Lesson Plan for LAB

Subject Code & Title: 18CSS202J Computer Communications

Session 2 Periods	Exercise
Lab 1	1.a - Introduction to Packet Tracer, Networking commands
	1.b - Demonstration of cross over and straight through cable
Lab 2	2.a - Configuration of IP Address in Router
	2.b - Configuration of IP Address in Router
Lab 3	3.a - Subnetting in WAN Configuration (DTE and DCE)
	3.b - Subnetting in WAN Configuration (DTE and DCE)
Lab 4	4.a - Mini - Project Review - I
	4.b - Mini - Project Review - I
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Lab 6	6.a - Demonstration of Static Routing
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Lab 9	9. a - EIGRP Authentication and Timers
	9. b - EIGRP Authentication and Timers
Lab 10	10.a - Single-Area OSPF Link Costs and Interface
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Lab 11	11.a - Multi-Area OSPF with Stub Areas and Authentication
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Lab 12	12.a - Examining Network Address Translation (NAT)
	12.b - Examining Network Address Translation (NAT)
Lab 13	13.a - BGP Configuration
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Lab 14	14.a - Mini - Project Review – II
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Lab 15	15.a - Mini – Project Review – II
	15.b - Mini – Project Review – II
Model Practical Examination	
End Semester Practical Examination	

Exercise 2: Configuration of IP Address in Router

Objective: To demonstrate the configuration of IP Address in router

Pre-requisite: IP Address, Range of IP Address and Classes of IP Address

Components:

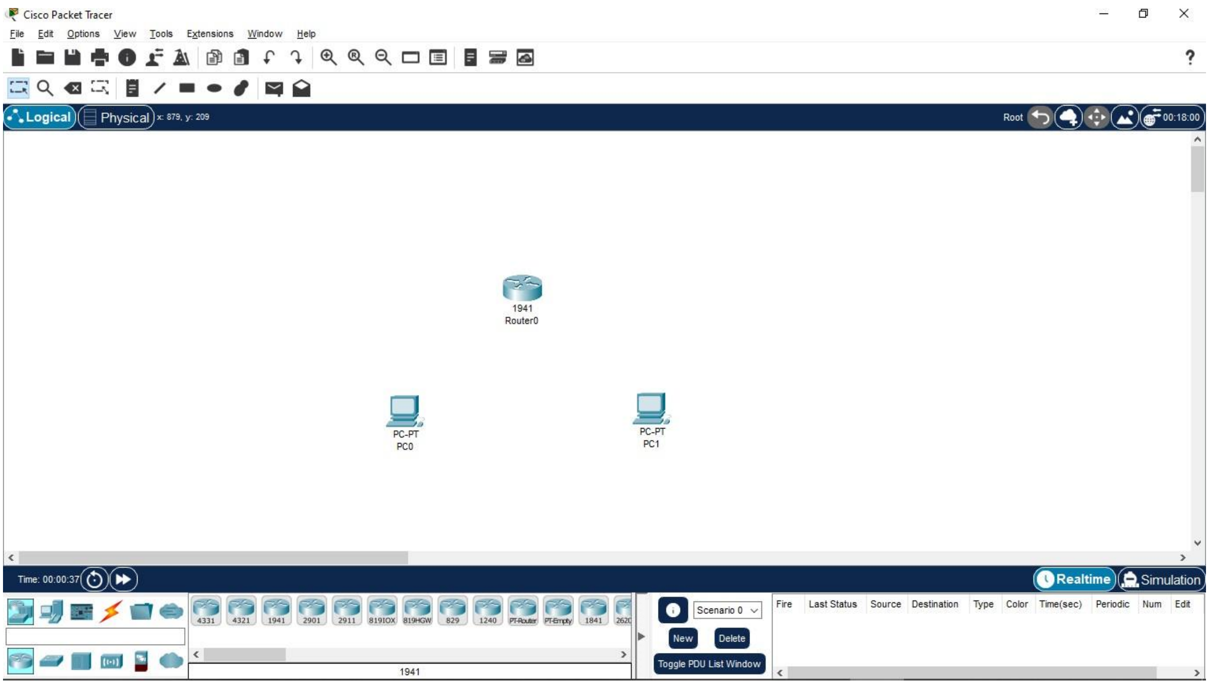
Devices	Required Nos
PCs	2
Copper cross-over Cables	2
Router	1

Addressing Table:

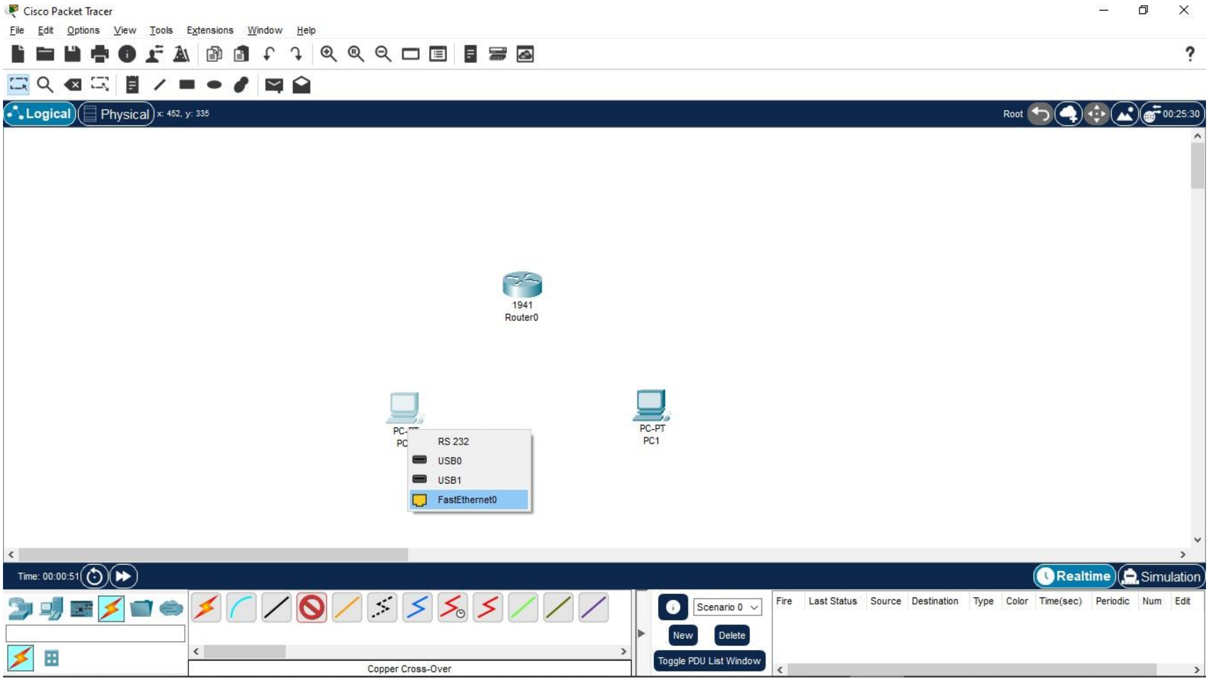
Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.0	192.168.10.1
PC1	Fa0/0	192.168.11.2	255.255.255.0	192.168.11.1
Router0	Gigabit 0/0	192.168.10.1	255.255.255.0	-
Router0	Gigabit 0/1	192.168.11.1	255.255.255.0	-

Procedure:

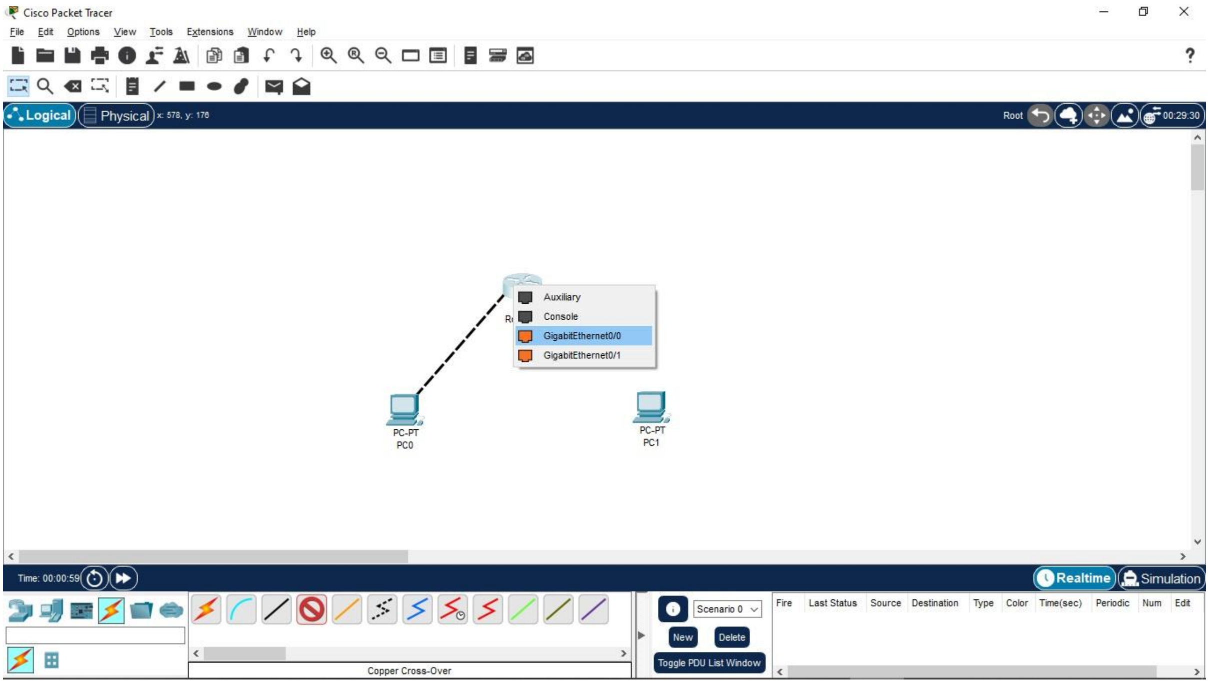
Step 1: Drag 2 PCs and a router in the console area.



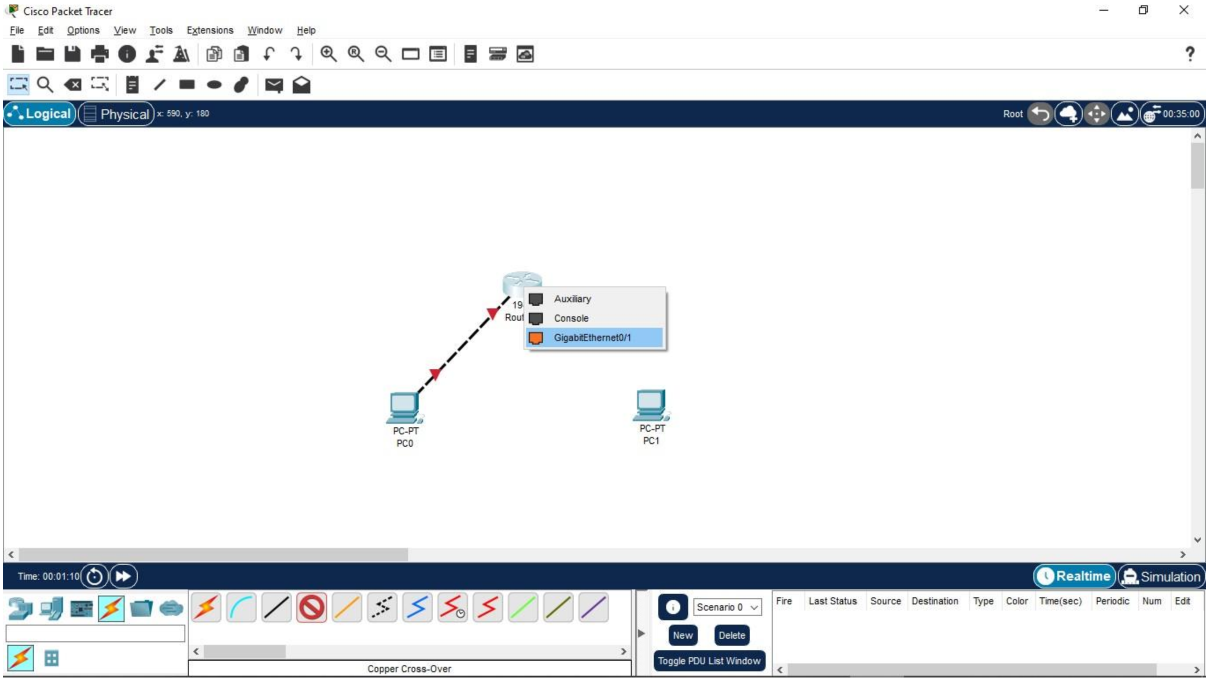
Step 2: Select Connectivity & Copper cross-over cable. Click on PC0 to get the interface options. Select Fa0/0



Step 3: Click on router0 to get the interface options and select GigabitEthernet0/0.



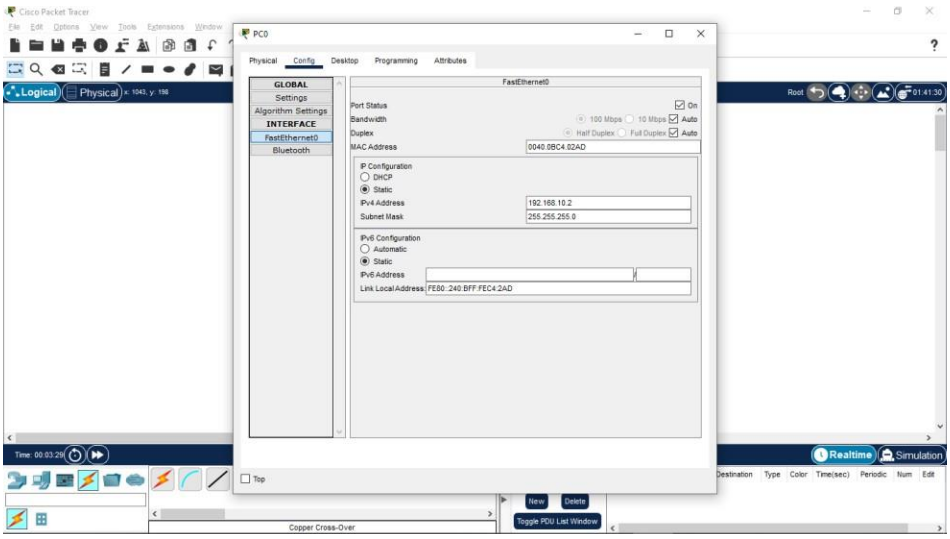
Step 4: Now PC0 and Router0 are physically connected. Again select copper cross-over cable and again click on Router0 to get the interface options and select GigabitEthernet0/1.



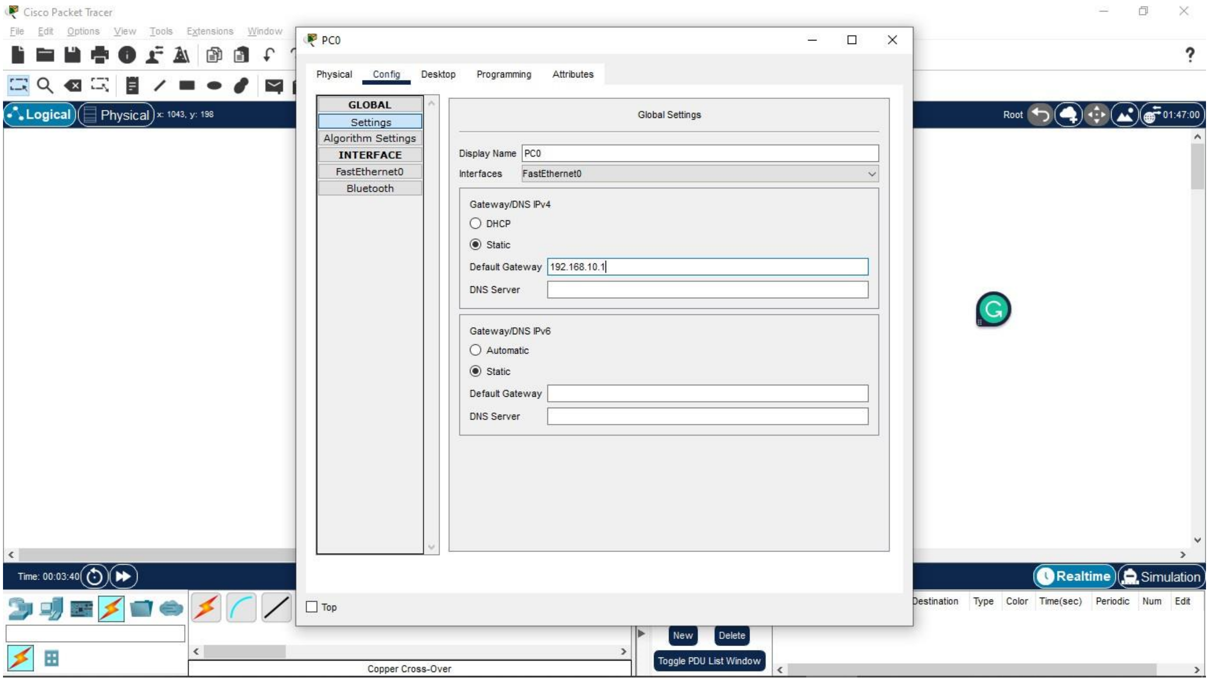
Step 5: Click on PC1 to get the interface options and select Fa0/0.

Step 6: Now the PCs are physically connected through Router. To establish logical connectivity,

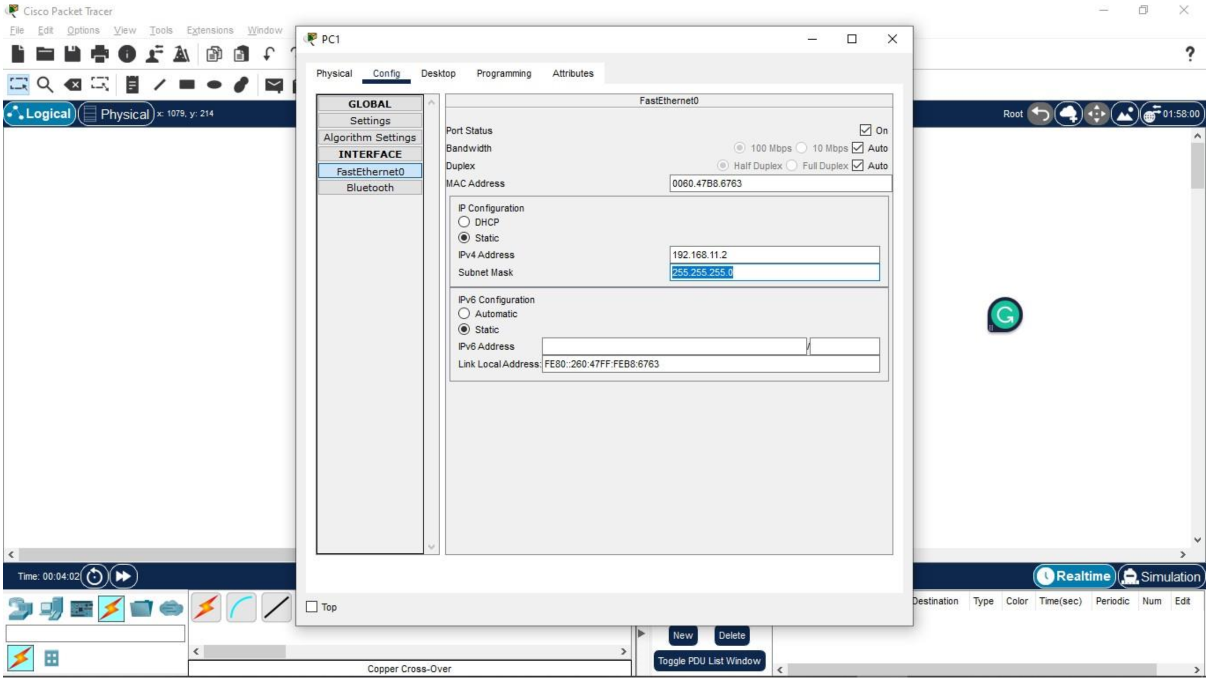
- Click on PC0.
- Select Config tab.
- Click on FastEhternet0/0 in the left pane.
- Configure the ip address 192.168.10.2 and subnet mask 255.255.255.0



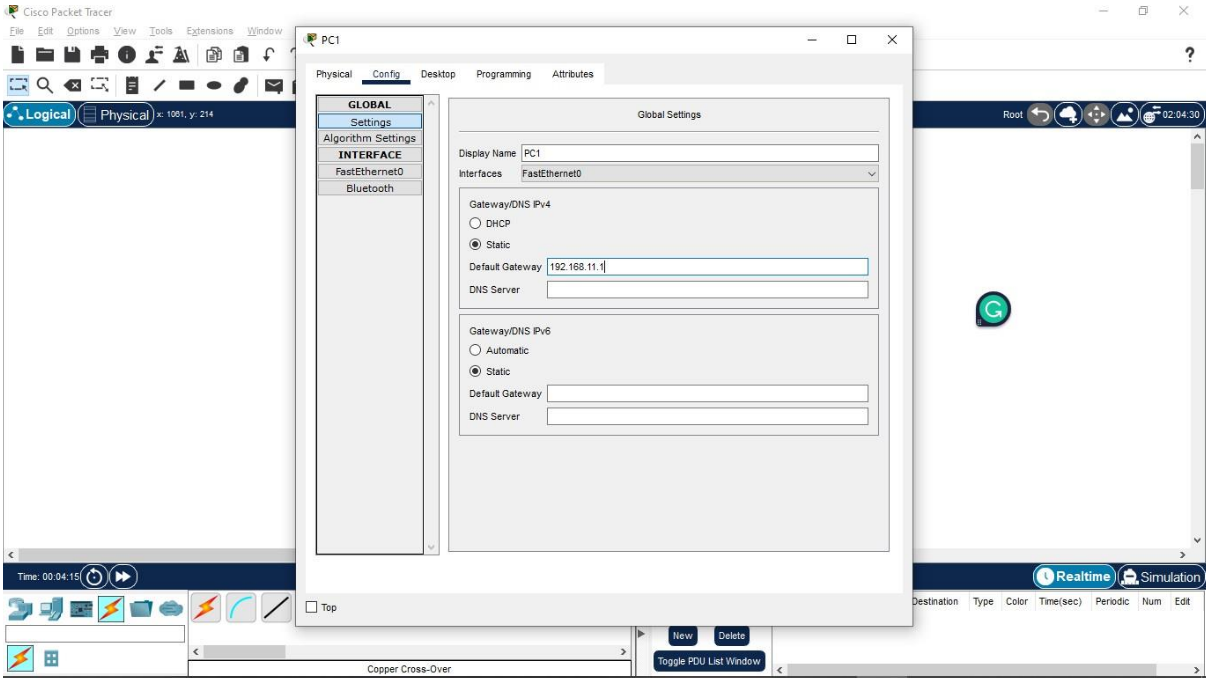
Step 7: Now click on settings and configure the gateway as 192.168.36.1



Step 8: Repeat the same procedure for PC1 and Configure the ip address 192.168.11.2 and subnet mask 255.255.255.0

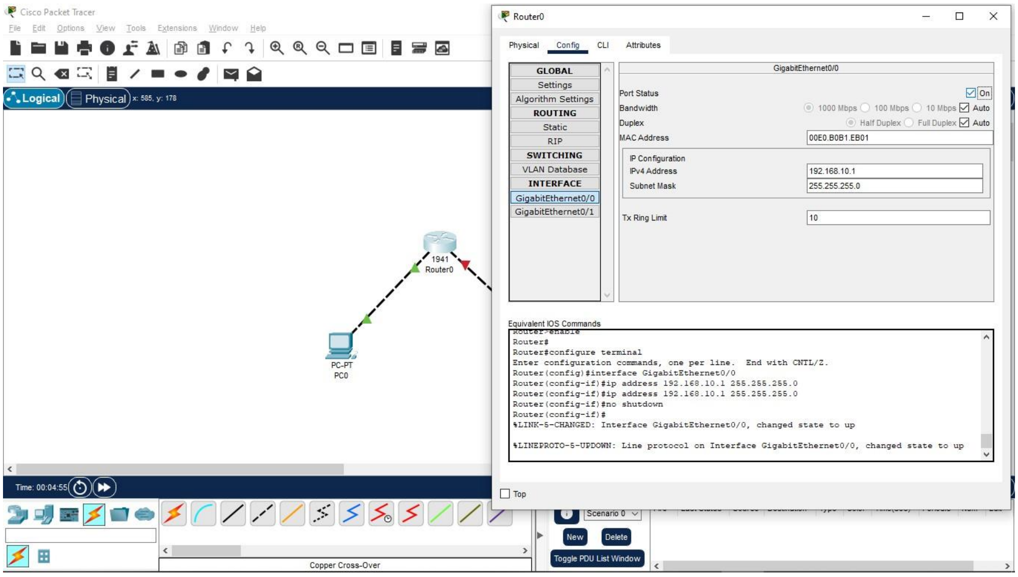


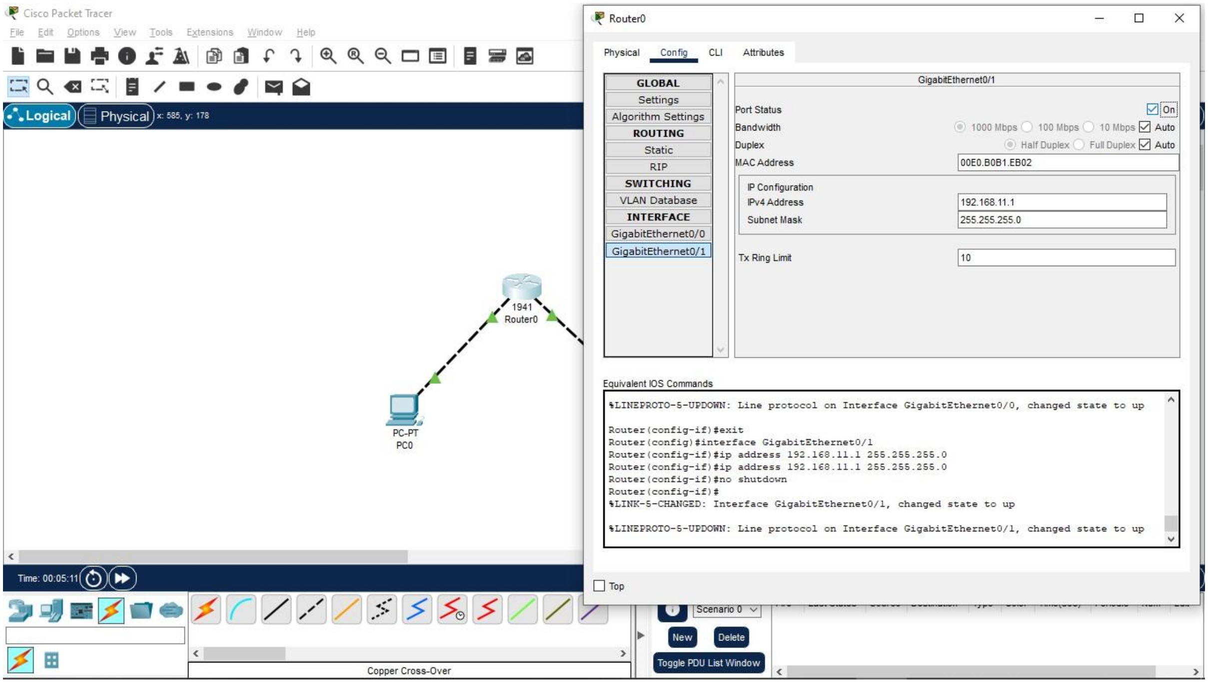
Step 9: Now click on settings and configure the gateway as 192.168.37.1



Step 10: Router configuration

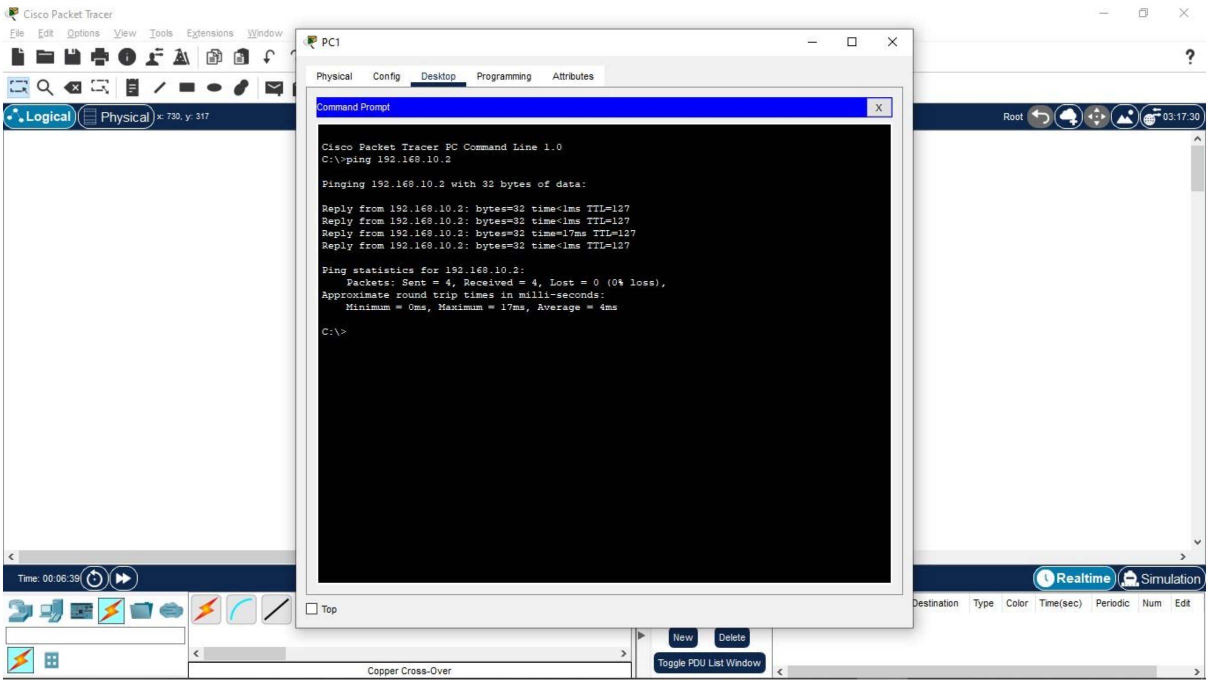
- Click on Router0 and select Config tab.
- Click on GigabitEthernet0/0 in the left pane and configure the ip address 192.168.10.1 and subnet mask 255.255.255.0
- Click on GigabitEthernet0/1 in the left pane and configure the ip address 192.168.11.1 and subnet mask 255.255.255.0





Step 11: Now both the PCs are physically and logically connected. To check the logical connectivity,

- Click on PC1.
- Select Desktop tab.
- Click on Command Prompt icon.
- Type ping 192.168.10.2 to fetch the output as follows



Exercise 3: Subnetting in WAN Configuration (DTE and DCE)

Objective: To demonstrate the configuration of IP Addressing with Subnetting in WAN Configuration

Pre-requisite: IP Address, Range of IP Address, Classes of IP Address, Subnetting

Components:

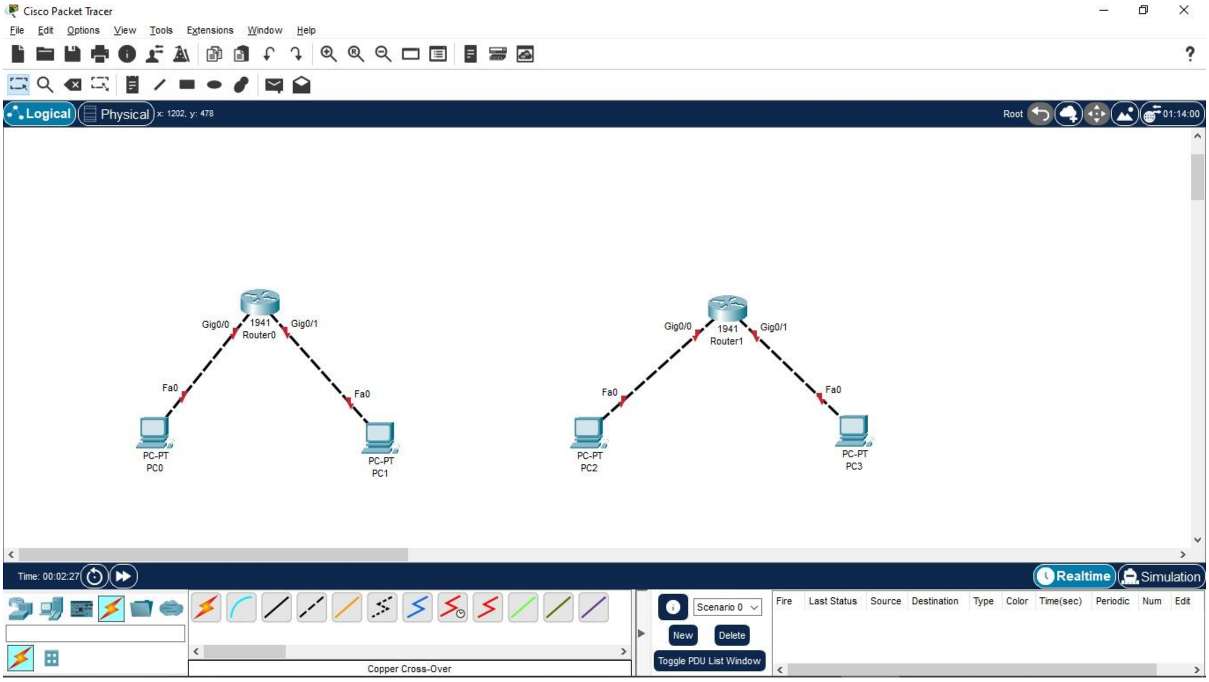
Devices	Required Nos
PCs	4
Copper cross-over Cables	4
Routers	2
Serial DCE	1

Addressing Table:

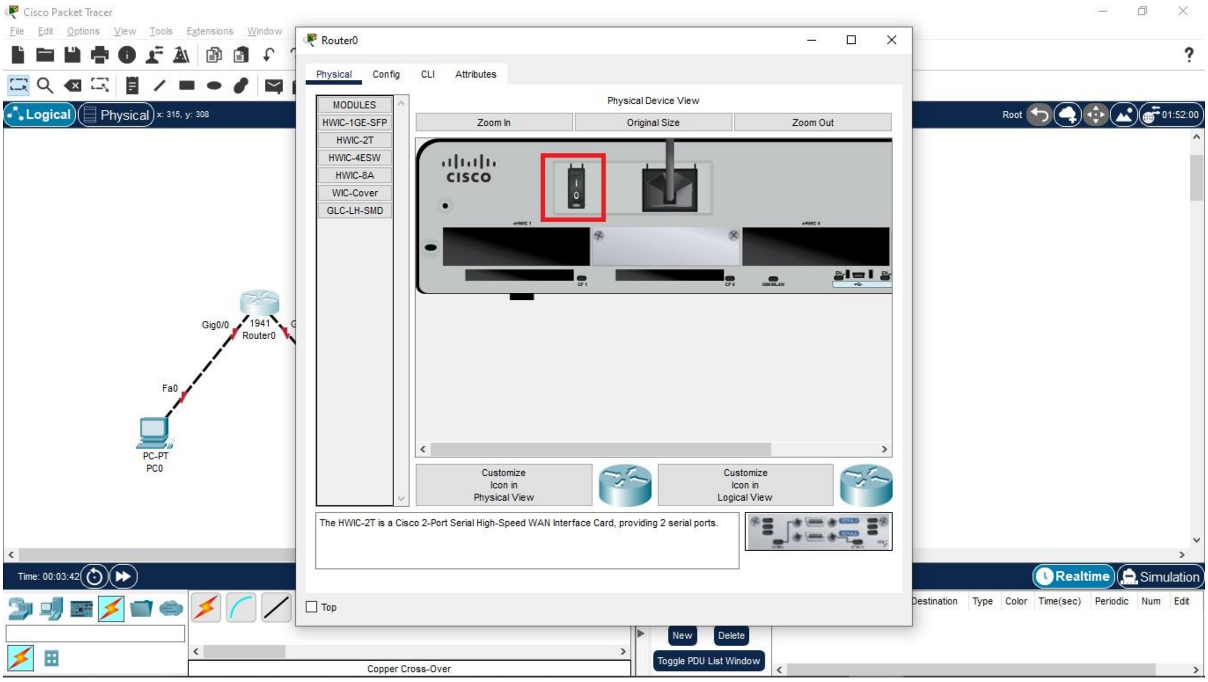
Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-

Procedure:

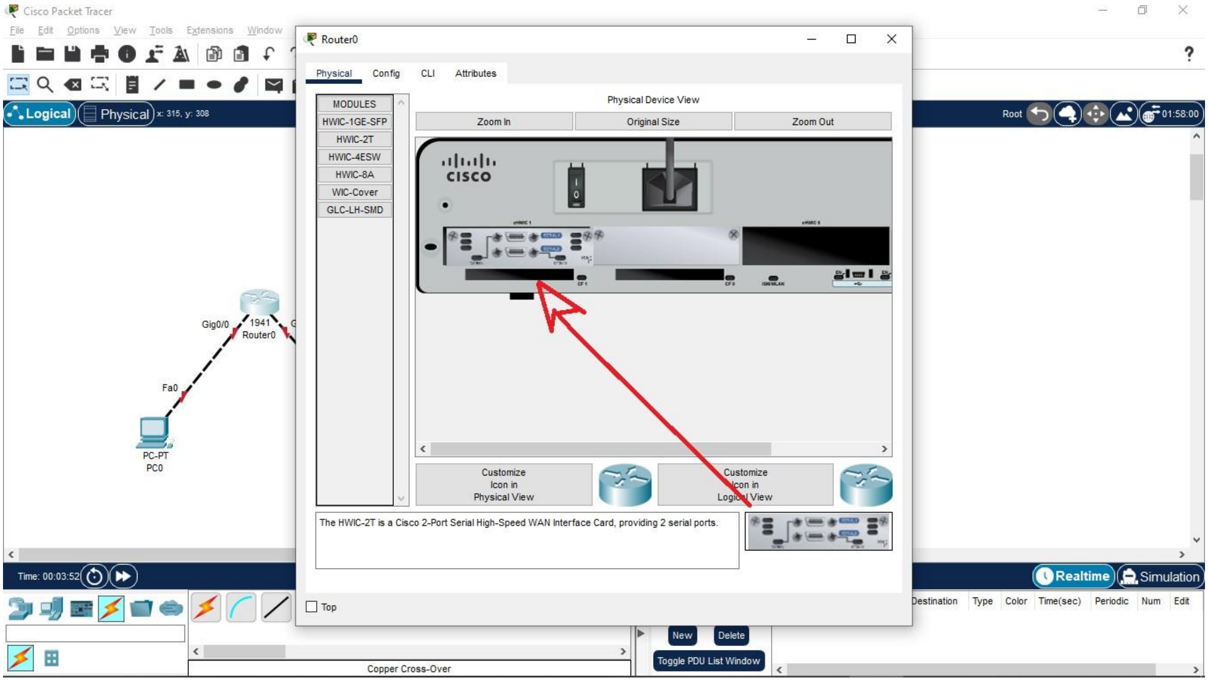
Step 1: Drag 4 PCs and 2 routers in the console area as shown in figure



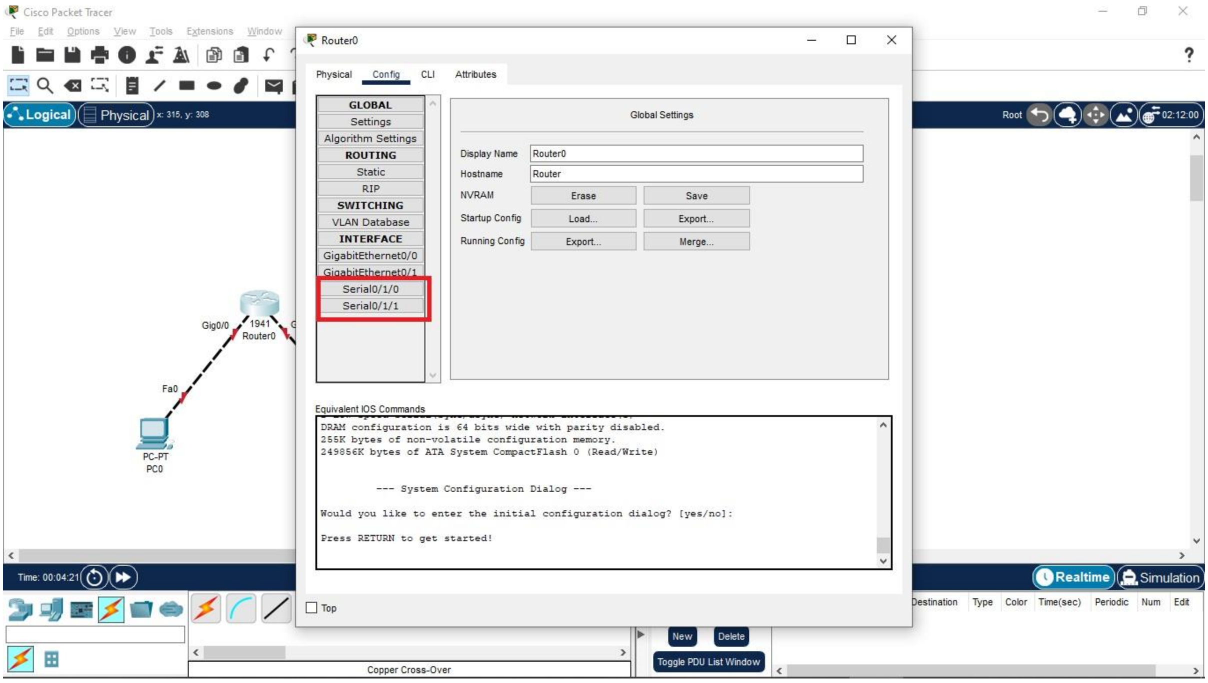
Step 2: Click on Router0 and go to Physical tab. Click HWIC2T in the left pane and Click on zoom in. Switch off the Hardware



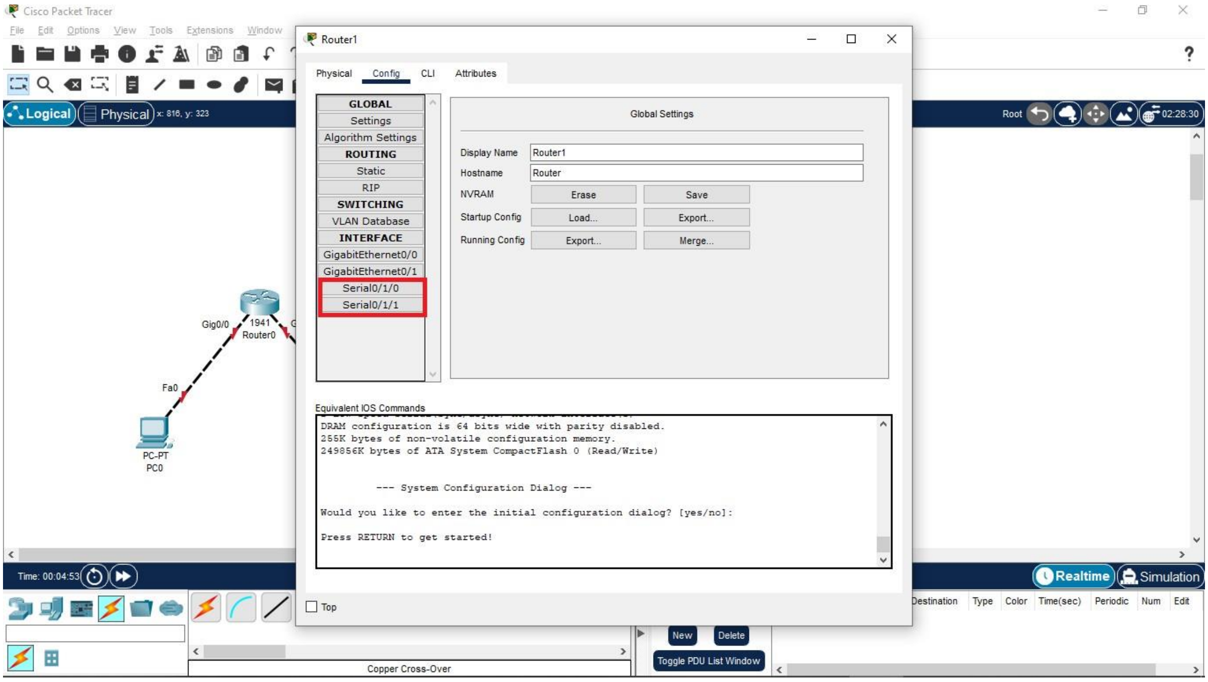
Step 3: Find the console from lower right corner. Drag and drop the console in the empty area as shown in the figure.



Step 4: Now again switch on the hardware and check in config tab for 2 serial ports added.

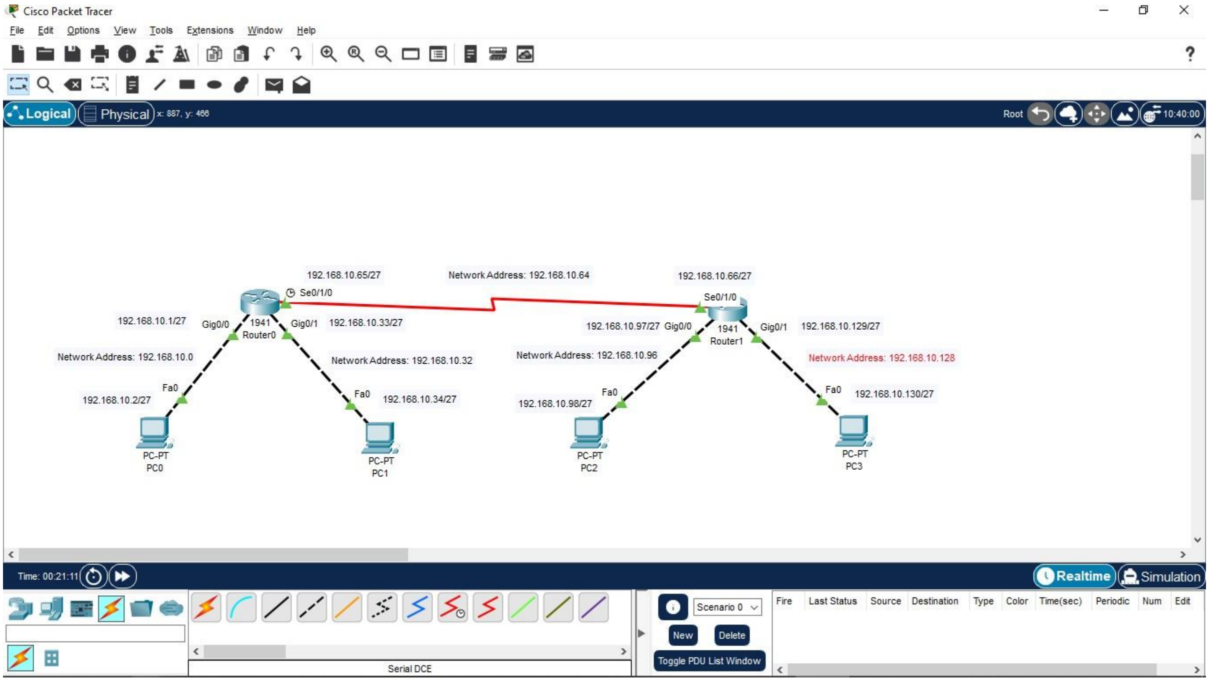


Step 5: Repeat the same procedure (Step 3 and Step 4) for Router1



Step 6: Now the PCs are physically connected through Router. To establish logical connectivity, assign IP addresses for 4 PCs (each 1 interface and corresponding router interface as gateway) and 2 Routers (each 3 ip addresses for 3 interfaces) as shown in the following table.

Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-



Scenario with Network Address for each link

Step 7:

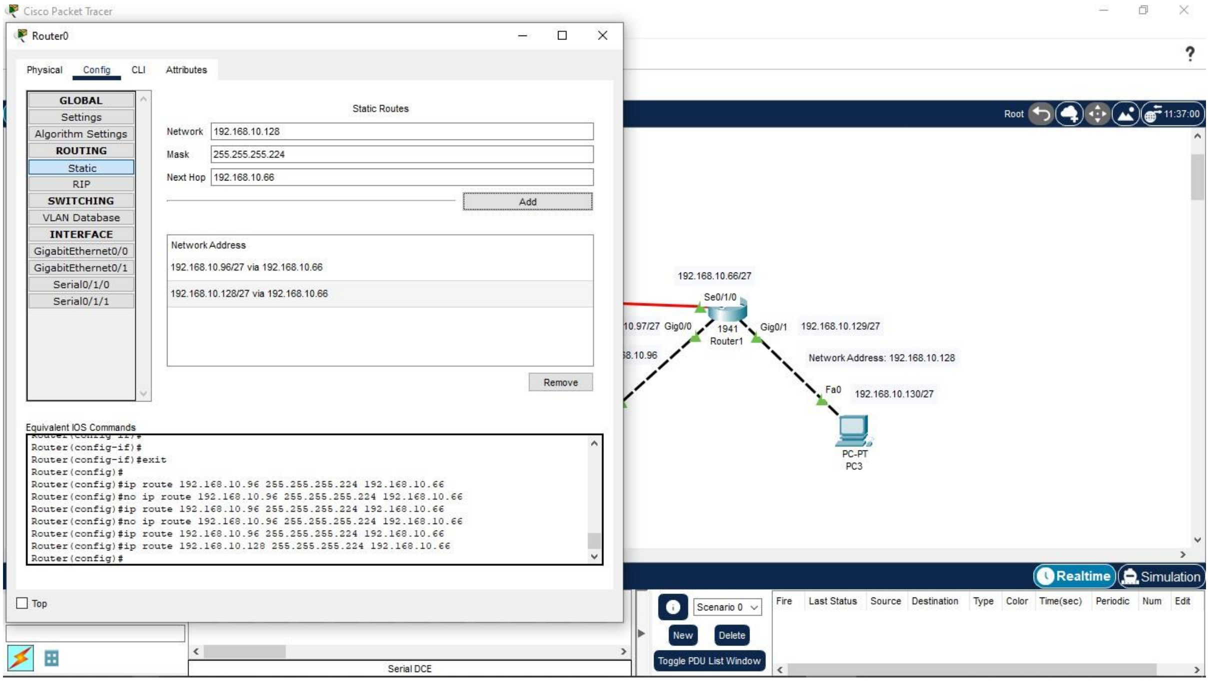
- **To enable packet transmission among the devices in the scenario, Static Routing has to be configured.**
- **To configure static routing, unknown networks and next-hop IP address to reach the unknown network for Router0 and Router1 has to be determined.**
- **Note: While specifying devices we should use IP-Address and while specifying network we should use Network Address.**
- **Unknown networks for the routers are derived in the following table**

Device	**Known Networks**	**Subnet Mask**	**Unknown Networks**	**Subnet Mask**	**Next-hop Address**
Router0	192.168.10.0	255.255.255.224	192.168.10.96	255.255.255.224	192.168.10.66
Router0	192.168.10.32	255.255.255.224	192.168.10.128	255.255.255.224	192.168.10.66
Router0	192.168.10.64	255.255.255.224	-	-	-
Router1	192.168.10.96	255.255.255.224	192.168.10.0	255.255.255.224	192.168.10.65
Router1	192.168.10.128	255.255.255.224	192.168.10.32	255.255.255.224	192.168.10.65
Router1	192.168.10.64	255.255.255.224	-	-	-

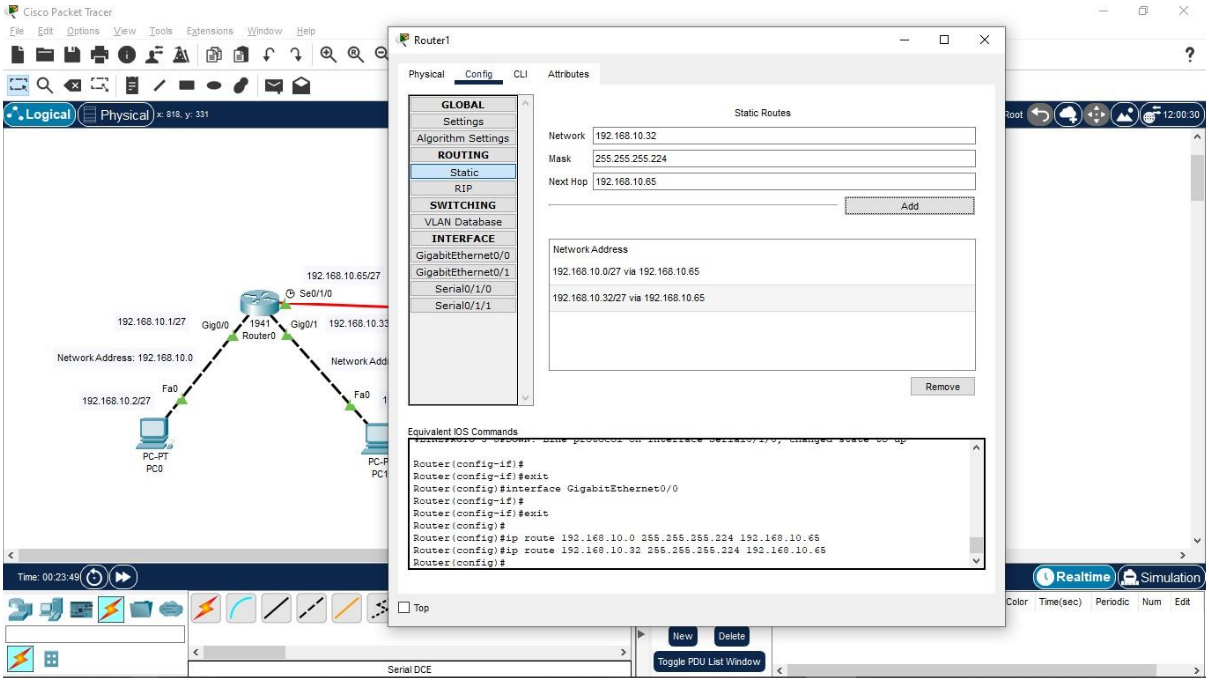
Only unknown networks should be configured for static routing

Step 8:

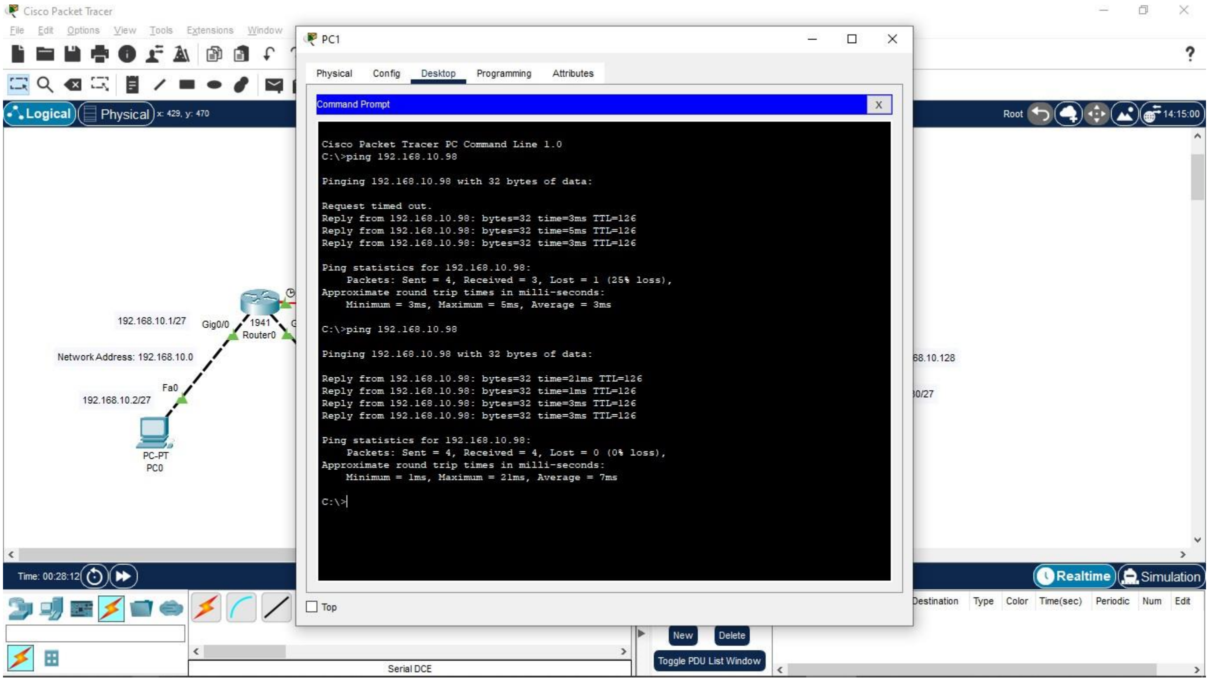
- To configure static routing, click on
  - Router0 => Config tab => Static =>Enter network address (refer unknown network for router0) => Subnet Mask for network address => Next-hop address => Add network
- Repeat the same to add the next network.
- Two networks should be added for the given scenario



Step 9: Repeat the same procedure to configure for Router1



Step 10: After configuration of Static routing in both Routers, Check the connectivity among any two devices using Ping Command



Step 11:

- To check routing table, go to CLI tab in Router and press enter to get the router prompt.
    - Router>
- Now type enable or en and press enter
    - Router>en
    - Router#

Follow the command “show ip route” to get the routing table of a router

```
Router>en
Router#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, E - EGP
i - IS-IS, 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

192.168.10.0/24 is variably subnetted, 8 subnets, 2 masks
C 192.168.10.0/27 is directly connected, GigabitEthernet0/0
L 192.168.10.1/32 is directly connected, GigabitEthernet0/0
C 192.168.10.32/27 is directly connected, GigabitEthernet0/1
L 192.168.10.33/32 is directly connected, GigabitEthernet0/1
C 192.168.10.64/27 is directly connected, Serial0/1/0
L 192.168.10.65/32 is directly connected, Serial0/1/0
S 192.168.10.96/27 [1/0] via 192.168.10.66
S 192.168.10.128/27 [1/0] via 192.168.10.66
```

Exercise 5.a: VLAN Switch Configuration

Objective: To demonstrate the configuration of VLAN switch with authentication

Pre-requisite: IP Address, Range of IP Address, Classes of IP Address, Subnetting

Components:

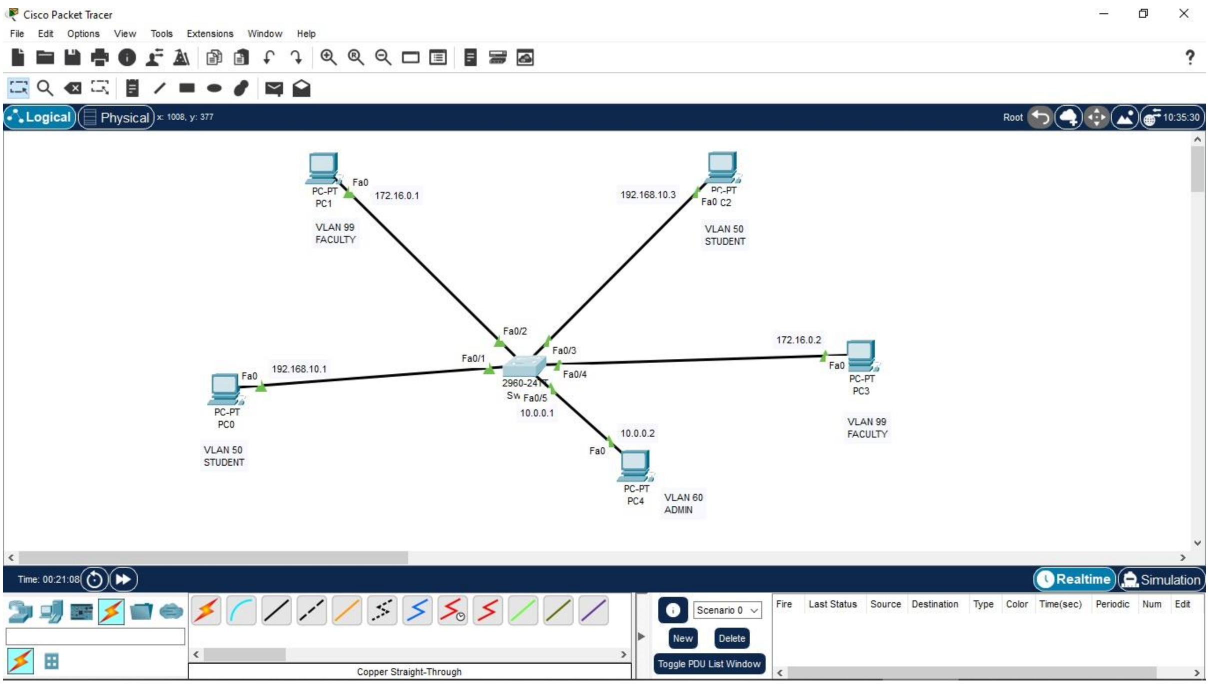
Devices	Required Nos
PCs	5
Copper straight-through Cables	5
Switch 2940	1

Addressing Table:

VLAN	Device	Interface	IP Address	Subnet Mask	Gateway
VLAN 50	PC0	Fa0/0	192.168.10.1	255.255.255.0	-
VLAN 99	PC1	Fa0/0	172.16.0.1	255.255.0.0	-
VLAN 50	PC2	Fa0/0	192.168.10.2	255.255.255.0	-
VLAN 99	PC3	Fa0/0	172.16.0.2	255.255.0.0	-
VLAN 60	PC3	Fa0/0	10.0.0.2	255.0.0.0	-
	Switch0	Fa0/5	10.0.0.1	255.0.0.0	-

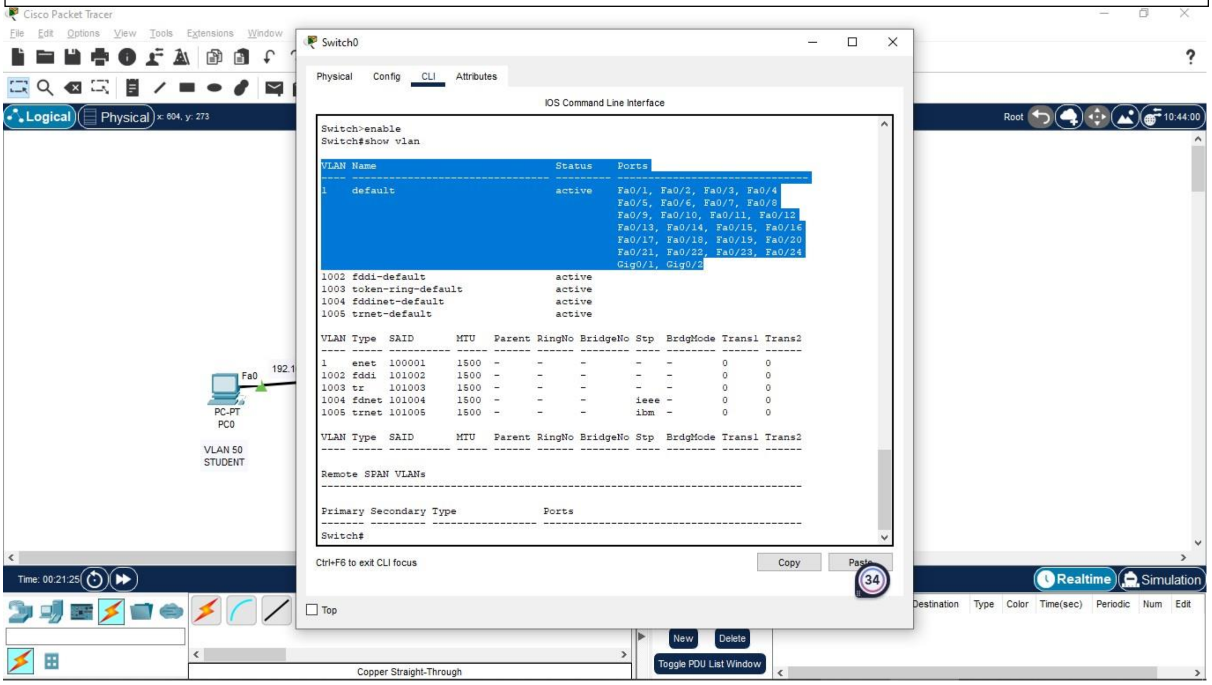
Procedure:

Step 1: Drag 5 PCs and 1 number of 2940 Switch in the console area and configure the IP address for all the PCs as shown in figure [Do not try to configure IP address for switch in this step]



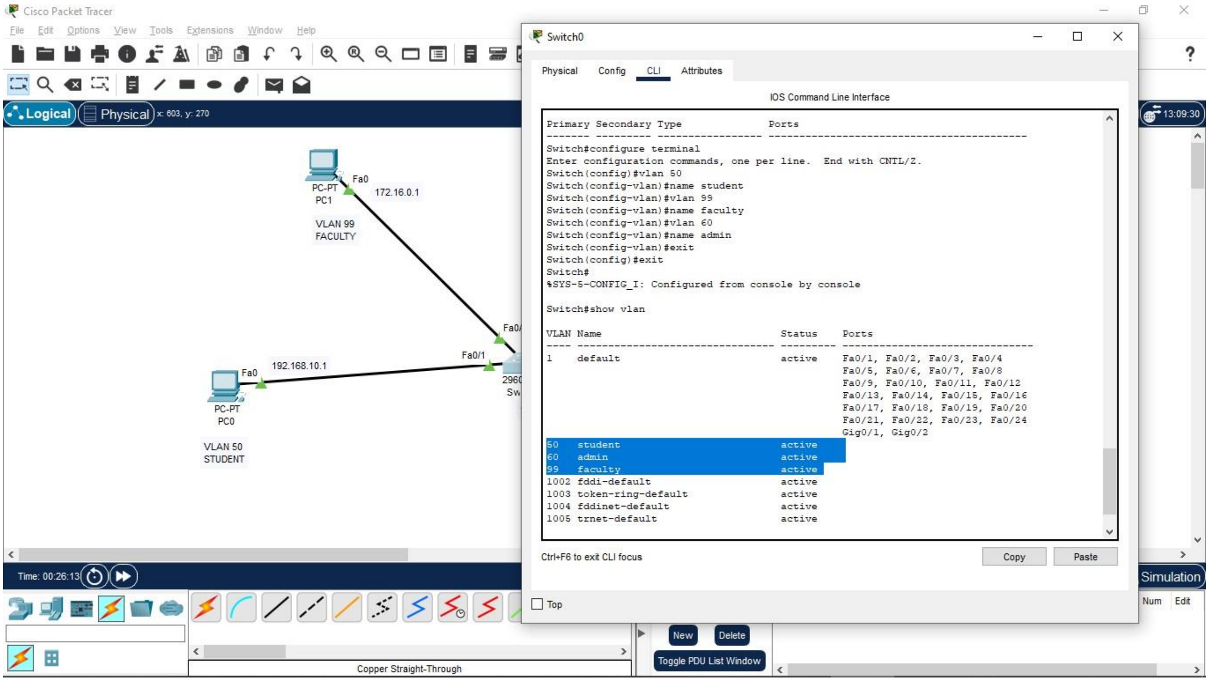
Step 2: To check the default VLAN, Click on Switch and go to the CLI tab and type the following in the prompt to check the default VLANs referred to as 1,1002,1003,1004,1005 with their names, status and ports assigned for the VLANs. Note that VLAN1 is the default VLAN where all ports are assigned to. You cannot delete these default VLANs but assign the ports to different VLANs

Switch>enable
Switch#show vlan



Step 3: To create new VLANs, type the following commands in the CLI

Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#vlan 50
Switch(config-vlan)#name student
Switch(config-vlan)#vlan 99
Switch(config-vlan)#name faculty
Switch(config-vlan)#vlan 60
Switch(config-vlan)#name admin
Switch(config-vlan)#exit
Switch(config)#exit
Switch#show vlan



Step 4: Now the VLANs are created and are active. To assign the ports to the corresponding VLAN, type the following commands.

```
Switch#
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface fa
Switch(config)#interface fastEthernet 0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 50
Switch(config-if)#exit
Switch(config)#interface fastEthernet 0/3
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 50
Switch(config-if)#exit
Switch(config)#interface fastEthernet 0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 99
Switch(config-if)#exit
Switch(config)#interface fastEthernet 0/4
```

Switch(config-if)#switchport mode access

Switch(config-if)#switchport access vlan 99

Switch(config-if)#exit

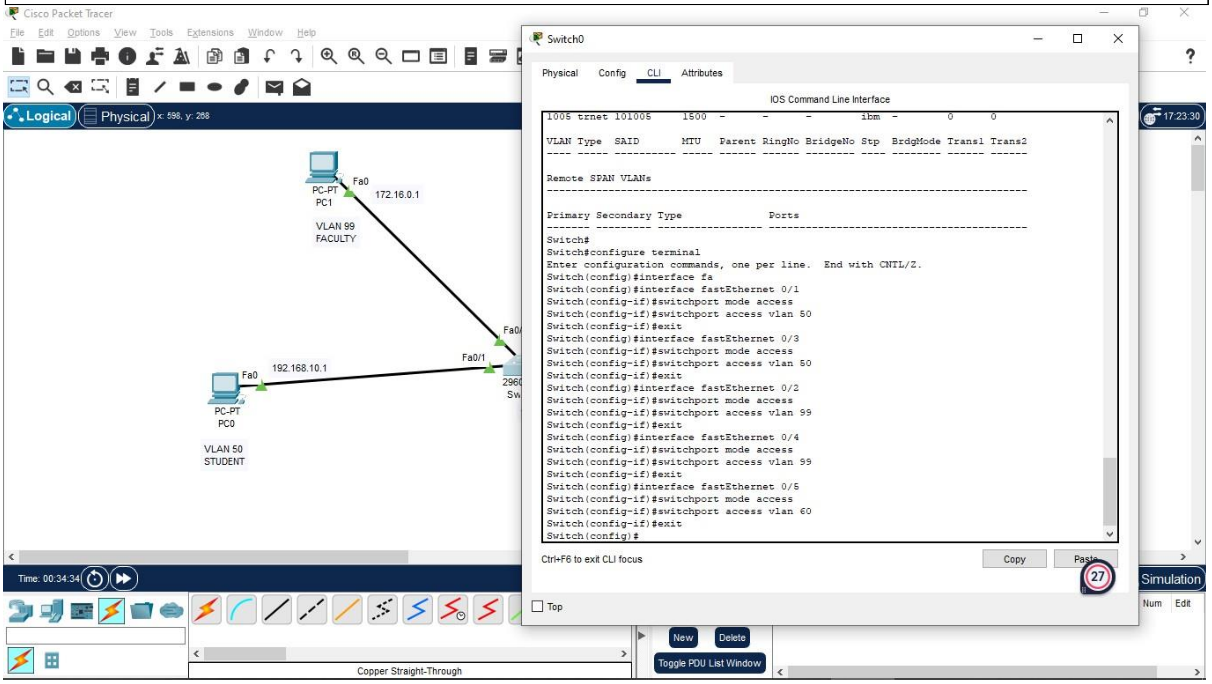
Switch(config)#interface fastEthernet 0/5

Switch(config-if)#switchport mode access

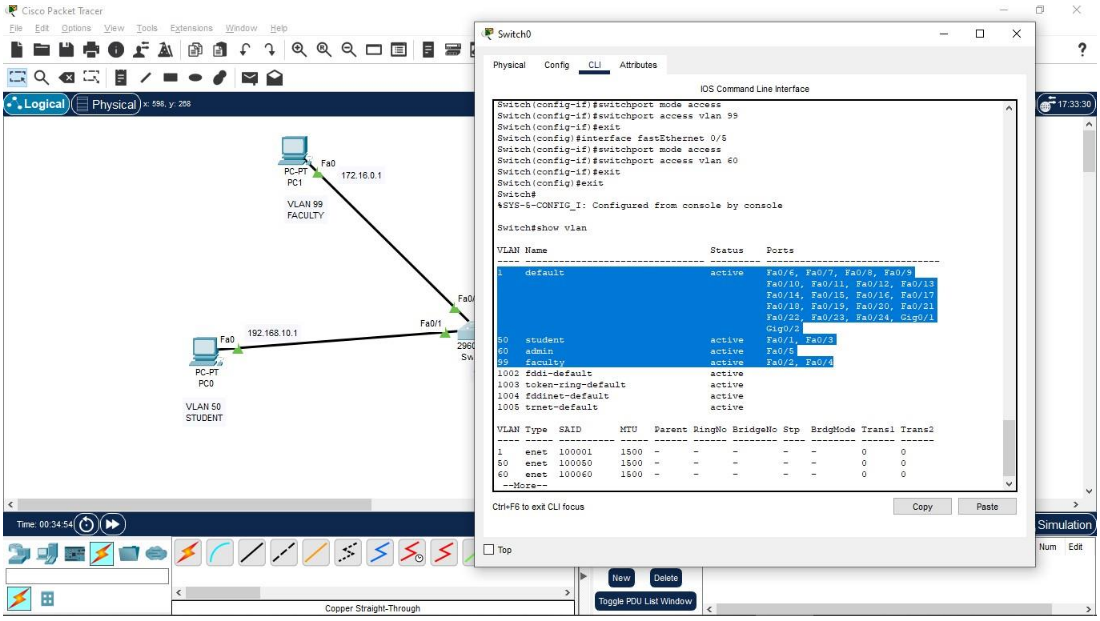
Switch(config-if)#switchport access vlan 60

Switch(config-if)#exit

Switch(config)#

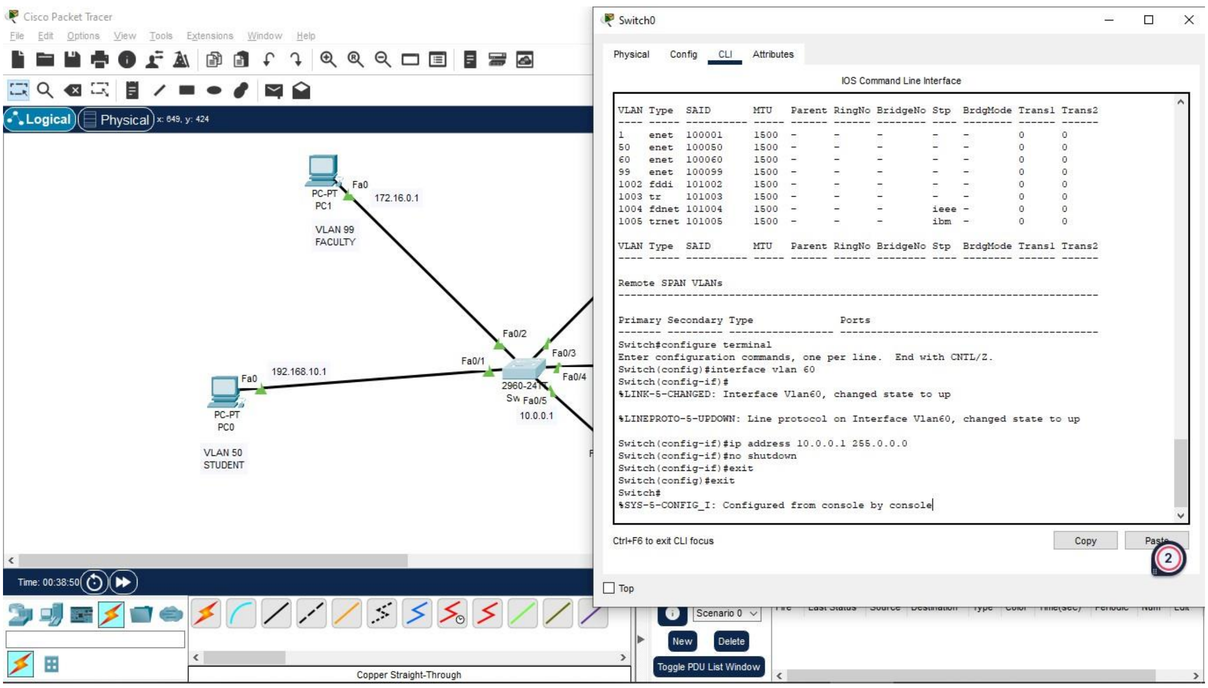


Step 5: Again check with the command "show vlan" in switch# prompt to check

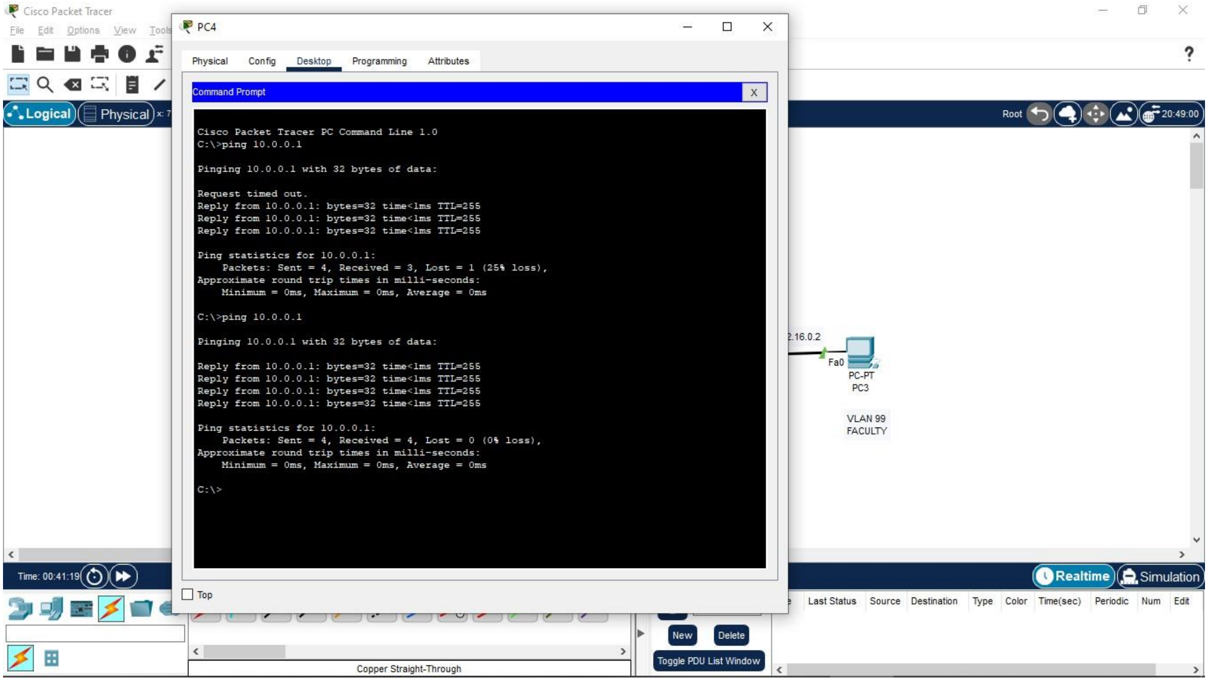


Step 6: The admin VLAN 60 needs to be enabled with a remote access privilege. To do so, the VLAN 60 has to be assigned with an IP address. Type the following commands to assign IP address for VLAN 60.

```
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface vlan 60
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan60, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan60, changed state to up

Switch(config-if)#ip address 10.0.0.1 255.0.0.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#exit
```

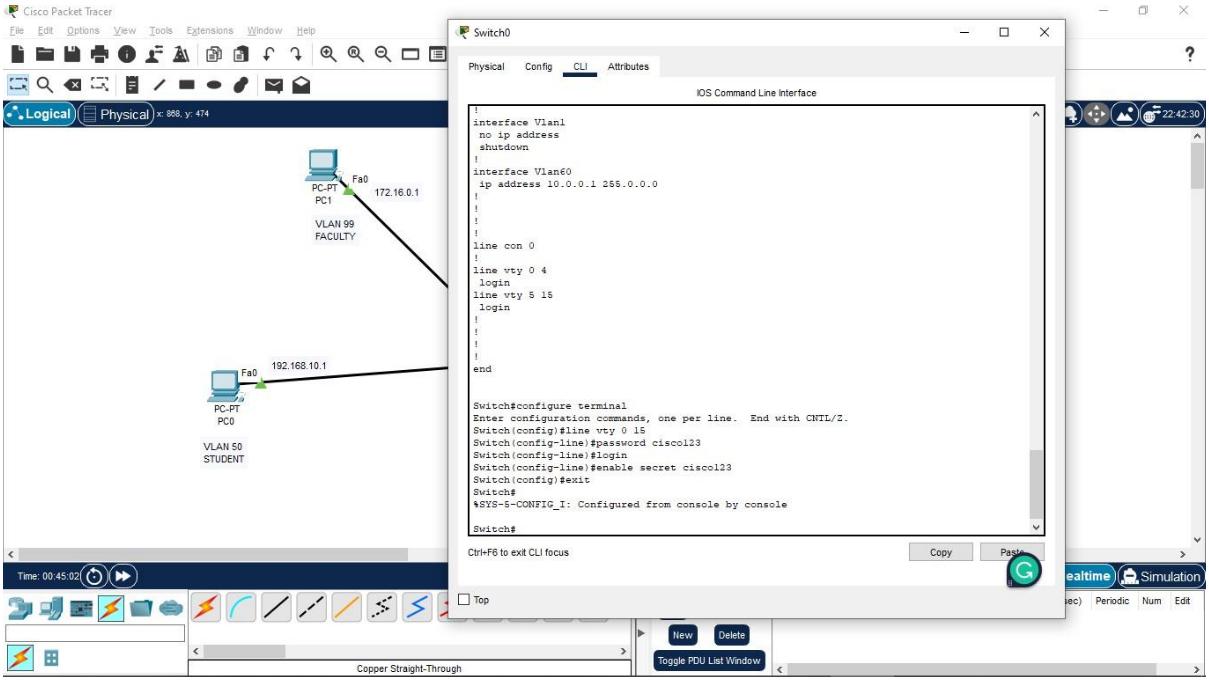


Step 7: To check the connectivity of the VLAN 60 IP address, click on PC5 (IP address – 10.0.0.2) and go to Desktop => Command Prompt => ping 10.0.0.1



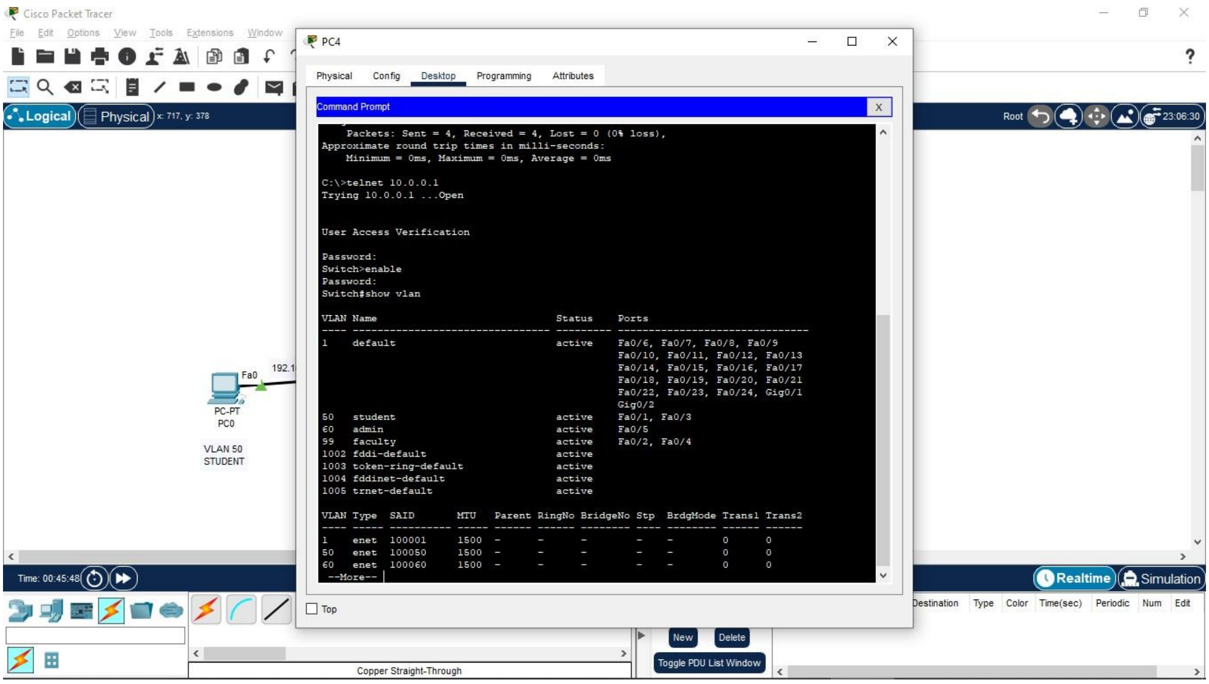
Step 8: To provide remote access privilege with authentication, type the following, in the CLI tab of switch.

```
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#line vty 0 15
Switch(config-line)#password cisco123
Switch(config-line)#login
Switch(config-line)#enable secret cisco123
Switch(config)#exit
Switch#
```



Step 8:

- To check for the remote access and authentication, click on PC5 and go to command prompt and type “telnet 10.0.0.1”
- Enter the password “cisco123” whenever asked
- Once authenticated to “Switch>” prompt, type “enable” and try the command “show vlan” to find out all the VLANs assigned in the switch from the PC5.



Exercise 5. b: Router Configuration through a Console

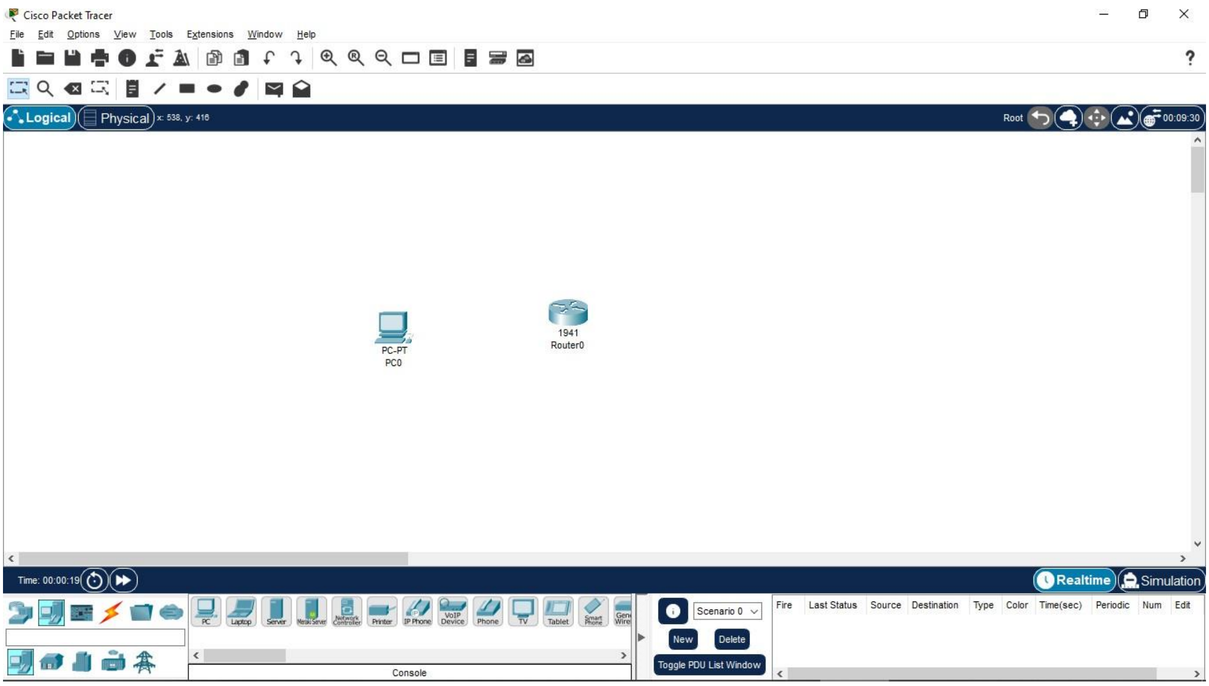
Objective: To demonstrate the configuration of Router with authentication through a console

Components:

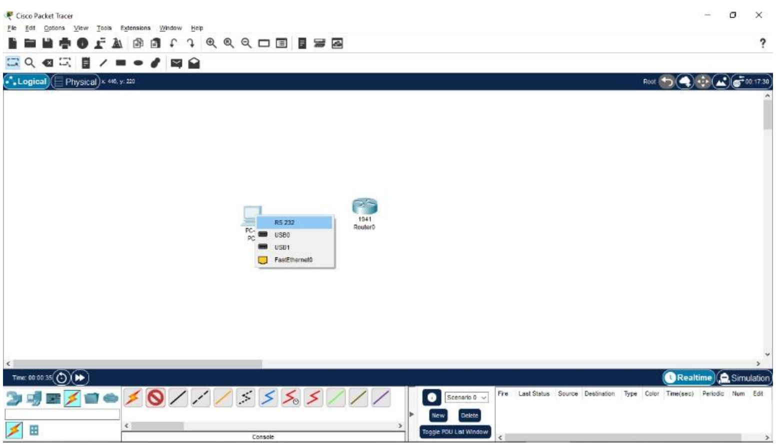
Devices	Required Nos
PCs	1
Console Cables	1
Router 1941	1

Procedure:

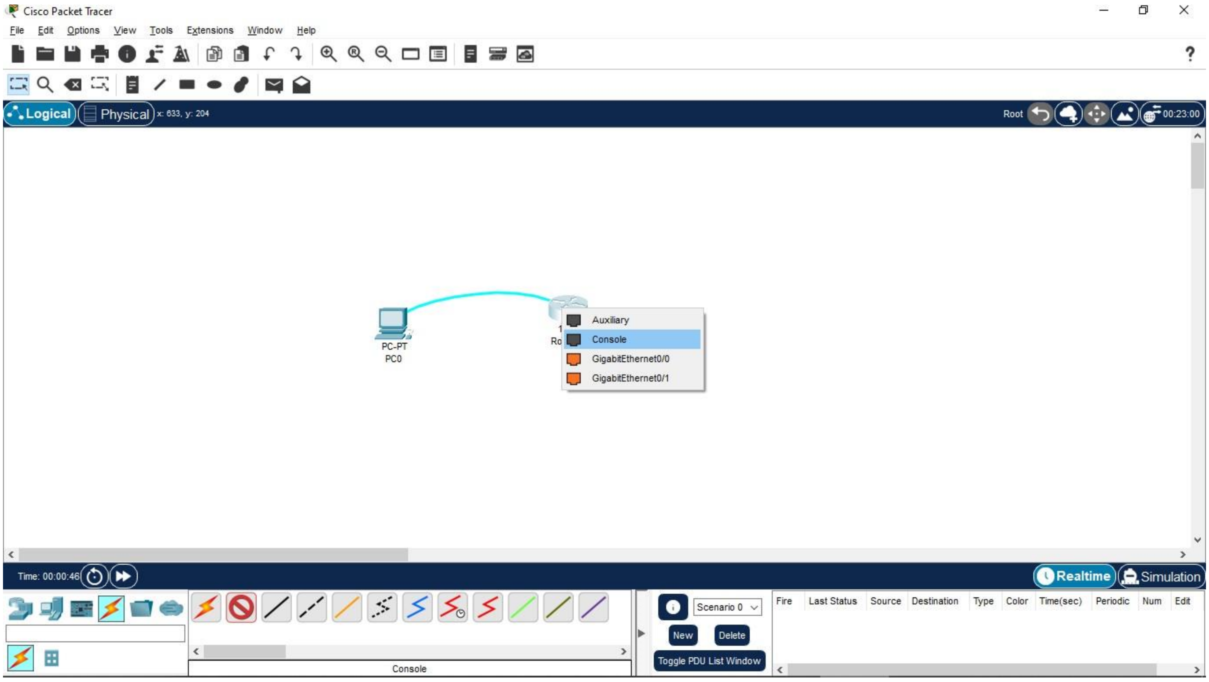
Step 1: Drag 1 PC and 1 number of 1941 Router in the console area



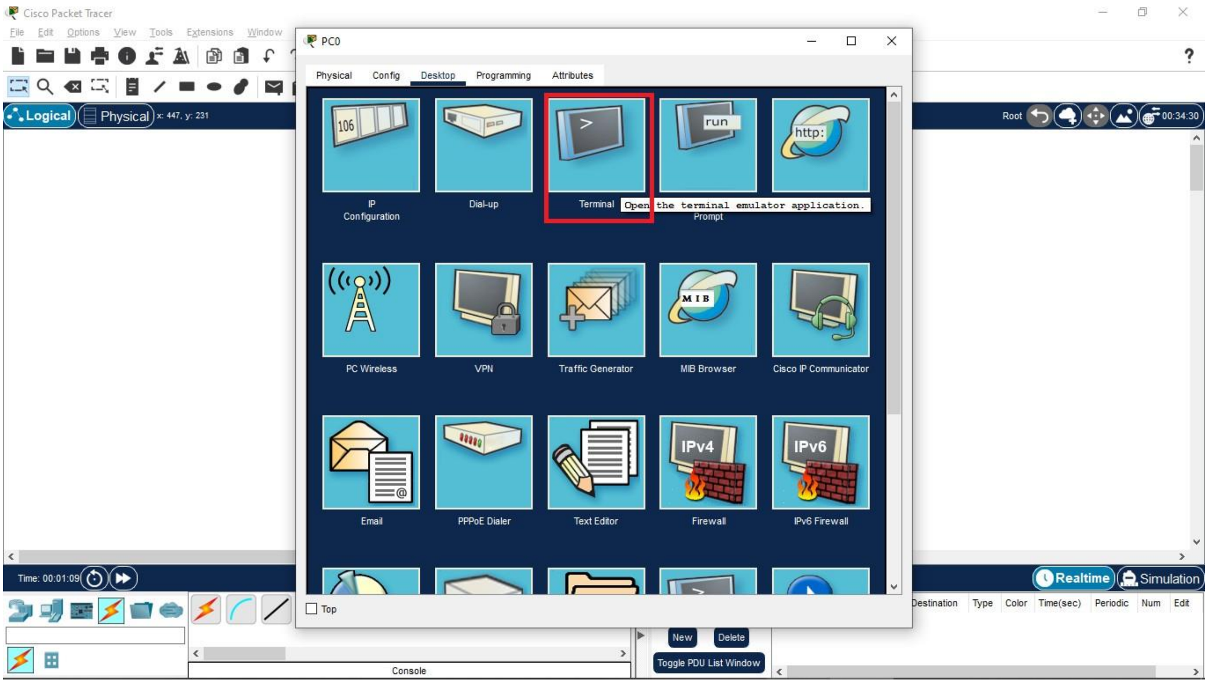
Step 2: Click on Connectivity and select Console cable. Click on PC and select RS232 interface.



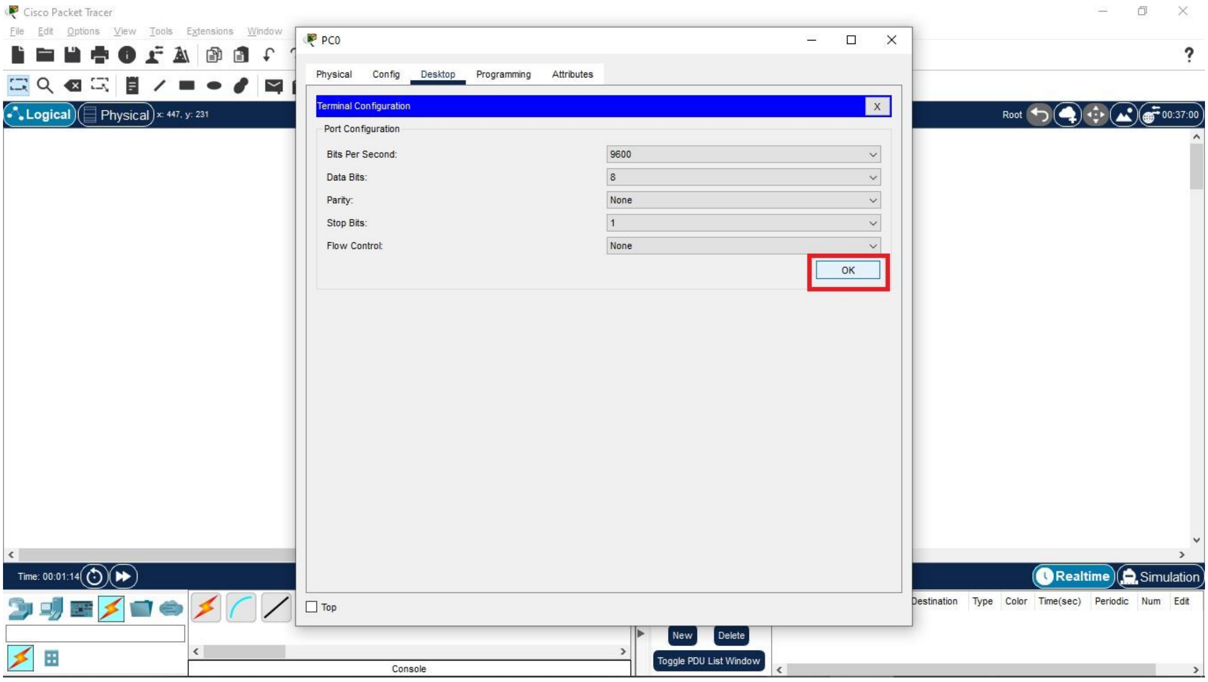
Step 3: Now click on Router and select Console interface to connect PC and Router with Console cable



Step 4: Now click on PC0 and go to Desktop => Terminal



Step 5: Click on OK for default Terminal parameters.

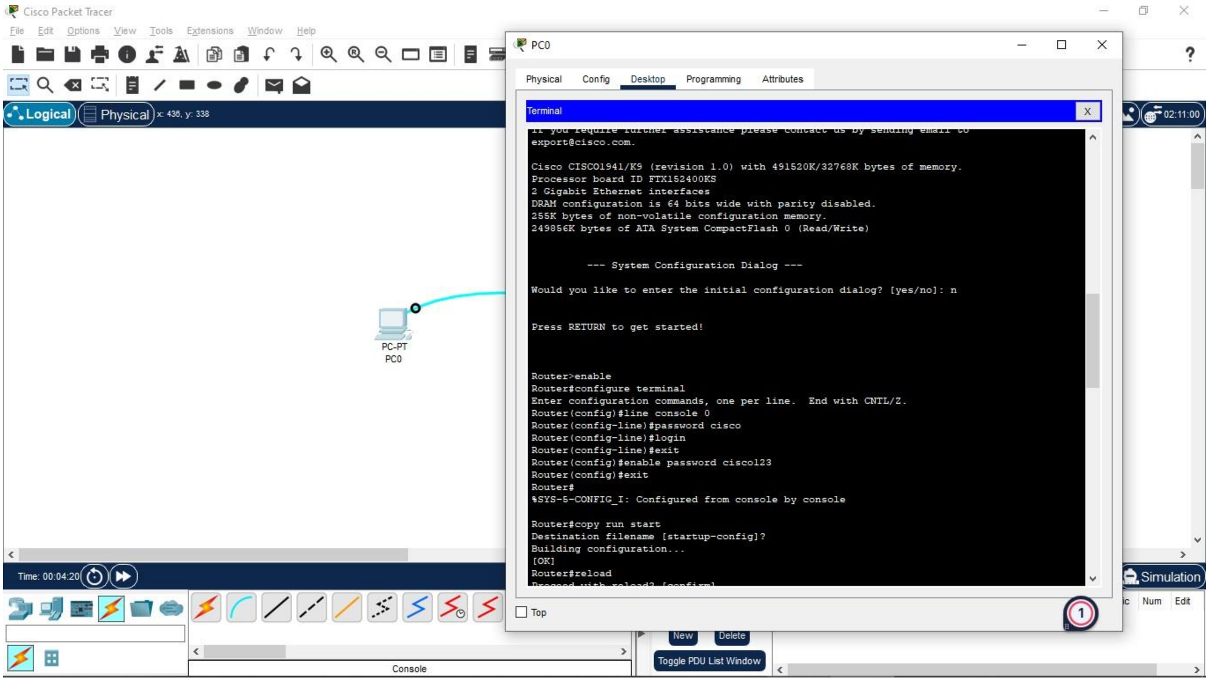


Step 6:

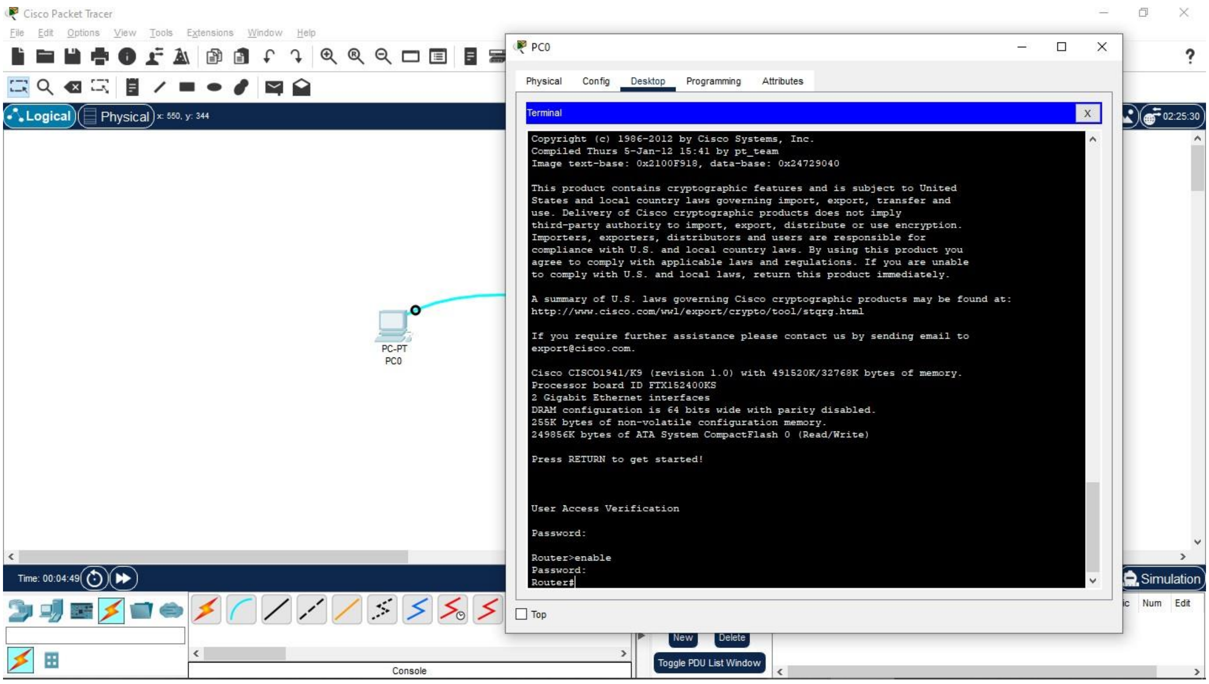
- Enter "no" when prompted, and type the following to configure "line console password" as "cisco" and privilege mode password as "cisco123"
- The "copy run start" command copies the running configuration parameters to start-up configuration parameters such that when you reload or reboot the router the configured parameters will not be erased from the Router memory RAM.

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#line console 0
Router(config-line)#password cisco
Router(config-line)#login
Router(config-line)#exit
Router(config)#enable password cisco123
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#copy run start
Destination filename [startup-config]?
```

```
Building configuration...
[OK]
Router#reload
Proceed with reload? [confirm]
```



Step 7: After reloading enter "cisco" as the password, when prompted to remote access and the password "cisco123" when you type "enable" to use Privilege mode access of Router from PC.



Exercise 6: Demonstration of Static and Default Routing

Exercise 6. a: Demonstration of Static Routing

Objective: To demonstrate the configuration of IP Addressing with Subnetting in WAN Configuration

Pre-requisite: IP Address, Range of IP Address, Classes of IP Address, Subnetting

Components:

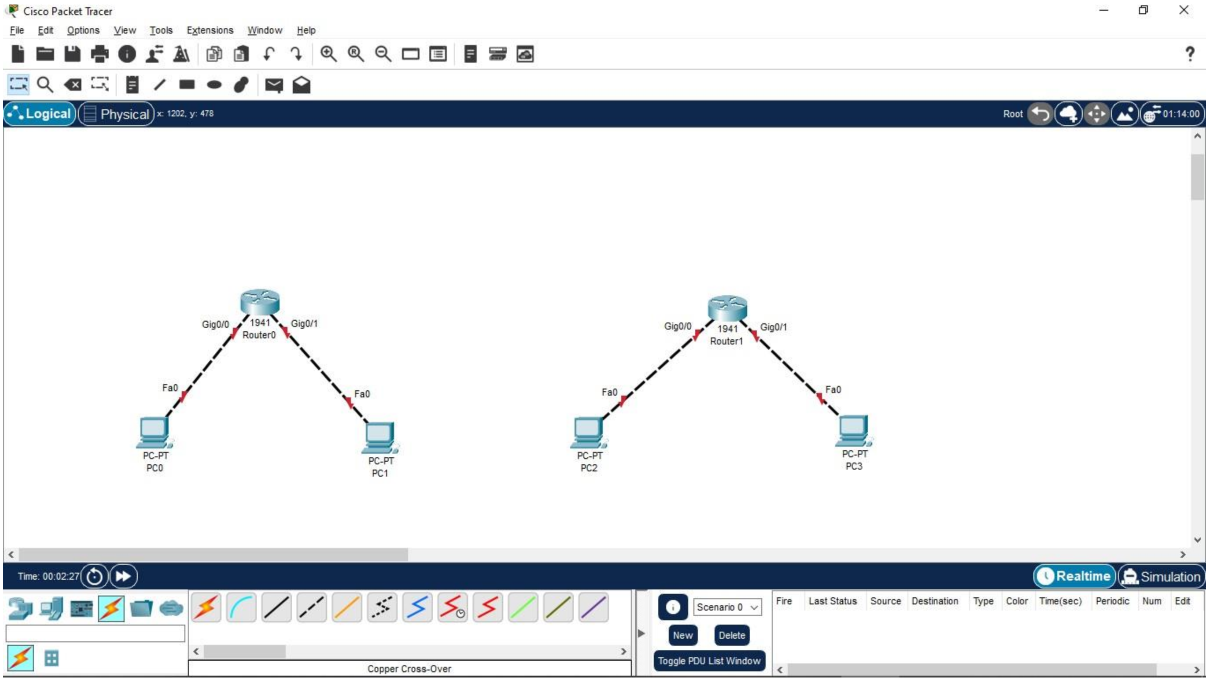
Devices	Required Nos
PCs	4
Copper cross-over Cables	4
Routers	2
Serial DCE	1

Addressing Table:

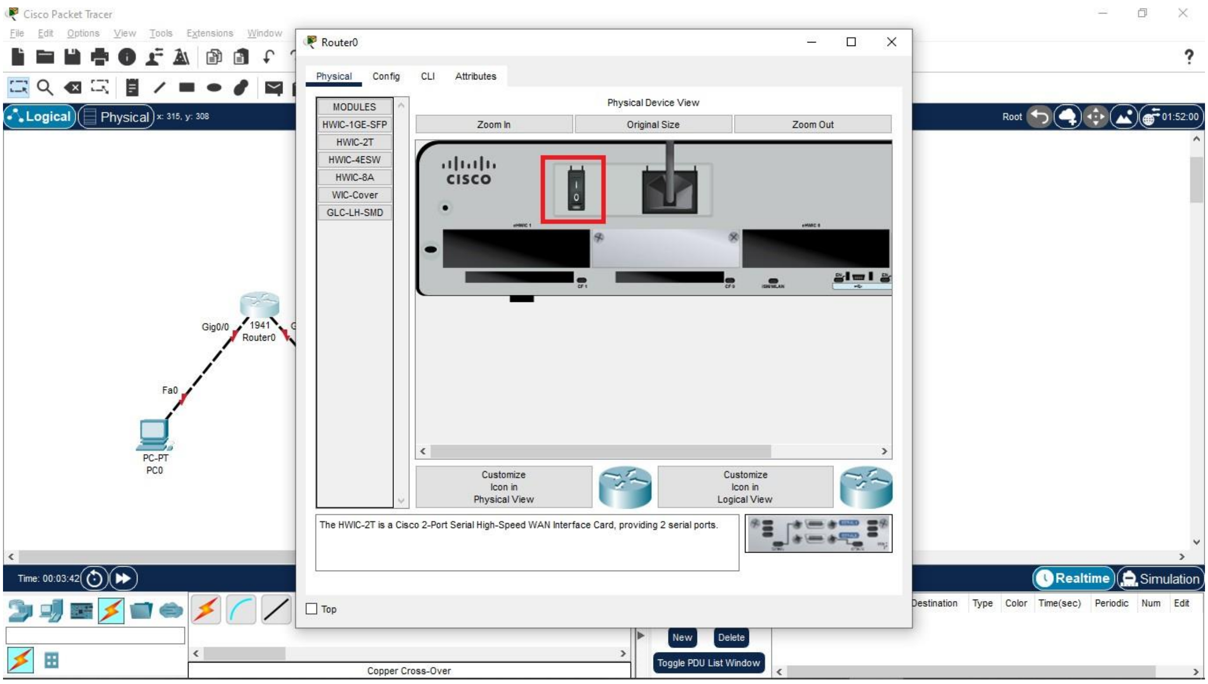
Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-

Procedure:

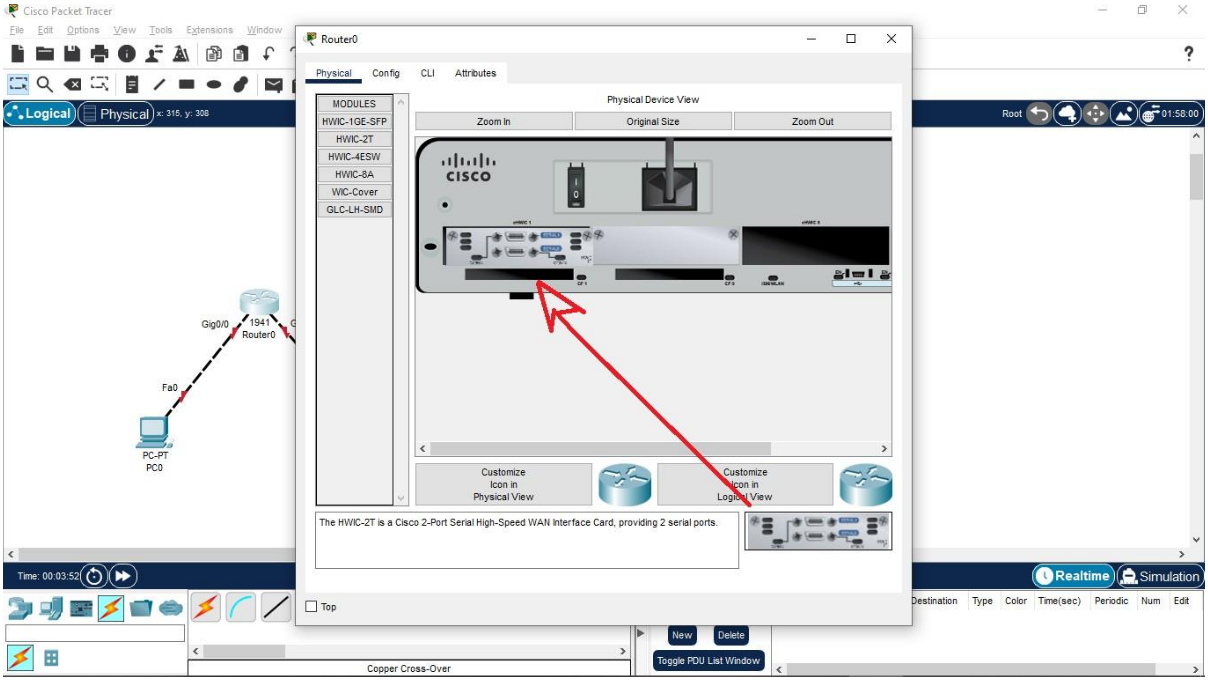
Step 1: Drag 4 PCs and 2 routers in the console area as shown in figure



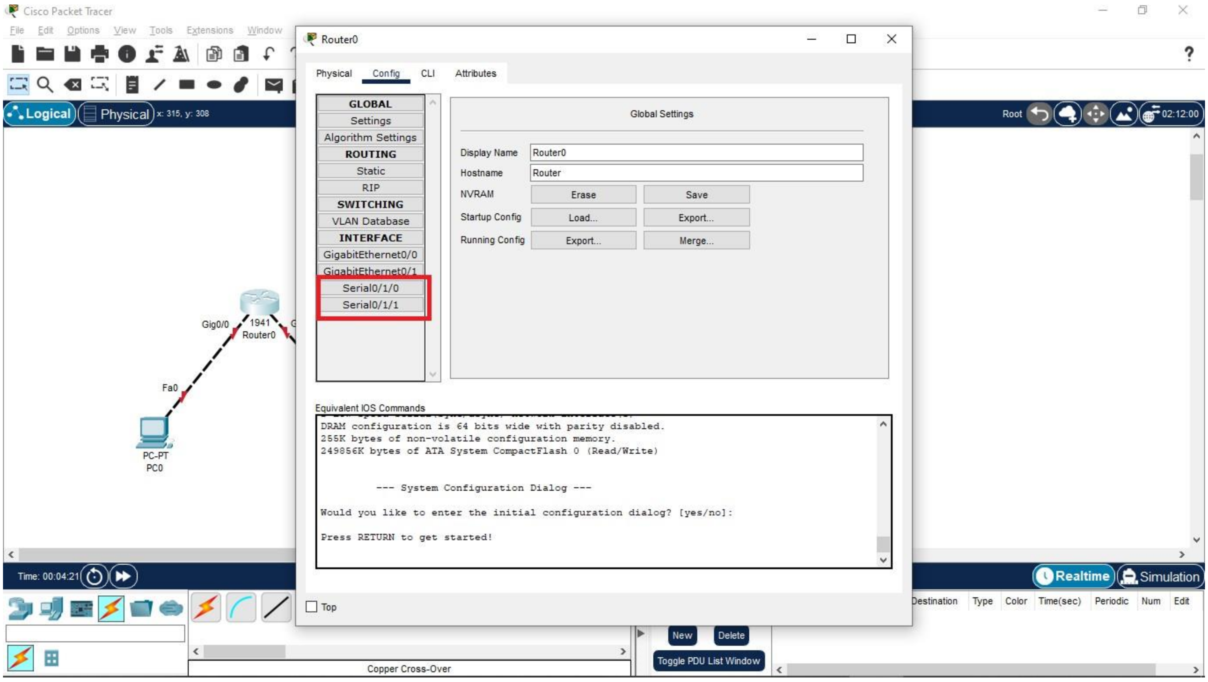
Step 2: Click on Router0 and go to Physical tab. Click HWIC2T in the left pane and Click on zoom in. Switch off the Hardware



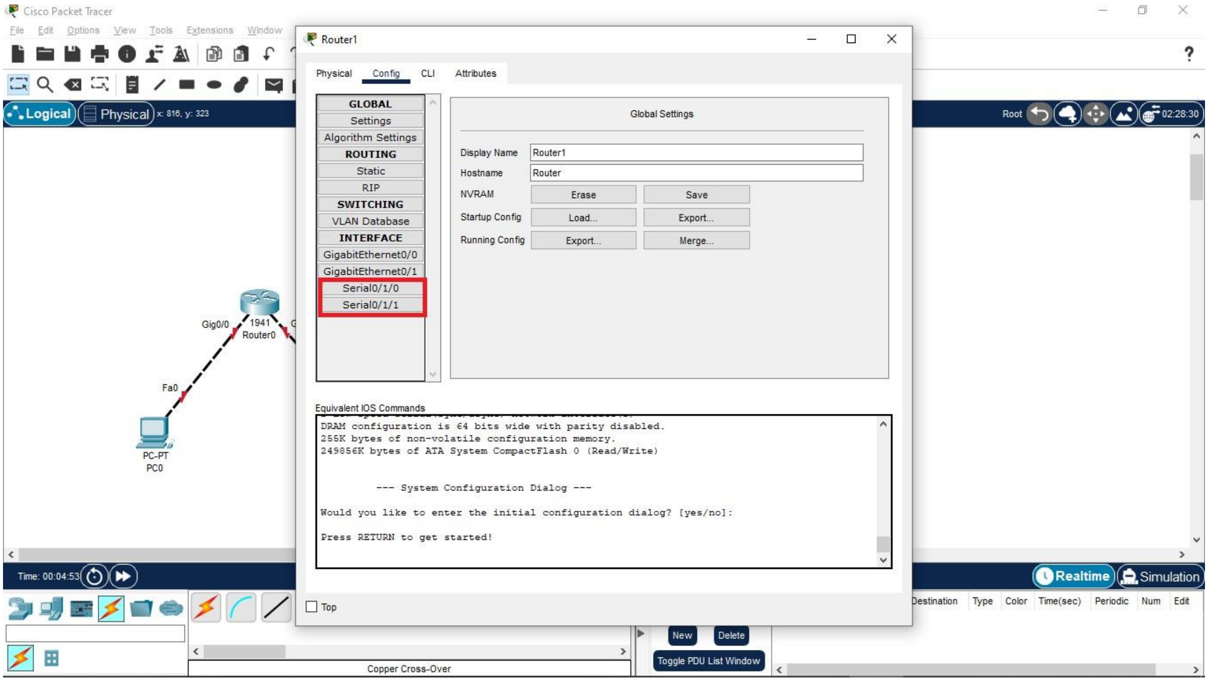
Step 3: Find the console from lower right corner. Drag and drop the console in the empty area as shown in the figure.



Step 4: Now again switch on the hardware and check in config tab for 2 serial ports added.

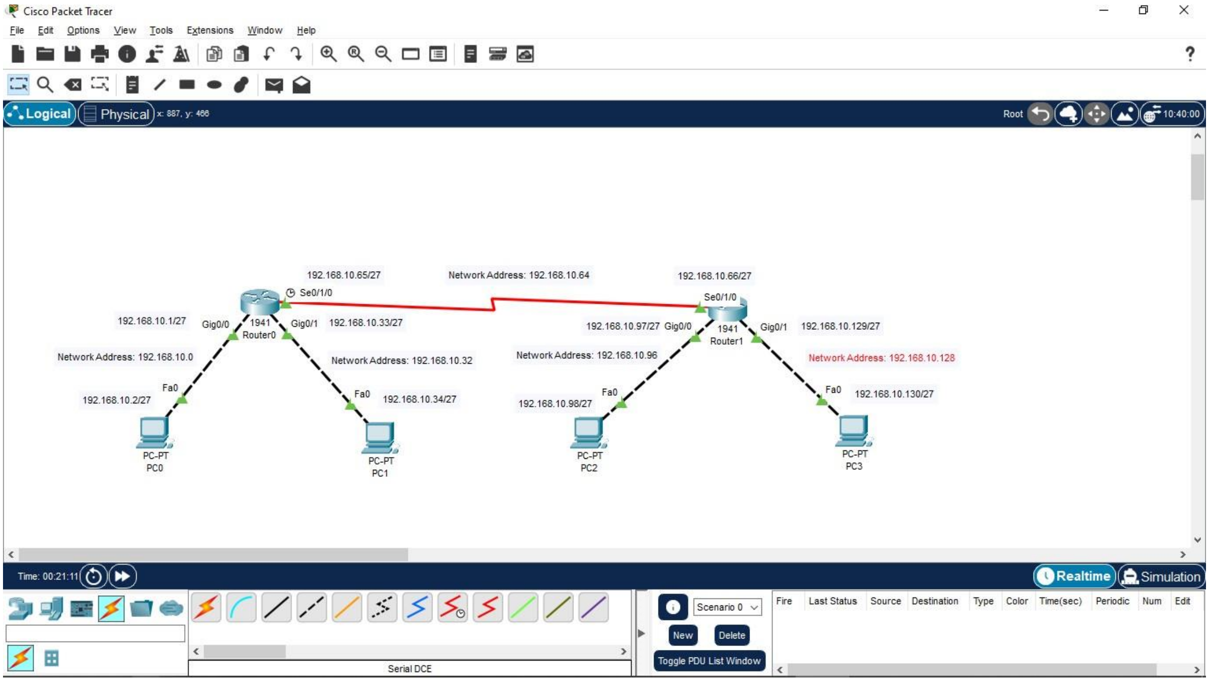


Step 5: Repeat the same procedure (Step 3 and Step 4) for Router1



Step 6: Now the PCs are physically connected through Router. To establish logical connectivity, assign IP addresses for 4 PCs (each 1 interface and corresponding router interface as gateway) and 2 Routers (each 3 ip addresses for 3 interfaces) as shown in the following table.

Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-



Scenario with Network Address for each link

Step 7:

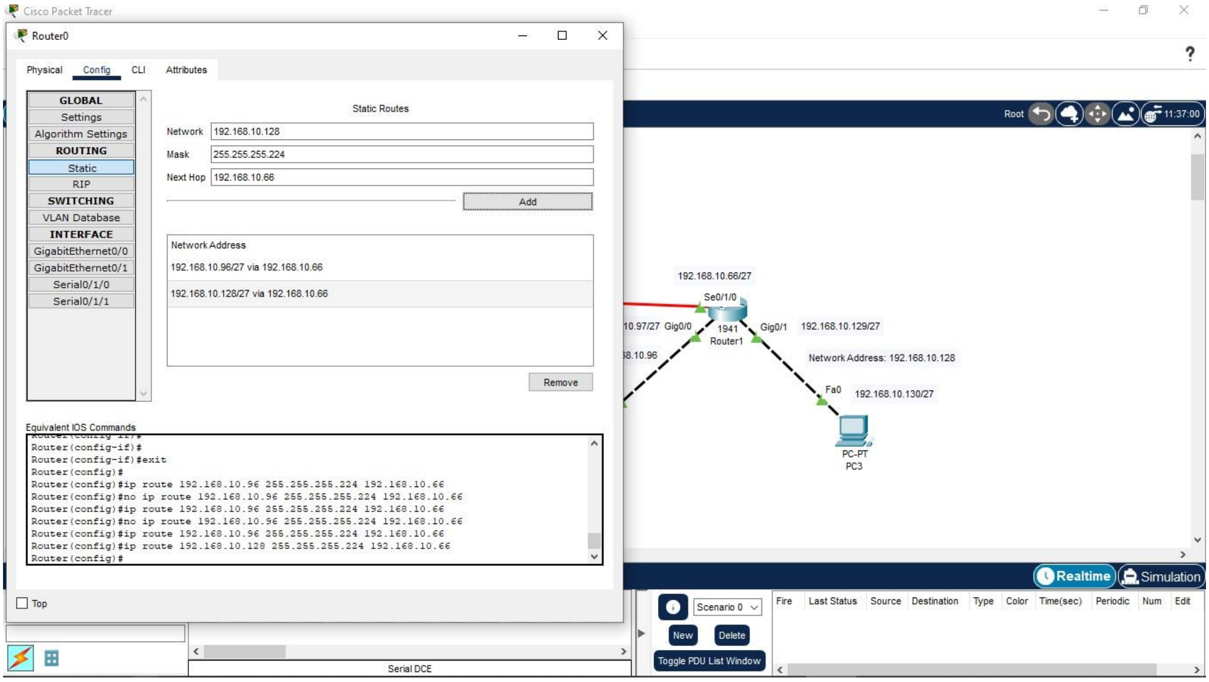
- **To enable packet transmission among the devices in the scenario, Static Routing has to be configured.**
- **To configure static routing, unknown networks and next-hop IP address to reach the unknown network for Router0 and Router1 has to be determined.**
- **Note: While specifying devices we should use IP-Address and while specifying network we should use Network Address.**
- **Unknown networks for the routers are derived in the following table**

Device	Known Networks	Subnet Mask	Unknown Networks	Subnet Mask	Next-hop Address
Router0	192.168.10.0	255.255.255.224	192.168.10.96	255.255.255.224	192.168.10.66
Router0	192.168.10.32	255.255.255.224	192.168.10.128	255.255.255.224	192.168.10.66
Router0	192.168.10.64	255.255.255.224	-	-	-
Router1	192.168.10.96	255.255.255.224	192.168.10.0	255.255.255.224	192.168.10.65
Router1	192.168.10.128	255.255.255.224	192.168.10.32	255.255.255.224	192.168.10.65
Router1	192.168.10.64	255.255.255.224	-	-	-

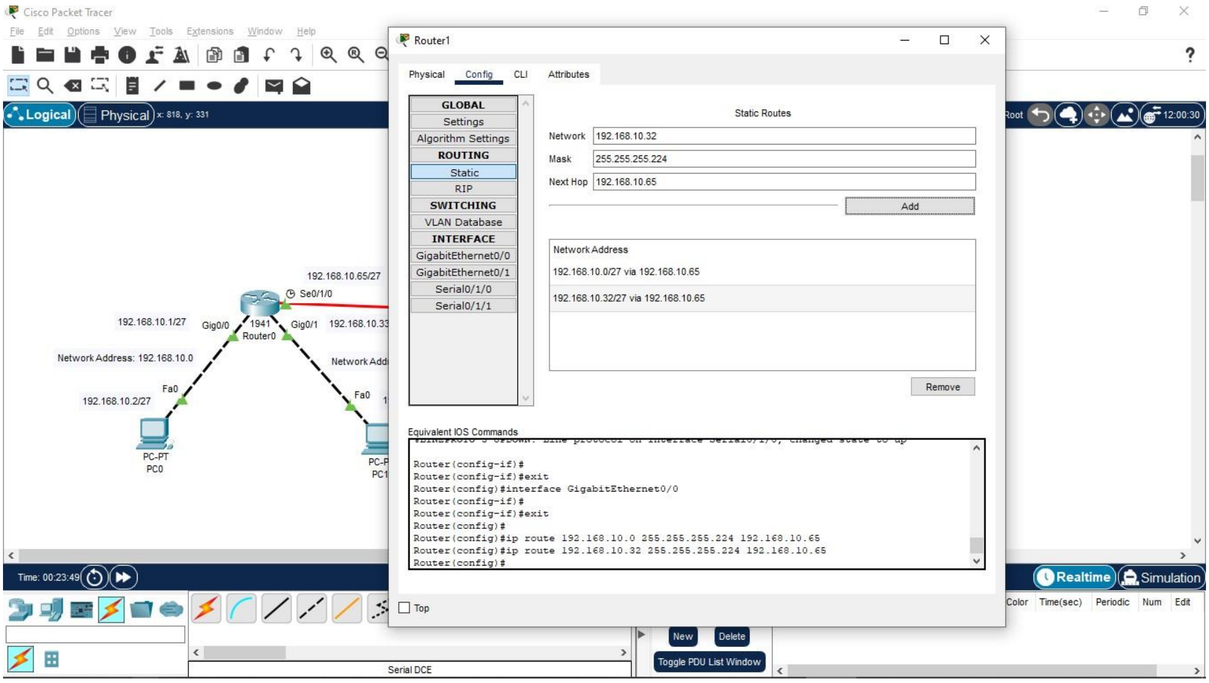
Only unknown networks should be configured for static routing

Step 8:

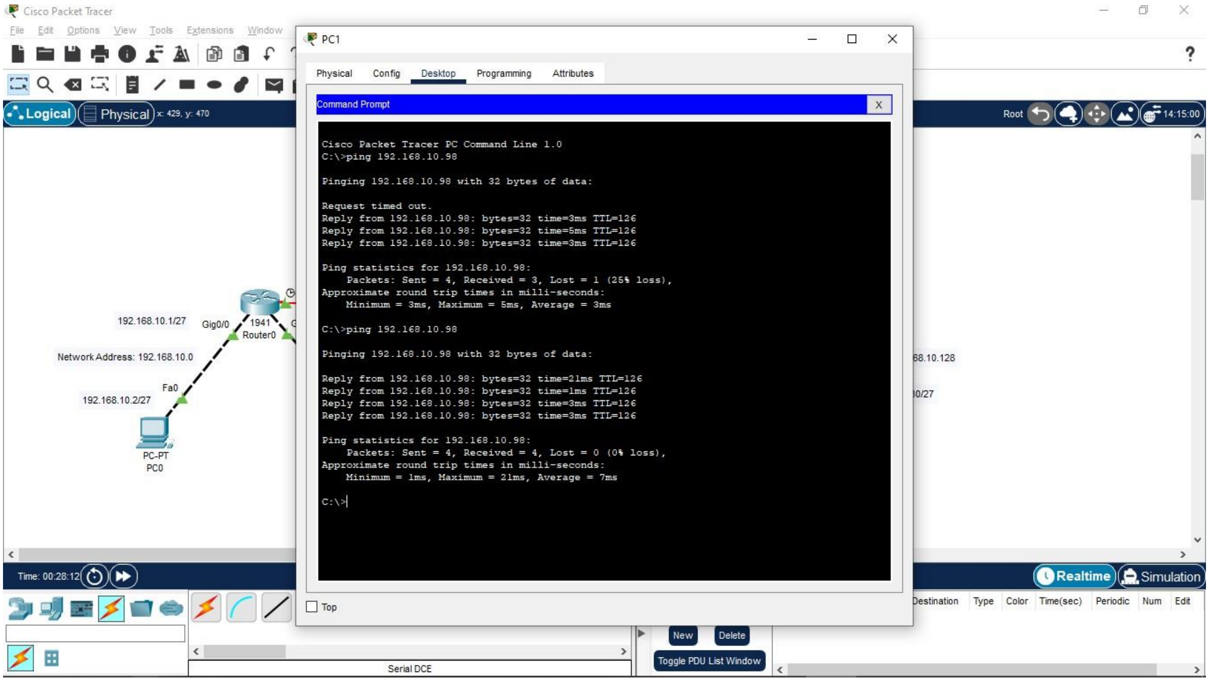
- To configure static routing, click on
    - Router0 => Config tab => Static =>Enter network address (refer unknown network for router0) => Subnet Mask for network address => Next-hop address => Add network
- Repeat the same to add the next network.
- Two networks should be added for the given scenario



Step 9: Repeat the same procedure to configure for Router1



Step 10: After configuration of Static routing in both Routers, Check the connectivity among any two devices using Ping Command



Step 11:

- To check routing table, go to CLI tab in Router and press enter to get the router prompt.
    - Router>
- Now type enable or en and press enter
    - Router>en
    - Router#

Follow the command “show ip route” to get the routing table of a router

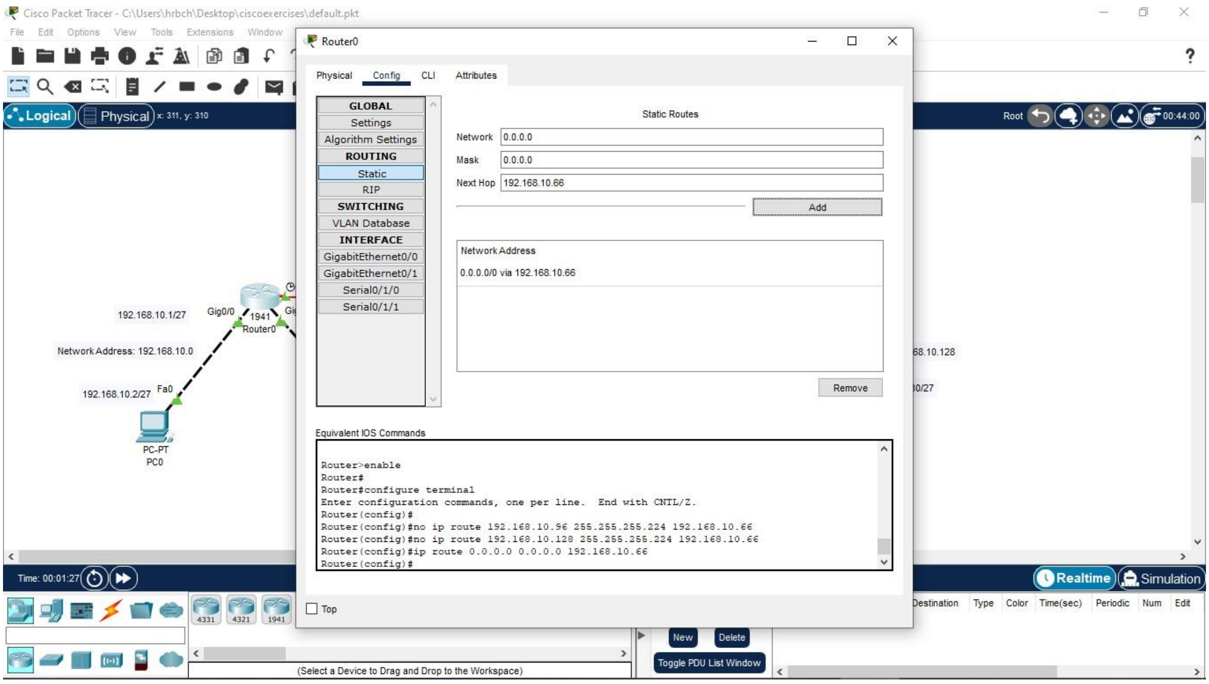
```
Router>en
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, 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

192.168.10.0/24 is variably subnetted, 8 subnets, 2 masks
C 192.168.10.0/27 is directly connected, GigabitEthernet0/0
L 192.168.10.1/32 is directly connected, GigabitEthernet0/0
C 192.168.10.32/27 is directly connected, GigabitEthernet0/1
L 192.168.10.33/32 is directly connected, GigabitEthernet0/1
C 192.168.10.64/27 is directly connected, Serial0/1/0
L 192.168.10.65/32 is directly connected, Serial0/1/0
S 192.168.10.96/27 [1/0] via 192.168.10.66
S 192.168.10.128/27 [1/0] via 192.168.10.66
```

6.b - Demonstration of Default Routing

For Default Routing replace Step 8 and Step 9 with Step 12 and Step 13

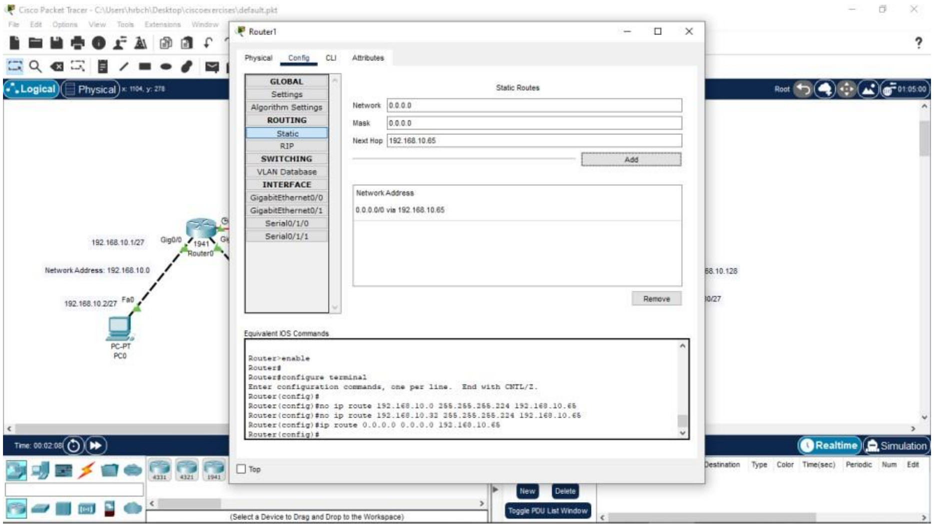
Step 12:

- To configure static routing, click on
  - Router0 => Config tab => Static =>Enter network address (as 0.0.0.0) => Subnet Mask (as 0.0.0.0) => Next-hop address (192.168.10.66) => Add network
- One entry should be added for the given scenario

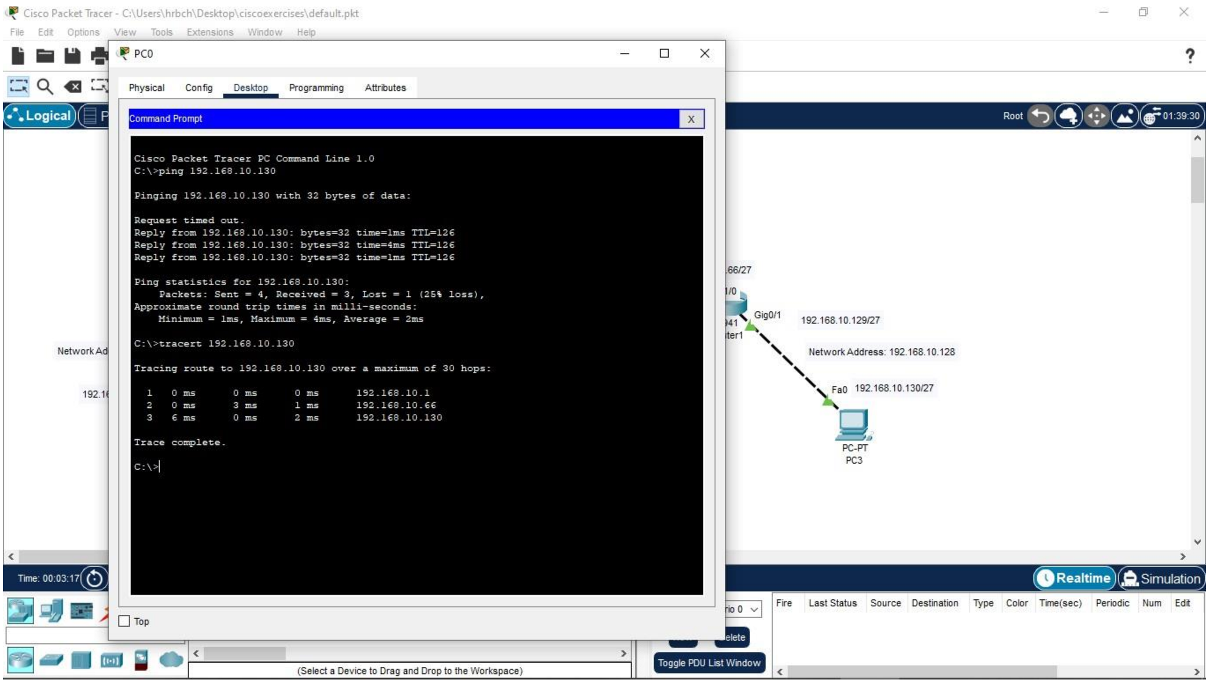


Step 13: Repeat the same procedure to configure for Router1.

Router1 => Config tab => Static =>Enter network address (as 0.0.0.0) => Subnet Mask (as 0.0.0.0) => Next-hop address (192.168.10.65) => Add network



Output for Default Routing: Click on PC0 => Desktop => Command Prompt and check **"tracert 192.168.10.130"** command



Exercise 7. a: Demonstration of RIP v1

[Note: RIP v1 does not support classless addressing mode and RIP v2 must be used in Subnet enabled Scenario]

Objective: To demonstrate the configuration of IP Addressing with Subnetting in WAN Configuration

Pre-requisite: IP Address, Range of IP Address, Classes of IP Address, Subnetting

Components:

Devices	Required Nos
PCs	4
Copper cross-over Cables	4
Routers [1941]	2
Serial DCE	1

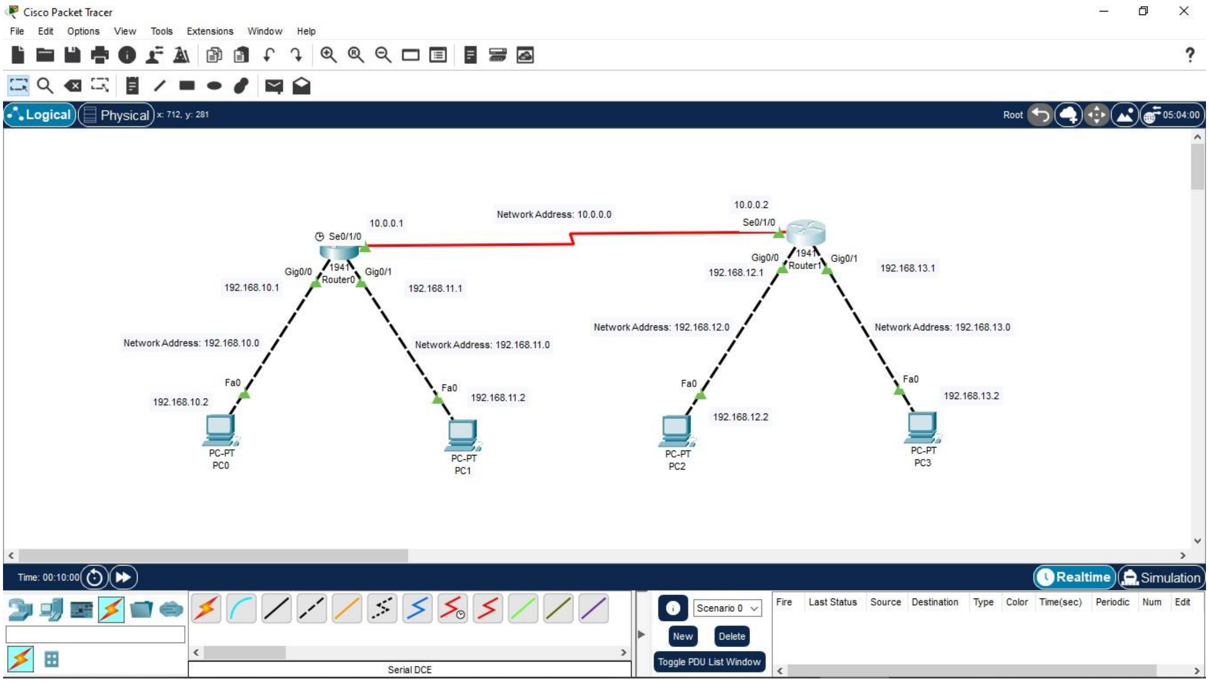
Addressing Table:

Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.0	192.168.10.1
PC1	Fa0/0	192.168.11.2	255.255.255.0	192.168.11.1
PC2	Fa0/0	192.168.12.2	255.255.255.0	192.168.12.1
PC3	Fa0/0	192.168.13.2	255.255.255.0	192.168.13.1
Router0	Gigabit 0/0	192.168.10.1	255.255.255.0	-
Router0	Gigabit 0/1	192.168.11.1	255.255.255.0	-
Router0	Se0/1/0	10.0.0.1	255.0.0.0	-
Router1	Gigabit 0/0	192.168.12.1	255.255.255.0	-
Router1	Gigabit 0/1	192.168.13.1	255.255.255.0	-
Router1	Se0/1/0	10.0.0.2	255.0.0.0	-

Procedure:

Step 1:

- Drag 4 PCs and 2 routers in the console area as shown in the figure.
- Follow the procedure for connecting **Serial DCE cable from Exercise 4.**
- Assign IP addresses for 4 PCs (each 1 interface and corresponding router interface as gateway) and 2 Routers (each 3 ip addresses for 3 interfaces) as shown in the Addressing Table



Step 2:

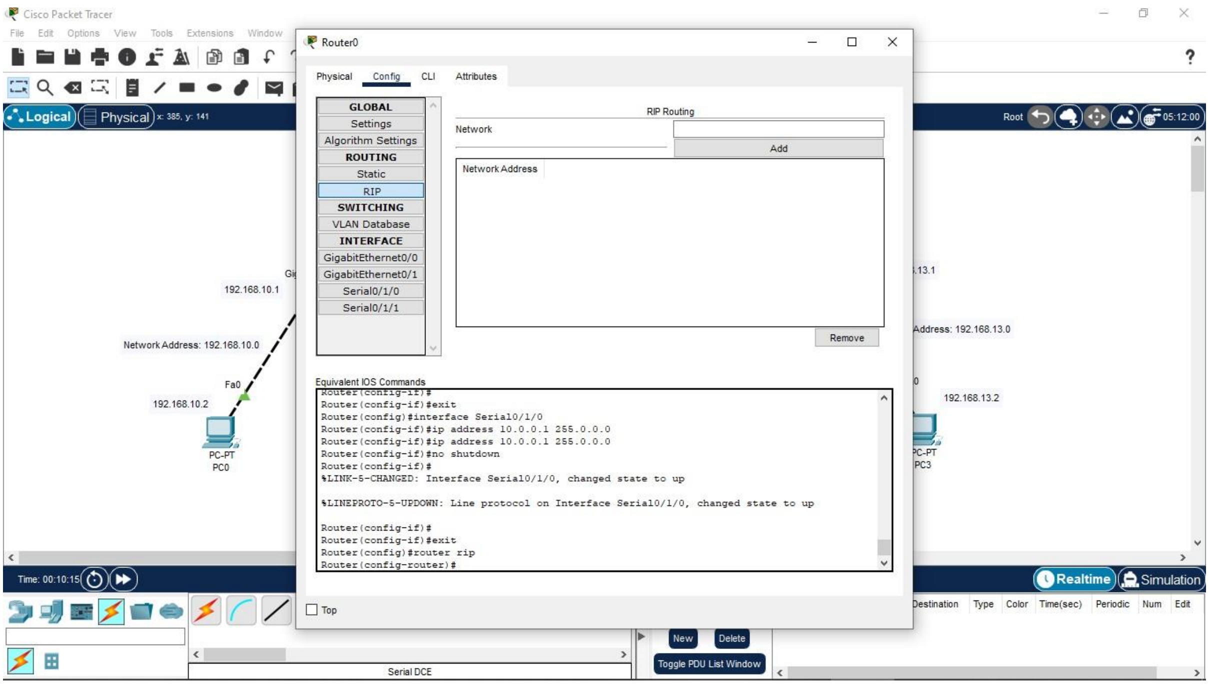
- To enable packet transmission among the devices in the scenario, RIP Routing has to be configured.
- To configure RIP routing, **known networks** for Router0 and Router1 has to be determined.
- Note: While specifying devices we should use IP-Address and while specifying network we should use Network Address.
- The **known networks** for the routers are derived in the following table

Device	Known Networks	Subnet Mask
Router0	192.168.10.0	255.255.255.0
Router0	192.168.11.0	255.255.255.0
Router0	10.0.0.0	255.0.0.0
Router1	192.168.12.0	255.255.255.0
Router1	192.168.13.0	255.255.255.0
Router1	10.0.0.0	255.0.0.0

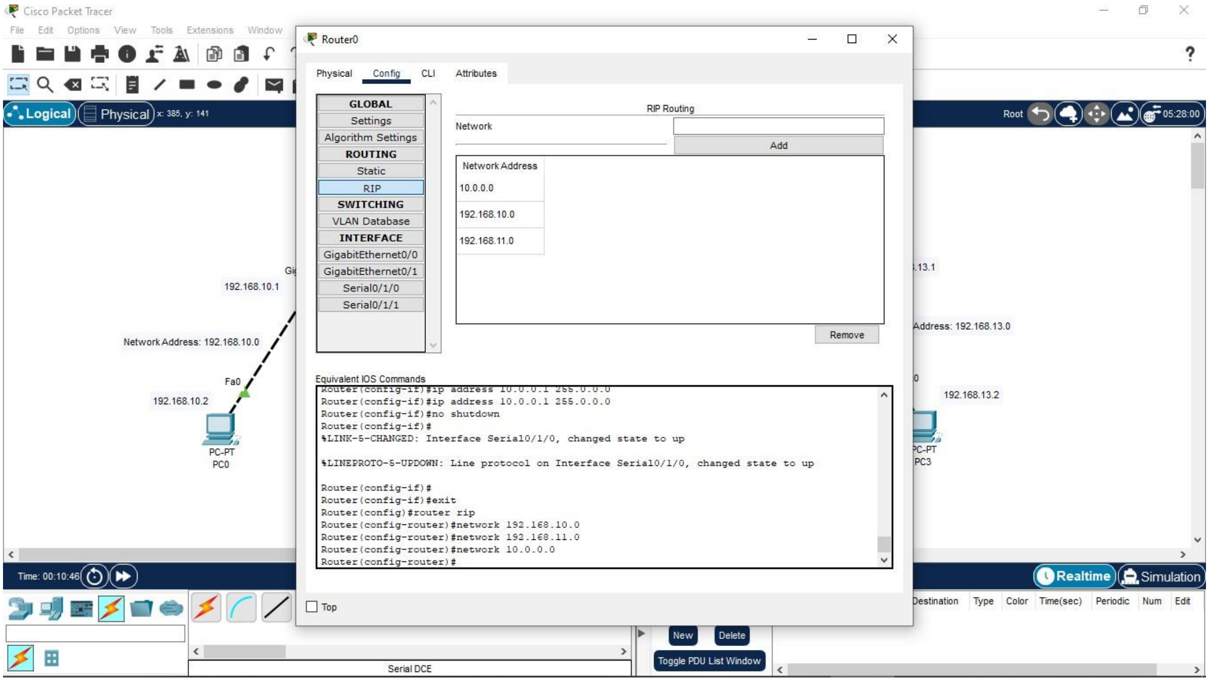
Only known networks should be configured for RIP routing

Step 3:

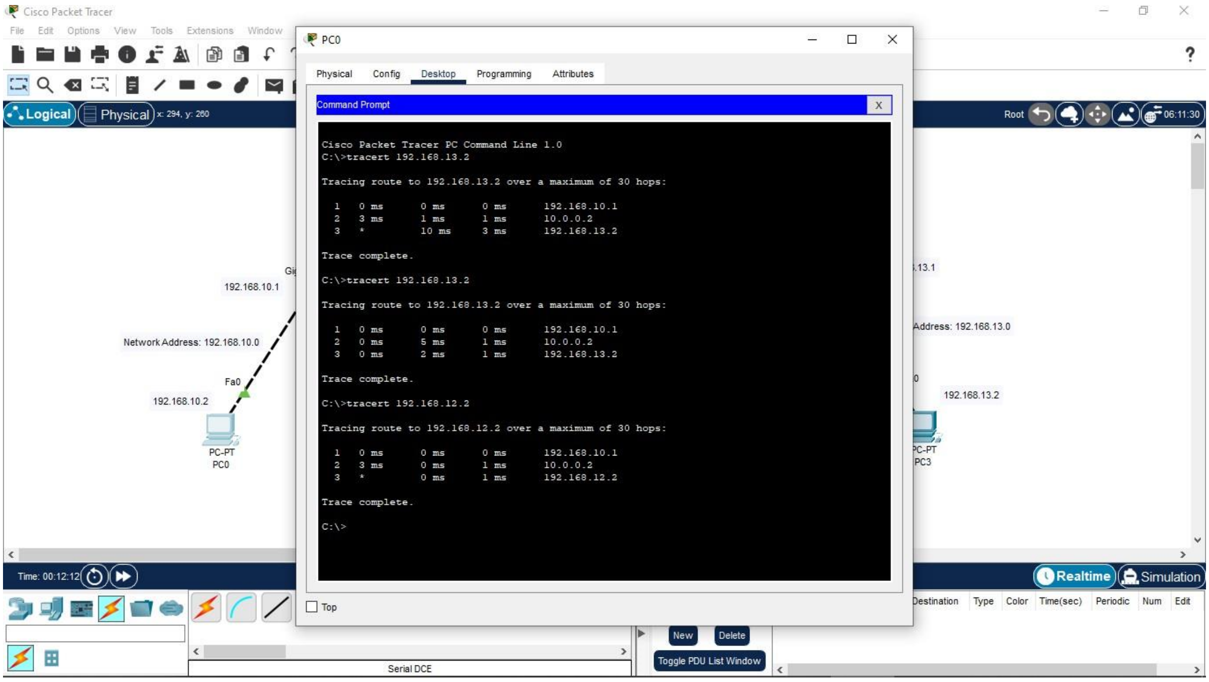
- To configure RIP routing, click on
  - Router0 => Config tab => RIP =>Enter network address (refer table) => Add network
- Repeat the same to add the next network.
- Three networks should be added for the given scenario



Step 4: Repeat the same procedure to configure for Router1

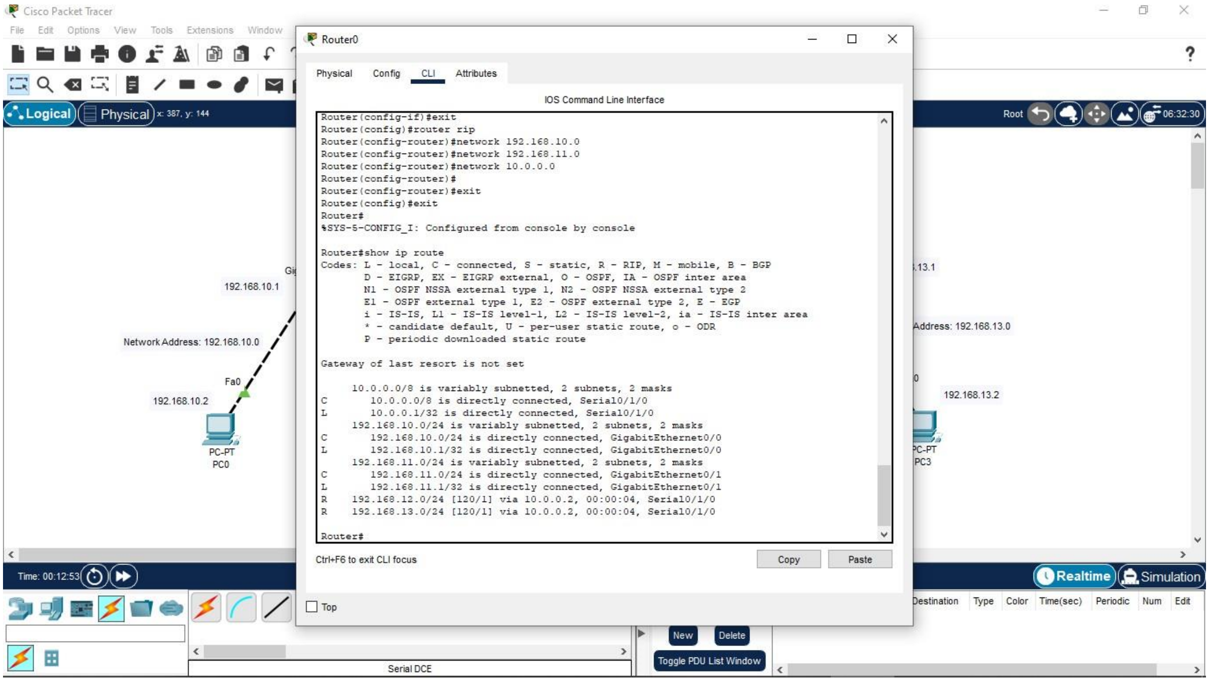


Step 5: After configuration of RIP routing in both Routers, Check the connectivity among any two devices using Ping Command or tracert command



Step 6:

- To check routing table, go to CLI tab in Router and press enter to get the router prompt.
    - Router>
- Now type enable or en and press enter
    - Router>en
    - Router# show ip route



Exercise 7. b: Demonstration of RIP v2

Objective: To demonstrate the configuration of RIP v2

Pre-requisite: IP Address, Range of IP Address, Classes of IP Address, Subnetting

Components:

Devices	Required Nos
PCs	4
Copper cross-over Cables	4
Routers	2
Serial DCE	1

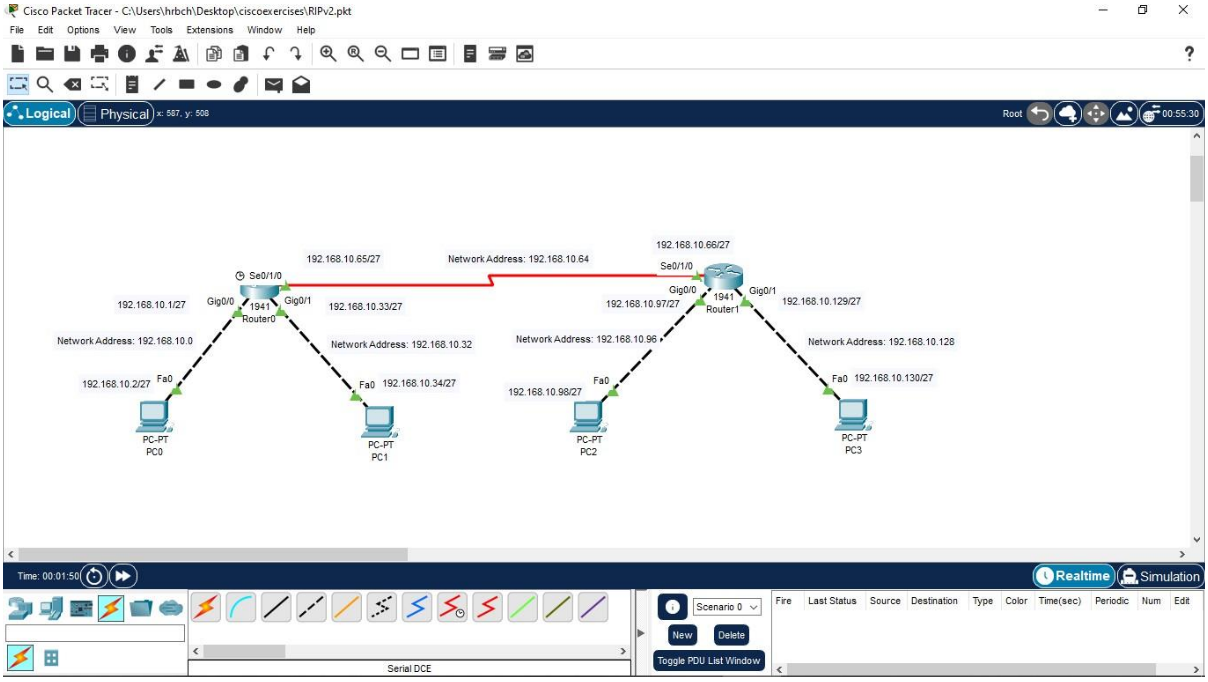
Addressing Table:

Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-

Procedure:

Step 1:

- Drag 4 PCs and 2 routers in the console area as shown in the figure.
- Follow the procedure for connecting **Serial DCE cable from Exercise 4.**
- Assign IP addresses for 4 PCs (each 1 interface and corresponding router interface as gateway) and 2 Routers (each 3 ip addresses for 3 interfaces) as shown in the Addressing Table



Step 2:

- To enable packet transmission among the devices in the scenario, RIP v2 Routing has to be configured.
- To configure RIP v2 routing, **known networks** for Router0 and Router1 has to be determined.
- Note: While specifying devices we should use IP-Address and while specifying network we should use Network Address.
- The **known networks** for the routers are derived in the following table

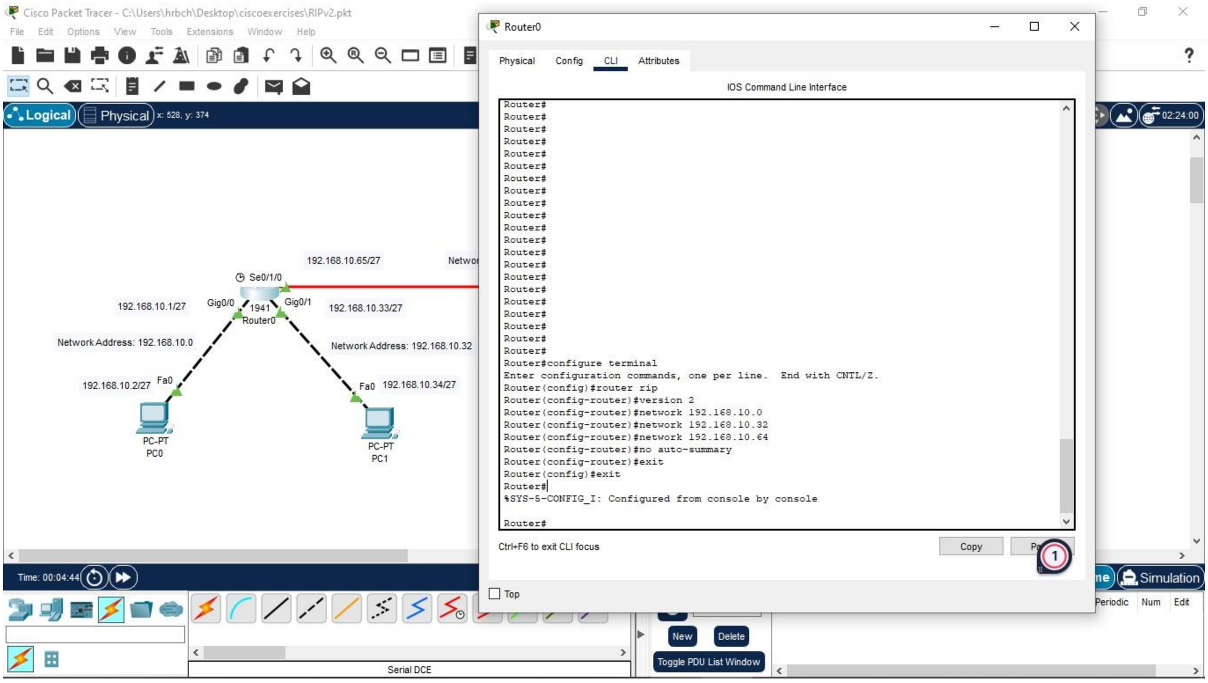
Device	Known Networks	Subnet Mask	Unknown Networks	Subnet Mask	Next-hop Address
Router0	192.168.10.0	255.255.255.224	192.168.10.96	255.255.255.224	192.168.10.66
Router0	192.168.10.32	255.255.255.224	192.168.10.128	255.255.255.224	192.168.10.66
Router0	192.168.10.64	255.255.255.224	-	-	-
Router1	192.168.10.96	255.255.255.224	192.168.10.0	255.255.255.224	192.168.10.65
Router1	192.168.10.128	255.255.255.224	192.168.10.32	255.255.255.224	192.168.10.65
Router1	192.168.10.64	255.255.255.224	-	-	-

Only unknown networks should be configured for static routing

Step 3:

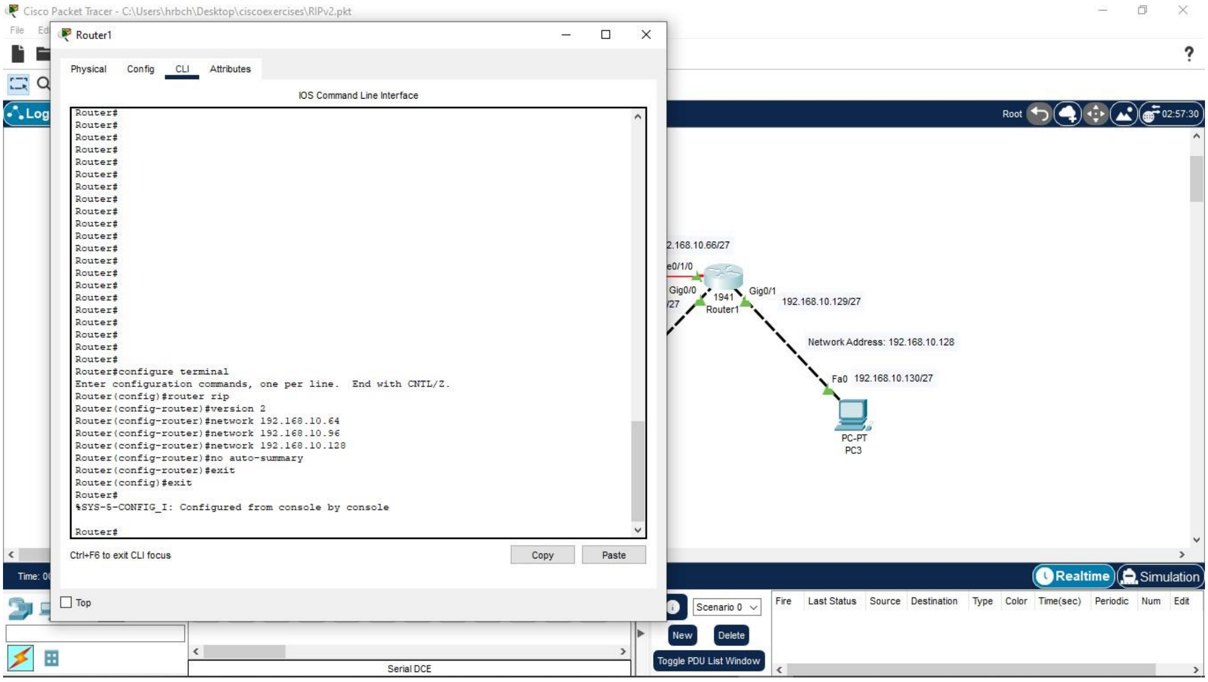
- To configure static routing, click on
  - Router0 => Config tab => CLI
- Type “enable” in “Router>” prompt and type the following commands to configure RIP v2 in Router0

```
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#network 192.168.10.0
Router(config-router)#network 192.168.10.32
Router(config-router)#network 192.168.10.64
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
```

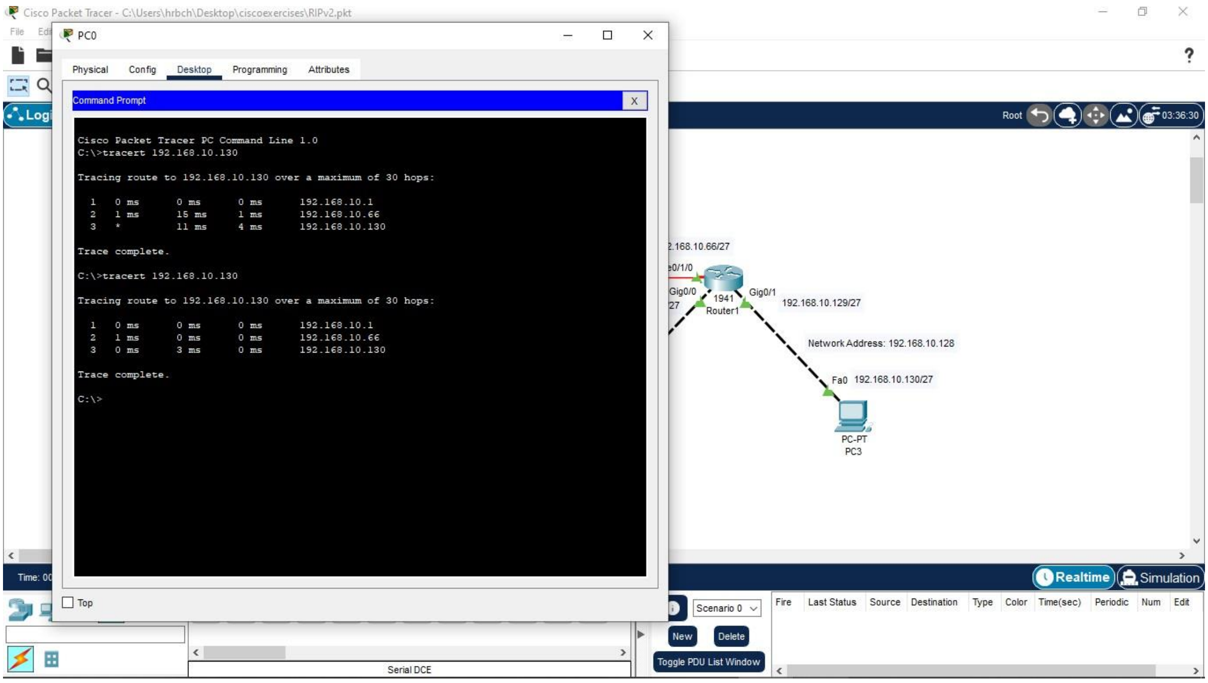


Step 4: Repeat the same procedure to configure for Router1

```
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#network 192.168.10.64
Router(config-router)#network 192.168.10.96
Router(config-router)#network 192.168.10.128
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
```

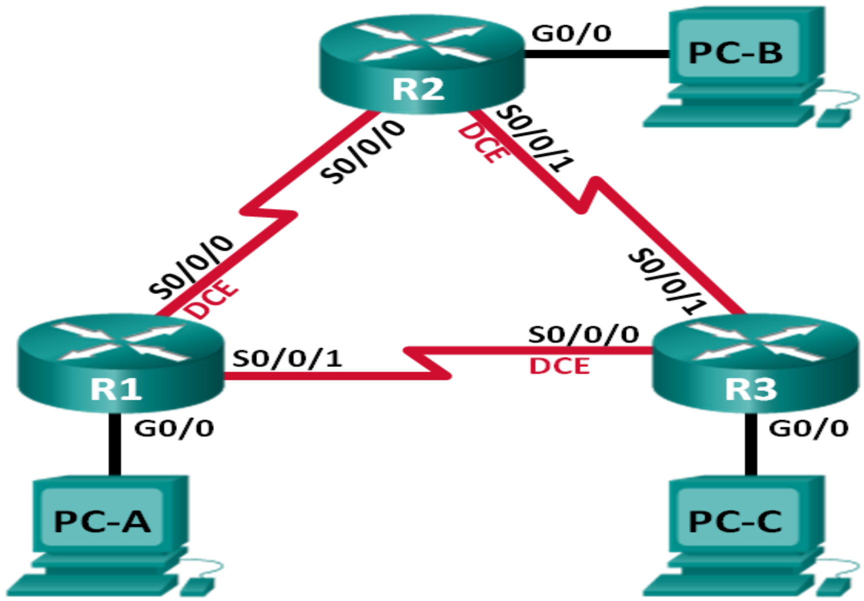


Step 5: After configuration of RIP v2 routing in both Routers, Check the connectivity among any two devices using Ping Command/ tracert command



Lab – 8 – EIGRP Configuration, Bandwidth, and Adjacencies

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0 (DCE)	10.1.1.1	255.255.255.252	N/A
	S0/0/1	10.3.3.1	255.255.255.252	N/A
R2	G0/0	192.168.2.1	255.255.255.0	N/A
	S0/0/0	10.1.1.2	255.255.255.252	N/A
	S0/0/1 (DCE)	10.2.2.2	255.255.255.252	N/A
R3	G0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0 (DCE)	10.3.3.2	255.255.255.252	N/A
	S0/0/1	10.2.2.1	255.255.255.252	N/A
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1
PC-B	NIC	192.168.2.3	255.255.255.0	192.168.2.1
PC-C	NIC	192.168.3.3	255.255.255.0	192.168.3.1

Objectives

Part 1: Build the Network and Verify Connectivity

Part 2: Configure EIGRP Routing

Part 3: Verify EIGRP Routing

Part 4: Configure Bandwidth

Background / Scenario

Enhanced Interior Gateway Routing Protocol (EIGRP) is a powerful distance vector routing protocol and is relatively easy to configure for basic networks.

In this lab, you will configure EIGRP for the topology and networks shown above. You will modify bandwidth and configure passive interfaces to allow EIGRP to function more efficiently.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 3 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1: Build the Network and Verify Connectivity

In Part 1, you will set up the network topology and configure basic settings, such as the interface IP addresses, device access, and passwords.

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

Step 2: Configure PC hosts.

Step 3: Initialize and reload the routers as necessary.

Step 4: Configure basic settings for each router.

a. Disable DNS lookup.

b. Configure IP addresses for the routers, as listed in the Addressing Table.

c. Configure device name as shown in the topology.

d. Copy the running configuration to the startup configuration.

Step 5: Verify connectivity.

The routers should be able to ping one another, and each PC should be able to ping its default gateway. The PCs will not be able to ping other PCs until EIGRP routing is configured. Verify and troubleshoot if necessary.

Part 2: Configure EIGRP Routing

Step 1: Enable EIGRP routing on R1. Use AS number 10.

```
R1(config)# router eigrp 10
```

Step 2: Advertise the directly connected networks on R1 using the wildcard mask.

```
R1(config-router)# network 10.1.1.0 0.0.0.3
R1(config-router)# network 192.168.1.0 0.0.0.255
```

```
R1(config-router)# network 10.3.3.0 0.0.0.3
```

Step 3: Enable EIGRP routing and advertise the directly connected networks on R2 and R3.

You will see neighbor adjacency messages as interfaces are added to the EIGRP routing process. The messages on R2 are displayed as an example.

```
*Apr 14 15:24:59.543: %DUAL-5-NBRCHANGE: EIGRP-IPv4 10: Neighbor 10.1.1.1
(Serial0/0/0) is up: new adjacency
```

Step 4: Verify end-to-end connectivity.

All devices should be able to ping each other if EIGRP is configured correctly.

Part 3: Verify EIGRP Routing

Step 1: Examine the EIGRP neighbor table.

On R1, issue the **show ip eigrp neighbors** command to verify that the adjacency has been established with its neighboring routers.

```
R1# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(10)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num
1   10.3.3.2                Se0/0/1                  13 00:24:58    8   100  0   17
0   10.1.1.2                Se0/0/0                  13 00:29:23    7   100  0   23
```

Step 2: Examine the IP EIGRP routing table.

```
R1# show ip route eigrp
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

      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
D        10.2.2.0/30 [90/2681856] via 10.3.3.2, 00:29:01, Serial0/0/1
                     [90/2681856] via 10.1.1.2, 00:29:01, Serial0/0/0
D     192.168.2.0/24 [90/2172416] via 10.1.1.2, 00:29:01, Serial0/0/0
D     192.168.3.0/24 [90/2172416] via 10.3.3.2, 00:27:56, Serial0/0/1
```

Step 3: Examine the EIGRP topology table.

```
R1# show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(10)/ID(192.168.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status
```

```
P 192.168.3.0/24, 1 successors, FD is 2172416
        via 10.3.3.2 (2172416/28160), Serial0/0/1
P 192.168.2.0/24, 1 successors, FD is 2172416
        via 10.1.1.2 (2172416/28160), Serial0/0/0
P 10.2.2.0/30, 2 successors, FD is 2681856
        via 10.1.1.2 (2681856/2169856), Serial0/0/0
        via 10.3.3.2 (2681856/2169856), Serial0/0/1
P 10.3.3.0/30, 1 successors, FD is 2169856
        via Connected, Serial0/0/1
P 192.168.1.0/24, 1 successors, FD is 2816
        via Connected, GigabitEthernet0/0
P 10.1.1.0/30, 1 successors, FD is 2169856
        via Connected, Serial0/0/0
```

Step 4: Verify the EIGRP routing parameters and networks advertised.

Issue the **show ip protocols** command to verify the EIGRP routing parameters used.

```
R1# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "eigrp 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP-IPv4 Protocol for AS(10)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
    NSF-aware route hold timer is 240
    Router-ID: 192.168.1.1
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 1

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    10.1.1.0/30
    10.3.3.0/30
    192.168.1.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.3.3.2              90      02:38:34
    10.1.1.2              90      02:38:34
  Distance: internal 90 external 170
```

Based on the output of issuing the **show ip protocols** command, answer the following questions.

What AS number is used?

What networks are advertised?

What is the administrative distance for EIGRP?

How many equal cost paths does EIGRP use by default?

Part 4: Configure Bandwidth

EIGRP uses a default bandwidth based on the type of interface in the router. In Part 4, you will modify the bandwidth so that the link between R1 and R3 has a lower bandwidth than the link between R1/R2 and R2/R3. In addition, you will set passive interfaces on each router.

Step 1: Observe the current routing settings.

a. Issue the **show interface s0/0/0** command on R1.

```
R1# show interface s0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is WIC MBRD Serial
  Internet address is 10.1.1.1/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:01, output 00:00:02, output hang never
  Last clearing of "show interface" counters 03:43:45
  Input queue: 0/75/0/0 (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
     4050 packets input, 270294 bytes, 0 no buffer
     Received 1554 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     1 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 1 abort
     4044 packets output, 271278 bytes, 0 underruns
     0 output errors, 0 collisions, 5 interface resets
     4 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     12 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Step 2: Modify the bandwidth on the routers.

a. Modify the bandwidth on R1 for the serial interfaces.

```
R1(config)# interface s0/0/0
R1(config-if)# bandwidth 2000
R1(config-if)# interface s0/0/1
R1(config-if)# bandwidth 64
```

Issue **show ip route** command on R1. Is there a difference in the routing table? If so, what is it?

```
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

      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C        10.1.1.0/30 is directly connected, Serial0/0/0
L        10.1.1.1/32 is directly connected, Serial0/0/0
D        10.2.2.0/30 [90/2681856] via 10.1.1.2, 00:03:09, Serial0/0/0
C        10.3.3.0/30 is directly connected, Serial0/0/1
L        10.3.3.1/32 is directly connected, Serial0/0/1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/0
D     192.168.2.0/24 [90/1794560] via 10.1.1.2, 00:03:09, Serial0/0/0
D     192.168.3.0/24 [90/2684416] via 10.1.1.2, 00:03:08, Serial0/0/0
```

b. Modify the bandwidth on the R2 and R3 serial interfaces.

```
R2(config)# interface s0/0/0
R2(config-if)# bandwidth 2000
R2(config-if)# interface s0/0/1
R2(config-if)# bandwidth 2000

R3(config)# interface s0/0/0
R3(config-if)# bandwidth 64
R3(config-if)# interface s0/0/1
R3(config-if)# bandwidth 2000
```

Step 3: Verify the bandwidth modifications.

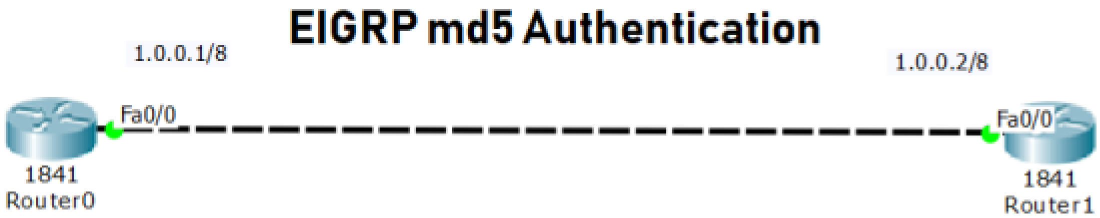
a. Verify bandwidth modifications. Issue a **show interface serial 0/0/x** command, with x being the appropriate serial interface on all three routers to verify that bandwidth is set correctly. R1 is shown as an example.

```
R1# show interface s0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is WIC MBRD Serial
  Internet address is 10.1.1.1/30
  MTU 1500 bytes, BW 2000 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:01, output 00:00:02, output hang never
  Last clearing of "show interface" counters 04:06:06
  Input queue: 0/75/0/0 (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
     4767 packets input, 317155 bytes, 0 no buffer
     Received 1713 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     1 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 1 abort
     4825 packets output, 316451 bytes, 0 underruns
     0 output errors, 0 collisions, 5 interface resets
```

```
4 unknown protocol drops
0 output buffer failures, 0 output buffers swapped out
12 carrier transitions
DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Lab – 8 – EIGRP Authentication and Timers

Topology



Step 1: Configure IP address on Router R1

Router>enable

Router#config t

Router (config) #host R1

R1(config)#int fa0/0

R1 (config-if) #ip add 1.0.0.1 255.0.0.0

R1(config-if)#no shut

EIGRP Configuration on Router R1

R1 (config) #router eigrp 1

R1 (config-router) #network 1.0.0.0

R1 (config-router) #exit

Step2: Configure IP Address on Router R2

Router>enable

Router#config t

Router (config) #Host R2

R2 (config) #int fa0/0

R2 (config-if) #ip add 1.0.0.2 255.0.0.0

R2 (config-if) #no shut

EIGRP Configuration on Router R2

R2#config t

R2 (config) #router eigrp 1

R2 (config-router) #network 1.0.0.0

Step 3: EIGRP Authentication on Router R1

R1#config t

R1 (config) #key chain satishkey

R1 (config-keychain) #key 1

R1 (config-keychain-key) #key-string 123

R1 (config-keychain-key) #end

R1#config t

R1 (config) #int fa0/0

R1 (config-if) #ip authentication mode eigrp 1 md5

R1 (config-if) #ip authentication key-chain eigrp 1 satishkey

Step 4: EIGRP Authentication on Router R2

R2#config t

R2 (config) #key chain satishkey

R2 (config-keychain) #key 1

R2 (config-keychain-key) #key-string 123

R2(config-keychain-key) #end

R2#config t

R2 (config) #int fa0/0

R2 (config-if) #ip authentication mode eigrp 1 md5

R2 (config-if) #ip authentication key-chain eigrp 1 satishkey

Step 5: Testing EIGRP Authentication

R2#debug eigrp packets

EIGRP Packets debugging is on

(UPDATE, REQUEST, QUERY, REPLY, HELLO, ACK)

R2#

EIGRP: Received packet with MD5 authentication, key id = 1

EIGRP: Received HELLO on FastEthernet0/0 nbr 1.0.0.1

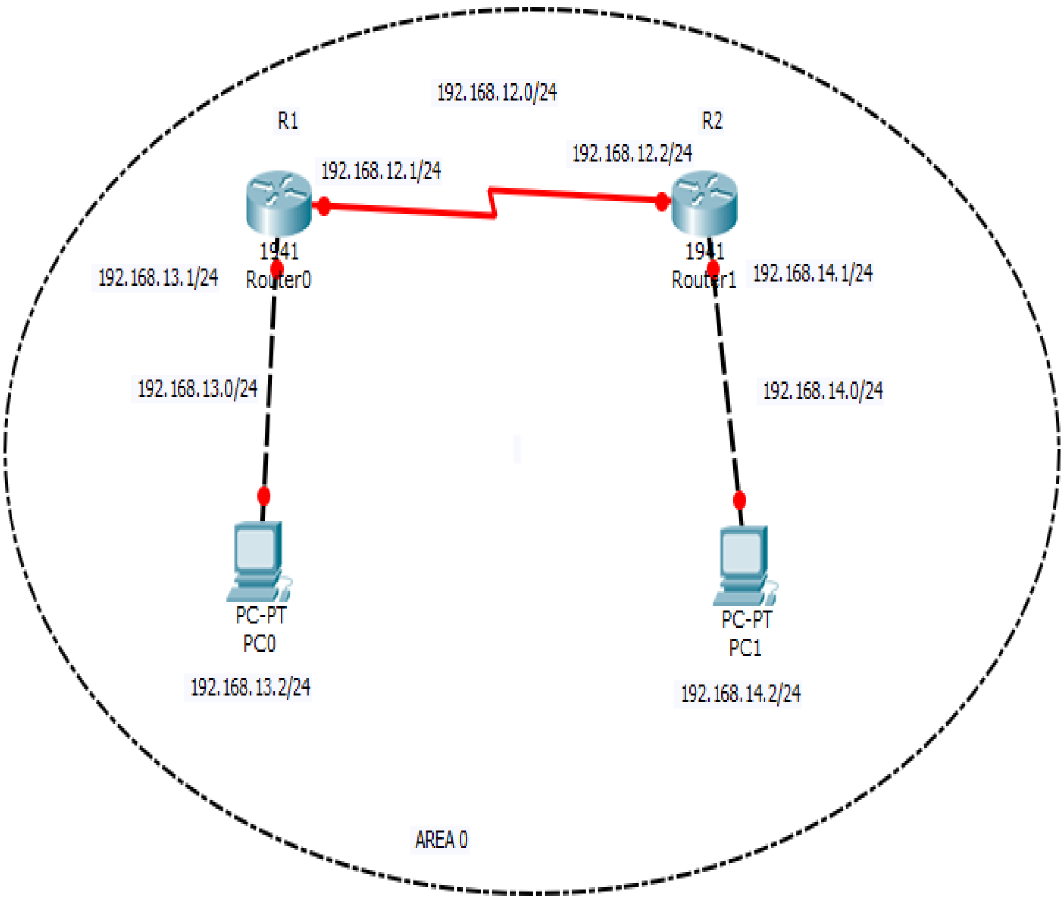
AS 1, Flags 0x0, Seq 2/0 idbQ 0/0

EIGRP: Sending HELLO on FastEthernet0/0

AS 1, Flags 0x0, Seq 2/0 idbQ 0/0 iidbQ un/rely 0/0

Exercise: 10 – Single Area OSPF

Topology



Part 1: Build the Network and Verify Connectivity

In Part 1, you will set up the network topology and configure basic settings, such as the interface IPaddresses.

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

Step 2: Configure PC hosts.

Step 3: Initialize and reload the routers as necessary.

Step 4: Configure basic settings for each router.

a. Configure IP addresses for the routers, as shown in topology diagram.

b. Configure device name as shown in the topology.

c. Copy the running configuration to the startup configuration.

Part 2: Configure OSPF Routing

Step 1: Enable OSPF routing on R1. Use process id as 1.

R1 (config) # **router ospf 1**

Step 2: Advertise the directly connected networks on R1 using the wildcard mask.

R1 (config-router) # **network 192.168.12.0 0.0.0.255 area 0**

R1 (config-router) # **network 192.168.13.0 0.0.0.255 area 0**

R1 (config-router) # **Exit**

Step 3: Enable OSPF routing on R2. Use process id as 1.

R2 (config) # **router ospf 1**

Step 4: Advertise the directly connected networks on R2 using the wildcard mask.

R2 (config-router) # **network 192.168.12.0 0.0.0.255 area 0**

R2 (config-router) # **network 192.168.14.0 0.0.0.255 area 0**

R2 (config-router) # **Exit**

Part 3: Verify OSPF Routing

R1# **show ip route ospf**

Similarly in R2,

R2# **show ip route ospf**

Part 4: Examine the OSPF topology table.

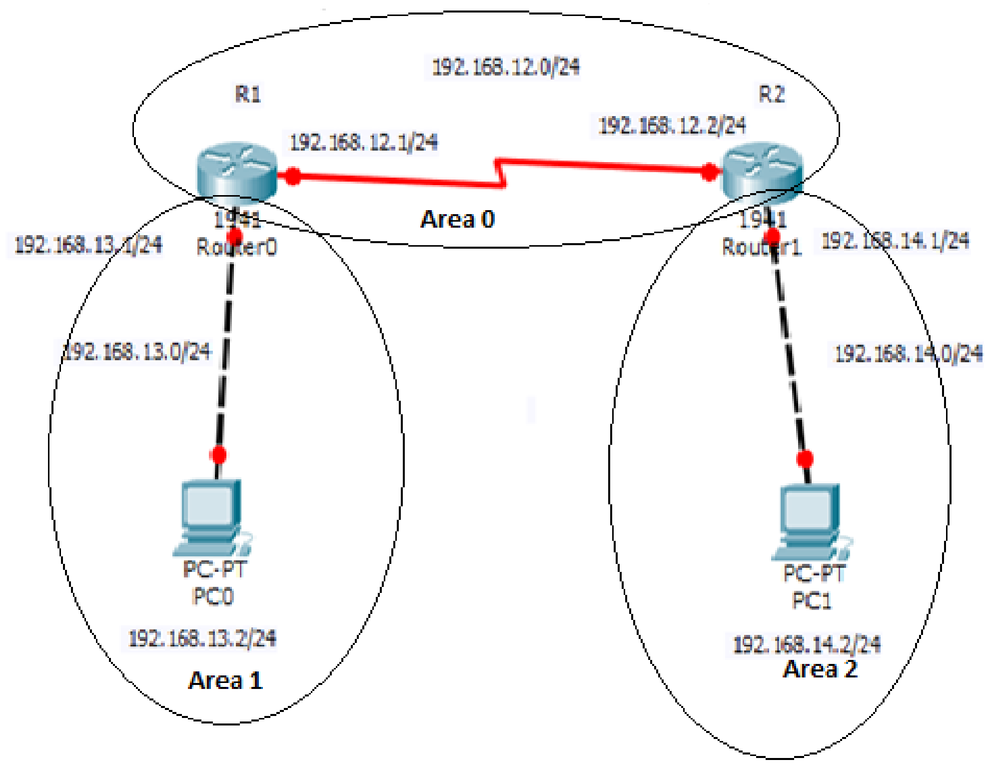
R1# **show ip ospf topology**

Similarly in R2,

R2# **show ip ospf topology**

Exercise: 11 – Multi Area OSPF

Topology



Part 1: Build the Network and Verify Connectivity

In Part 1, you will set up the network topology and configure basic settings, such as the interface IPaddresses.

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

Step 2: Configure PC hosts.

Step 3: Initialize and reload the routers as necessary.

Step 4: Configure basic settings for each router.

a. Configure IP addresses for the routers, as shown in topology diagram.

b. Configure device name as shown in the topology.

c. Copy the running configuration to the startup configuration.

Part 2: Configure OSPF Routing

Step 1: Enable OSPF routing on R1. Use process id as 1.

R1 (config) # **router ospf 1**

Step 2: Advertise the directly connected networks on R1 using the wildcard mask.

R1 (config-router) # **network 192.168.12.0 0.0.0.255 area 0**

R1 (config-router) # **network 192.168.13.0 0.0.0.255 area 1**

R1 (config-router) # **Exit**

Step 3: Enable OSPF routing on R2. Use process id as 1.

R2 (config) # **router ospf 1**

Step 4: Advertise the directly connected networks on R2 using the wildcard mask.

R2 (config-router) # **network 192.168.12.0 0.0.0.255 area 0**

R2 (config-router) # **network 192.168.14.0 0.0.0.255 area 2**

R2 (config-router) # **Exit**

Part 3: Verify OSPF Routing

R1# **show ip route ospf**

Similarly in R2,

R2# **show ip route ospf**

Part 4: Examine the OSPF topology table.

R1# **show ip ospf topology**

Similarly in R2,

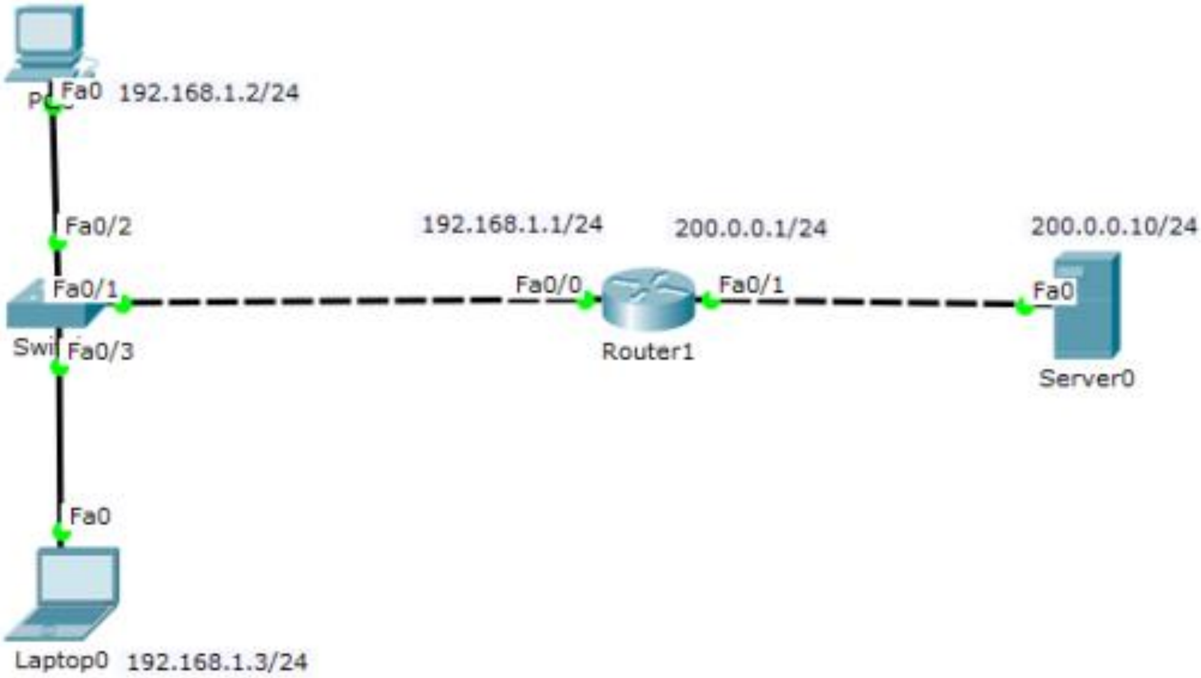
R2# **show ip ospf topology**

Ex. No: 12 Dynamic NAT configuration in Packet Tracer

In dynamic NAT, the router will dynamically pick a public address from the pool. The dynamic mapping entry will stay in the NAT translations as long as the traffic is being exchanged. Otherwise, after a period of no traffic flow, the global IP address will be reused for new translations.

Now, let’s configure Dynamic NAT in Packet Tracer.

First build the network topology:



Router

Router(config) # int fa0/0

Router(config-if) # ip add 192.168.1.1 255.255.255.0

Router (config-if) #no shut

Router (config-if) #

Router (config-if) #int fa0/1

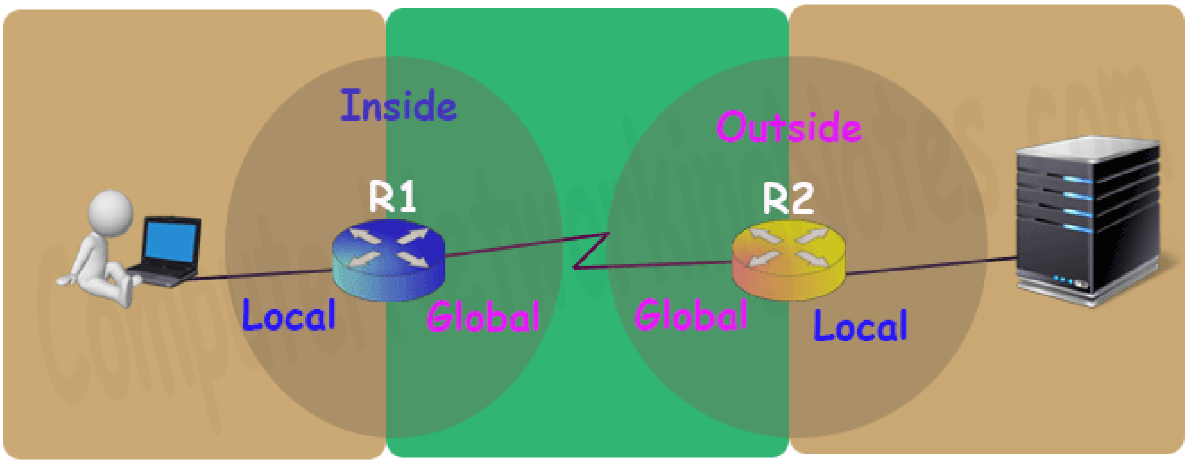
Router (config-if) # ip add 200.0.0.1 255.255.255.0

Router (config-if) #no shut

PC IP add 192.168.1.2/24 Default gateway 192.168.1.1(int fa0/0)

Laptop IP add 192.168.1.3/24 Default gateway 192.168.1.1 (int fa0/0)

Server IP add 200.0.0.10/24 Default gateway 200.0.0.1 (int fa0/1)



Now, to configure Dynamic NAT on the router we'll need to:

1. Configure the router's **inside address** using *ip nat inside* command.

2. Configure the router's **outside address** using *ip nat outside* command.

3. Create an **access list** of inside source source addresses to be translated.

4. Configure the pool of global IP addresses using the command

ip nat pool POOL_NAME FIRST_IP LAST _IP netmask SUBNET_MASK

5. Enable dynamic NAT on the router using:

ip nat inside source list ACL_NUMBER pool POOL_NAME

Dynamic NAT configurations:

```
Router (config) #int fa0/0
Router (config-if) #ip nat inside
Router (config-if) #int fa0/1
Router (config-if) #ip nat outside
Router (config-if) #exit
Router (config) #access- list 1 permit 192.168.1.0 0.0.0.5
Router (config) #ip nat pool mypool 155.21.21.10 155.21.21.15 netmask 255.255.0.0
Router (config) #ip nat inside source list 1 pool  mypool
```

That's all for configurations. We now proceed to test whether the address translations are actually taking place.

So then:Ping the server from the PC to 'trigger' off dynamic NAT translations.

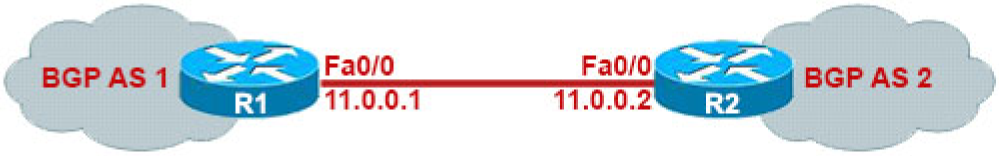
When the PC sends the server a request via the router, the router will first map the private IP address of the PC into a public IP address from the pool. The router will then forward the request to the server, with the public IP address of the PC as the source address.

When the server responds with a packet destined for the PC,the router will look into its dynamic NAT table and translate the public IP of the PC to the private one, then forward the packet to the PC via the *ip NAT inside* interface (int fa0/0).

Verify dynamic NAT translations in the router using *show ip nat statistics* command:

Router# show ip nat statistics

```
Router#show ip nat statistics
Total translations: 0 (0 static, 0 dynamic, 0 extended)
Outside Interfaces: FastEthernet0/1
Inside Interfaces: FastEthernet0/0
Hits: 0  Misses: 5
Expired translations: 0
Dynamic mappings:
-- Inside Source
access-list 1 pool mypool refCount 0
 pool mypool: netmask 255.255.0.0
       start 155.21.21.10 end 155.21.21.15
       type generic, total addresses 6 , allocated 0 (0%), misses 0
```



First we need to configure some interfaces on two routers as follows:

R1(config)#interface fastethernet0/0 R1(config-if)#ip address 11.0.0.1 255.255.255.0 R1(config-if)#no shutdown R1(config-if)#interface loopback 0 R1(config-if)#ip address 1.1.1.1 255.255.255.0	R2(config)#interface fastethernet0/0 R2(config-if)#ip address 11.0.0.2 255.255.255.0 R2(config-if)#no shutdown R2(config-if)#interface loopback 0 R2(config-if)#ip address 2.2.2.2 255.255.255.0

So we have just configured interface fa0/0 and loopback0 on both routers. Next we will configure the BGP configuration part on R1:

R1(config)#**router bgp 1**
R1(config-router)#**neighbor 11.0.0.2 remote-as 2**

The configuration is very simple with only two lines on R1. In the first line, BGP configuration begins with a familiar type of command: the **router bgp** command, where **AS number** is the BGP AS number used by that router (same as EIGRP, OSPF configuration).

The next command defines the IP address of the neighbor. Unlike OSPF or EIGRP, BGP cannot discover its neighbors automatically so we have to explicitly declare them. We also have to know and declare the neighbor's BGP AS number as well. In this case R1 wants to establish BGP neighbor relationship with R2 (in BGP AS 2) so it choose an interface on R2 (Fa0/0: **11.0.0.2**) and specify R2 is in **BGP AS 2** via the command "neighbor **11.0.0.2** remote-as **2**". At the other end R2 will do the same thing for R1 to set up BGP neighbor relationship.

R2(config)#**router bgp 2**
R2(config-router)#**neighbor 11.0.0.1 remote-as 1**

After a moment we should see a message (on each router) similar to the following, letting us know that an adjacency has been formed:

On R1:

*Aug 17 00:09:38.453: %BGP-5-ADJCHANGE: neighbor 11.0.0.2 Up

On R2:

*Aug 17 00:09:38.453: %BGP-5-ADJCHANGE: neighbor 11.0.0.1 Up

So after forming BGP neighbor relationship we can verify by using the "show ip bgp summary" command on both routers:

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
11.0.0.2        4     2      19      19        1    0    0 00:16:21         0
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
11.0.0.1        4     1      20      20        1    0    0 00:17:13        0
```

Please pay attention to the "State/PfxRcd" column of the output. It indicates the number of prefixes that have been received from a neighbor. If this value is a number (including "0", which means BGP neighbor does not advertise any route) then the BGP neighbor relationship is good. If this value is a word (including "Idle", "Connect", "Active", "OpenSent", "OpenConfirm") then the BGP neighbor relationship is not good.

In the outputs above we see the BGP neighbor relationship between R1 & R2 is good with zero Prefix Received (PfxRcd) because they have not advertised any routes yet.

How about the BGP routing table? We can check with the "show ip bgp" command but currently this table is empty! This is because although they formed BGP neighbor relationship but they have not exchanged any routes. Let's try advertising the loopback 0 interface on R1 to R2:

R1(config-router)#**network 1.1.1.0 mask 255.255.255.0**

As you see, unlike other routing protocols like OSPF or EIGRP, we have to use subnet mask (255.255.255.0 in this case), not wildcard mask, to advertise the routes in the "network" command.

Note: With BGP, you must advertise the correct network and subnet mask in the "network" command (in this case network 1.1.1.0/24). BGP is very strict in the routing advertisements. In other words, BGP only advertises the network which exists exactly in the routing table (in this case network 1.1.1.0/24 exists in the routing table as the loopback 0 interface). If you put the command "network 1.1.0.0 mask 255.255.0.0" or "network 1.0.0.0 mask 255.0.0.0" or "network 1.1.1.1 mask 255.255.255.255" then BGP will not advertise anything.

Now the BGP routing tables on these two routers contain this route:

```
R1#sh ip bgp
BGP table version is 4, local router ID is 11.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf  Weight   Path
*> 1.1.1.0/24       0.0.0.0                  0          32768   i
R2#sh ip bgp
BGP table version is 2, local router ID is 11.0.0.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf  Weight   Path
*> 1.1.1.0/24       11.0.0.1                 0              0   1 i
```

An asterisk (*) in the first column means that the route has a valid next hop. A greater-than sign (>) indicates the route has been selected as the best path to that network.

The "Metric" column here is not the usual metric like in OSPF or EIGRP. It is the Multi Exit Discriminator (MED) attribute of BGP. "Weight" is another BGP attribute. The default values of both MED and Weight are 0 (as you see at the outputs above).

The “Path” column shows the AS paths that prefix were sent to reach us. It would better to read the “Path” from right to left to understand which path this prefix travel to reach our router. Letter “i” is considered the starting point of the prefix and the next number is the originating AS where this prefix originated. Next numbers are the recorded paths it traveled. For example if a prefix had to travel from AS 1 -> 2 -> 3 -> 4 -> 5 (our AS) then we will see the path “4 3 2 1 i” on our router.

Note: A blank AS path (only letter “i” is shown) means that the route was originated in the local AS. In the R1 output above, network 1.1.1.0/24 is originated from R1 so we see the path only has one letter “i”.

One notice is on R1 the “Next Hop” is 0.0.0.0 which means this prefix is originated from the local router. On R2 the Next Hop is pointing toward the interface Fa0/0 of R1 (11.0.0.1) to which R2 will send traffic for the destination 1.1.1.0/24.

Now R1 advertised prefix 1.1.1.0/24 to R2 so we can re-check R2 with the “show ip bgp summary” command to see the “Prefix received” increased to 1:

```
R2#sh ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 2, main routing table version 2
1 network entries using 117 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 441 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
11.0.0.1        4     1       5       4        2    0    0 00:01:36        1
```

Also in the routing table of R2 we will see this prefix, which is advertised with BGP from R1:

```
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

     1.0.0.0/24 is subnetted, 1 subnets
B       1.1.1.0 [20/0] via 11.0.0.1, 00:00:20
     2.0.0.0/24 is subnetted, 1 subnets
C       2.2.2.0 is directly connected, Loopback0
     11.0.0.0/24 is subnetted, 1 subnets
C       11.0.0.0 is directly connected, FastEthernet0/0
```