CHAPTER 3

Shooting Trouble with IP

This chapter focuses on a number of objectives falling under the CCNP Troubleshooting guidelines. Understanding basic TCP/IP troubleshooting principles not only applies to the CCNP certification but to all industry certifications. A solid understanding of how IP works is essential for troubleshooting any small, medium, or large network.

This chapter and the remaining chapters assume knowledge of the previous chapters, which deal conceptually with protocol characteristics, models, troubleshooting methods, support tools, and resources. Each chapter starts by introducing a hands-on chapter scenario. To gain practical experience, build the network in the scenario if at all possible and follow along. If that isn't possible, the content and explanations are detailed enough for you to learn from without needing the equipment in front of you. Several integrated walk-through scenarios and Trouble Tickets enable you to benefit from the added learning advantages offered by practical application. After the Shooting Trouble with IP scenario, I explore TCP/IP concepts, symptoms, problems, and action plans.

This chapter covers the following topics:

- Scenario: Shooting Trouble with IP
- Protocols and Packets
- Addressing
- Routing Protocols
- Trouble Tickets
- Trouble Tickets Solutions

Supporting Website Files

You can find files and links to utilities that support this book on the Cisco Press website at www.ciscopress.com/1587200570. Even if you do not have a lab, you can take advantage of the supporting configuration files including the logs to understand device input and output. The files are listed throughout the chapters in italics.

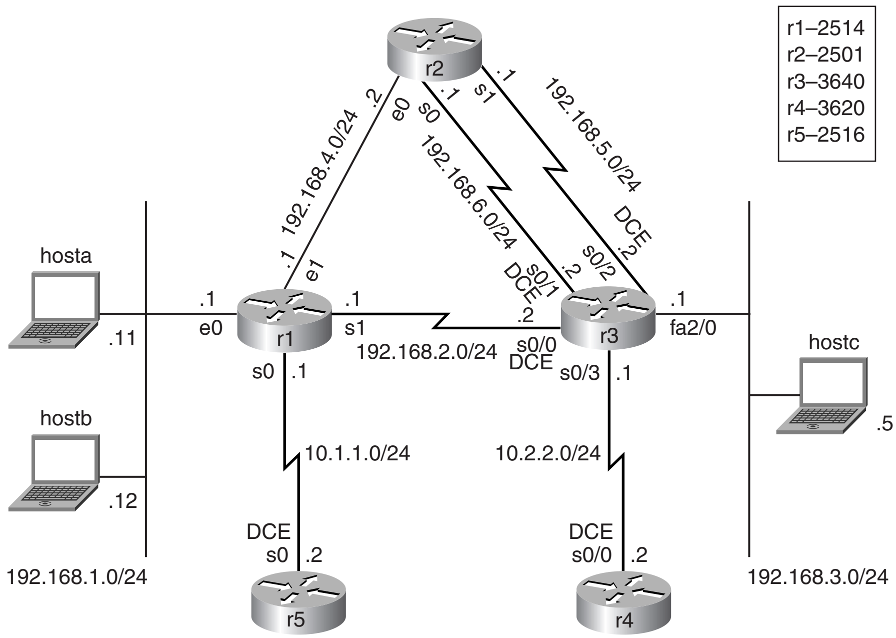
In order to be able to read and work with some of the supporting files offered at www.ciscopress.com/1587200570, you may want to download some of the programs listed in Table I-1 in the Introduction.

Scenario: Shooting Trouble with IP

It is now time to get started with the practical Shooting Trouble with IP scenario. First, add the additional equipment, perform a **write erase** or **erase startup-config** to clear your configurations from previous labs, and rewire according to Figure 3-1.

NOTE My lab uses the 2514, 2501, 3640, 3620, and 2516 Cisco routers, but yours can include any number of devices that have similar interfaces. See Appendix C, "Equipment Reference," for the hardware used throughout the book.

Figure 3-1 *Shooting Trouble with IP*



The scenario goal is to put in the basic configurations, and then add Routing Information Protocol (RIP) as the routing protocol to work toward end-to-end connectivity between the hosts. Where appropriate, use best practices such as descriptions on interfaces, hosts tables, and so on. Configure r1 and work your way through r5. As always, test and document along the way and when you finish configuring.

Remember, however, that there is not always one right or wrong way to accomplish the tasks presented. The ability to obtain the end result using good practices is extremely important in any real-world network. My troubleshooting and device configurations start in Example 3-1;

you can compare your work to that and perhaps see a different approach to obtaining the end result. Figure 3-2 shows a picture of my lab before wiring, and Figure 3-3 shows the after-wiring picture. I have physically labeled each of my devices so that I don't have to think about that later. Refer back to Figure 3-1 as you continue to set up and troubleshoot.

Figure 3-2 *Scenario Lab Photo Before Wiring*

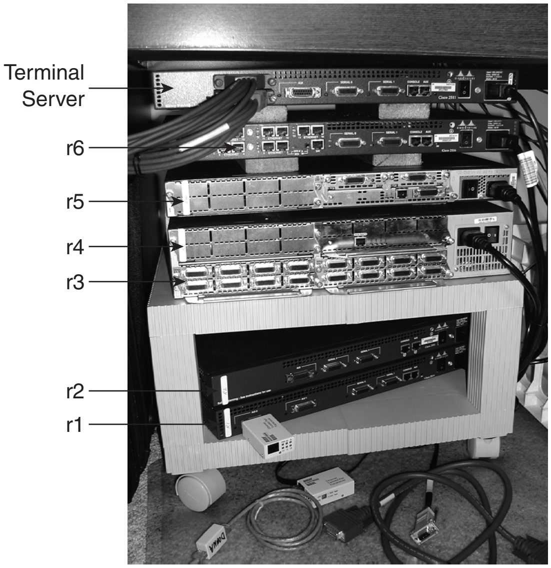
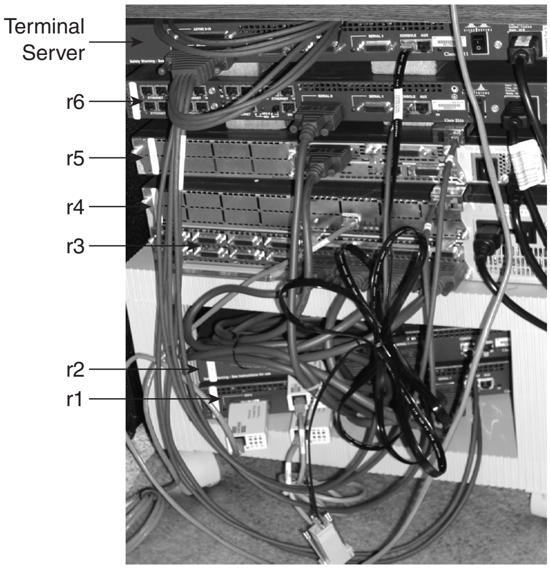


Figure 3-3 *Scenario Lab Photo After Wiring*



The terminal server at the top of the equipment stack in Figure 3-2 is not a required piece of equipment for the lab, but more a convenience. I am using a Cisco 2511 with the first five terminal leads connected to each of the console ports on my five routers. See Appendix C for more information on how to configure a terminal server and use one for your lab. My 2511 configuration is in Example 3-1 with the significant output shaded.

Example 3-1 *Terminal Server Configuration (2511)*

```
ts#show running-config
...
hostname ts
enable password donna
ip subnet-zero
ip host r1 2001 1.1.1.1
ip host r2 2002 1.1.1.1
ip host r3 2003 1.1.1.1
ip host r4 2004 1.1.1.1
ip host r5 2005 1.1.1.1
interface Loopback0
 ip address 1.1.1.1 255.0.0.0
 no ip directed-broadcast
...
line con 0
 transport input none
line 1 16
 transport input all
 no exec
line aux 0
line vty 0 4
 exec-timeout 30 0
 password donna
 logging synchronous
 login
end
```

Although I give you Figures 3-1 through 3-3, it is really a better practice to draw your own network diagram. Some people prefer columns and rows of this type of data, but I prefer colorful diagrams to assist with troubleshooting later. For example, you might draw your devices and media with a blue pen, label the IP parameters with a black pen, label IPX parameters with a red pen, draw a green circle around the Open Shortest Path First (OSPF) areas, and so on. Label which interfaces are DCE or DTE for your lab. Document device names, locations, Layer 2 and Layer 3 addresses, routed and bridged protocols, routing protocols, access control lists (ACLs), configuration files, and verify full connectivity. Perform some simple ping and trace tests (see Table 3-1), run **show tech-support**, and document some more. All of this gives you a starting point for normal *baseline* activity when your network is running well. Keep in mind that I want you to concentrate *only* on IP-related baselining for this chapter.

NOTE You will adjust your hands-on lab for new equipment, software, protocols, media, services, problems, and so on as you progress through various Trouble Tickets and chapters. Feel free to substitute whatever equipment you have for the hosts, routers, and switches in Figure 3-1. All 2600s and 3600s, or better yet all 6500s, would be nice, but that isn't what I have either.

Table 3-1 gives you a layered yet divide-and-conquer approach to quickly spotting IP issues. It would be wonderful if I could tell you to just start at the first item in the table and work your way through, but you need to think methodically (as Chapter 1, "Shooting Trouble," suggested). It is helpful to divide and conquer along the way in practical application to quickly narrow down the real problem. If you can't communicate with your gateway, for instance, it is a little difficult to communicate with a remote host. If you can't communicate with yourself, it is impossible to communicate with a local host.

Table 3-1 *IP Troubleshooting Checklist*

Isolating Problems	Commands and Symptoms
Check MAC address, IP address, subnet mask, default gateway, and other static or DHCP* parameters.	Windows NT/2000: **ipconfig /all** Windows 95/98: **winipcfg** UNIX: **ifconfig**
Ping your loopback from your workstation to see whether the TCP/IP stack is loaded.	**ping 127.0.0.1**
Ping yourself from your workstation to verify your NIC*.	**ping 192.168.1.11**
Ping a local host from your workstation to verify local communications.	**ping 192.168.1.12**
Ping your default gateway from your workstation to verify you can communicate with your local router interface.	**ping 192.168.1.1**
Are you getting ARPs* from the gateway? If so, the gateway's MAC address should be in the workstation ARP table.	**arp –a**
Ping a remote host and another if it fails from your workstation.	**ping 192.168.3.5**
Perform a trace to the remote host to find hop-by-hop router issues.	Windows: **tracert** [**-d**] UNIX/Cisco: **traceroute**
Is it a host problem or a router problem?	**show ip interface brief** **show run interface e0** **show ip interface e0** **show interfaces e0** **show ip route** **show ip protocols** **show ip arp** **show ip cache** **show ip access-list**

continues

Table 3-1 *IP Troubleshooting Checklist (Continued)*

Combine ping and trace to look for packet loss in the path.	**pathping 192.168.3.5**
Use an application to test the upper layers. NetBIOS issues Sockets issues	**Start => Run \\\\192.168.3.5** Find computer **nbtstat –A** *IP_address* **ping 192.168.3.1** **telnet 192.168.3.1** **ftp 192.168.3.1** **tftp 192.168.3.1**
Eliminate any name resolution issues by not using hostnames or NetBIOS names at first. When other things are working, fix any name resolution issues. Ensure name resolution files are in their required locations and have the appropriate names. Troubleshoot files, DNS*/WINS* servers, and the network issues to and from these devices.	Name resolution DNS, **hosts** file, NIS tables WINS, **lmhosts** file (NetBIOS) **nbtstat –c** (view cache) **nbtstat –R** (reload cache) Microsoft Browser services (NetBIOS issues) **Start**, **Run \\\\computername** Find computer or **net view** **nbtstat –A** *IP_address* Sockets issues **ping hostc** **telnet hostc**

*DHCP = Dynamic Host Configuration Protocol
NICs = Network interface card
ARPs = Address Resolution Protocol
DNS = Domain Name Service
WINS = Windows Internet Naming Service

NOTE Although the commands I use in this book are in their complete form, using truncated commands is virtually a mandatory practice in the real world. More importantly however, you should know the submode from which the command can be issued. At times I tend to issue global configuration commands in interface submode. This works just fine assuming that you don't need help in the midst of the command. If you are unsure, however, type the command from the appropriate submode and make use of the Tab key and ? for help.

Using the scenario diagram in Figure 3-1, configure r1 similar to what is in Example 3-2. My r1 is a Cisco 2514, but you can use any Cisco router that has two Ethernet interfaces and two serial interfaces for the lab. My passwords are all donna because that is easy to remember for the labs, but that is exactly why they should not all be donna for practical application. Throughout the following examples, I have made a few careless mistakes that you may or may not make. I will troubleshoot them when all my routers are configured per the scenario diagram.

Example 3-2 *r1 Configuration (2514)*

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname r1
r1(config)#enable password donna
r1(config)#line vty 0 4
r1(config-line)#login
r1(config-line)#password donna
r1(config-line)#exit
r1(config)#interface ethernet 0
r1(config-if)#description e0 to hosta and hostb
r1(config-if)#ip address 192.168.1.1 255.255.255.0
r1(config-if)#no shut
00:10:12: %LINK-3-UPDOWN: Interface Ethernet0, changed state to up
00:10:13: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0,
    changed state to up
r1(config)#interface ethernet 1
r1(config-if)#description e1 to r2e0
r1(config-if)#ip address 192.168.4.1 255.255.255.0
r1(config-if)#no shut
r1(config-if)#interface serial 0
r1(config-if)#description s0 to r5s0
r1(config-if)#ip address 10.1.1.1 255.255.255.0
r1(config-if)#bandwidth 64
r1(config-if)#no shut
00:13:11: %LINK-3-UPDOWN: Interface Serial0, changed state to down
r1(config-if)#ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
r1(config)#ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
r1(config)#$192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
r1(config)#ip host r4 10.2.2.2
r1(config)#ip host r5 10.1.1.2
r1(config)#router rip
r1(config-router)#network 192.168.1.0
r1(config-router)#network 192.168.2.0
r1(config-router)#network 192.168.4.0
r1(config-router)#network 10.1.1.0
r1(config-router)#end
r1#copy running-config startup-config
```

NOTE For the first router configuration, I illustrate the **enable** command to take you into enable mode **Router#** and the **configure terminal** command to take you to the global configuration mode **Router(config)#**, where the Cisco output reminds you that you can press Ctrl+Z to return to enable mode from any prompt. Alternatively, you can type **end** to return to the privileged prompt (enable mode) or **exit** to back up one level at a time. I will assume from this point on that you are very comfortable with entering and exiting these modes and therefore I will eliminate the initial **enable** and **configure terminal** commands from my examples.

NOTE Remember that the dollar sign ($) at the beginning of a line of user input is the Cisco IOS indication that the text was too much for the width of the terminal screen. You can always press Ctrl+A to get to the beginning or Ctrl+E to get to the end of a line.

Now move on to configuring r2 as in Example 3-3. My r2 is a Cisco 2501, but you can use any Cisco router that has at least one Ethernet interface and two serial interfaces for the lab. I copied the hosts table lines from r1 and pasted them into this configuration. In future examples, I plan to just paste the configuration for the hosts table and passwords to save a little typing.

Example 3-3 *r2 Configuration (2501)*

```
Router(config)#hostname r2
r2(config)#enable password donna
r2(config)#line vty 0 4
r2(config-line)#login
r2(config-line)#password donna
r2(config-line)#exit
r2(config)#interface ethernet 0
r2(config-if)#description e0 to r1e1
r2(config-if)#ip address 192.168.4.2 255.255.255.0
r2(config-if)#no shut
r2(config-if)#int
00:41:44: %LINK-3-UPDOWN: Interface Ethernet0, changed state to up
00:41:45: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0,
   changed state to ups0
r2(config-if)#description s0 to r3s0/1
r2(config-if)#bandwidth 64
r2(config-if)#ip address 192.168.6.1 255.255.255.0
r2(config-if)#no shut
00:42:22: %LINK-3-UPDOWN: Interface Serial0, changed state to down
r2(config-if)#interface serial 1
r2(config-if)#description s1 to r3s0/2
r2(config-if)#bandwidth 64
r2(config-if)#ip address 192.168.5.1 255.255.255.0
r2(config-if)#router rip
r2(config-router)#network 192.168.4.0
r2(config-router)#network 192.168.5.0
```

Example 3-3 *r2 Configuration (2501) (Continued)*

```
r2(config-router)#network 192.168.6.0
r2(config-router)#exit
r2(config)#ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
r2(config)#ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
r2(config)#$192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
r2(config)#ip host r4 10.2.2.2
r2(config)#ip host r5 10.1.1.2
r2(config)#end
r2#copy running-config startup-config
```

NOTE The shaded output may appear a little confusing in text and is quite annoying in practice. Had I turned on **logging synchronous**, my input would not have been interrupted. You should do this for your configurations.

Configure the rest of your routers now and check your work using the following examples. I copied the text in Example 3-4 to Windows Notepad to easily paste it into r3, r4, and r5.

Example 3-4 *Notepad File Including Passwords and Hosts Table*

```
enable password donna
ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
ip host r3 192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
ip host r4 10.2.2.2
ip host r5 10.1.1.2
line vty 0 4
login
password donna
line console 0
logging synchronous
exit
```

Example 3-5 and Example 3-6 start my r3 configuration. My r3 is a Cisco 3640, but you can use any Cisco router that has at least one Ethernet interface and four serial interfaces for the lab. Although the capabilities are not important in this chapter, having multiple serial interfaces on a router enables you to set up your own Frame Relay switch later in the book. Depending on the capabilities, the Fast Ethernet interface will give you an opportunity to experiment with duplex and speed concepts as well.

Note in Example 3-5 that I attempted to configure the e0 interface when it was really fa2/0 that I needed to configure. A physical inspection of the device confirmed that the Fast Ethernet port was located in Slot 2; because you can't physically see my device, however, I proceeded with the **show interfaces** command.

NOTE In practical troubleshooting, don't forget the little things. For example, the position of the caret (^) is quite helpful in finding exactly where the syntax error exists within a line.

Wherever you see ... I eliminated some of the output to shorten the length of the configuration.

Example 3-5 *r3 Configuration (3640)*

```
Router(config)#hostname r3
r3(config)#enable password donna
r3(config)#ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
r3(config)#ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
r3(config)#$192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
r3(config)#ip host r4 10.2.2.2
r3(config)#ip host r5 10.1.1.2
r3(config)#line vty 0 4
r3(config-line)#login
r3(config-line)#password donna
r3(config-line)#line console 0
r3(config-line)#logging synchronous
r3(config-line)#exit
r3(config)#int e0
                ^
% Invalid input detected at '^' marker.
r3(config)#end
r3#show interfaces
Serial0/0 is administratively down, line protocol is down
  Hardware is CD2430 in sync mode
...
FastEthernet2/0 is administratively down, line protocol is down
  Hardware is AmdFE, address is 00b0.6481.e300 (bia 00b0.6481.e300)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  Half-duplex, 100Mb/s, 100BaseTX/FX
  ARP type: ARPA, ARP Timeout 04:00:00
...
r3#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
r3(config)#interface fastethernet 2/0
r3(config-if)#ip address 192.168.3.1 255.255.255.0
r3(config-router)#interface serial 0/0
r3(config-if)#desc r3s0/0 to r1s1
r3(config-if)#bandwidth 64
r3(config-if)#clock rate 64000
r3(config-if)#ip address 192.168.2.2 255.255.255.0
r3(config-if)#no shut
r3(config-if)#interface serial 0/1
r3(config-if)#description r3s0/1 to r2s0
r3(config-if)#bandwidth 64
```

Example 3-5 *r3 Configuration (3640) (Continued)*

```
r3(config-if)#clock rate 64000
r3(config-if)#ip address 192.168.6.2 255.255.255.0
r3(config-if)#no shut
r3(config-if)#interface serial 0/2
r3(config-if)#description r3s0/2 to r2s1
r3(config-if)#bandwidth 64
r3(config-if)#clock rate 64000
r3(config-if)#ip address 192.168.5.2 255.255.255.0
r3(config-if)#no shut
```

Finish configuring r3, r4, and r5 and test your configurations.

Now that you have configured your lab, perform some basic lower-layer tests to verify your drawing and your internetwork. Make sure all used interfaces are in a line protocol up state as in Example 3-6; if they are not in a line protocol up state, fix any noticeable problems at this point. Notice how **show ip interface brief** is a very appropriate command to quickly spot lower-level issues.

Example 3-6 *IP Interface Testing*

```
r1>show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0              192.168.1.1     YES NVRAM  up                    up
Ethernet1              192.168.4.1     YES manual up                    up
Serial0                10.1.1.1        YES NVRAM  up                    up
Serial1                unassigned      YES unset  administratively down down
r2>show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0              192.168.4.2     YES NVRAM  up                    up
Serial0                192.168.6.1     YES NVRAM  up                    up
Serial1                192.168.5.1     YES NVRAM  administratively down down
r3>show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0              192.168.2.2     YES unset  down                  down
Serial0/1              192.168.6.2     YES unset  up                    up
Serial0/2              192.168.5.2     YES unset  down                  down
Serial0/3              unassigned      YES unset  down                  down
...
FastEthernet2/0        192.168.3.1     YES manual up                    down
r4>show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            unassigned      YES unset  administratively down down
Serial0/0              10.2.2.2        YES manual down                  down
Serial0/1              unassigned      YES unset  administratively down down
r5>sh ip int brie
Interface              IP-Address      OK? Method Status                Protocol
BRI0                   unassigned      YES unset  administratively down down
BRI0:1                 unassigned      YES unset  administratively down down
BRI0:2                 unassigned      YES unset  administratively down down
Ethernet0              unassigned      YES unset  administratively down down
Serial0                10.1.1.2        YES manual up                    up
Serial1                unassigned      YES unset  administratively down down
```

NOTE In the real world of supporting networks, I typically use the shortcut **sh ip int brie** to quickly identify my interface status and addresses. I spell **brief** out to the cheese (**brie**) just in case there are any ISDN Basic Rate Interfaces (BRI).

Think about these line and protocol issues. Target the lower layers to get all the required interfaces to a status of *up/up* before you continue. Check your work using the following examples.

First I spotted, for interface s1, the unassigned IP address and the administratively down status on r1, which I correct in Example 3-7. Because my interface command was interrupted once more, I must have forgotten **logging synchronous** on r1, so I added it and saved the configuration.

Example 3-7 *Correcting Interface Issues on r1*

```
r1(config)#interface serial 1
r1(config-if)#description s1 to r3s0/0
r1(config-if)#bandwidth 64
r1(config-if)#ip address 192.168.2.1 255.255.255.0
r1(config-if)#no shut
05:16:39: %LINK-3-UPDOWN: Interface Serial1, changed state to up
05:16:40: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1, changed state
  to up
r1(config-if)#end
r1#sh i
05:16:50: %SYS-5-CONFIG_I: Configured from console by consolep int brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0              192.168.1.1     YES NVRAM  up                    up
Ethernet1              192.168.4.1     YES manual up                    up
Serial0                10.1.1.1        YES NVRAM  up                    up
Serial1                192.168.2.1     YES manual up                    up
r1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
r1(config)#line console 0
r1(config-line)#logging synchronous
r1(config-line)#end
r1#copy running-config startup-config
```

The r1s1 interface would have come up fine without the bandwidth statement, but it is optimal for routing protocols to configure the correct bandwidth statement on your interfaces. The **description** is optional as well, but it certainly makes troubleshooting easier when you know exactly what is connected to an interface. Now move along to r2, which has issues with interface s1 being administratively down. Fix these issues now and check your work in Example 3-8.

Example 3-8 *Correcting Interface Issues on r2*

```
r2(config)#interface serial 1
r2(config-if)#no shut
05:20:08: %LINK-3-UPDOWN: Interface Serial1, changed state to up
05:20:09: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1,
    changed state to up
r2(config-if)#end
r2#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0              192.168.4.2     YES NVRAM  up                    up
Serial0                192.168.6.1     YES NVRAM  up                    up
Serial1                192.168.5.1     YES NVRAM  up                    up
r2#copy running-config startup-config
```

r3 requires you to look at your drawing more closely so that you can concentrate on just the interfaces being used. Configure any missing IP addresses and issue a **no shut** command on any used interfaces that are showing as *administratively down*. Check the status of the interfaces in Example 3-9.

Example 3-9 *Correcting Interface Issues on r3*

```
r3#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0              192.168.2.2     YES manual up                    up
Serial0/1              192.168.6.2     YES manual up                    up
Serial0/2              192.168.5.2     YES manual up                    up
Serial0/3              unassigned      YES manual down                  down
...
FastEthernet2/0        192.168.3.1     YES manual up                    down
```

Example 3-9 indicates that a problem still exists with s0/3 and fa2/0. The other end (host) is not running for my Ethernet hostc connection, but you need to examine further the cause of the down/down status for s0/3. Think about what's in your tool bag from the preceding chapter to assist you further in spotting lower-layer problems. Check your thoughts against Example 3-10.

Example 3-10 *Correcting Physical Issues on r3*

```
r3#show controllers serial 0/3
CD2430 Slot 0, Port 3, Controller 0, Channel 3, Revision 15
Channel mode is synchronous serial
idb 0x6129A1A0, buffer size 1524, V.35 DTE cable
...
```

Everything looks normal on the r3 end of things from a physical point of view, so now investigate the other end of the connection as in Example 3-11.

Example 3-11 *Investigate r4 serial 0/0 Connection*

```
r4#show controllers serial 0/0
Interface Serial0/0
Hardware is Quicc 68360
No serial cable attached
idb at 0x60AC9A40, driver data structure at 0x60ACEE10
...
```

I have an advantage in that I can physically inspect my devices; I hope you can do the same if you are following along in your own lab. If you look very closely in the picture of my equipment, you may be able to detect the error, but I won't assume that for now. The **show controllers** commands certainly display the problem here. Although I did not specifically illustrate the output of **show controllers s0/1**, the output of s0/0 is quite helpful. I had the cable plugged into s0/1 rather than s0/0 on r4. On the 3640, s0/0 is closest to the power switch, which is typical. This mistake affected the serial connection between r3 and r4. Example 3-12 shows the output **show ip interface brief** after the physical correction and assigning the appropriate address to s0/3.

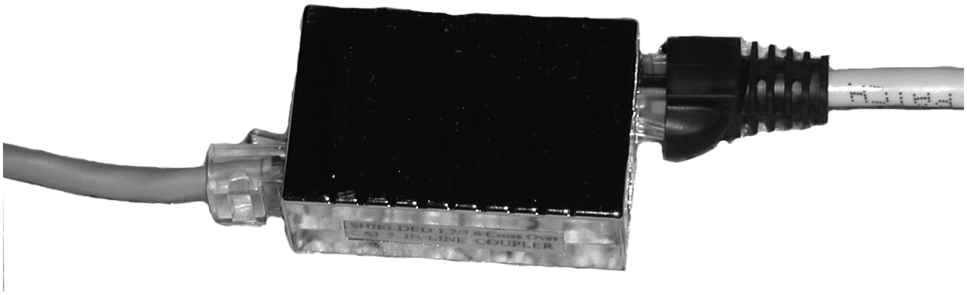
Example 3-12 *After the Physical Cable Swap from serial 0/1 to serial 0/0*

```
r3#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0              192.168.2.2     YES manual up                    up
Serial0/1              192.168.6.2     YES manual up                    up
Serial0/2              192.168.5.2     YES manual up                    up
Serial0/3              10.2.2.1        YES manual up                    up
...
FastEthernet2/0        192.168.3.1     YES manual up                    down
r3#copy running-config startup-config
```

After you bring your hosts back online, the Fast Ethernet 2/0 status should change from *up/down* to *up/up*. I give that a test in Example 3-13. My Fast Ethernet interface did not come up when I brought the host online, so follow along to determine the issue.

The first thing I noted was that the network card dongle did not light up for 10 or 100 Mbps. Next, look at Figure 3-1 and label what type of cable you need if you have the PC connected directly into the Fast Ethernet port. Category 5 crossover is correct. I fixed the problem by replacing my original straight-through cable with a crossover Category 5 in-line coupler so that I could use two short straight-through cables to make my connection. Figure 3-4 shows a picture of the coupler. In practical application, this is where using colored cables would help you to very quickly spot the issue. For example, use the normal gray cable for straight-through and use red for crossovers. Things appear to be working for now in Example 3-13.

Figure 3-4 *Crossover Category 5 In-line Coupler*



Example 3-13 *Fast Ethernet 2/0 Status*

```
r3#show run interface fastethernet 2/0
interface FastEthernet2/0
 ip address 192.168.3.1 255.255.255.0
 no ip directed-broadcast
end
...
07:22:02: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0,
    changed state to up
r3#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0              192.168.2.2     YES manual up                    up
Serial0/1              192.168.6.2     YES manual up                    up
Serial0/2              192.168.5.2     YES manual up                    up
Serial0/3              10.2.2.1        YES manual up                    up
...
FastEthernet2/0        192.168.3.1     YES manual up                    up
```

Make sure you have made all corrections, including those that you need for your lab, so that you can continue the tests in Example 3-14 for some simple router ping tests. Recall from the preceding chapters that ping tests up through Layer 3.

Example 3-14 *Testing the Scenario with Ping*

```
r1>ping r2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.4.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 4/4/4 ms
r1>ping r3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/30/32 ms
r1>ping r4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
r1>ping r5
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 = 28/30/32 ms
```

Next check the routing tables and routing protocols as in Example 3-15 to make sure r1 has a route to get to r4.

Example 3-15 *r1 Routing Table*

```
r1>show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR
Gateway of last resort is not set…
C    192.168.4.0/24 is directly connected, Ethernet1
R    192.168.5.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial1
     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Serial0
R    192.168.6.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial1
C    192.168.1.0/24 is directly connected, Ethernet0
C    192.168.2.0/24 is directly connected, Serial1
R    192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:02, Serial1
r1>show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 3 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 1, receive any version
    Interface        Send  Recv   Key-chain
    Ethernet0        1     1 2
    Ethernet1        1     1 2
    Serial0          1     1 2
```

Example 3-15 *r1 Routing Table (Continued)*

```
    Serial1          1     1 2
  Routing for Networks:
    10.0.0.0
    192.168.1.0
    192.168.2.0
    192.168.4.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.2          120      00:00:02
  Distance: (default is 120)
```

Continue to think about the issue here; the output contains some pretty useful information (particularly the shaded areas). However, you should analyze any problems that I specifically mentioned and fix them now. Check your configurations against mine so that you can return and continue to test out end-to-end host connectivity. I made a few other minor changes, which I highlight in the next few examples. Examples 3-16 through 3-21 include the running configurations for all my routers at this time.

NOTE Checking the running and startup configurations is not the most efficient way to troubleshoot, but this is a good check to make sure that your configurations are as close to mine as possible with your lab environment. For those of you who are relying on me for your lab, this gives you an opportunity to analyze the configurations for existing and future issues.

Example 3-16 *r1 (2514) Configuration*

```
r1#show running-config
...
hostname r1
enable password donna
ip subnet-zero
ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
ip host r3 192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
ip host r4 10.2.2.2
ip host r5 10.1.1.2
!
interface Ethernet0
 description e0 to hosta and hostb
 ip address 192.168.1.1 255.255.255.0
 no ip directed-broadcast
interface Ethernet1
 description e1 to r2e0
 ip address 192.168.4.1 255.255.255.0
 no ip directed-broadcast
interface Serial0
 description s0 to r5s0
 bandwidth 64
```

continues

Example 3-16 *r1 (2514) Configuration (Continued)*

```
 ip address 10.1.1.1 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
interface Serial1
 description s1 to r3s0/0
 bandwidth 64
 ip address 192.168.2.1 255.255.255.0
 no ip directed-broadcast
router rip
 network 10.0.0.0
 network 192.168.1.0
 network 192.168.2.0
 network 192.168.4.0
ip classless
line con 0
 logging synchronous
 transport input none
line aux 0
line vty 0 4
 password donna
 login
end
r1#
```

Next look at r2's configuration in Example 3-17.

Example 3-17 *r2 (2501) Configuration*

```
r2#show running-config
...
hostname r2
enable password donna
ip subnet-zero
ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
ip host r3 192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
ip host r4 10.2.2.2
ip host r5 10.1.1.2
interface Ethernet0
 description e0 to r1e1
 ip address 192.168.4.2 255.255.255.0
 no ip directed-broadcast
interface Serial0
 description s0 to r3s0/1
 bandwidth 64
 ip address 192.168.6.1 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 no fair-queue
interface Serial1
 description s1 to r3s0/2
 bandwidth 64
 ip address 192.168.5.1 255.255.255.0
```

Example 3-17 *r2 (2501) Configuration*

```
 no ip directed-broadcast
router rip
 network 192.168.4.0
 network 192.168.5.0
 network 192.168.6.0
ip classless
line con 0
 logging synchronous
 transport input none
line aux 0
line vty 0 4
 password donna
 login
end
r2#
```

Make any adjustments to your r2, and then analyze the r3 configuration in Example 3-18.

Example 3-18 *r3 (3640) Configuration*

```
r3#show running-config
...
hostname r3
enable password donna
ip subnet-zero
ip host r1 192.168.1.1 192.168.2.1 192.168.4.1 10.1.1.1
ip host r2 192.168.4.2 192.168.5.1 192.168.6.1
ip host r3 192.168.2.2 192.168.5.2 192.168.6.2 192.168.3.1 10.2.2.1
ip host r4 10.2.2.2
ip host r5 10.1.1.2
interface Serial0/0
 description s0/0 to r1s1
 bandwidth 64
 ip address 192.168.2.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 clockrate 64000
interface Serial0/1
 description s0/1 to r2s0
 bandwidth 64
 ip address 192.168.6.2 255.255.255.0
 no ip directed-broadcast
 clockrate 64000
interface Serial0/2
 description s0/2 to r2s1
 bandwidth 64
 ip address 192.168.5.2 255.255.255.0
 no ip directed-broadcast
 clockrate 64000
...
interface FastEthernet2/0
 description fa2/0 to hostc
 ip address 192.168.3.1 255.255.255.0
 no ip directed-broadcast
```

continues