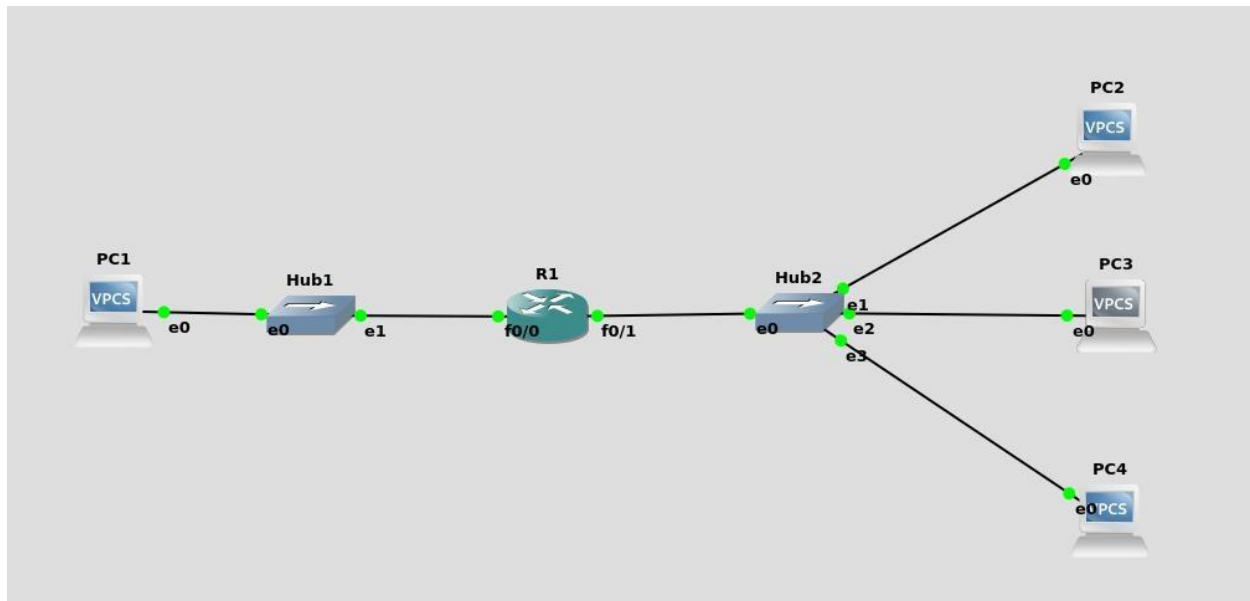


**Q1.** In this exercise you study how the network prefixes (netmasks) play a role when hosts determine if a datagram can be directly delivered or if it must be sent to a router. This part uses the network setup shown in Figure 5.1.

The network includes one router, four hosts and two hubs. The IP addresses of all devices are given in Figure 5.2. Here, each host has only a default route. In other words, the routing table at a host only knows about the directly connected networks and the default gateway.



## Pinging PC1 to PC3

```

PC1> ping 10.0.2.137 -c2
10.0.2.137 icmp_seq=1 timeout
84 bytes from 10.0.2.137 icmp_seq=2 ttl=63 time=21.692 ms
84 bytes from 10.0.2.137 icmp_seq=3 ttl=63 time=19.082 ms
84 bytes from 10.0.2.137 icmp_seq=4 ttl=63 time=12.414 ms
84 bytes from 10.0.2.137 icmp_seq=5 ttl=63 time=12.949 ms

PC1> save arp
Saving startup configuration to arp.vpc
. done

PC1> clear arp

PC1> show arp
arp table is empty

PC1>
  
```

```

PC3> ip 10.0.2.137 255.255.255.248 10.0.2.138
Checking for duplicate address...
PC3 : 10.0.2.137 255.255.255.248 gateway 10.0.2.138

PC3> show arp
c4:01:06:f9:00:01 10.0.2.138 expires in 116 seconds

PC3> save arp
Saving startup configuration to arp.vpc
. done

PC3> clear arp

PC3> show arp
arp table is empty

PC3>
  
```

```

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

10.0.0.0/24 is subnetted, 2 subnets
C      10.0.2.0 is directly connected, FastEthernet0/1
C      10.0.1.0 is directly connected, FastEthernet0/0
R1#
  
```

No.	Time	Source	Destination	Protocol	Length	Info
18	127.657044	10.0.1.10	10.0.2.137	ICMP	98	Echo (ping) request id=0x56b8, seq=1/256, ttl=64 (no response found!)
19	129.658180	10.0.1.10	10.0.2.137	ICMP	98	Echo (ping) request id=0x58b8, seq=2/512, ttl=64 (reply in 20)
20	129.679659	10.0.2.137	10.0.1.10	ICMP	98	Echo (ping) reply id=0x58b8, seq=2/512, ttl=63 (request in 19)
21	129.996714	c4:01:06:f9:00:00	c4:01:06:f9:00:00	LOOP	60	Reply
22	130.682347	10.0.1.10	10.0.2.137	ICMP	98	Echo (ping) request id=0x59b8, seq=3/768, ttl=64 (reply in 23)
23	130.701190	10.0.2.137	10.0.1.10	ICMP	98	Echo (ping) reply id=0x59b8, seq=3/768, ttl=63 (request in 22)
24	131.701668	10.0.1.10	10.0.2.137	ICMP	98	Echo (ping) request id=0x5ab8, seq=4/1024, ttl=64 (reply in 25)
25	131.713870	10.0.2.137	10.0.1.10	ICMP	98	Echo (ping) reply id=0x5ab8, seq=4/1024, ttl=63 (request in 24)
26	132.716382	10.0.1.10	10.0.2.137	ICMP	98	Echo (ping) request id=0x5bb8, seq=5/1280, ttl=64 (reply in 27)
27	132.729082	10.0.2.137	10.0.1.10	ICMP	98	Echo (ping) reply id=0x5bb8, seq=5/1280, ttl=63 (request in 26)
28	139.996849	c4:01:06:f9:00:00	c4:01:06:f9:00:00	LOOP	60	Reply
29	149.996707	c4:01:06:f9:00:00	c4:01:06:f9:00:00	LOOP	60	Reply
30	160.001583	c4:01:06:f9:00:00	c4:01:06:f9:00:00	LOOP	60	Reply
31	168.894725	c4:01:06:f9:00:00	CDP/VTP/DTP/PAGP/UD...	CDP	359	Device ID: R1 Port ID: FastEthernet0/0
32	170.001868	c4:01:06:f9:00:00	c4:01:06:f9:00:00	LOOP	60	Reply
■ Frame 22: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0 ■ Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: c4:01:06:f9:00:00 (c4:01:06:f9:00:00) ■ Internet Protocol Version 4, Src: 10.0.1.10, Dst: 10.0.2.137 ■ Internet Control Message Protocol						
0000	c4 01 06 f9 00 00 00 50	79 66 68 00 08 00 45 00	.....P yfh...E.			
0010	00 54 b8 58 00 00 40 01	aa be 0a 00 01 0a 0a 00	.T.X..@.....			
0020	02 89 08 00 c6 50 59 b8	00 03 08 09 0a 0b 0c 0d	....PY.....			
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 28 29 2a 2b 2c 2d	..! "#\$% &'()*+,-			
0050	2e 2f 30 31 32 33 34 35	36 37 38 39 3a 3b 3c 3d	./012345 6789;<=			
0060	3e 3f		>?			

## Pinging PC3 to PC4

The image shows a network simulation environment with two routers, PC3 and PC4, and a packet capture window.

**PC3 Configuration:**

```
PC3> save arp
Saving startup configuration to arp.vpc
done

PC3> clear arp

PC3> show arp
arp table is empty

PC3> clear arp

PC3> ping 10.0.2.139 -c3
4 bytes from 10.0.2.139 icmp_seq=1 ttl=64 time=0.225 ms
4 bytes from 10.0.2.139 icmp_seq=2 ttl=64 time=0.489 ms
4 bytes from 10.0.2.139 icmp_seq=3 ttl=64 time=0.354 ms
4 bytes from 10.0.2.139 icmp_seq=4 ttl=64 time=0.356 ms
4 bytes from 10.0.2.139 icmp_seq=5 ttl=64 time=0.335 ms

PC3>
```

**PC4 Configuration:**

```
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC4> 10.0.2.139/28
Bad command: "10.0.2.139/28". Use ? for help.

PC4> ip 10.0.2.139/24
Checking for duplicate address...
PC4 : 10.0.2.139 255.255.255.0

PC4> ip 10.0.2.139 255.255.255.0 10.0.2.138
Checking for duplicate address...
PC4 : 10.0.2.139 255.255.255.0 gateway 10.0.2.138

PC4> show arp
00:50:79:66:68:02 10.0.2.137 expires in 114 seconds

PC4>
```

**Packet Capture (Capturing from [PC3 Ethernet0 to Hub2 Ethernet2]):**

No.	Time	Source	Destination	Protocol	Length	Info
15	183.622325	Private_66:68:03	Private_66:68:02	ARP	64	10.0.2.139 is at 00:50:79:66:68:03
16	183.623467	10.0.2.137	10.0.2.139	ICMP	98	Echo (ping) request id=0x8bba, seq=1/256, ttl=64 (reply in 17)
17	183.623620	10.0.2.139	10.0.2.137	ICMP	98	Echo (ping) reply id=0x8bba, seq=1/256, ttl=64 (request in 16)
18	184.626496	10.0.2.137	10.0.2.139	ICMP	98	Echo (ping) request id=0x8cba, seq=2/512, ttl=64 (reply in 19)
19	184.626813	10.0.2.139	10.0.2.137	ICMP	98	Echo (ping) reply id=0x8cba, seq=2/512, ttl=64 (request in 18)
20	185.628629	10.0.2.137	10.0.2.139	ICMP	98	Echo (ping) request id=0x8dba, seq=3/768, ttl=64 (reply in 21)
21	185.628863	10.0.2.139	10.0.2.137	ICMP	98	Echo (ping) reply id=0x8dba, seq=3/768, ttl=64 (request in 20)
22	186.630858	10.0.2.137	10.0.2.139	ICMP	98	Echo (ping) request id=0x8eba, seq=4/1024, ttl=64 (reply in 23)
23	186.631086	10.0.2.139	10.0.2.137	ICMP	98	Echo (ping) reply id=0x8eba, seq=4/1024, ttl=64 (request in 22)
24	187.632944	10.0.2.137	10.0.2.139	ICMP	98	Echo (ping) request id=0x8fba, seq=5/1280, ttl=64 (reply in 25)
25	187.633172	10.0.2.139	10.0.2.137	ICMP	98	Echo (ping) reply id=0x8fba, seq=5/1280, ttl=64 (request in 24)
26	111.197950	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
27	119.999089	c4:01:06:f9:00:01	c4:01:06:f9:00:01	CDP/VTP/DTP/PagP/UD...	359	Device ID: R1 Port ID: FastEthernet0/1
28	121.191611	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
29	131.198992	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
30	141.196646	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
TTL: 180 seconds						
Checksum: 0xf703 [correct]						
[Checksum Status: Good]						
Device ID: R1						
Software Version						
Type: Software version (0x0005)						
Length: 251						
Software version: Cisco IOS Software, 3700 Software (C3745-ADVIPSERVICESK9-M), Version 12.4(25d), RELEASE SOFTWARE (fc1)						
0020	00 05 00 f6 43 69 73 63 6f 20 49 4f 53 20 53 6f	Cisco IOS Software, 3700 Software (C3745-ADVIPSERVICESK9-M), Version 12.4(25d), RELEASE SOFTWARE (fc1) Techn				
0030	66 74 77 61 72 65 2c 20 33 37 30 30 20 53 6f 66	ical Support: http://www.cisco.com/techsupport				
0040	74 77 61 72 65 20 28 43 33 37 34 35 2d 41 44 56	Copyright (c) 1986-2010 by Cisco Systems, Inc. Compiled Wed 18-Au				
0050	49 50 53 45 52 56 49 43 45 53 4b 39 2d 4d 29 2c					
0060	20 56 65 72 73 69 6f 6e 20 31 32 2e 34 28 32 35					
0070	64 29 2c 20 52 45 4c 45 41 53 45 20 53 4f 46 54					
0080	57 41 52 45 20 28 66 63 31 29 8a 54 65 63 68 6e					
0090	69 63 61 6c 20 53 75 70 70 6f 72 74 3a 20 68 74					
00a0	74 70 3a 2f 2f 77 77 77 2e 63 69 73 63 6f 2e 63					
00b0	6f 6d 2f 74 65 63 68 73 75 70 70 6f 72 74 0a 43					
00c0	6f 70 79 72 69 67 68 74 20 28 63 29 20 31 39 38					
00d0	36 2d 32 30 31 30 20 62 79 20 43 69 73 63 6f 20					
00e0	53 79 73 74 65 6d 73 2c 20 49 6e 63 2e 0a 43 6f					
00f0	6d 70 69 6c 65 64 20 57 65 64 20 31 38 2d 41 75					

Software version (cdp software version), 103 bytes

Packets: 30 - Displayed: 30 (100.0%)

Profile: Default



## Pinging PC3 to PC2

The screenshot displays a network simulation environment. On the left, a terminal window shows the configuration and execution of a ping command from PC3 to PC2 (10.0.2.10). The configuration includes setting the IP address, gateway, and clearing the ARP table. The ping command is executed, showing successful results with TTL=63 and various times.

```
PC3> ping 10.0.2.10

84 bytes from 10.0.2.10 icmp_seq=1 ttl=63 time=31.270 ms
84 bytes from 10.0.2.10 icmp_seq=2 ttl=63 time=31.180 ms
84 bytes from 10.0.2.10 icmp_seq=3 ttl=63 time=32.585 ms
84 bytes from 10.0.2.10 icmp_seq=4 ttl=63 time=29.276 ms
84 bytes from 10.0.2.10 icmp_seq=5 ttl=63 time=31.423 ms

PC3>
```

On the right, another terminal window shows the configuration of PC2, including setting the IP address, gateway, and showing the ARP table. The ARP table shows the MAC address of PC3 (c4:01:06:f9:00:01) and its IP address (10.0.2.138).

```
PC2> clear arp
PC2> show arp

c4:01:06:f9:00:01 10.0.2.138 expires in 106 seconds

PC2>
```

Below the terminal windows, a Wireshark packet capture is shown, capturing traffic on the FastEthernet0/0 interface of PC3. The capture shows several ICMP Echo (ping) requests and replies, as well as a CDP packet. The packet list shows the following details:

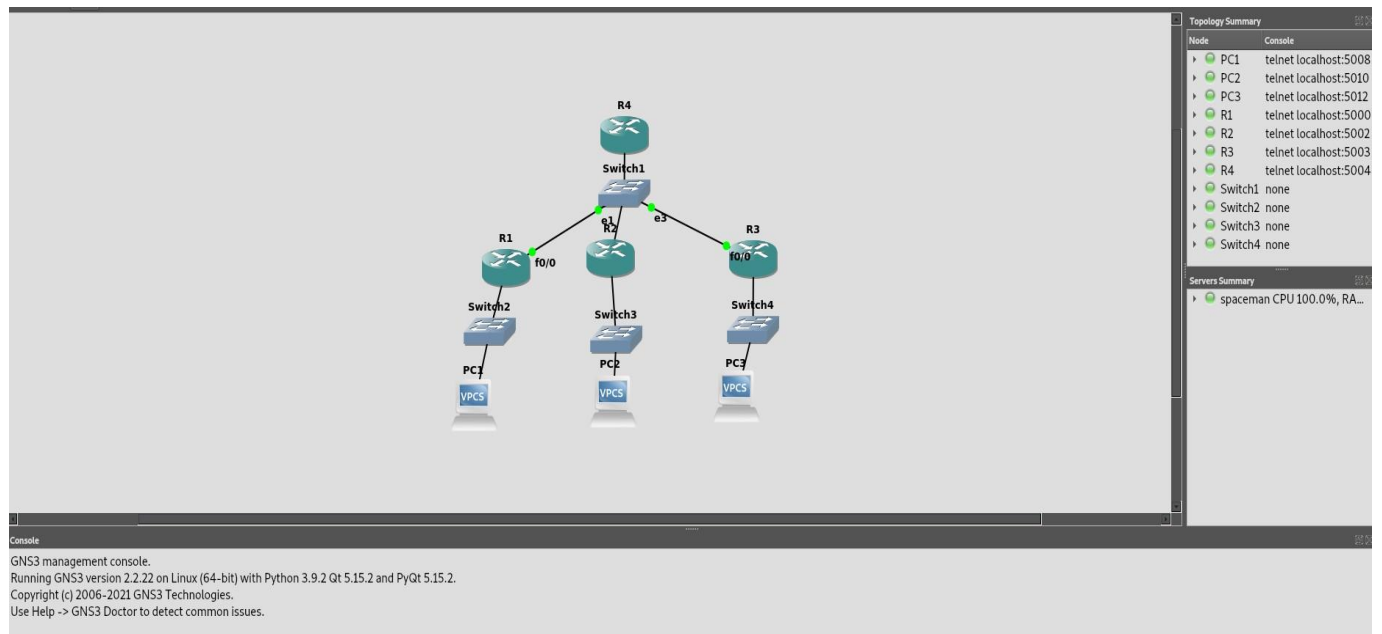
No.	Time	Source	Destination	Protocol	Length	Info
59	236.439975	10.0.2.138	10.0.2.137	ICMP	70	Redirect (Redirect for host)
60	236.459714	10.0.2.137	10.0.2.10	ICMP	98	Echo (ping) request id=0x10bb, seq=4/1024, ttl=63 (reply in 61)
61	236.459925	10.0.2.10	10.0.2.137	ICMP	98	Echo (ping) reply id=0x10bb, seq=4/1024, ttl=64 (request in 60)
62	236.461114	10.0.2.10	10.0.2.137	ICMP	98	Echo (ping) reply id=0x10bb, seq=4/1024, ttl=63
63	237.463029	10.0.2.137	10.0.2.10	ICMP	98	Echo (ping) request id=0x11bb, seq=5/1280, ttl=64 (no response found!)
64	237.472685	10.0.2.138	10.0.2.137	ICMP	70	Redirect (Redirect for host)
65	237.483394	10.0.2.137	10.0.2.10	ICMP	98	Echo (ping) request id=0x11bb, seq=5/1280, ttl=63 (reply in 66)
66	237.483674	10.0.2.10	10.0.2.137	ICMP	98	Echo (ping) reply id=0x11bb, seq=5/1280, ttl=64 (request in 65)
67	237.494139	10.0.2.10	10.0.2.137	ICMP	98	Echo (ping) reply id=0x11bb, seq=5/1280, ttl=63
68	240.000039	c4:01:06:f9:00:01	c4:01:06:f9:00:01	CDP/VTP/DTP/PagP/UD...	359	Device ID: R1 Port ID: FastEthernet0/1
69	241.197792	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
70	251.199378	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
71	261.192208	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
72	271.200658	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply
73	281.200592	c4:01:06:f9:00:01	c4:01:06:f9:00:01	LOOP	60	Reply

The packet details pane shows the following information for the selected packet (No. 68):

- TTL: 180 seconds
- Checksum: 0xf703 [correct]
- [Checksum Status: Good]
- Device ID: R1
- Software Version
- Type: Software version (0x0005)
- Length: 251
- Software version: Cisco IOS Software, 3700 Software (C3745-ADVIPSERVICESK9-M), Version 12.4(25d), RELEASE SOFTWARE (fc1)

The packet bytes pane shows the raw data of the packet, including the software version string.

**Q2.** An organization is granted a block of addresses with the beginning address 14.24.74.0/24. The organization needs to have 3 subblocks of addresses to use in its three subnets: one subblock of 10 addresses, one subblock of 60 addresses, and one subblock of 120 addresses. Design the subblocks. Use the topology shown below.



## Router configurations

R1:

```
R1#enable
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface f0/0
R1(config-if)#ip add 14.24.74.193 255.255.255.240
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:04:50.903: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:04:51.903: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#exit
R1(config)#interface f0/1
R1(config-if)#ip add 10.0.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:05:24.723: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:05:25.723: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1(config-if)#exit
R1(config)#end
R1#
*Mar 1 00:05:36.415: %SYS-5-CONFIG_I: Configured from console by console
R1#write
Building configuration...
[OK]
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 14.24.74.128 255.255.255.192 10.0.1.2
R1(config)#ip route 14.24.74.0 255.255.255.128 10.0.1.3
R1(config)#write
^
% Invalid input detected at '^' marker.

R1(config)#write
^
% Invalid input detected at '^' marker.

R1(config)#exit
R1#
*Mar 1 00:07:08.995: %SYS-5-CONFIG_I: Configured from console by console
R1#write
Building configuration...
[OK]
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

    10.0.0.0/24 is subnetted, 1 subnets
C       10.0.1.0 is directly connected, FastEthernet0/1
    14.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
S       14.24.74.0/25 [1/0] via 10.0.1.3
C       14.24.74.192/28 is directly connected, FastEthernet0/0
S       14.24.74.128/26 [1/0] via 10.0.1.2
R1#
```

R2:

```
R2#enable
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface f0/1
R2(config-if)#ip add 10.0.1.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#
*Mar 1 00:12:04.823: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:12:05.823: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config-if)#exit
R2(config)#interface f0/0
R2(config-if)#ip add 14.24.74.129 255.255.255.192
R2(config-if)#no shutdown
R2(config-if)#
*Mar 1 00:12:43.019: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:12:44.019: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#end
R2#
*Mar 1 00:12:46.319: %SYS-5-CONFIG_I: Configured from console by console
R2#end
Translating "end"

Translating "end"
% Unknown command or computer name, or unable to find computer address
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#ip route 14.24.74.192 255.255.255.240 10.0.1.1
R2(config)#exit
R2#
*Mar 1 00:13:21.067: %SYS-5-CONFIG_I: Configured from console by console
R2#write
Building configuration...
[OK]
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

    10.0.0.0/24 is subnetted, 1 subnets
C       10.0.1.0 is directly connected, FastEthernet0/1
    14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
S       14.24.74.192/28 [1/0] via 10.0.1.1
C       14.24.74.128/26 is directly connected, FastEthernet0/0
```



R3:

```
R3#enable
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#interface f0/0
R3(config-if)#ip add 14.24.74.1 255.255.255.128
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:17:01.447: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:17:02.447: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#exit
R3(config)#interface f0/1
R3(config-if)#ip add 10.0.1.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:17:30.599: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:17:31.599: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config-if)#end
R3#
*Mar 1 00:17:35.219: %SYS-5-CONFIG_I: Configured from console by console
R3#write
Building configuration...
[OK]
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#ip route 14.24.74.192 255.255.255.240 10.0.1.1
R3(config)#exit
R3#w
*Mar 1 00:18:43.411: %SYS-5-CONFIG_I: Configured from console by console
R3#write
Building configuration...
[OK]
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

    10.0.0.0/24 is subnetted, 1 subnets
C       10.0.1.0 is directly connected, FastEthernet0/1
    14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       14.24.74.0/25 is directly connected, FastEthernet0/0
S       14.24.74.192/28 [1/0] via 10.0.1.1
R3#
```

```
PC1> ip 14.24.74.194/28 14.24.74.193
Checking for duplicate address...
PC1 : 14.24.74.194 255.255.255.240 gateway 14.24.74.193
```

```
PC2> ip 14.24.74.130/26 14.24.74.129
Checking for duplicate address...
PC2 : 14.24.74.130 255.255.255.192 gateway 14.24.74.129
```

```
PC3> ip 14.24.74.2/25 14.24.74.1
Checking for duplicate address...
PC3 : 14.24.74.2 255.255.255.128 gateway 14.24.74.1
```

```
PC3>
```