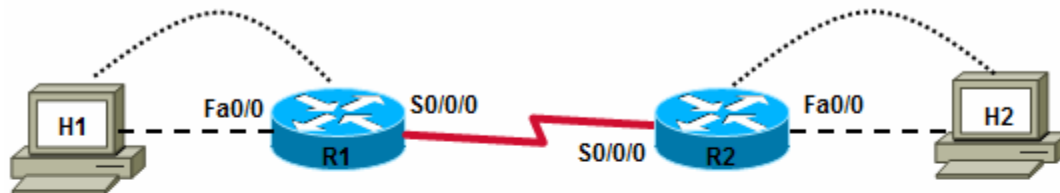


Lab 9.2.5 Troubleshooting WAN Connectivity



Device	Host Name	Interface	IP Address	Subnet Mask	Default Gateway
R1	R1	Fast Ethernet 0/0	192.168.1.1	255.255.255.0	N/A
		Serial 0/0/0 (DCE)	192.168.3.1	255.255.255.252	N/A
R2	R2	Fast Ethernet 0/0	192.168.2.1	255.255.255.0	N/A
		Serial 0/0/0 (DTE)	192.168.3.2	255.255.255.252	N/A
H1	H1	NIC	192.168.1.11	255.255.255.0	192.168.1.1
H2	H2	NIC	192.168.2.22	255.255.255.0	192.168.2.1

Objectives:

- Build a multi-router network and verify connectivity.
- Troubleshoot WAN connectivity using the LEDs and **show** commands to find link problems and encapsulation and timing mismatches.

Background / Preparation

Troubleshooting a serial WAN connection is different from troubleshooting Ethernet LAN connections. Most serial interface and line problems can be identified and corrected using information gathered from the **show interface serial** command. In addition to the transmission errors shown in the error counters, serial connections may experience problems caused by errors or mismatches in encapsulation and timing. In prototype networks, such as those created in a lab environment, a router can be configured to provide DCE clocking functions, eliminating the CSU or modem.

In this lab, you build a multi-router network with a serial WAN link. You will alter the encapsulation and clock speed settings for the serial interfaces and observe the effects on links lights and interface status.

Set up a network similar to the one in the topology diagram. Any router that meets the interface requirements displayed in that diagram—such as 800, 1600, 1700, 1800, 2500, or 2600 routers, or a combination of these, can be used. See the Router Interface Summary table at the end of the lab to determine which interface identifiers to use based on the equipment in the lab. Depending on the model of the router, output may vary from what is shown in this lab.

Required Resources

The following resources are required:

- Two 1841 routers or other routers with one Fast Ethernet and one serial interface
- Two Windows XP computers
- Two crossover Category 5 Ethernet cables
- Null serial cable (R1 to R2)
- At least one console cable
- Access to the command prompt for each host
- Access to the network TCP/IP configuration host

From the host computer, start a HyperTerminal session to the router.

Note: Make sure that the routers have been erased and have no startup configurations. Instructions for erasing are provided in the Lab Manual, located on Academy Connection in the Tools section. Check with the instructor if you are unsure of how to do this.

Task 1: Build the Network and Configure Devices

Step 1: Configure the basic information on the routers.

- Build and configure the network according to the topology diagram and device configuration table. Configure basic settings on router R1 and R2. If necessary, see Lab 5.3.5, "Configuring Basic Router Settings with the Cisco IOS CLI," for instructions on setting the host name, passwords, and interface addresses.

Note: Be sure to configure the clock rate for the R1 serial 0/0/0 interface (DCE).

- Save the running configuration on router R1 and R2 using the **copy running-config startup-config** command from privileged EXEC mode.

Step 2: Configure the hosts.

Configure H1 and H2 with an IP address, subnet mask, and default gateway according to the device configuration table.

Task 2: Verify Cabling and Interface LEDs

Step 1: Visually inspect the network connections.

- After cabling the network devices, verify the connections. Attention to detail now minimizes the time required to troubleshoot network connectivity issues later.
- Are all cables and terminations in good condition? _____

Step 2: Visually inspect interface link LEDs.

- What is the color of the link lights for the router R1 Fast Ethernet interface to which host H1 is attached? _____
- What is the color of the link light on the host H1 NIC? _____
- What is the color of the link light for the router R1 serial 0/0/0 to which router R2 is attached? _____

Task 3: Verify Router Interface Status and Connectivity

Step 1: Verify the status of the interfaces on R1.

- a. From the HyperTerminal session on router R1, use the **show ip interface brief** command to see the status summary of all interfaces.

```
R1#show ip interface brief
Interface          IP-Address      OK? Method Status                Protocol
FastEthernet0/0    192.168.1.1    YES NVRAM    up                    up
FastEthernet0/1    unassigned      YES manual    administratively down down
Serial0/0/0        192.168.3.1    YES manual    up                    up
Serial0/0/1        unassigned      YES NVRAM    administratively down down
Vlan1              unassigned      YES NVRAM    up                    down
```

- b. Which interfaces have a status of **up** and a protocol that is **up**? _____

Step 2: View the details of the serial 0/0/0 interface on R1.

- a. Issue the **show interface serial** command to view the details of the interface.

```
R1#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: WAN link to R2
  Internet address is 192.168.3.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:05, output 00:00:08, 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: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations 0/1/256 (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
    1154 packets input, 75892 bytes, 0 no buffer
    Received 914 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    908 packets output, 63486 bytes, 0 underruns
    0 output errors, 0 collisions, 8 interface resets
    0 output buffer failures, 0 output buffers swapped out
    25 carrier transitions

  DCD=up DSR=up DTR=up RTS=up CTS=up
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. What is the Internet address? _____
- e. What is the encapsulation? _____

Step 3: Verify the status of the interfaces on R2.

- a. From the HyperTerminal session on router R2, use the **show ip interface brief** command to see the status summary of all interfaces.

```
R2#show ip interface brief
Interface          IP-Address      OK? Method Status                Protocol
FastEthernet0/0    192.168.2.1     YES NVRAM   up                    up
FastEthernet0/1    unassigned      YES manual  administratively down  down
Serial0/0/0        192.168.3.2     YES manual  up                    up
Serial0/0/1        unassigned      YES NVRAM   administratively down  down
Vlan1              unassigned      YES NVRAM   up                    down
```

- b. Which interfaces have a status of up and a protocol that is up? _____

Step 4: View the details of serial 0/0/0 interface on R2.

- a. Enter the **show interface serial** command to view the details of the interface.

```
R2#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: WAN link to R1
  Internet address is 192.168.3.2/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:02, output 00:00:00, 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: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations  0/1/256 (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
    179 packets input, 13104 bytes, 0 no buffer
    Received 169 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    195 packets output, 13252 bytes, 0 underruns
    0 output errors, 0 collisions, 3 interface resets
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions
  DCD=up   DSR=up   DTR=up   RTS=up   CTS=up
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. What is the Internet address? _____
- e. What is the encapsulation? _____

Step 5: Verify serial link connectivity between the routers.

From the HyperTerminal session on R1, ping the IP address of the R2 serial 0/0/0 interface.

```
R1#ping 192.168.3.2
```

Note: If the pings are not successful, troubleshoot the router configurations and connections.

Task 4: Change the Clock Rate

Step 1: On router R1, remove the clock rate from serial 0/0/0.

The R1 serial 0/0/0 interface is currently providing the DCE clock signal for the serial WAN link.

- a. Use the **no clock rate** command to remove the clock from Serial 0/0/0.

```
R1(config)#interface serial 0/0/0
R1(config-if)#no clock rate
R1(config-if)#end
```

- b. Which console messages, if any, are displayed when the clock rate is removed?
-

Step 2: View the details of the interface.

- a. Issue the **show interface serial** command on R1.

Note: The following output is from a Cisco 1841 router. If you are not using an 1841 and you received an error message in the previous step, the line protocol is down.

```
R1#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Description: WAN link to R2
  Internet address is 192.168.3.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:01, 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: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations  0/1/256 (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
    80 packets input, 6205 bytes, 0 no buffer
    Received 80 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    81 packets output, 6229 bytes, 0 underruns
    0 output errors, 0 collisions, 5 interface resets
    0 output buffer failures, 0 output buffers swapped out
    1 carrier transitions
    DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

- b. What is the status of the R1 serial 0/0/0 interface and line protocol? _____

Note: This lab uses Cisco 1841 routers with Cisco IOS software release 12.4(10). When the clock rate is removed from the DCE serial 0/0/0 interface, the 1841 router automatically reinserts the clock rate at a default speed of 2000000 bps (2 Mbps).

If a router such as a 2600 series is used, the serial 0/0/0 interface goes to up/down status when the clock rate is removed from the DCE interface serial 0/0/0.

Step 3: On router R1, reset the clock rate on serial 0/0/0.

- Use the Cisco IOS help feature with the **clock rate** command to determine the range of clock rate settings.

```
R1(config)#interface serial 0/0/0
R1(config-if)#clock rate ?
```

- What is the highest setting listed? _____
- On router R1, apply a clock rate of 128000 bps to serial 0/0/0.

```
R1(config)#interface serial 0/0/0
R1(config-if)#clock rate 128000
R1(config-if)#end
```

Note: Even though the **clock rate** command lists settings up to 8000000, depending on the router model and serial interface type, the router interface may not be able to support speeds above 128000. The 1841 router with a WIC 2T modular serial interface can support speeds up to 8000000 bps.

The following message is from a 2600 router with Cisco IOS software release 12.2 and a WIC 2A/S modular serial interface. The WIC 2A/S interface supports speeds up to 128000 but displays an error message when attempting to set the clock rate to anything higher.

```
R1(config-if)#clock rate 148000
%Error: Unsupported clock rate for this interface
```

Task 5: Remove the Serial Cable and Observe the Effects

Step 1: Remove the cable from router R1 serial 0/0/0.

Which console messages, if any, are displayed when the cable is removed?

Step 2: On router R1, use the show interface serial command.

- Issue the **show interface serial** command to view the details of the interface.

```
R1#show interface serial 0/0/0
Serial0/0/0 is down, line protocol is down
Hardware is GT96K Serial
Description: WAN link to R2
Internet address is 192.168.3.1/30
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:04:03, output 00:03:56, output hang never
Last clearing of "show interface" counters 01:36:07
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 0/1/256 (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
954 packets input, 36318 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
1163 packets output, 37144 bytes, 0 underruns
0 output errors, 0 collisions, 119 interface resets
0 output buffer failures, 0 output buffers swapped out
145 carrier transitions
DCD=up DSR=up DTR=down RTS=down CTS=up
```

- b. What is the status of the R1 serial 0/0/0 interface and line protocol? _____

Step 3: Reconnect the serial cable to the R1 serial 0/0/0 interface.

- a. Did the interface and line protocol come back up? _____
- b. Are there any runts, giants, input errors, CRC errors, output errors, collisions, or interface resets?
-

Step 4: On router R1, clear the counters on serial 0/0/0.

- a. Use the **clear counters serial** command to reset the interface statistics.

```
R1#clear counters serial 0/0/0
Clear "show interface" counters on this interface [confirm]
R1#
*Mar  5 21:30:54.258: %CLEAR-5-COUNTERS: Clear counter on interface
Serial0/0/0 by console
```

- b. Issue the **show interface serial 0/0/0** command to view the details of the interface. Have the interface statistics been reset? _____

Task 6: Change the Encapsulation Type

Step 1: Verify the current serial status and Data Link Layer 2 encapsulation.

- a. Issue the **show interface serial 0/0/0** command to view the details of the interface on R1.

```
R1#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is down
Hardware is GT96K Serial
Description: WAN link to R2
Internet address is 192.168.3.1/30
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:08, output 00:00:17, output hang never
Last clearing of "show interface" counters 00:01:25
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 0/1/256 (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
```

```
9 packets input, 206 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
20 packets output, 280 bytes, 0 underruns
0 output errors, 0 collisions, 4 interface resets
0 output buffer failures, 0 output buffers swapped out
6 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. What is the encapsulation? _____

Step 2: Change the serial interface encapsulation on R1.

- a. Use the Cisco IOS help feature with the **encapsulation** command to see which encapsulation type settings are available.

```
R1(config)#interface serial 0/0/0
R1(config-if)#encapsulation ?
```

- b. Which encapsulation choices are available?

- c. Change the encapsulation type to PPP.

```
R1(config)#interface serial 0/0/0
R1(config-if)#encapsulation ppp
```

- d. What console messages are displayed?

Step 3: Verify the interface status and encapsulation on R1.

- a. Issue the **show interface serial** to view the details of the R1 serial 0/0/0 interface.

```
R1#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is down
Hardware is GT96K Serial
Description: WAN link to R2
Internet address is 192.168.3.1/30
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, LCP Listen, loopback not set
Keepalive set (10 sec)
Last input 00:00:08, output 00:00:17, output hang never
Last clearing of "show interface" counters 00:01:25
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 0/1/256 (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
9 packets input, 206 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
```



```
20 packets output, 280 bytes, 0 underruns
0 output errors, 0 collisions, 4 interface resets
0 output buffer failures, 0 output buffers swapped out
6 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. What is the encapsulation? _____

Step 4: Check the serial interface encapsulation on R2.

- a. Issue the **show interface serial** command to view the details of the R2 serial 0/0/0 interface.

```
R2#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is down
Hardware is GT96K Serial
Description: WAN link to R1
Internet address is 192.168.3.2/30
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:03, output 00:00:01, 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: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations 0/1/256 (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
729 packets input, 30809 bytes, 0 no buffer
Received 729 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
548 packets output, 30055 bytes, 0 underruns
0 output errors, 0 collisions, 63 interface resets
0 output buffer failures, 0 output buffers swapped out
204 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. What is the encapsulation? _____
- e. Why is the line protocol for both R1 and R2 now down?

Step 5: Change the serial interface encapsulation on R2.

- a. Now change the encapsulation type on the R2 interface to PPP.

```
R2(config)#interface serial 0/0/0
R2(config-if)#encapsulation ppp
```

- b. What console messages are displayed?

Step 6: Check the interface status on R2.

- a. Issue the **show ip interface brief** command to view the status of all R2 interfaces.

```
R2#show ip interface brief
Interface          IP-Address      OK? Method Status                Protocol
FastEthernet0/0    192.168.2.1     YES NVRAM    up                    up
FastEthernet0/1    unassigned      YES NVRAM    administratively down down
Serial0/0/0        192.168.3.2     YES NVRAM    up                    up
Serial0/0/1        unassigned      YES NVRAM    administratively down down
Vlan1              unassigned      YES NVRAM    up                    down
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____

Step 7: Check the interface status on R1.

- a. Issue the **show ip interface brief** command to view the status of all R1 interfaces.

```
R1#show ip interface brief
```

- b. What is the status of serial 0/0/0? _____
- c. What is the status of the line protocol? _____
- d. Issue the **show running-config interface** command to view the commands used to configure the R1 serial 0/0/0 interface.

```
R1(config)#show run int Serial 0/0/0

Building configuration...

Current configuration : 137 bytes
!
interface Serial0/0/0
 description WAN link to R2
 ip address 192.168.3.1 255.255.255.252
 encapsulation ppp
 clockrate 128000
end
```

Step 8: Verify that the serial connection is functioning.

- a. Ping from R1 to R2 to verify that there is connectivity between the two routers.

```
R1#ping 192.168.3.2
R2#ping 192.168.3.1
```

Can the serial interface on R2 be pinged from R1? _____

Can the serial interface on R1 be pinged from R2? _____

- b. If the answer is no for either question, troubleshoot the router configurations to find the error. Repeat the pings until they are successful.

Task 7: Reflection

When WAN connectivity problems exist, always check link lights first and then check the cabling and terminations. Verify that interfaces are not shutdown. Verify that interfaces are set to the proper encapsulation and clock rate (if applicable). Check interface errors to determine if there is a problem with the physical interface itself. Always check both ends of the connection, if possible.

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
800 (806)	Ethernet 0 (E0)	Ethernet 1 (E1)		
1600	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
1700	Fast Ethernet 0 (FA0)	Fast Ethernet 1 (FA1)	Serial 0 (S0)	Serial 1 (S1)
1800	Fast Ethernet 0/0 (FA0/0)	Fast Ethernet 0/1 (FA0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2500	Ethernet 0 (E0)	Ethernet 1 (E1)	Serial 0 (S0)	Serial 1 (S1)
2600	Fast Ethernet 0/0 (FA0/0)	Fast Ethernet 0/1 (FA0/1)	Serial 0/0 (S0/0)	Serial 0/1 (S0/1)
Note: To find out exactly how the router is configured, look at the interfaces. The interface identifies the type of router and how many interfaces the router has. There is no way to effectively list all combinations of configurations for each router class. What is provided are the identifiers for the possible combinations of interfaces in the device. This interface chart does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The information in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.				