Experiment No: 3
Experiment Name: Advanced IP Address Planning Using Variable Length Subnet Masking (VLSM) in a Multi-Network Environment.

Objectives:

- To understand the concept of Variable Length Subnet Masking (VLSM).
- To design an IP addressing scheme using VLSM.
- To implement subnetting based on different department needs.
- To configure the network in **Cisco Packet Tracer**.

Theory:

What is VLSM?

VLSM (Variable Length Subnet Masking) is an advanced technique in IP subnetting that allows subnets to be created with different sizes based on host requirements. It increases the efficiency of IP address utilization by minimizing address waste.

Why Use VLSM?

- Efficient IP address management.
- Network design flexibility.
- Better segmentation and security.

Key Terms:

- **CIDR Notation:** A shorthand for subnet mask (e.g., /24 for 255.255.255.0).
- **FLSM vs VLSM:**
  - **FLSM:** All subnets have the same size.
  - **VLSM:** Subnet sizes vary according to need.

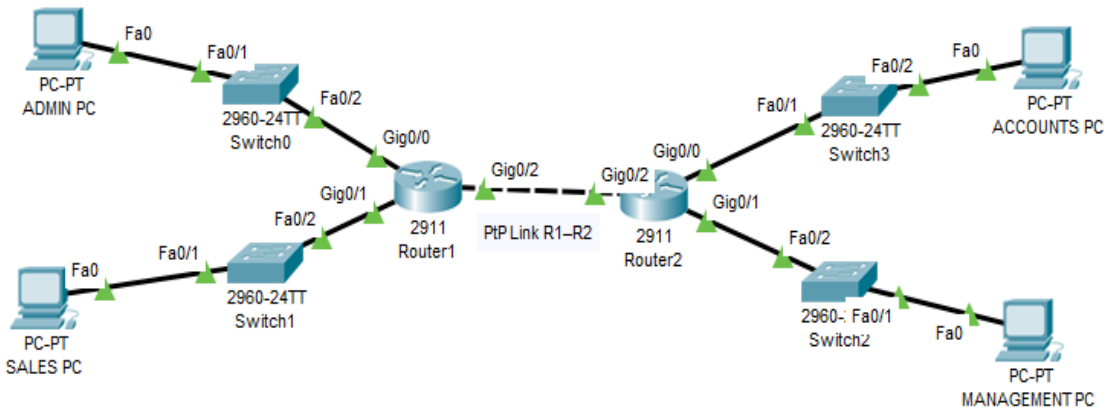
Scenario-1: Assume a company with the following departmental host requirements:

Department	Number of Hosts
Admin	100
Sales	50
Accounts	20
Management	10
Point-to-Point	2 (Router links)

IP Address Planning (Given Block: 192.168.10.0/24)

Department	Hosts	Subnet	Subnet Mask	Subnet Address	Usable IP Range	Broadcast Address	Router
Admin	100	/25	255.255.255.128	192.168.10.0	192.168.10.1 – 126	192.168.10.127	R1
Sales	50	/26	255.255.255.192	192.168.10.128	192.168.10.129 – 190	192.168.10.191	R1
Accounts	20	/27	255.255.255.224	192.168.10.192	192.168.10.193 – 222	192.168.10.223	R2
Management	10	/28	255.255.255.240	192.168.10.224	192.168.10.225 – 238	192.168.10.239	R2
PtP Link R1–R2	2	/30	255.255.255.252	192.168.10.240	192.168.10.241 – 242	192.168.10.243	Both

Scenario in CISCO packet Tracer:



Router Interface Configuration: (Optional for Experiment-3 Laboratory Class)

Router1 Configuration *(Handles Admin, Sales, and PtP link to Router2)*

```
Router1> enable
Router1# configure terminal

! Configure Admin network interface (192.168.10.0/25)
Router1(config)# interface g0/0
Router1(config-if)# ip address 192.168.10.1 255.255.255.128
Router1(config-if)# no shutdown

! Configure Sales network interface (192.168.10.128/26)
Router1(config)# interface g0/1
Router1(config-if)# ip address 192.168.10.129 255.255.255.192
Router1(config-if)# no shutdown

! Configure Point-to-Point link to Router2 (192.168.10.240/30)
Router1(config)# interface g0/2
Router1(config-if)# ip address 192.168.10.241 255.255.255.252
Router1(config-if)# no shutdown

! Enable routing
Router1(config)# ip routing
```

Router2 Configuration ***(Handles Accounts, Management, and PtP link from Router1)***

```
Router2> enable
Router2# configure terminal

! Configure Point-to-Point link from Router1
(192.168.10.240/30)
Router2(config)# interface g0/2
Router2(config-if)# ip address 192.168.10.242 255.255.255.252
Router2(config-if)# no shutdown

! Configure Accounts network interface (192.168.10.192/27)
Router2(config)# interface g0/0
Router2(config-if)# ip address 192.168.10.193 255.255.255.224
Router2(config-if)# no shutdown

! Configure Management network interface (192.168.10.224/28)
Router2(config)# interface g0/1
Router2(config-if)# ip address 192.168.10.225 255.255.255.240
Router2(config-if)# no shutdown

! Enable routing
Router2(config)# ip routing
```

Optional Static Routing (for full connectivity)

On Router1: Router1 manages the **Admin** and **Sales** networks, but needs routes to reach **Accounts** and **Management** networks, which are behind Router2.

```
Router1(config)# ip route 192.168.10.192 255.255.255.224
192.168.10.242
! Route to Accounts network (192.168.10.192/27) via Router2

Router1(config)# ip route 192.168.10.224 255.255.255.240
192.168.10.242
! Route to Management network (192.168.10.224/28) via Router2
```

These commands tell Router1: "To reach the Accounts or Management network, forward the traffic to the next-hop IP: **192.168.10.242** (Router2's PtP interface)."

On Router2: Router2 manages the **Accounts** and **Management** networks, but needs routes to reach **Admin** and **Sales** networks, which are behind Router1.

```
Router2(config)# ip route 192.168.10.0 255.255.255.128
192.168.10.241
! Route to Admin network (192.168.10.0/25) via Router1

Router2(config)# ip route 192.168.10.128 255.255.255.192
192.168.10.241
! Route to Sales network (192.168.10.128/26) via Router1
```

These commands tell Router2: "To reach the Admin or Sales network, forward the traffic to the next-hop IP: **192.168.10.241** (Router1's PtP interface)."

PC Configuration (Example)

Admin PC1:

- IP: 192.168.10.10
- Subnet Mask: 255.255.255.128
- Default Gateway: 192.168.10.1

Sales PC1:

- IP: 192.168.10.130
- Subnet Mask: 255.255.255.192
- Default Gateway: 192.168.10.129

Accounts PC1:

- IP: 192.168.10.194
- Subnet Mask: 255.255.255.224
- Default Gateway: 192.168.10.193

Management PC1:

- IP: 192.168.10.226
- Subnet Mask: 255.255.255.240
- Default Gateway: 192.168.10.225

Testing Commands

From any PC:
ping <default-gateway>
ping <PC in another department>
tracert <destination IP>

Scenario-2: You are a network engineer tasked to design a network for a company with 5 departments connected via 4 routers. The department networks and their host requirements are:

Network	Hosts Required
Net1	500 hosts
Net2	100 hosts
Net3	70 hosts
Net4	20 hosts
Net5	8 hosts

There are 4 routers connecting these networks and you want to assign subnets efficiently using **VLSM** to optimize IP usage.

Step 1: Choose a major network block

Let's assume the company has been assigned the IP block: **192.168.0.0/22.** This gives 1024 IP addresses (192.168.0.0 to 192.168.3.255).

Step 2: Sort networks by size (largest to smallest)

Network	Hosts Needed	Next Power of 2 (Hosts + 2)	Subnet Mask
Net1	500	512	/23 (255.255.254.0)
Net2	100	128	/25 (255.255.255.128)
Net3	70	128	/25 (255.255.255.128)
Net4	20	32	/27 (255.255.255.224)
Net5	8	16	/28 (255.255.255.240)

Step 3: Assign subnets using VLSM

Start from the beginning of the block 192.168.0.0:

Network	Subnet Address	Mask	Hosts Usable
Net1	192.168.0.0/23	255.255.254.0	510
Net2	192.168.2.0/25	255.255.255.128	126
Net3	192.168.2.128/25	255.255.255.128	126
Net4	192.168.3.0/27	255.255.255.224	30
Net5	192.168.3.32/28	255.255.255.240	14

Step 4: Connect the routers

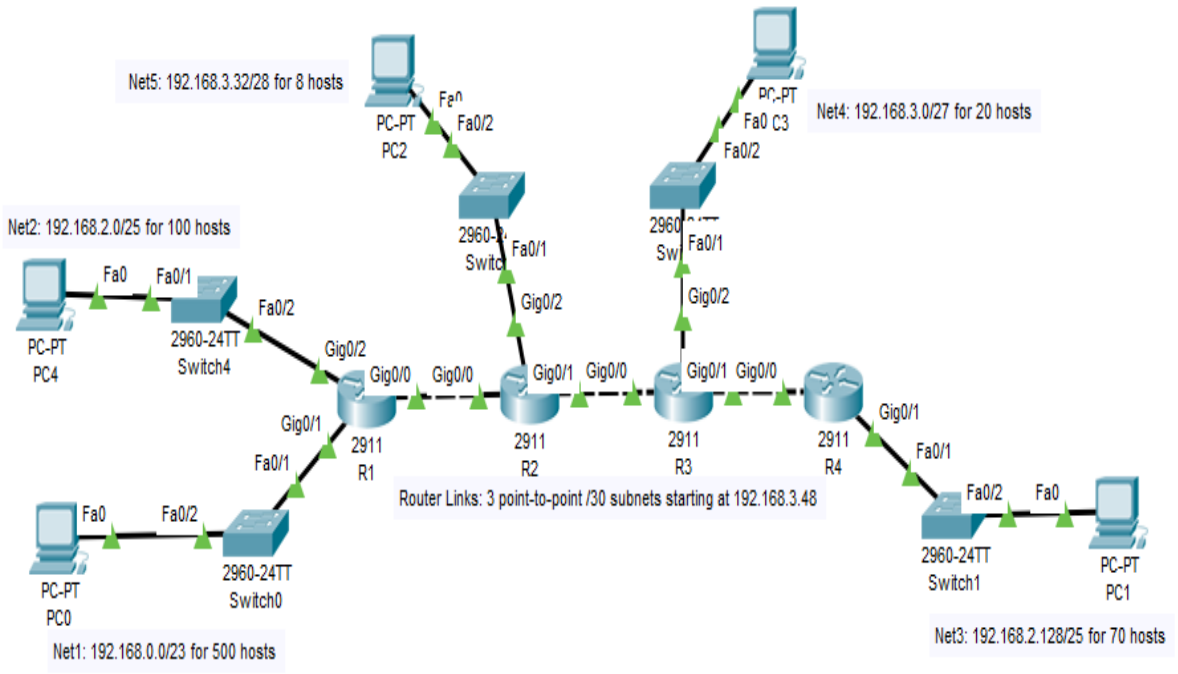
Assuming router interconnections require point-to-point /30 subnets (4 addresses, 2 usable):

Router Link	Subnet Address	Mask	Usable Hosts
R1 - R2	192.168.3.48/30	255.255.255.252	2
R2 - R3	192.168.3.52/30	255.255.255.252	2
R3 - R4	192.168.3.56/30	255.255.255.252	2

Summary

- **Net1:** 192.168.0.0/23 for 500 hosts
- **Net2:** 192.168.2.0/25 for 100 hosts
- **Net3:** 192.168.2.128/25 for 70 hosts
- **Net4:** 192.168.3.0/27 for 20 hosts
- **Net5:** 192.168.3.32/28 for 8 hosts
- Router Links: 3 point-to-point /30 subnets starting at 192.168.3.48

Scenario in CISCO packet Tracer:



Scenario-3: In the laboratory session, an additional example will be provided in the form of a Cisco network scenario. Students will be required to analyze the given scenario and determine the appropriate IP addressing scheme for all networks using Variable Length Subnet Masking (VLSM).