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Objectives:

1. Learn how to assign IP Addresses.
2. Learn how to create Subnets.
3. Introduce the concepts of routing.

Introduction:

What is routing?

Network routing is the process of selecting a path across one or more networks. The principles of routing can apply to any type of network, from telephone networks to public transportation. In packet-switching networks, such as the Internet, routing selects the paths for Internet Protocol (IP) packets to travel from their origin to their destination. These Internet routing decisions are made by specialized pieces of network hardware called routers

How does Routing work?

Routers refer to internal routing tables to make decisions about how to route packets along network paths. A routing table records the paths that packets should take to reach every destination that the router is responsible for. Think of train timetables, which train passengers consult to decide which train to catch. Routing tables are like that, but for network paths rather than trains

Routers work in the following way: when a router receives a packet, it reads the headers* of the packet to see its intended destination, like the way a train conductor may check a passenger's tickets to determine which train they should go on. It then determines where to route the packet based on information in its routing tables

Figure 1: Router model

Subnets

A subnet, or subnetwork, is a segmented piece of a larger network. More specifically, subnets are a logical partition of an IP network into multiple, smaller network segments. The Internet Protocol (IP) is the method for sending data from one computer to another over the internet. Each computer, or host, on the internet has at least one IP address as a unique identifier. Organizations will use a subnet to subdivide large networks into smaller, more efficient subnetworks. One goal of a subnet is to split a large network into a grouping of smaller, interconnected networks to help minimize traffic. This way, traffic doesn't have to flow through unnecessary routs, increasing network speeds.
Subnetting, the segmentation of a network address space, improves address allocation efficiency. It is described in the formal document, Request for Comments 950, and is tightly linked to IP addresses, subnet masks and Classless Inter-Domain Routing (CIDR) notation

Lab Procedure:

Part I: Packet Tracer

Example 1:

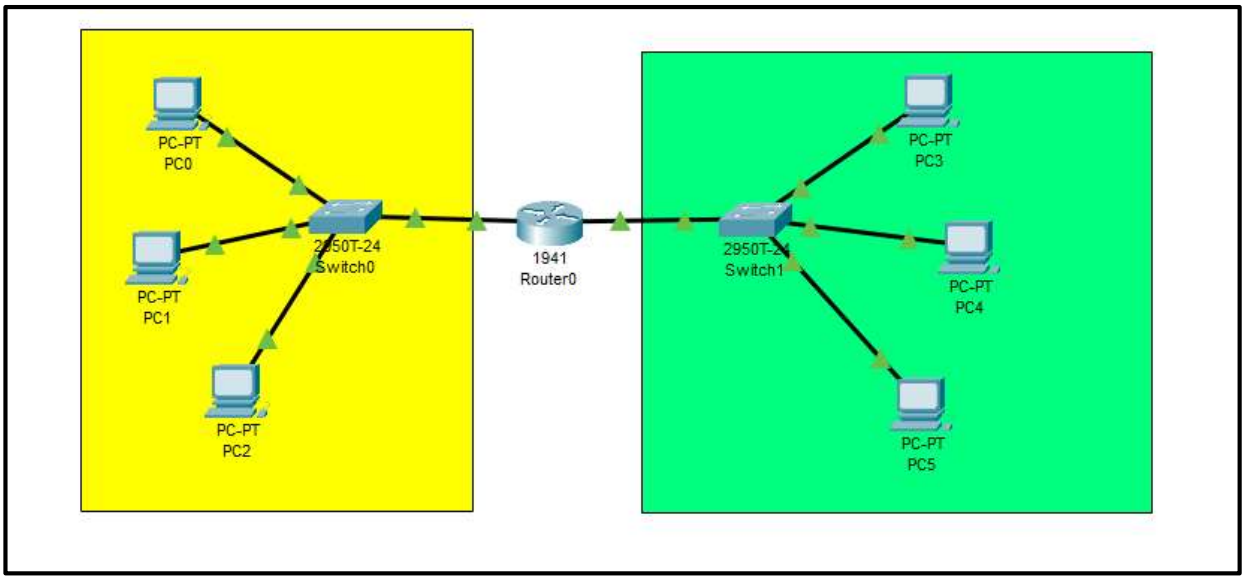
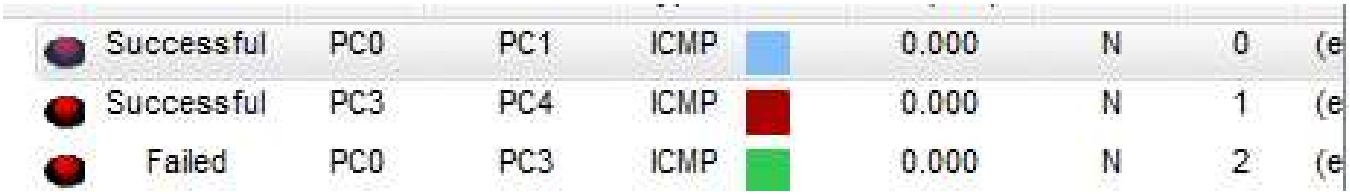


Figure 2: Router model

We built the scenario in packet tracer as shown in figure 2, and make sure to set the IP address for each PC in whole network. In the yellow network we set the network ID to **192.168.1.0** while in the green network, we set the network ID to **192.168.2.0**



Successful	PC0	PC1	ICMP		0.000	N	0
Successful	PC3	PC4	ICMP		0.000	N	1
Failed	PC0	PC3	ICMP		0.000	N	2

Figure 3

When we try to send message to PC which connect to same network the message was successfully received to the designation. While when we try to send message to PC which connect to different network, the message get lost and didn't reach the destination. So we have to configure the Router in order to communicate between different Networks.

```
Router>enable
Router#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
Router(config)#interface gigabitEthernet 0/0
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 GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0,
changed state to up

Router(config-if)#exit
Router(config)#interface gigabitEthernet 0/1
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1,
```

First we enabled the router , then we configured the interface gigabitEthernet 0/0 by type "ip address followed by the default getaway and subnet mask , then use the command no shutdown and do the same steps for the interface 0/1

Figure 4

```
C:\>ping 192.168.1.12

Pinging 192.168.1.12 with 32 bytes of data:

Reply from 192.168.1.12: bytes=32 time=2ms TTL=128
Reply from 192.168.1.12: bytes=32 time=1ms TTL=128
Reply from 192.168.1.12: bytes=32 time<1ms TTL=128
Reply from 192.168.1.12: bytes=32 time<1ms TTL=128
```

We test the connection by using the ping command to send to the PC whose connect to same network as a result we got replays.

```
C:\>ping 192.168.2.12

Pinging 192.168.2.12 with 32 bytes of data:

Reply from 192.168.2.12: bytes=32 time=1ms TTL=127
Reply from 192.168.2.12: bytes=32 time=12ms TTL=127
Reply from 192.168.2.12: bytes=32 time=11ms TTL=127
Reply from 192.168.2.12: bytes=32 time=3ms TTL=127
```

We test the connection by using the ping command to send to the PC whose connect to different network as a result we got replays.

Figure 5

Example 2:

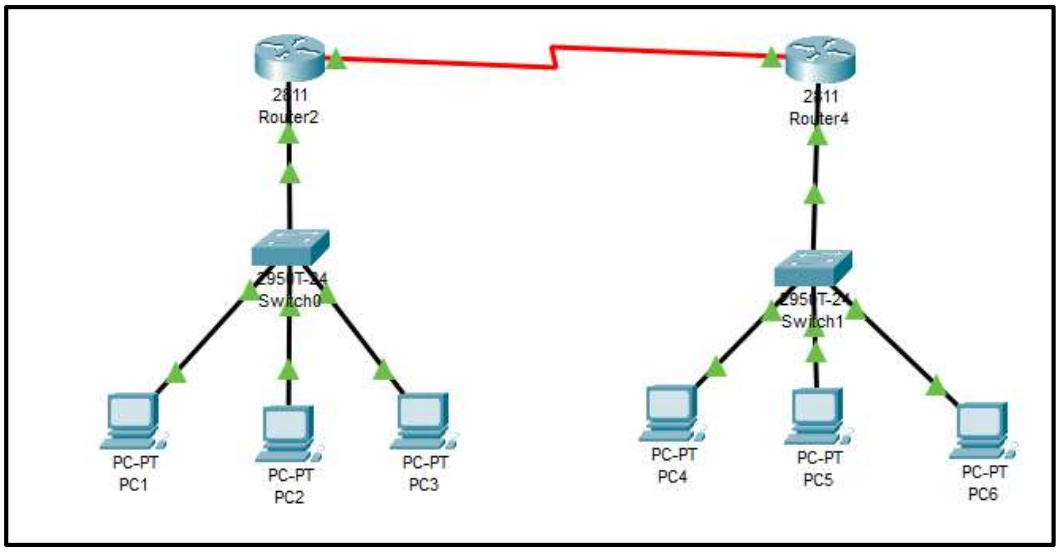


Figure 6

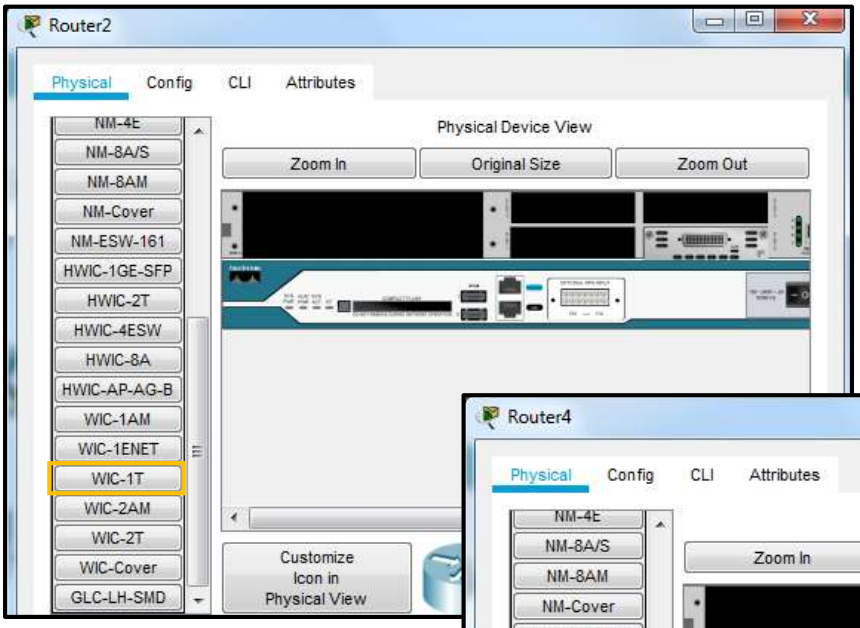


Figure 7

Click on Router 2, turn on the Router select "WIC-1T" from the modules and place it in the router then turn on. Then connect serial connection between two Routers

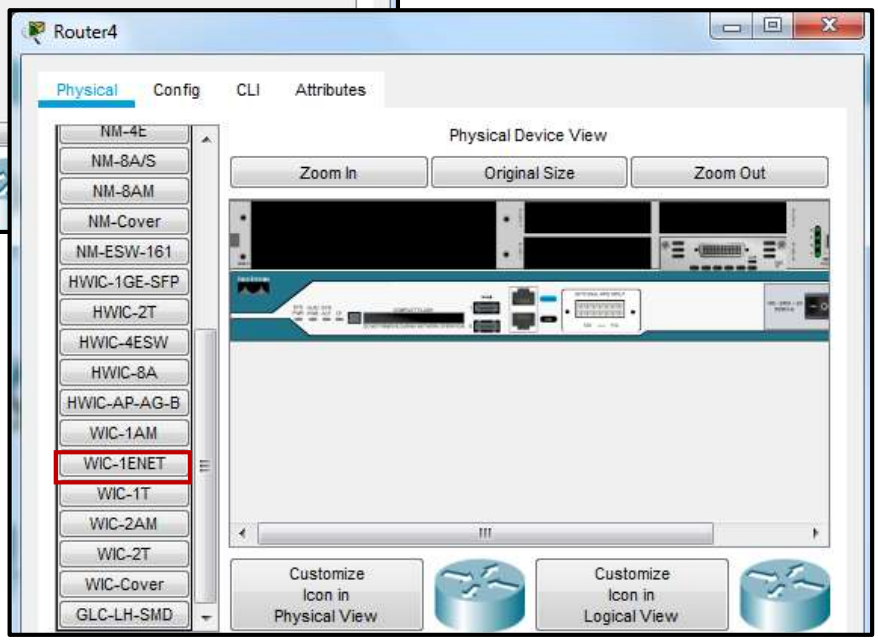


Figure 8

We set the IP address for PC1 to PC3 to **192.168.10.2 and 192.168.10.4** and set the default getaway to "192.168.10.1" and for PC4 to PC6 to **192.168.20.2 and 192.168.20.3** and set the default getaway to "192.168.10.1

Router configuration

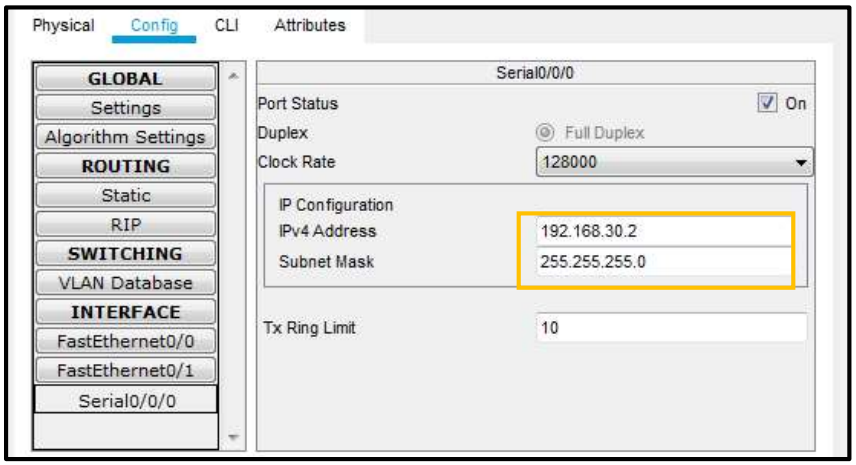


Figure 9

Click on Router 2, click on config go to serial 0/0/0 and make the clock rate to 128000 and set the IP address to 192.168.30.2 then turn it on.

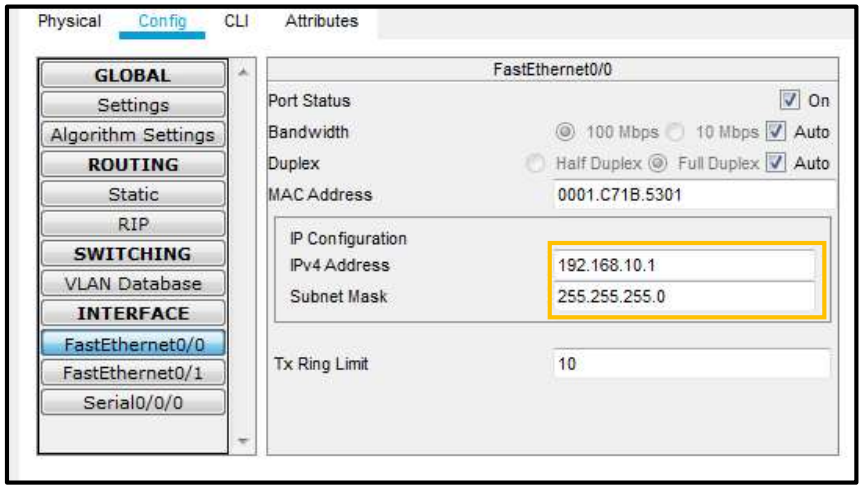


Figure 10

Go to FastEthernet 0/0 to set the IP address getway which is 192.168.10.1 then turn it on as shown in figure 10

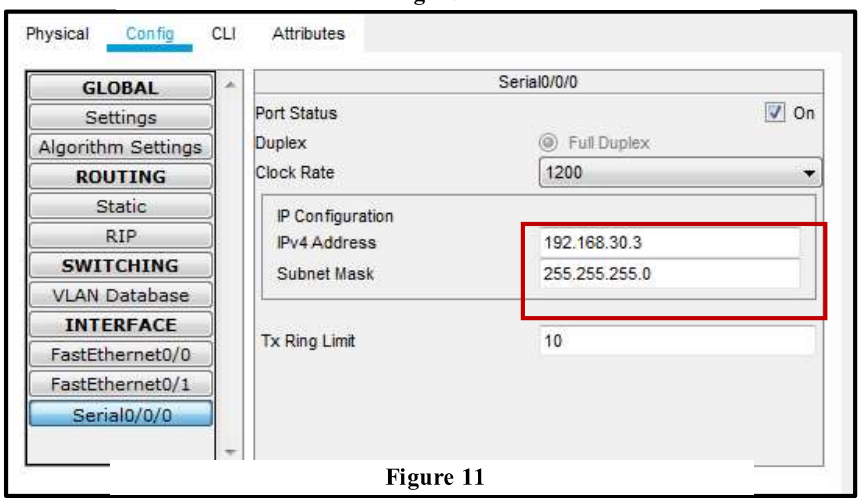
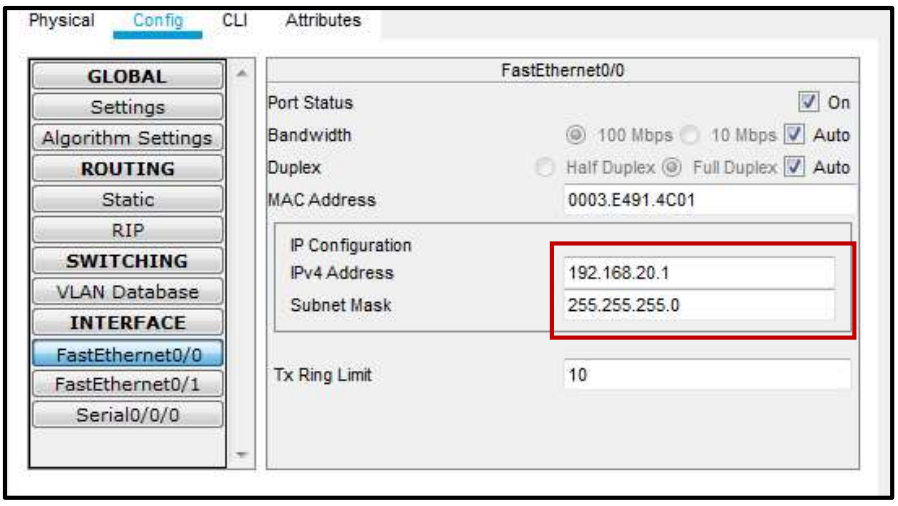


Figure 11

Click on Router 4, click on config go to serial 0/0/0 and make the clock rate to 128000 and set the IP address to 192.168.30.3 then turn it on.



Go to FastEthernet 0/0 to set the IP address getway which is 192.168.10.1 then turn it on as shown in figure 10

Figure 12

```
Router(config)#ip route 0.0.0.0 0.0.0.0 192.168.30.1
Router(config)#exit
```

Figure 13

Type the command ip route 0.0.0.0 0.0.0.0 192.168.30.1 for both routers

Successful	PC2	PC5	ICMP		0.000	N	0
Successful	PC3	PC2	ICMP		0.000	N	1
Successful	PC1	PC4	ICMP		0.000	N	2

Figure 14

When we try to send message from PC2 to PC3 in same network the message was delivered successfully. And the message is delivered to the destination address successfully when we send to different network as well as in figure 14.

Part II

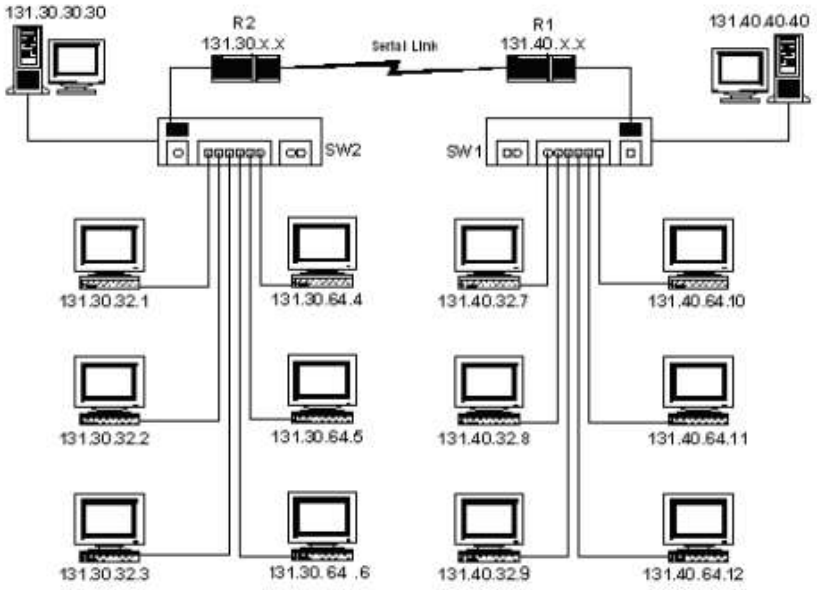


Figure 15

This figure shows you a diagram of two networks (LANS). A router is connected to each network. The two networks communicate through the serial link between the two routers (This link forms what in reality would be considered as the WAN connection). The diagram shows the IP addresses of all workstations and Ethernet interfaces of the routers to the LAN

Note: Assume the following:

- Subnet mask is 255.255.224.0.
- Your computer name is WS#, where # is the number of your workstation
- Ask your instructor about x.x. values.
- The Serial router interfaces will be found by telnet to the router.

A. Answer the following questions with full details:

1. How many subnets does this diagram have?
   a. 131.30.32.0
   b. 131.30.64.0
   c. 131.40.32.0
   d. 131.40.64.0

2. What is the IP address of your PC?
   131.30.64.8

3. What is the subnet ID of your PC?
   131.30.64.0

4. What is the range of the hosts your subnet can have?
   131.30.64.1 till 131.30.64.254

5. What is the subnet mask of your network?
   255.255.224.0

6. What is your Default Gateway?
   131.30.0.1

7. Explain how can you reach to the other network?
   To connect two networks to each other we need a router. In our experiment we connected two subnets to each other by a router and two other subnets to a different router. For a subnet from the first network to reach the subnet of a different network, both routers must be connected with each other.

B. Fill in the following table:

The following table is divided into three sections. All groups within the class need to synchronize the starting of each section together

Section I: Routers are switched on & link between routers is connected		
Choose any workstation within your subnet 131.30.64.9	**Choose any workstation which is not within your subnet** 131.30.32.7	**Choose any workstation which is not within your network** 131.40.32.13
Can you ping this station? (answer Y or N) why? Yes, because Switch, connecting these hosts is ON	**Can you ping this station? (answer Y or N) why?** Yes, because Switch, router connecting these 2 subnets is ON	**Can you ping this station? (answer Y or N) why?** Yes, cause connection between router is ON and Switch is ON
Can you tracert this station? (answer Y or N) why? If you can ping you can tracert easily	**Can you tracert this station? (answer Y or N) why?** If you can ping you can tracert easily	**Can you tracert this station? (answer Y or N) why?** Yes, if you can ping you can tracert

Section II: Routers are switched on & link between routers is disconnected		
Choose any workstation within your subnet 131.30.64.9	**Choose any workstation which is not within your subnet** 131.30.32.7	**Choose any workstation which is not within your network** 131.40.32.13
Can you ping this station? (answer Y or N) why? Yes, because Switch, connecting these hosts is ON	**Can you ping this station? (answer Y or N) why?** Yes, because Switch, router connecting these 2 subnets is ON	**Can you ping this station? (answer Y or N) why?** No, because the link between these 2 different networks are OFF
Can you tracert this station? (answer Y or N) why? Yes, because we can ping it	**Can you tracert this station? (answer Y or N) why?** Yes, because we can ping it	**Can you tracert this station? (answer Y or N) why?** No, we can't even ping it

Section III: Routers are switched off & link between routers is disconnected		
Choose any workstation within your subnet 131.30.64.9	**Choose any workstation which is not within your subnet** 131.30.32.7	**Choose any workstation which is not within your network** 131.40.32.13
Can you ping this station? (answer Y or N) why? Yes, because Switch, connecting these hosts is ON	**Can you ping this station? (answer Y or N) why?** No, because the router that connects them is off	**Can you ping this station? (answer Y or N) why?** No, because the link between these 2 different networks are OFF
Can you tracert this station? (answer Y or N) why? Yes, because we can ping it	**Can you tracert this station? (answer Y or N) why?** No, we can't even ping it	**Can you tracert this station? (answer Y or N) why?** No, we can't even ping it

Questions:

Assume the network address is 192.168.10.0 and the subnet mask is 255.255.255.192. Answer the following questions:

a) How many subnets exist in this network?

First Subnet (192.168.10.01XXXXXX [X being numbers in binary])

Second Subnet (192.168.10.10XXXXXX [X being numbers in binary])

2 subnets

b) How many hosts available per subnet?

We have 6 bits for the host, which means that using (2^6 – 2), we can find the number of available hosts per subnet which is 62.

c) What are the valid subnets can this network has?

192.168.10.01XXXXXX (X being numbers in binary)
192.168.10.10XXXXXX (X being numbers in binary)

d) What are the valid hosts for each subnet?

192.168.10.01000001 to 192.168.10.01111110

(192.168.10.65 till 192.168.10.126)

192.168.10.10000001 to 192.168.10.10111110

(192.168.10.129 till 192.168.10.190)