Course: Cloud and Network Security
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Week 2: Build a Switch and Router Network Using Packet Tracer

Introduction

A **switch** is a hardware device that connects multiple devices within a Local Area network(LAN) and allows them to communicate by receiving and forwarding data packets to their intended destinations through packet switching. It uses a **MAC address** to send data to the correct port at the data link layer (Layer 2) of the OSI model, rather than broadcast the data to all devices. A switch is also used to segment networks into different subnetworks called subnets or LAN segments. Initially, hubs were used in place of switches; they broadcasted data to all connected devices, operating at the physical layer (Layer 1) which presented significant security risks. Switches are more secure because they prevent other devices from seeing traffic not intended for them.

A **router** is a network device that connects two or more packet-switched networks. Routers forward packets to their intended IP addresses and allow multiple devices to use the same Internet connection. A LAN usually requires a single router.

In this lab, I had to cable the equipment as shown in the topology diagram below in Packet Tracer. I then had to configure the devices to match the addressing table. After the configurations had been saved, I had to verify my configurations by testing for network connectivity. I used IOS commands to retrieve information from the devices to answer questions about my network equipment.

Addressing Table

Device	Interface	IP Address / Prefix	Default Gateway
R1	G0/0/0	192.168.0.1 /24	N/A
		2001:db8:acad::1/64	

		fe80::1	
	G0/0/1	192.168.1.1 /24	N/A
		200:db8:acad:1::1/64	
		fe80::1	
S1	VLAN 1	192.168.1.2 /24	192.168.1.1
PC-A	NIC	192.168.1.3 /24	192.168.1.1
		2001:db8:acad:1::3/64	fe80::1
PC-B	NIC	192.168.0.3 /24	192.168.0.1
		2001:db8:acad::3/64	fe80::1

Requirements

• 1 Router (Cisco 4221 with Cisco IOS XE Release 16.9.4 universal image or comparable) • 1 Switch (Cisco 2960 with Cisco IOS Release 15.2(2) lanbasek9 image or comparable) • 2 PCs (Windows with a terminal emulation program, such as Tera Term)

• Console cables to configure the Cisco IOS devices via the console ports

• Ethernet cables as shown in the topology

Note: The Gigabit Ethernet interfaces on Cisco 4221 routers are autosensing and an Ethernet straight through cable may be used between the router and PC-B. If using another model Cisco router, it may be necessary to use an Ethernet crossover cable.

Objectives

1. Set Up the Topology and Initialize Devices

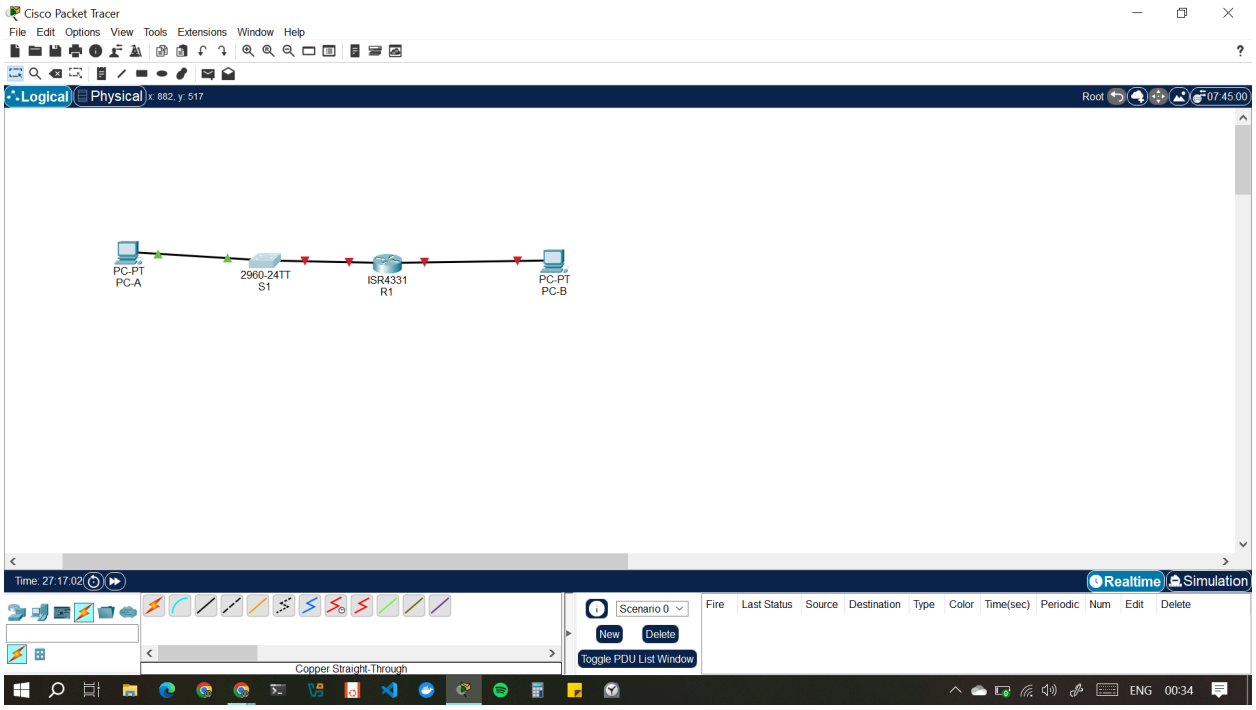
2. Configure Devices and Verify Connectivity

Part 1: Set Up Topology and Initialize Devices

Step 1: Cable the network as shown in the topology.

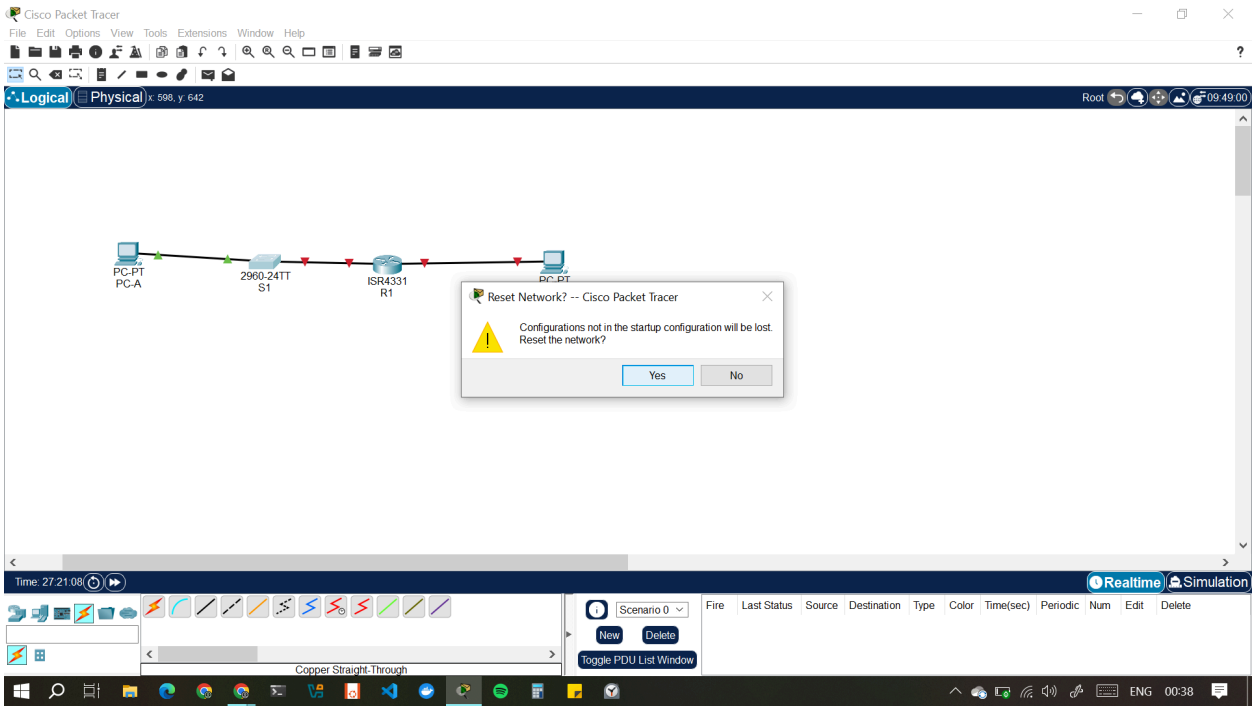
a. Attach the devices shown in the topology diagram, and cable, as necessary.

b. Power on all the devices in the topology.



Step 2: Initialize and reload the router and switch.

If configuration files were previously saved on the router and switch, initialize and reload these devices back to their default configurations.

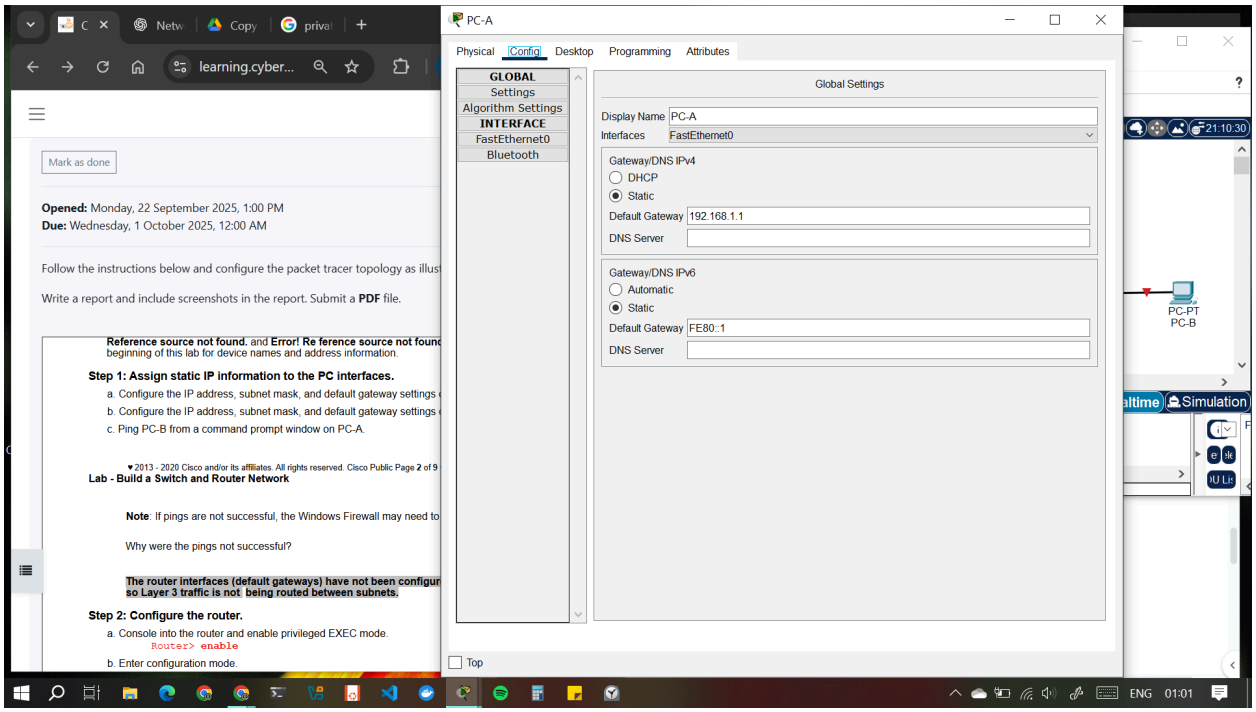


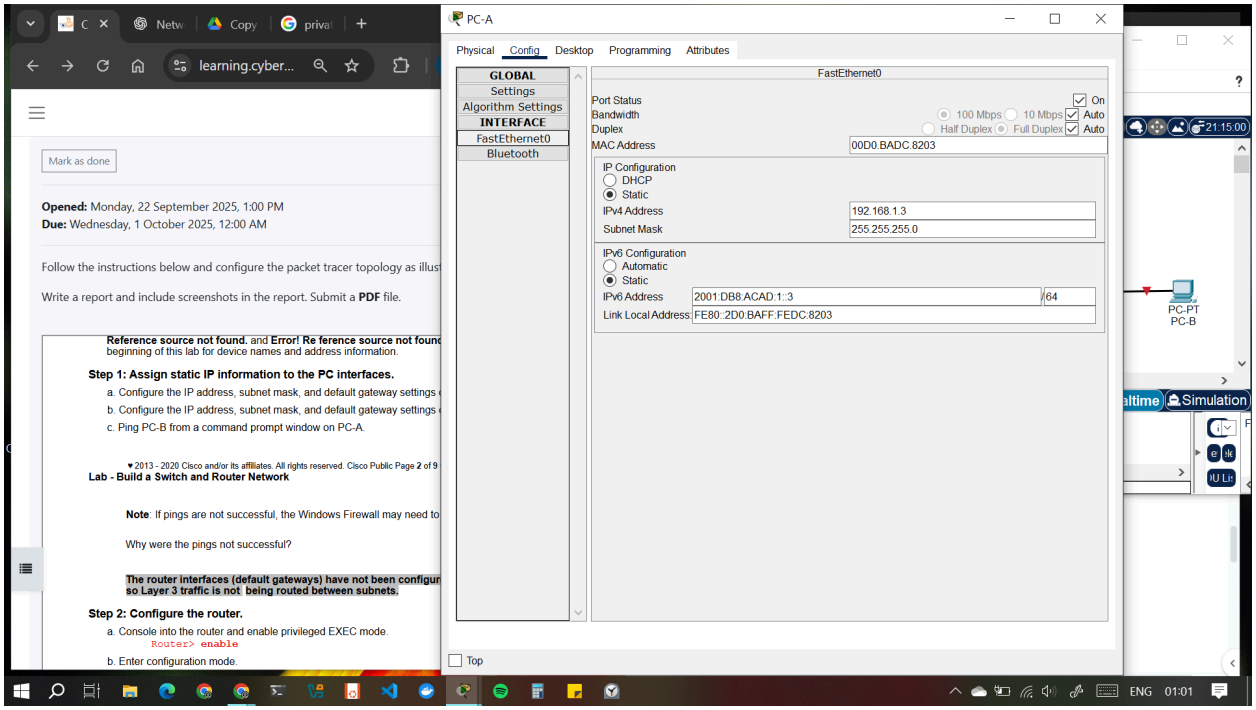
Part 2: Configure Devices and Verify Connectivity

In Part 2, I set up the network topology and configure basic settings, such as the interface IP addresses, device access, and passwords. Refer to the **Error! Reference source not found.** and **Error! Reference source not found.** at the beginning of this lab for device names and address information.

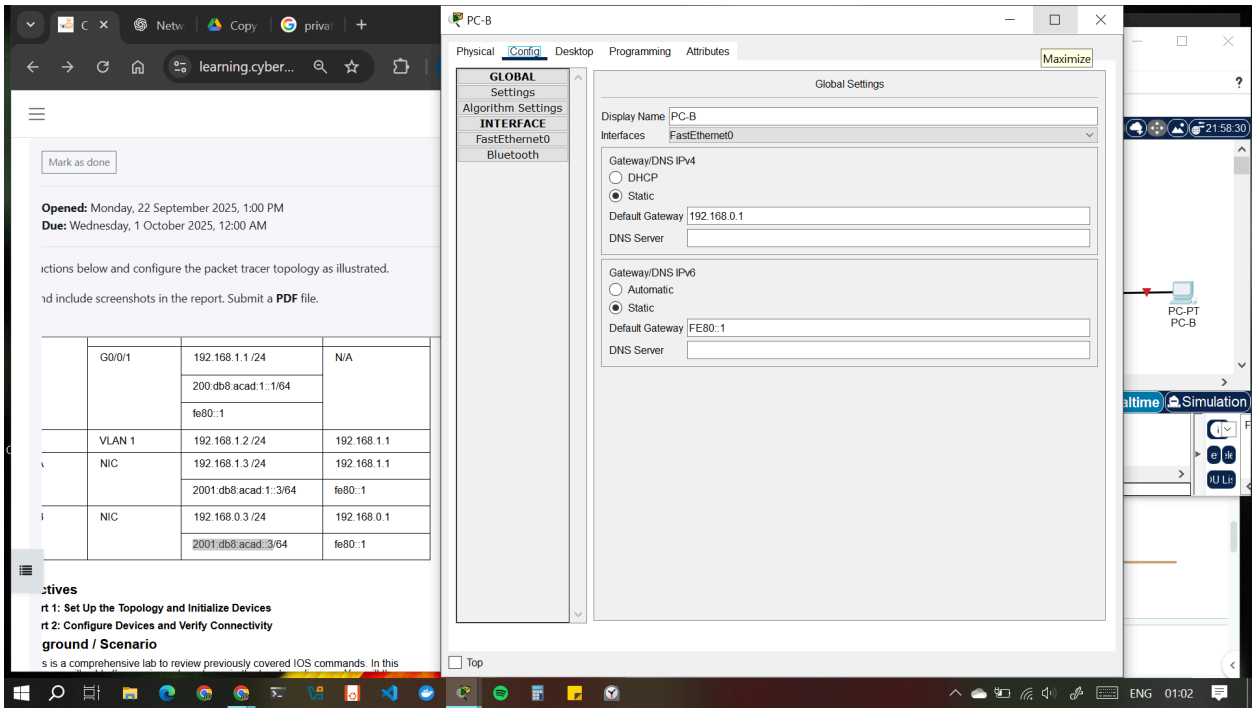
Step 1: Assign static IP information to the PC interfaces.

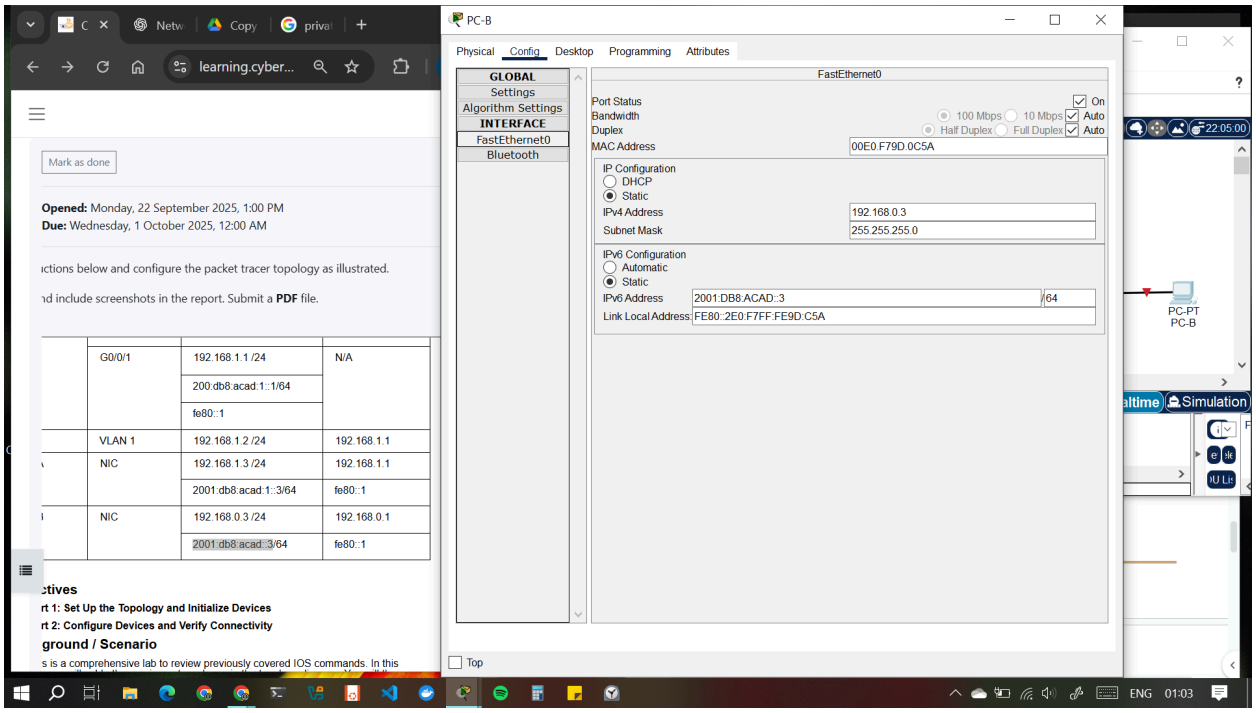
a. Configure the IP address, subnet mask, and default gateway settings on PC-A.



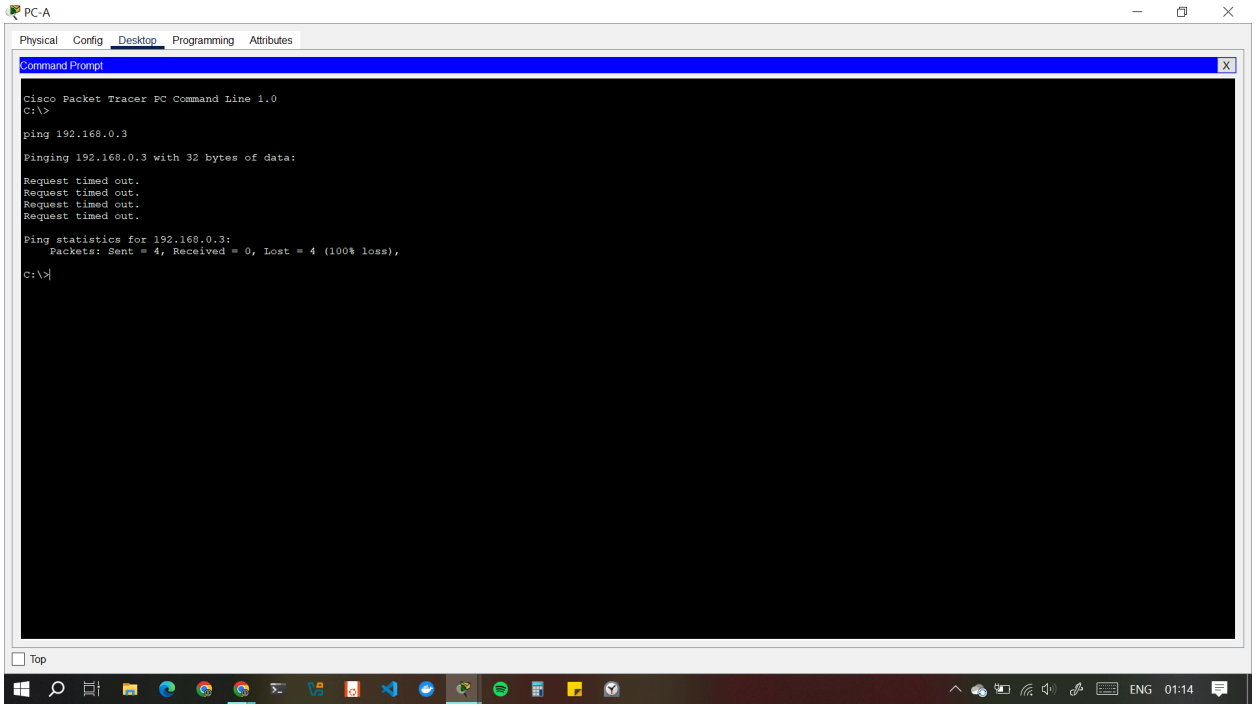


b. Configure the IP address, subnet mask, and default gateway settings on PC-B.





c. Ping PC-B from a command prompt window on PC-A.

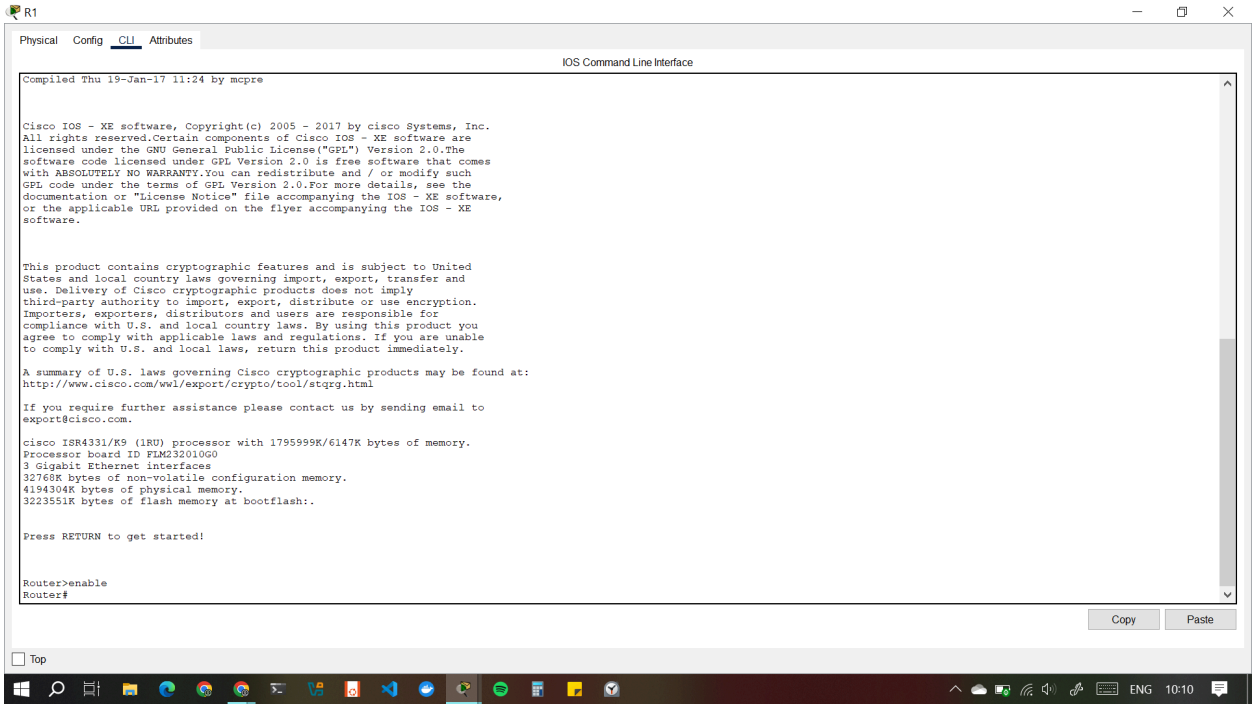


The pings were not successful because the router interfaces(default gateways) were not yet configured, so Layer 3 traffic(using IP addresses) was not routed between subnets.

Step 2: Configure the router.

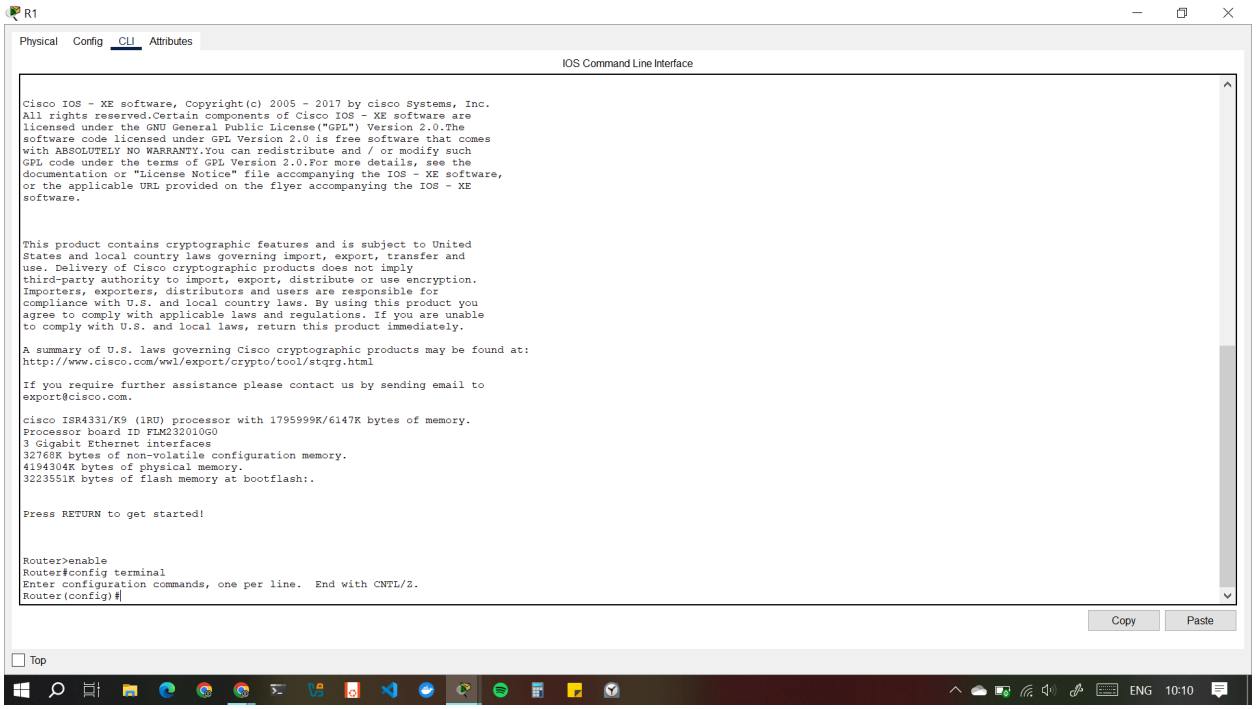
a. Console into the router and enable privileged EXEC mode i.e.

Router> enable



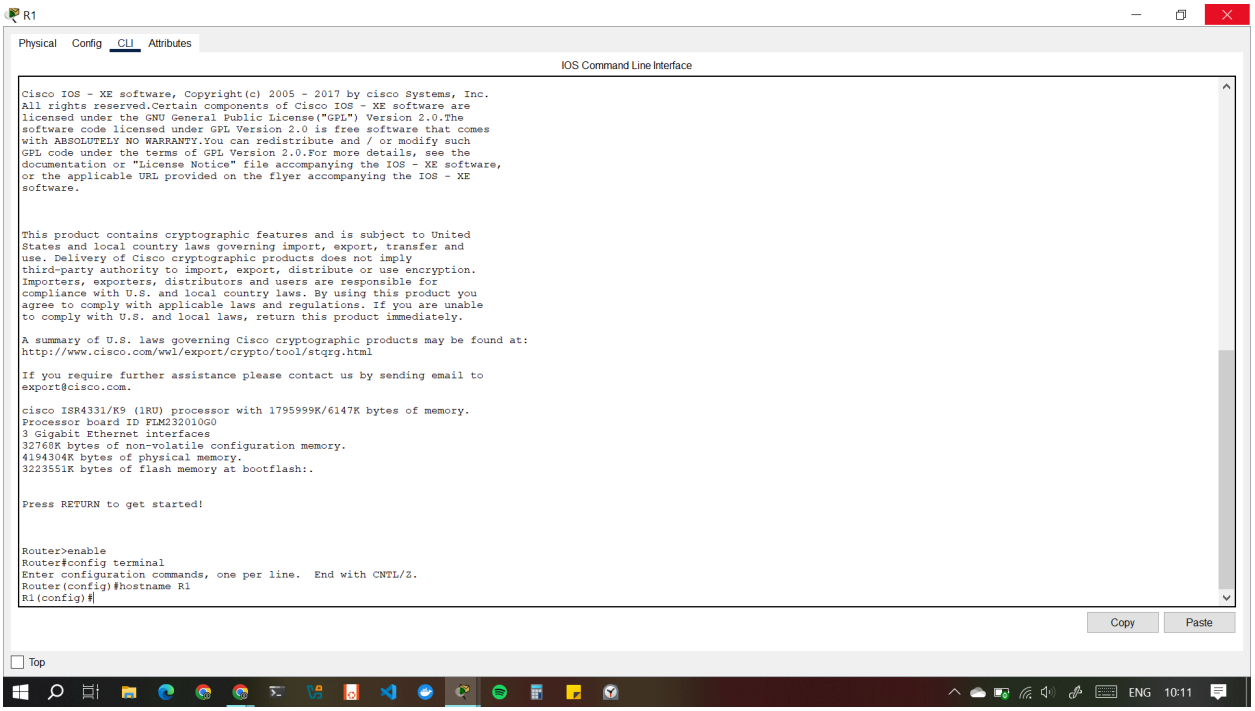
b. Enter configuration mode. i.e.

Router# config terminal



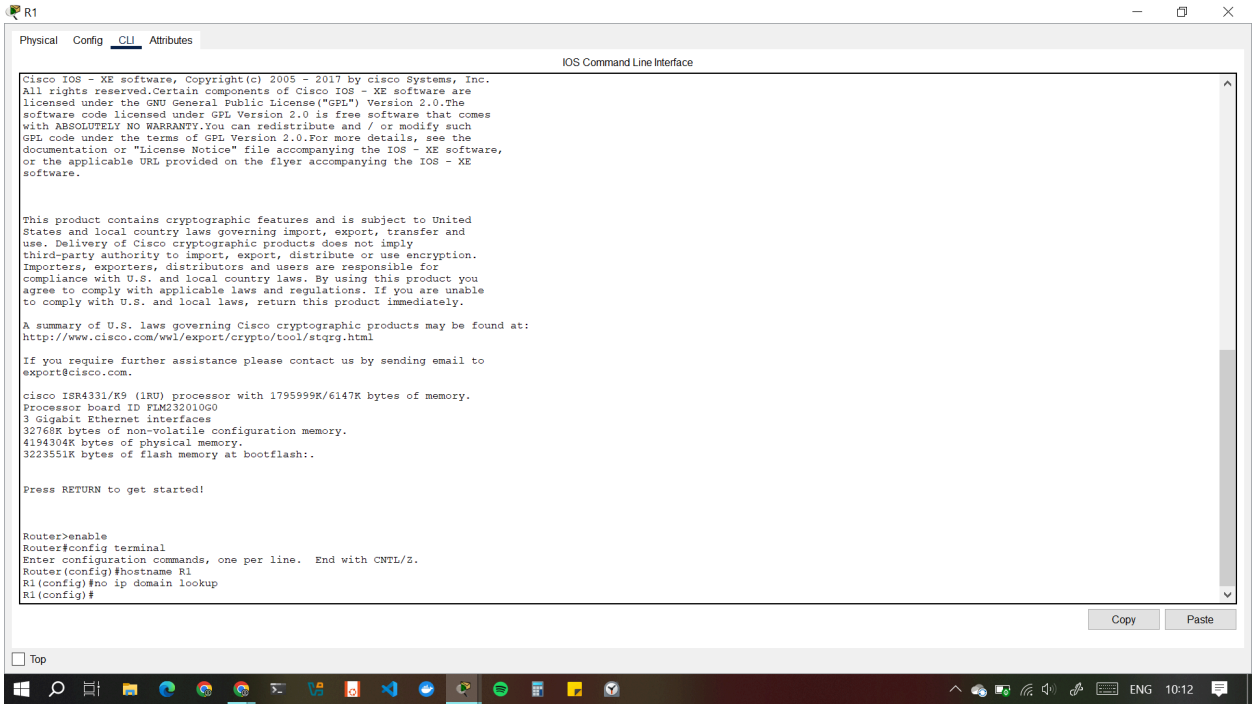
c. Assign a device name to the router.

Router(config)# hostname R1



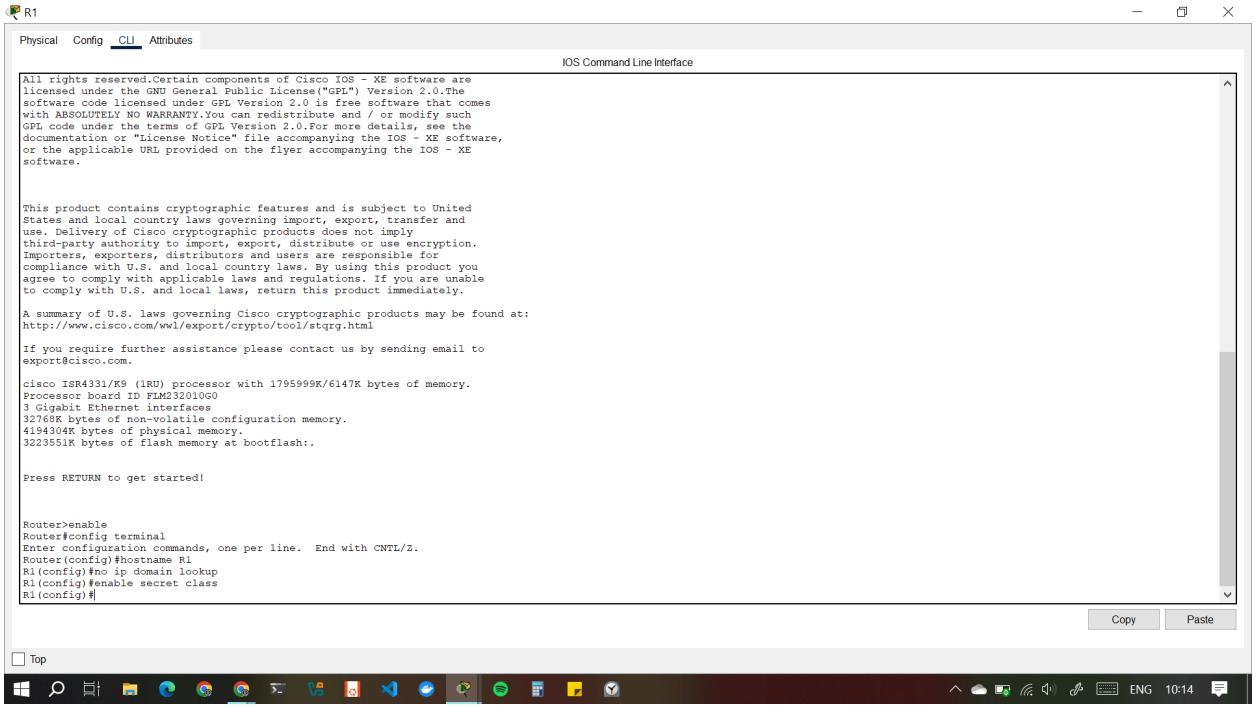
d. Disable DNS lookup to prevent the router from attempting to translate incorrectly entered commands as though they were host names.

R1(config)# no ip domain lookup



e. Assign class as the privileged EXEC encrypted password.

R1(config)# enable secret class

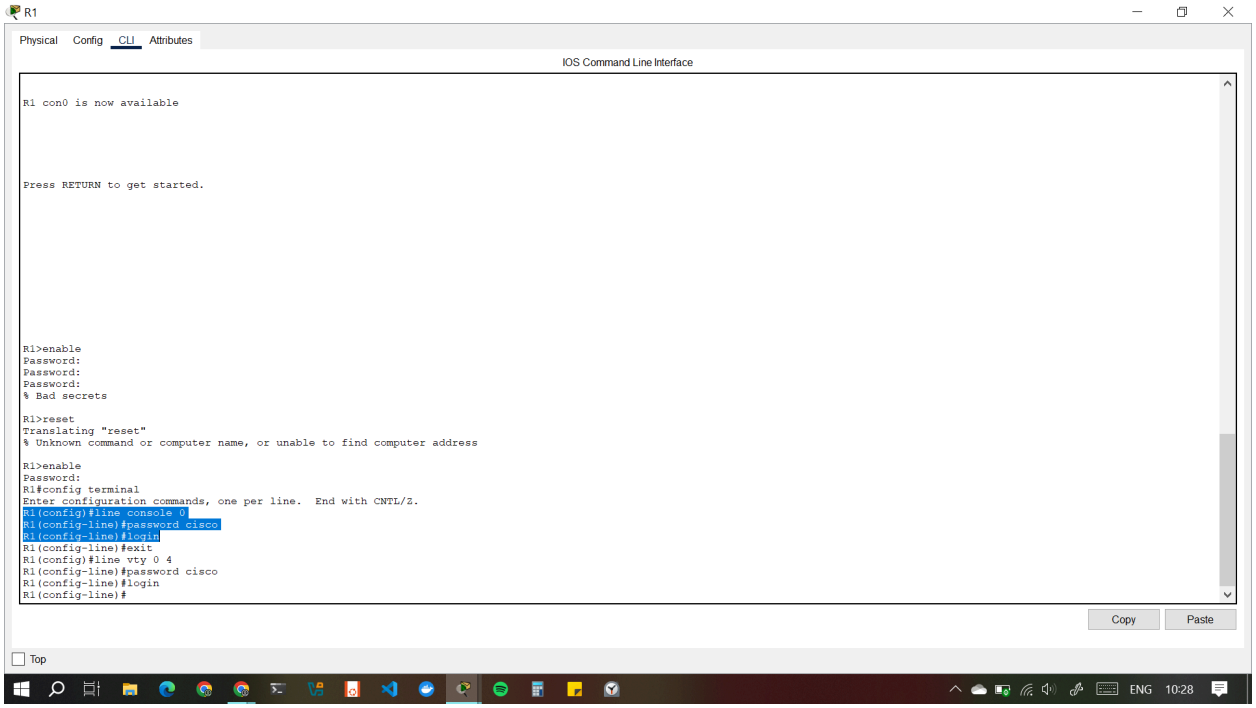


f. Assign cisco as the console password and enable login.

R1(config)# line console 0

R1(config-line)# password cisco

R1(config-line)# login

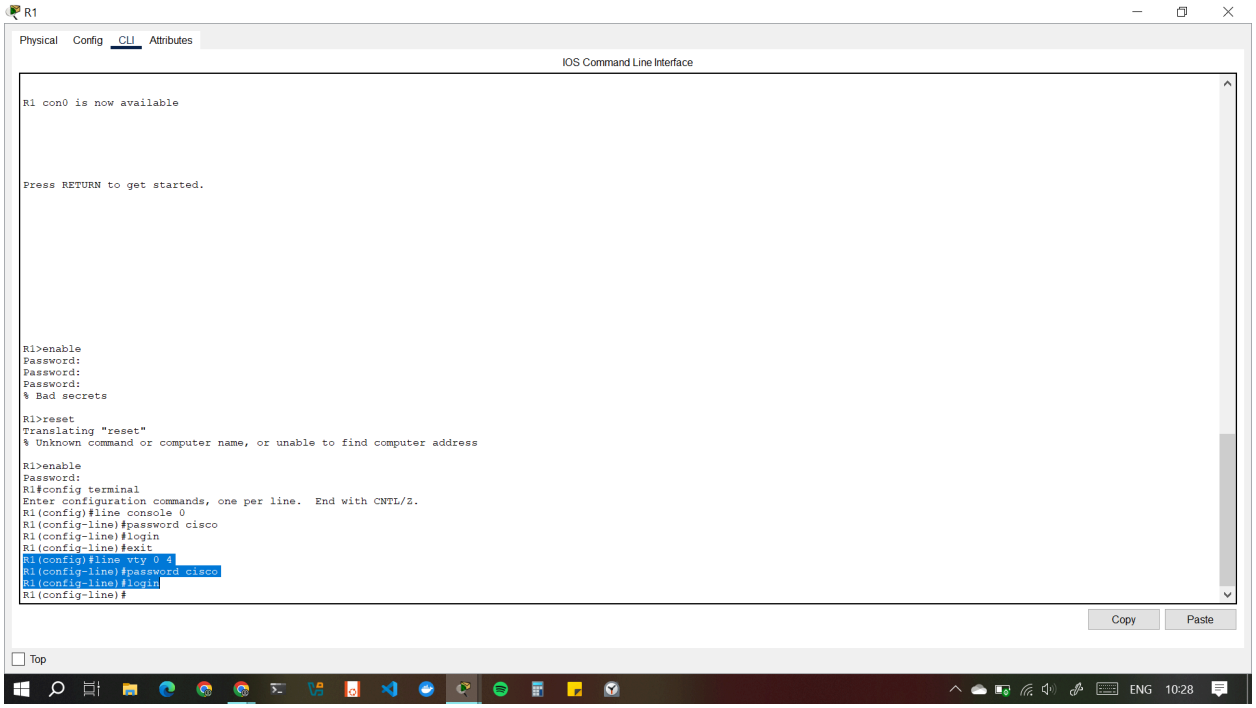


g. Assign cisco as the VTY password and enable login.

R1(config)# line vty 0 4

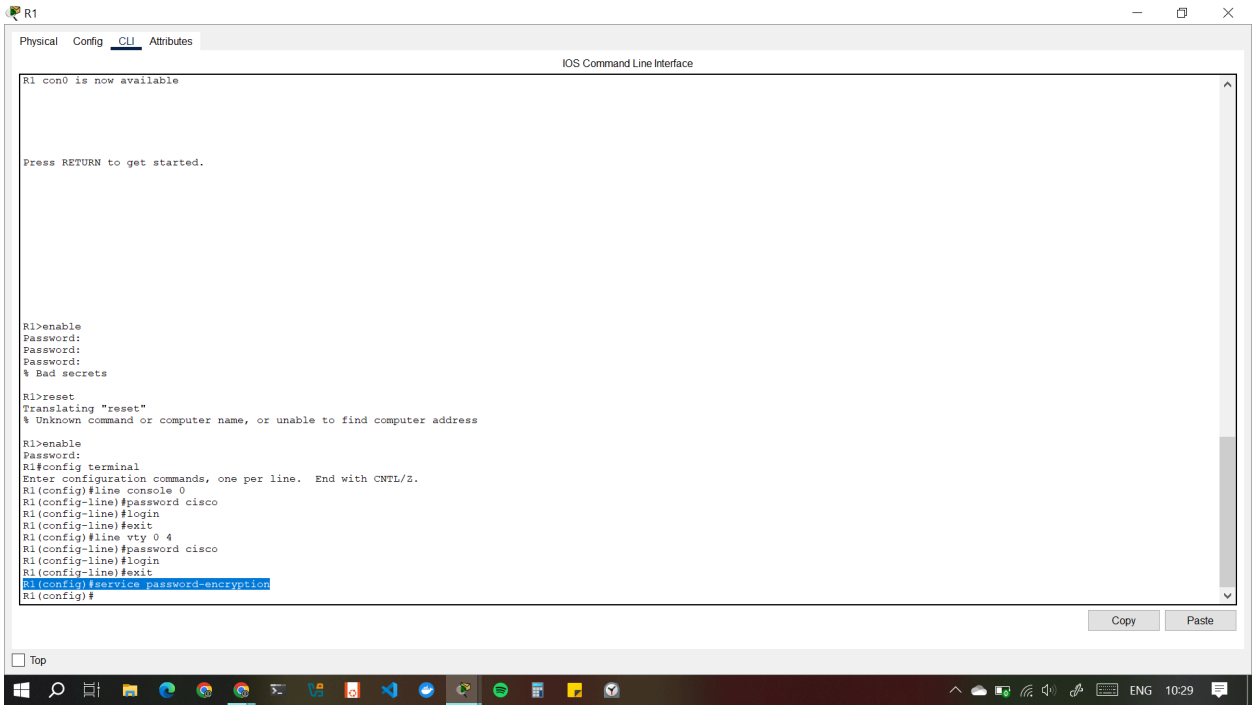
R1(config-line)# password cisco

R1(config-line)# login



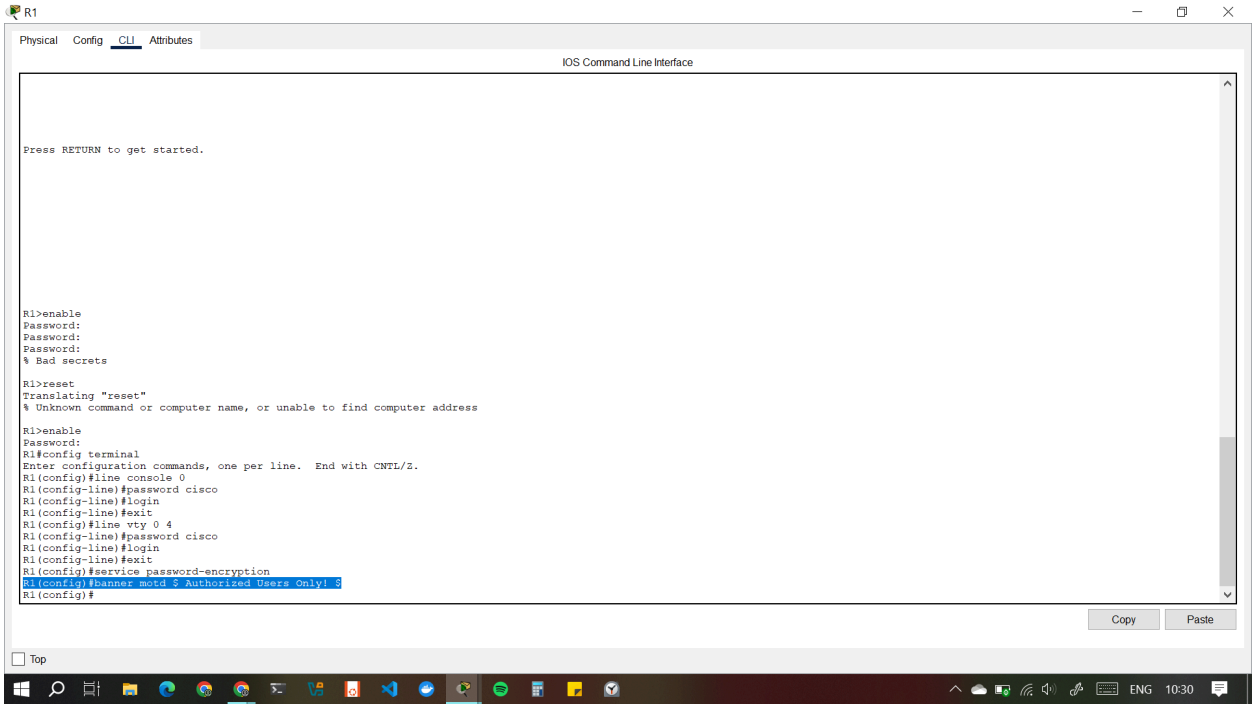
h. Encrypt the plaintext passwords.

R1(config)# service password-encryption



i. Create a banner that warns anyone accessing the device that unauthorized access is prohibited.

R1(config)# banner motd $ Authorized Users Only! $



j. Configure and activate both interfaces on the router.

R1(config)# interface g0/0/0

R1(config-if)# ip address 192.168.0.1 255.255.255.0

R1(config-if)# ipv6 address 2001:db8:acad::1/64

R1(config-if)# ipv6 address FE80::1 link-local

R1(config-if)# no shutdown

R1(config-if)# exit

R1(config)# interface g0/0/1

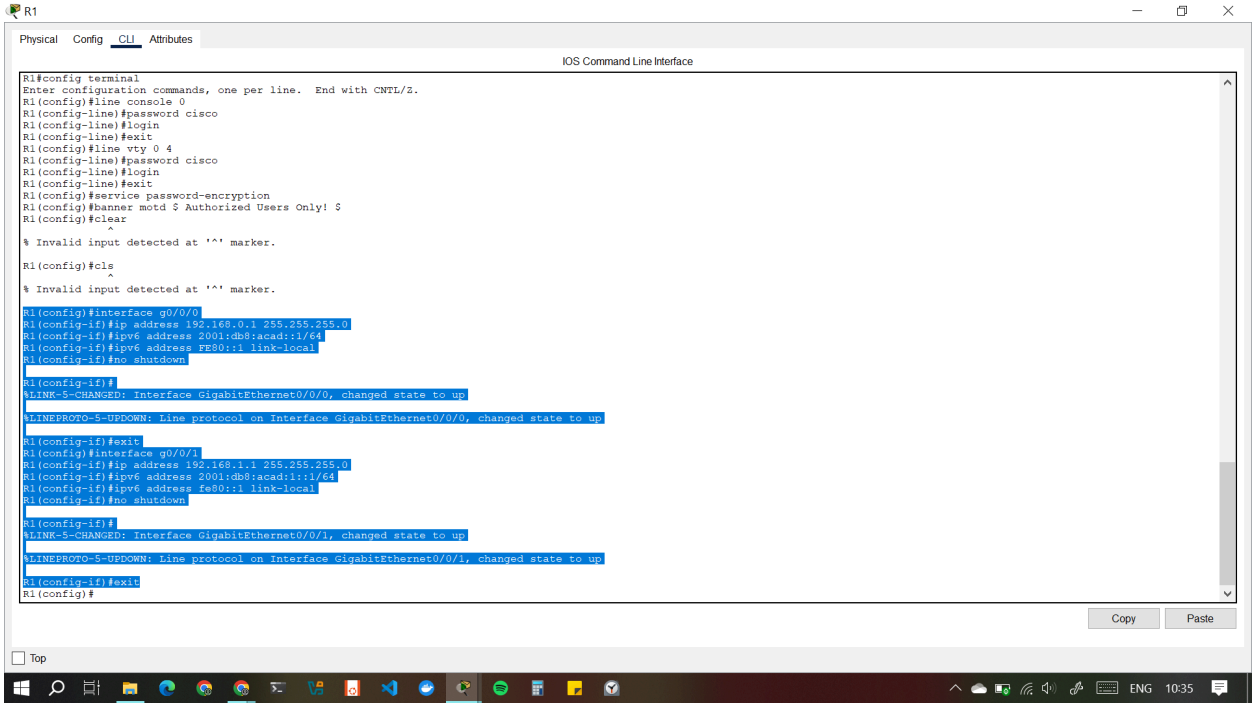
R1(config-if)# ip address 192.168.1.1 255.255.255.0

R1(config-if)# ipv6 address 2001:db8:acad:1::1/64

R1(config-if)# ipv6 address fe80::1 link-local

R1(config-if)# no shutdown

R1(config-if)# exit



k. Configure an interface description for each interface indicating which device is connected to it.

R1(config)# interface g0/0/1

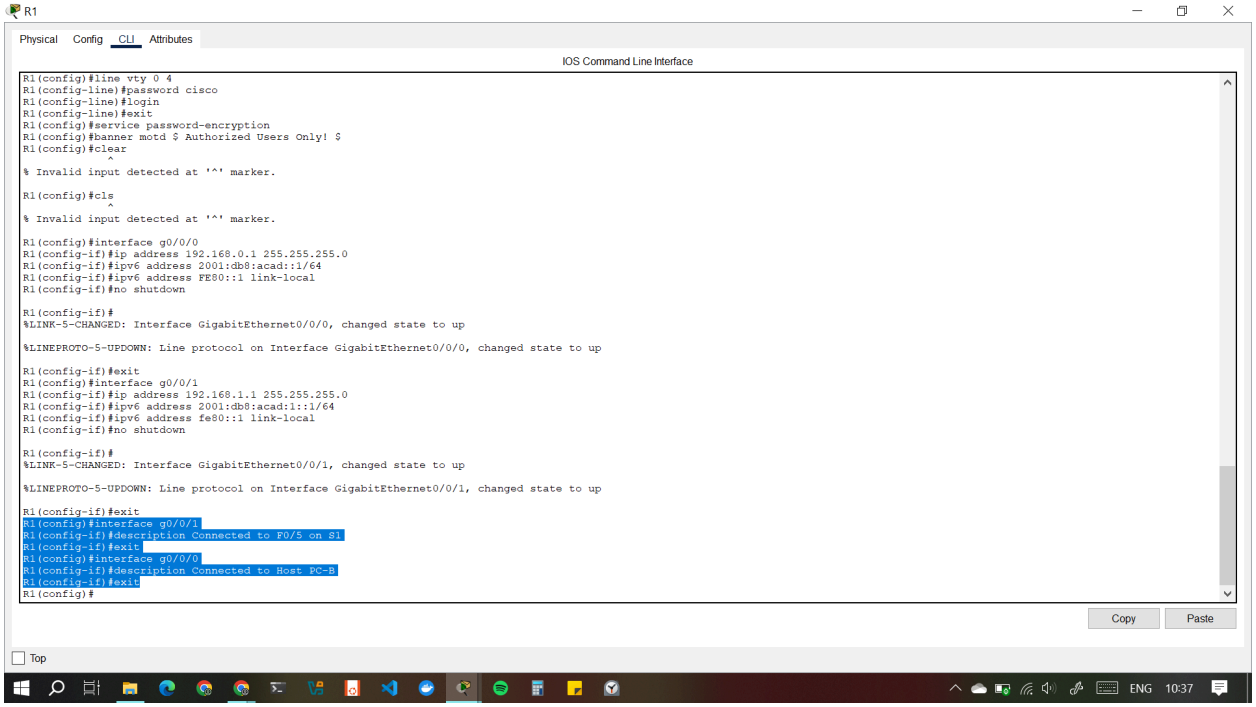
R1(config-if)# description Connected to F0/5 on S1

R1(config-if)# exit

R1(config)# interface g0/0/0

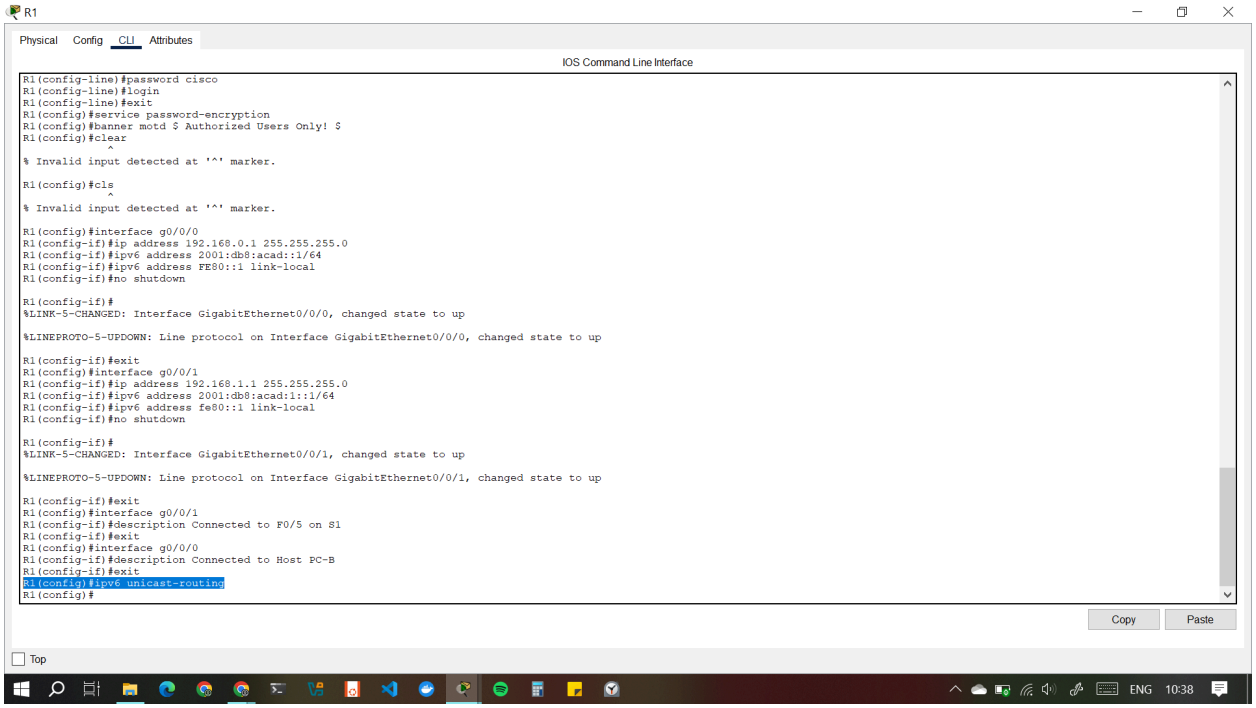
R1(config-if)# description Connected to Host PC-B

R1(config-if)# exit



l. To enable IPv6 routing, enter the command ipv6 unicast-routing.

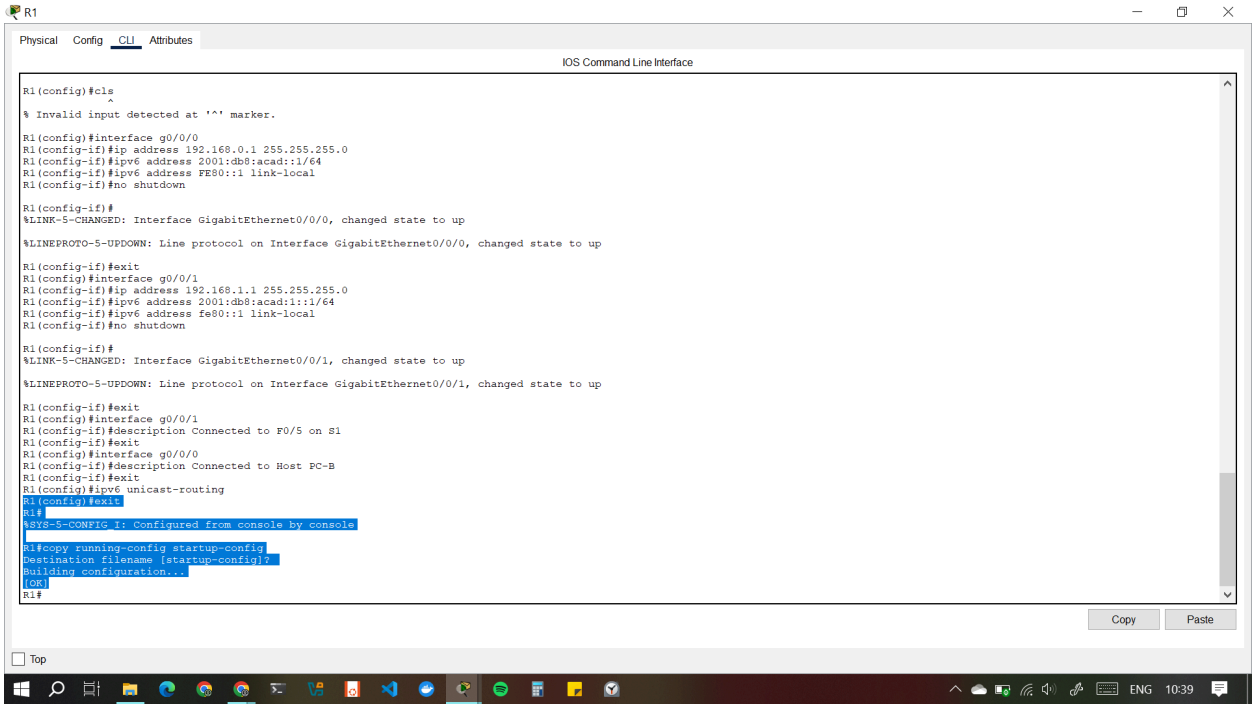
R1(config)# ipv6 unicast-routing



m. Save the running configuration to the startup configuration file.

R1(config)# exit

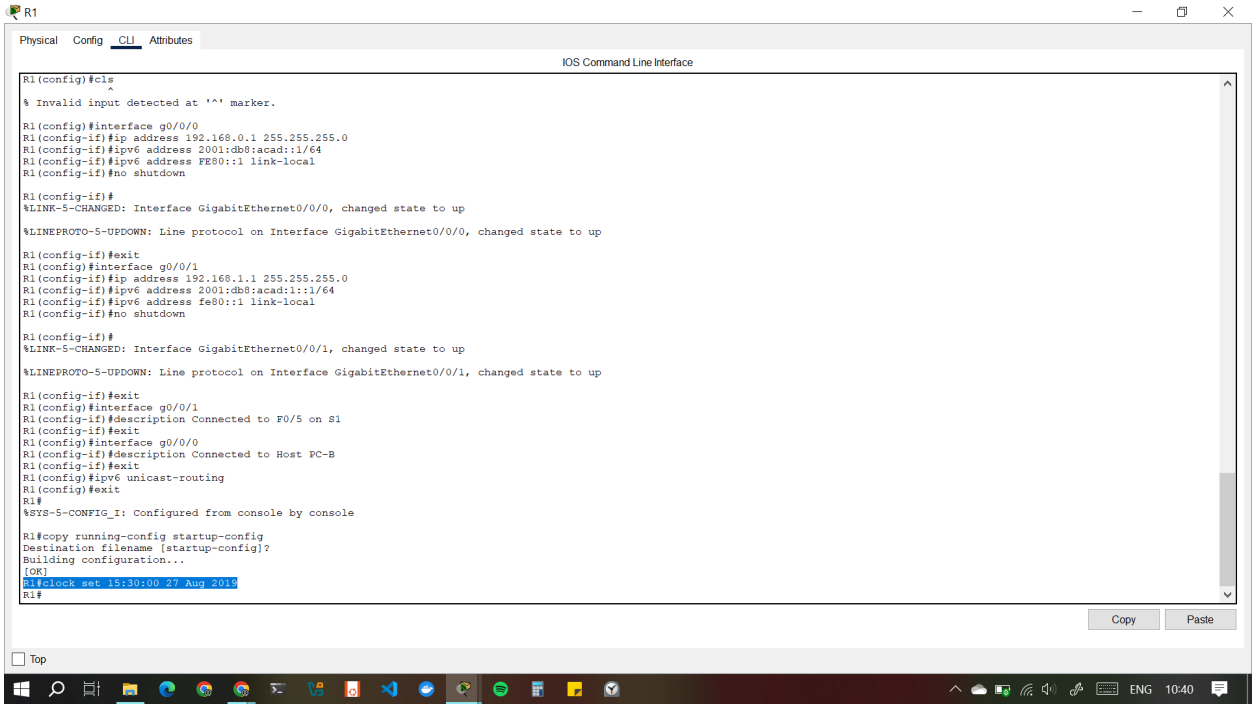
R1# copy running-config startup-config



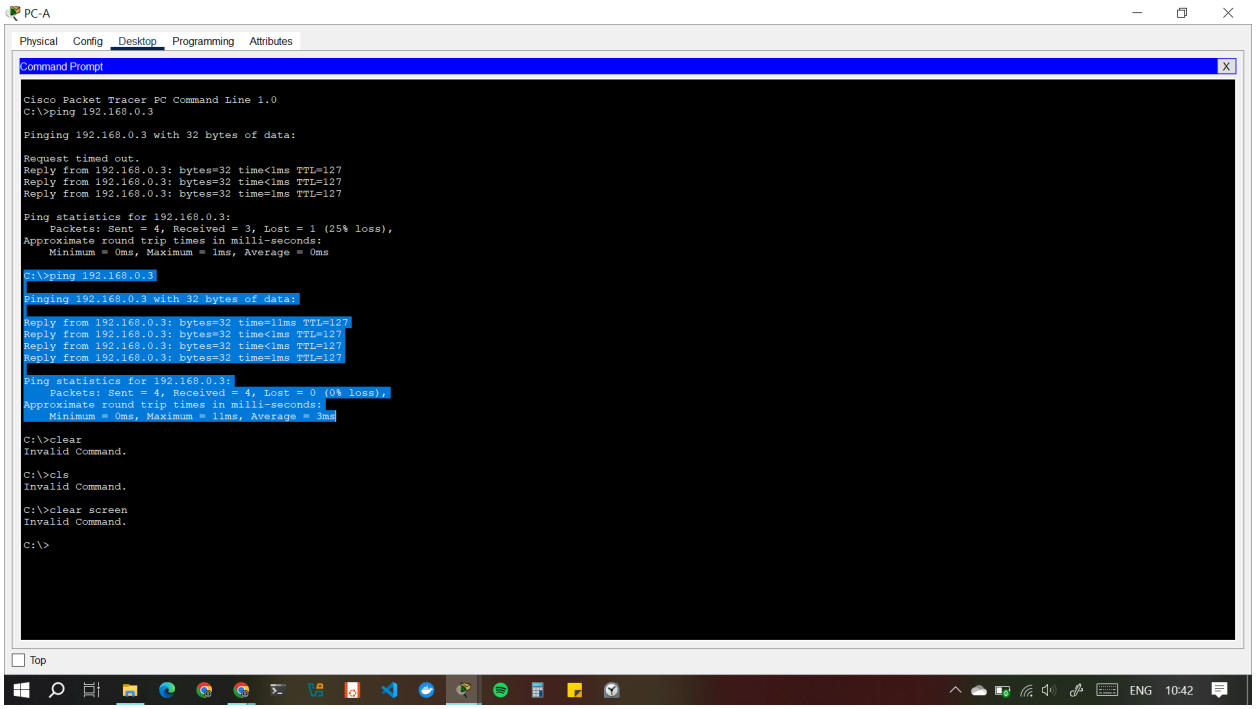
n. Set the clock on the router.

R1# clock set 15:30:00 27 Aug 2019

Note: Use the question mark (?) to help with the correct sequence of parameters needed to execute this command.

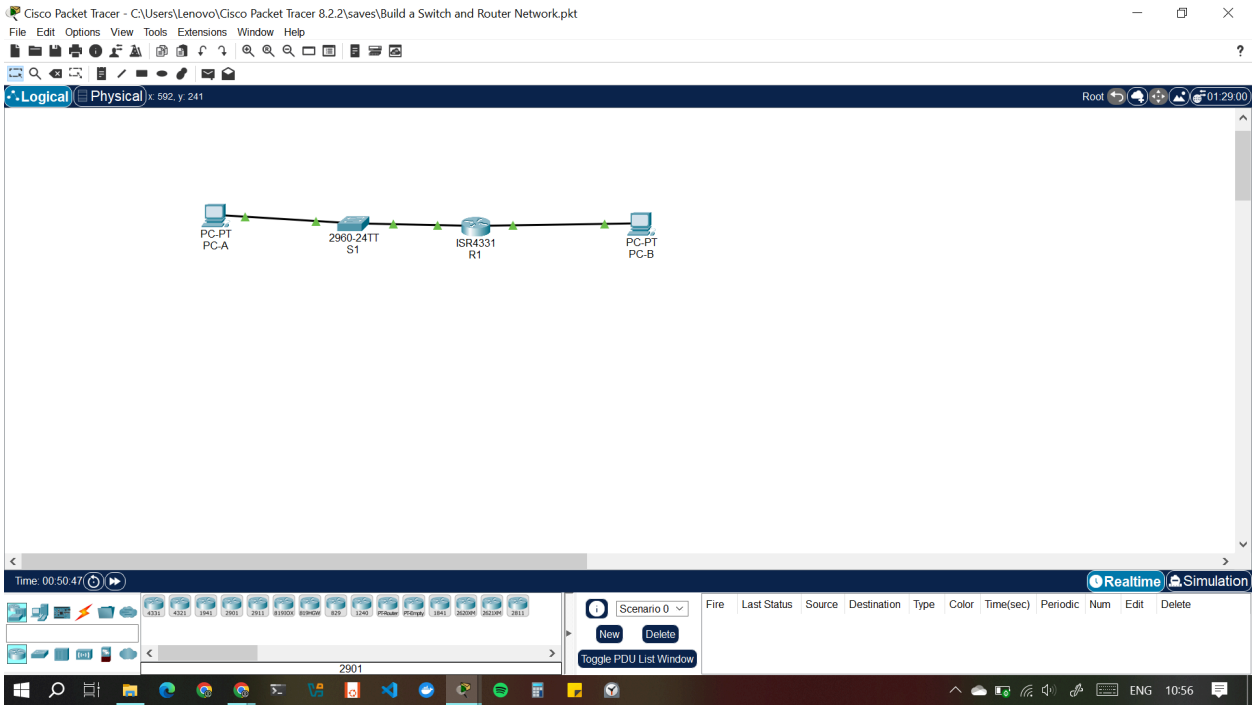


o. Ping PC-B from a command prompt window on PC-A.



Question: Were the pings successful? Explain.

Answer: Yes. The router is routing the ping traffic across the two subnets. The default settings for the 2960 switch will automatically turn up the interfaces that are connected to devices.



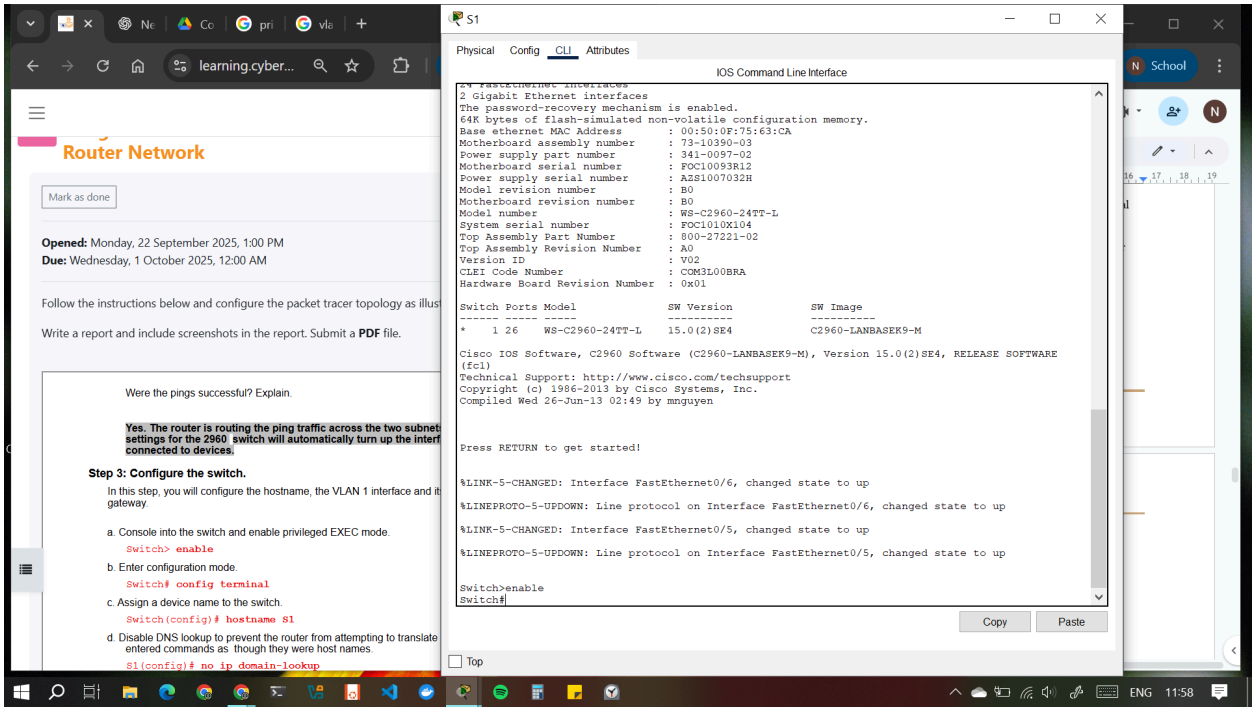
Step 3: Configure the switch.

In this step, I configured the hostname, the VLAN 1 interface and its default gateway.

- A **VLAN (Virtual Local Area Network)** is a way to logically divide a single physical LAN into multiple smaller, isolated virtual networks based on software, rather than physical cables. This allows network administrators to group devices for functional or security reasons, create separate broadcast domains, improve network efficiency, and manage traffic more effectively on the same network hardware

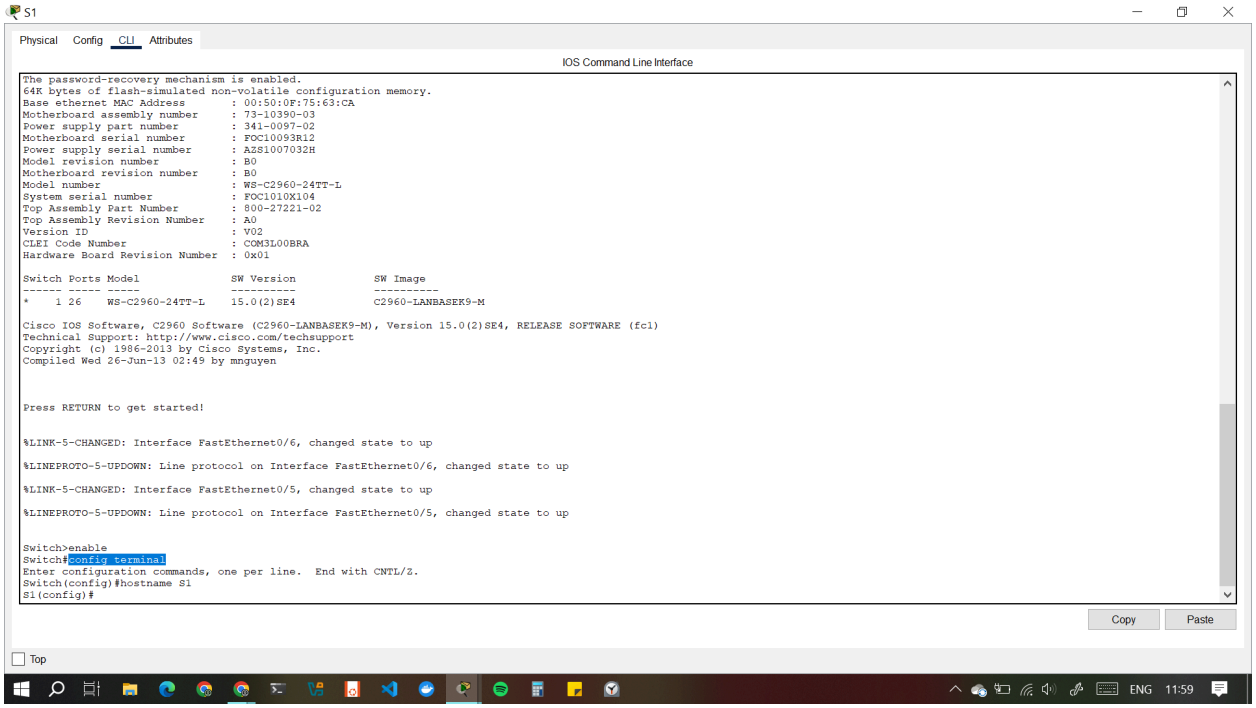
a. Console into the switch and enable privileged EXEC mode.

Switch> enable



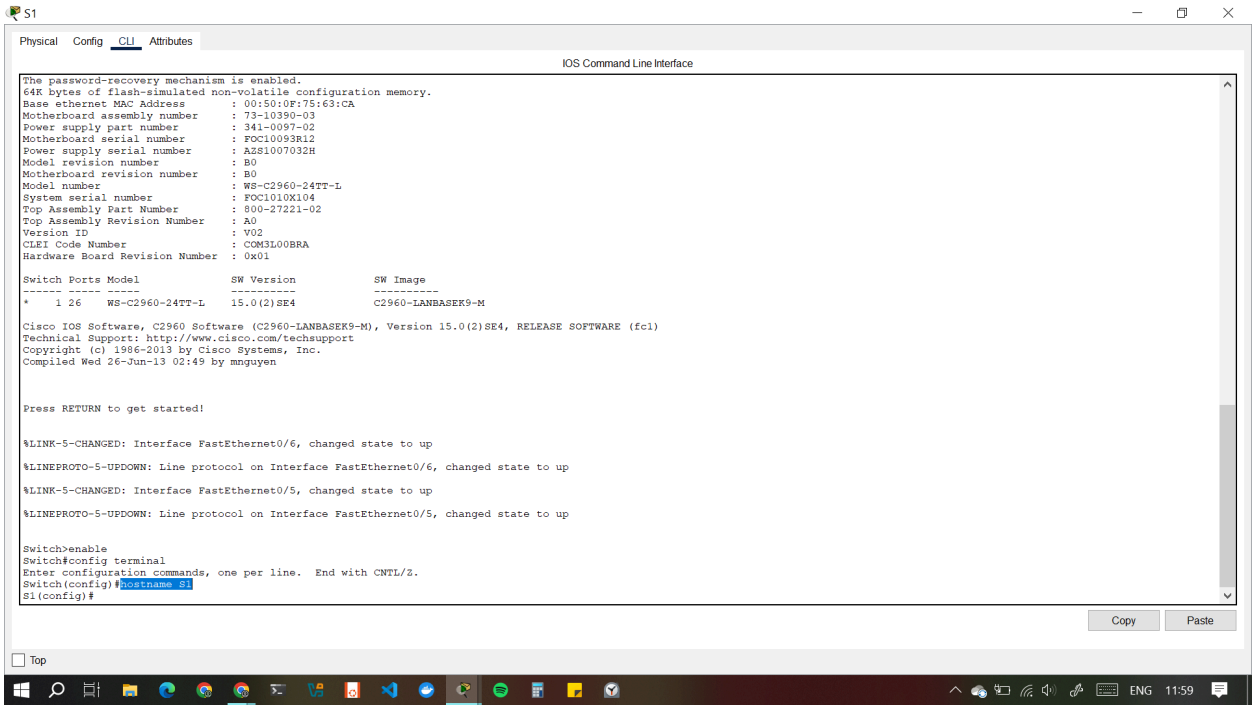
b. Enter configuration mode.

Switch# config terminal



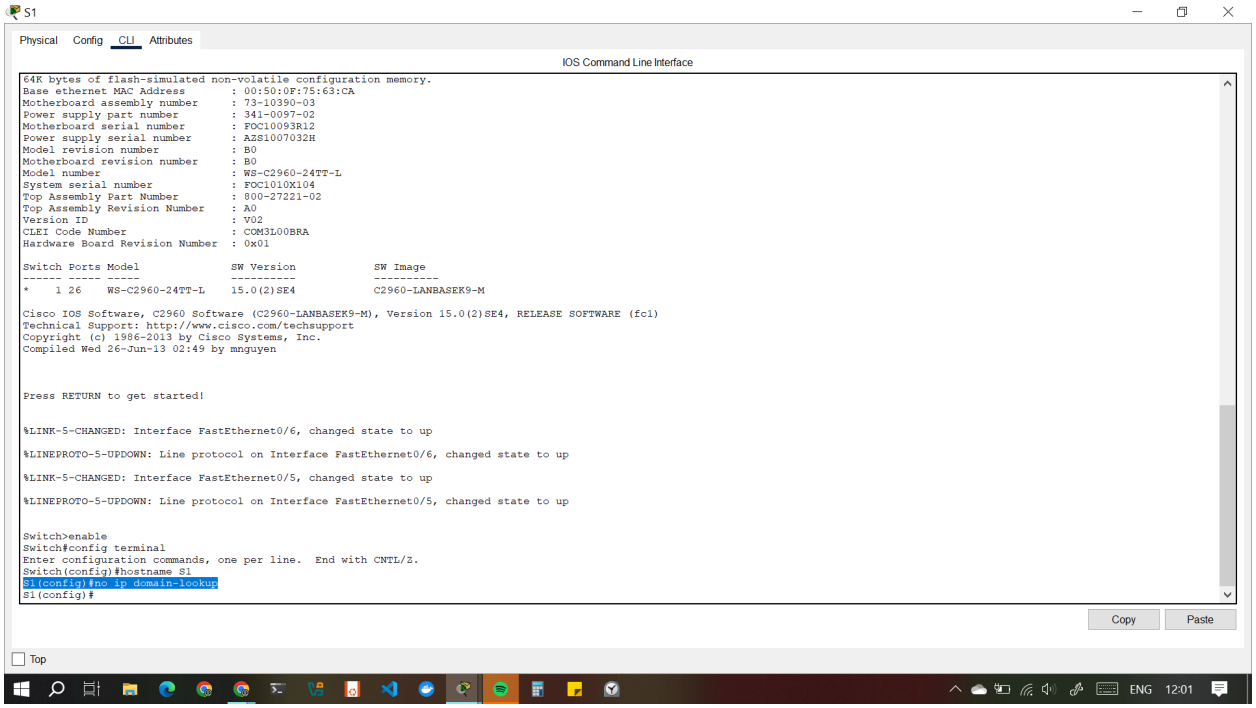
c. Assign a device name to the switch.

Switch(config)# hostname S1



d. Disable DNS lookup to prevent the router from attempting to translate incorrectly entered commands as though they were host names.

S1(config)# no ip domain-lookup



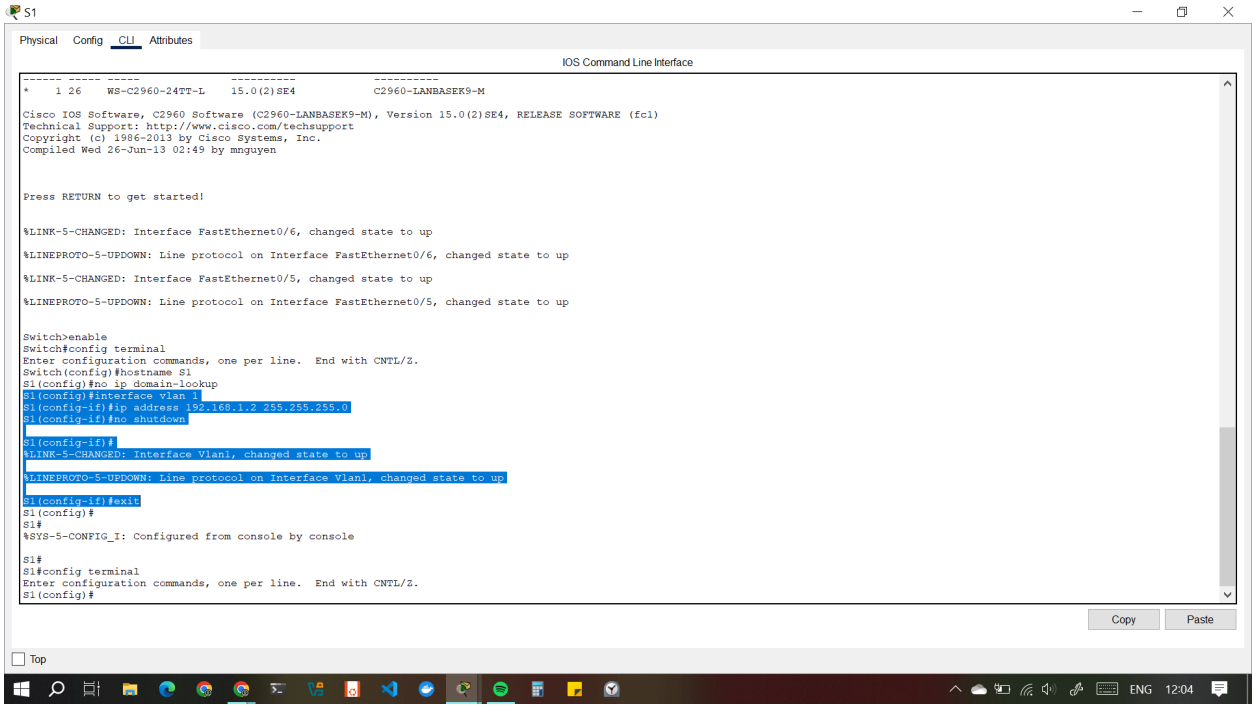
e. Configure and activate the VLAN interface on the switch S1.

S1(config)# interface vlan 1

S1(config-if)# ip address 192.168.1.2 255.255.255.0

S1(config-if)# no shutdown

S1(config-if)# exit

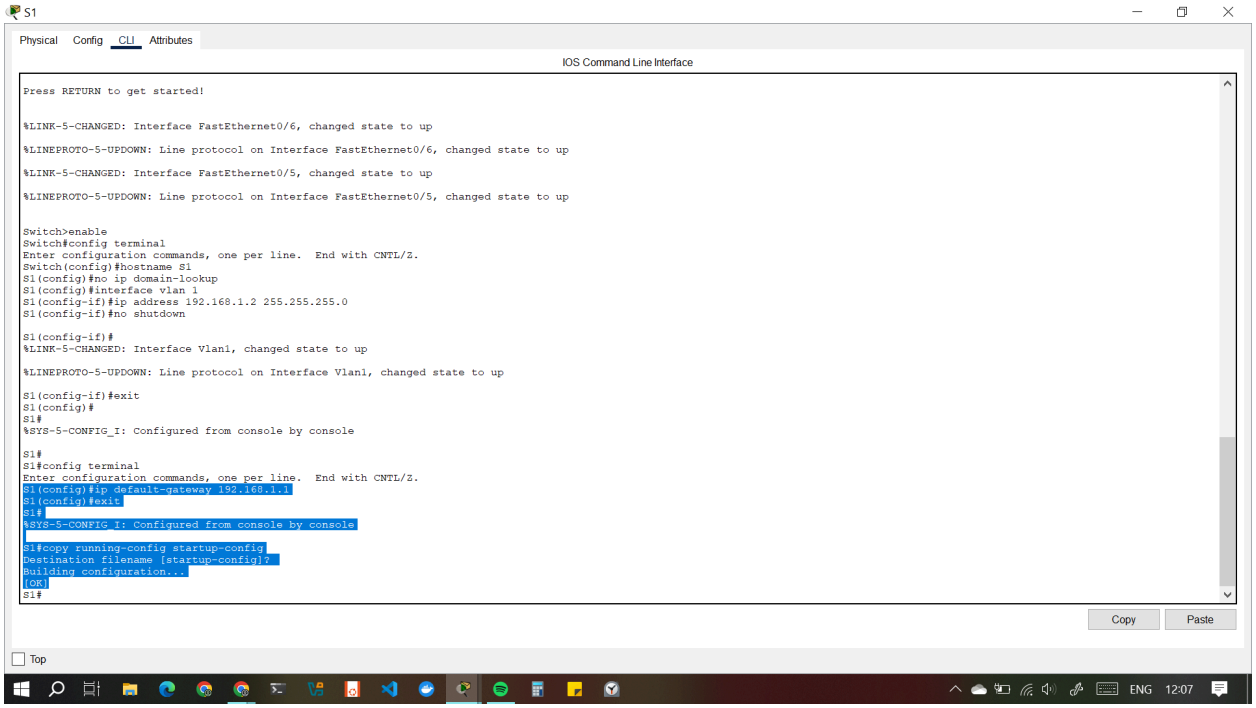


f. Configure the default gateway for the switch S1.

S1(config)# ip default-gateway 192.168.1.1

S1(config-if)# exit

g. Save the running configuration to the startup configuration file.

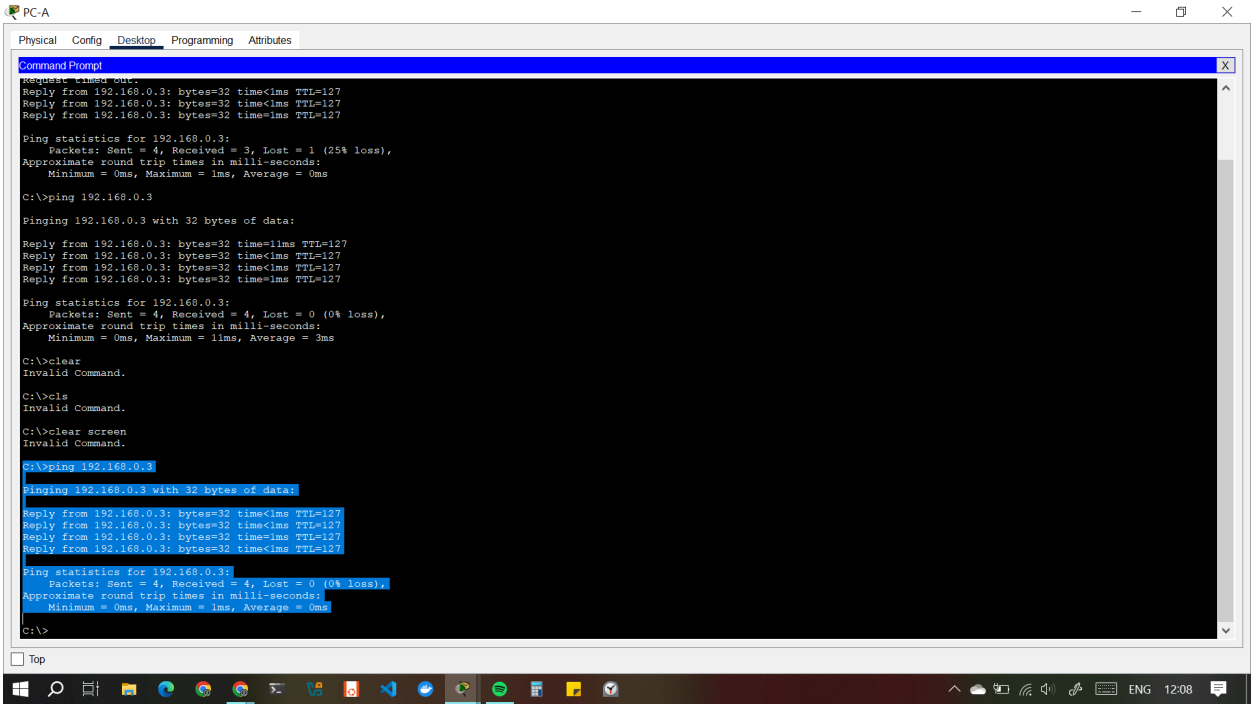


Step 4: Verify connectivity end-to-end connectivity.

a. From PC-A, ping PC-B.

b. From S1, ping PC-B.

All the pings should be successful.



Close configuration window

Part 3: Display Device Information

In Part 3, you will use show commands to retrieve interface and routing information from the router and switch.

Step 1: Display the routing table on the router.

a. Use the show ip route command on the router R1 to answer the following questions.

Open configuration window

R1# show ip route

Codes: L - local, 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, H - NHRP, l - LISP + - replicated route, % - next hop override

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks

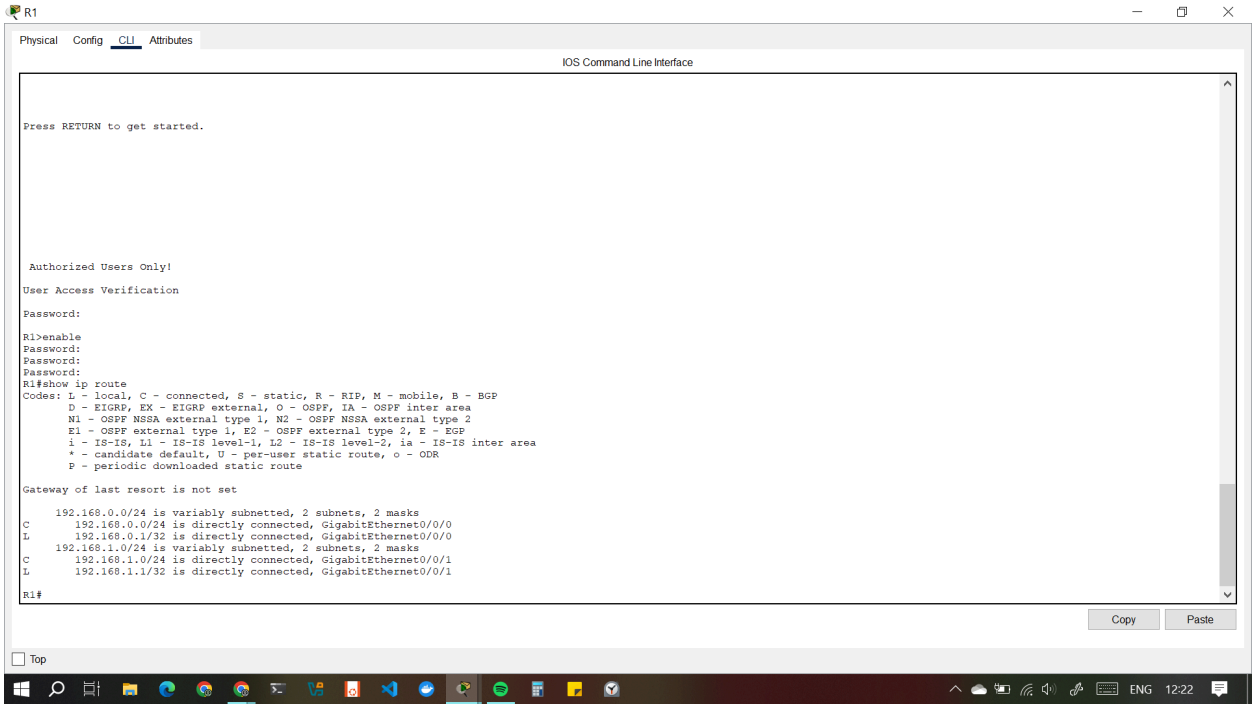
C 192.168.0.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.0.1/32 is directly connected, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.1.0/24 is directly connected, GigabitEthernet0/0/1

L 192.168.1.1/32 is directly connected, GigabitEthernet0/0/1



Question: What code is used in the routing table to indicate a directly connected network?

Answer: The C designates a directly connected subnet. An L designates a local interface. Both answers are correct.

Question: How many route entries are coded with a C code in the routing table?

Answer: 2

Question: What interface types are associated with the C coded routes?

Answer: GigabitEthernet0/0/0 and GigabitEthernet0/0/1.

b. Use the show ipv6 route command on router R1 to display the IPv6 routes.

R1# show ipv6 route

IPv6 Routing Table - default - 5 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy a - Application

C 2001:DB8:ACAD::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD::1/128 [0/0]

via GigabitEthernet0/0/0, receive

C 2001:DB8:ACAD:1::/64 [0/0]

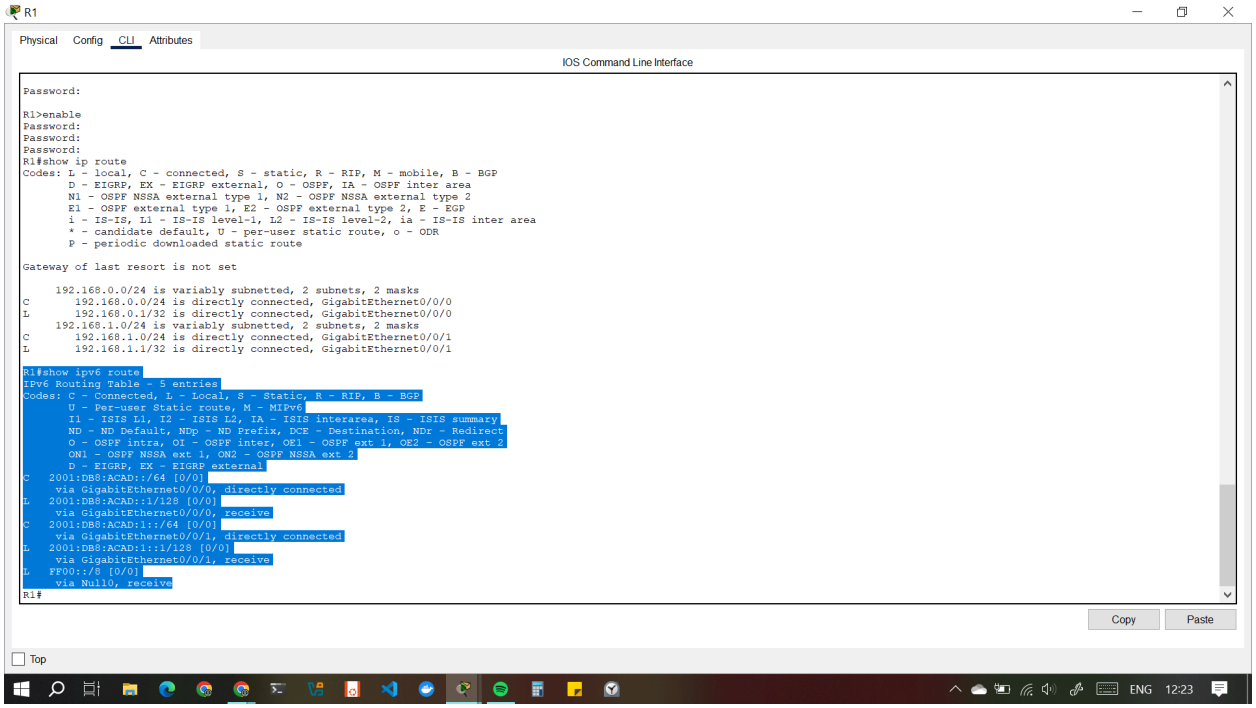
via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:1::1/128 [0/0]

via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]

via Null0, receive



Step 2: Display interface information on the router R1.

a. Use the **show ip interface g0/0/1** to answer the following questions.

R1# show ip interfaces g0/0/1

GigabitEthernet0/0/1 is up, line protocol is up

Hardware is ISR4321-2x1GE, address is a0e0.af0d.e141 (bia a0e0.af0d.e141)

Description: Connected to F0/5 on S1

Internet address is 192.168.1.1/24

MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,

reliability 255/255, txload 1/255, rxload 1/255

Encapsulation ARPA, loopback not set

Keepalive not supported

Full Duplex, 100Mbps, link type is auto, media type is RJ45

output flow-control is off, input flow-control is off

ARP type: ARPA, ARP Timeout 04:00:00

Last input 00:00:00, output 00:00:19, output hang never

Last clearing of "show interface" counters never

Input queue: 0/375/0/0 (size/max/drops/flushes); Total output 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

4579 packets input, 637737 bytes, 0 no buffer

Received 1092 broadcasts (0 IP multicasts)

0 runts, 0 giants, 0 throttles

0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored

0 watchdog, 2863 multicast, 0 pause input

700 packets output, 115187 bytes, 0 underruns

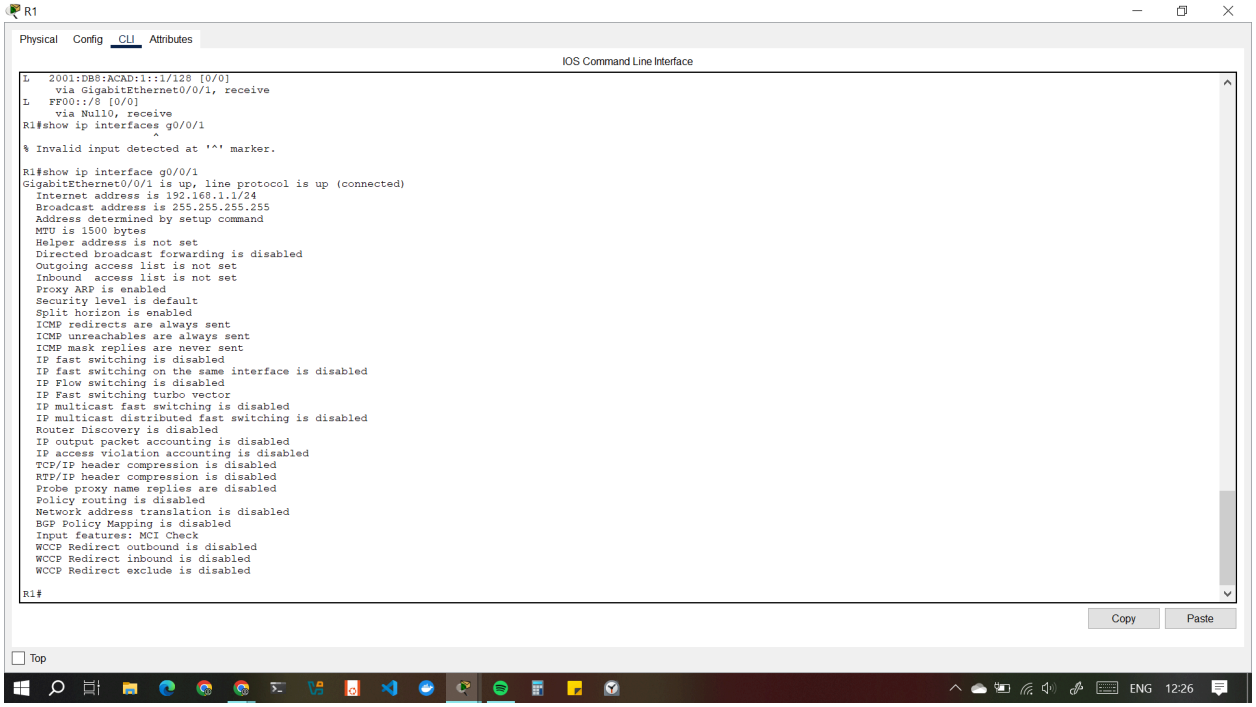
0 output errors, 0 collisions, 1 interface resets

0 unknown protocol drops

0 babbles, 0 late collision, 0 deferred

0 lost carrier, 0 no carrier, 0 pause output

0 output buffer failures, 0 output buffers swapped out



Questions

What is the operational status of the G0/0/1 interface?

Answer: GigabitEthernet0/0/1 is up, line protocol is up (connected)

What is the Media Access Control (MAC) address of the G0/1 interface?

Answer: 0001.63dc.e102

How is the Internet address displayed in this command?

Answer: Internet address is 192.168.1.1/24.

b. For the IPv6 information, enter the **show ipv6 interface** interface command.

R1# show ipv6 interface g0/0/1

GigabitEthernet0/0/1 is up, line protocol is up

IPv6 is enabled, link-local address is FE80::1

No Virtual link-local address(es):

Description: Connected to F0/5 on S1

Global unicast address(es):

2001:DB8:ACAD:1::1, subnet is 2001:DB8:ACAD:1::/64

Joined group address(es):

FF02::1

FF02::2

FF02::1:FF00:1

MTU is 1500 bytes

ICMP error messages limited to one every 100 milliseconds

ICMP redirects are enabled

ICMP unreachables are sent

ND DAD is enabled, number of DAD attempts: 1

ND reachable time is 30000 milliseconds (using 30000)

ND advertised reachable time is 0 (unspecified)

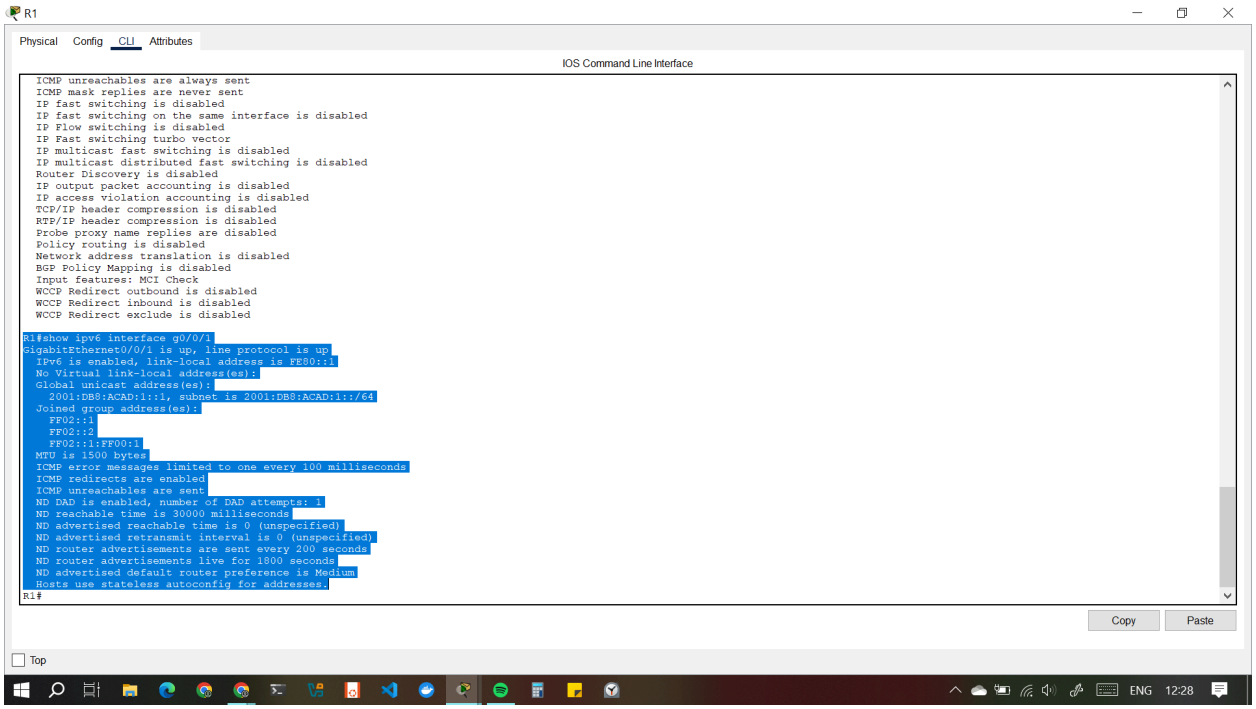
ND advertised retransmit interval is 0 (unspecified)

ND router advertisements are sent every 200 seconds

ND router advertisements live for 1800 seconds

ND advertised default router preference is Medium

Hosts use stateless autoconfig for addresses.



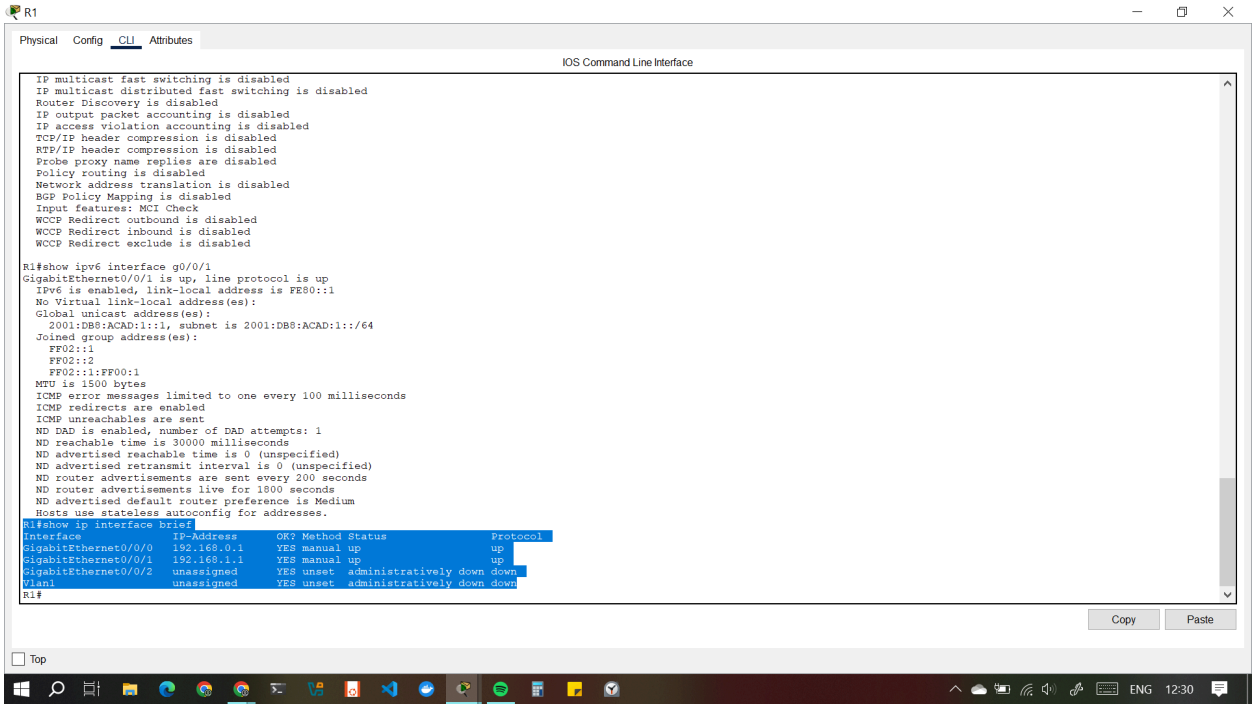
Step 3: Display a summary list of the interfaces on the router and switch.

There are several commands that can be used to verify an interface configuration. One of the most useful of these is the **show ip interface brief** command. The command output displays a summary list of the interfaces on the device and provides immediate feedback to the status of each interface.

a. Enter the show ip interface brief command on the router R1.

R1# show ip interface brief

Interface IP-Address OK? Method Status Protocol GigabitEthernet0/0/0 192.168.0.1 YES manual up up GigabitEthernet0/0/1 192.168.1.1 YES manual up up Serial0/1/0 unassigned YES unset up up Serial0/1/1 unassigned YES unset up up



b. To see the IPv6 interface information, enter the show ipv6 interface brief command on R1.

R1# show ipv6 interface brief

GigabitEthernet0/0/0 [up/up]

FE80::1

2001:DB8:ACAD::1

GigabitEthernet0/0/1 [up/up]

FE80::1

2001:DB8:ACAD:1::1

Serial0/1/0 [up/up]

Unassigned

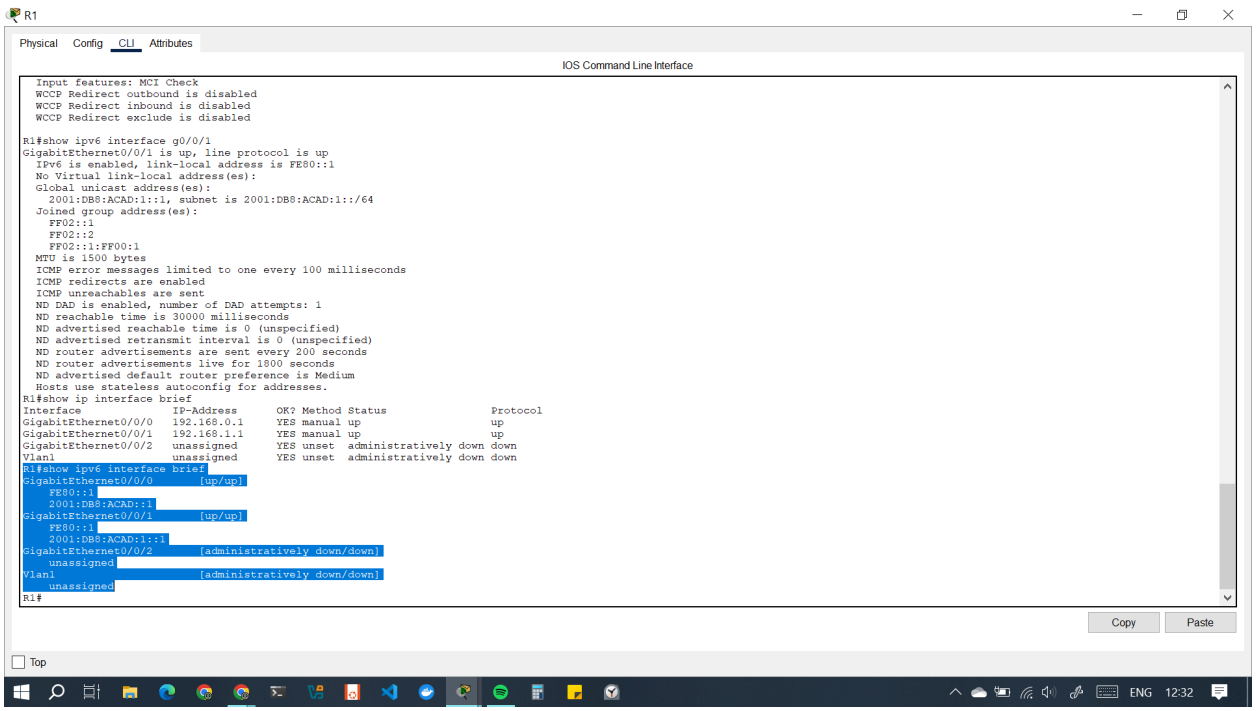
Serial0/1/1 [up/up]

Unassigned

GigabitEthernet0 [down/down]

Unassigned

Close configuration window



c. Enter the show ip interface brief command on the switch S1.

Open configuration windowS1# show ip interface brief

Interface IP-Address OK? Method Status Protocol Vlan1 192.168.1.2 YES NVRAM up up FastEthernet0/1 unassigned YES unset down down FastEthernet0/2 unassigned YES unset down down FastEthernet0/3 unassigned YES unset down down

FastEthernet0/4 unassigned YES unset down down

FastEthernet0/5 unassigned YES unset up up FastEthernet0/6 unassigned YES unset up up FastEthernet0/7 unassigned YES unset down down FastEthernet0/8 unassigned YES unset down down FastEthernet0/9 unassigned YES unset down down

FastEthernet0/10 unassigned YES unset down down

FastEthernet0/11 unassigned YES unset down down

FastEthernet0/12 unassigned YES unset down down

FastEthernet0/13 unassigned YES unset down down

FastEthernet0/14 unassigned YES unset down down

FastEthernet0/15 unassigned YES unset down down

FastEthernet0/16 unassigned YES unset down down

FastEthernet0/17 unassigned YES unset down down

FastEthernet0/18 unassigned YES unset down down

FastEthernet0/19 unassigned YES unset down down

FastEthernet0/20 unassigned YES unset down down

FastEthernet0/21 unassigned YES unset down down

FastEthernet0/22 unassigned YES unset down down

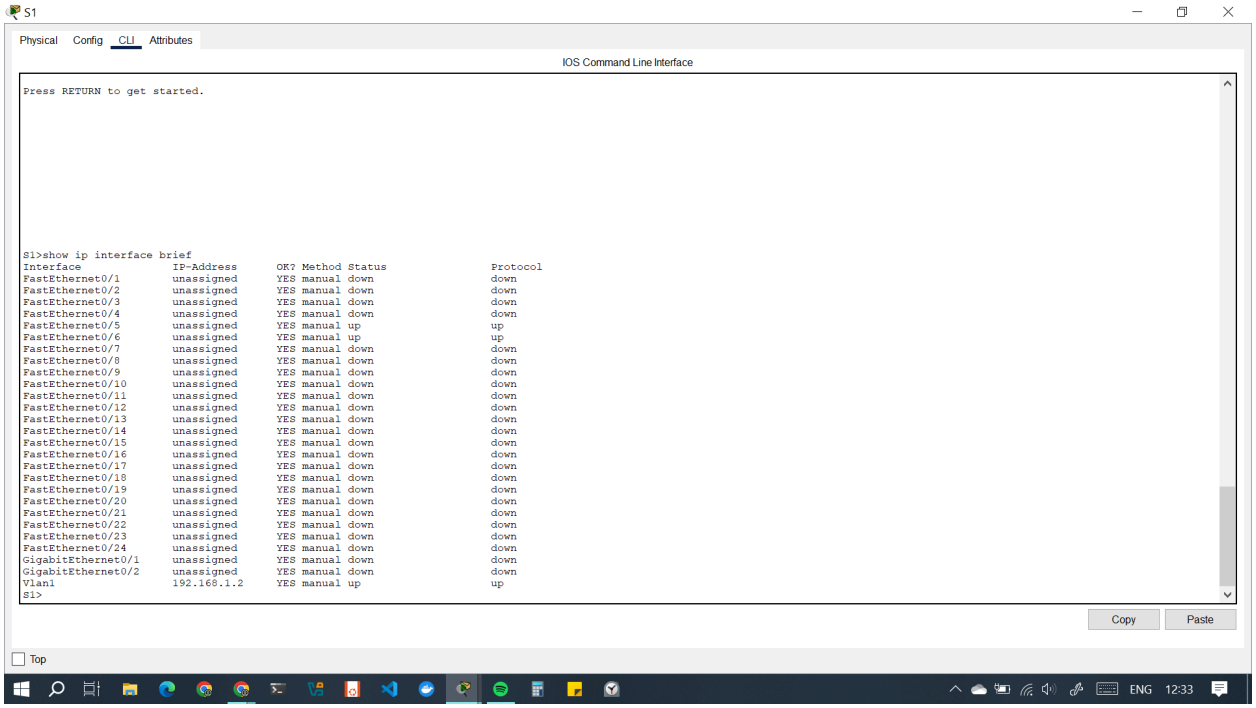
FastEthernet0/23 unassigned YES unset down down

FastEthernet0/24 unassigned YES unset down down

GigabitEthernet0/1 unassigned YES unset down down

GigabitEthernet0/2 unassigned YES unset down down

Close configuration window



Reflection Questions

1. If the G0/0/1 interface showed that it was administratively down, what interface configuration command would you use to turn the interface up?

   Answer: **R1(config-if)# no shutdown**

2. What would happen if you had incorrectly configured interface G0/0/1 on the router with an IP address of 192.168.1.2?

Answers: PC-A would not be able to ping PC-B. This is because PC-B is on a different network than PC-A which requires the default-gateway router to route these packets. PC-A is configured to use the IP address of 192.168.1.1 for the default-gateway router, but this address is not assigned to any device on the LAN. Any packets that need to be sent to the default-gateway for routing will never reach their destination.

Conclusion

In this lab, I successfully built a small routed network consisting of a Cisco router, a switch, and two end devices. The devices were properly cabled, powered on, and initialized before configuration. I configured static IP addressing for both IPv4 and IPv6 on the PCs and router interfaces, set up the switch management interface with a default gateway, and implemented basic security measures such as console, VTY, and enable passwords with encryption. Descriptions and banners were also added for proper documentation and security awareness.

After saving the configurations, I verified end-to-end connectivity using **ping tests**, confirming that the router was correctly routing between subnets and that all devices could communicate. I also used various **show commands** (`show ip route`, `show ipv6 route`, `show interfaces`, `show ip interface brief`) to examine routing tables, interface status, MAC addresses, and IPv6 settings. These commands validated both the Layer 2 and Layer 3 configurations.

Overall, the lab reinforced key networking skills: **device initialization, interface configuration, IPv4/IPv6 addressing, basic security, and connectivity troubleshooting**. It demonstrated how routers interconnect different networks, how switches provide local connectivity, and how IOS commands can be used to monitor and verify the network. This exercise provided valuable practice in setting up and managing a functional LAN that integrates both IPv4 and IPv6.