包括源 IP 地址、目标 IP 地址、UDP 报头。第四行以及后面的内容是 UDP 数据部分，表示端口号、长度和校验和。最后一行的 0e 0f 10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d 是实际的数据部分，表示 UDP 负载。

1.4 实验条件

- 华为 eNSP 仿真平台中：2 台 PC，3 台路由器；
- 网线若干。

1.5 实验步骤

硬件连接

在实验开始前，完成 PC1、PC2 到路由器的网络连接；PC1 到路由器 RT1 控制线的连接，PC2 到路由器 RT2 控制线的连接。

设置 IP 地址

为 PC1、PC2 分别设置 IP 地址、掩码和网关，确保网络连接正常。

The screenshot shows the 'PC1' configuration window with the '基础配置' (Basic Configuration) tab selected. The '主机名' (Hostname) field is empty. The 'MAC 地址' (MAC Address) field is set to '54-89-98-0C-6B-F3'. Under the 'IPv4 配置' (IPv4 Configuration) section, the '静态' (Static) radio button is selected. The 'IP 地址' (IP Address) is '192.168.1.2', '子网掩码' (Subnet Mask) is '255.255.255.0', and '网关' (Gateway) is '192.168.1.1'. The 'DNS1' and 'DNS2' fields are both set to '0.0.0.0'. The '自动获取 DNS 服务器地址' (Automatically obtain DNS server address) checkbox is unchecked. The 'IPv6 配置' (IPv6 Configuration) section shows the '静态' (Static) radio button selected, with 'IPv6 地址' (IPv6 Address) set to '::', '前缀长度' (Prefix Length) set to '128', and 'IPv6 网关' (IPv6 Gateway) set to '::'. An '应用' (Apply) button is at the bottom right.

图 3: PC1 设置 IP 地址

The screenshot shows the 'PC2' configuration window with the '基础配置' (Basic Configuration) tab selected. The '主机名' (Hostname) field is empty. The 'MAC 地址' (MAC Address) field is set to '54-89-98-CA-4E-D6'. Under the 'IPv4 配置' (IPv4 Configuration) section, the '静态' (Static) radio button is selected. The 'IP 地址' (IP Address) is '192.168.4.2', '子网掩码' (Subnet Mask) is '255.255.255.0', and '网关' (Gateway) is '192.168.4.1'. The 'DNS1' and 'DNS2' fields are both set to '0.0.0.0'. The '自动获取 DNS 服务器地址' (Automatically obtain DNS server address) checkbox is unchecked. The 'IPv6 配置' (IPv6 Configuration) section shows the '静态' (Static) radio button selected, with 'IPv6 地址' (IPv6 Address) set to '::', '前缀长度' (Prefix Length) set to '128', and 'IPv6 网关' (IPv6 Gateway) set to '::'. An '应用' (Apply) button is at the bottom right.

图 4: PC2 设置 IP 地址

命名路由器

使用 `sysname` 命令为三个路由器命名,。记录输入的命令和输出。

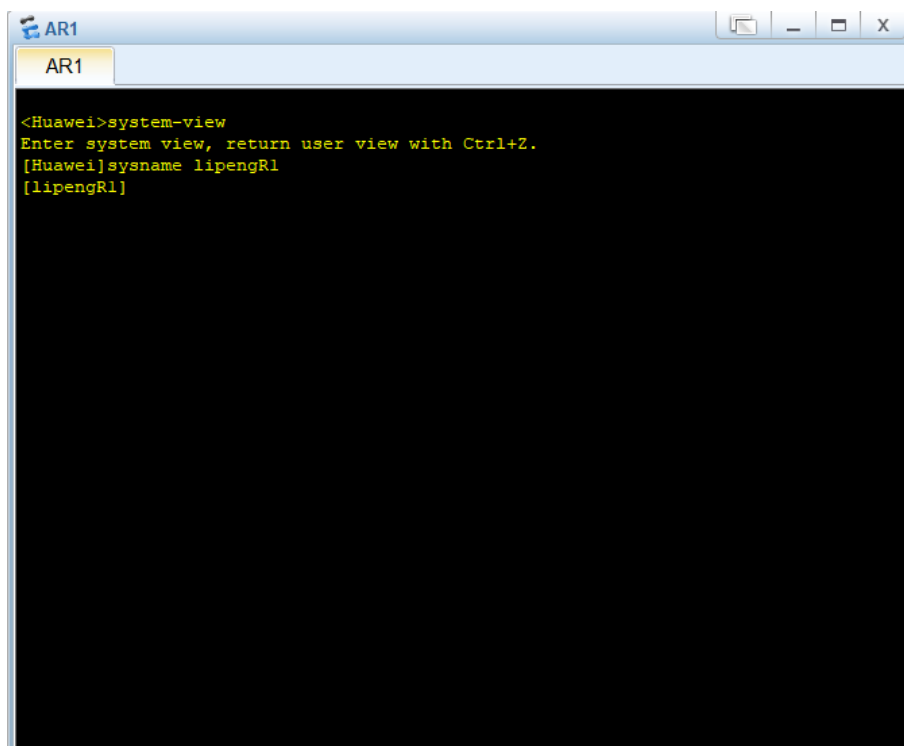


图 5: AR1 命名

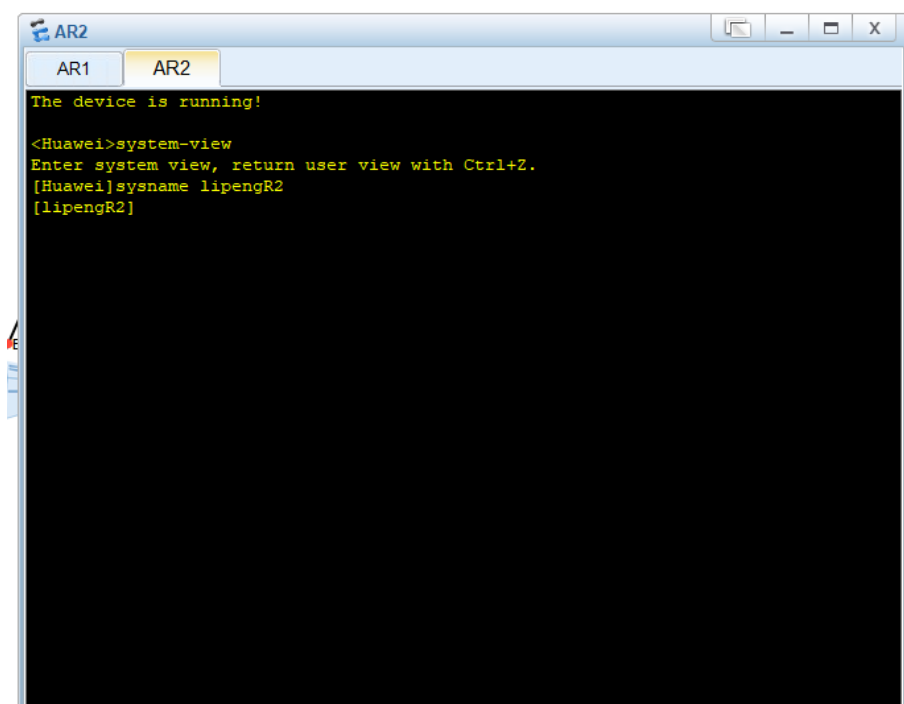


图 6: AR2 命名

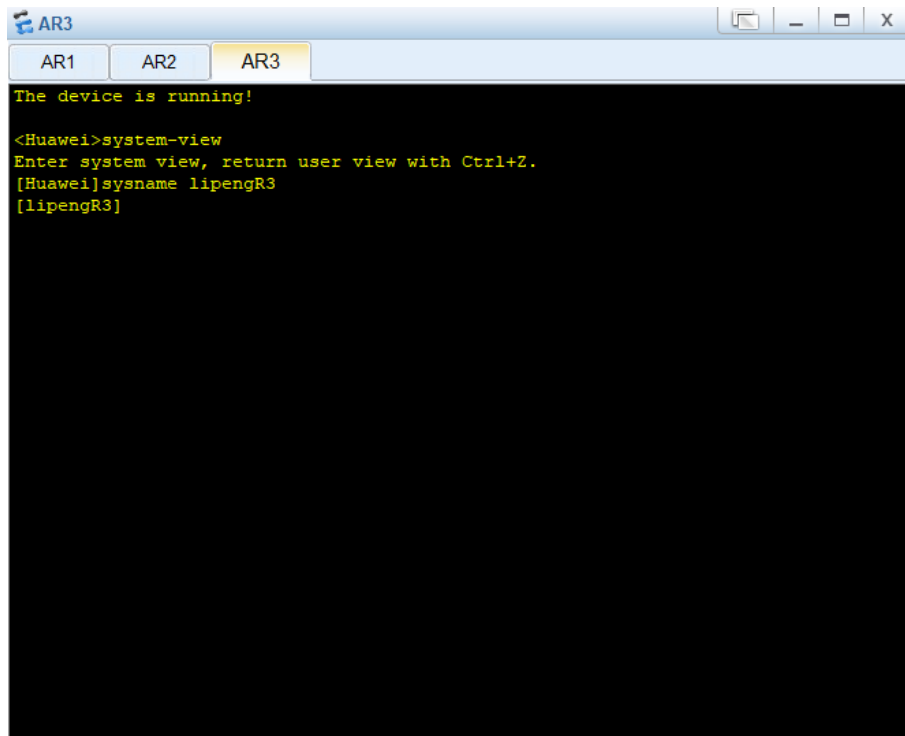
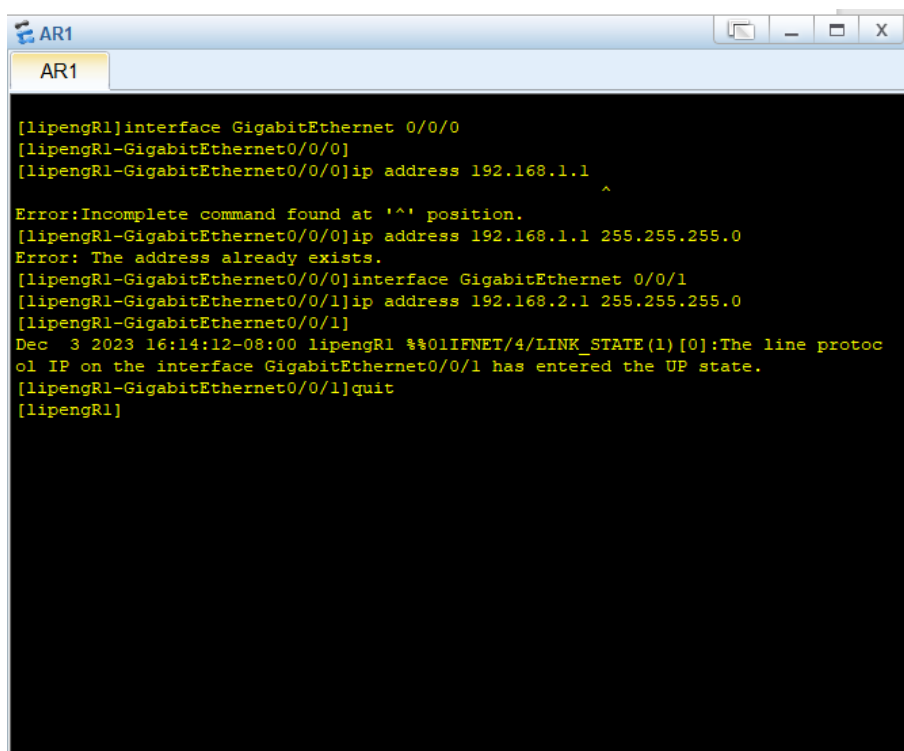


图 7: AR3 命名

配置接口 IP 地址

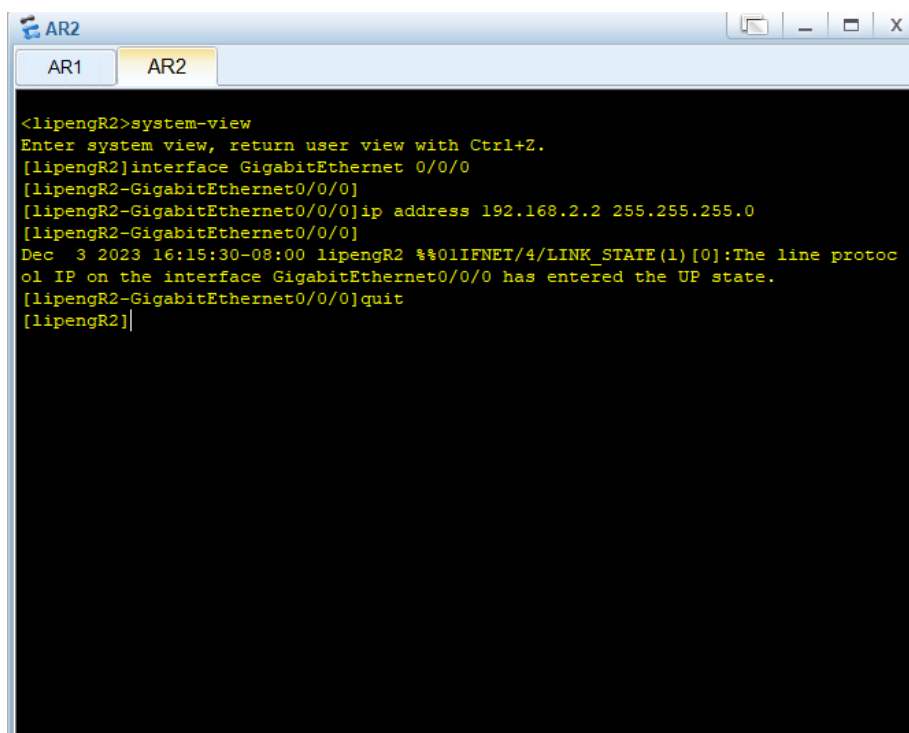
为路由器 R1 的两个接口配置 IP 地址，确保 PC1 可以 Ping 通 RT1 的 E0 口的地址。



```
AR1

[lipengR1]interface GigabitEthernet 0/0/0
[lipengR1-GigabitEthernet0/0/0]
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1
Error:Incomplete command found at '^' position.
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 255.255.255.0
Error: The address already exists.
[lipengR1-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[lipengR1-GigabitEthernet0/0/1]ip address 192.168.2.1 255.255.255.0
[lipengR1-GigabitEthernet0/0/1]
Dec 3 2023 16:14:12-08:00 lipengR1 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.
[lipengR1-GigabitEthernet0/0/1]quit
[lipengR1]
```

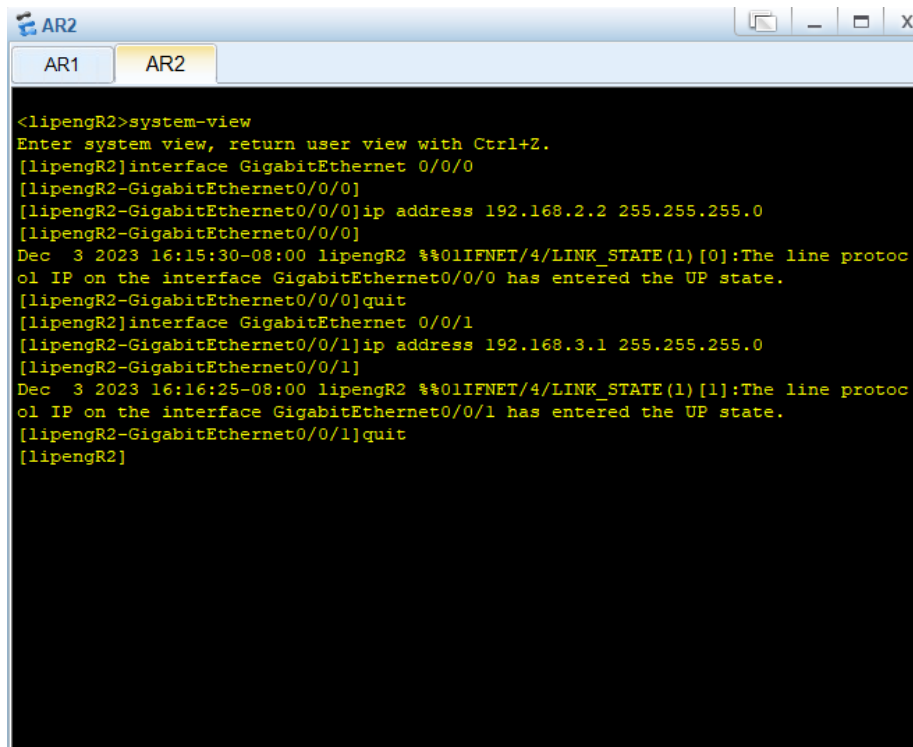
图 8: AR1 的 IP 配置



```
AR2

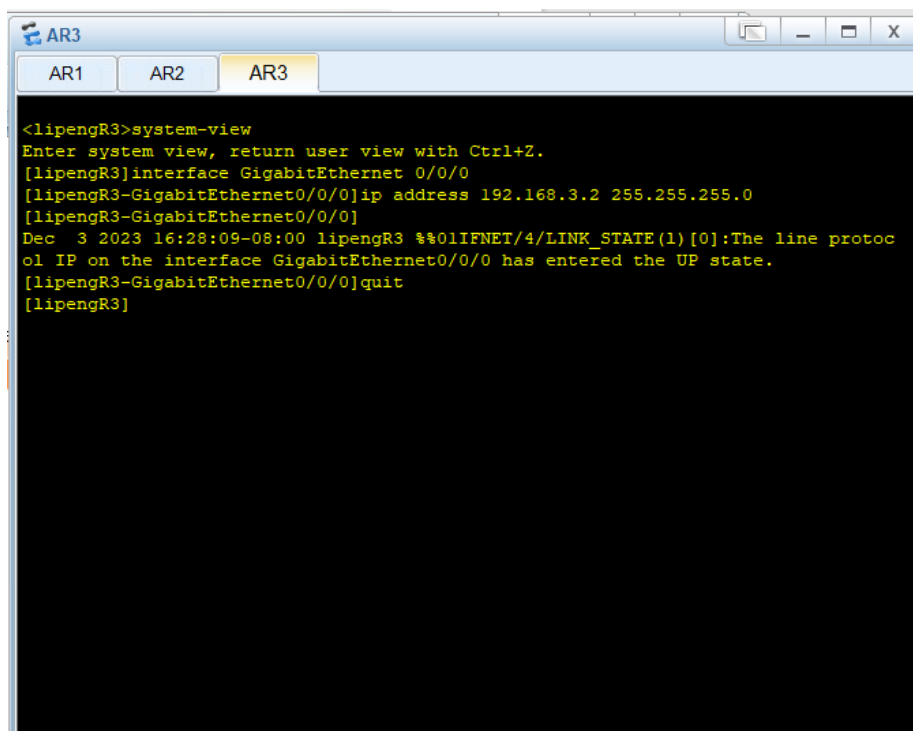
<lipengR2>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR2]interface GigabitEthernet 0/0/0
[lipengR2-GigabitEthernet0/0/0]
[lipengR2-GigabitEthernet0/0/0]ip address 192.168.2.2 255.255.255.0
[lipengR2-GigabitEthernet0/0/0]
Dec 3 2023 16:15:30-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR2-GigabitEthernet0/0/0]quit
[lipengR2]
```

图 9: AR2 的 IP 配置



```
<lipengR2>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR2]interface GigabitEthernet 0/0/0
[lipengR2-GigabitEthernet0/0/0]ip address 192.168.2.2 255.255.255.0
[lipengR2-GigabitEthernet0/0/0]
Dec 3 2023 16:15:30-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR2-GigabitEthernet0/0/0]quit
[lipengR2]interface GigabitEthernet 0/0/1
[lipengR2-GigabitEthernet0/0/1]ip address 192.168.3.1 255.255.255.0
[lipengR2-GigabitEthernet0/0/1]
Dec 3 2023 16:16:25-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.
[lipengR2-GigabitEthernet0/0/1]quit
[lipengR2]
```

图 10: AR2 的 IP 配置



```
<lipengR3>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR3]interface GigabitEthernet 0/0/0
[lipengR3-GigabitEthernet0/0/0]ip address 192.168.3.2 255.255.255.0
[lipengR3-GigabitEthernet0/0/0]
Dec 3 2023 16:28:09-08:00 lipengR3 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR3-GigabitEthernet0/0/0]quit
[lipengR3]
```

图 11: AR3 的 IP 配置

配置静态路由

为三个路由器分别从左至右配置静态路由，确保网络能够正确路由。记录输入的命令和输出（截屏或文本复制）。

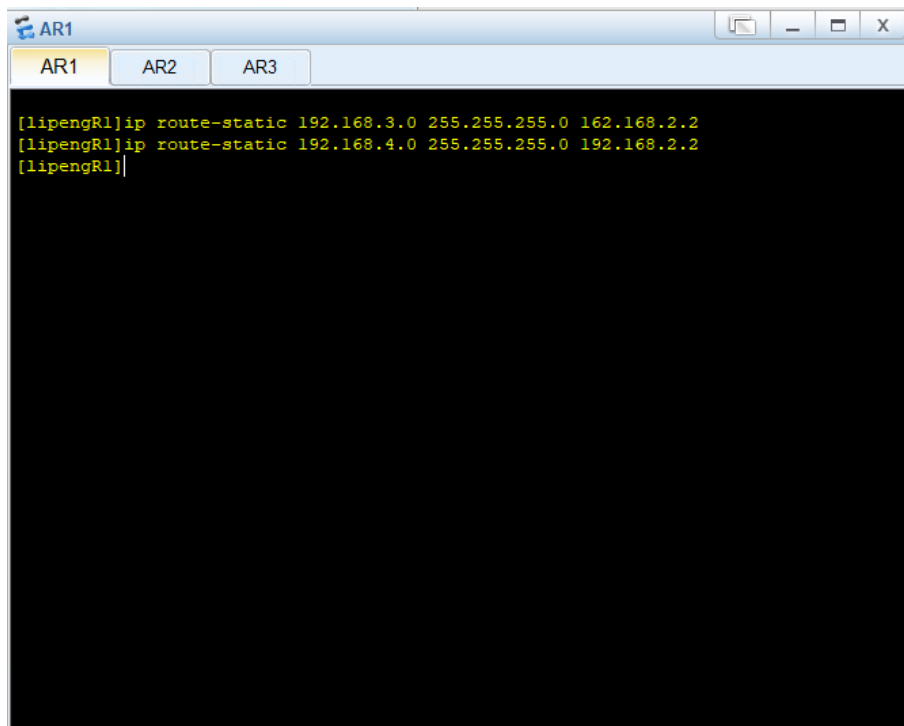


图 12: AR1 的静态路由配置

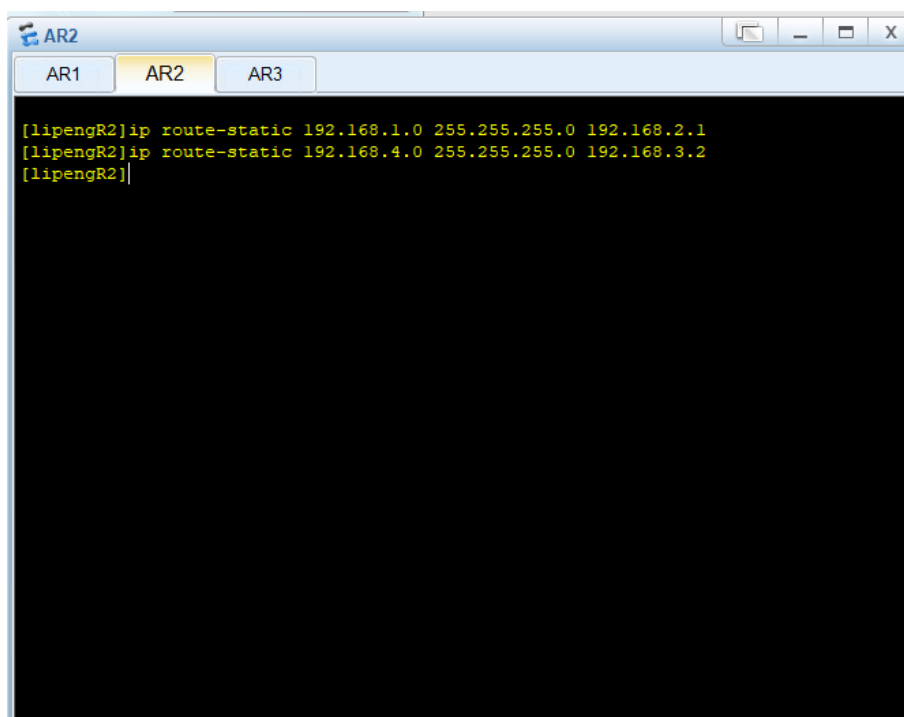


图 13: AR2 的静态路由配置

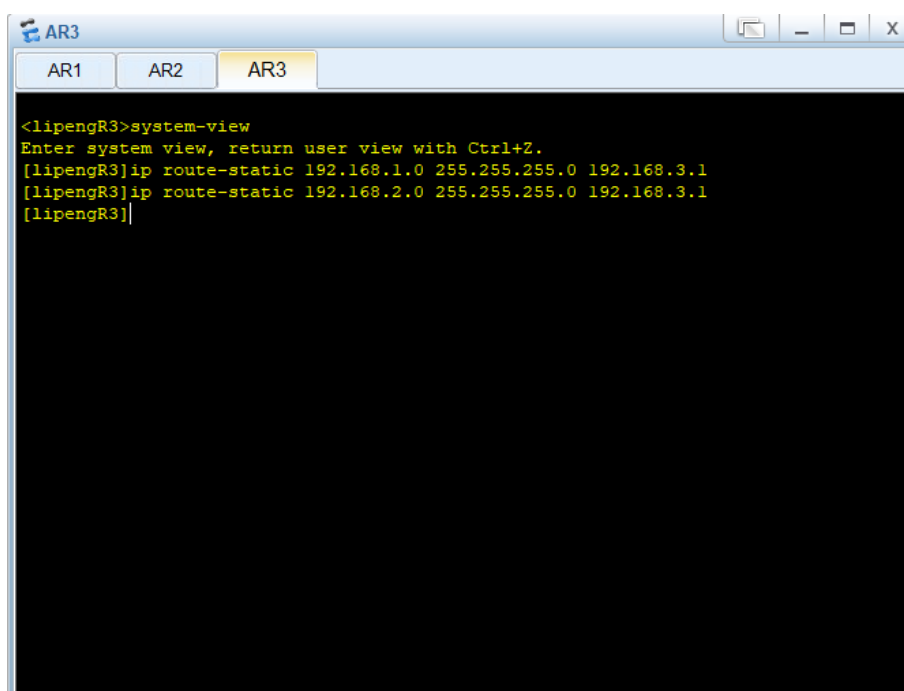
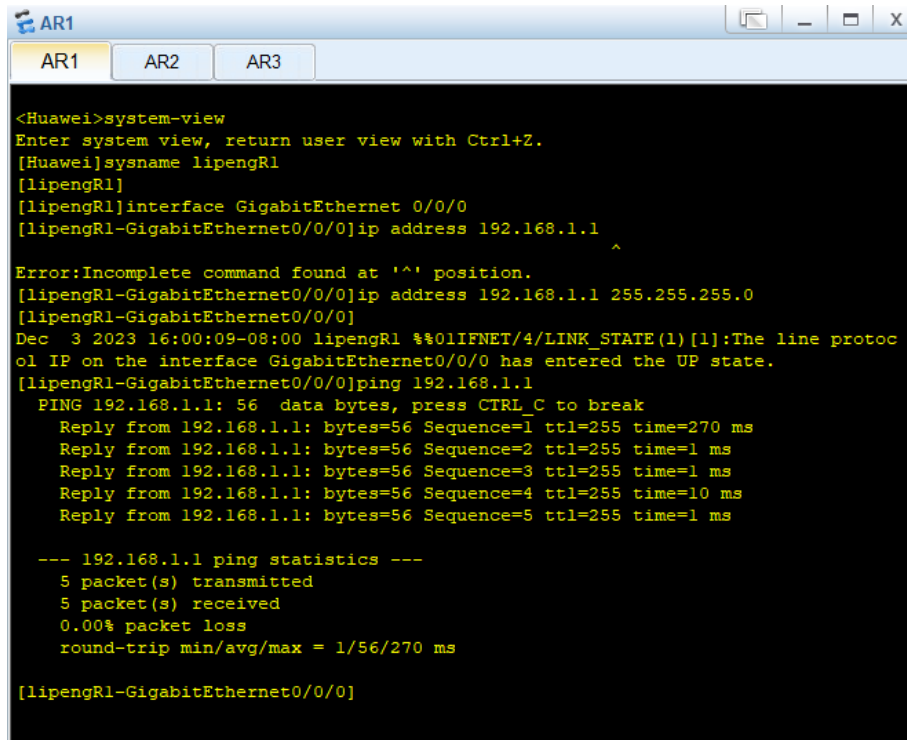


图 14: AR3 的静态路由配置

验证网络收敛

确认配置正确后，验证网络收敛，即任何两点之间均可 Ping 通。记录输入的命令和输出（截屏）。

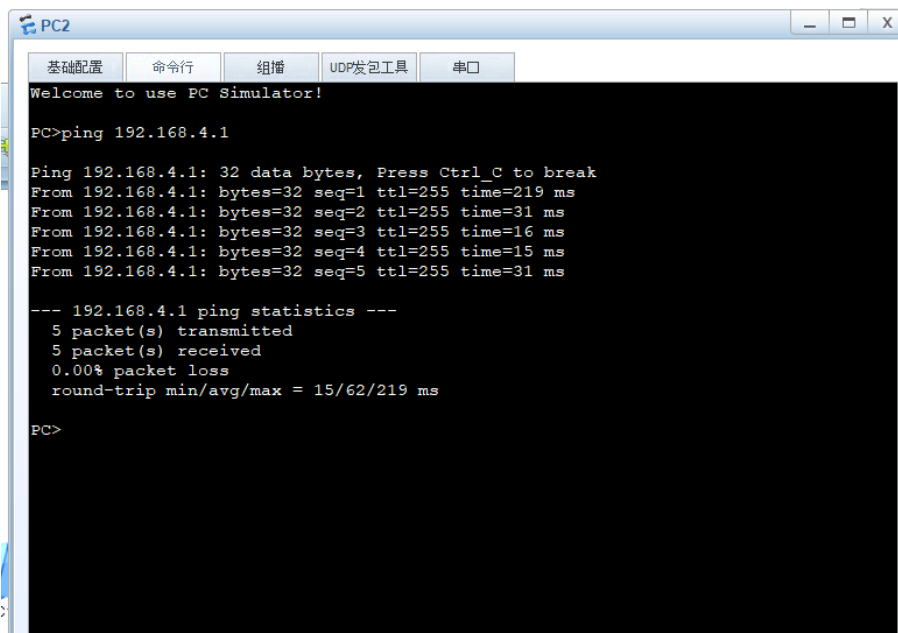


```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname lipengR1
[lipengR1]
[lipengR1]interface GigabitEthernet 0/0/0
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1
^
Error:Incomplete command found at '^' position.
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 255.255.255.0
[lipengR1-GigabitEthernet0/0/0]
Dec  3 2023 16:00:09-08:00 lipengR1 %01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR1-GigabitEthernet0/0/0]ping 192.168.1.1
  PING 192.168.1.1: 56 data bytes, press CTRL_C to break
    Reply from 192.168.1.1: bytes=56 Sequence=1 ttl=255 time=270 ms
    Reply from 192.168.1.1: bytes=56 Sequence=2 ttl=255 time=1 ms
    Reply from 192.168.1.1: bytes=56 Sequence=3 ttl=255 time=1 ms
    Reply from 192.168.1.1: bytes=56 Sequence=4 ttl=255 time=10 ms
    Reply from 192.168.1.1: bytes=56 Sequence=5 ttl=255 time=1 ms

--- 192.168.1.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 1/56/270 ms

[lipengR1-GigabitEthernet0/0/0]
```

图 15: AR1 ping PC1



```
Welcome to use PC Simulator!

PC>ping 192.168.4.1

Ping 192.168.4.1: 32 data bytes, Press Ctrl_C to break
From 192.168.4.1: bytes=32 seq=1 ttl=255 time=219 ms
From 192.168.4.1: bytes=32 seq=2 ttl=255 time=31 ms
From 192.168.4.1: bytes=32 seq=3 ttl=255 time=16 ms
From 192.168.4.1: bytes=32 seq=4 ttl=255 time=15 ms
From 192.168.4.1: bytes=32 seq=5 ttl=255 time=31 ms

--- 192.168.4.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 15/62/219 ms

PC>
```

图 16: PC2 ping PC1

抓包工具抓包

在 PC1 上使用抓包工具进行抓包。首先使用 `arp-d` 命令清空 `arp` 表，然后使用 `Ping` 命令测试报文。

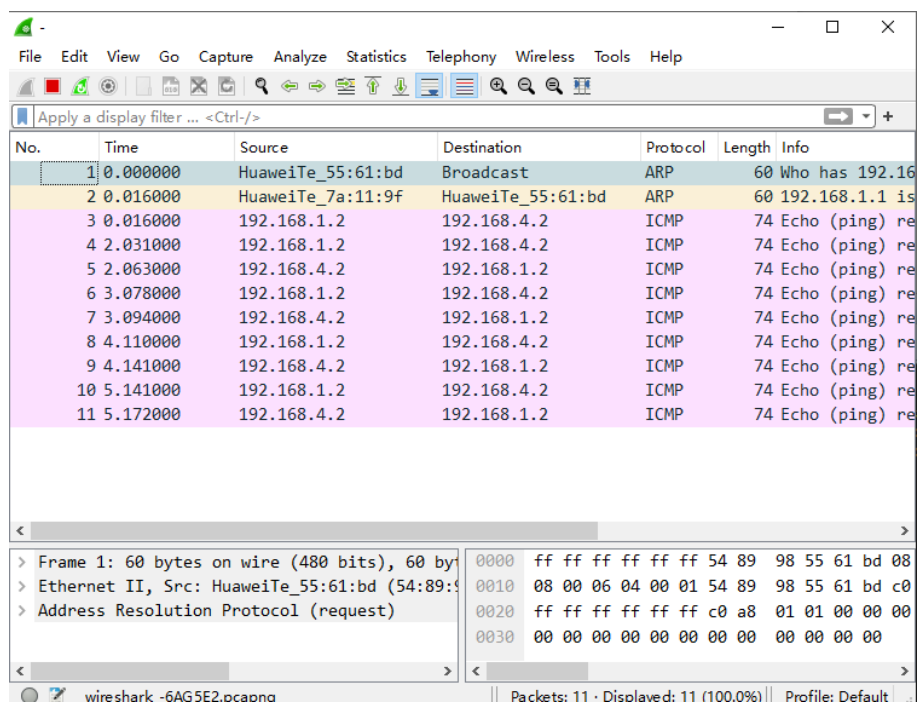


图 17: wireshark 捕获数据包

保存已配置命令和拓扑文件

保存已配置的命令和拓扑文件，便于日后参考和复现实验环境。

2 实验 3.2 动态路由（RIP）

2.1 实验目的

理解动态路由协议 RIP 的工作原理；掌握采用动态路由协议 RIP 进行网络设计的基本原则和方法。

2.2 实验内容

- 华为路由器 IP 地址的配置；

- 动态路由协议 rip 的配置；
- 路由规划；
- 网络测试与排错操作；
- 静态路由与动态路由的区别。

2.3 实验原理、方法和手段

RIP (Routing Information Protocol) 是一种距离矢量路由协议，使用跳数作为路径度量。它适用于小型、简单拓扑、低成本和低带宽需求的网络。然而，由于其有限跳数和相对较慢的收敛速度，RIP 在大型、复杂网络中可能不够灵活，需要考虑使用其他更高级的路由协议。

RIP 的工作原理：

距离矢量算法：RIP 使用距离矢量算法来决定最佳路径。每个路由器都维护一张路由表，其中包含到达目标网络的最短路径距离。

跳数作为度量：RIP 以跳数（经过的路由器数量）作为路径的度量标准。路径的跳数越少，被认为是更好的路径。

定期更新：路由器之间定期交换路由更新信息，以确保网络拓扑的及时反映。默认情况下，RIP 每 30 秒发送一次路由更新。

毒性逆转：为了防止路由环路，RIP 使用毒性逆转机制，即将某个路由器到目标网络的距离设置为无穷大（16 跳）。

分割-横离开：RIP 通过将网络分割为多个区域来减小路由表的大小。每个区域内的路由器只知道有关其他区域的总体信息，而不知道区域内的详细信息。

RIP 的适用范围：

小型网络：RIP 最适合用于小型网络，特别是对于那些网络直径相对较小的场景。在大型网络中，RIP 的有限跳数（15 跳）可能不足以支持更大的网络规模。

简单拓扑：RIP 更适合于简单的网络拓扑，如星型或总线拓扑。对于复杂的网络结构，可能需要更复杂的路由协议。

低成本要求：由于 RIP 是一种简单的协议，实现和维护相对容易，适用于成本敏感的环境。

低带宽需求：RIP 产生的路由更新信息相对较小，适用于带宽有限的网络。

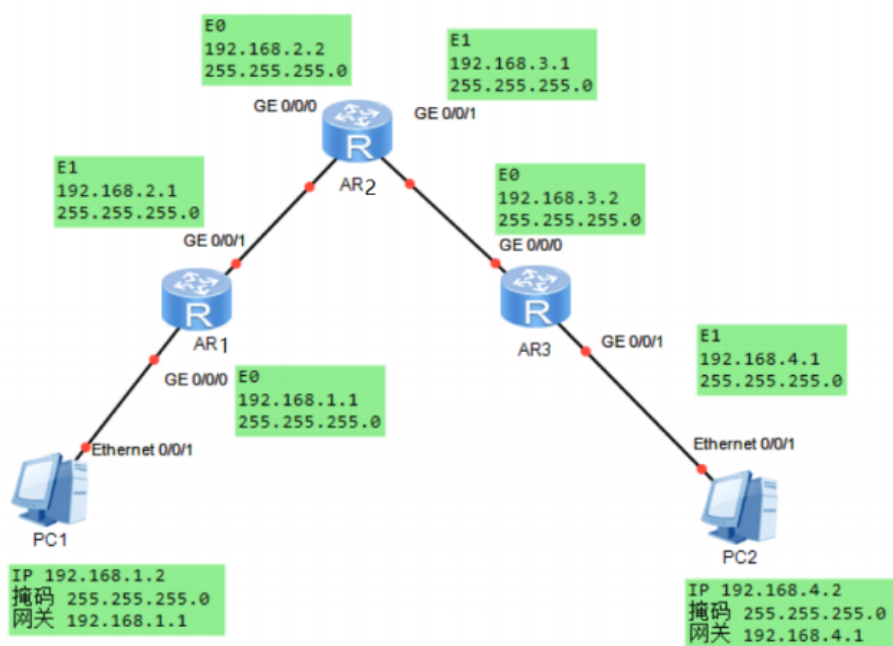


图 18: 实验拓扑图

2.4 实验条件

- 华为 eNSP 仿真平台中：2 台 PC，3 台路由器；
- 网线若干。

2.5 实验步骤

1. 同实验一。
2. 配置动态路由协议 RIP：为三个路由器分别配置动态路由协议 rip（从左至右）。


```
AR1 AR2 AR3

(lspengh1ip route-static 192.168.3.0 255.255.255.0 192.168.2.1
(lspengh1ip route-static 192.168.4.0 255.255.255.0 192.168.2.1
(lspengh1

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

(lspengh1system-view
Enter system view, return user view with Ctrl+Z.
(lspengh1rip
(lspengh1rip-lsnetwork 192.168.1.0
(lspengh1rip-lsnetwork 192.168.3.0
(lspengh1rip-lsnetwork 192.168.4.0
Route Flags: R - relay, D - download to FIB

Routing Table: Public
      Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8         Direct   0       0         D 127.0.0.1             InLoopBack0
127.0.0.0/24        Direct   0       0         D 127.0.0.1             InLoopBack0
127.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
255.255.1.0/24      Direct   0       0         D 192.168.1.1           GigabitEthernet0/0/0
0/0/0
192.168.1.1/32      Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.1.255/32    Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.2.0/24      Direct   0       0         D 192.168.2.1           GigabitEthernet0/0/0
0/0/0
192.168.2.1/32      Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.2.255/32    Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.4.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.4.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
(lspengh1rip-1]
```

图 19: AR1 的路由表

```
AR1 AR2 AR3

(lspengh2ip route-static 192.168.1.0 255.255.255.0 192.168.2.1
(lspengh2ip route-static 192.168.4.0 255.255.255.0 192.168.2.1
(lspengh2

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

(lspengh2system-view
Enter system view, return user view with Ctrl+Z.
(lspengh2rip
(lspengh2rip-lsnetwork 192.168.1.0
(lspengh2rip-lsnetwork 192.168.3.0
(lspengh2rip-lsnetwork 192.168.4.0
Route Flags: R - relay, D - download to FIB

Routing Table: Public
      Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8         Direct   0       0         D 127.0.0.1             InLoopBack0
127.0.0.0/24        Direct   0       0         D 127.0.0.1             InLoopBack0
127.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
255.255.1.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Direct   0       0         D 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Direct   0       0         D 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.255/32    Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.4.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.4.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
(lspengh2rip-1]
```

图 20: AR2 的路由表

```
(lspengh3system-view
Enter system view, return user view with Ctrl+Z.
(lspengh3ip route-static 192.168.1.0 255.255.255.0 192.168.2.1
(lspengh3ip route-static 192.168.2.0 255.255.255.0 192.168.3.1
(lspengh3

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

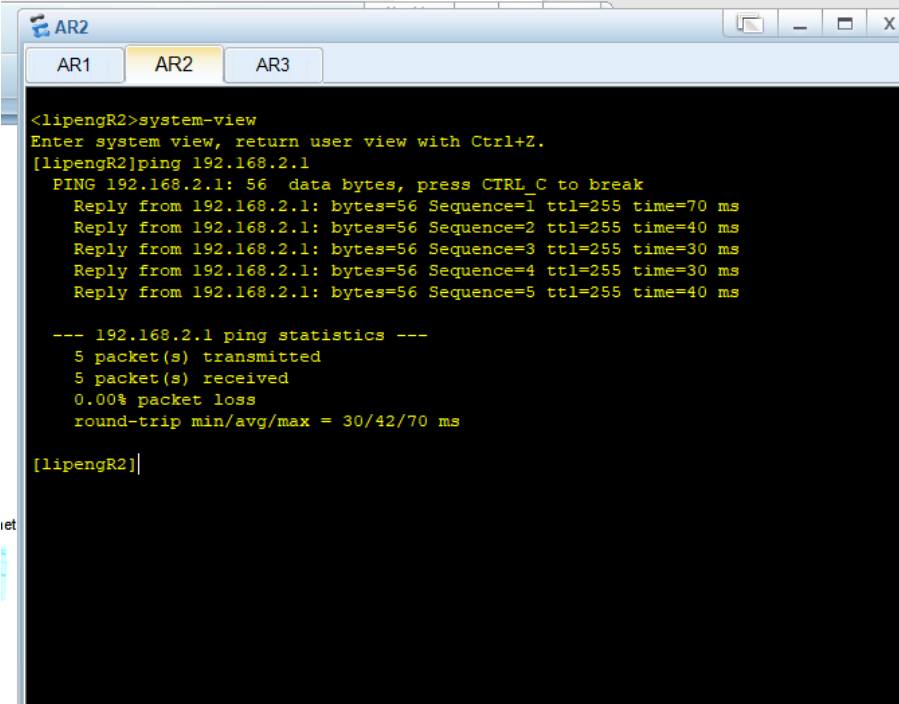
(lspengh3system-view
Enter system view, return user view with Ctrl+Z.
(lspengh3rip
(lspengh3rip-lsnetwork 192.168.3.0
(lspengh3rip-lsnetwork 192.168.4.0
(lspengh3rip-lsnetwork 192.168.1.0
Route Flags: R - relay, D - download to FIB

Routing Table: Public
      Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8         Direct   0       0         D 127.0.0.1             InLoopBack0
127.0.0.0/24        Direct   0       0         D 127.0.0.1             InLoopBack0
127.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
255.255.1.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Static   60      80         RD 192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24      Direct   0       0         D 192.168.3.1           GigabitEthernet0/0/0
0/0/0
192.168.3.255/32    Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.4.0/24      Direct   0       0         D 192.168.4.1           GigabitEthernet0/0/0
0/0/0
192.168.4.1/32      Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.168.4.255/32    Direct   0       0         D 127.0.0.1             GigabitEthernet0/0/0
0/0/0
192.255.255.255/32  Direct   0       0         D 127.0.0.1             InLoopBack0
(lspengh3rip-1]
```

图 21: AR3 的路由表

3. 验证连通性：验证 PC1 和 PC2 可以 ping 通。

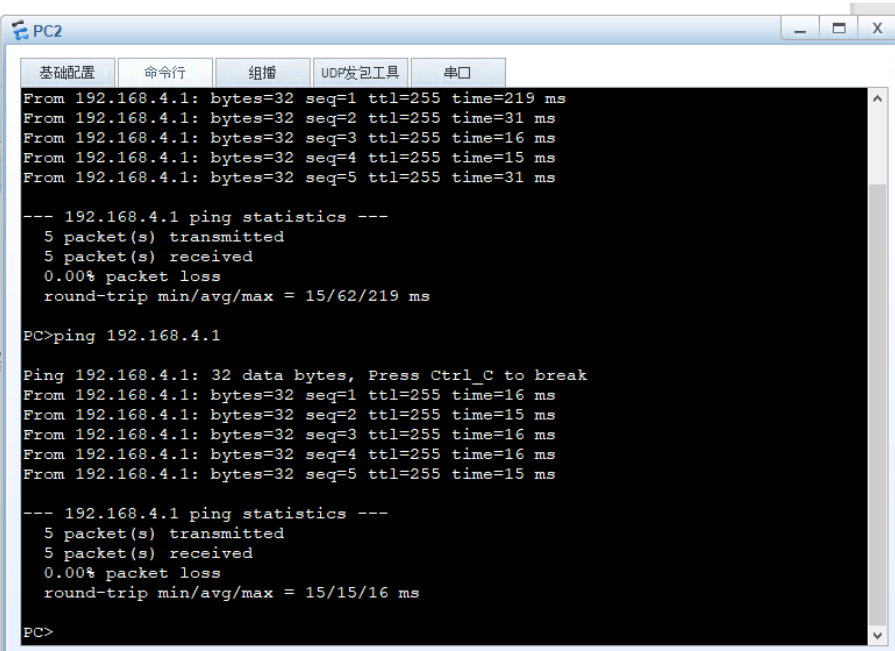


```
<lipengR2>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR2]ping 192.168.2.1
  PING 192.168.2.1: 56 data bytes, press CTRL_C to break
    Reply from 192.168.2.1: bytes=56 Sequence=1 ttl=255 time=70 ms
    Reply from 192.168.2.1: bytes=56 Sequence=2 ttl=255 time=40 ms
    Reply from 192.168.2.1: bytes=56 Sequence=3 ttl=255 time=30 ms
    Reply from 192.168.2.1: bytes=56 Sequence=4 ttl=255 time=30 ms
    Reply from 192.168.2.1: bytes=56 Sequence=5 ttl=255 time=40 ms

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

[lipengR2]
```

图 22: AR2 ping AR1



```
基础配置 命令行 组播 UDP发包工具 串口
From 192.168.4.1: bytes=32 seq=1 ttl=255 time=219 ms
From 192.168.4.1: bytes=32 seq=2 ttl=255 time=31 ms
From 192.168.4.1: bytes=32 seq=3 ttl=255 time=16 ms
From 192.168.4.1: bytes=32 seq=4 ttl=255 time=15 ms
From 192.168.4.1: bytes=32 seq=5 ttl=255 time=31 ms

--- 192.168.4.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 15/62/219 ms

PC>ping 192.168.4.1

Ping 192.168.4.1: 32 data bytes, Press Ctrl C to break
From 192.168.4.1: bytes=32 seq=1 ttl=255 time=16 ms
From 192.168.4.1: bytes=32 seq=2 ttl=255 time=15 ms
From 192.168.4.1: bytes=32 seq=3 ttl=255 time=16 ms
From 192.168.4.1: bytes=32 seq=4 ttl=255 time=16 ms
From 192.168.4.1: bytes=32 seq=5 ttl=255 time=15 ms

--- 192.168.4.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 15/15/16 ms

PC>
```

图 23: PC2 ping AR3

4. 保存配置：保存已配置命令和拓扑文件。

3 实验 3.3 动态路由 (OSPF)

3.1 实验目的

理解动态路由协议 OSPF 的工作原理；掌握采用动态路由协议 OSPF 进行网络设计的基本原则和方法。

3.2 实验内容

- 华为路由器 IP 地址的配置；
- 动态路由协议 ospf 的配置；
- 路由规划；
- 网络测试与排错操作；
- rip 与 ospf 路由协议的区别。

3.3 实验原理、方法和手段

相对于 RIP (Routing Information Protocol), OSPF (Open Shortest Path First) 协议的优势主要体现在以下几个方面：

路由计算方式：

RIP：使用跳数 (hop count) 作为路径的度量标准。这种度量方式简单，但可能导致选择不是最优路径，因为路径长度并不仅仅由跳数决定。

OSPF：使用链路状态信息，采用了 Dijkstra 算法，计算路径的最短距离。这种方式更加准确，能够选择最优路径，考虑到实际链路的带宽、延迟等因素。

网络支持：

RIP：主要适用于小型网络，对于大型网络可能导致网络不稳定、收敛慢等问题。

OSPF：更适用于复杂的大型网络，能够提供更好的网络稳定性和快速的收敛。

分层设计：

RIP：单一区域，所有路由器处于同一广播域。

OSPF：支持多区域设计，通过区域划分，减小了路由表的规模，提高了网络的可伸缩性。

灵活的路径选择：

RIP：路径选择较为刚性，无法根据实际链路负载情况进行动态调整。

OSPF：能够根据链路状态信息实时调整路径选择，具有更好的灵活性和适应性。

支持 VLSM 和 CIDR：

RIP：不支持可变长度子网掩码（VLSM）和无类域间路由（CIDR）。

OSPF：支持 VLSM 和 CIDR，能够更有效地利用 IP 地址空间。

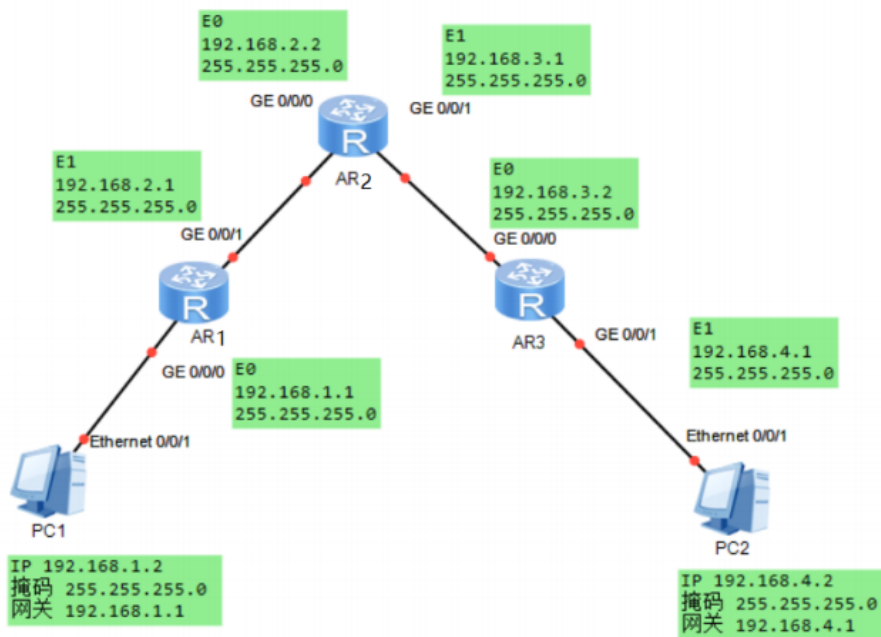


图 24: 实验拓扑图

3.4 实验条件

- 华为 eNSP 仿真平台中：2 台 PC，3 台路由器；
- 绞线若干。

3.5 实验步骤

实验说明：路由器端口以具体选用的设备为准，如果是实际设备，请观察路由器前面板和后面板的端口名称，并使用 `disp int` 或者 `disp cur` 命令查看端口的实际名称。在对路由器进行配置时，可使用 `disp cur` 命令来检查当前路由器上生效的配置命令。

配置动态路由协议 ospf

为 3 个路由器配置动态路由协议 ospf，首先删除原来的 rip 配置。要求记录输入的命令和输出（截屏或文本复制）。配置后可以用 display current configuration 检查配置，或者 display ip routing-table 检查路由表。为 3 个路由器分别配置动态路由协议 ospf。area 命令用来创建 OSPF 区域，并进入 OSPF 区域视图。配置后可以用 disp cur 检查配置，或者 disp ip routing-table 检查路由表。配置完成后，网络收敛，则网络任意两点间，应该可以互相 Ping 通。

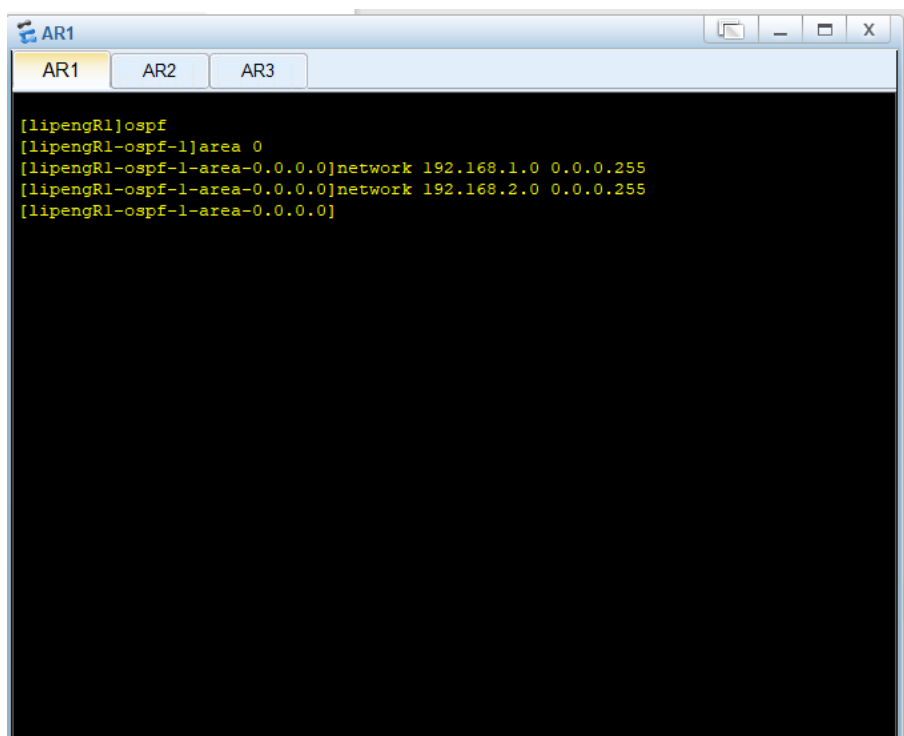


图 25: AR1 的动态路由配置

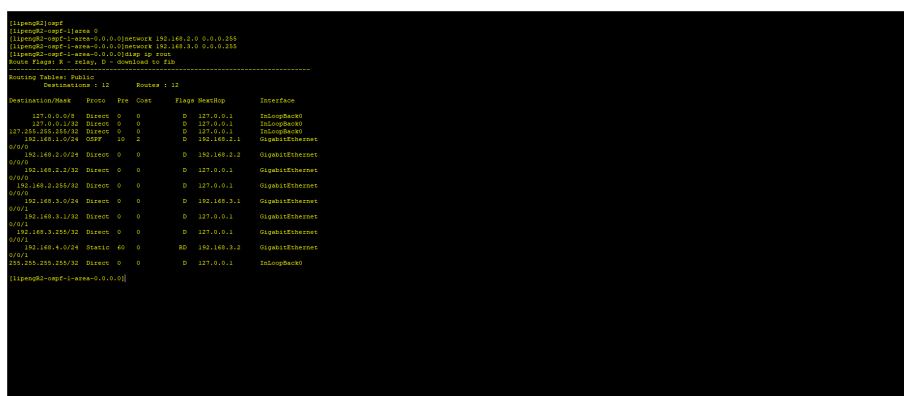


图 26: AR2 的动态路由配置

```
[lipeng@ospf-l-area-0]
[ospf@ospf-l-area-0.0.0.0]network 192.168.3.0 0.0.0.255
[ospf@ospf-l-area-0.0.0.0]network 192.168.4.0 0.0.0.255
[ospf@ospf-l-area-0.0.0.0]quit
Route Flags: R - relay, D - download to fib

Routing Table: Public
Destinations: 12
Routes: 12

Destination/Mask Proto Pre Cost Flags NextHop Interface
-----
127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0
127.0.0.0/32 Direct 0 0 D 127.0.0.1 InLoopBack0
127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
0/0/0 192.168.1.0/24 OSPF 10 0 D 192.168.2.1 GigabitEthernet0/0/0
0/0/0 192.168.3.0/24 Direct 0 0 D 192.168.3.2 GigabitEthernet0/0/0
0/0/0 192.168.3.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0 192.168.3.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0 192.168.4.0/24 Direct 0 0 D 192.168.4.1 GigabitEthernet0/0/1
0/0/1 192.168.4.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1 192.168.4.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1 255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
[ospf@ospf-l-area-0.0.0.0]
```

图 27: AR2 的动态路由配置

```
AR3
AR1 AR2 AR3
0/0/0
192.168.3.0/24 Direct 0 0 D 192.168.3.2 GigabitEthernet0/0/0
0/0/0
192.168.3.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0
192.168.3.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0
192.168.4.0/24 Direct 0 0 D 192.168.4.1 GigabitEthernet0/0/1
0/0/1
192.168.4.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1
192.168.4.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

[lipengR3-ospf-l-area-0.0.0.0]ping 192.168.1.2
PING 192.168.1.2: 56 data bytes, press CTRL_C to break
Reply from 192.168.1.2: bytes=56 Sequence=1 ttl=126 time=150 ms
Reply from 192.168.1.2: bytes=56 Sequence=2 ttl=126 time=30 ms
Reply from 192.168.1.2: bytes=56 Sequence=3 ttl=126 time=50 ms
Reply from 192.168.1.2: bytes=56 Sequence=4 ttl=126 time=60 ms
Reply from 192.168.1.2: bytes=56 Sequence=5 ttl=126 time=50 ms

--- 192.168.1.2 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 30/68/150 ms

[lipengR3-ospf-l-area-0.0.0.0]
```

图 28: AR3 的动态路由配置

```

<lipengR1>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR1]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
-----
      127.0.0.0/8     Direct  0    0          D   127.0.0.1       InLoopBack0
      127.0.0.1/32     Direct  0    0          D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0    0          D   127.0.0.1       InLoopBack0
      192.168.1.0/24   Direct  0    0          D   192.168.1.1     GigabitEthernet
0/0/0
      192.168.1.1/32   Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.1.255/32 Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.2.0/24   Direct  0    0          D   192.168.2.1     GigabitEthernet
0/0/1
      192.168.2.1/32   Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.2.255/32 Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.3.0/24   OSPF    10    2          D   192.168.2.2     GigabitEthernet
0/0/1
      192.168.4.0/24   OSPF    10    3          D   192.168.2.2     GigabitEthernet
0/0/1
255.255.255.255/32   Direct  0    0          D   127.0.0.1       InLoopBack0

[lipengR1]

```

图 29: AR3 的动态路由配置

```

[lipengR3]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
-----
      127.0.0.0/8     Direct  0    0          D   127.0.0.1       InLoopBack0
      127.0.0.1/32     Direct  0    0          D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0    0          D   127.0.0.1       InLoopBack0
      192.168.1.0/24   OSPF    10    3          D   192.168.3.1     GigabitEthernet
0/0/0
      192.168.2.0/24   OSPF    10    2          D   192.168.3.1     GigabitEthernet
0/0/0
      192.168.3.0/24   Direct  0    0          D   192.168.3.2     GigabitEthernet
0/0/0
      192.168.3.2/32   Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.3.255/32 Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.4.0/24   Direct  0    0          D   192.168.4.1     GigabitEthernet
0/0/1
      192.168.4.1/32   Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.4.255/32 Direct  0    0          D   127.0.0.1       GigabitEthernet
0/0/1
255.255.255.255/32   Direct  0    0          D   127.0.0.1       InLoopBack0

[lipengR3]

```

图 30: AR3 的动态路由配置

```
[lipengR2-ospf-1-area-0.0.0.0]quit
[lipengR2-ospf-1]quit
[lipengR2]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
-----
    127.0.0.0/8      Direct   0    0          D   127.0.0.1         InLoopBack0
    127.0.0.1/32      Direct   0    0          D   127.0.0.1         InLoopBack0
127.255.255.255/32   Direct   0    0          D   127.0.0.1         InLoopBack0
    192.168.1.0/24    OSPF     10    2          D   192.168.2.1       GigabitEthernet
0/0/0
    192.168.2.0/24    Direct   0    0          D   192.168.2.2       GigabitEthernet
0/0/0
    192.168.2.2/32    Direct   0    0          D   127.0.0.1         GigabitEthernet
0/0/0
    192.168.2.255/32   Direct   0    0          D   127.0.0.1         GigabitEthernet
0/0/0
    192.168.3.0/24    Direct   0    0          D   192.168.3.1       GigabitEthernet
0/0/1
    192.168.3.1/32    Direct   0    0          D   127.0.0.1         GigabitEthernet
0/0/1
    192.168.3.255/32   Direct   0    0          D   127.0.0.1         GigabitEthernet
0/0/1
    192.168.4.0/24    OSPF     10    2          D   192.168.3.2       GigabitEthernet
0/0/1
255.255.255.255/32   Direct   0    0          D   127.0.0.1         InLoopBack0

[lipengR2]Z
```

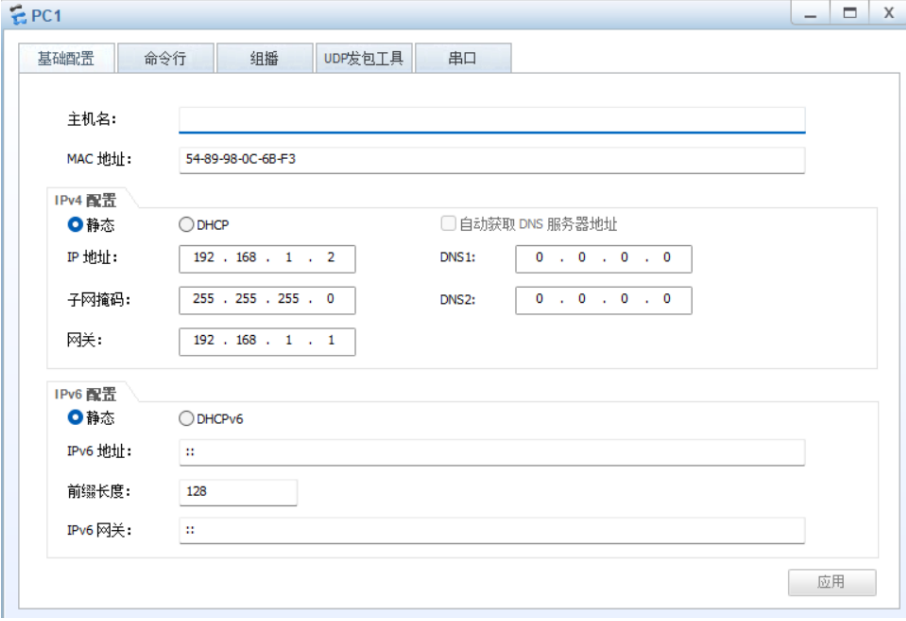
图 31: 路由表对比

4 实验结论及心得体会

通过本次实验，进行了静态路由的配置和实际网络测试，了解了网络的收敛过程和数据包的传输机制。华为路由器的基本配置命令和 eNSP 模拟器的使用方法加深了对 RIP 协议的理解，学会了在华为路由器上配置动态路由，了解了 RIP 的工作原理及适用场景。配置 OSPF 协议，相较于 RIP，OSPF 在复杂网络中表现更为出色，特别是在大型网络中，OSPF 的优势更为明显。通过对比 RIP 和 OSPF，对不同动态路由协议的优缺点有了更清晰的认识。

5 实验截图

以下是本次实验的截图：



The image shows the configuration window for PC1. It has tabs for '基础配置' (Basic Configuration), '命令行' (Command Line), '组播' (Multicast), 'UDP发包工具' (UDP Packet Tool), and '串口' (Serial Port). The '基础配置' tab is active. It contains fields for '主机名' (Hostname), 'MAC 地址' (MAC Address: 54-89-98-0C-6B-F3), and 'IPv4 配置' (IPv4 Configuration). Under IPv4, '静态' (Static) is selected, and '自动获取 DNS 服务器地址' (Automatically obtain DNS server address) is unchecked. The IP address is 192.168.1.2, subnet mask is 255.255.255.0, and gateway is 192.168.1.1. DNS1 and DNS2 are both 0.0.0.0. There is also an 'IPv6 配置' (IPv6 Configuration) section with '静态' (Static) selected, IPv6 address as ::, prefix length as 128, and IPv6 gateway as ::. An '应用' (Apply) button is at the bottom right.

PC1

基础配置 命令行 组播 UDP发包工具 串口

主机名:

MAC 地址: 54-89-98-0C-6B-F3

IPv4 配置

☒ 静态 ☐ DHCP ☐ 自动获取 DNS 服务器地址

IP 地址: 192 . 168 . 1 . 2 DNS1: 0 . 0 . 0 . 0

子网掩码: 255 . 255 . 255 . 0 DNS2: 0 . 0 . 0 . 0

网关: 192 . 168 . 1 . 1

IPv6 配置

☒ 静态 ☐ DHCPv6

IPv6 地址: ::

前缀长度: 128

IPv6 网关: ::

应用

图 32: PC1 设置 IP 地址



The image shows the configuration window for PC2. It has tabs for '基础配置' (Basic Configuration), '命令行' (Command Line), '组播' (Multicast), 'UDP发包工具' (UDP Packet Tool), and '串口' (Serial Port). The '基础配置' tab is active. It contains fields for '主机名' (Hostname), 'MAC 地址' (MAC Address: 54-89-98-CA-4E-D6), and 'IPv4 配置' (IPv4 Configuration). Under IPv4, '静态' (Static) is selected, and '自动获取 DNS 服务器地址' (Automatically obtain DNS server address) is unchecked. The IP address is 192.168.4.2, subnet mask is 255.255.255.0, and gateway is 192.168.4.1. DNS1 and DNS2 are both 0.0.0.0. There is also an 'IPv6 配置' (IPv6 Configuration) section with '静态' (Static) selected, IPv6 address as ::, prefix length as 128, and IPv6 gateway as ::. An '应用' (Apply) button is at the bottom right.

PC2

基础配置 命令行 组播 UDP发包工具 串口

主机名:

MAC 地址: 54-89-98-CA-4E-D6

IPv4 配置

☒ 静态 ☐ DHCP ☐ 自动获取 DNS 服务器地址

IP 地址: 192 . 168 . 4 . 2 DNS1: 0 . 0 . 0 . 0

子网掩码: 255 . 255 . 255 . 0 DNS2: 0 . 0 . 0 . 0

网关: 192 . 168 . 4 . 1

IPv6 配置

☒ 静态 ☐ DHCPv6

IPv6 地址: ::

前缀长度: 128

IPv6 网关: ::

应用

图 33: PC2 设置 IP 地址

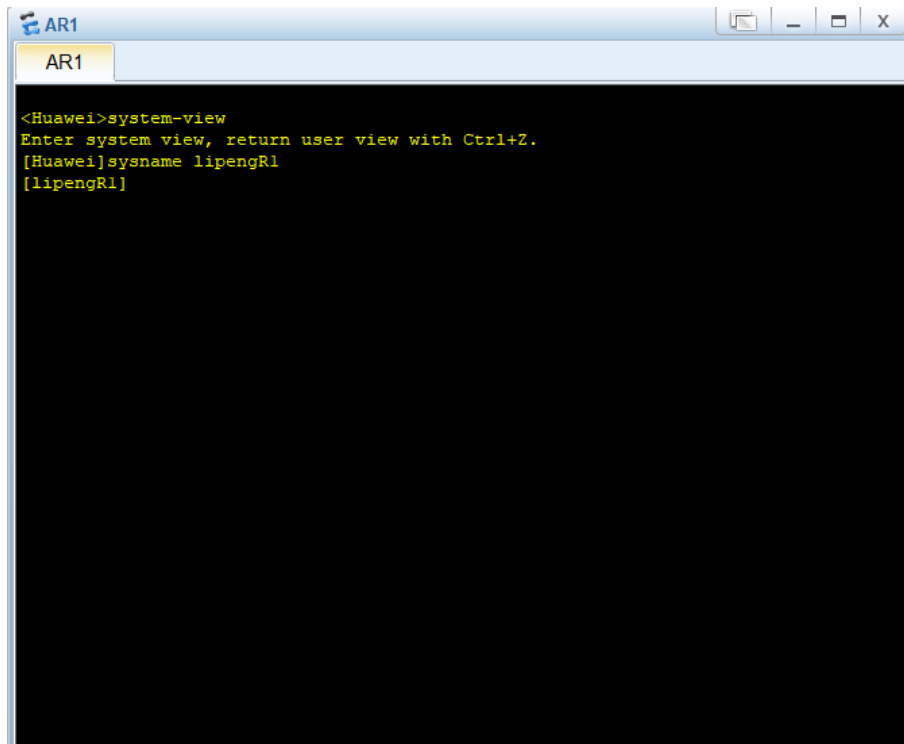


图 34: AR1 命名

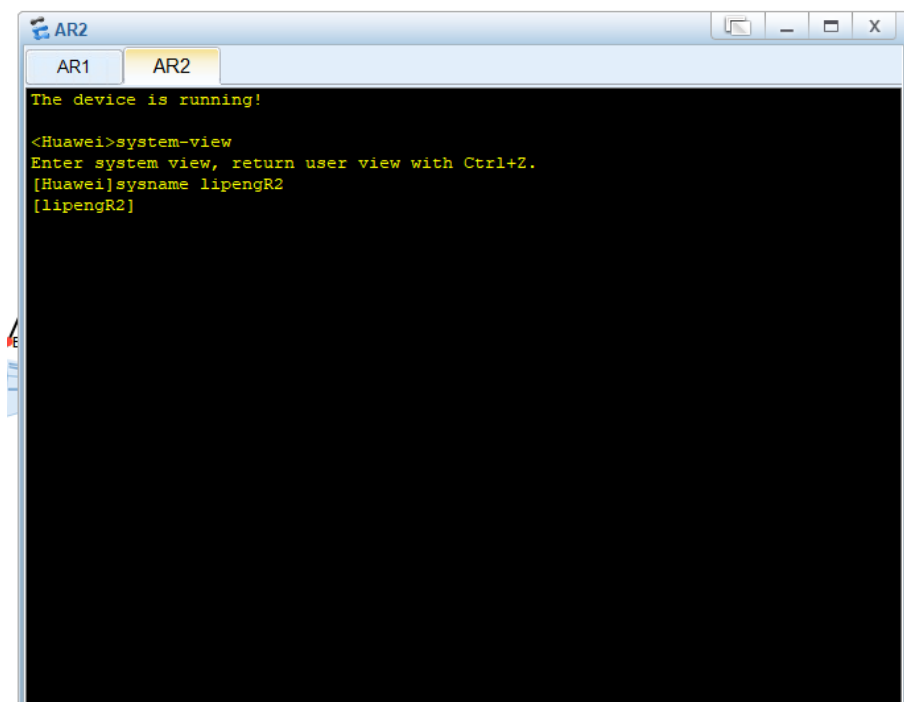


图 35: AR2 命名

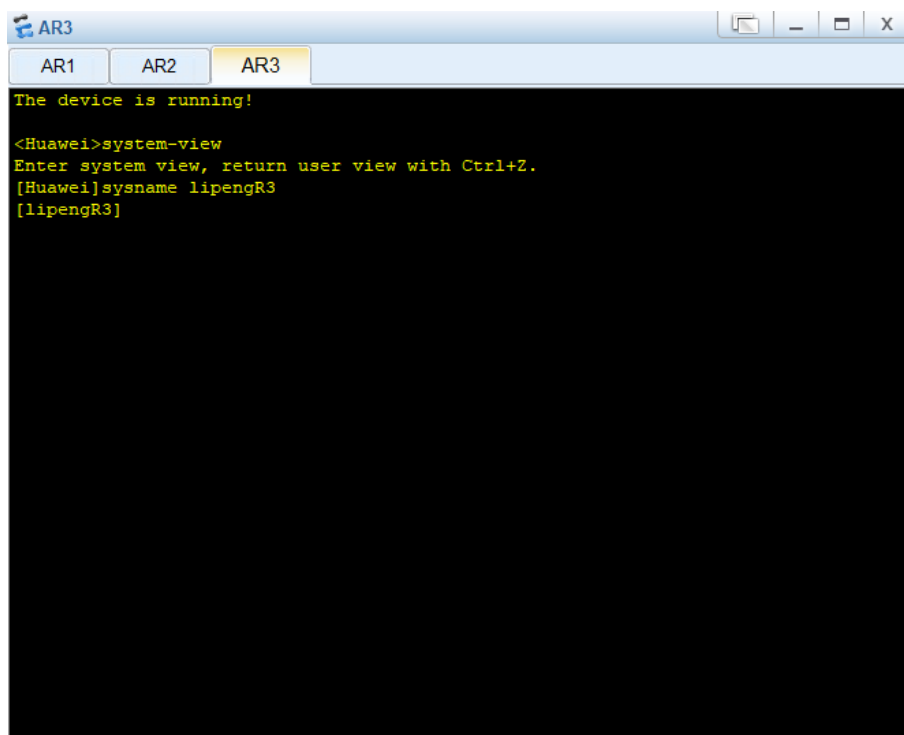


图 36: AR3 命名

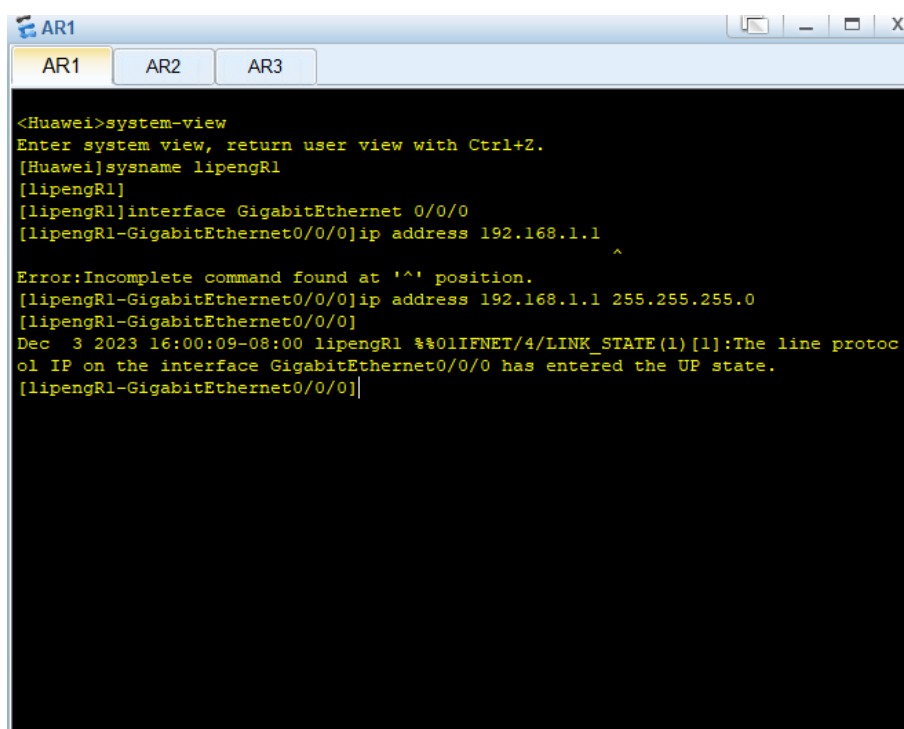
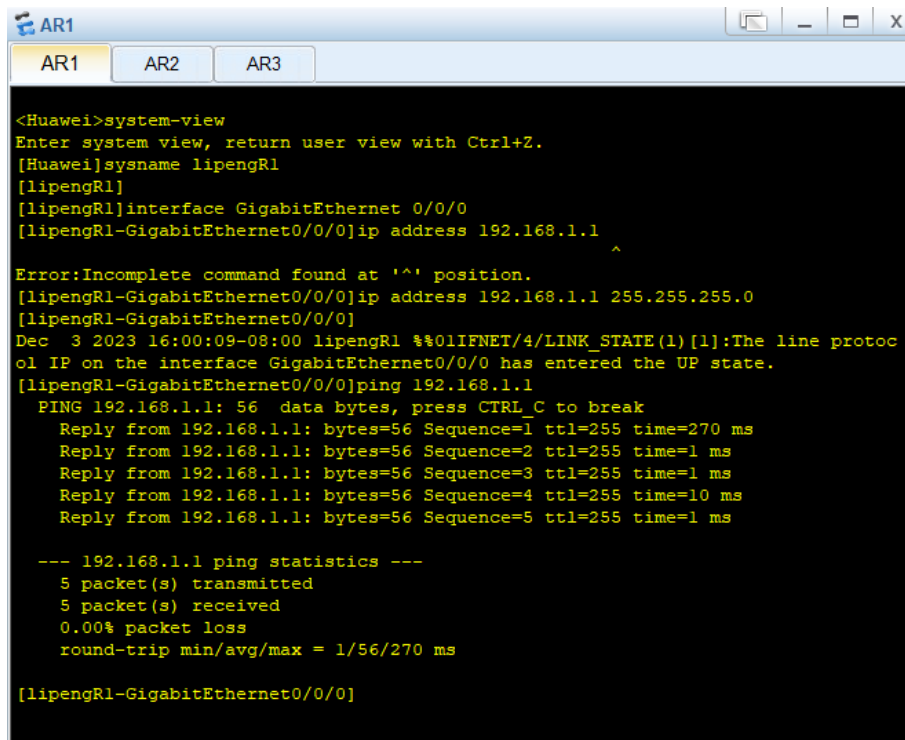


图 37: AR1 的 IP 配置

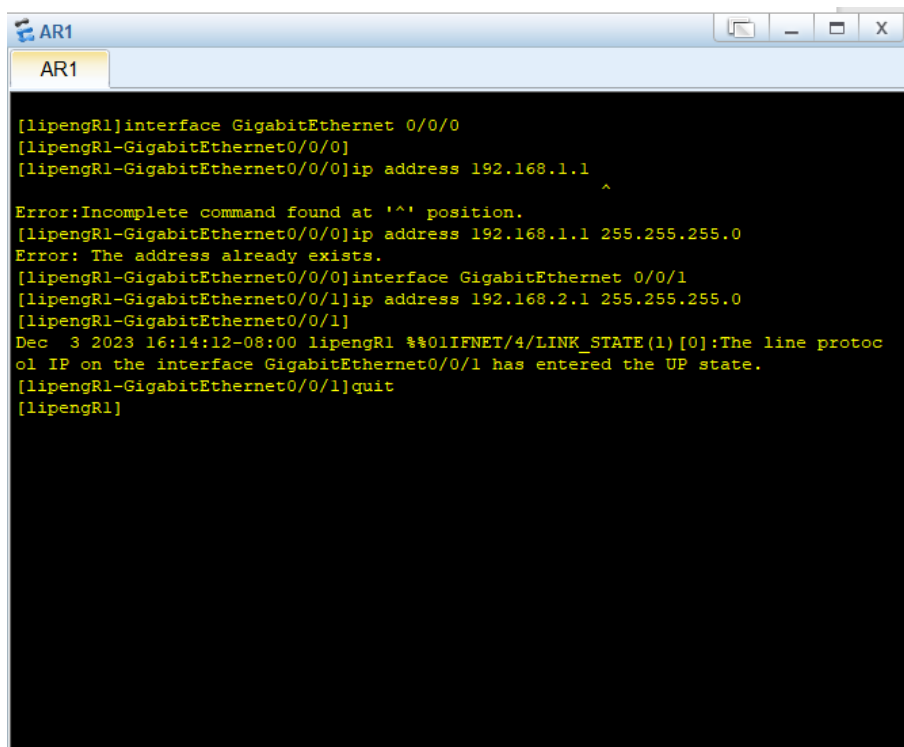


```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname lipengR1
[lipengR1]
[lipengR1]interface GigabitEthernet 0/0/0
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 ^
Error:Incomplete command found at '^' position.
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 255.255.255.0
[lipengR1-GigabitEthernet0/0/0]
Dec 3 2023 16:00:09-08:00 lipengR1 %%01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR1-GigabitEthernet0/0/0]ping 192.168.1.1
  PING 192.168.1.1: 56 data bytes, press CTRL_C to break
    Reply from 192.168.1.1: bytes=56 Sequence=1 ttl=255 time=270 ms
    Reply from 192.168.1.1: bytes=56 Sequence=2 ttl=255 time=1 ms
    Reply from 192.168.1.1: bytes=56 Sequence=3 ttl=255 time=1 ms
    Reply from 192.168.1.1: bytes=56 Sequence=4 ttl=255 time=10 ms
    Reply from 192.168.1.1: bytes=56 Sequence=5 ttl=255 time=1 ms

--- 192.168.1.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 1/56/270 ms

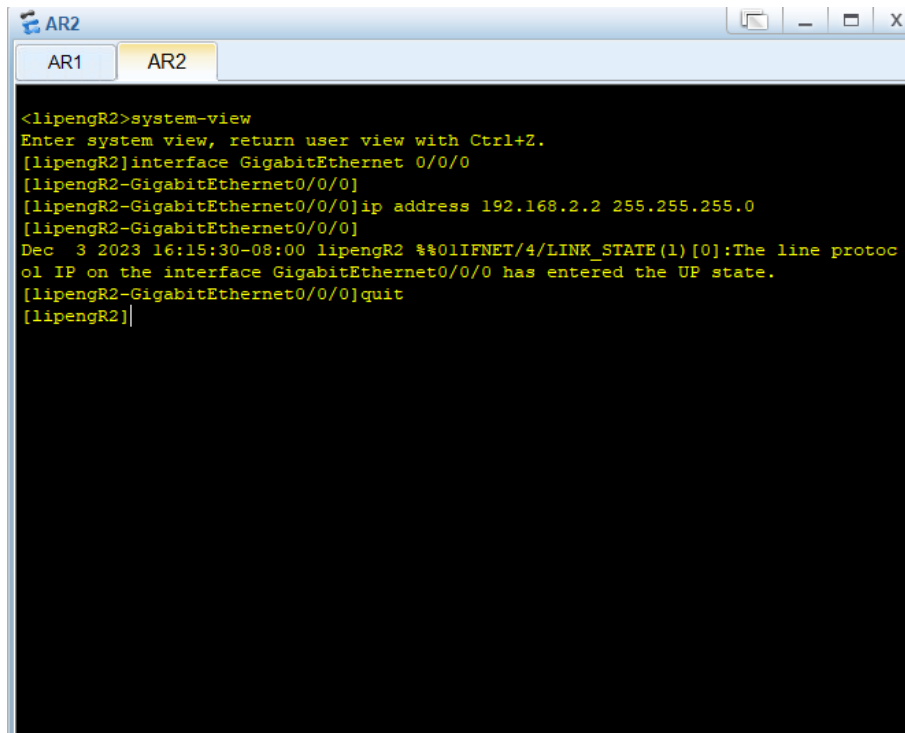
[lipengR1-GigabitEthernet0/0/0]
```

图 38: AR1 ping PC1



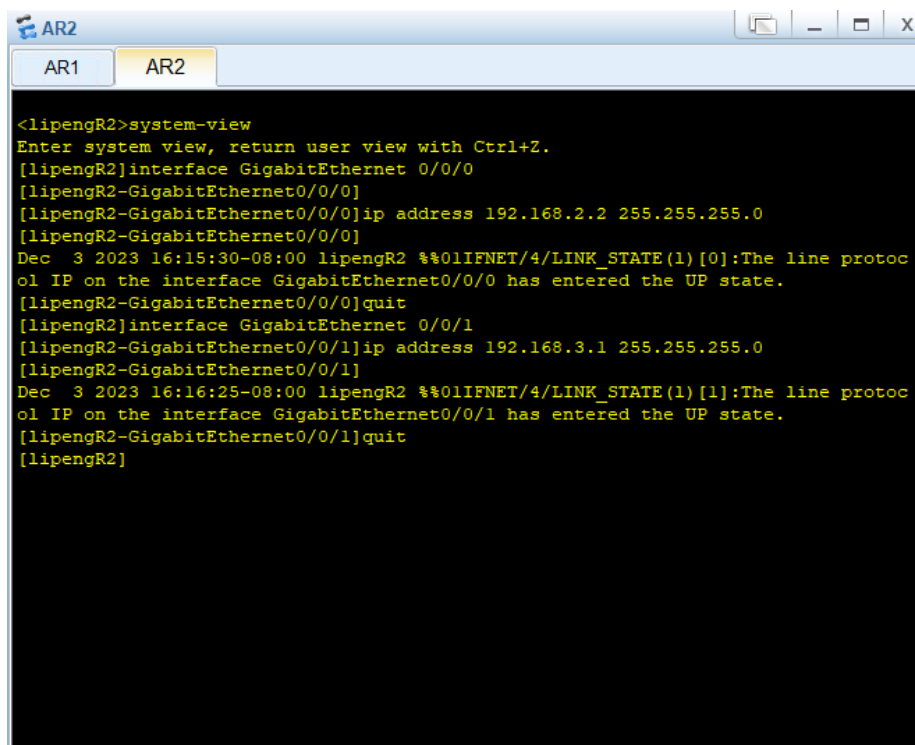
```
[lipengR1]interface GigabitEthernet 0/0/0
[lipengR1-GigabitEthernet0/0/0]
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 ^
Error:Incomplete command found at '^' position.
[lipengR1-GigabitEthernet0/0/0]ip address 192.168.1.1 255.255.255.0
Error: The address already exists.
[lipengR1-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[lipengR1-GigabitEthernet0/0/1]ip address 192.168.2.1 255.255.255.0
[lipengR1-GigabitEthernet0/0/1]
Dec 3 2023 16:14:12-08:00 lipengR1 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.
[lipengR1-GigabitEthernet0/0/1]quit
[lipengR1]
```

图 39: AR1 的 IP 配置



```
<lipengR2>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR2]interface GigabitEthernet 0/0/0
[lipengR2-GigabitEthernet0/0/0]
[lipengR2-GigabitEthernet0/0/0]ip address 192.168.2.2 255.255.255.0
[lipengR2-GigabitEthernet0/0/0]
Dec 3 2023 16:15:30-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR2-GigabitEthernet0/0/0]quit
[lipengR2]
```

图 40: AR2 的 IP 配置



```
<lipengR2>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR2]interface GigabitEthernet 0/0/0
[lipengR2-GigabitEthernet0/0/0]
[lipengR2-GigabitEthernet0/0/0]ip address 192.168.2.2 255.255.255.0
[lipengR2-GigabitEthernet0/0/0]
Dec 3 2023 16:15:30-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[lipengR2-GigabitEthernet0/0/0]quit
[lipengR2]interface GigabitEthernet 0/0/1
[lipengR2-GigabitEthernet0/0/1]ip address 192.168.3.1 255.255.255.0
[lipengR2-GigabitEthernet0/0/1]
Dec 3 2023 16:16:25-08:00 lipengR2 %%01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.
[lipengR2-GigabitEthernet0/0/1]quit
[lipengR2]
```

图 41: AR2 的 IP 配置

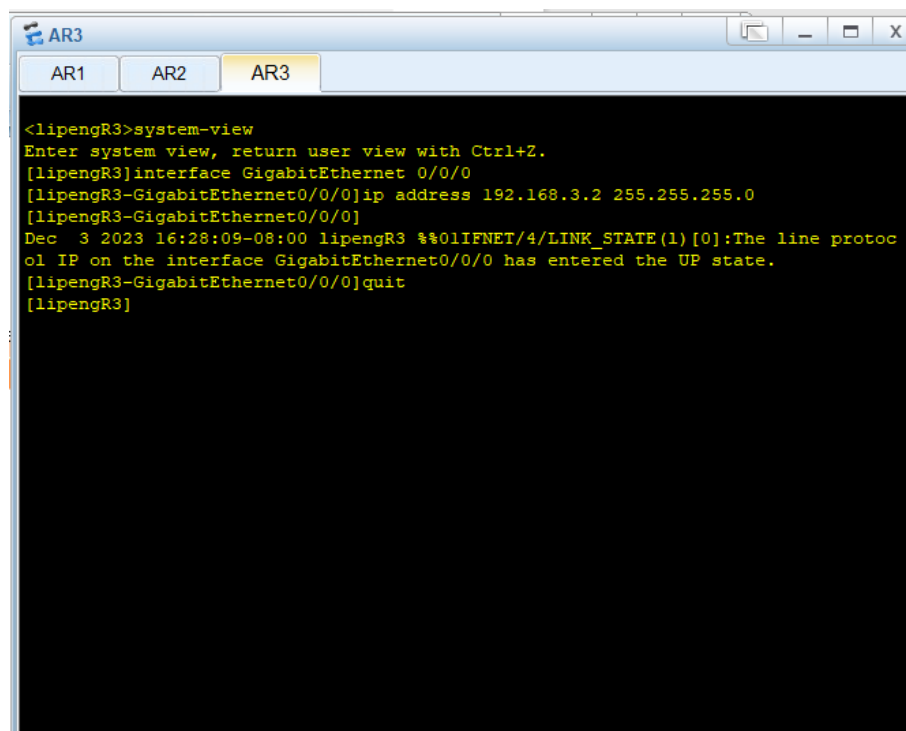


图 42: AR3 的 IP 配置

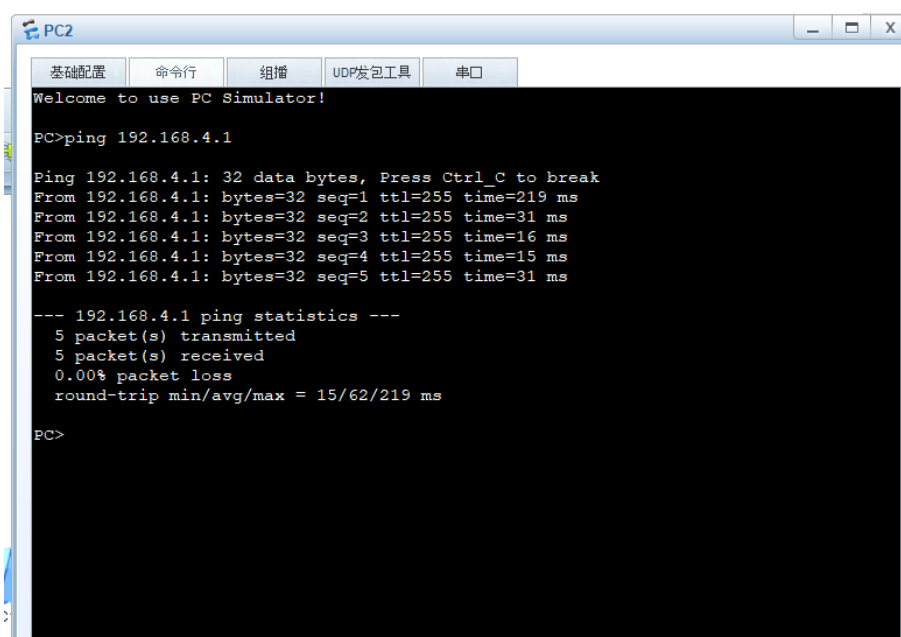
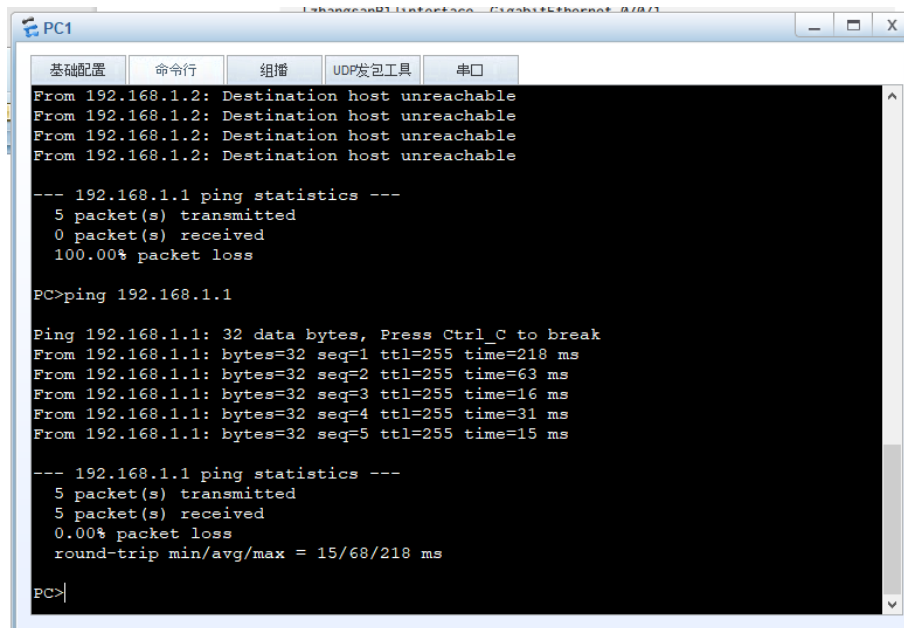


图 43: PC2 ping PC1



The screenshot shows a command window for PC1. The window has tabs for '基础配置', '命令行', '组播', 'UDP发包工具', and '串口'. The '命令行' tab is active. The output shows a failed ping to 192.168.1.2 (Destination host unreachable) and a successful ping to 192.168.1.1. The successful ping statistics show 5 packets transmitted, 5 received, and 0% loss, with a round-trip time of 15/68/218 ms.

```
PC1
基础配置 命令行 组播 UDP发包工具 串口
From 192.168.1.2: Destination host unreachable
From 192.168.1.2: Destination host unreachable
From 192.168.1.2: Destination host unreachable
From 192.168.1.2: Destination host unreachable

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

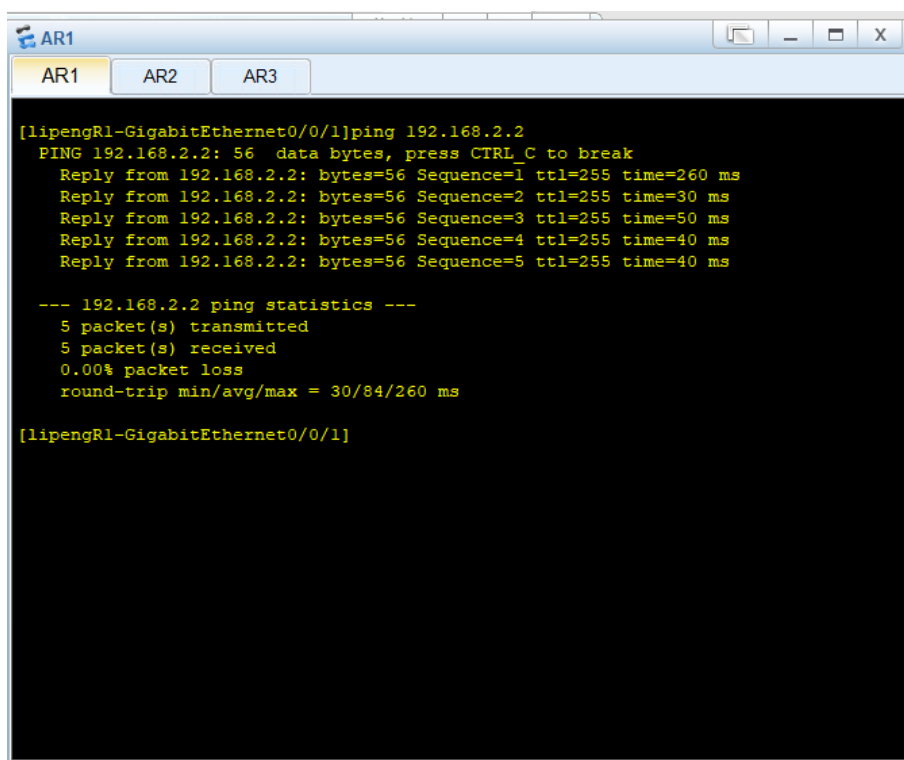
PC>ping 192.168.1.1

Ping 192.168.1.1: 32 data bytes, Press Ctrl_C to break
From 192.168.1.1: bytes=32 seq=1 ttl=255 time=218 ms
From 192.168.1.1: bytes=32 seq=2 ttl=255 time=63 ms
From 192.168.1.1: bytes=32 seq=3 ttl=255 time=16 ms
From 192.168.1.1: bytes=32 seq=4 ttl=255 time=31 ms
From 192.168.1.1: bytes=32 seq=5 ttl=255 time=15 ms

--- 192.168.1.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 15/68/218 ms

PC>
```

图 44: PC1 ping PC2



The screenshot shows a command window for AR1. The window has tabs for 'AR1', 'AR2', and 'AR3'. The 'AR1' tab is active. The output shows a successful ping to 192.168.2.2. The successful ping statistics show 5 packets transmitted, 5 received, and 0% loss, with a round-trip time of 30/84/260 ms.

```
AR1
AR1 AR2 AR3
[lipengR1-GigabitEthernet0/0/1]ping 192.168.2.2
PING 192.168.2.2: 56 data bytes, press CTRL_C to break
  Reply from 192.168.2.2: bytes=56 Sequence=1 ttl=255 time=260 ms
  Reply from 192.168.2.2: bytes=56 Sequence=2 ttl=255 time=30 ms
  Reply from 192.168.2.2: bytes=56 Sequence=3 ttl=255 time=50 ms
  Reply from 192.168.2.2: bytes=56 Sequence=4 ttl=255 time=40 ms
  Reply from 192.168.2.2: bytes=56 Sequence=5 ttl=255 time=40 ms

--- 192.168.2.2 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 30/84/260 ms

[lipengR1-GigabitEthernet0/0/1]
```

图 45: AR1 ping AR2

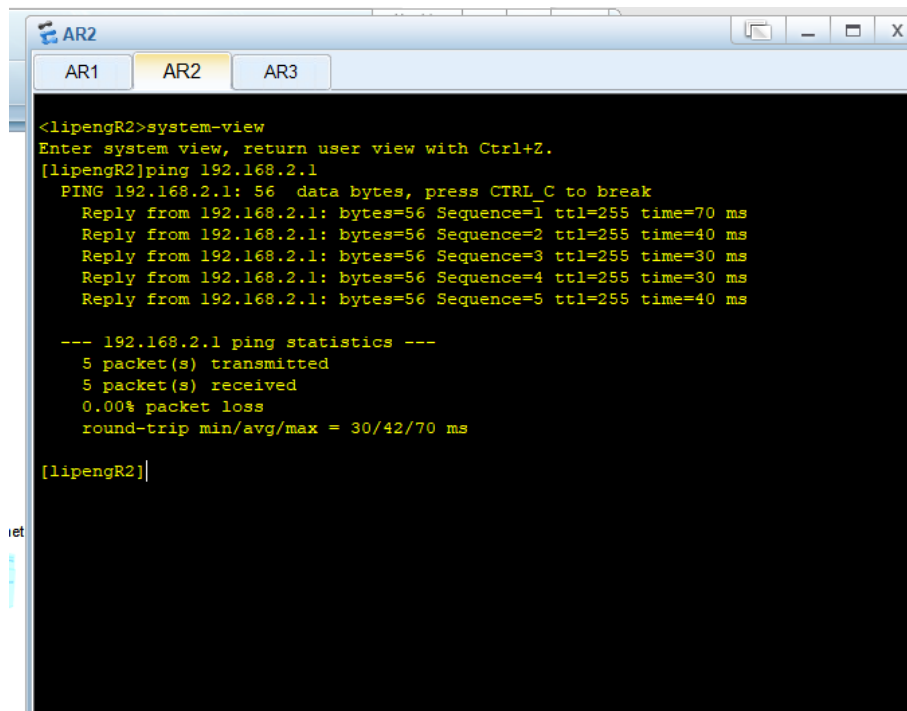


图 46: AR2 ping AR1

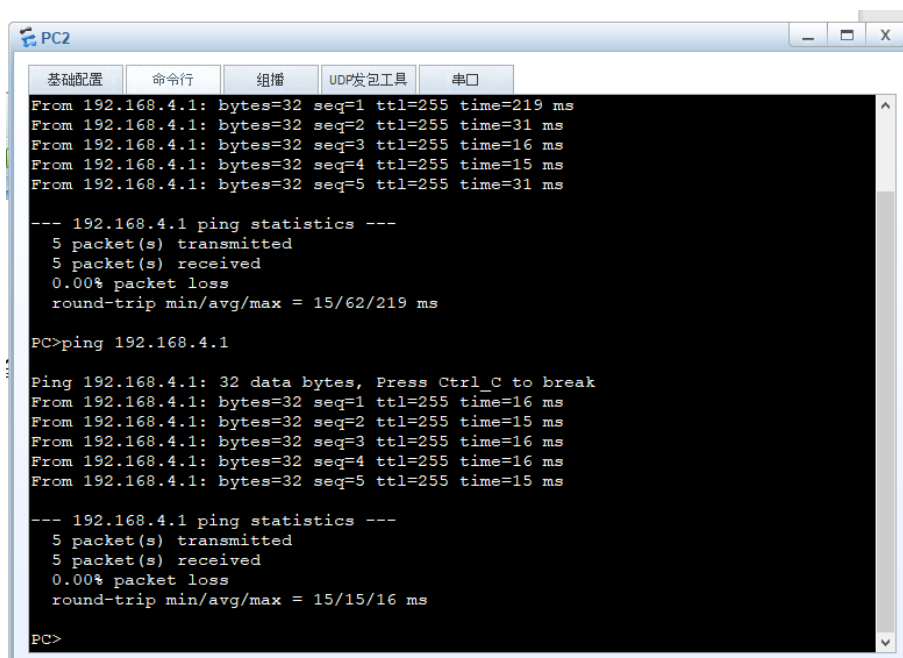


图 47: PC2 ping AR3

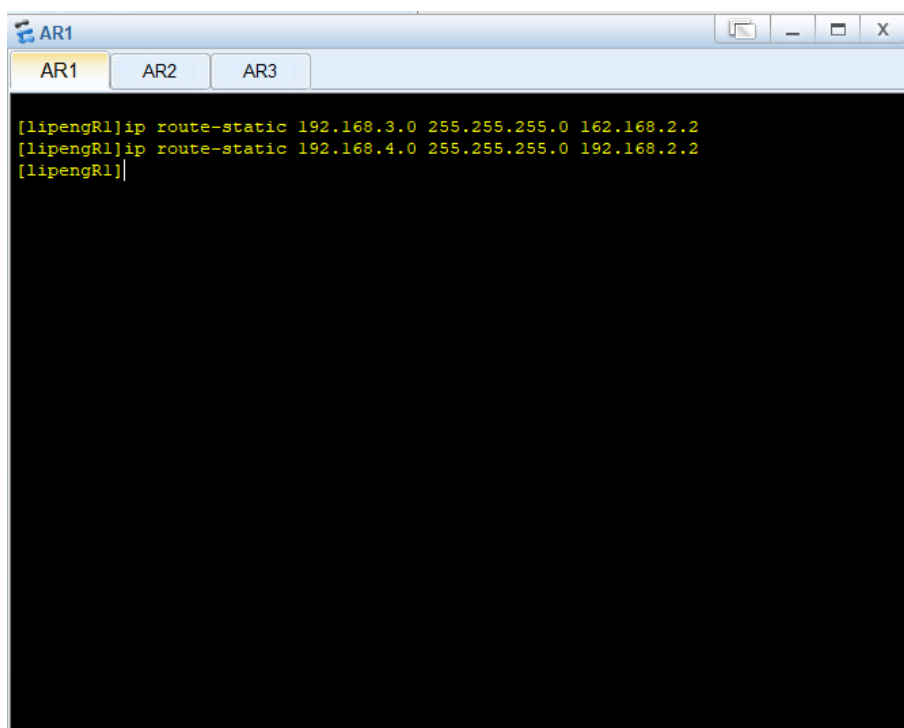


图 48: AR1 的静态路由配置

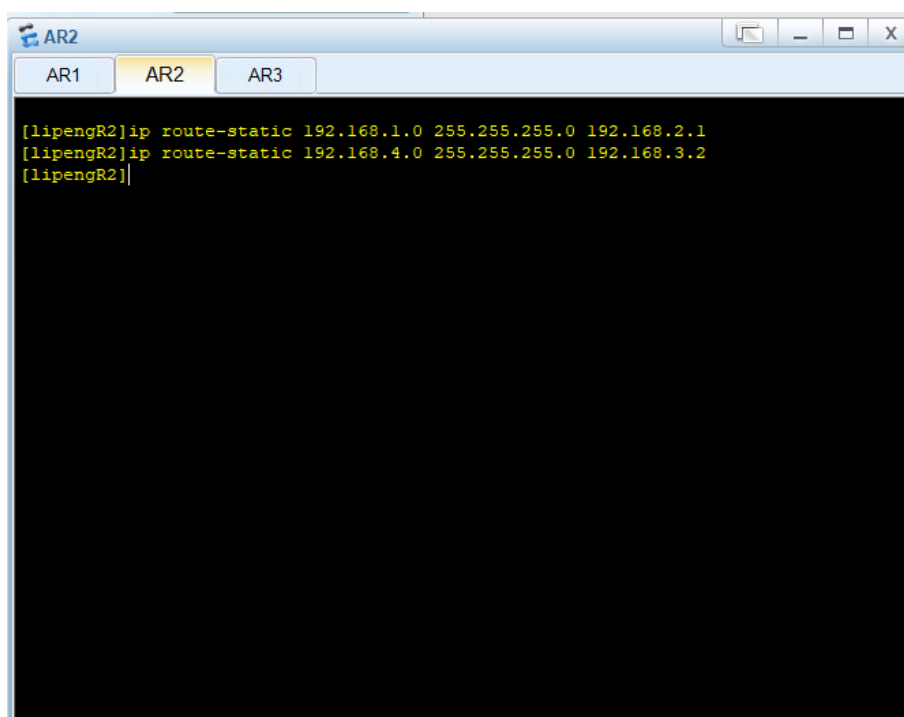


图 49: AR2 的静态路由配置

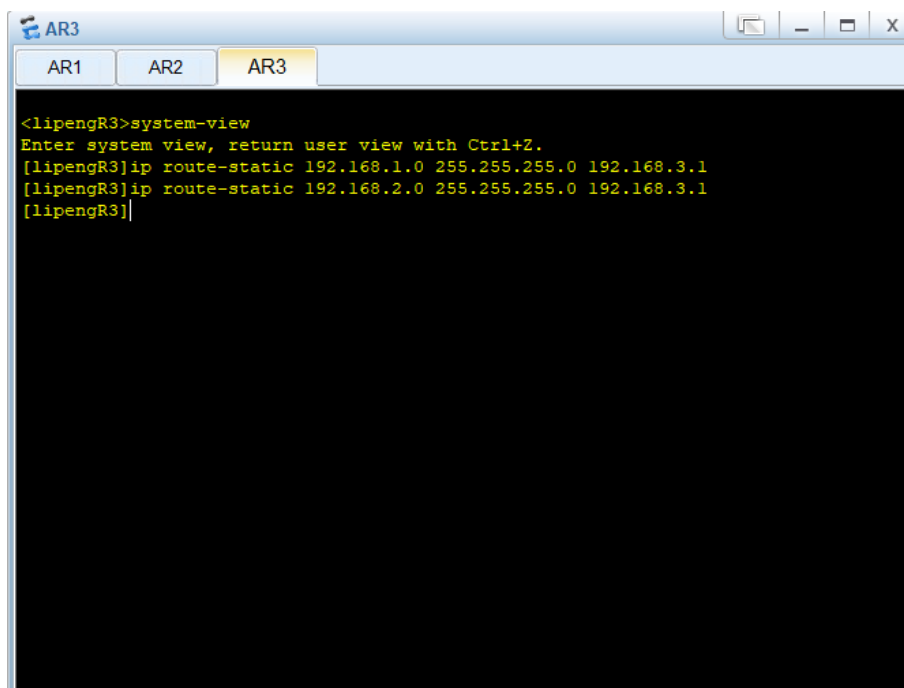


图 50: AR3 的静态路由配置

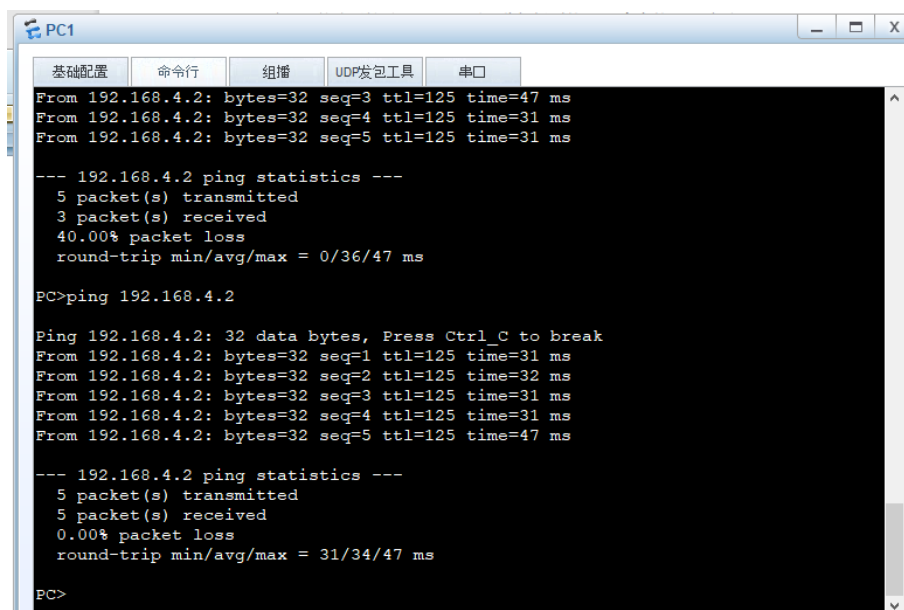
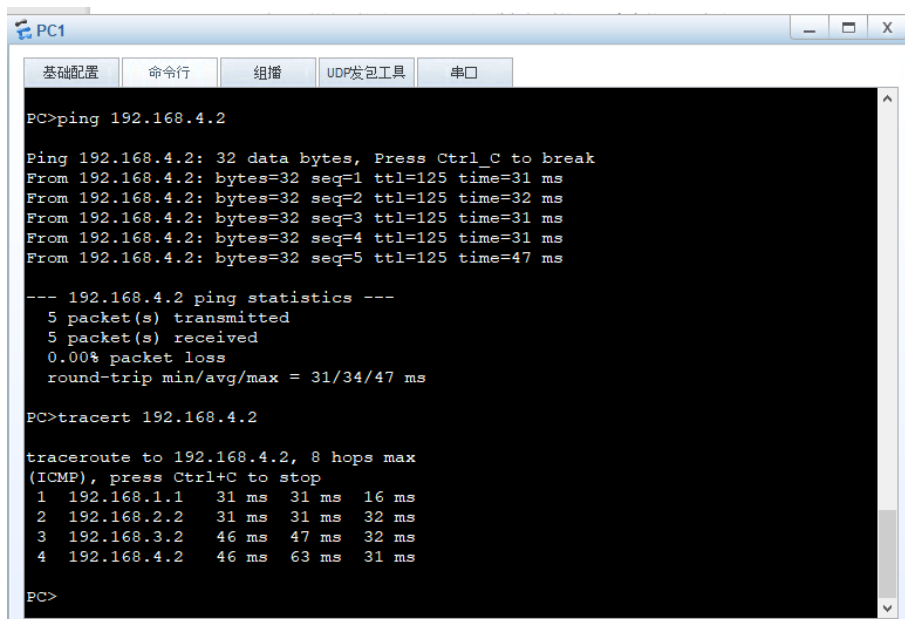


图 51: PC1 ping AR1



```

PC1
基础配置 命令行 组播 UDP发包工具 串口

PC>ping 192.168.4.2

Ping 192.168.4.2: 32 data bytes, Press Ctrl_C to break
From 192.168.4.2: bytes=32 seq=1 ttl=125 time=31 ms
From 192.168.4.2: bytes=32 seq=2 ttl=125 time=32 ms
From 192.168.4.2: bytes=32 seq=3 ttl=125 time=31 ms
From 192.168.4.2: bytes=32 seq=4 ttl=125 time=31 ms
From 192.168.4.2: bytes=32 seq=5 ttl=125 time=47 ms

--- 192.168.4.2 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 31/34/47 ms

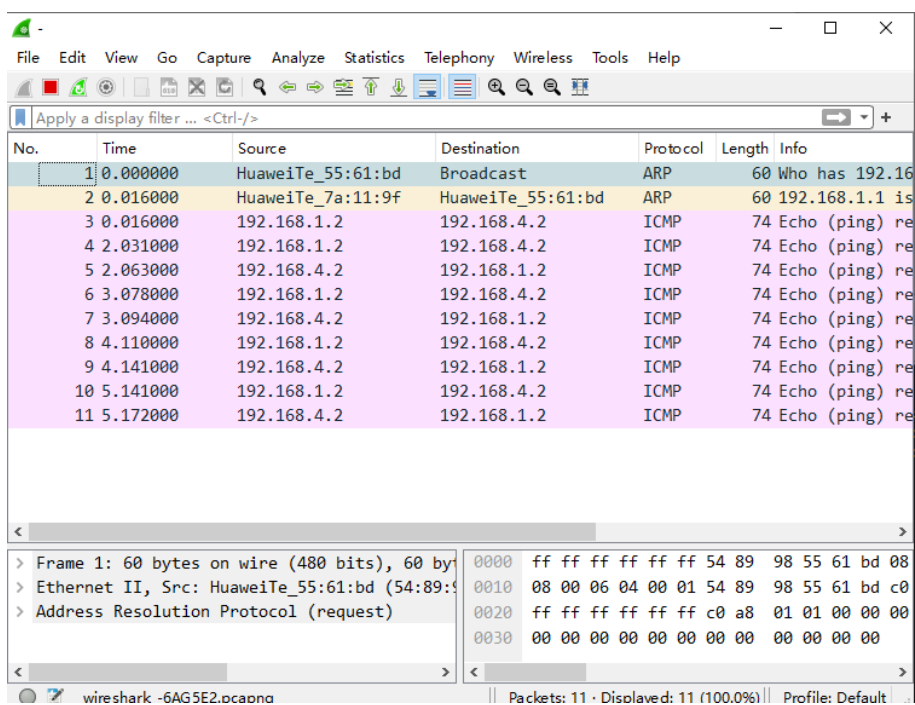
PC>tracert 192.168.4.2

tracert to 192.168.4.2, 8 hops max
(ICMP), press Ctrl+C to stop
 1 192.168.1.1 31 ms 31 ms 16 ms
 2 192.168.2.2 31 ms 31 ms 32 ms
 3 192.168.3.2 46 ms 47 ms 32 ms
 4 192.168.4.2 46 ms 63 ms 31 ms

PC>

```

图 52: PC1 ping AR1



| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|----------|-------------------|-------------------|----------|--------|---|
| 1 | 0.000000 | HuaweiTe_55:61:bd | Broadcast | ARP | 60 | Who has 192.168.4.2? (type 0x0001) from 192.168.1.1 |
| 2 | 0.016000 | HuaweiTe_7a:11:9f | HuaweiTe_55:61:bd | ARP | 60 | 192.168.1.1 is at 55:61:bd:7a:11:9f |
| 3 | 0.016000 | 192.168.1.2 | 192.168.4.2 | ICMP | 74 | Echo (ping) request |
| 4 | 2.031000 | 192.168.1.2 | 192.168.4.2 | ICMP | 74 | Echo (ping) request |
| 5 | 2.063000 | 192.168.4.2 | 192.168.1.2 | ICMP | 74 | Echo (ping) reply |
| 6 | 3.078000 | 192.168.1.2 | 192.168.4.2 | ICMP | 74 | Echo (ping) request |
| 7 | 3.094000 | 192.168.4.2 | 192.168.1.2 | ICMP | 74 | Echo (ping) reply |
| 8 | 4.110000 | 192.168.1.2 | 192.168.4.2 | ICMP | 74 | Echo (ping) request |
| 9 | 4.141000 | 192.168.4.2 | 192.168.1.2 | ICMP | 74 | Echo (ping) reply |
| 10 | 5.141000 | 192.168.1.2 | 192.168.4.2 | ICMP | 74 | Echo (ping) request |
| 11 | 5.172000 | 192.168.4.2 | 192.168.1.2 | ICMP | 74 | Echo (ping) reply |

Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
 Ethernet II, Src: HuaweiTe_55:61:bd (54:89:9f:55:61:bd), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 Address Resolution Protocol (request)

0000 ff ff ff ff ff ff 54 89 98 55 61 bd 08
 0010 08 00 06 04 00 01 54 89 98 55 61 bd c0
 0020 ff ff ff ff ff ff c0 a8 01 01 00 00
 0030 00 00 00 00 00 00 00 00 00 00 00

wireshark -6AG5E2.ocaabnc Packets: 11 · Disposed: 11 (100.0%) Profile: Default

图 53: wireshark 捕获数据包

```

AR1 AR2 AR3

[ispengh1ip route-static 192.168.3.0 255.255.255.0 192.168.2.1
[ispengh1ip route-static 192.168.4.0 255.255.255.0 192.168.2.1
[ispengh1

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

[ispengh1system-view
Rui>system-view, return user view with Ctrl+Z.
[ispengh1]
[ispengh1]rip
[ispengh1]rip [network 192.168.1.0
[ispengh1]rip [network 192.168.3.0
[ispengh1]rip [summary 0.0.0.0
Route Flags: R - relay, D - download to fib

Routing Table: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8        Direct   0       0         D  127.0.0.1             InLoopBack0
127.0.0.0/24       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  192.168.1.1           GigabitEthernet0/0/0
0/0/0
192.168.1.1/32     Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.1.255/32   Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.2.0/24     Direct   0       0         D  192.168.2.1           GigabitEthernet0/0/0
192.168.2.1/32     Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.2.255/32   Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.4.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.4.1/32     Direct   0       0         D  127.0.0.1             InLoopBack0
192.255.255.255/32 Direct   0       0         D  127.0.0.1             InLoopBack0
[ispengh1-rip-1]

```

图 54: AR1 的路由表

```

AR1 AR2 AR3

[ispengh2ip route-static 192.168.1.0 255.255.255.0 192.168.2.1
[ispengh2ip route-static 192.168.4.0 255.255.255.0 192.168.2.1
[ispengh2]

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

[ispengh2system-view
Rui>system-view, return user view with Ctrl+Z.
[ispengh2]
[ispengh2]rip
[ispengh2]rip [network 192.168.1.0
[ispengh2]rip [network 192.168.3.0
[ispengh2]rip [summary 0.0.0.0
Route Flags: R - relay, D - download to fib

Routing Table: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8        Direct   0       0         D  127.0.0.1             InLoopBack0
127.0.0.0/24       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  192.168.2.2           GigabitEthernet0/0/0
0/0/0
192.168.2.0/24     Direct   0       0         D  192.168.2.2           GigabitEthernet0/0/0
192.168.2.2/32     Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.2.255/32   Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.4.0/24     Static   60      80        RD  192.168.2.2           GigabitEthernet0/0/0
192.168.4.1/32     Direct   0       0         D  127.0.0.1             InLoopBack0
192.255.255.255/32 Direct   0       0         D  127.0.0.1             InLoopBack0
[ispengh2-rip-1]

```

图 55: AR2 的路由表

```

[ispengh3system-view
Rui>system-view, return user view with Ctrl+Z.
[ispengh3ip route-static 192.168.1.0 255.255.255.0 192.168.2.1
[ispengh3ip route-static 192.168.2.0 255.255.255.0 192.168.3.1
[ispengh3]

Please check whether system data has been changed, and save data in time
Configuration console time out, please press any key to log on

[ispengh3system-view
Rui>system-view, return user view with Ctrl+Z.
[ispengh3]
[ispengh3]rip
[ispengh3]rip [network 192.168.3.0
[ispengh3]rip [network 192.168.4.0
[ispengh3]rip [summary 0.0.0.0
Route Flags: R - relay, D - download to fib

Routing Table: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre    Cost    Flags NextHop         Interface
-----
127.0.0.0/8        Direct   0       0         D  127.0.0.1             InLoopBack0
127.0.0.0/24       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  192.168.3.1           GigabitEthernet0/0/0
0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.3.1           GigabitEthernet0/0/0
192.168.3.0/24     Static   60      80        RD  192.168.3.1           GigabitEthernet0/0/0
192.168.3.2/32     Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.3.255/32   Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.4.0/24     Static   60      80        RD  192.168.3.1           GigabitEthernet0/0/0
192.168.4.1/32     Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.168.4.255/32   Direct   0       0         D  127.0.0.1             GigabitEthernet0/0/0
192.255.255.255/32 Direct   0       0         D  127.0.0.1             InLoopBack0
[ispengh3-rip-1]

```

图 56: AR3 的路由表

```

(ripengpi-rip-1)show ip route
Route Flags: R -- running, S -- standby, D -- disabled, F -- FIB
Routing Table: IPv4
  Destinations : 12          Routes : 12

Destination/Next      Proto  Pre  Cost      Flags NextHop          Interface
-----
  127.0.0.0/8          Direct 0    0          D  127.0.0.1      InloopBack0
  127.0.0.0/8          Direct 0    0          D  127.0.0.1      InloopBack0
  127.255.255.255/32   Direct 0    0          D  127.0.0.1      InloopBack0
  192.168.1.0/24        Direct 0    0          D  192.168.1.1    GigabitEthernet0/0/0
  192.168.1.1/32       Direct 0    0          D  127.0.0.1      GigabitEthernet0/0/0
  192.168.1.255/32     Direct 0    0          D  127.0.0.1      GigabitEthernet0/0/0
  192.168.2.0/24        Direct 0    0          D  192.168.2.1    GigabitEthernet0/0/1
  192.168.2.1/32       Direct 0    0          D  127.0.0.1      GigabitEthernet0/0/1
  192.168.2.255/32     Direct 0    0          D  127.0.0.1      GigabitEthernet0/0/1
  192.168.3.0/24        Static 60    0          RD  192.168.2.2    GigabitEthernet0/0/1
  192.168.4.0/24        Static 60    0          RD  192.168.2.2    GigabitEthernet0/0/1
  192.255.255.255/32   Direct 0    0          D  127.0.0.1      InloopBack0

(ripengpi-rip-1)

```

图 57: AR1 的路由表

[illegible]

图 58: AR2 的路由表

[illegible]

图 59: AR3 的路由表

图 60: 路由表对比

图 61: 路由表对比

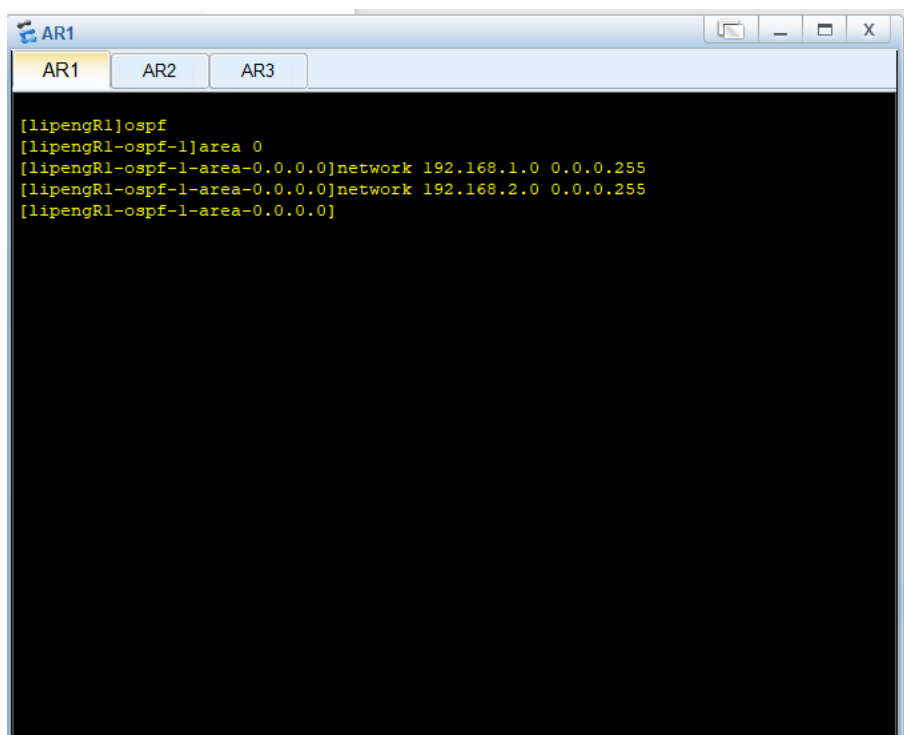


图 62: AR1 的动态路由配置

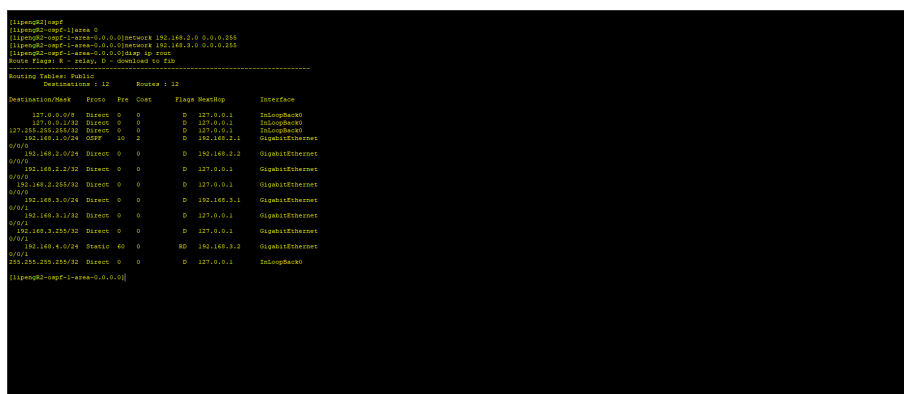


图 63: AR2 的动态路由配置

```
[lipeng@ospf-l-area-0]
[lipeng@ospf-l-area-0.0.0.0]network 192.168.3.0 0.0.0.255
[lipeng@ospf-l-area-0.0.0.0]network 192.168.4.0 0.0.0.255
[lipeng@ospf-l-area-0.0.0.0]quit
Route Flags: R - relay, D - download to fib

Routing Table: Public
Destination: 11
Routes: 12

Destination/Mask Proto Pre Cost Flags NextHop Interface
-----
127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0
127.0.0.0/32 Direct 0 0 D 127.0.0.1 InLoopBack0
127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
0/0/0 0/0/0 OSPF 10 0 D 192.168.3.2 GigabitEthernet0/0/0
192.168.3.0/24 Direct 0 0 D 192.168.3.2 GigabitEthernet0/0/0
192.168.3.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
192.168.3.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
192.168.4.0/24 Direct 0 0 D 192.168.4.1 GigabitEthernet0/0/1
192.168.4.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
192.168.4.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
[lipeng@ospf-l-area-0.0.0.0]
```

图 64: AR2 的动态路由配置

```
AR3
AR1 AR2 AR3
0/0/0
192.168.3.0/24 Direct 0 0 D 192.168.3.2 GigabitEthernet0/0/0
0/0/0
192.168.3.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0
192.168.3.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
0/0/0
192.168.4.0/24 Direct 0 0 D 192.168.4.1 GigabitEthernet0/0/1
0/0/1
192.168.4.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1
192.168.4.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1
0/0/1
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

[lipengR3-ospf-1-area-0.0.0.0]ping 192.168.1.2
PING 192.168.1.2: 56 data bytes, press CTRL_C to break
Reply from 192.168.1.2: bytes=56 Sequence=1 ttl=126 time=150 ms
Reply from 192.168.1.2: bytes=56 Sequence=2 ttl=126 time=30 ms
Reply from 192.168.1.2: bytes=56 Sequence=3 ttl=126 time=50 ms
Reply from 192.168.1.2: bytes=56 Sequence=4 ttl=126 time=60 ms
Reply from 192.168.1.2: bytes=56 Sequence=5 ttl=126 time=50 ms

--- 192.168.1.2 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 30/68/150 ms

[lipengR3-ospf-1-area-0.0.0.0]
```

图 65: AR3 的动态路由配置


```

<lipengR1>system-view
Enter system view, return user view with Ctrl+Z.
[lipengR1]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto   Pre  Cost   Flags NextHop         Interface
-----
      127.0.0.0/8     Direct  0     0       D   127.0.0.1       InLoopBack0
      127.0.0.1/32     Direct  0     0       D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0     0       D   127.0.0.1       InLoopBack0
      192.168.1.0/24   Direct  0     0       D   192.168.1.1     GigabitEthernet
0/0/0
      192.168.1.1/32   Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.1.255/32 Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.2.0/24   Direct  0     0       D   192.168.2.1     GigabitEthernet
0/0/1
      192.168.2.1/32   Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.2.255/32 Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.3.0/24   OSPF    10    2       D   192.168.2.2     GigabitEthernet
0/0/1
      192.168.4.0/24   OSPF    10    3       D   192.168.2.2     GigabitEthernet
0/0/1
255.255.255.255/32   Direct  0     0       D   127.0.0.1       InLoopBack0

[lipengR1]

```

图 66: AR3 的动态路由配置

```

[lipengR3]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 12          Routes : 12

Destination/Mask    Proto   Pre  Cost   Flags NextHop         Interface
-----
      127.0.0.0/8     Direct  0     0       D   127.0.0.1       InLoopBack0
      127.0.0.1/32     Direct  0     0       D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0     0       D   127.0.0.1       InLoopBack0
      192.168.1.0/24   OSPF    10    3       D   192.168.3.1     GigabitEthernet
0/0/0
      192.168.2.0/24   OSPF    10    2       D   192.168.3.1     GigabitEthernet
0/0/0
      192.168.3.0/24   Direct  0     0       D   192.168.3.2     GigabitEthernet
0/0/0
      192.168.3.2/32   Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.3.255/32 Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/0
      192.168.4.0/24   Direct  0     0       D   192.168.4.1     GigabitEthernet
0/0/1
      192.168.4.1/32   Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/1
      192.168.4.255/32 Direct  0     0       D   127.0.0.1       GigabitEthernet
0/0/1
255.255.255.255/32   Direct  0     0       D   127.0.0.1       InLoopBack0

[lipengR3]

```

图 67: AR3 的动态路由配置

```

[lipengR2-ospf-1-area-0.0.0.0]quit
[lipengR2-ospf-1]quit
[lipengR2]disp ip rout
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
      Destinations : 12          Routes : 12

Destination/Mask    Proto    Pre  Cost           Flags NextHop         Interface
-----
      127.0.0.0/8     Direct   0     0             D    127.0.0.1         InLoopBack0
      127.0.0.1/32     Direct   0     0             D    127.0.0.1         InLoopBack0
127.255.255.255/32   Direct   0     0             D    127.0.0.1         InLoopBack0
      192.168.1.0/24   OSPF     10    2             D    192.168.2.1       GigabitEthernet
0/0/0
      192.168.2.0/24   Direct   0     0             D    192.168.2.2       GigabitEthernet
0/0/0
      192.168.2.2/32   Direct   0     0             D    127.0.0.1         GigabitEthernet
0/0/0
      192.168.2.255/32 Direct   0     0             D    127.0.0.1         GigabitEthernet
0/0/0
      192.168.3.0/24   Direct   0     0             D    192.168.3.1       GigabitEthernet
0/0/1
      192.168.3.1/32   Direct   0     0             D    127.0.0.1         GigabitEthernet
0/0/1
      192.168.3.255/32 Direct   0     0             D    127.0.0.1         GigabitEthernet
0/0/1
      192.168.4.0/24   OSPF     10    2             D    192.168.3.2       GigabitEthernet
0/0/1
255.255.255.255/32   Direct   0     0             D    127.0.0.1         InLoopBack0

[lipengR2]Z

```

图 68: 路由表对比