TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

LAB – 5: Subnetting and Supernetting

(Computer Network)

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Lab 5: Subnetting and Supernetting

Lab Objectives:

1. To be familiar with subnetting and FLSM and VLSM.
2. To be familiar with supernetting and classless addressing.

Requirements:

- Network simulation tool: Packet Tracer

Subnet mask:

● A subnet mask is used to divide an IP address into two parts ⇒ one part identifies the host computer, the other part identifies the network to which the host belongs
● The format of subnet mask is also similar with IP address
● Subnet mask is used by a host to identify whether the destination is within same subnet or on a different subnet
● The subnet mask has a very important role in subnetting (FLSM as well as VLSM) and supernetting

<u>Exercises</u>

I. What is a subnet mask? Why is it used? Explain with examples.
=> A subnet mask is a 32-bit number that divides an IP address into network and host portions, that is crucial for determining the network a host belongs to and whether a destination IP address is within the same network. It performs a bitwise AND operation between the IP address and the subnet mask, resulting in the network address. For instance, with a subnet mask of 255.255.255.0, the IP address 192.168.1.1 has a network address of 192.168.1.0. This mask helps routers and hosts decide if they need to send data within the local network or to another one. Subnet masks enable subnetting, which allows networks to be divided into smaller segments for better organization, resource allocation, and security. They play a crucial role in efficient network management by reducing broadcast traffic and defining the scope of communication within a network. Understanding subnet masks is crucial for configuring networks and optimizing data transmission in different network segments.

II. What is subnetting with FLSM & subnetting with VLSM? Mention their importance in networking with examples.
=> Subnetting with FLSM (Fixed Length Subnet Mask) and VLSM (Variable Length Subnet Mask) are strategies used in IP addressing to partition networks into smaller subnets. FLSM assigns a uniform subnet mask to all subnets within a network, ensuring each subnet has the same number of IP addresses. For example, dividing a 192.168.1.0/24 network into four subnets with a 255.255.255.192 mask results in subnets of equal size, each with 64 addresses. This method is ideal for networks with uniform requirements but can lead to inefficient use of IP addresses when subnets have varying size requirements.
VLSM allows for subnets of different sizes by using subnet masks of varying lengths within the same network address space. For instance, from the same 192.168.1.0/24 network, VLSM can create subnets such as 192.168.1.0/26 (64 addresses), 192.168.1.64/27 (32 addresses), and 192.168.1.96/28 (16 addresses). Flexibility optimizes IP address allocation, especially for complex networks with varied demands for hosts. VLSM is crucial in modern networking for efficiently managing IP address resources and accommodating diverse network configurations and requirements. It reduces wastage of IP addresses and provides the ability to tailor subnet sizes to actual needs, making it essential for scalable and efficient network design.

III. What is classless routing? Why is it important in the Internet system? Explain with suitable examples.
=> Classless routing is a method in networking where routing protocols do not strictly adhere to the predefined class boundaries of IP addresses (Class A, B, C networks). Instead, it employs variable length subnet masks (VLSMs) to provide more flexibility in subnetting and route summarization. This approach allows networks to efficiently utilize IP address space by creating subnets of various sizes according to specific needs, rather than being constrained by fixed class-based divisions. In the context of the Internet system, classless routing is crucial for optimizing IP address allocation and routing efficiency. It supports scalable network growth, accommodates diverse network configurations, and enables finer control over routing tables. For instance, Internet Service Providers (ISPs) utilize classless routing to manage and advertise routes more effectively across their networks, ensuring efficient data transmission and connectivity for global internet traffic.

<u>Activities:</u>

A. Q.1. Assign the IP address of PC1, PC2, PC3 and PC4 as 202.22.22.11, 202.22.22.21,202.22.22.41, 202.22.22.81 respectively with a subnet mask of 255.255.255.0 to all.

=> The network topology was created, and the IP address along with subnet mask were assigned to all the PCs.

Q.2. Test the connectivity from each of the computers to all other computers using ping. Like from PC1 to other three computers, PC2 to other three computers and so on.

=> Since all the computers were on the same network, all the pings, from PC1, PC2, PC3 and PC4 to each other, were successful and verified the connectivity between them.

Q.3. Change the subnet mask of all computers to 255.255.255.192 and test the connectivity from each of the computers to all other computers using ping.

=> After changing the subnet mask to 255.255.255.192, any ping with or from PC4 was unsuccessful. After the change of subnet mask all the PCs lied in the same network except PC4.

Q.4. Change the subnet mask of all computers to 255.255.255.224 and test the connectivity from each of the computers to all other computers using ping.

=> After changing the subnet mask to 255.255.255.224, pings were successful from PC0 to PC1 and vice versa only. All other pings were unsuccessful, indicating that only these two PCs were in the same network.

Q.5. Change the subnet mask of all computers to 255.255.255.240 and test the connectivity from each of the computers to all other computers using ping.

=> No PC could ping any other PC. It is because all of them are in different networks now, and there is no routing configuration to connect them for packet transfer.

Q.6. For the situation given in 5 above, replace the central switch i.e. Switch0 by a routeri.e. Router0 as shown in figure 2 below and configure the hostname of the router as your Firstname. Also configure its interfaces with following IP addresses and subnet mask of 255.255.255.240.

○ Fa 0/0 → 202.22.22.12
○ Fa 1/0 → 202.22.22.22
○ Fa 2/0 → 202.22.22.42
○ Fa 3/0 → 202.22.22.82

=> The router was configured as mentioned.

```
>enable
#configure terminal
config#hostname roshni
```

Q.7. Configure each computer with a default gateway i.e. IP address of the corresponding interface of the router. Test the connectivity from each of the computers to all other computers using ping.

=> After configuring the default gateway all the PCs could ping other PCs in the network.

B. Create the network topology as shown in figure 1 above and assign the IP address of PC1, PC2, PC3 and PC4 as 202.44.8.2, 202.44.9.2, 202.44.10.2 and 202.44.12.2 respectively with a subnet mask of 255.255.255.0 to all.

Q.1. Test the connectivity from each of the computers to another using ping.

=> No ping, from any PC to another PC was successful.

Q.2. Change the subnet mask of all computers to 255.255.254.0 and test the connectivity from each of the computers to another using ping.

=>Only PC1 and PC2 could ping each other. Here, the subnet mask was /23.

Q.3. Change the subnet mask of all computers to 255.255.252.0 and test the connectivity from each of the computers to another using ping.
=>PC1,PC2 and PC3 could ping each other. The subnet mask was /22.

Q.4. Change the subnet mask of all computers to 255.255.248.0 and test the connectivity from each of the computers to another using ping.
=>All the PCs could ping each other. The subnet mask was /21.

This is an example of supernetting, where change of subnet mask can aggregate the address. Hence, PCs could communicate.

C. This is an example of FLSM . It was a combination of subnetting, aggregation. The network address was divided such that aggregation is possible, and easy. From the ISP, the default route was sent outside our network, to server0.

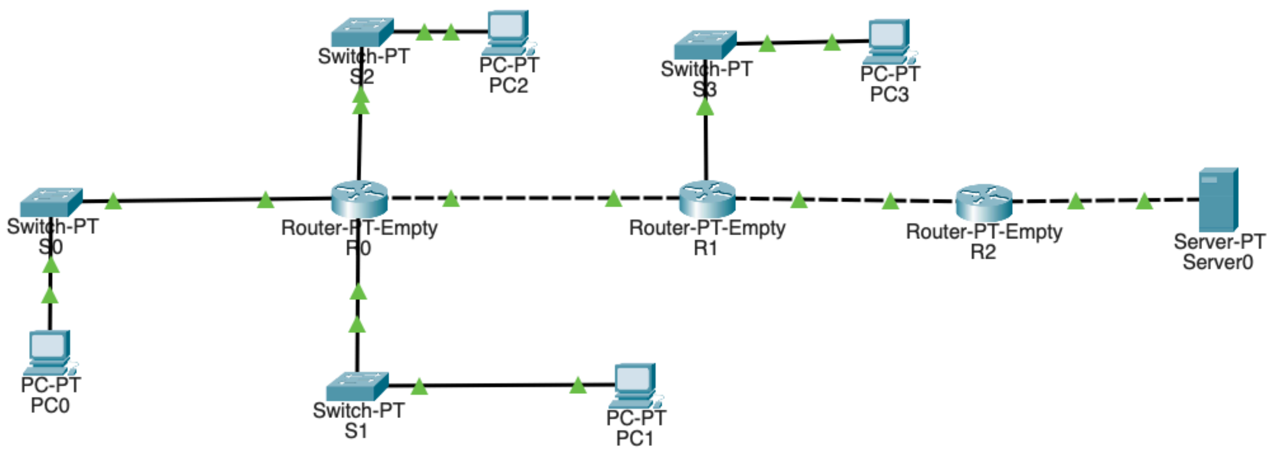

Fig: Network Topology 3

Network	Net-Id	Broadcast Address	Subnet Mask
A	200.70.90.32	200.70.90.63	255.255.255.224
B	200.70.90.64	200.70.90.95	255.255.255.224
C	200.70.90.96	200.70.90.127	255.255.255.224
D	200.70.90.128	200.70.90.159	255.255.255.224
E	200.70.90.160	200.70.90.191	255.255.255.224
F	200.70.90.192	200.70.90.223	255.255.255.224

Fig: Address range of networks.

Unused range of IP addresses- 200.70.90.0 to 200.70.90.31, 200.70.90.224 to 200.70.90.255.
Q.1. All the pings were successful. This gave me the complete understanding of all the routing configurations, subnetting and aggregation.

Q.2. The tracert command, from a PC in network C to network D showed this route. The hops were made to router0 and Router2 to reach the destination.

```
C:\>tracert 200.70.90.130

Tracing route to 200.70.90.130 over a maximum of 30 hops:

  1   8 ms      0 ms      0 ms      200.70.90.65
  2   0 ms      0 ms      0 ms      200.70.90.98
  3   0 ms      0 ms      0 ms      200.70.90.130

Trace complete.
```

Q.3. Traceroute to a random destination traversed the default path configured earlier. Beyond the ISP router, the request timed out.

```
C:\>tracert 103.5.150.3

Tracing route to 103.5.150.3 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      200.70.90.33
  2   *         0 ms      0 ms      200.70.90.98
  3   *         *         *         Request timed out.
  4   *         *         *         Request timed out.
```

D.

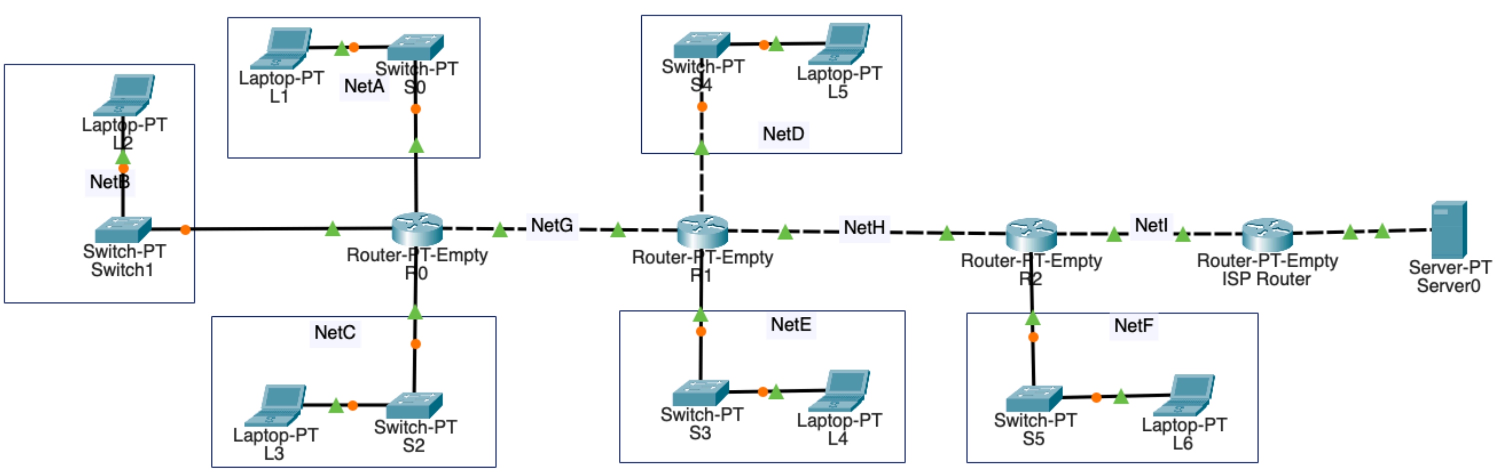

Fig: Network structure with different subnets

Network	Network Id	Broadcast ID	Subnet Mask
100 A	200.50.40.0	200.50.40.127	255.255.255.128
40 B	200.50.40.128	200.50.40.191	255.255.255.192
50 C	200.50.40.192	200.50.40.255	255.255.255.192
60 D	200.50.41.0	200.50.41.63	255.255.255.192
20 F	200.50.41.64	200.50.41.95	255.255.255.224
12 E	200.50.41.96	200.50.41.111	255.255.255.240
2 G	200.50.41.112	200.50.41.115	255.255.255.252

2 H	200.50.41.116	200.50.41.119	255.255.255.252
2 I	200.50.41.120	200.50.41.123	255.255.255.252

Fig: Address Range of Networks

ip route configurations of Routers:

R0

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     200.50.40.0/24 is variably subnetted, 3 subnets, 2 masks
C       200.50.40.0/25 is directly connected, GigabitEthernet0/0
C       200.50.40.128/26 is directly connected, GigabitEthernet1/0
C       200.50.40.192/26 is directly connected, GigabitEthernet2/0
     200.50.41.0/30 is subnetted, 1 subnets
C       200.50.41.112 is directly connected, GigabitEthernet3/0
S*   0.0.0.0/0 is directly connected, GigabitEthernet3/0

roshni_1#
```

R1

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S    200.50.40.0/24 is directly connected, GigabitEthernet1/0
     200.50.41.0/24 is variably subnetted, 4 subnets, 3 masks
C       200.50.41.0/26 is directly connected, GigabitEthernet0/0
C       200.50.41.96/28 is directly connected, GigabitEthernet2/0
C       200.50.41.112/30 is directly connected, GigabitEthernet1/0
C       200.50.41.116/30 is directly connected, GigabitEthernet3/0
S*   0.0.0.0/0 is directly connected, GigabitEthernet3/0

roshni_2#
```

R2

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S    200.50.40.0/24 is directly connected, GigabitEthernet0/0
     200.50.41.0/24 is variably subnetted, 6 subnets, 4 masks
S       200.50.41.0/26 is directly connected, GigabitEthernet0/0
C       200.50.41.64/27 is directly connected, GigabitEthernet1/0
S       200.50.41.96/28 is directly connected, GigabitEthernet0/0
S       200.50.41.112/30 is directly connected, GigabitEthernet0/0
C       200.50.41.116/30 is directly connected, GigabitEthernet0/0
C       200.50.41.120/30 is directly connected, GigabitEthernet2/0
S*   0.0.0.0/0 is directly connected, GigabitEthernet2/0

roshni_3#
```

ISP

```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S    200.50.40.0/23 is directly connected, GigabitEthernet0/0
     200.50.41.0/30 is subnetted, 2 subnets
C       200.50.41.120 is directly connected, GigabitEthernet0/0
C       200.50.41.124 is directly connected, GigabitEthernet1/0
S*   0.0.0.0/0 is directly connected, GigabitEthernet1/0

roshni_4#
```

Q.1. The ping command was successful from any to all networks. All the networks could communicate with each other.

Q.2. Tracert command showed the hops from the source till the destination.

```
C:\>tracert 200.50.41.122

Tracing route to 200.50.41.122 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      200.50.40.129
  2   0 ms      0 ms      0 ms      200.50.41.114
  3   *         0 ms      0 ms      200.50.41.118
  4   *         0 ms      0 ms      200.50.41.122

Trace complete.
```

Q.3. The tracert command showed the default path following in the routing for an unknown destination. It reached till the ISP and then the request timed out.

```
C:\>tracert 103.5.150.3

Tracing route to 103.5.150.3 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      200.50.40.129
  2   *         0 ms      0 ms      200.50.41.114
  3   *         0 ms      0 ms      200.50.41.118
  4   *         0 ms      0 ms      200.50.41.122
  5   *         *         *         Request timed out.
```

Here, in VLSM, we can start the address of the subnet from 0, unlike in FLSM where the beginning address is reserved. In Router0, direct 200.40.50.0/23 can be set to pass towards Router1. It works simpler.

Conclusion:

The exercises in this Lab provided a comprehensive understanding of subnetting, supernetting, and classless addressing, essential components in modern network design and management. By delving into Fixed Length Subnet Mask (FLSM) and Variable Length Subnet Mask (VLSM) subnetting, we gained insights into optimizing IP address allocation, which is critical for maintaining efficient and scalable networks. The practical application of changing subnet masks demonstrated the impact on network connectivity and highlighted the importance of precise network planning.

Additionally, the exercises involving classless routing showcased its significance in enabling flexible and efficient use of IP address space. The successful configuration and testing of network topologies, including the integration of routers to manage different subnet masks, reinforced the theoretical concepts learned. This hands-on approach not only solidified our understanding of subnetting and supernetting but also illustrated the practical challenges and solutions in real-world networking.