Practical work 4: Network topology and routing

Fixed Problems

According to the feedback, I tried to fix the following problems: firstly, the answer of the difference between a /24 and a /30 subnet is updated. For the second problem, I misunderstood the question before. Now all routing options are set up with different metrics, and the loop-back is deleted. Besides, the calculation for losing packets is added. The remaining problems are caused by careless writing, the “no shuo” in VG-task 1 and the RIP in problem four are fixed for this document. The changes are stated after the Network configuration.

Network configuration

Router 1

Console Command

```
conf t
int f0/0
ip address 10.1.1.1 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end

conf t
int f0/1
ip address 20.1.1.1 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end

conf t
int f1/0
ip address 40.1.1.1 255.255.255.252
bandwidth 10000
speed 10
duplex full
no shut
```

```
end

conf t
int f2/0
ip address 192.168.1.1 255.255.255.0
duplex full
no shut
end
```

Interfaces Status

```
R1#show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            10.1.1.1        YES manual up                    up
Serial0/0                  unassigned      YES NVRAM  administratively down down
FastEthernet0/1            20.1.1.1        YES manual up                    up
Serial0/1                  unassigned      YES NVRAM  administratively down down
FastEthernet1/0            40.1.1.1        YES manual up                    up
FastEthernet2/0            192.168.1.1     YES manual up                    up
Loopback0                  1.1.1.1         YES NVRAM  up                    up
R1#
```

Router 2

Console Command

```
conf t
int f0/0
ip address 10.1.1.2 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end

conf t
int f0/1
ip address 50.1.1.1 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end
```

Interfaces Status

```
R2#show ip int brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        10.1.1.2        YES manual up                    up
Serial0/0              unassigned      YES NVRAM  administratively down down
FastEthernet0/1        50.1.1.1        YES manual up                    up
Serial0/1              unassigned      YES NVRAM  administratively down down
FastEthernet1/0        unassigned      YES NVRAM  administratively down down
Serial2/0              unassigned      YES NVRAM  administratively down down
Serial2/1              unassigned      YES NVRAM  administratively down down
Serial2/2              unassigned      YES NVRAM  administratively down down
Serial2/3              unassigned      YES NVRAM  administratively down down
Loopback0              2.2.2.2         YES NVRAM  up                    up
R2#
```

Router 3

Console Command

```
conf t
int f0/0
ip address 20.1.1.2 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end

conf t
int s0/0
ip address 30.1.1.1 255.255.255.252
no shut
end
```

Interfaces Status

```
R3#show ip int brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        20.1.1.2        YES manual up                    up
Serial0/0              30.1.1.1        YES manual up                    up
FastEthernet0/1        unassigned      YES unset  administratively down down
Serial0/1              unassigned      YES unset  administratively down down
FastEthernet1/0        unassigned      YES unset  administratively down down
Serial2/0              unassigned      YES unset  administratively down down
Serial2/1              unassigned      YES unset  administratively down down
Serial2/2              unassigned      YES unset  administratively down down
Serial2/3              unassigned      YES unset  administratively down down
R3#
```

Router 4

Console Command

```
conf t
int f0/0
ip address 40.1.1.2 255.255.255.252
bandwidth 10000
```

```
speed 10
duplex full
no shut
end

conf t
int f0/1
ip address 50.1.1.2 255.255.255.252
bandwidth 100000
speed 100
duplex full
no shut
end

conf t
int s0/0
ip address 30.1.1.2 255.255.255.252
no shut
end

conf t
int f1/0
ip address 172.16.1.1 255.255.255.0
duplex full
no shut
end
```

Interfaces Status

```
R4#show ip int brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        40.1.1.2        YES manual up                    up
Serial0/0              30.1.1.2        YES manual up                    up
FastEthernet0/1        50.1.1.2        YES manual up                    up
Serial0/1              unassigned      YES unset  administratively down down
FastEthernet1/0        172.16.1.1      YES manual up                    up
FastEthernet2/0        unassigned      YES unset  administratively down down
R4#
```

PC-1

Console Command

```
ip 192.168.1.2 255.255.255.0 192.168.1.1
```

PC-2

Console Command

```
ip 172.16.1.2 255.255.255.0 172.16.1.1
```

Ping test

R1

```
  vmi-dump              Dump  VMI debug info test command
  vmi-neighbor-create   Create VMI neighbor test command
  vmi-neighbor-kill     Create VMI neighbor test command
  voice                 Voice Commands
  vtp                   Configure global VTP state
  webvpn                WebVPN exec command
  where                 List active connections
  which-route           Do OSI route table lookup and display results
  write                 Write running configuration to memory, network, or
                        terminal
  x28                   Become an X.28 PAD
  x3                    Set X.3 parameters on PAD
  xconnect              Xconnect EXEC commands

R1#ping 20.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.1.1.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 16/26/44 ms
R1#ping 20.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/16/24 ms
R1#ping 10.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 12/73/224 ms
R1#ping 10.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/16/36 ms
R1#
```

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R2

```
drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog
     0 input packets with dribble condition detected
     306 packets output, 32198 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
R2#wr
Building configuration...
[OK]
R2#
R2#ping 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/71/80 ms
R2#ping 50.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 50.1.1.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 8/19/32 ms
R2#ping 50.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 50.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/16/24 ms
R2#
```

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R3

```
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output
drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/0/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     Available Bandwidth 1158 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 ab
ort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 5 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up

R3#wr
Building configuration...
[OK]
R3#
*Mar  1 01:50:04.715: %LINEPROTO-5-UPDOWN: Line protocol on Int
erface Serial0/0, changed state to up
R3#ping 20.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/19/24 ms
R3#ping 30.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 30.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/20 ms
R3#
```

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R4

```
     Available Bandwidth 1158 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 ab
ort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 5 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up

R4#ping 50.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 50.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/18/32 ms
R4#ping 30.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 30.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/8 ms
R4#ping 40.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 40.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/18/28 ms
R4#ping 172.16.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/9/20 ms
R4#
```

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PC-1

```
MAC          : 00:50:79:66:68:00
LPORT        : 10006
RHOST:PORT   : 127.0.0.1:10007
MTU:         : 1500

PC-1> show ip

NAME         : PC-1[1]
IP/MASK      : 192.168.1.2/24
GATEWAY      : 192.168.1.1
DNS          :
MAC          : 00:50:79:66:68:00
LPORT        : 10006
RHOST:PORT   : 127.0.0.1:10007
MTU:         : 1500

PC-1> ip 192.168.1.2 255.255.255.0 192.168.1.1
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.0 gateway 192.168.1.1

PC-1> show ip

NAME         : PC-1[1]
IP/MASK      : 192.168.1.2/24
GATEWAY      : 192.168.1.1
DNS          :
MAC          : 00:50:79:66:68:00
LPORT        : 10006
RHOST:PORT   : 127.0.0.1:10007
MTU:         : 1500

PC-1> ping 192.168.1.1
84 bytes from 192.168.1.1 icmp_seq=1 ttl=255 time=1.999 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=255 time=1.999 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=255 time=7.986 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=255 time=10.010 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=255 time=8.011 ms

PC-1>
```

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PC-2

```
MTU:        : 1500

PC-2> ping 172.16.1.1
84 bytes from 172.16.1.1 icmp_seq=1 ttl=255 time=10.992 ms
84 bytes from 172.16.1.1 icmp_seq=2 ttl=255 time=6.996 ms
84 bytes from 172.16.1.1 icmp_seq=3 ttl=255 time=2.000 ms
84 bytes from 172.16.1.1 icmp_seq=4 ttl=255 time=7.996 ms
84 bytes from 172.16.1.1 icmp_seq=5 ttl=255 time=2.002 ms

PC-2> ping 172.16.1.1
84 bytes from 172.16.1.1 icmp_seq=1 ttl=255 time=9.975 ms
84 bytes from 172.16.1.1 icmp_seq=2 ttl=255 time=10.009 ms
84 bytes from 172.16.1.1 icmp_seq=3 ttl=255 time=6.001 ms
84 bytes from 172.16.1.1 icmp_seq=4 ttl=255 time=9.956 ms
84 bytes from 172.16.1.1 icmp_seq=5 ttl=255 time=2.987 ms

PC-2> ip 172.16.1.2 255.255.255.0 172.16.1.1
Checking for duplicate address...
PC1 : 172.16.1.2 255.255.255.0 gateway 172.16.1.1

PC-2> show ip

NAME        : PC-2[1]
IP/MASK     : 172.16.1.2/24
GATEWAY     : 172.16.1.1
DNS         :
MAC         : 00:50:79:66:68:01
LPORT       : 10004
RHOST:PORT  : 127.0.0.1:10005
MTU:        : 1500

PC-2> ping 172.16.1.1
84 bytes from 172.16.1.1 icmp_seq=1 ttl=255 time=2.997 ms
84 bytes from 172.16.1.1 icmp_seq=2 ttl=255 time=1.984 ms
84 bytes from 172.16.1.1 icmp_seq=3 ttl=255 time=0.996 ms
84 bytes from 172.16.1.1 icmp_seq=4 ttl=255 time=1.996 ms
84 bytes from 172.16.1.1 icmp_seq=5 ttl=255 time=3.915 ms

PC-2>
```

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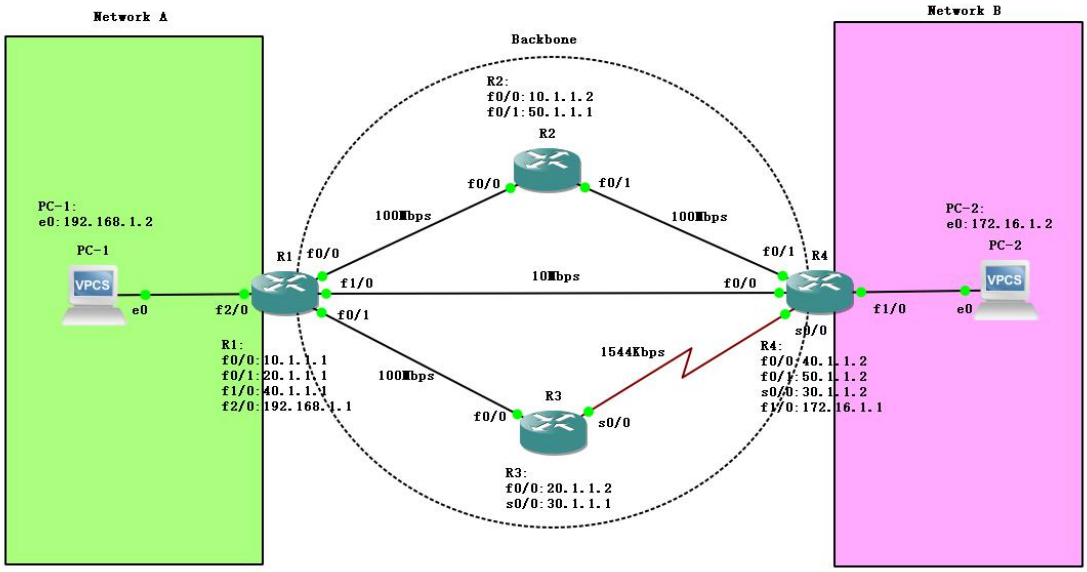
Problem 1

Network topology



Screenshot of pings from R1 to PC-1

```
R1#ping 192.168.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/11/24 ms
R1#
```

Screenshot of pings from R1 to R4

```
R1#ping 40.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 40.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/13/24 ms
R1#
```

An explanation of NM-1FE-TX and WIC-1T abbreviations and why these modules are chosen among the available alternatives.

- `NM-1FE-TX` is the abbreviation of 1-port Fast Ethernet network module with TX connector. This module provides an RJ-45 connector for direct connection to 100BASE-T Ethernet networks.

- The 1-port serial WAN interface card (`WIC-1T`) provides serial connections to remote sites or legacy serial network devices such as Synchronous Data Link Control (SDLC) concentrators, alarm systems, and packet over SONET (POS) devices.

What is the practical difference between a /24 and a /30 subnet?

A Subnet mask is a 32-bit number that masks an IP address, and divides the IP address into network address and host address. Subnet Mask is made by setting network bits to all "1"s and setting host bits to all "0"s.

The binary netmask of a /24 subnet is `11111111 11111111 11111111 00000000`. 0-23 bits are the network address, 24-31 bits are the host address which can contain $2^8 = 256$ host addresses. Exclude network address and broadcast address, the actual available host address is $2^8 - 2 = 254$.

The binary netmask of a /30 subnet is `11111111 11111111 11111111 11111100`. 0-29 bits are the network address, 30-31 bits are the host address which can contain $2^2 = 4$ host addresses. Exclude network address and broadcast address, the actual available host address is $2^2 - 2 = 2$.

Problem 2

Primary routing pass: `PC-1 -> R1 -> R2 -> R4 -> PC-2`

Preferred routing pass: `PC-1 -> R1 -> R4 -> PC-2`, `PC-1 -> R1 -> R3 -> R4 -> PC-2`

Configuration of R1

```
enable
conf t
ip route 172.16.1.0 255.255.255.0 40.1.1.2 10
ip route 172.16.1.0 255.255.255.0 20.1.1.2 20
ip route 172.16.1.0 255.255.255.0 10.1.1.2 1
end
```

Route table of R1

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip route 172.16.1.0 255.255.255.0 40.1.1.2 10
R1(config)#ip route 172.16.1.0 255.255.255.0 20.1.1.2 20
R1(config)#ip route 172.16.1.0 255.255.255.0 10.1.1.2 1
R1(config)#end
R1#
*Mar  1 00:57:44.695: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 10.1.1.2
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet2/0
R1#
```

Configuration of R4

```
enable
conf t
ip route 192.168.1.0 255.255.255.0 40.1.1.1 10
ip route 192.168.1.0 255.255.255.0 30.1.1.1 20
ip route 192.168.1.0 255.255.255.0 50.1.1.1 1
end
```

Route table of R4

```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#ip route 192.168.1.0 255.255.255.0 40.1.1.1 10
R4(config)#ip route 192.168.1.0 255.255.255.0 30.1.1.1 20
R4(config)#ip route 192.168.1.0 255.255.255.0 50.1.1.1 1
R4(config)#end
R4#
*Mar  1 00:53:28.535: %SYS-5-CONFIG_I: Configured from console by console
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     50.0.0.0/30 is subnetted, 1 subnets
C       50.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, FastEthernet1/0
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet0/0
S    192.168.1.0/24 [1/0] via 50.1.1.1
     30.0.0.0/30 is subnetted, 1 subnets
C       30.1.1.0 is directly connected, Serial0/0
R4#
```

Configuration of R2

```
enable
conf t
ip route 192.168.1.0 255.255.255.0 10.1.1.1 1
ip route 172.16.1.0 255.255.255.0 50.1.1.2 1
end
```

Route table of R2

```
R2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     50.0.0.0/30 is subnetted, 1 subnets
C       50.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 50.1.1.2
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
S    192.168.1.0/24 [1/0] via 10.1.1.1
R2#
```

Configuration of R3

```
enable
conf t
ip route 192.168.1.0 255.255.255.0 20.1.1.1 1
ip route 172.16.1.0 255.255.255.0 30.1.1.2 1
end
```

Route table of R3

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#ip route 192.168.1.0 255.255.255.0 20.1.1.1 1
R3(config)#ip route 172.16.1.0 255.255.255.0 30.1.1.2 1
R3(config)#end
R3#show i
*Mar  1 00:39:14.655: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/0
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 30.1.1.2
S    192.168.1.0/24 [1/0] via 20.1.1.1
     30.0.0.0/30 is subnetted, 1 subnets
C       30.1.1.0 is directly connected, Serial0/0
R3#
```

Ping test & traceroute

```
PC-1> ping 172.16.1.2
84 bytes from 172.16.1.2 icmp_seq=1 ttl=62 time=37.995 ms
84 bytes from 172.16.1.2 icmp_seq=2 ttl=62 time=35.979 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=62 time=30.982 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=62 time=29.982 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=62 time=27.981 ms

PC-1>
```

```
PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   5.987 ms  10.007 ms  8.999 ms
 2   10.1.1.2   30.961 ms  28.995 ms  30.997 ms
 3   50.1.1.2   51.986 ms  40.987 ms  41.977 ms
 4   *172.16.1.2   50.973 ms (ICMP type:3, code:3, Destination port unreachable)

PC-1>
```

```
PC-2> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=62 time=42.973 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=62 time=35.981 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=62 time=34.996 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=62 time=13.992 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=62 time=34.982 ms

PC-2>
```

```
PC-2> trace 192.168.1.2
trace to 192.168.1.2, 8 hops max, press Ctrl+C to stop
 1   172.16.1.1   8.009 ms  8.996 ms  9.994 ms
 2   50.1.1.1   31.979 ms  31.997 ms  30.981 ms
 3   10.1.1.1   52.011 ms  52.943 ms  51.973 ms
 4   *192.168.1.2   62.978 ms (ICMP type:3, code:3, Destination port unreachable)

PC-2>
```

Shot down F1/0 on R1

```
conf t
int f1/0
shut
end
```

```
R1#show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            10.1.1.1        YES manual up                    up
Serial0/0                  unassigned      YES NVRAM  administratively down down
FastEthernet0/1            20.1.1.1        YES manual up                    up
Serial0/1                  unassigned      YES NVRAM  administratively down down
FastEthernet1/0            40.1.1.1        YES manual administratively down down
FastEthernet2/0            192.168.1.1     YES manual up                    up
Loopback0                  1.1.1.1         YES NVRAM  up                    up
R1#
```

Shut down F0/0 on R4

```
conf t
int f0/0
shut
end
```

```
R4#show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            40.1.1.2        YES manual administratively down down
Serial0/0                  30.1.1.2        YES manual up                    up
FastEthernet0/1            50.1.1.2        YES manual up                    up
Serial0/1                  unassigned      YES unset  administratively down down
FastEthernet1/0            172.16.1.1      YES manual up                    up
FastEthernet2/0            unassigned      YES unset  administratively down down
R4#
```

Route table before changing

R1

```
S level-2
       ia - IS-IS inter area, * - candidate default, U - per-user s
tatic route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 10.1.1.2
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet2/0
R1#
```

R4

```
S level-2
       ia - IS-IS inter area, * - candidate default, U - per-user s
tatic route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     50.0.0.0/30 is subnetted, 1 subnets
C       50.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, FastEthernet1/0
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet0/0
S    192.168.1.0/24 [1/0] via 50.1.1.1
     30.0.0.0/30 is subnetted, 1 subnets
C       30.1.1.0 is directly connected, Serial0/0
R4#
```

Ping test after changing

```
PC-1> ping 172.16.1.2 -t
84 bytes from 172.16.1.2 icmp_seq=1 ttl=61 time=55.960 ms
84 bytes from 172.16.1.2 icmp_seq=2 ttl=61 time=54.958 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=53.969 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=45.987 ms
172.16.1.2 icmp_seq=5 timeout
84 bytes from 172.16.1.2 icmp_seq=6 ttl=62 time=36.963 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=62 time=37.969 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=62 time=39.975 ms
84 bytes from 172.16.1.2 icmp_seq=9 ttl=62 time=37.988 ms
84 bytes from 172.16.1.2 icmp_seq=10 ttl=62 time=30.984 ms
84 bytes from 172.16.1.2 icmp_seq=11 ttl=62 time=39.959 ms
84 bytes from 172.16.1.2 icmp_seq=12 ttl=62 time=26.970 ms
84 bytes from 172.16.1.2 icmp_seq=13 ttl=62 time=33.978 ms
84 bytes from 172.16.1.2 icmp_seq=14 ttl=62 time=28.972 ms
84 bytes from 172.16.1.2 icmp_seq=15 ttl=62 time=33.983 ms
84 bytes from 172.16.1.2 icmp_seq=16 ttl=62 time=39.990 ms
84 bytes from 172.16.1.2 icmp_seq=17 ttl=62 time=40.004 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   9.020 ms  9.983 ms  11.016 ms
 2   40.1.1.2   29.111 ms  19.989 ms  21.973 ms
 3   *172.16.1.2   29.980 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1>
```

From the screenshot we can found that 1 packet was lost when configuring the remaining two routing paths.

How to know that a routing pass changed?

We can use `traceroute` tool to trace routing pass. From the screenshot we can found that the routing pass has changed to `PC-1 -> R1 -> R4 -> PC-2`.

```
PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   9.020 ms  9.983 ms  11.016 ms
 2   40.1.1.2   29.111 ms  19.989 ms  21.973 ms
 3   *172.16.1.2   29.980 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1>
```

VG-task 1

Add a loopback interface (/24) on R4

```
conf t
int loop 0
ip address 4.4.4.4 255.255.255.0
no shut
end
```

```
R4#show interfaces Loopback0
Loopback0 is up, line protocol is up
  Hardware is Loopback
  Internet address is 4.4.4.4/24
  MTU 1514 bytes, BW 8000000 Kbit/sec, DLY 5000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation LOOPBACK, loopback not set
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
R4#
```

Ping test from PC-1

Because the routing table of the router R1 does not contain the entries of the network 4.4.4.0/24, the PC-1 cannot successfully ping the loop-back interface of the R4.

```
PC-1> ping 4.4.4.4
*192.168.1.1 icmp_seq=1 ttl=255 time=13.989 ms (ICMP type:3, code:1, Destination host unreachable
)
*192.168.1.1 icmp_seq=2 ttl=255 time=11.992 ms (ICMP type:3, code:1, Destination host unreachable
)
*192.168.1.1 icmp_seq=3 ttl=255 time=10.995 ms (ICMP type:3, code:1, Destination host unreachable
)
*192.168.1.1 icmp_seq=4 ttl=255 time=7.986 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.1.1 icmp_seq=5 ttl=255 time=0.999 ms (ICMP type:3, code:1, Destination host unreachable)

PC-1>
```

Problem 3

Configure RIPv2 in all routers

R1

```
enable
conf t
router rip
version 2
no auto-summary
network 10.1.1.0
network 20.1.1.0
network 40.1.1.0
network 192.168.1.0
end
```

R2

```
enable
conf t
router rip
version 2
no auto-summary
network 10.1.1.0
network 50.1.1.0
end
```

R3

```
enable
conf t
router rip
version 2
no auto-summary
network 20.1.1.0
network 30.1.1.0
end
```

R4

```
enable
conf t
router rip
version 2
no auto-summary
network 20.1.1.0
network 30.1.1.0
network 40.1.1.0
network 172.16.1.0
end
```

Ping test & traceroute from PC-1 to PC-2

```
PC-1> ping 172.16.1.2
84 bytes from 172.16.1.2 icmp_seq=1 ttl=62 time=38.982 ms
84 bytes from 172.16.1.2 icmp_seq=2 ttl=62 time=40.991 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=62 time=40.976 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=62 time=41.976 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=62 time=39.991 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   10.993 ms  7.996 ms  9.994 ms
 2   40.1.1.2   30.001 ms  35.980 ms  32.018 ms
 3   *172.16.1.2   40.991 ms (ICMP type:3, code:3, Destination port unreachable)
```

From the screenshot we can find that RIPv2 selects the path `PC-1 -> R1 -> R4 -> PC-2`. Since the RIP protocol selects the path according to the hop count, it can be easily found from the network topology, path `PC- 1 -> R1 -> R4 -> PC-2` requires only 3 hops, and the remaining two paths have a hop count of 4.

Shut down F1/0 on R1

```
conf t
int f1/0
shut
end
```

When the interface f1/0 of R1 is shut down, PC-1 fails to ping PC-2. The `icmp_seq` is 16.

```
PC-1   PC-2   R2   R3   R4
84 bytes from 4.4.4.4 icmp_seq=4 ttl=254 time=21.989 ms
84 bytes from 4.4.4.4 icmp_seq=5 ttl=254 time=18.989 ms

PC-1>
PC-1>
PC-1>
PC-1> ping 172.16.1.2 -t
172.16.1.2 icmp_seq=1 timeout
172.16.1.2 icmp_seq=2 timeout
84 bytes from 172.16.1.2 icmp_seq=3 ttl=62 time=27.985 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=62 time=39.967 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=62 time=32.979 ms
84 bytes from 172.16.1.2 icmp_seq=6 ttl=62 time=37.986 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=62 time=24.985 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=62 time=39.959 ms
84 bytes from 172.16.1.2 icmp_seq=9 ttl=62 time=39.963 ms
84 bytes from 172.16.1.2 icmp_seq=10 ttl=62 time=41.962 ms
84 bytes from 172.16.1.2 icmp_seq=11 ttl=62 time=26.985 ms
84 bytes from 172.16.1.2 icmp_seq=12 ttl=62 time=30.977 ms
84 bytes from 172.16.1.2 icmp_seq=13 ttl=62 time=32.991 ms
84 bytes from 172.16.1.2 icmp_seq=14 ttl=62 time=38.976 ms
84 bytes from 172.16.1.2 icmp_seq=15 ttl=62 time=33.997 ms
*192.168.1.1 icmp_seq=16 ttl=255 time=34.981 ms (ICMP type:3, code:
1, Destination host unreachable)
*192.168.1.1 icmp_seq=17 ttl=255 time=1.972 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=18 ttl=255 time=3.996 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=19 ttl=255 time=1.999 ms (ICMP type:3, code:1
, Destination host unreachable)
172.16.1.2 icmp_seq=20 timeout
172.16.1.2 icmp_seq=21 timeout
172.16.1.2 icmp_seq=22 timeout
172.16.1.2 icmp_seq=23 timeout
172.16.1.2 icmp_seq=24 timeout
172.16.1.2 icmp_seq=25 timeout
172.16.1.2 icmp_seq=26 timeout
172.16.1.2 icmp_seq=27 timeout
```

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```
R1
     50.0.0.0/30 is subnetted, 1 subnets
R       50.1.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
                 [120/1] via 10.1.1.2, 00:00:02, FastEthernet0/0
     4.0.0.0/24 is subnetted, 1 subnets
R       4.4.4.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
R       172.16.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet2/0
     30.0.0.0/30 is subnetted, 1 subnets
R       30.1.1.0 [120/1] via 40.1.1.2, 00:00:24, FastEthernet1/0
                 [120/1] via 20.1.1.2, 00:00:19, FastEthernet0/1
R1#ping 4.4.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/24/3
R1#
R1#
R1#
R1#
R1#
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f1/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:16:48.295: %LINK-5-CHANGED: Interface FastEthernet1/0, c
hanged state to administratively down
*Mar  1 01:16:49.295: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to down
R1(config-if)#
```

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When `icmp_seq=132`, PC-1 pings PC-2 successfully and a total of *132 – 16 = 116* packets were lost during the period of finding a new path.

```
PC-1  PC-2  R2  R3  R4
172.16.1.2 icmp_seq=119 timeout
172.16.1.2 icmp_seq=120 timeout
172.16.1.2 icmp_seq=121 timeout
172.16.1.2 icmp_seq=122 timeout
172.16.1.2 icmp_seq=123 timeout
172.16.1.2 icmp_seq=124 timeout
172.16.1.2 icmp_seq=125 timeout
172.16.1.2 icmp_seq=126 timeout
172.16.1.2 icmp_seq=127 timeout
172.16.1.2 icmp_seq=128 timeout
172.16.1.2 icmp_seq=129 timeout
172.16.1.2 icmp_seq=130 timeout
172.16.1.2 icmp_seq=131 timeout
84 bytes from 172.16.1.2 icmp_seq=132 ttl=61 time=49.968 ms
84 bytes from 172.16.1.2 icmp_seq=133 ttl=61 time=35.986 ms
172.16.1.2 icmp_seq=134 timeout
172.16.1.2 icmp_seq=135 timeout
84 bytes from 172.16.1.2 icmp_seq=136 ttl=61 time=35.978 ms
84 bytes from 172.16.1.2 icmp_seq=137 ttl=61 time=57.973 ms
84 bytes from 172.16.1.2 icmp_seq=138 ttl=61 time=61.957 ms
84 bytes from 172.16.1.2 icmp_seq=139 ttl=61 time=49.974 ms
84 bytes from 172.16.1.2 icmp_seq=140 ttl=61 time=62.982 ms
84 bytes from 172.16.1.2 icmp_seq=141 ttl=61 time=50.999 ms
84 bytes from 172.16.1.2 icmp_seq=142 ttl=61 time=50.973 ms
84 bytes from 172.16.1.2 icmp_seq=143 ttl=61 time=42.996 ms
84 bytes from 172.16.1.2 icmp_seq=144 ttl=61 time=55.971 ms
84 bytes from 172.16.1.2 icmp_seq=145 ttl=61 time=43.969 ms
84 bytes from 172.16.1.2 icmp_seq=146 ttl=61 time=49.969 ms
84 bytes from 172.16.1.2 icmp_seq=147 ttl=61 time=33.990 ms
84 bytes from 172.16.1.2 icmp_seq=148 ttl=61 time=48.973 ms
84 bytes from 172.16.1.2 icmp_seq=149 ttl=61 time=55.966 ms
84 bytes from 172.16.1.2 icmp_seq=150 ttl=61 time=43.990 ms
84 bytes from 172.16.1.2 icmp_seq=151 ttl=61 time=36.980 ms
84 bytes from 172.16.1.2 icmp_seq=152 ttl=61 time=22.987 ms
84 bytes from 172.16.1.2 icmp_seq=153 ttl=61 time=61.950 ms
84 bytes from 172.16.1.2 icmp_seq=154 ttl=61 time=57.964 ms
84 bytes from 172.16.1.2 icmp_seq=155 ttl=61 time=48.972 ms
84 bytes from 172.16.1.2 icmp_seq=156 ttl=61 time=53.968 ms
84 bytes from 172.16.1.2 icmp_seq=157 ttl=61 time=53.967 ms
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```

```
R1
     50.0.0.0/30 is subnetted, 1 subnets
R       50.1.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
                 [120/1] via 10.1.1.2, 00:00:02, FastEthernet0/0
     4.0.0.0/24 is subnetted, 1 subnets
R       4.4.4.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
R       172.16.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet2/0
     30.0.0.0/30 is subnetted, 1 subnets
R       30.1.1.0 [120/1] via 40.1.1.2, 00:00:24, FastEthernet1/0
                 [120/1] via 20.1.1.2, 00:00:19, FastEthernet0/1
R1#ping 4.4.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/24/3
R1#
R1#
R1#
R1#
R1#
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f1/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:16:48.295: %LINK-5-CHANGED: Interface FastEthernet1/0, c
hanged state to administratively down
*Mar  1 01:16:49.295: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to down
R1(config-if)#
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```

The output of traceroute shows that RIP selected routing path `PC-1 -> R1 -> R2 -> R4 -> PC-2`.

```
PC-1  PC-2  R2  R3  R4
84 bytes from 172.16.1.2 icmp_seq=200 ttl=61 time=47.955 ms
84 bytes from 172.16.1.2 icmp_seq=201 ttl=61 time=46.977 ms
84 bytes from 172.16.1.2 icmp_seq=202 ttl=61 time=49.972 ms
84 bytes from 172.16.1.2 icmp_seq=203 ttl=61 time=63.965 ms
84 bytes from 172.16.1.2 icmp_seq=204 ttl=61 time=61.975 ms
84 bytes from 172.16.1.2 icmp_seq=205 ttl=61 time=46.959 ms
84 bytes from 172.16.1.2 icmp_seq=206 ttl=61 time=49.963 ms
84 bytes from 172.16.1.2 icmp_seq=207 ttl=61 time=36.964 ms
84 bytes from 172.16.1.2 icmp_seq=208 ttl=61 time=52.967 ms
84 bytes from 172.16.1.2 icmp_seq=209 ttl=61 time=39.993 ms
84 bytes from 172.16.1.2 icmp_seq=210 ttl=61 time=53.962 ms
84 bytes from 172.16.1.2 icmp_seq=211 ttl=61 time=49.972 ms
84 bytes from 172.16.1.2 icmp_seq=212 ttl=61 time=52.971 ms
84 bytes from 172.16.1.2 icmp_seq=213 ttl=61 time=43.956 ms
84 bytes from 172.16.1.2 icmp_seq=214 ttl=61 time=45.955 ms
84 bytes from 172.16.1.2 icmp_seq=215 ttl=61 time=57.971 ms
84 bytes from 172.16.1.2 icmp_seq=216 ttl=61 time=52.971 ms
84 bytes from 172.16.1.2 icmp_seq=217 ttl=61 time=52.981 ms
84 bytes from 172.16.1.2 icmp_seq=218 ttl=61 time=36.006 ms
84 bytes from 172.16.1.2 icmp_seq=219 ttl=61 time=52.970 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   9.980 ms  9.991 ms  9.999 ms
 2   10.1.1.2   32.977 ms  32.981 ms  19.988 ms
 3   50.1.1.2   32.982 ms  20.990 ms  19.987 ms
 4   *  *  *
 5   *172.16.1.2   34.959 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   7.987 ms  8.979 ms  9.017 ms
 2   10.1.1.2   30.983 ms  20.980 ms  20.005 ms
 3   50.1.1.2   32.981 ms  31.983 ms  31.984 ms
 4   *172.16.1.2   51.971 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1>
solarwinds | Solar-PuTTY free tool  © 2018 SolarWinds Worldwide, LLC. All rights reserved.
```

```
R1
     50.0.0.0/30 is subnetted, 1 subnets
R       50.1.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
                 [120/1] via 10.1.1.2, 00:00:02, FastEthernet0/0
     4.0.0.0/24 is subnetted, 1 subnets
R       4.4.4.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     20.0.0.0/30 is subnetted, 1 subnets
C       20.1.1.0 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 1 subnets
R       172.16.1.0 [120/1] via 40.1.1.2, 00:00:13, FastEthernet1/0
     40.0.0.0/30 is subnetted, 1 subnets
C       40.1.1.0 is directly connected, FastEthernet1/0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet2/0
     30.0.0.0/30 is subnetted, 1 subnets
R       30.1.1.0 [120/1] via 40.1.1.2, 00:00:24, FastEthernet1/0
                 [120/1] via 20.1.1.2, 00:00:19, FastEthernet0/1
R1#ping 4.4.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/24/3
R1#
R1#
R1#
R1#
R1#
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f1/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:16:48.295: %LINK-5-CHANGED: Interface FastEthernet1/0, c
hanged state to administratively down
*Mar  1 01:16:49.295: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to down
R1(config-if)#
solarwinds | Solar-PuTTY free tool  © 2018 SolarWinds Worldwide, LLC. All rights reserved.
```

Problem 4

Configure OSPF in all routers

R1

```
enable
conf t
router ospf 1
network 10.1.1.0 0.0.0.3 area 0
network 20.1.1.0 0.0.0.3 area 0
network 40.1.1.0 0.0.0.3 area 0
network 192.168.1.0 0.0.0.255 area 1
end
```

R2

```
enable
conf t
router ospf 1
network 10.1.1.0 0.0.0.3 area 0
network 50.1.1.0 0.0.0.3 area 0
end
```

R3

```
enable
conf t
router ospf 1
network 20.1.1.0 0.0.0.3 area 0
network 30.1.1.0 0.0.0.3 area 0
end
```

R4

```
enable
conf t
router ospf 1
network 40.1.1.0 0.0.0.3 area 0
network 50.1.1.0 0.0.0.3 area 0
network 30.1.1.0 0.0.0.3 area 0
network 172.16.1.0 0.0.0.255 area 2
end
```

Ping test & traceroute from PC-1 to PC-2

```
PC-1> ping 172.16.1.2
172.16.1.2 icmp_seq=1 timeout
84 bytes from 172.16.1.2 icmp_seq=2 ttl=61 time=45.997 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=44.968 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=48.954 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=50.970 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   10.009 ms  8.996 ms  10.994 ms
 2   10.1.1.2   31.983 ms  29.982 ms  29.998 ms
 3   50.1.1.2   52.974 ms  50.973 ms  41.962 ms
 4     *  *  *
 5   *172.16.1.2   42.985 ms (ICMP type:3, code:3, Destination port unreachable)

PC-1>
```

Shut down F0/0 on R1

```
conf t
int f0/0
shut
end
```

When the interface f0/0 of R1 is shut down, PC-1 fails to ping PC-2. The `icmp_seq` is 18.

```
 unreachable)

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   2.005 ms  9.996 ms  8.997 ms
 2   10.1.1.2   26.987 ms  28.968 ms  20.987 ms
 3   50.1.1.2   32.979 ms  34.976 ms  31.984 ms
 4   *172.16.1.2   43.980 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1> ping 172.16.1.2 -t
172.16.1.2 icmp_seq=1 timeout
172.16.1.2 icmp_seq=2 timeout
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=48.973 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=54.970 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.974 ms
84 bytes from 172.16.1.2 icmp_seq=6 ttl=61 time=55.964 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=61 time=54.954 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=61 time=51.986 ms
84 bytes from 172.16.1.2 icmp_seq=9 ttl=61 time=50.975 ms
84 bytes from 172.16.1.2 icmp_seq=10 ttl=61 time=61.963 ms
84 bytes from 172.16.1.2 icmp_seq=11 ttl=61 time=61.965 ms
84 bytes from 172.16.1.2 icmp_seq=12 ttl=61 time=41.993 ms
84 bytes from 172.16.1.2 icmp_seq=13 ttl=61 time=51.970 ms
84 bytes from 172.16.1.2 icmp_seq=14 ttl=61 time=52.968 ms
84 bytes from 172.16.1.2 icmp_seq=15 ttl=61 time=43.977 ms
84 bytes from 172.16.1.2 icmp_seq=16 ttl=61 time=36.975 ms
84 bytes from 172.16.1.2 icmp_seq=17 ttl=61 time=54.986 ms
*192.168.1.1 icmp_seq=18 ttl=255 time=22.984 ms (ICMP type:3, code:
1, Destination host unreachable)
*192.168.1.1 icmp_seq=19 ttl=255 time=6.026 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=20 ttl=255 time=11.993 ms (ICMP type:3, code:
1, Destination host unreachable)
*192.168.1.1 icmp_seq=21 ttl=255 time=2.998 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=22 ttl=255 time=3.995 ms (ICMP type:3, code:1
, Destination host unreachable)
```

```
anged state to up
*Mar  1 01:00:55.599: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to up
R1(config-if)#end
R1#sh
*Mar  1 01:00:56.111: %SYS-5-CONFIG_I: Configured from console by c
onsole
R1#show ip
*Mar  1 01:00:57.379: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.1.1 on
FastEthernet1/0 from LOADING to FULL, Loading Done
R1#show ip int brief
Interface              IP-Address      OK? Method Status
        Protocol
FastEthernet0/0        10.1.1.1        YES NVRAM  up
        up
Serial0/0              unassigned      YES NVRAM  administrativ
ely down down
FastEthernet0/1        20.1.1.1        YES NVRAM  up
        up
Serial0/1              unassigned      YES NVRAM  administrativ
ely down down
FastEthernet1/0        40.1.1.1        YES NVRAM  up
        up
FastEthernet2/0        192.168.1.1     YES NVRAM  up
        up
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:02:41.891: %OSPF-5-ADJCHG: Process 1, Nbr 50.1.1.1 on Fa
stEthernet0/0 from FULL to DOWN, Neighbor Down: Interface down or d
etached
R1(config-if)#
*Mar  1 01:02:43.875: %LINK-5-CHANGED: Interface FastEthernet0/0, c
hanged state to administratively down
*Mar  1 01:02:44.875: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet0/0, changed state to down
R1(config-if)#
```

When `icmp_seq=23`, PC-1 pings PC-2 successfully and a total of $23 - 18 = 5$ packets were lost during the period of finding a new path.

```
 3   50.1.1.2   32.979 ms  34.976 ms  31.984 ms
 4   *172.16.1.2   43.980 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1> ping 172.16.1.2 -t
172.16.1.2 icmp_seq=1 timeout
172.16.1.2 icmp_seq=2 timeout
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=48.973 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=54.970 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.974 ms
84 bytes from 172.16.1.2 icmp_seq=6 ttl=61 time=55.964 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=61 time=54.954 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=61 time=51.986 ms
84 bytes from 172.16.1.2 icmp_seq=9 ttl=61 time=50.975 ms
84 bytes from 172.16.1.2 icmp_seq=10 ttl=61 time=61.963 ms
84 bytes from 172.16.1.2 icmp_seq=11 ttl=61 time=61.965 ms
84 bytes from 172.16.1.2 icmp_seq=12 ttl=61 time=41.993 ms
84 bytes from 172.16.1.2 icmp_seq=13 ttl=61 time=51.970 ms
84 bytes from 172.16.1.2 icmp_seq=14 ttl=61 time=52.968 ms
84 bytes from 172.16.1.2 icmp_seq=15 ttl=61 time=43.977 ms
84 bytes from 172.16.1.2 icmp_seq=16 ttl=61 time=36.975 ms
84 bytes from 172.16.1.2 icmp_seq=17 ttl=61 time=54.986 ms
*192.168.1.1 icmp_seq=18 ttl=255 time=22.984 ms (ICMP type:3, code:
1, Destination host unreachable)
*192.168.1.1 icmp_seq=19 ttl=255 time=6.026 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=20 ttl=255 time=11.993 ms (ICMP type:3, code:
1, Destination host unreachable)
*192.168.1.1 icmp_seq=21 ttl=255 time=2.998 ms (ICMP type:3, code:1
, Destination host unreachable)
*192.168.1.1 icmp_seq=22 ttl=255 time=3.995 ms (ICMP type:3, code:1
, Destination host unreachable)
84 bytes from 172.16.1.2 icmp_seq=23 ttl=62 time=40.978 ms
84 bytes from 172.16.1.2 icmp_seq=24 ttl=62 time=34.986 ms
84 bytes from 172.16.1.2 icmp_seq=25 ttl=62 time=29.983 ms
84 bytes from 172.16.1.2 icmp_seq=26 ttl=62 time=30.966 ms
84 bytes from 172.16.1.2 icmp_seq=27 ttl=62 time=40.950 ms
84 bytes from 172.16.1.2 icmp_seq=28 ttl=62 time=22.007 ms
84 bytes from 172.16.1.2 icmp_seq=29 ttl=62 time=27.986 ms
```

```
anged state to up
*Mar  1 01:00:55.599: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to up
R1(config-if)#end
R1#sh
*Mar  1 01:00:56.111: %SYS-5-CONFIG_I: Configured from console by c
onsole
R1#show ip
*Mar  1 01:00:57.379: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.1.1 on
FastEthernet1/0 from LOADING to FULL, Loading Done
R1#show ip int brief
Interface                  IP-Address      OK? Method Status
        Protocol
FastEthernet0/0            10.1.1.1        YES NVRAM  up
        up
Serial0/0                  unassigned      YES NVRAM  administrativ
ely down down
FastEthernet0/1            20.1.1.1        YES NVRAM  up
        up
Serial0/1                  unassigned      YES NVRAM  administrativ
ely down down
FastEthernet1/0            40.1.1.1        YES NVRAM  up
        up
FastEthernet2/0            192.168.1.1     YES NVRAM  up
        up
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:02:41.891: %OSPF-5-ADJCHG: Process 1, Nbr 50.1.1.1 on Fa
stEthernet0/0 from FULL to DOWN, Neighbor Down: Interface down or d
etached
R1(config-if)#
*Mar  1 01:02:43.875: %LINK-5-CHANGED: Interface FastEthernet0/0, c
hanged state to administratively down
*Mar  1 01:02:44.875: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet0/0, changed state to down
R1(config-if)#
```

The output of traceroute shows that OSPF selected routing path `PC-1 -> R1 -> R4 -> PC-2`.

```
84 bytes from 172.16.1.2 icmp_seq=35 ttl=62 time=27.990 ms
84 bytes from 172.16.1.2 icmp_seq=36 ttl=62 time=32.979 ms
84 bytes from 172.16.1.2 icmp_seq=37 ttl=62 time=33.976 ms
84 bytes from 172.16.1.2 icmp_seq=38 ttl=62 time=42.980 ms
84 bytes from 172.16.1.2 icmp_seq=39 ttl=62 time=34.980 ms
84 bytes from 172.16.1.2 icmp_seq=40 ttl=62 time=109.937 ms
84 bytes from 172.16.1.2 icmp_seq=41 ttl=62 time=69.961 ms
84 bytes from 172.16.1.2 icmp_seq=42 ttl=62 time=164.904 ms
84 bytes from 172.16.1.2 icmp_seq=43 ttl=62 time=29.983 ms
84 bytes from 172.16.1.2 icmp_seq=44 ttl=62 time=26.985 ms
84 bytes from 172.16.1.2 icmp_seq=45 ttl=62 time=35.979 ms
84 bytes from 172.16.1.2 icmp_seq=46 ttl=62 time=34.980 ms
84 bytes from 172.16.1.2 icmp_seq=47 ttl=62 time=29.987 ms
84 bytes from 172.16.1.2 icmp_seq=48 ttl=62 time=16.991 ms
84 bytes from 172.16.1.2 icmp_seq=49 ttl=62 time=33.980 ms
84 bytes from 172.16.1.2 icmp_seq=50 ttl=62 time=25.982 ms
84 bytes from 172.16.1.2 icmp_seq=51 ttl=62 time=22.355 ms
84 bytes from 172.16.1.2 icmp_seq=52 ttl=62 time=22.987 ms
84 bytes from 172.16.1.2 icmp_seq=53 ttl=62 time=28.982 ms
84 bytes from 172.16.1.2 icmp_seq=54 ttl=62 time=38.990 ms
84 bytes from 172.16.1.2 icmp_seq=55 ttl=62 time=34.209 ms
84 bytes from 172.16.1.2 icmp_seq=56 ttl=62 time=38.990 ms
84 bytes from 172.16.1.2 icmp_seq=57 ttl=62 time=42.980 ms
84 bytes from 172.16.1.2 icmp_seq=58 ttl=62 time=40.982 ms
84 bytes from 172.16.1.2 icmp_seq=59 ttl=62 time=30.985 ms
84 bytes from 172.16.1.2 icmp_seq=60 ttl=62 time=29.981 ms
84 bytes from 172.16.1.2 icmp_seq=61 ttl=62 time=26.225 ms
84 bytes from 172.16.1.2 icmp_seq=62 ttl=62 time=35.980 ms
84 bytes from 172.16.1.2 icmp_seq=63 ttl=62 time=22.984 ms
84 bytes from 172.16.1.2 icmp_seq=64 ttl=62 time=39.976 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   10.994 ms  8.993 ms  13.991 ms
 2   40.1.1.2   24.986 ms  20.985 ms  21.986 ms
 3   *172.16.1.2   35.980 ms (ICMP type:3, code:3, Destination port
 unreachable)

PC-1>
```


```
anged state to up
*Mar  1 01:00:55.599: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet1/0, changed state to up
R1(config-if)#end
R1#sh
*Mar  1 01:00:56.111: %SYS-5-CONFIG_I: Configured from console by c
onsole
R1#show ip
*Mar  1 01:00:57.379: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.1.1 on
FastEthernet1/0 from LOADING to FULL, Loading Done
R1#show ip int brief
Interface                  IP-Address      OK? Method Status
        Protocol
FastEthernet0/0            10.1.1.1        YES NVRAM  up
        up
Serial0/0                  unassigned      YES NVRAM  administrativ
ely down down
FastEthernet0/1            20.1.1.1        YES NVRAM  up
        up
Serial0/1                  unassigned      YES NVRAM  administrativ
ely down down
FastEthernet1/0            40.1.1.1        YES NVRAM  up
        up
FastEthernet2/0            192.168.1.1     YES NVRAM  up
        up
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:02:41.891: %OSPF-5-ADJCHG: Process 1, Nbr 50.1.1.1 on Fa
stEthernet0/0 from FULL to DOWN, Neighbor Down: Interface down or d
etached
R1(config-if)#
*Mar  1 01:02:43.875: %LINK-5-CHANGED: Interface FastEthernet0/0, c
hanged state to administratively down
*Mar  1 01:02:44.875: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet0/0, changed state to down
R1(config-if)#
```

VG-task 2

Configure EIGRP in all routers

R1

```
enable
conf t
router eigrp 100
no auto-summary
network 10.1.1.0
network 20.1.1.0
network 40.1.1.0
network 192.168.1.0
end
```

R2

```
enable
conf t
router eigrp 100
no auto-summary
network 10.1.1.0
network 50.1.1.0
end
```

R3

```
enable
conf t
router eigrp 100
no auto-summary
network 20.1.1.0
network 30.1.1.0
end
```

R4

```
enable
conf t
router eigrp 100
no auto-summary
network 20.1.1.0
network 30.1.1.0
network 40.1.1.0
network 172.16.1.0
end
```

Ping test & traceroute from PC-1 to PC-2

```
PC-1> ping 172.16.1.2
172.16.1.2 icmp_seq=1 timeout
84 bytes from 172.16.1.2 icmp_seq=2 ttl=61 time=45.959 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=64.982 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=63.978 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.980 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   4.993 ms  8.994 ms  9.991 ms
 2   10.1.1.2   22.988 ms  24.983 ms  20.987 ms
 3   50.1.1.2   35.976 ms  34.981 ms  30.981 ms
 4   *172.16.1.2   41.976 ms (ICMP type:3, code:3, Destination port unreachable)

PC-1>
```

From the screenshot we can find that EIGRP selects the path `PC-1 -> R1 -> R2 -> R4 -> PC-2`. EIGRP uses a variety of Keys to calculate the Metric value to the target network, including bandwidth, total delay, reliability, load, hop count, it can be easily found from the network topology diagram that the routing path `PC-1 -> R1 -> R2 -> R4 -> PC-2` has the largest network bandwidth, so EIGRP chose this path.

Shut down F0/0 on R1

Before the change, `traceroute` can be used to find that the current routing path from PC-1 to PC-2 is `PC1->R1->R2->R4 >PC-2`. We shut down the interface F0/0 of R1 to R2 with the following command.

```
conf t
int f0/0
shut
end
```

When the interface f0/0 of R1 is shut down, PC-1 fails to ping PC-2. The `icmp_seq` is 9.

```
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.0 gateway 192.168.1.1

PC-1> ping 172.16.1.2
*192.168.1.1 icmp_seq=1 ttl=255 time=9.012 ms (ICMP type:3, code:1,
*192.168.1.1 icmp_seq=2 ttl=255 time=7.006 ms (ICMP type:3, code:1,
*192.168.1.1 icmp_seq=3 ttl=255 time=2.998 ms (ICMP type:3, code:1,
*192.168.1.1 icmp_seq=4 ttl=255 time=7.996 ms (ICMP type:3, code:1,
*192.168.1.1 icmp_seq=5 ttl=255 time=0.985 ms (ICMP type:3, code:1,

PC-1> ping 172.16.1.2
172.16.1.2 icmp_seq=1 timeout
84 bytes from 172.16.1.2 icmp_seq=2 ttl=61 time=45.959 ms
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=64.982 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=63.978 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.980 ms

PC-1> trace 172.16.1.2
trace to 172.16.1.2, 8 hops max, press Ctrl+C to stop
 1   192.168.1.1   4.993 ms  8.994 ms  9.991 ms
 2   10.1.1.2   22.988 ms  24.983 ms  20.987 ms
 3   50.1.1.2   35.976 ms  34.981 ms  30.981 ms
 4   *172.16.1.2   41.976 ms (ICMP type:3, code:3, Destination port

PC-1> ping 172.16.1.2 -t
172.16.1.2 icmp_seq=1 timeout
172.16.1.2 icmp_seq=2 timeout
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=38.977 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=56.963 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.979 ms
84 bytes from 172.16.1.2 icmp_seq=6 ttl=61 time=46.989 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=61 time=48.971 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=61 time=25.984 ms
172.16.1.2 icmp_seq=9 timeout
172.16.1.2 icmp_seq=10 timeout
172.16.1.2 icmp_seq=11 timeout
```

```
*Mar  1 00:04:41.195: %SYS-5-CONFIG_I: Configured from console by c
R1#show ip eigrp to
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(100)/ID(192.168.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.1.0/30, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 20.1.1.0/30, 1 successors, FD is 28160
        via Connected, FastEthernet0/1
P 40.1.1.0/30, 1 successors, FD is 258560
        via Connected, FastEthernet1/0
P 192.168.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet2/0
R1#
*Mar  1 00:08:38.927: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor
up: new adjacency
R1#
*Mar  1 00:09:02.375: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor
up: new adjacency
R1#
*Mar  1 00:10:00.867: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor
up: new adjacency
R1#conf
Configuring from terminal, memory, or network [terminal]? t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#shut
R1(config-if)#
*Mar  1 01:48:32.723: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor
10.1.1.2 (FastEthernet0/0) is down: interface down
R1(config-if)#
*Mar  1 01:48:34.659: %LINK-5-CHANGED: Interface FastEthernet0/0, c
hanged state to administratively down
*Mar  1 01:48:35.659: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet0/0, changed state to down
R1(config-if)#
```

When `icmp_seq=14`, PC-1 pings PC-2 successfully and a total of $14 - 9 = 5$ packets were lost during the period of finding a new path.

```
 1   192.168.1.1   4.993 ms  8.994 ms  9.991 ms
 2   10.1.1.2   22.988 ms  24.983 ms  20.987 ms
 3   50.1.1.2   35.976 ms  34.981 ms  30.981 ms
 4   *172.16.1.2   41.976 ms (ICMP type:3, code:3, Destination port

PC-1> ping 172.16.1.2 -t
172.16.1.2 icmp_seq=1 timeout
172.16.1.2 icmp_seq=2 timeout
84 bytes from 172.16.1.2 icmp_seq=3 ttl=61 time=38.977 ms
84 bytes from 172.16.1.2 icmp_seq=4 ttl=61 time=56.963 ms
84 bytes from 172.16.1.2 icmp_seq=5 ttl=61 time=44.979 ms
84 bytes from 172.16.1.2 icmp_seq=6 ttl=61 time=46.989 ms
84 bytes from 172.16.1.2 icmp_seq=7 ttl=61 time=48.971 ms
84 bytes from 172.16.1.2 icmp_seq=8 ttl=61 time=25.984 ms
172.16.1.2 icmp_seq=9 timeout
172.16.1.2 icmp_seq=10 timeout
172.16.1.2 icmp_seq=11 timeout
172.16.1.2 icmp_seq=12 timeout
172.16.1.2 icmp_seq=13 timeout
172.16.1.2 icmp_seq=14 timeout
84 bytes from 172.16.1.2 icmp_seq=15 ttl=62 time=27.987 ms
84 bytes from 172.16.1.2 icmp_seq=16 ttl=62 time=34.979 ms
84 bytes from 172.16.1.2 icmp_seq=17 ttl=62 time=30.978 ms
84 bytes from 172.16.1.2 icmp_seq=18 ttl=62 time=18.973 ms
84 bytes from 172.16.1.2 icmp_seq=19 ttl=62 time=30.971 ms
84 bytes from 172.16.1.2 icmp_seq=20 ttl=62 time=29.979 ms
84 bytes from 172.16.1.2 icmp_seq=21 ttl=62 time=31.981 ms
84 bytes from 172.16.1.2 icmp_seq=22 ttl=62 time=37.972 ms
84 bytes from 172.16.1.2 icmp_seq=23 ttl=62 time=30.983 ms
84 bytes from 172.16.1.2 icmp_seq=24 ttl=62 time=38.979 ms
84 bytes from 172.16.1.2 icmp_seq=25 ttl=62 time=23.986 ms
84 bytes from 172.16.1.2 icmp_seq=26 ttl=62 time=41.975 ms
84 bytes from 172.16.1.2 icmp_seq=27 ttl=62 time=38.973 ms
84 bytes from 172.16.1.2 icmp_seq=28 ttl=62 time=26.985 ms
84 bytes from 172.16.1.2 icmp_seq=29 ttl=62 time=35.989 ms
84 bytes from 172.16.1.2 icmp_seq=30 ttl=62 time=32.983 ms
84 bytes from 172.16.1.2 icmp_seq=31 ttl=62 time=22.001 ms
84 bytes from 172.16.1.2 icmp_seq=32 ttl=62 time=27.989 ms
```

```
*Mar  1 00:04:41.195: %SYS-5-CONFIG_I: Configured from console by c
R1#show ip eigrp to
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(100)/ID(192.168.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.1.0/30, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 20.1.1.0/30, 1 successors, FD is 28160
        via Connected, FastEthernet0/1
P 40.1.1.0/30, 1 successors, FD is 258560
        via Connected, FastEthernet1/0
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Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int f0/0
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*Mar  1 01:48:34.659: %LINK-5-CHANGED: Interface FastEthernet0/0, c
hanged state to administratively down
*Mar  1 01:48:35.659: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
ce FastEthernet0/0, changed state to down
R1(config-if)#
```
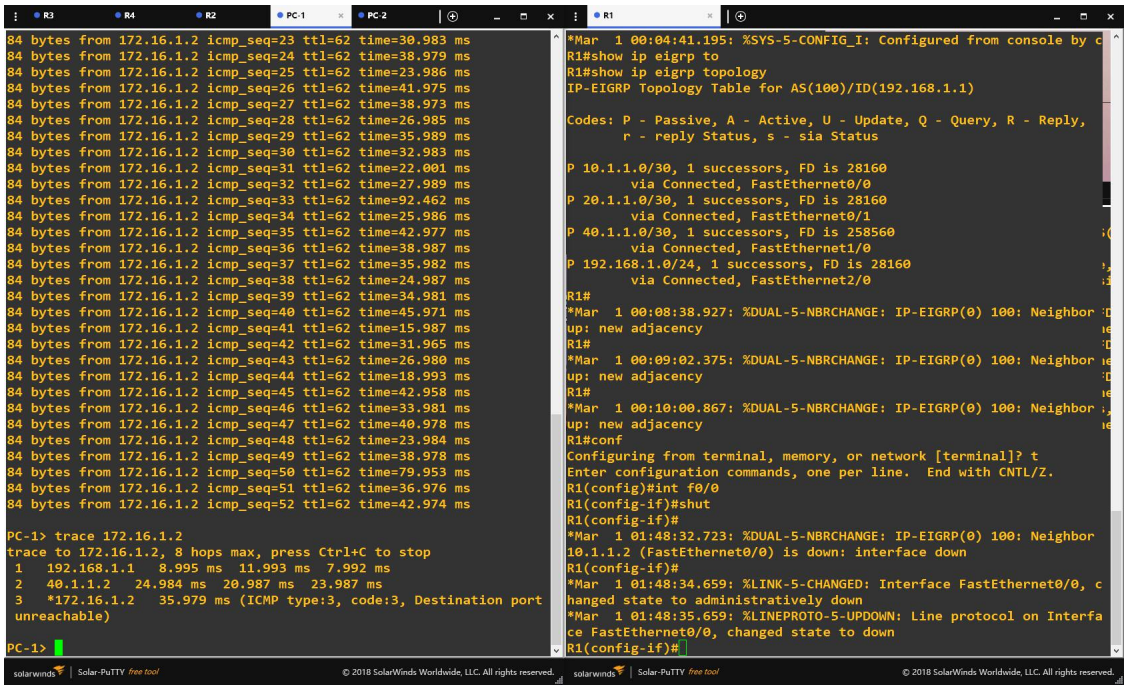

The output of traceroute shows that EIGRP selected routing path `PC-1 -> R1 -> R4 -> PC-2`.



Conclusion

Static

The routing entry of a static route is manually configured, not dynamically determined. Unlike dynamic routing, static routes are fixed and do not change, even if the network conditions have changed or are reconfigured. In general, static routes are added to the routing table by the network administrator.

- **Scenarios:** Small network.
- **Features:** Another benefit of using static routing is the high level of network security. Dynamic routing requires frequent exchange of routing tables between routers, and analysis of routing tables can reveal information such as network topology and network addresses. Therefore, the network can also use static routing for security reasons. Does not consume network bandwidth because static routes do not generate update traffic.
- **Disadvantages:** Static routes are generally not suitable for large and complex network environments. On the one hand, it is difficult for the network

administrator to fully understand the topology of the entire network. On the other hand, when the topology and link status of the network change, the static routing information in the router needs to be adjusted in a large scale. And the complexity is very high. When the network changes or the network fails, the route cannot be re-routed, and the route is likely to fail.

RIPv2

RIP (Routing Information Protocol) is a routing protocol based on distance vector algorithm, which uses hop count as a measurement standard. It has lower requirements in terms of bandwidth, configuration, and management, and is mainly suitable for small networks.

- **Scenarios:** Small network. The number of hop count is less than 15.
- **Features:** Without manual configuration, the router can automatically maintain and learn the routing table, which is widely used in small networks.
- **Disadvantages:**
  - Since 15 hops are the maximum, RIP can only be applied to small-scale networks
  - The route selected based on the hop count is not necessarily the optimal route.
  - RIP has slow convergence and count to infinity problems.
  - Learning and maintaining the routing table's packets consumes a certain amount of link bandwidth and router resources.

OSPF

Open shortest path first (OSPF) uses SPF to calculate the shortest path, which is better than the distance vector algorithm when the network size becomes larger.

- **Scenarios:** large network

- **Features:**
  - Fast convergence
  - No routing loop
  - Support variable length subnet mask
  - Support area division
  - Supports sending protocol packets with multicast addresses.
- **Disadvantages:**

  The SPF algorithm needs CPU resources when calculating, and needs to have better router performance.

EIGRP

Enhanced Interior Gateway Routing Protocol (EIGRP) is an advanced distance-vector routing protocol that is used on a computer network for automating routing decisions and configuration. EIGRP is used on a router to share routes with other routers within the same autonomous system. Unlike other well known routing protocols, such as RIP, EIGRP only sends incremental updates, reducing the workload on the router and the amount of data that needs to be transmitted.[1]

- **Scenarios:** large network
- **Features:**
  - Fast convergence
  - Sends topology changes, rather than sending the entire routing table when a route is changed.
  - Support multiple network protocols, IPv6, IPX and AppleTalk.
  - Support for load balancing on parallel links between sites.

- Periodically checks if a route is available, and propagates routing changes to neighboring routers if any changes have occurred.
- MD5 and SHA-2 authentication between two routers.
- Easy to configuration

Administrative distance is the first criterion that a router uses to determine which routing protocol to use if two protocols provide route information for the same destination. Administrative distance is a measure of the trustworthiness of the source of the routing information. Administrative distance has only local significance, and is not advertised in routing updates.

The smaller the administrative distance value, the more reliable the protocol. If router lose the source of the EIGRP (Internal)-derived information, the software uses the IGRP-derived information until the EIGRP-derived information reappears.

Default Distance Value Table [2]

This table lists the administrative distance default values of the protocols that Cisco supports:

Route Source	Default Administrative Distance Values
Connected interface	0
Static route	1
Enhanced Interior Gateway Routing Protocol (EIGRP) summary route	5
External Border Gateway Protocol (BGP)	20
Internal EIGRP	90
IGRP	100
OSPF	110
Intermediate System-to-Intermediate System (IS-IS)	115
Routing Information Protocol (RIP)	120
Exterior Gateway Protocol (EGP)	140
On Demand Routing (ODR)	160
External EIGRP	170
Internal BGP	200
Unknown*	255

References

[1] Enhanced Interior Gateway Routing Protocol. (2019). Retrieved from https://en.wikipedia.org/wiki/Enhanced*Interior*Gateway*Routing*Protocol

[2] What Is Administrative Distance?. (2019). Retrieved from https://www.cisco.com/c/en/us/support/docs/ip/border-gateway-protocol-bgp/15986-admin-distance.html