Department of Computer Science and Engineering

Islamic University of Technology (IUT)

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Laboratory Report

CSE 4412: Data Communication and Networking Lab

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Section : **BSc in SWE(Group A)**

Semester : **4th Semester**

Academic Year : **2022-23**

Date : **27/01/2023**

Lab No : **04**

Title: Router Configuration and using static routing to connect multiple LANs in CISCO Packet Tracer.

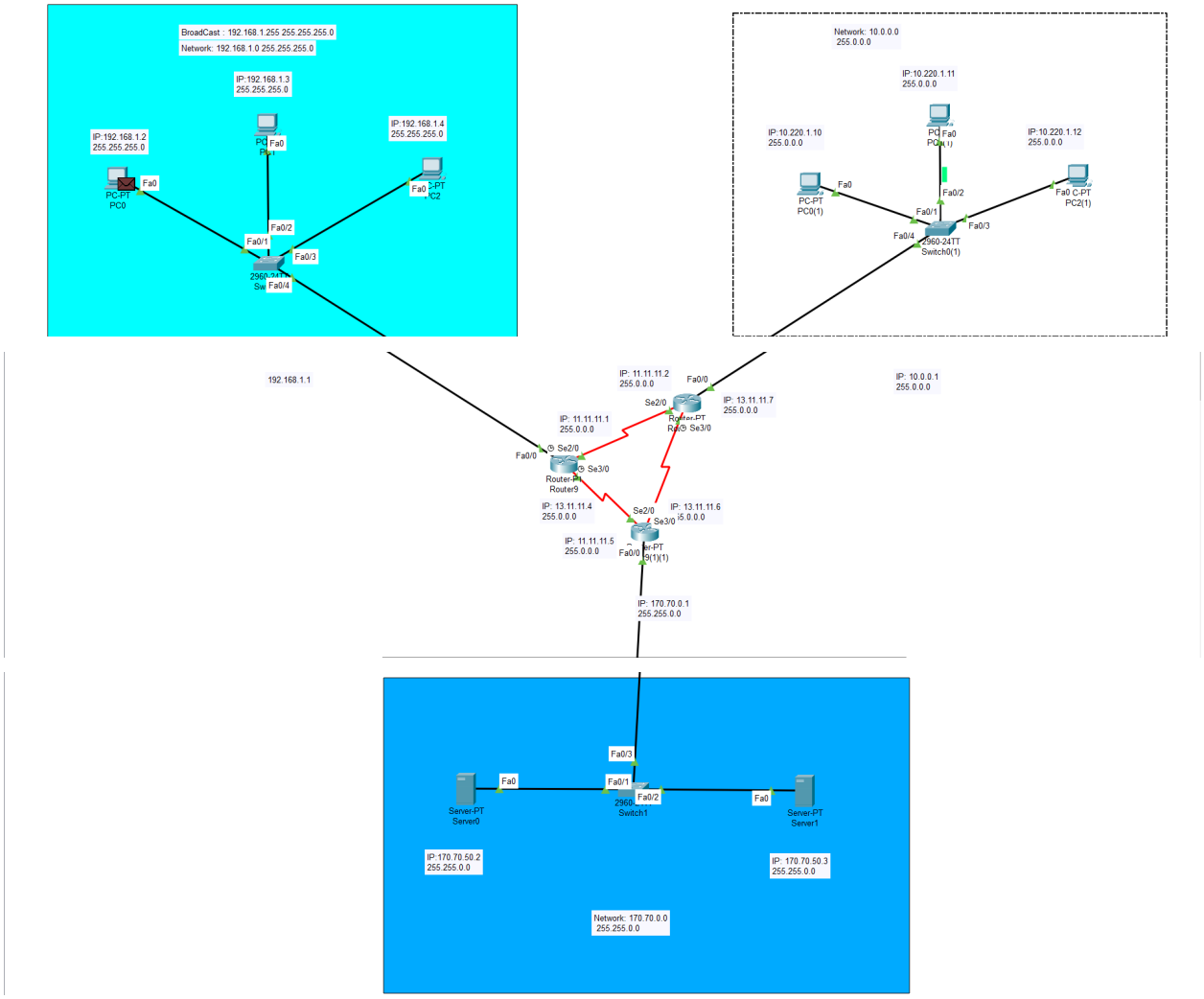
Objective:

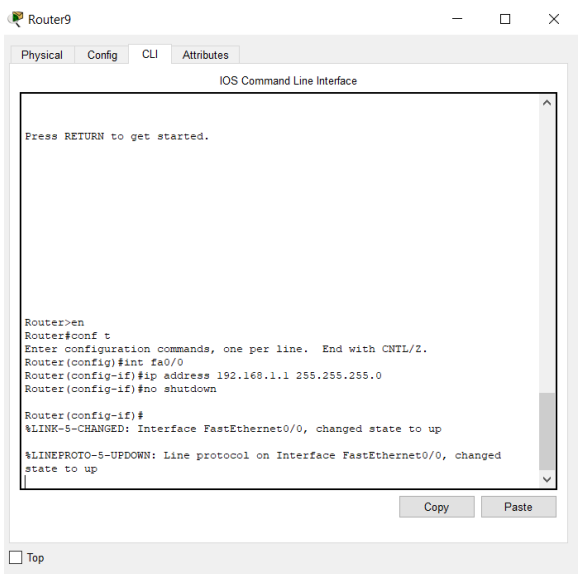
1. Understand Default Gateway
2. Difference between Switch and Router.
3. Router to Router Wiring [Using DCE and DTE Cables]
4. Static Routing Configuration
5. Default Route

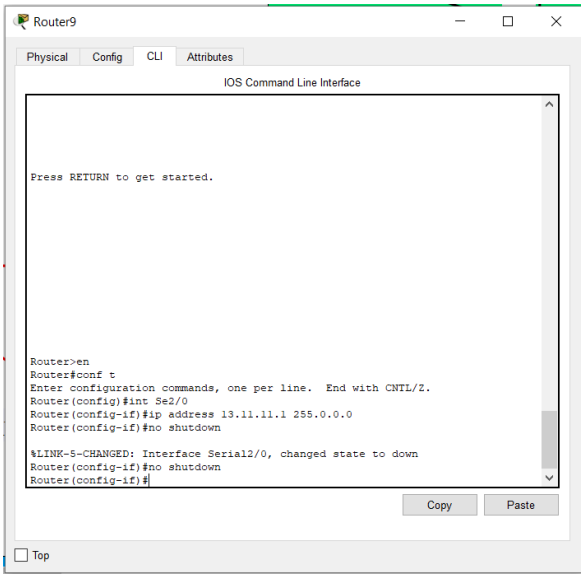
Devices/Software Used:

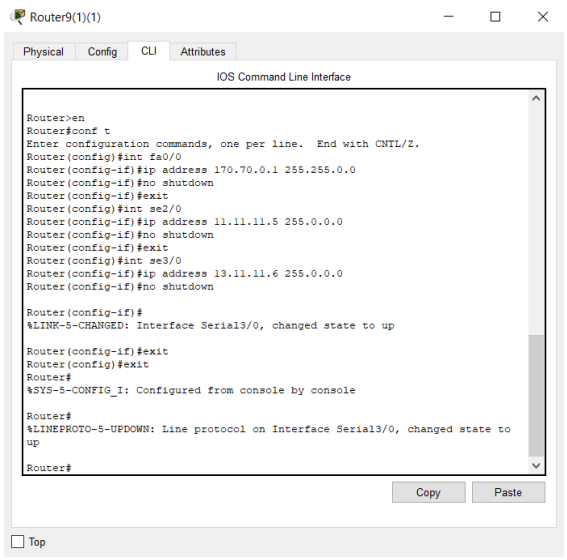
1. PT-Switch
2. PC-PT
3. Server-PT
4. PT-Router
5. Straight-Through Wires
6. Serial Connection Wire(DCE and DTE Cables)
7. Router Configure Terminal
8. IP Configuration of PC in Cisco Packet Tracer
9. Cisco Packet Tracer

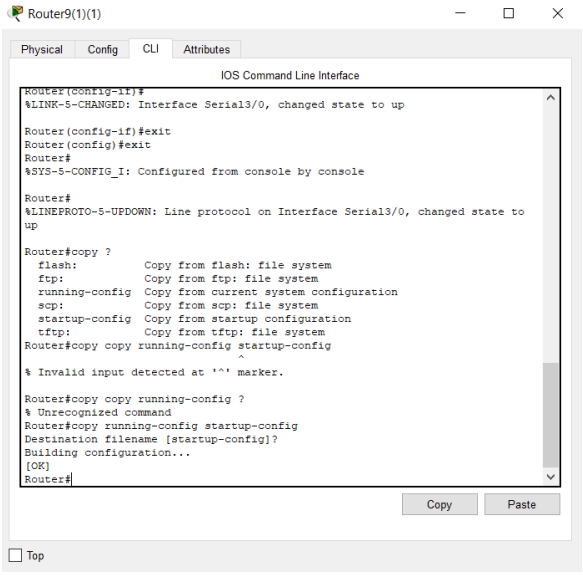
Diagram of the experiment:

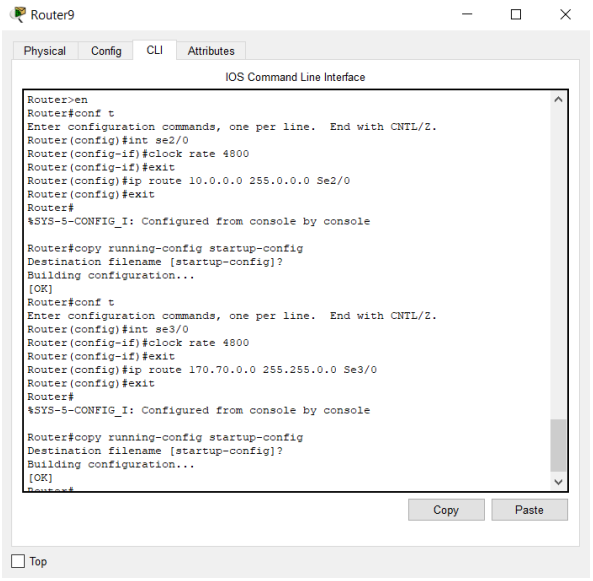


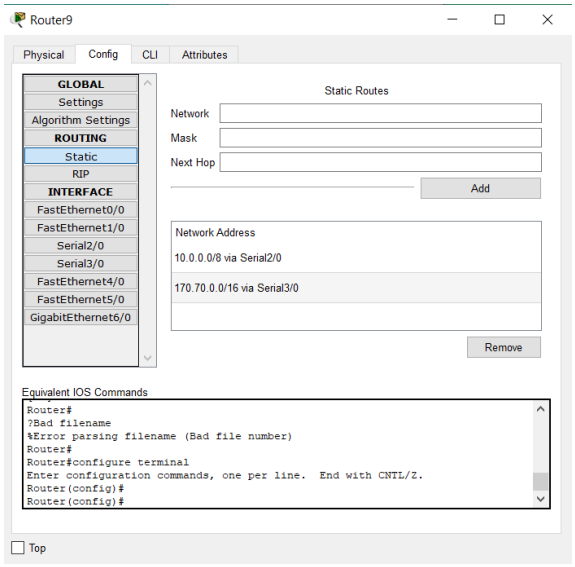

Router9
Physical
Config
CLI
Attributes
IOS Command Line Interface
Press RETURN to get started.
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Copy
Paste
Top

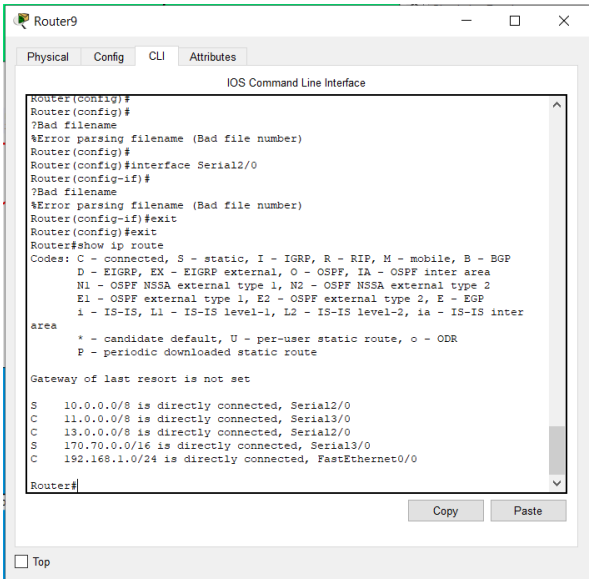

Router9
Physical
Config
CLI
Attributes
IOS Command Line Interface
Press RETURN to get started.
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int Se2/0
Router(config-if)#ip address 13.11.11.1 255.0.0.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial2/0, changed state to down
Router(config-if)#no shutdown
Router(config-if)#
Copy
Paste
Top

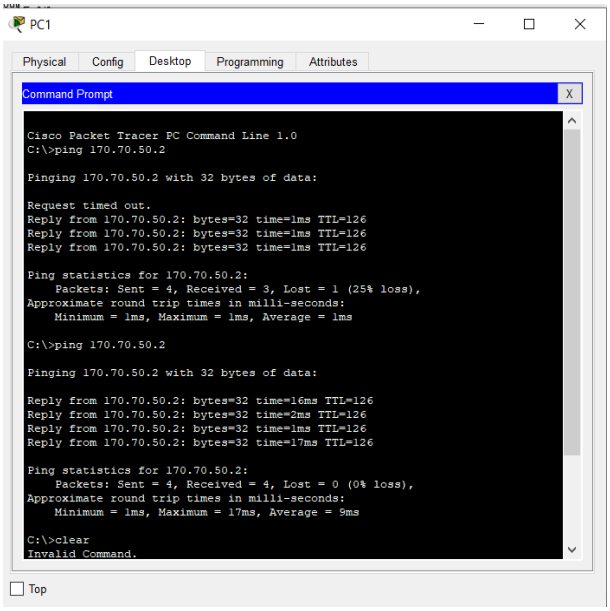

Router9(1)(1)
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 170.70.0.1 255.255.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#int se2/0
Router(config-if)#ip address 11.11.11.5 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#int se3/0
Router(config-if)#ip address 13.11.11.6 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up
Router#
Copy
Paste
Top


Router9(1)(1)
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router(config-if)#
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up
Router#copy ?
  flash: Copy from flash: file system
  ftp: Copy from ftp: file system
  running-config   Copy from current system configuration
  scp: Copy from scp: file system
  startup-config   Copy from startup configuration
  tftp: Copy from tftp: file system
Router#copy copy running-config startup-config
                    ^
% Invalid input detected at '^' marker.
Router#copy copy running-config ?
% Unrecognized command
Router#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Copy
Paste
Top


Router9
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int se2/0
Router(config-if)#clock rate 4800
Router(config-if)#exit
Router(config)#ip route 10.0.0.0 255.0.0.0 Se2/0
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int se3/0
Router(config-if)#clock rate 4800
Router(config-if)#exit
Router(config)#ip route 170.70.0.0 255.255.0.0 Se3/0
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Copy
Paste
Top


Router9
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
GigabitEthernet6/0
Static Routes
Network
Mask
Next Hop
Add
Network Address
10.0.0.0/8 via Serial2/0
170.70.0.0/16 via Serial3/0
Remove
Equivalent IOS Commands
Router#
?Bad filename
%Error parsing filename (Bad file number)
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#
Top


Router9
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router(config)#
Router(config)#
?Bad filename
%Error parsing filename (Bad file number)
Router(config)#
Router(config)#interface Serial2/0
Router(config-if)#
?Bad filename
%Error parsing filename (Bad file number)
Router(config-if)#exit
Router(config)#exit
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, 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
S   10.0.0.0/8 is directly connected, Serial2/0
C   11.0.0.0/8 is directly connected, Serial3/0
C   13.0.0.0/8 is directly connected, Serial2/0
S   170.70.0.0/16 is directly connected, Serial3/0
C   192.168.1.0/24 is directly connected, FastEthernet0/0
Router#
Copy
Paste
Top


PC1
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 170.70.50.2
Pinging 170.70.50.2 with 32 bytes of data:
Request timed out.
Reply from 170.70.50.2: bytes=32 time=1ms TTL=126
Reply from 170.70.50.2: bytes=32 time=1ms TTL=126
Reply from 170.70.50.2: bytes=32 time=1ms TTL=126
Ping statistics for 170.70.50.2:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms
C:\>ping 170.70.50.2
Pinging 170.70.50.2 with 32 bytes of data:
Reply from 170.70.50.2: bytes=32 time=16ms TTL=126
Reply from 170.70.50.2: bytes=32 time=2ms TTL=126
Reply from 170.70.50.2: bytes=32 time=1ms TTL=126
Reply from 170.70.50.2: bytes=32 time=17ms TTL=126
Ping statistics for 170.70.50.2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 17ms, Average = 9ms
C:\>clear
Invalid Command.
Top

Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.006	PC0	Switch0	ICMP
	0.006	Switch0	Router9	ICMP
	0.007	Switch0	Router9	ICMP
	0.007	Router9	Router9(1)	ICMP
	0.007	--	Router9(1)	ARP
	0.008	Router9	Router9(1)	ICMP
	0.008	Router9(1)	Switch0(1)	ARP
	0.008	--	Router9(1)	ARP
	0.009	Switch0(1)	PC0(1)	ARP
	0.009	Switch0(1)	PC1(1)	ARP
	0.009	Switch0(1)	PC2(1)	ARP
	0.010	PC0(1)	Switch0(1)	ARP
	0.011	Switch0(1)	Router9(1)	ARP
	6.002	--	PC0	ICMP
	6.003	PC0	Switch0	ICMP
	6.004	Switch0	Router9	ICMP
	6.005	Router9	Router9(1)	ICMP
	6.006	Router9(1)	Switch0(1)	ICMP
	6.007	Switch0(1)	PC0(1)	ICMP
	6.008	PC0(1)	Switch0(1)	ICMP

Reset Simulation | Constant Delay | Captured to: 6.009 s

Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.007	Router9	Router9(1)	ICMP
	0.007	--	Router9(1)	ARP
	0.008	Router9	Router9(1)	ICMP
	0.008	Router9(1)	Switch0(1)	ARP
	0.008	--	Router9(1)	ARP
	0.009	Switch0(1)	PC0(1)	ARP
	0.009	Switch0(1)	PC1(1)	ARP
	0.009	Switch0(1)	PC2(1)	ARP
	0.010	PC0(1)	Switch0(1)	ARP
	0.011	Switch0(1)	Router9(1)	ARP
	6.002	--	PC0	ICMP
	6.003	PC0	Switch0	ICMP
	6.004	Switch0	Router9	ICMP
	6.005	Router9	Router9(1)	ICMP
	6.006	Router9(1)	Switch0(1)	ICMP
	6.007	Switch0(1)	PC0(1)	ICMP
	6.008	PC0(1)	Switch0(1)	ICMP
	6.009	Switch0(1)	Router9(1)	ICMP
	6.010	Router9(1)	Router9	ICMP

Reset Simulation | Constant Delay | Captured to: 6.010 s

PDU Information at Device: Router9(1)

OSI Model | Inbound PDU Details | Outbound PDU Details

At Device: Router9(1)
Source: PC0
Destination: PC0(1)

In Layers	Out Layers
Layer7	Layer7
Layer6	Layer6
Layer5	Layer5
Layer4	Layer4
Layer 3: IP Header Src. IP: 192.168.1.2, Dest. IP: 10.220.1.10 ICMP Message Type: 8	Layer 3: IP Header Src. IP: 192.168.1.2, Dest. IP: 10.220.1.10 ICMP Message Type: 8
Layer 2: HDLC Frame HDLC	Layer 2:
Layer 1: Port Serial2/0	Layer1

1. The device looks up the destination IP address in the routing table.

Challenge Me | << Previous Layer | Next Layer >>

PDU Information at Device: Router9(1)

OSI Model | Inbound PDU Details | Outbound PDU Details

At Device: Router9(1)
Source: PC0
Destination: PC0(1)

In Layers	Out Layers
Layer7	Layer7
Layer6	Layer6
Layer5	Layer5
Layer4	Layer4
Layer 3: IP Header Src. IP: 192.168.1.2, Dest. IP: 10.220.1.10 ICMP Message Type: 8	Layer 3: IP Header Src. IP: 192.168.1.2, Dest. IP: 10.220.1.10 ICMP Message Type: 8
Layer 2: HDLC Frame HDLC	Layer 2:
Layer 1: Port Serial2/0	Layer1

1. The routing table finds a routing entry to the destination IP address.
2. The destination network is directly connected. The device sets destination as the next-hop.
3. The device decrements the TTL on the packet.

Challenge Me | << Previous Layer | Next Layer >>

Theory:

Default Gateway:

(If it is not set what may happen?)
The default gateway is the IP address of a network device that serves as a sort of entry point for devices on a network to access resources on a different network. In a local area network (LAN), the default gateway is usually a router that connects the LAN to the Internet.

If the default gateway is not set, devices on the network will not be able to access resources located on a different network, including the Internet. This can limit their functionality and prevent them from communicating with other devices outside of the local network. Also in the Cisco packet tracer, it is usually automatically configured to 0.0.0.0.

Difference between Switch and Router

A switch is a layer-2 device while a router is a layer-3 device. This means that while a switch can identify devices by their MAC Address in layer 2, a router can also identify and dispatch packets to IP addresses using the routing algorithm. Switches simply function by forwarding packets based on the MAC addresses of the devices in the network which they identify by the use of an ARP table as mentioned in the last lab. It is used to segment a large network into smaller subnets to reduce network congestion and improve performance. Switches do not support network layer routing protocols, so they cannot make decisions based on IP addresses or other network layer information which is seen more clearly in our last lab than initially, the switch floods packets to determine the MAC address for the corresponding IP addresses and then acts accordingly. Router's main goal is to connect multiple LAN networks together, often to the internet. Router forward packets by destination IP address. Routers are used to route traffic between different networks and subnets, including forwarding packets to the appropriate next hop based on routing tables. Finally, unlike switches routers support network layer routing protocols, so they can make decisions based on IP addresses and other network layer information.

Router to Router Wiring [Using DCE and DTE Cables]

In our experiment we were asked to use serial connectors. DCE and DTE cables represent the connection of 2 routers via serial connection. The main aim of this connection is to establish a WAN by connecting multiple routers. The DCE cable is primarily responsible

for providing a clock rate that helps in the synchronous transmission of data. More information regarding how the connection is carried out is provided later in the lab report.

Static Route

A static route is basically manually entering the records for the routing table. It is useful for small networks where we know from which router to which the packets are to be transmitted. Mainly useful in simple networks. Static routes are manually configured via the network administrator and do not change until or unless the network administrator themselves change it. The main advantage is that they provide a specific and consistent path for network traffic. This also makes the network more secure as a more predictable path is provided allowing security to be enforced accordingly. The process of manually assigning the IP address routes is known as **static binding**.

Default Route

A default route is the pre-determined path that the packets take when the destination network address isn't explicitly specified in the routing table. When a router receives a packet with a destination address that is not found in its routing table, the packet is forwarded to the default gateway. The default gateway is responsible for forwarding the packet to its final destination, either within the local network or on another network. The default route is a crucial component of a routing table, as it allows the router to forward packets to other networks and the Internet.

Configuration of Routers:

To configure the routers, the first step is to connect the routers via serial cables. After which each of the router's interfaces needs to be assigned an IP address. The IP address corresponding to the fast ethernet cable also acts as the default gateway of the router, and the computers connected to the router or in the presence of the router's subnet must also configure the default gateway according to the IP address provided in the fast ethernet protocol. In this experiment, we made use of static routing. In static routing, we manually configure the IP address and subnet mask to make up the routing table. And the packets are dispatched according to the routing table. Firstly for every internal network connected to a switch, we identify the network address and the broadcast address. The first address for a network ID represents the network address and the last address represents the broadcast address. Keeping this information in mind we can configure the routers accordingly. In the diagram, we observe that after setting the FastEthernet connector, we set the serial connector. For the serial connector, it is usually the DCE connector that has the clock rate. For setting any wired connection in the router we made use of the router config terminal. To access this, we first enter the CLI option of the router and in the command line provided, we use the **enable** command to enter the Privilege mode to make changes. Then we enter the **configure terminal** and then the **interface** for that particular wire such as Serial2/0 or FastEthernet0/0. After that, we set the IP address and the subnet mask. Upon configuring the wired connection. In the config mode, we set the clock rate. For the purpose of this experiment, I

set the **clock rate** as **4800 Bps**. After setting the clock rate we use the IP route command to configure the router to communicate with the other routers and their subnets. For this, we make use of the network address. For each serial connector, we utilize the network address of the subnet of the router we are trying to connect to. The network address and the subnet mask for the network address together help the **ip route** command to insert the static route to the routing table. In addition, we also specify the interface details for the ip route command. Instead of the interface details, we could also provide the next-hop IP address or the IP address of the interface of the router it is connected to. This set of tasks can be carried out for each router. Now there is a change that upon switching the router, the router's configuration may be lost for this in the privilege mode outside the config mode, we can copy the running-config of the router to the startup-config so that even if the router is switched off its configuration is not lost. This briefly summarizes the configuration process.

Observation:

In this experiment, during trial and error, I observed that two switches cannot be connected via an intermediary switch to transfer ICMP packets as it leads to an error. For this reason, we needed to introduce a router for two LAN networks to be connected. The benefit of the router is that it dispatches packets by IP addresses from a routing table instead of MAC addresses from an ARP table. So a router needs a routing table and in this experiment, we saw that when the router is initialized with a static routing table no additional flooding operation is needed for router initialization unlike that of a switch. I also learned about network addresses and broadcast addresses, consider the IP address 192.168.1.3 which is the IP address of a PC in the experiment, the network address is the minimum value of the IP address that can represent a specific network IP, which in this case is 192.168.1.0 and the broadcast address conversely is the maximum IP address, represented by 192.168.1.255. The network address is what is added to the routing table. The router also has assigned default gateways, which help provide a default route for packets reaching a router before they can be dispatched to the appropriate device connected to the net. Another key observation was that the in the first ping command there was one packet loss. This happened as the routing table was being configured so the route wasn't yet properly configured. We also observed that in the broadcast domain, no additional device is needed to transmit the packet to the destination as all the connected devices get the packet. This is the significance of the broadcast address. I also observed that when it comes to class A addressing if the first octet contains the same value and the router has multiple interfaces. Multiple interfaces cannot be assigned the same class A IP address as this leads to conflict and tends to hamper the IP route command from working properly. So the first octet must be different for the different interfaces involved especially if they are the same type of interface. We also observe that the changes made in the CLI are reflected in the config menu of the router. And in the diagram, we also observe in the PDU details about how the router dispatches packets on a specific route using the routing table. Using the **show ip route**s command in the privilege mode we can see all the entities of the

routing table. To see the ip address interface we can also make use of the **show ip interface brief** which briefly shows the current state and the connections of the wires along with their respective IP addresses. And in this experiment we also monitored the packets in the simulation mode, I showed the outputs of the simulation panel earlier. These outputs show how the packet reaches a destination from a sender along a fixed path determined by the ARP and the routing tables. Other additional things we observed involve that the CLI supports tab autocomplete and is very user-friendly as you can see in command details by using the '?' symbol. Finally, we discuss in detail why the initial packet loss occurred: the routing table when first configured might take some time to be fully built and start forwarding packets, and the initial traffic surge may cause the router that makes use of packet-switching technology to drop packets as the buffer becomes full due to increased load, the ARP cache on the router may need to be updated with the new network configuration, leading to certain forms of ARP request broadcast and temporary packet losses. There may be configuration errors such as incorrect IP addresses or subnets and even firewall rules may also be hampering the flow of traffic and thus leading to packet loss. Overall, the initial packet loss is usually temporary and resolves itself within a few minutes or hours as the router adjusts to its new configuration. This summarizes the observations for this experiment.

Challenges:

For me, the biggest challenge was keeping up with the IP addresses of multiple devices while configuring the routers. The different IP addresses made it hard to keep track of. Furthermore, another challenge for me was figuring out the working principle of the "ip route" command as I kept on getting an error saying "inconsistent address and mask", later I figured out that it was due to a conceptual issue about configuring the routers and that I had to give the network ID of the appropriate subnet rather than the IP of the interfaces. I solved that issue and talked about it earlier.