Course: SWE-Computer Network Practical			
Instructor	Dr. Asad Raza Malik	Practical/Lab No.	07
Date	18-09-2024	CLOs	03
Student's Roll no:		Point Scored:	
Date of Conduct:		Teacher's Signature:	

LAB PERFORMANCE INDICATOR	Subject Knowledge	Data Analysis and Interpretation	Ability to Conduct Experiment	Presentation	Calculation and Coding	Observation/ Result	Score

Topic	**To configure the STATIC routers between two routers**
Objective	• To configure and verify static routing between two routers. • To understand the role and operation of static in routing between networks

Lab Discussion: Theoretical concepts and Procedural steps

Theoretical Background:

The process of choosing a path across one or more networks is known as Network Routing. Nowadays, individuals are more connected on the internet and hence, the need to use Routing Communication essential.

Routing chooses the routers along which Internet Protocol (IP) packet get from their source to their source to their destination packet-switching networks. This Lab will discuss the details of the Routing Process along with its different types and working principles.

What is a Router?

Routers are specialized pieces of network hardware that make these judgments about Internet routing. It is a networking device that forwards data packets between computer networks. Also, it helps to direct traffic based on the destination IP address. It ensures that data reaches its intended destination.

As the router connects different networks, it manages data traffic between them. The Router operates at Layer 3 (the network layer) of the OSI Model. It is also responsible for determining the best path for data to travel from one network to another.

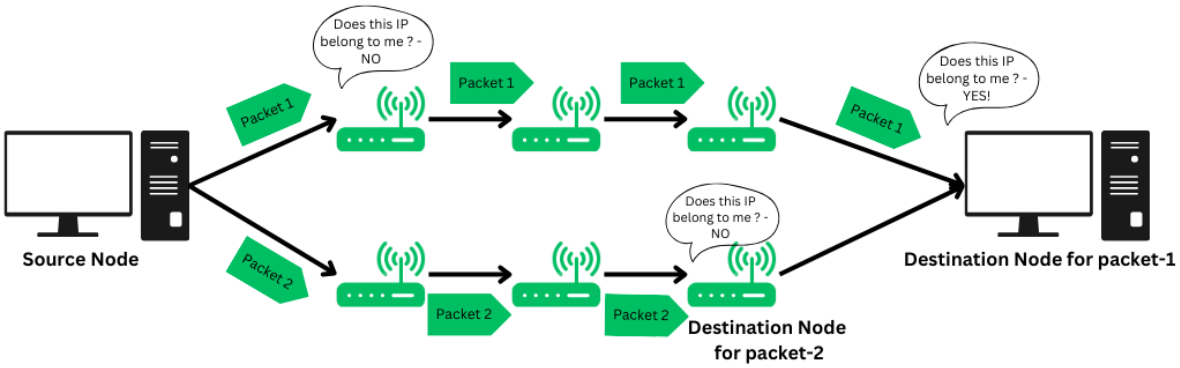
What is Routing?

Routing refers to the process of directing a data packet from one node to another. It is an autonomous process handled by the network devices to direct a data packet to its intended destination. Note that, the node here refers to a network device called – 'Router '.

Routing is a crucial mechanism that transmits data from one location to another across a network (Network type could be any like LAN, WAN, or MAN). The process of routing involves making various routing decisions to ensure reliable & efficient delivery of the data

packet by finding the shortest path using various routing metrics which we will be discussing in this article.

Routing of a data packet is done by analyzing the destination IP Address of the packet. Look at the below image:

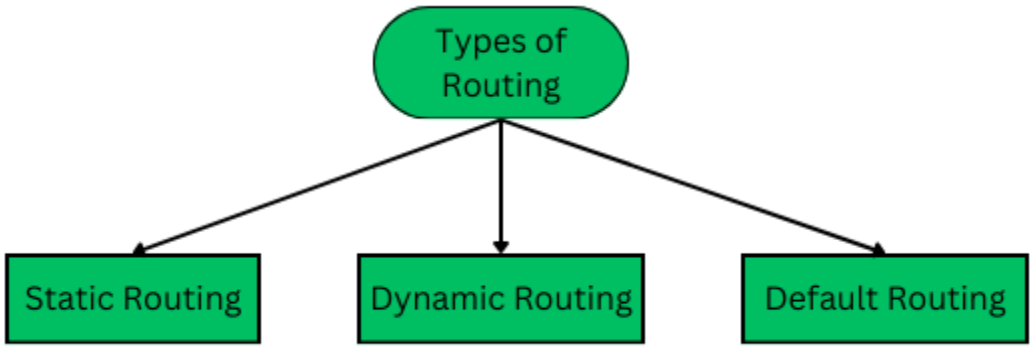


- The Source Node (Sender) sends the data packet on the network, embedding the IP in the header of the data packet.
- The nearest router receives the data packet, and based on some metrics, further routes the data packet to other routers.
- Step 2 occurs recursively till the data packet reaches its intended destination.

Note: There are limits to how many hop counts a packet can do if it is exceeded, the packet is considered to be lost.

What are Different Types of Routing?

Routing is typically of 3 types, each serving its purpose and offering different functionalities.



1. Static Routing

Static routing is also called as “non-adaptive routing”. In this, routing configuration is done manually by the network administrator. Let’s say for example, we have 5 different routes to transmit data from one node to another, so the network administrator will have to manually enter the routing information by assessing all the routes.

- A network administrator has full control over the network, routing the data packets to their concerned destinations

- Routers will route packets to the destination configured manually by the network administrator.
- Although this type of routing gives fine-grained control over the routes, it may not be suitable for large-scale enterprise networks.

2. Dynamic Routing

Dynamic Routing is another type of routing in which routing is an autonomous procedure without any human intervention. Packets are transmitted over a network using various shortest-path algorithms and pre-determined metrics. This type of routing is majorly preferred in modern networks as it offers more flexibility and versatile functionality.

- It is also known as adaptive routing.
- In this, the router adds new routes to the routing table based on any changes made in the topology of the network.
- The autonomous procedure of routing helps in automating every routing operation from adding to removing a route upon updates or any changes made to the network.

3. Default Routing

Default Routing is a routing technique in which a router is configured to transmit packets to a default route that is, a gateway or next-hop device if no specific path is defined or found. It is commonly used when the network has a single exit point. The IP Router has the following address as the default route: 0.0.0.0/0.

What is the Working Principle of Routing?

Routing works by finding the shortest path from the source node to the destination node across a network. Here's the step-by-step working of routing:

Step 1: Communication initiation

The first step that typically happens is, one node (client or server) initiates a communication across a network using HTTP protocols.

Step 2: Data Packets

The source device now breaks a big chunk of information into small data packets for reliable and efficient transmission. This process is called de-assembling and encapsulating the data payload. Then each data packet is labeled with the destination node's IP address.

Step 3: Routing Table

The Routing table is a logical data structure used to store the IP addresses and relevant information regarding the nearest routers. The source node then looks up the IP addresses of all the nodes that can transmit the packet to its destination selects the shortest path using the shortest path algorithm and then routes accordingly.

The Routing Table is stored in a router, a network device that determines the shortest path and routes the data packet.

Step 4: Hopping procedure

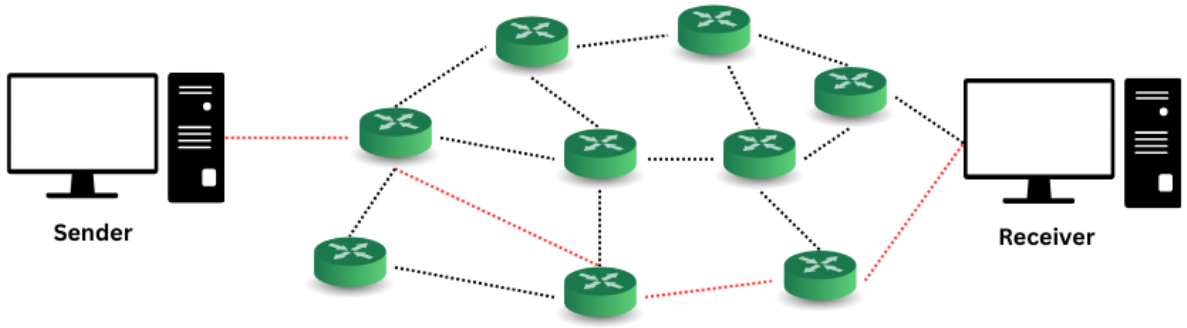
In the procedure or routing, the data packet will undergo many hops across various nodes in a network till it reaches its destination node. Hop count is defined as the number of nodes required to traverse through to finally reach the intended destination node.

This hopping procedure has certain criteria defined for every data packet, there's a limited number of hops a packet can take if the packet exceeds that, then it's considered to be lost and is retransmitted.

Step 5: Reaching the destination node

Once all the data packets reach their intended destination node, they re-assemble and transform into complete information that was sent by the sender (source node). The receiver will perform various error-checking mechanisms to verify the authenticity of the data packets.

Overall, the data packet will be transmitted over the least hop-count path as well as the path on which there is less traffic to prevent packet loss.



Routing Working Example

In the above image, we have 3 major components

- Sender
- Receiver
- Routers

The shortest path is highlighted in red, the path with the least hop count. As we can see, there are multiple paths from source to node but if all the appropriate metrics are satisfied, the data packets will be transmitted through the shortest path (highlighted in red).

Lab Activity:

Implementation of Static Routing in Cisco - 2 Router Connections

Static routing is a routing protocol that helps to keep your network organized and to optimize routing performance. It enables the router to assign a specific path to each network segment and to keep track of network changes. This helps to improve network stability and continuity. This adds security because a single administrator can only authorize routing to particular networks.

Steps to Configure and Verify Two Router Connections in Cisco Packet Tracer:

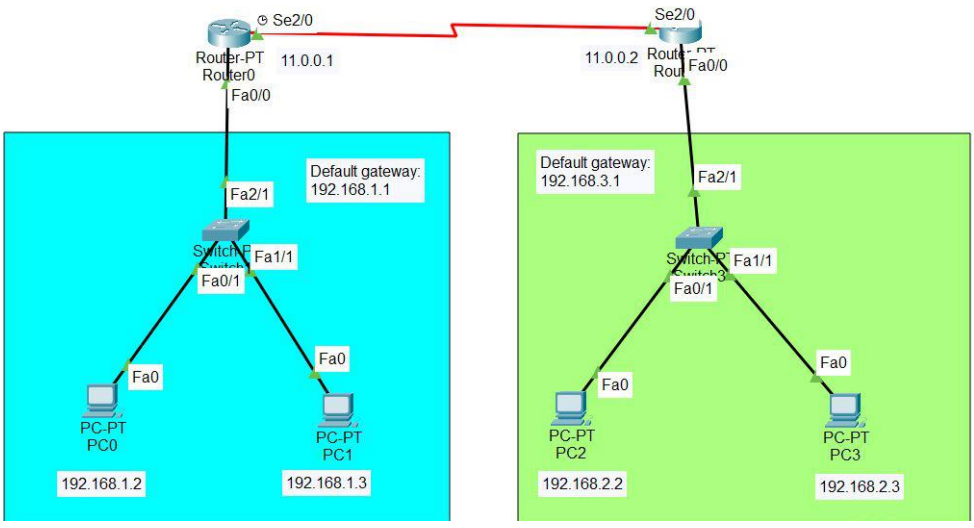
Step 1: First, open the cisco packet tracer desktop and select the devices given below:

S. No	Device	Model Name	Qty.
1.	PC	PC	4
2.	Switch	PT-Switch	2
3.	Router	PT-Router	2

IP Addressing Table For PCs:

S.No	Device	IPv4 Address	Subnet Mask	Default Gateway
1	Pc0	192.168.1.2	255.255.255.0	192.168.1.1
2	Pc1	192.168.1.3	255.255.255.0	192.168.1.1
3	Pc3	192.168.2.2	255.255.255.0	192.168.2.1
4	Pc4	192.168.2.3	255.255.255.0	192.168.2.1

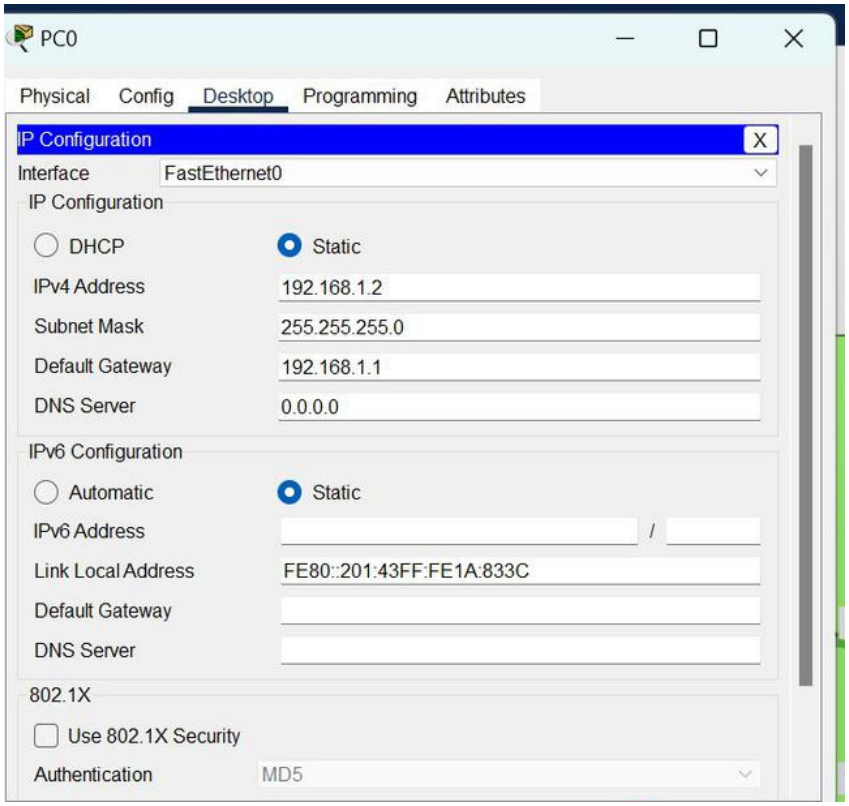
- Then, create a network topology as shown below the image.
- Use an Automatic connecting cable to connect the devices with others.



Correction: Default Gateway in 2nd network is 192.168.2.1

Step 2: Configure the PCs (hosts) with IPv4 address and Subnet Mask according to the IP addressing table given above.

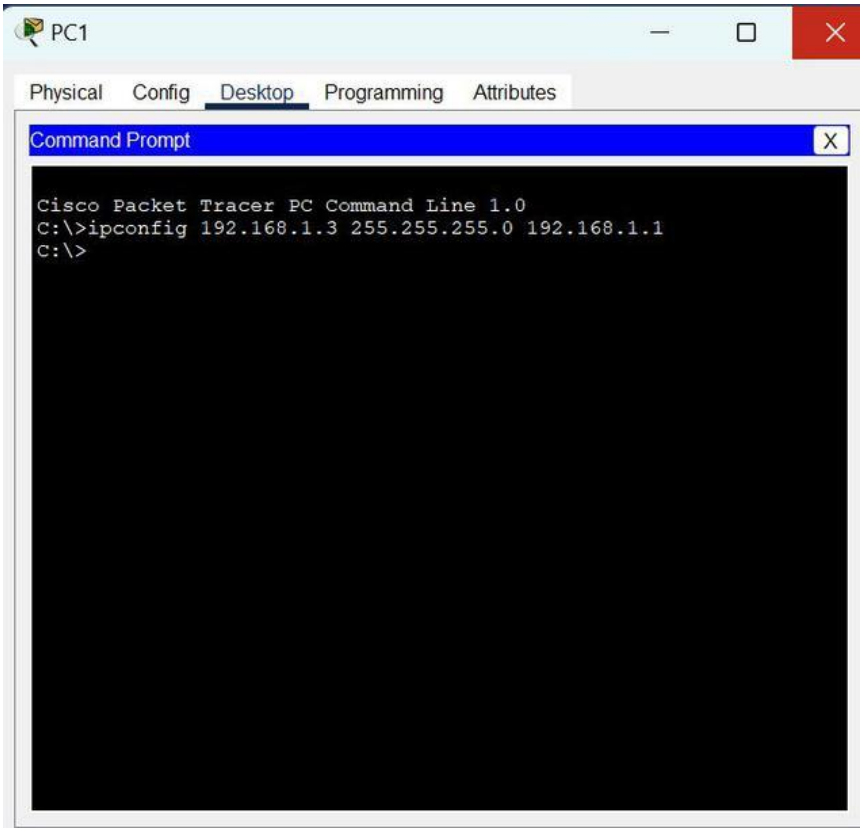
- To assign an IP address in PC0, click on PC0.
- Then, go to desktop and then IP configuration and there you will IPv4 configuration.
- Fill IPv4 address and subnet mask.



Step 3: Assigning IP address using the ipconfig command.

- We can also assign an IP address with the help of a command.
- Go to the command terminal of the PC.
- Then, type ipconfig <IPv4 address><subnet mask><default gateway>(if needed)

Example: ipconfig 192.168.1.3 255.255.255.0 192.168.1.1

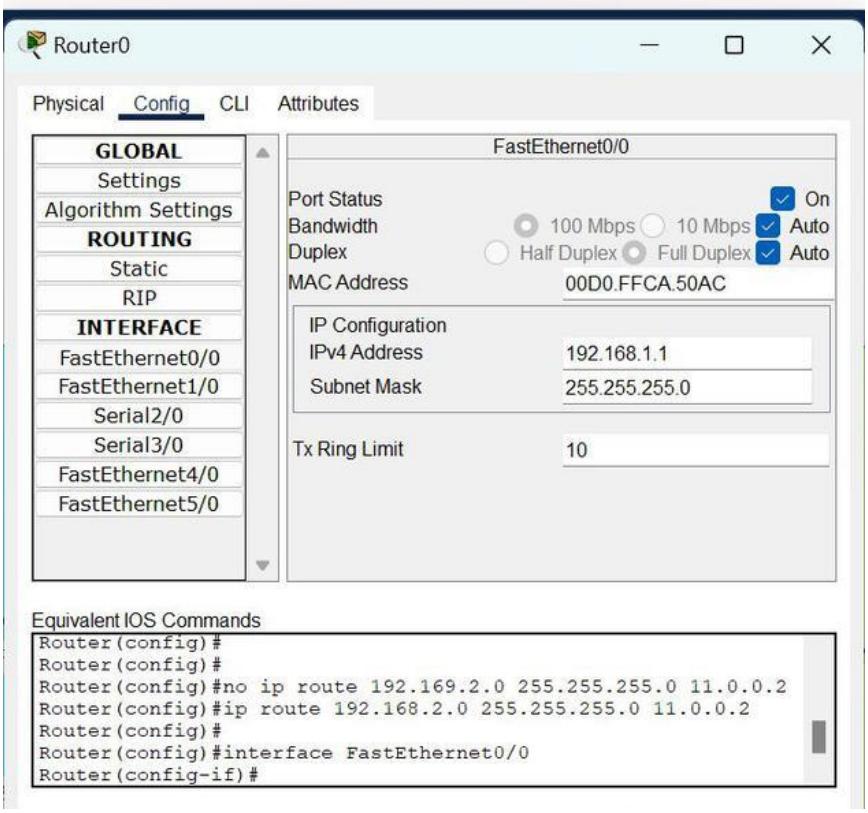


- Repeat the same procedure with other PCs to configure them thoroughly.

Step 4: Configure router with IP address and subnet mask.

S. No	Device	Interface	IPv4 Addressing	Subnet Mask
1.	Router0	FastEthernet 0/0	192.168.1.1	255.255.255.0
		Serial2/0	11.0.0.1	255.255.255.0
2.	Router 1	FastEthernet 0/0	192.168.2.1	255.255.255.0
		Serial2/0	11.0.0.2	255.255.255.0

- To assign an IP address in router0, click on router0.
- Then, go to config and then Interfaces.
- Then, configure the IP address in FastEthernet and serial ports according to IP addressing Table.
- Fill IPv4 address and subnet mask.



- Repeat the same procedure with other routers to configure them thoroughly.

Step 5: After configuring all of the devices we need to assign the routes to the routers.

To assign static routes to the particular router:

- First, click on router0 then Go to CLI.
- Then type the commands and IP information given below.

CLI command : ip route <network id> <subnet mask><next hop>

Static Routes for Router0 are given below:

Router(config)#ip route 192.168.2.0 255.255.255.0 11.0.0.2

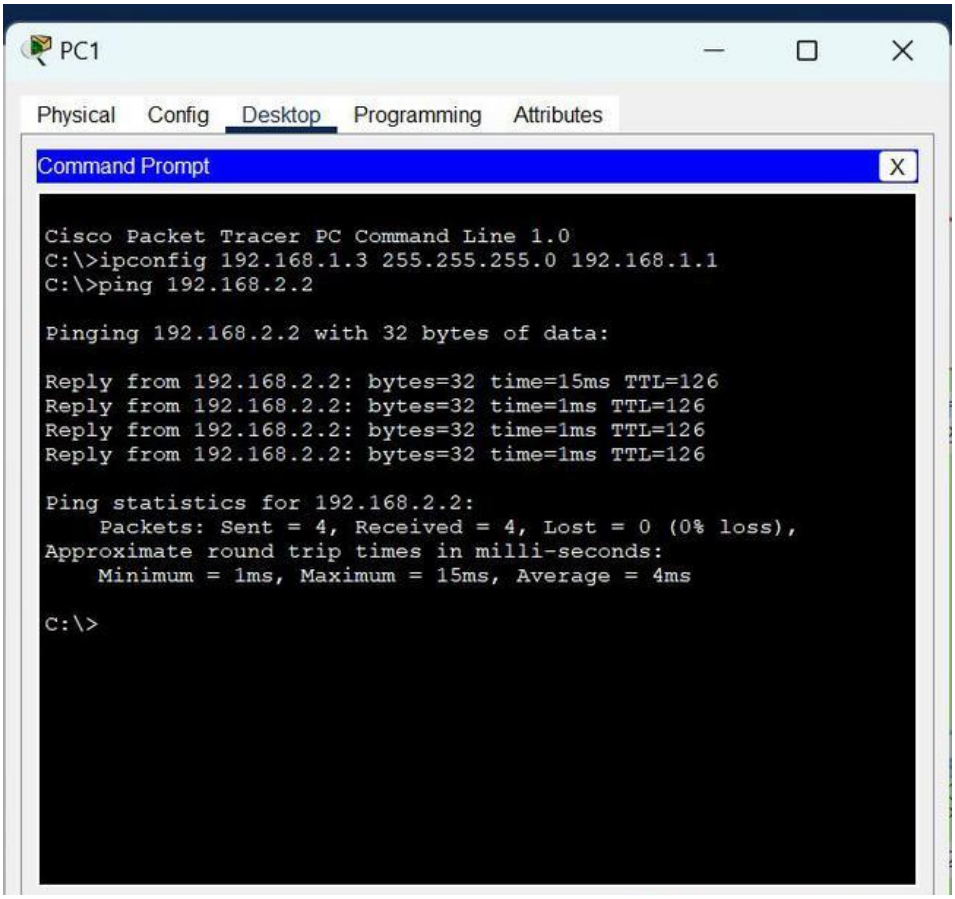
Static Routes for Router1 are given below:

Router(config)#ip route 192.168.1.0 255.255.255.0 11.0.0.1

Step 6: Verifying the network by pinging the IP address of any PC. We will use the ping command to do so.

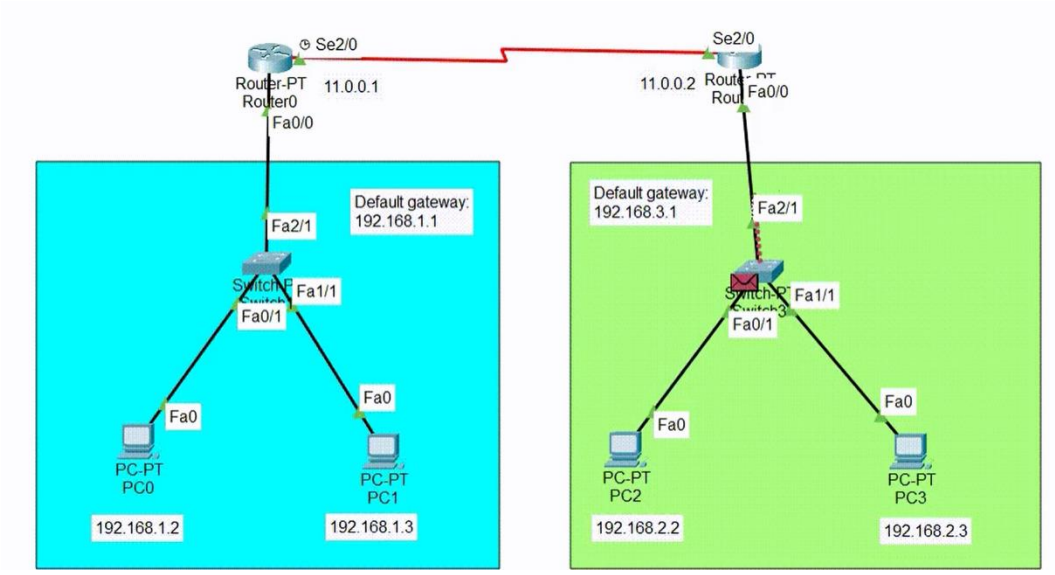
- First, click on PC1 then Go to the command prompt
- Then type ping <IP address of targeted node>
- As we can see in the below image we are getting replies which means the connection is working very fine

Example : ping 192.168.2.2



Simulation:

We are sending PDU from PC0 to PC2.



Student Assignment:

Group A: Basic Two-Router Configuration

- **Scenario**: You have two routers (R1 and R2) connected through a serial link. Each router is connected to a PC. Configure static routing between the two routers so that PCs on both networks can communicate.
- **IP Addressing**:
    - **R1** LAN: 192.168.1.0/24
    - **R2** LAN: 192.168.2.0/24
    - **Serial link**: 10.0.0.0/30

Group B: Three-Router Chain

- **Scenario**: Configure static routes between three routers (R1, R2, R3) connected in a chain. Each router has a LAN with a PC connected to it. Ensure all PCs can communicate across the routers.
- **IP Addressing**:
    - **R1** LAN: 192.168.10.0/24
    - **R2** LAN: 192.168.20.0/24
    - **R3** LAN: 192.168.30.0/24
    - **R1-R2 Serial link**: 10.1.1.0/30
    - **R2-R3 Serial link**: 10.1.2.0/30

Group C: Dual-Router, Dual LAN

- **Scenario**: Configure two routers (R1, R2) connected by a serial link, with each router having two LANs and PCs connected. Use static routes to ensure all PCs can communicate.
- **IP Addressing**:
    - **R1 LAN1**: 192.168.50.0/24
    - **R1 LAN2**: 192.168.60.0/24
    - **R2 LAN1**: 192.168.70.0/24
    - **R2 LAN2**: 192.168.80.0/24
    - **Serial link**: 172.16.0.0/30

Group D: Multiple Networks with Single Router

- **Scenario**: One router (R1) is connected to three different networks. Use static routing to allow communication between all networks.
- **IP Addressing**:
    - **Network 1**: 192.168.100.0/24
    - **Network 2**: 192.168.110.0/24
    - **Network 3**: 192.168.120.0/24
    - **Router Interfaces**: Assign IP addresses for each interface to connect all networks.

Group E: Redundant Router Path

- **Scenario**: Configure two routers (R1, R2) connected by two redundant serial links. Use static routing to implement load balancing or redundancy between the two routers.
- **IP Addressing**:
    - **R1 LAN**: 192.168.200.0/24
    - **R2 LAN**: 192.168.210.0/24
    - **Serial Link 1**: 10.10.10.0/30
    - **Serial Link 2**: 10.10.11.0/30

Group F: Static Routing with VLANs

- **Scenario**: Configure two routers connected through a switch. The switch is set up with two VLANs. Use static routing to route traffic between the VLANs.
- **IP Addressing**:
    - **VLAN 1**: 192.168.130.0/24
    - **VLAN 2**: 192.168.140.0/24
    - **Inter-Router link**: 10.1.10.0/30

Group G: Inter-office Network with Static Routes

- **Scenario**: Two routers connect two branch offices, each having its own LAN. Implement static routing between the two routers.
- **IP Addressing**:

- **Office 1**: 192.168.150.0/24
- **Office 2**: 192.168.160.0/24
- **Serial link**: 172.16.5.0/30

Group H: Router with Internet Access

- **Scenario**: One router connects two internal networks and provides Internet access using static routing.
- **IP Addressing**:
  - **LAN 1**: 192.168.170.0/24
  - **LAN 2**: 192.168.180.0/24
  - **WAN (Internet-facing)**: 203.0.113.0/30

Group I: Static Route to an External Network

- **Scenario**: A company has two internal networks, and one external network connected via a router. Use static routes to allow communication between all networks.
- **IP Addressing**:
  - **Internal Network 1**: 192.168.220.0/24
  - **Internal Network 2**: 192.168.230.0/24
  - **External Network**: 10.1.20.0/30

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