UTM UNIVERSITI TEKNOLOGI MALAYSIA

FACULTY OF COMPUTING
UTM Johor Bahru

SECR1213-05

NETWORK COMMUNICATIONS

Semester 03, 2025/2026

TASK 5 | SURVIVOR

Lecturer:

MUHAMMAD ZAFRAN BIN MUHAMMAD ZALY SHAH

Group 02 Members:

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BRIEF EXPLANATION OF THE TASK

In Task 5, our goal is to create a working IP address plan for the new Faculty of Computing building. Since every computer, phone, and camera needs a unique ID to communicate, we need to break down the main Network Address provided by the lecturer into smaller, usable sections. This task focuses on assigning these numbers correctly so that the different labs and rooms we planned in the previous tasks can connect without conflicts.

We approached this by using the Variable Length Subnet Masking (VLSM) method. Instead of giving every room the same amount of space, we looked at the actual number of devices in each area, before assigning blocks of addresses to all the student labs and classrooms. This calculation ensures that we don't waste addresses and we have enough space for every piece of hardware we selected in Task 2.

The final output of this task is a complete IP addressing table that matches every room to its specific range of numbers. We have also included the step by step math used to calculate these ranges, proving that the design fits all current devices while still keeping some extra addresses available for future expansion.

REQUIREMENT ANALYSIS

Before allocating resources to specific departments, we first analyzed the properties of the network block assigned to our group. The following parameters show the strict boundaries and total capacity of our network infrastructure.

Network Parameter	Value
Assigned IP Address	`172.22.56.0`
CIDR Prefix	/23
Subnet Mask	`255.255.254.0`
Total Capacity	512 IP Addresses (2^9)
Usable Host Range	`172.22.56.1 – 172.22.57.254`
Broadcast Address	`172.22.57.255`

Table 1: Network Parameter

User Group	Host Count	Requirement	Justification
Student Group (VLAN 10)	150	/24	Includes all wired PCs in the 4 Labs
Student Wi-Fi (VLAN 20)	~100	/25	High density BYOD area. Needs 126 usable IPs
IP Devices (VLAN 30)	~16	/27	Includes Webcams, Speakers, Network Printers, and Wireless Access Point management IPs
Management (VLAN 90)	~20	/27	Servers, Admin PCs, & Network Switches

Table 2: User Group analysis

VLAN 10: Student Group (Laboratories & Hybrid Classroom)

- **Subnet Assignment:** `172.22.56.0/24` (254 Usable IPs)
- **Justification:** This VLAN serves the faculty's core educational facilities which are the four computer laboratories and a Hybrid Classroom. With a requirement of 150 wired workstations, a /25 subnet (126 IPs) would be insufficient. Therefore, we assigned the entire Lower Half of the available address block to this group to ensure all lab computers reside in a contiguous range.
- **Policy Integration:**
    - **DHCP:** Since these are fixed desktop PCs that will not move around, we apply a Long Lease (7 Days). This reduces network broadcast traffic ("chatter") by minimizing frequent renewal requests
    - **NAT:** Traffic from these 150 hosts is multiplexed via NAT Overload (PAT) at the router that allows the entire lab infrastructure to share the single ISP public IP address.

VLAN 20: Student Wi-Fi (Lounge & BYOD)

- **Subnet Assignment:** `172.22.57.0/25` (126 Usable IPs)
- **Justification:** This subnet covers the high density Student Lounge and Hybrid Classroom areas. We estimated up to 100 concurrent wireless users. A /25 subnet provides 126 IPs
- **Policy Integration:**
    - **DHCP:** To prevent "IP Exhaustion" in this limited pool, we enforce a Short Lease (2 Hours). This ensures that when a student leaves the lounge, their IP address is immediately recycled and made available for the next user.
    - **NAT (Scalability):** This VLAN relies on NAT Overload (Port Address Translation). By tracking unique source ports, NAT allows these concurrent mobile users to share the single ISP connection simultaneously without causing IP conflicts or requiring extra public addresses.

VLAN 30: IP Devices (Infrastructure)

- **Subnet Assignment:** `172.22.57.128/27` (30 Usable IPs)
- **Justification:** Connects critical hardware, including Webcams, Network Speakers, Printers, and Wireless Access Points (WAPs). The /27 subnet supports 30 devices, which accommodates the current estimated hardware while leaving space for future.
- **Policy Integration:**
    - **Static Addressing:** Unlike student devices, this hardware is assigned Static IPs or DHCP Reservations. This guarantees service continuity, for example, a lecturer can always connect to a network printer at the same IP address without it changing after a reboot.

VLAN 90: Management (Admin & Servers)

- **Subnet Assignment:** `172.22.57.160/27` (30 Usable IPs)
- **Justification:** This subnet houses the core equipment, the Servers, Admin PCs, and Network Switch management interfaces. A /27 block is sufficient for the ~20 critical devices required for network administration.
- **Policy Integration:**
    - **Remote Management (SSH):** This is the only VLAN authorized to initiate remote connections. We enforce SSH v2 to encrypt all management sessions, protecting administrative credentials from potential sniffing attacks.
    - **ACL Enforcement:** The router and switches are configured to drop any management traffic that does not originate from this specific subnet range, ensuring students cannot access the network backbone.

Reserved (Future Growth)

- **Subnet Assignment:** `172.22.57.192/26` (62 Usable IPs)
- **Justification:** By efficiently sizing the previous VLANs using VLSM, we successfully preserved a contiguous block of 62 IP addresses at the end of the range. This "spare" capacity allows the faculty to add new labs or offices in the future without disrupting the existing network addressing scheme

SUBNETTING STRATEGY

The primary challenge of this design was fitting a large user base into the limited 172.22.56.0/23 address space, which provides a total of 512 IP addresses. A standard fixed length strategy would have failed because all the user groups are not equal in size (e.g., the Students Group is five times larger than the Management group).

To solve this, we used **Variable Length Subnet Masking (VLSM)** to create a hierarchical structure.

Phase 1: Primary Segmentation

The main network block (`172.22.56.0/23`) provides a total of 512 IP addresses. The first step is to divide this block into two equal halves of 256 IPs each (two `/24` subnets):

- **Lower Half (`172.22.56.0/24`):** Dedicated entirely to VLAN 10 (Student Group).
    - With a requirement of 150 wired hosts in student labs, a /25 subnet (126 IPs) is insufficient. Assigning the full /24 ensures contiguous addressing for all lab PCs and provides ~100 spare IPs for future lab expansion.
- **Upper Half (`172.22.57.0/24`):** Reserved for all other services (Wi-Fi, IP Devices, Management).

Phase 2: Secondary Segmentation (The Upper Half)

The remaining 256 IPs in the Upper Half (`172.22.57.x`) were divided using VLSM to match these specific requirements:

1. **Student Wi-Fi (VLAN 20):** We allocated the first 128 IPs (`172.22.57.0/25`) to this group to support high-density BYOD traffic in the student lounge.
2. **Remaining Space:** The remaining 128 IPs (`172.22.57.128/25`) were split again to accommodate smaller infrastructure groups:
    - **IP Devices (VLAN 30):** Allocated a /27 block (30 IPs) for cameras, printers, and speakers.
    - **Management (VLAN 90):** Allocated a /27 block (30 IPs) for servers and admin switches.
    - **Reserve:** The final block is left unassigned to provide a buffer for future organizational growth.

SUBNETTING CALCULATIONS

These calculations are performed to determine the exact subnet masks required for each user group based on the formula 2^n - 2 >= Required Hosts, where n represents the number of host bits.

Base Network

- **Assigned Block:** `172.22.56.0/23`
- **Total Host Bits:** 32 - 23 = 9 bits
- **Total Available IPs:** 2^9 = 512 addresses (Range: `172.22.56.0` to `172.22.57.255`)

VLAN 10: Student Group

- **Requirement:** 150 Hosts
- **Calculation:**
  - n=8:
  - 2^8 - 2 = 254 usable IPs (sufficient)
- **New Subnet Mask:** 32 - 8 = /24
- **Result:**
  - Network Address: `172.22.56.0`
  - Broadcast Address: `172.22.56.255`

VLAN 20: Student Wi-Fi

- **Requirement:** ~100 Hosts
- **Calculation:**
  - n=7
  - 2^7 - 2 = 126 usable IPs (sufficient)
- **New Subnet Mask:** 32 - 7 = /25
- **Result:**
  - Network Address: `172.22.57.0`
  - Broadcast Address: `172.22.57.127`

VLAN 30 & 90: IP Devices & Management

- **Requirement:** ~20–30 Hosts (for Devices/Admin)
- **Calculation:**
  - n=5
  - 2^5 - 2 = 30 usable IPs (sufficient)
- **New Subnet Mask:** 32 - 5 = /27
- **Results:**
  - VLAN 30 Network: `172.22.57.128` (Range: `.129 – .158`)
  - VLAN 90 Network*:* `172.22.57.160` (Range: `.161 – .190`)

IP ADDRESSING TABLE (SUBNET)

The Final IP Addressing Table (Table 3) below demonstrates the successful implementation of the VLSM hierarchy proposed in the subnetting strategy.

VLAN ID	Subnet Name	Prefix	Usable IPs	Network Address	Usable Range	Broadcast Address
VLAN 10	Student Group	/24	254	172.22.56.0	.56.1 – .56.254	.56.255
VLAN 20	Student Wi-Fi	/25	126	172.22.57.0	.57.1 – .57.126	.57.127
VLAN 30	IP Devices	/27	30	172.22.57.128	.57.129 – .57.158	.57.159
VLAN 90	Management	/27	30	172.22.57.160	.57.161 – .57.190	.57.191
Reserved	Future Growth	/26	62	172.22.57.192	.57.193 – .57.254	.57.255

Table 3: IP addresses allocation (SUBNET)

Logical Segmentation

Our design splits the network into two distinct halves to make management easier. The entire first half of the address block (`172.22.56.x`) is dedicated to the wired Student Labs, while the second half (`172.22.57.x`) handles the Wireless network and Management devices. This separation creates a simple rule for the IT team: if an IP address starts with `.56`, it is definitely a Lab PC, if it starts with `.57`, it is a wireless or infrastructure device. This clarity is proposed to reduce confusion during troubleshooting.

Zero-Gap Contiguity

We have arranged the subnets so they fit together perfectly without any gaps. As shown in the table, the Lab network fills the address space exactly up to the halfway point (`.56.255`), and the Student Wi-Fi picks up the very next number (`.57.0`). By lining up the subnets like this, we ensure that not a single IP address is lost or wasted in the space between different user groups.

Efficiency and Reservation

By assigning smaller blocks of IP addresses to the IP Devices and Management groups instead of giving them large blocks they don't need, we saved a significant amount of space. This planning allowed us to consolidate all the leftover addresses into a single Reserved group at the end of the list. We successfully saved 62 IP addresses, guaranteeing that the faculty has enough room to build new labs or offices in the future without having to redesign the entire network.

IP ASSIGNATION BY ROOM (DHCP SCOPE)

Room Name	VLAN ID	Device Description	Assigned IP Range
General Lab 1	VLAN 10	30 Student Workstations	172.22.56.10 – 172.22.56.49
	VLAN 30	Wireless Access Point	172.22.57.135 (Static)
General Lab 2	VLAN 10	30 Student Workstations	172.22.56.50 – 172.22.56.89
	VLAN 30	Wireless Access Point	172.22.57.136 (Static)
Cisco Networking Lab	VLAN 10	30 Student Workstations	172.22.56.90 – 172.22.56.129
	VLAN 30	Wireless Access Point	172.22.57.137 (Static)
Embedded Lab	VLAN 10	30 Student Workstations	172.22.56.130 – 172.22.56.169
	VLAN 30	Wireless Access Point	172.22.57.138 (Static)
Hybrid Classroom	VLAN 10	30 Student Workstations	172.22.56.170 – 172.22.56.199
	VLAN 30	Wireless Access Point	172.22.57.139 (Static)
	VLAN 30	Webcam & Speakers	172.22.57.132 – 172.22.57.134
Video Conference Room	VLAN 30	Webcam & Speakers	172.22.57.130 – 172.22.57.131
	VLAN 30	Wireless Access Point	172.22.57.140 (Static)
Student Lounge	VLAN 20	BYOD (Wi-Fi Users)	172.22.57.2 – 172.22.57.126
	VLAN 30	Wireless Access Point	172.22.57.141 (Static)
Admin	VLAN 90	Admin PCs & Servers	172.22.57.162 – 172.22.57.190
	VLAN 30	Wireless Access Point	172.22.57.142 (Static)

Table 4: IP addresses allocation by area

Note: refer to **Table 3 (Final IP Addressing Table) in the previous section for the complete technical specifications, including the Subnet Name, Network Address, and Broadcast Address corresponding to each VLAN ID.*

Analysis of Room-Level Allocation

Table 4 provides a breakdown of how the available IP address space is distributed across different physical locations.

Network Address Allocation (Buffer Strategy)

To ensure organized network management, the primary Student Group subnet (`172.22.56.0/24`) has been segmented into specific IP blocks for each laboratory. We allocated ranges of 40 IP addresses to each room (e.g., General Lab 1 utilizes `.10` to `.49`). Since each lab contains 30 fixed workstations, there will be 10 IP operational buffers within each room. This specific reserve ensures that transient devices such as a temporary replacement PC, or IT troubleshooting hardware can connect immediately without causing IP conflicts.

Infrastructure Management (VLAN 30)

As detailed in the table, every room equipped with a Wireless Access Point (WAP) includes a specific entry for VLAN 30. While the students in the room utilize VLAN 10 or 20 for their data traffic, the WAP hardware itself is assigned a Static IP (e.g., `.135`, `.136`) in the infrastructure range. This ensures that the management interface used for configuring the device is isolated from the student network for more security.

IP ASSIGNMENT POLICY

Dynamic Host Configuration Protocol (DHCP)

DHCP is applied to optimize the usage of the limited IP pool. The lease time, which is the duration a device holds an IP address will vary based on the user behavior in each VLAN.

- **VLAN 20 (Student Wi-Fi): Short Lease (2 Hours)**
  - **Context:** This network services transient student devices in the Student Lounge. Students typically stay for short durations between classes.
  - **Policy:** The lease time is set to 2 hours.
  - **Justification:** This aggressive recycling ensures that addresses released by departing students are immediately made available for new users. Without this policy, the pool of 126 IPs could be exhausted by midday, preventing new students from connecting.

- **VLAN 10 (Student Group): Long Lease (7 Days)**
  - **Context:** This network services 150 fixed desktop computers in the laboratories. These devices never leave the building.
  - **Policy:** The lease time is set to 7 days.
  - **Justification:** Long leases reduce network "chatter." Since these devices are permanent, there is no need for them to request a new IP address every few hours which will minimize DHCP broadcast traffic, leaving more bandwidth for other educational purposes.

- **VLAN 30 (IP Devices): Static Reservations**
  - **Policy:** Infrastructure devices (Network Printers, Wireless Access Points, Webcams, Speakers) are assigned **Static IPs** or **DHCP Reservations**.
  - **Justification:** Service continuity. Staff members must be able to map a printer or access a camera using a consistent IP address that does not change after a reboot.

Network Address Translation (NAT) Policy

Since the entire faculty network operates on private IP addresses (RFC 1918), a translation mechanism is required for internet access.

- **Mode: NAT Overload (Port Address Translation - PAT)**.
- **Configuration:** The Edge Router is configured to translate the source addresses of all internal VLANs (10, 20, 30, 90) to the single public IP address provided by the ISP.
- **Mechanism:** The router distinguishes between simultaneous connections from different students by assigning unique **Source Port numbers** to each session. This allows the estimated 300+ internal devices to share one public IP simultaneously without conflict.

Remote Management Policy via Secure Shell (SSH)

To fulfill the requirement for Easy Management while maintaining security, the following access protocols are implemented:

- **Protocol: Secure Shell (SSH v2)**
    - **Justification**: Telnet transmits passwords in plain text. In a learning environment where students in the Cisco Network Lab may be learning packet sniffing (Wireshark), using Telnet would expose administrative credentials. SSH encrypts the session, mitigating this risk.

- **Access Control List (ACL):**
    - **Policy:** Remote management is strictly limited to the **Management Subnet** (VLAN 90).
    - **Implementation:** An Access Control List (ACL) is applied to the VTY (Virtual Teletype) lines of the switches. Any SSH connection attempt originating from Student VLANs (10 or 20) is automatically dropped, ensuring only the Admin VLAN can access the device CLI.

APPENDIX

Minutes Meeting Bil.01

DATE / TIME	
LOCATION	
AGENDA	
Meeting MC	

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
ABDURRAFIQ BIN ZAKARIA		
AHMAD MUNIF BIN BAHARUM		
NAJMUDDIN BIN KAMARUDIN		
DANIEL IMAN HAQIMIE BIN YUSOFF		

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Meeting started	-	
2		-	
3		-	
4		-	
5	Meeting ended	- Rafiq ends this meeting with tasbeeh kifarah and surah al-asr. - Next meeting will be held on ___ - Meeting ended at ___	

Minutes Meeting Bil.02

DATE / TIME	
LOCATION	
AGENDA	
Meeting MC	

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
ABDURRAFIQ BIN ZAKARIA		
AHMAD MUNIF BIN BAHARUM		
NAJMUDDIN BIN KAMARUDIN		
DANIEL IMAN HAQIMIE BIN YUSOFF		

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Meeting started	-	
2		-	
3		-	
4		-	
5	Meeting ended	- Rafiq ends this meeting with tasbeeh kifarah and surah al-asr. - Next meeting will be held on ___ - Meeting ended at ___	

Minutes Meeting Bil.03

DATE / TIME	
LOCATION	
AGENDA	
Meeting MC	

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
ABDURRAFIQ BIN ZAKARIA		
AHMAD MUNIF BIN BAHARUM		
NAJMUDDIN BIN KAMARUDIN		
DANIEL IMAN HAQIMIE BIN YUSOFF		

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Meeting started	-	
2		-	
3		-	
4		-	
5	Meeting ended	- Rafiq ends this meeting with tasbeeh kifarah and surah al-asr. - Next meeting will be held on ___ - Meeting ended at ___	

Minutes Meeting Bil.04

DATE / TIME	
LOCATION	
AGENDA	
Meeting MC	

ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
ABDURRAFIQ BIN ZAKARIA		
AHMAD MUNIF BIN BAHARUM		
NAJMUDDIN BIN KAMARUDIN		
DANIEL IMAN HAQIMIE BIN YUSOFF		

MINUTES			
NO.	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Meeting started	-	
2		-	
3		-	
4		-	
5	Meeting ended	- Rafiq ends this meeting with tasbeeh kifarah and surah al-asr. - Next meeting will be held on ___ - Meeting ended at ___	

TASK DISTRIBUTIONS

Member	Task/Responsibilities	Works completed
AHMAD MUNIF BIN BAHARUM	- Listing the Requirement analysis (VLANs) related to policies - Deep research on Policies for IP addressing logic & implementation	- Requirement Analysis - IP Assignment Policy
ABDURRAFIQ BIN ZAKARIA	- Subnetting logic and calculations - Cross checking the final IP addressing table & Subnetting Strategy	- Subnetting Calculations - IP Addressing tables
DANIEL IMAN HAQIMIE BIN YUSOFF	- Deep research on Policies for IP addressing logic & implementation - Cross check the current logic with previous task's (devices connectivity)	- IP Assignment Policy - IP Addressing tables
NAJMUDDIN BIN KAMARUDIN	- Studies the Subnetting Strategy (VLSM) & plan how the IP addresses are allocated - Record meeting minutes	- Subnetting Strategy - Meetings Minutes

ASSESSMENT RUBRIC

TASK 5	
ITEM	**MARKS**
IP Addressing	
Use correct network address for group	1
Workings is provided clearly and labelled	4
IP division is appropriate and logical	1
Complete detail of all IP assignation for all labs and room	4
TOTAL	**10**