# Lab 5: Subnetting & Supernetting

## Objectives:

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

## Requirements:

- Network simulation tool: Packet Tracer

## Procedure:

**A:** The network topology was created as shown in Figure 1. The IP addresses of PC1, PC2, PC3, and PC4 were assigned as 202.22.22.11, 202.22.22.21, 202.22.22.41, and 202.22.22.81 respectively, with a subnet mask of 255.255.255.0. The connectivity from each computer to all other computers was tested using ping. The subnet mask of all computers was then changed to 255.255.255.192, and the connectivity was tested again using ping. The subnet mask was subsequently changed to 255.255.255.224 and 255.255.255.240, with connectivity tests performed after each change. The central switch (Switch0) was replaced by a router (Router0) configured with the hostname corresponding to my first name. The router interfaces were configured with IP addresses Fa 0/0 → 202.22.22.12, Fa 1/0 → 202.22.22.22, Fa 2/0 → 202.22.22.42, and Fa 3/0 → 202.22.22.82, all with a subnet mask of 255.255.255.240. Each computer was configured with a default gateway corresponding to the router's interface IP addresses, and connectivity was tested from each computer to all others using ping.

**B:** The network topology shown in Figure 1 was recreated. The IP addresses of PC1, PC2, PC3, and PC4 were assigned 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. The connectivity from each computer to the others was tested using ping. The subnet mask of all computers was then changed to 255.255.254.0, and the connectivity was tested using ping. The subnet mask was subsequently changed to 255.255.252.0 and 255.255.248.0, with connectivity tests performed after each change using ping.

**C:** The IP address range of 200.70.90.0/24 was divided equally for departments A, B, C, D, and two networks E & F for interconnection between routers, as shown in Figure 3. The IP address range for each department was allocated, including the network address, broadcast address, and subnet mask. Any unused IP address ranges were listed. The hostname of each router was configured as Firstname_1, Firstname_2, and so on. Static routing was configured between each department's networks and to the Internet via the ISP Router, with all Internet traffic forwarded to the ISP's router. Route aggregation was considered while assigning IP address blocks and configuring static routing. The connectivity from each network to the rest of the given networks was tested using ping. The output of the traceroute from a computer in each network to the rest of the given networks was observed. The output of the traceroute to the destination address 103.5.150.3 was also observed.

**D:** The IP address range of 200.50.40.0/23 was divided for departments A, B, C, D, E, and F, as shown in Figure 4. Each department was allocated an IP address range sufficient for 100, 40, 50, 60, 12, and 20 hosts respectively. Additionally, three networks G, H, and I were each allocated IP addresses for two hosts. The IP address range for each sub-network was allocated, including the network address, broadcast address, and subnet mask, and any unused IP address ranges were listed. The hostname of each router was configured as Firstname_1, Firstname_2, and so on. Static routing was configured between each department's networks and to the Internet via the ISP Router. Route aggregation was considered while assigning IP address blocks and configuring static routing. The connectivity from each network to the rest of the given networks was tested using ping. The output of the traceroute from a computer in each network to the rest of the given networks was observed. The output of the traceroute to the destination address 103.5.150.3 was also observed.

# Observation:

## Activity A

### Answer for 2

Ping replies were received from each PC to all other PCs when using the IP addresses 202.22.22.11 for PC1, 202.22.22.21 for PC2, 202.22.22.41 for PC3, and 202.22.22.81 for PC4, with a subnet mask of 255.255.255.0.

**Answer for 3**

When the subnet mask was changed to 255.255.255.192, ping replies were received between PC1, PC2, and PC3, but not with PC4.

**Answer for 4**

When the subnet mask was changed to 255.255.255.224, ping replies were received only between PC1 and PC2. There was no connectivity with the other PCs.

**Answer for 5**

When the subnet mask was changed to 255.255.255.240, no ping replies were received. The connection requests timed out for all PCs.

**Answer for 7**

After configuring the router, ping replies were successfully received between PCs on different networks. This was due to the router facilitating communication between the subnets.

## Activity B

**Answer for 1**

When the subnet mask of all computers was set to 255.255.255.0, no connectivity was observed using ping; all requests timed out.

**Answer for 2**

When the subnet mask of all computers was changed to 255.255.254.0, ping replies were observed only between PC1 and PC2; the other requests timed out.

**Answer for 3**

When the subnet mask of all computers was changed to 255.255.252.0, ping replies were observed between PC1, PC2, and PC3; PC4's connection timed out.

**Answer for 4**

When the subnet mask of all computers was changed to 255.255.248.0, ping replies were observed between all PCs, as they shared the same network subnet mask.

## Activity C

### IP Allocation and Network Details

The given IP address range of 200.70.90.0/24 from the ISP was divided into six different networks as follows:

| Departments | Net ID | Range | Broadcast | Subnet Mask |
|---|---|---|---|---|
| A | 200.70.90.0 | 1-30 | 200.70.90.31 | 255.255.255.224 |
| B | 200.70.90.32 | 33-62 | 200.70.90.63 | 255.255.255.224 |
| C | 200.70.90.64 | 65-94 | 200.70.90.95 | 255.255.255.224 |
| D | 200.70.90.96 | 97-126 | 200.70.90.127 | 255.255.255.224 |
| E | 200.70.90.128 | 129-158 | 200.70.90.159 | 255.255.255.224 |
| F | 200.70.90.160 | 161-190 | 200.70.90.191 | 255.255.255.224 |

Table 1: Network Division

The unused IP addresses are as follows:

- Network A: 32-2-4
- Network B: 32-2-4
- Network C: 32-2-4
- Network D: 32-2-4
- Network E: 32-2-2
- Network F: 32-2-2

**Answer for 3**

Using traceroute to the destination address 103.5.150.3, after default routing was configured, multiple requests timed out.

## Activity D

### IP Allocation and Network Details

The given IP address range of 200.50.40.0/23 from the ISP was divided into the following networks:

| Departments | Net ID | Range | Broadcast | Subnet Mask |
|---|---|---|---|---|
| A | 200.50.40.0 | 1-126 | 200.50.40.127 | 255.255.255.128 |
| D | 200.50.40.128 | 129-190 | 200.50.40.191 | 255.255.255.192 |
| C | 200.50.40.192 | 193-254 | 200.50.40.255 | 255.255.255.192 |
| B | 200.50.41.0 | 1-62 | 200.50.41.63 | 255.255.255.192 |
| F | 200.50.41.64 | 65-94 | 200.50.41.95 | 255.255.255.224 |
| E | 200.50.41.96 | 97-110 | 200.50.41.111 | 255.255.255.240 |
| I | 200.50.41.112 | 113-114 | 200.50.41.115 | 255.255.255.252 |
| H | 200.50.41.116 | 117-118 | 200.50.41.119 | 255.255.255.252 |
| G | 200.50.41.120 | 121-122 | 200.50.41.123 | 255.255.255.252 |

Table 2: Network Division

The unused IP addresses are as follows:

- Network A: 128-2-3
- Network D: 64-2-3
- Network C: 64-2-3
- Network B: 64-2-3
- Network F: 32-2-3
- Network E: 16-2-3
- Network I: 4-2-2
- Network H: 4-2-2
- Network G: 4-2-2

### Answer for 3

Using traceroute to the destination address 103.5.150.3, after default routing was configured, multiple requests timed out.

## Conclusion:

In conclusion, this lab activity provided a detailed understanding of setting up and managing a network, including subnetting and supernetting. We assigned IP addresses, changed subnet masks, and configured routers to create different subnetworks. Subnetting involved dividing a large network into smaller, more manageable sub-networks, which helped improve network performance and security. We also used supernetting, which combines multiple smaller networks into a larger one, to simplify routing and improve efficiency. Connectivity was tested using ping and traceroute, ensuring that all parts of the network communicated well. This hands-on practice highlighted the importance of careful configuration and testing to ensure reliable and efficient network communication across various subnets and aggregated networks.

## Exercises:

### Question 1: 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. It is used to identify which part of an IP address refers to the network and which part refers to the device (host) within that network. The subnet mask helps in routing traffic within and between networks efficiently.

For example, consider the IP address 192.168.1.10 with a subnet mask of 255.255.255.0. In binary, the IP address is:

```
11000000.10101000.00000001.00001010
```

And the subnet mask is:

```
11111111.11111111.11111111.00000000
```

The first three octets (24 bits) are network bits, and the last octet (8 bits) are host bits. This means the network portion is 192.168.1, and the device identifier is 10.

### Question 2: What is subnetting with FLSM and subnetting with VLSM? Mention their importance in networking with suitable examples.

**Subnetting with Fixed-Length Subnet Mask (FLSM):**

FLSM means dividing a network into subnets where all subnets have the same number of addresses. This method is simple but not flexible and can lead to inefficient IP address utilization.

**Example:**

A company has a 192.168.1.0/24 network and needs to create 4 subnets. Using FLSM, each subnet would have 64 addresses (256/4):

Subnet 1: 192.168.1.0/26

Subnet 2: 192.168.1.64/26

Subnet 3: 192.168.1.128/26

Subnet 4: 192.168.1.192/26

**Subnetting with Variable-Length Subnet Mask (VLSM):**

VLSM allows subnets to have different sizes, providing more efficient use of IP addresses. VLSM enables creating subnets tailored to specific needs, avoiding wasted IP addresses.

**Example:**

The same company has different departments requiring subnets of varying sizes:

Subnet 1: 50 addresses → 192.168.1.0/26

Subnet 2: 20 addresses → 192.168.1.64/27

Subnet 3: 10 addresses → 192.168.1.96/28

Subnet 4: 5 addresses → 192.168.1.112/29

## Question 3: What is classless routing? Why is it important in the Internet system? Explain with suitable examples.

Classless routing, also known as Classless Inter-Domain Routing (CIDR), is a method of allocating IP addresses and routing that does not rely on the traditional class-based IP address structure (Class A, B, C). CIDR allows more efficient use of IP address space and better route aggregation, which reduces the size of routing tables.

**Importance in the Internet System:**

Efficient IP Address Utilization: CIDR allows networks to be allocated based on need, rather than fitting into a predefined class, reducing wasted IP addresses. Smaller Routing Tables: CIDR enables the aggregation of routes into a single entry, simplifying and reducing the size of routing tables, which improves router performance.

**Example:**

Without CIDR, a network might be assigned multiple classful addresses:

192.168.1.0/24

192.168.2.0/24

With CIDR, these can be combined into a single entry:

192.168.1.0/23

This means routing decisions can be made more efficiently, using fewer resources. CIDR is essential for the scalability of the Internet, supporting the ever-increasing number of devices and networks globally.