



南开大学  
Nankai University

# 《计算机网络》实验报告

(2022~2023 学年第一学期)

实验名称：静态路由与动态路由

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2022 年 12 月 6

# 实验名称 (实验 3:静态路由与动态路由)

## 1 实验目的

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。

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。

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。

## 2 实验条件

设备：PC 机一台，连入局域网

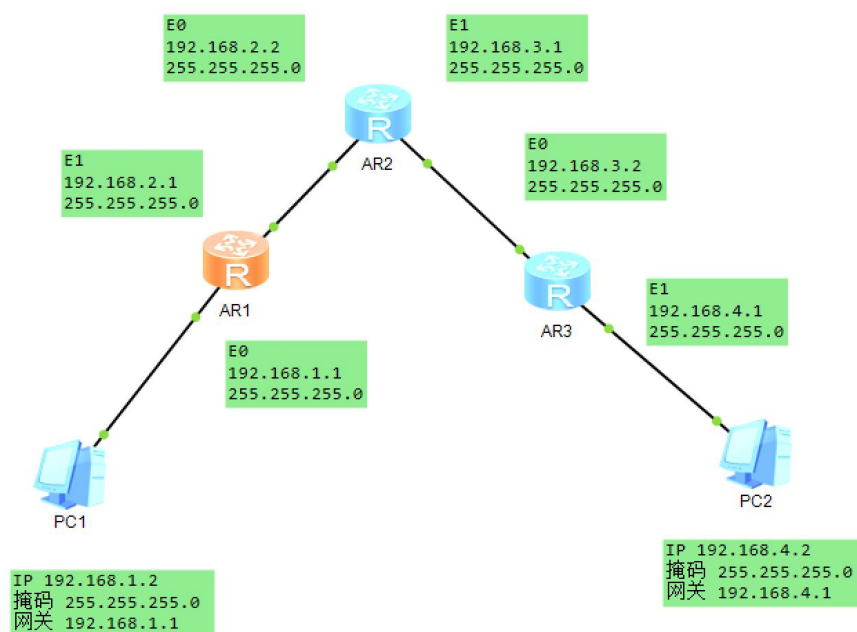
所用工具：VirtualBox、Wireshark、eNSP、WinPcap

## 3 实验报告内容及原理

### 3、1 静态路由

1)、硬件连接，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。

2)、为PC1、PC2分别设置IP地址、掩码和网关。



3)、使用sysname命令为三个路由器命名。路由器R1的名称为学生自己的姓名拼音+R1, 路由器R2的名称为学生自己的姓名拼音+R2, 路由器R3的名称为学生自己的姓名拼音+R3。

命令（以R1为例）：

sys

Sysname ywxR1

```
AR1
The device is running!
#####
<Huawei>
Nov 21 2022 19:55:58-08:00 Huawei %%01IFPDT/4/IF_STATE(1)[0]:Interface GigabitEthernet0/0/0 has turned into UP state.
<Huawei>
Nov 21 2022 19:55:58-08:00 Huawei %%01IFPDT/4/IF_STATE(1)[1]:Interface GigabitEthernet0/0/1 has turned into UP state.
<Huawei>sys
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname ywxR1
[ywxR1]
```

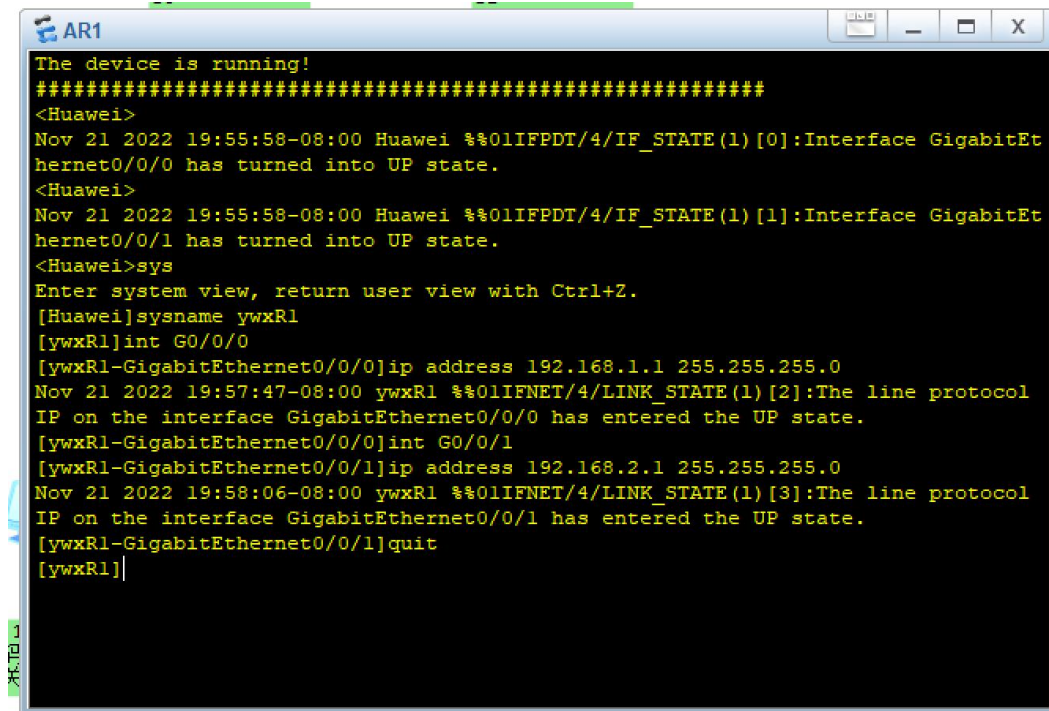
4)、为路由器R1的两个接口配置IP地址。配置完成后PC1应该可以Ping通R1

的E0口的地址。要求记录输入的命令和输出。

命令:

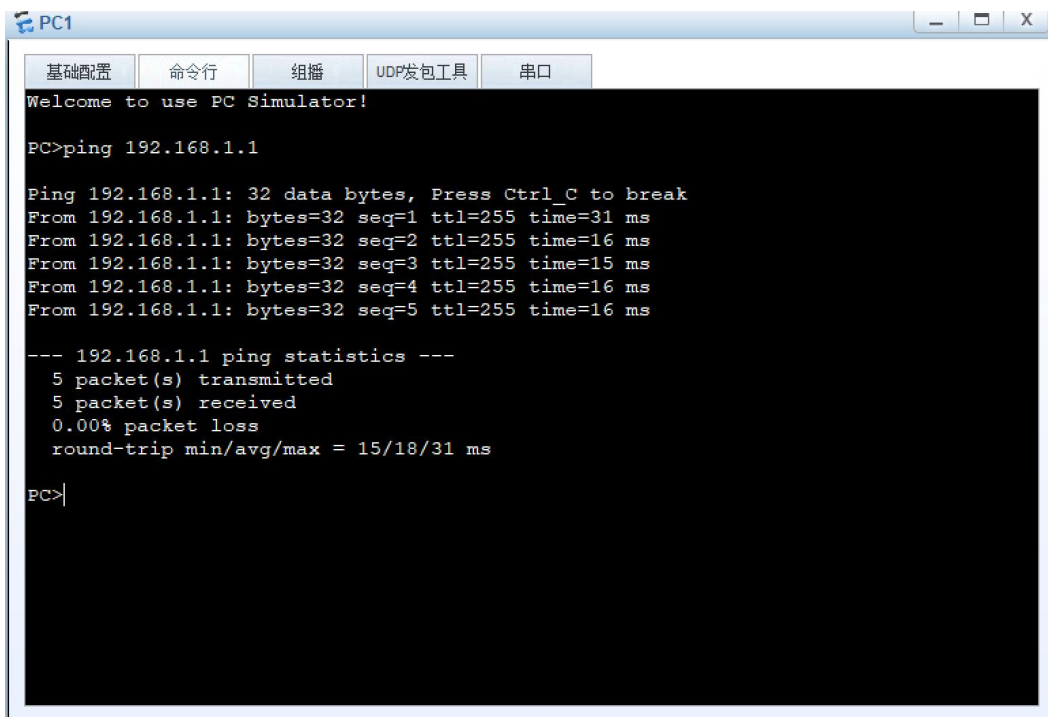
int G0/0/0

Ip address 192.168.1.1 255.255.255.0



```
AR1
The device is running!
#####
<Huawei>
Nov 21 2022 19:55:58-08:00 Huawei %01IFPDT/4/IF_STATE(1)[0]:Interface GigabitEthernet0/0/0 has turned into UP state.
<Huawei>
Nov 21 2022 19:55:58-08:00 Huawei %01IFPDT/4/IF_STATE(1)[1]:Interface GigabitEthernet0/0/1 has turned into UP state.
<Huawei>sys
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname ywxR1
[ywxR1]int G0/0/0
[ywxR1-GigabitEthernet0/0/0]ip address 192.168.1.1 255.255.255.0
Nov 21 2022 19:57:47-08:00 ywxR1 %01IFNET/4/LINK_STATE(1)[2]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.
[ywxR1-GigabitEthernet0/0/0]int G0/0/1
[ywxR1-GigabitEthernet0/0/1]ip address 192.168.2.1 255.255.255.0
Nov 21 2022 19:58:06-08:00 ywxR1 %01IFNET/4/LINK_STATE(1)[3]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.
[ywxR1-GigabitEthernet0/0/1]quit
[ywxR1]|
```

5)、执行ping命令，检查是否连通



```
PC1
Welcome to use PC Simulator!

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=31 ms
From 192.168.1.1: bytes=32 seq=2 ttl=255 time=16 ms
From 192.168.1.1: bytes=32 seq=3 ttl=255 time=15 ms
From 192.168.1.1: bytes=32 seq=4 ttl=255 time=16 ms
From 192.168.1.1: bytes=32 seq=5 ttl=255 time=16 ms

--- 192.168.1.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 15/18/31 ms

PC>|
```

6)、为三个路由器分别从左至右配置静态路由。配置后可以用`disp cur`检查配置,或者`disp ip route`检查路由表。要求记录输入的命令和输出

命令: `ip route-static 192.168.3.0 255.255.255.0 192.168.2.2`

```
AR1
sys
Enter system view, return user view with Ctrl+Z.
[ywxR1]ip route-static 192.168.3.0 255.255.255.0 192.168.2.2
[ywxR1]ip route-static 192.168.4.0 255.255.255.0 192.168.2.2
[ywxR1]disp cur
[V200R003C00]
#
sysname ywxR1
#
snmp-agent local-engineid 800007DB03000000000000
snmp-agent
#
clock timezone China-Standard-Time minus 08:00:00
#
portal local-server load portalpage.zip
#
drop illegal-mac alarm
#
set cpu-usage threshold 80 restore 75
#
aaa
authentication-scheme default
authorization-scheme default
accounting-scheme default
domain default
domain default_admin
local-user admin password cipher %$%K$m.Nt84DZ)e#<0`8bmE3Uw)%$%$
local-user admin service-type http
#
firewall zone Local
priority 15
#
interface GigabitEthernet0/0/0
ip address 192.168.1.1 255.255.255.0
#
interface GigabitEthernet0/0/1
ip address 192.168.2.1 255.255.255.0
#
interface GigabitEthernet0/0/2
#
interface NULL0
#
ip route-static 192.168.3.0 255.255.255.0 192.168.2.2
ip route-static 192.168.4.0 255.255.255.0 192.168.2.2
#
```

7)、如配置正确,此时网络收敛,则任何两点之间(含非直连)均可ping通,分别使用ping命令和traceRT命令来验证。

```
PC1
基础配置  命令行  组播  UDP发包工具  串口
From 192.168.4.2: bytes=32 seq=2 ttl=125 time=16 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=16 ms
From 192.168.4.2: bytes=32 seq=5 ttl=125 time=31 ms

--- 192.168.4.2 ping statistics ---
 5 packet(s) transmitted
 4 packet(s) received
20.00% packet loss
round-trip min/avg/max = 0/23/31 ms

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=16 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=16 ms

--- 192.168.4.2 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
round-trip min/avg/max = 16/25/31 ms

PC>
```

```

PC1
基础配置  命令行  组播  UDP发包工具  串口

--- 192.168.4.2 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 16/25/31 ms

PC>traceRT 192.168.4.2

traceroute to 192.168.4.2, 8 hops max
(ICMP), press Ctrl+C to stop
 1  192.168.1.1    31 ms  <1 ms  16 ms
 2  192.168.2.2    16 ms  15 ms  31 ms
 3  192.168.3.2    32 ms  15 ms  16 ms
 4  192.168.4.2    16 ms  31 ms  15 ms

PC>traceRT 192.168.4.2

traceroute to 192.168.4.2, 8 hops max
(ICMP), press Ctrl+C to stop
 1  192.168.1.1    15 ms  16 ms  <1 ms
 2  192.168.2.2    15 ms  16 ms  16 ms
 3  192.168.3.2    15 ms  16 ms  16 ms
 4  192.168.4.2    31 ms  15 ms  16 ms

PC>

```

8) (选做)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。再使用Ping命令测试到PC2的连通性。分析抓到的ping命令的icmp报文。

3.11ICMP.pcapng

文件(F) 编辑(E) 视图(V) 跳转(G) 捕获(C) 分析(A) 统计(S) 电话(Y) 无线(W) 工具(T) 帮助(H)

icmp

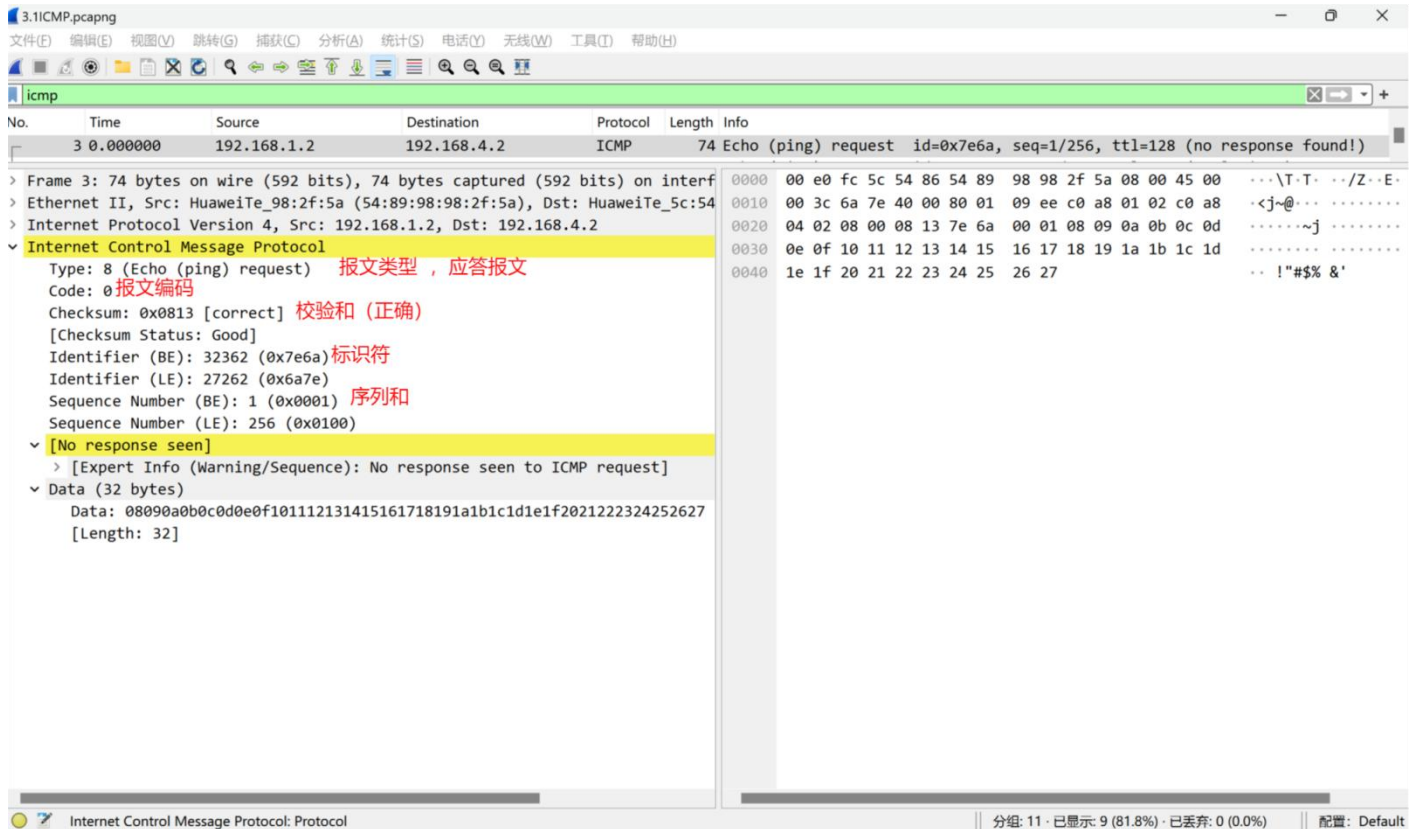
No.	Time	Source	Destination	Protocol	Length	Info
3	0.000000	192.168.1.2	192.168.4.2	ICMP	74	Echo (ping) request id=0x7e6a, seq=1/256, ttl=128 (no response found!)
4	2.015000	192.168.1.2	192.168.4.2	ICMP	74	Echo (ping) request id=0x806a, seq=2/512, ttl=128 (reply in 5)
5	2.031000	192.168.4.2	192.168.1.2	ICMP	74	Echo (ping) reply id=0x806a, seq=2/512, ttl=125 (request in 4)
6	3.031000	192.168.1.2	192.168.4.2	ICMP	74	Echo (ping) request id=0x816a, seq=3/768, ttl=128 (reply in 7)
7	3.047000	192.168.4.2	192.168.1.2	ICMP	74	Echo (ping) reply id=0x816a, seq=3/768, ttl=125 (request in 6)
8	4.047000	192.168.1.2	192.168.4.2	ICMP	74	Echo (ping) request id=0x826a, seq=4/1024, ttl=128 (reply in 9)
9	4.078000	192.168.4.2	192.168.1.2	ICMP	74	Echo (ping) reply id=0x826a, seq=4/1024, ttl=125 (request in 8)
10	5.078000	192.168.1.2	192.168.4.2	ICMP	74	Echo (ping) request id=0x836a, seq=5/1280, ttl=128 (reply in 11)
11	5.109000	192.168.4.2	192.168.1.2	ICMP	74	Echo (ping) reply id=0x836a, seq=5/1280, ttl=125 (request in 10)

Internet Control Message Protocol: Protocol

分组: 11 · 已显示: 9 (81.8%) · 已丢弃: 0 (0.0%)

配置: Default

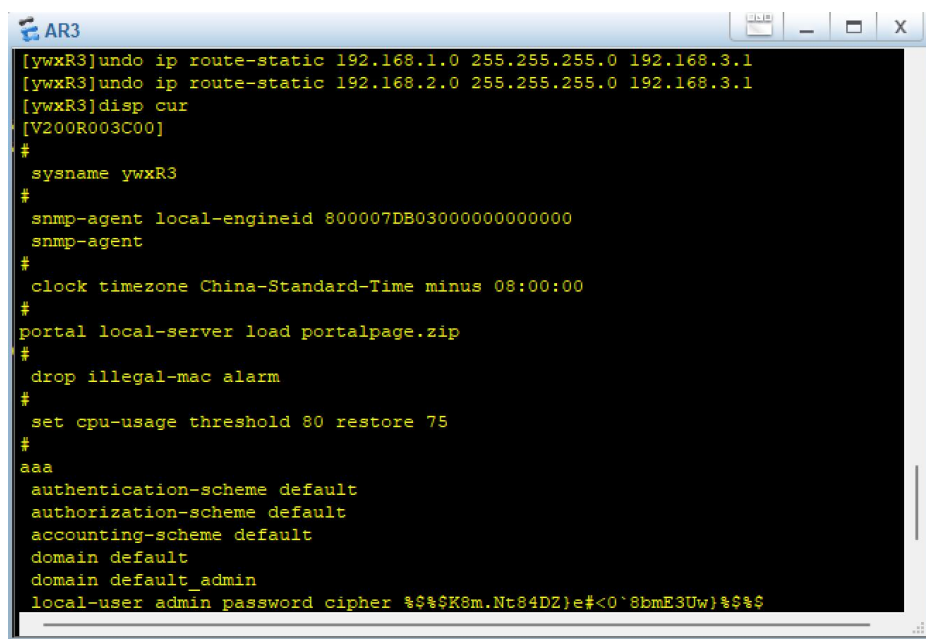




### 3、2 动态路由（RIP）（接在3.1后继续进行）

1）、为3个路由器配置动态路由协议rip, 首先删除原来的静态路由配置。配置后可以用display current configuration检查配置，或者display ip routing-table检查路由表。

删除路由命令：undo ip route-static 192.168.1.0 255.255.255.0 192.168.3.1



添加rip命令:

rip

network 192.168.1.0

network 192.168.2.0

```

AR1
[ywxR1]rip
[ywxR1-rip-1]network 192.168.1.0
[ywxR1-rip-1]network 192.168.2.0
[ywxR1-rip-1]disp cur
[V200R003C00]
#
sysname ywxR1
#
snmp-agent local-engineid 800007DB03000000000000
snmp-agent
#
clock timezone China-Standard-Time minus 08:00:00
#
portal local-server load portalpage.zip
#
drop illegal-mac alarm
#
set cpu-usage threshold 80 restore 75
#
aaa
authentication-scheme default
authorization-scheme default
accounting-scheme default
domain default
domain default_admin
local-user admin password cipher %K6m.Nt84DZ)e#<0`8bmE3Uw)%$%$
local-user admin service-type http
#
firewall zone Local
priority 15
#
interface GigabitEthernet0/0/0
ip address 192.168.1.1 255.255.255.0
#
interface GigabitEthernet0/0/1
ip address 192.168.2.1 255.255.255.0
#
interface GigabitEthernet0/0/2
#
interface NULL0
#
rip 1
network 192.168.1.0
network 192.168.2.0

```

2)、为3个路由器分别配置动态路由协议rip。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。

AR1:

```

[ywxR1-rip-1]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
-----
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      RIP      100     1        D  192.168.2.2         GigabitEthernet
0/0/1
192.168.4.0/24      RIP      100     2        D  192.168.2.2         GigabitEthernet
0/0/1
255.255.255.255/32  Direct   0       0        D  127.0.0.1           InLoopBack0
[ywxR1-rip-1]

```



AR2:

```
[ywxR2-rip-1]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
-----
      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   RIP      100    1             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   RIP      100    1             D    192.168.3.2         GigabitEthernet
0/0/1
255.255.255.255/32   Direct   0     0             D    127.0.0.1           InLoopBack0

[ywxR2-rip-1]
```

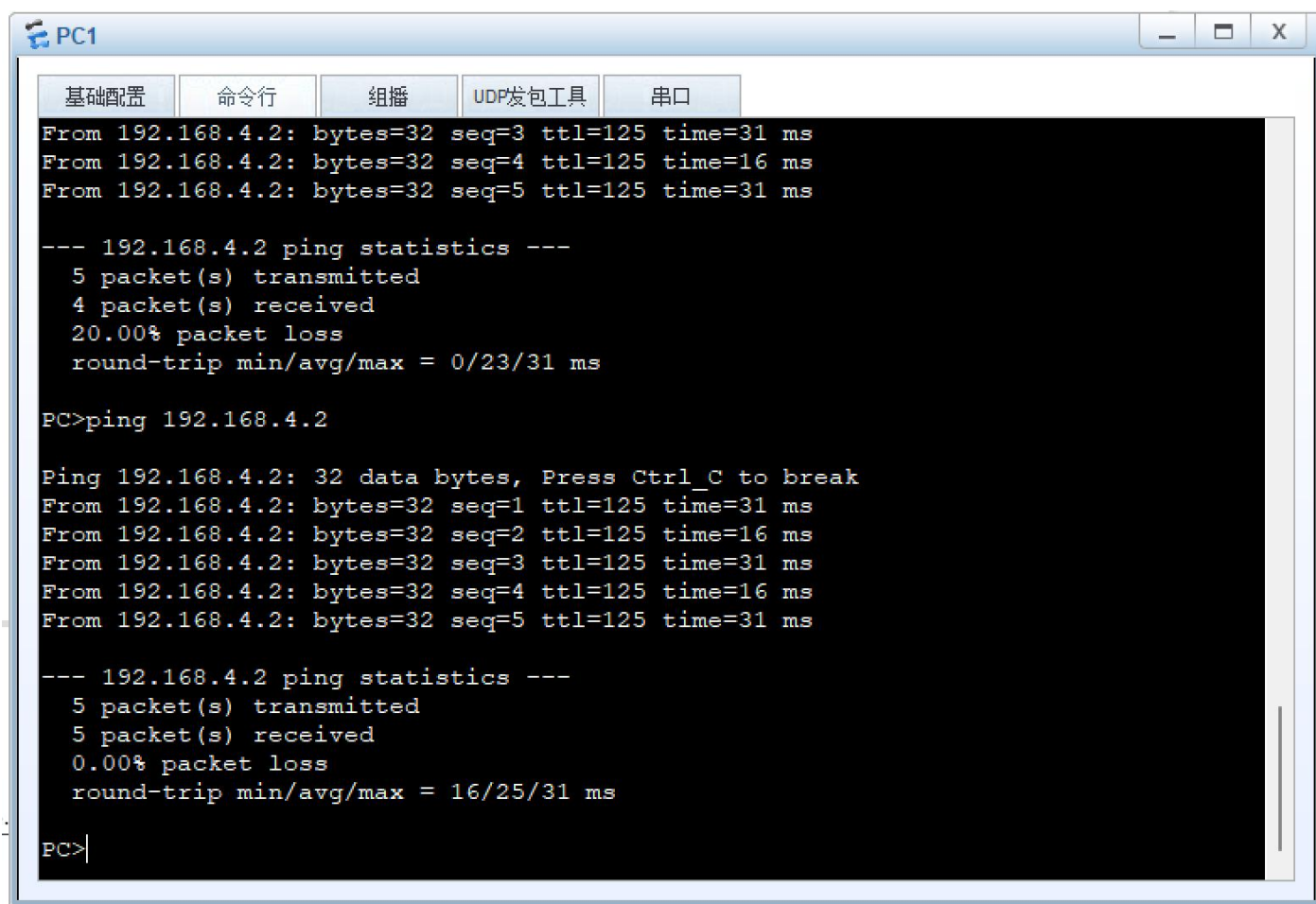
AR3:

```
[ywxR3-rip-1]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
-----
      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   RIP      100    2             D    192.168.3.1         GigabitEthernet
0/0/0
      192.168.2.0/24   RIP      100    1             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

[ywxR3-rip-1]
```

## 3) PC1对PC2进行ping命令, 查看是否能ping通



### 3.3 动态路由 (ospf)

4)、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。配置后可以用display current configuration检查配置, 或者display ip routing-table检查路由表。

删除路由命令: undo rip 1 (注意计算机自动分配rip 1)

5)、为3个路由器分别配置动态路由协议ospf。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。

添加ospf命令: ospf

area 0

network 192.168.3.0 0.0.0.255

network 192.168.4.0 0.0.0.255

AR1:

```

[ywxR1]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
-----
      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

[ywxR1]

```

AR2:

```

[ywxR2]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
-----
      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

[ywxR2]

```

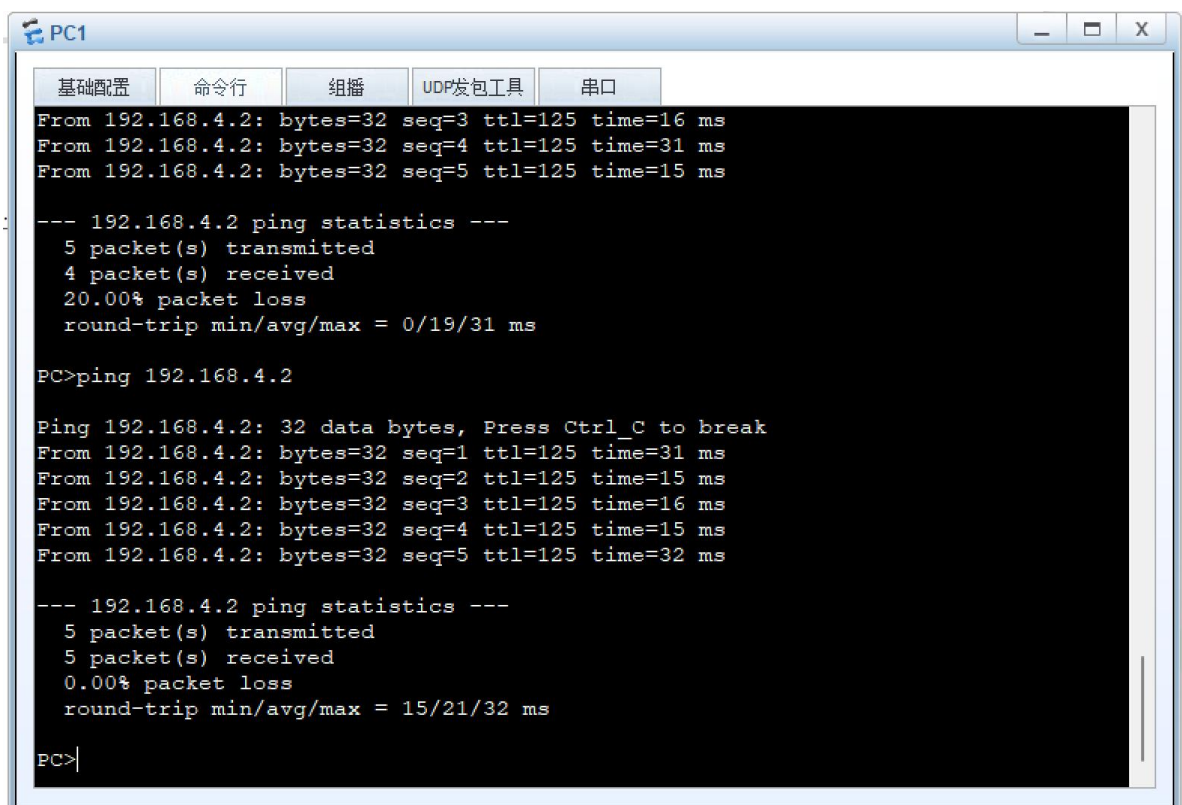
AR3:

```
[ywxR3]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
-----
 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

[ywxR3]
```

6) PC1对PC2进行ping命令, 查看是否能ping通



## 4 实验结论及心得体会

此次实验，最终进行了两次才成功，第一次实验，在进行ping命令的时候，最终没有ping成功，怀疑是某个路由的接口设置错误，最终，重新画了一次拓扑图，但是这样比较浪费精力。在第二次中，同样出现了ping不通的问题，但是这次，通过，每一个连接的路由分别ping其旁边的路由，来通过查看是否能ping通，再辅以通过命令disp cur，来查看路由的详细信息，就可以发现最终问题在哪个路由的设置上了，那么就可以通过该一个路由来解决问题，这样就大大提高了改错的效率。