UTM
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Network Communications

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Task #6A

Network Design for Faculty of Computing Block N28B

By NetLink Solutions

NETLINK SOLUTIONS

Group 4: NetLink Solutions

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1. Report Abstract

This report presents the complete design and implementation of a network infrastructure for the **Faculty of Computing Block N28B**, focusing on efficiency, scalability, and cost-effectiveness. The project was executed in six tasks, each contributing to the overall goal of delivering a robust and future-ready network.

In **Task 1**, the layout of the building was analyzed, and working areas were identified, including labs, classrooms, conference rooms, and shared spaces. **Task 2** focused on determining the most efficient network topology, resulting in a hierarchical design that optimizes data flow and supports scalability. **Task 3** involved selecting the most suitable networking devices, balancing performance and budget constraints, while ensuring compatibility with the infrastructure's requirements.

Task 4 addressed the cabling and connectivity plan, specifying cable types, lengths, and routes to interconnect all devices across the building. The plan included Cat6 cables for short-distance connections, fiber optic cables for backbone links, and patch panels for efficient cable management. **Task 5** outlined the IP addressing scheme, utilizing subnetting to allocate IP addresses logically to each lab, room, and device, ensuring no conflicts and allowing for future expansion.

The report also reflects on the design process, discussing strengths such as the scalability of the topology, efficient use of IP addresses, and adherence to client requirements. Weaknesses and areas for improvement are identified, including potential enhancements like introducing more redundancy or upgrading to fiber optics in key areas. Financial considerations are documented, providing a detailed budget breakdown for devices, cables, and other expenses.

This report serves as a comprehensive guide for implementing the proposed network, providing all necessary technical details, diagrams, and justifications to support client decision-making. Through collaborative efforts and detailed planning, the project aims to deliver a state-of-the-art network that meets the current and future needs of the faculty.

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2. Introduction

This project aims at designing and implementing a fast and scalable network infrastructure for the Faculty of Computing, Block N28B. It provides a connectivity solution to support different spaces including the general labs, specialized labs (e.g. Cisco Lab, IoT Lab), classrooms, conference rooms, and shared spaces (lounges and reception). It would support academic and administrative activities while offering the speed, reliability, and future proof connectivity.

The project follows a systematic approach, divided into multiple tasks: Considering the building layout, choosing a network topology, picking up on the right devices, laying out cabling routes and determining IP addresses. Together these tasks carry out work to form a coherent and well structured design that satisfies the requirements of the faculty.

Aims and Objectives

The main aims of this project are:

- It aims to bring seamless connection across all spaces in Block N28B.
- In order to build an extensible network which can handle future growth.
- In order to select the best devices and technologies to optimize performance and cost.
- It’s about designing an infrastructure that will span the future in order to support upgrades and technological advancements.

Scope and Assumptions

Structures of cabling, placement of devices, IP addressing and wireless access point for the coverage are included in the network design. It further assumes that if the design is proposed as planned, it will remain within available budget and that network usage will follow standard academic and administrative patterns

3. Background and Overview

The faculty of Computing at Block N28B is a growing academic institution in the field of computing and spreading education, research, and innovation. With the increase of faculty activities, a powerful network infrastructure has become essential. With the coming of increasing number of users, devices, and data traffic, the presently constituted network setup if any, is not sufficient to manage the rising scope. Connectivity issues, improper data sharing, and shocking lack of scalability, are the result of this insufficiency.

Key Challenges Identified

1. **Limited Connectivity:**
    - Indulging into seamless connectivity from one region to another does not receive any spatial support from the current infrastructure as there are gaps that slow down and inefficiencies in collaborative tasks.
    - There's too much missing — gaps in labs and classrooms where coverage is needed most.
2. **Scalability Issues:**
    - However, the gaining number of devices and users does not fit the existing setup, especially when new specialized labs such as the Cisco and IoT labs are being introduced.
    - A scalable network is required for future growth in student enrollment and technological advancements.
3. **Lack of Unified Infrastructure:**
    - If the network is fragmented or outdated, you have inconsistent performance and network management challenges.
    - There’s no proper cabling nor device integration in labs or classrooms.
4. **Security Concerns:**
    - If devices and data are exposed to potential security vulnerabilities, then no properly designed network.
    - They don’t provide any provisions to monitor, redundancy nor failover mechanisms.

5. **Administrative and Operational Inefficiencies:**
    - Poor network design hampers such tasks as managing devices, sharing resources (such as printers and projectors), and activities on the Internet (e.g., video conferencing).

The Client's Vision

A modern, reliable future proof network is what the Faculty of Computing envisages for academic excellence, administrative efficiency and collaboration. This includes:

- For all areas, connectivity at high speed, wired and wireless.
- A scalable and extensible network infrastructure to support a variety of workloads from high throughput student labs to research.
- The management of network devices and resources centralized.
- Better security plus scalability in support of growth and future advances.

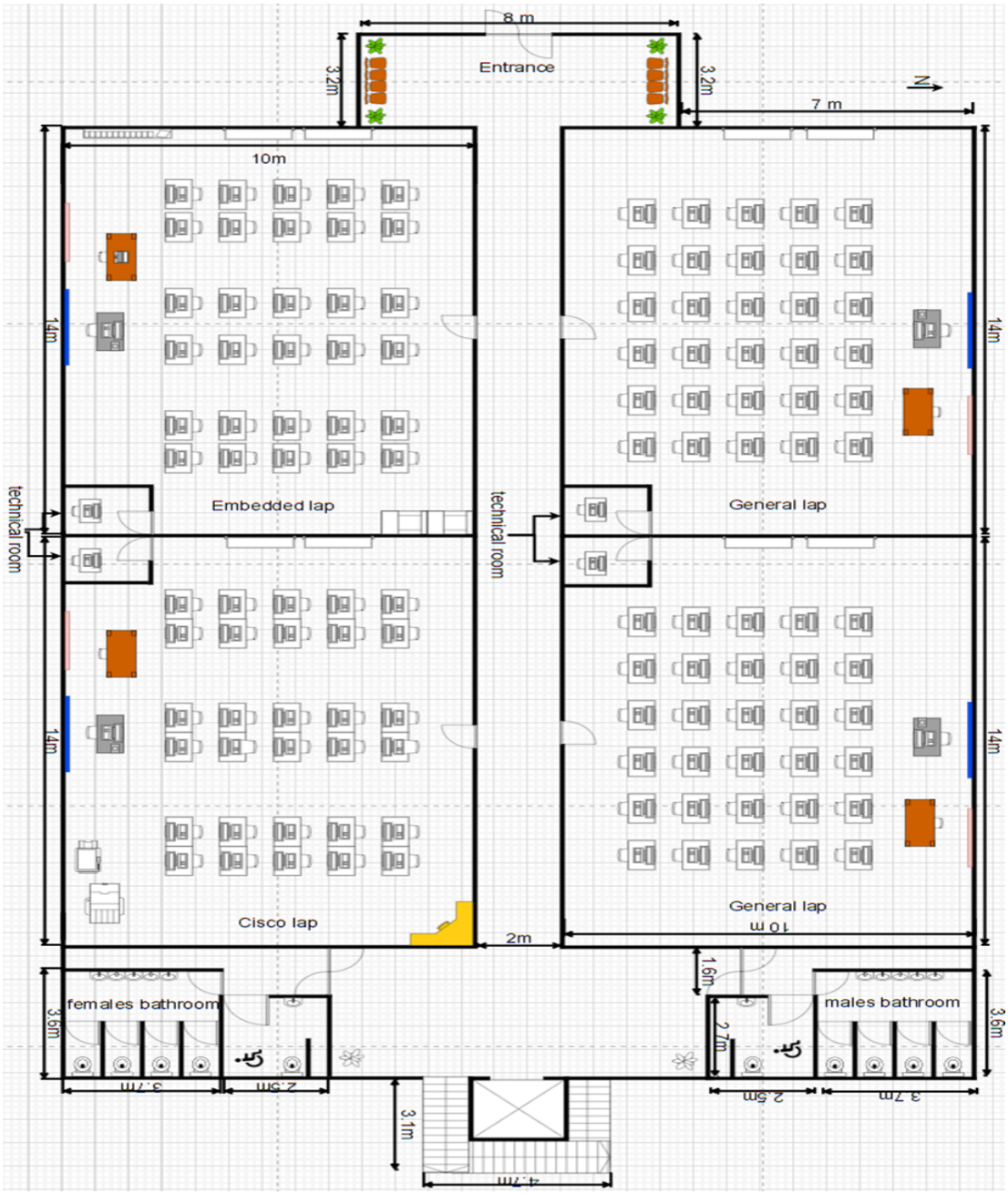
Proposed Solution

This project seeks to address the faculty's challenges by designing a network infrastructure that:

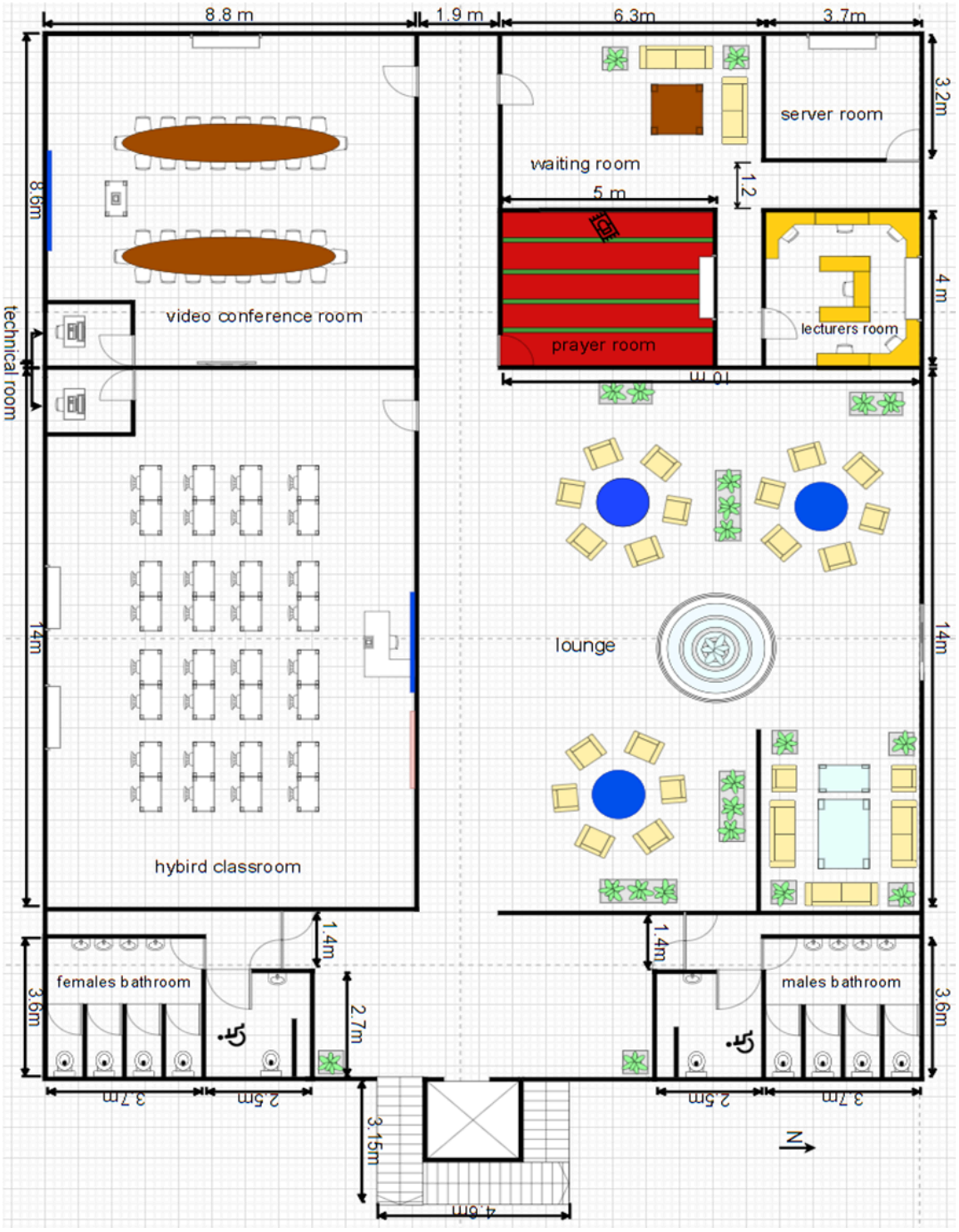
- Delivers seamless connectivity and high data transfer speeds for all labs, classrooms, shared spaces and beyond.
- Provides a scalable topology towards future requirements.
- Supports structured cabling and logical IP addressing to prevent conflicts that make network management easy.
- It builds from dependable devices, such as routers, switches, and wireless access points, to improve performance.
- It prioritizes security, redundancy, resource allocation efficiency.

4. Complied Tasks

4.1 Floor Plan

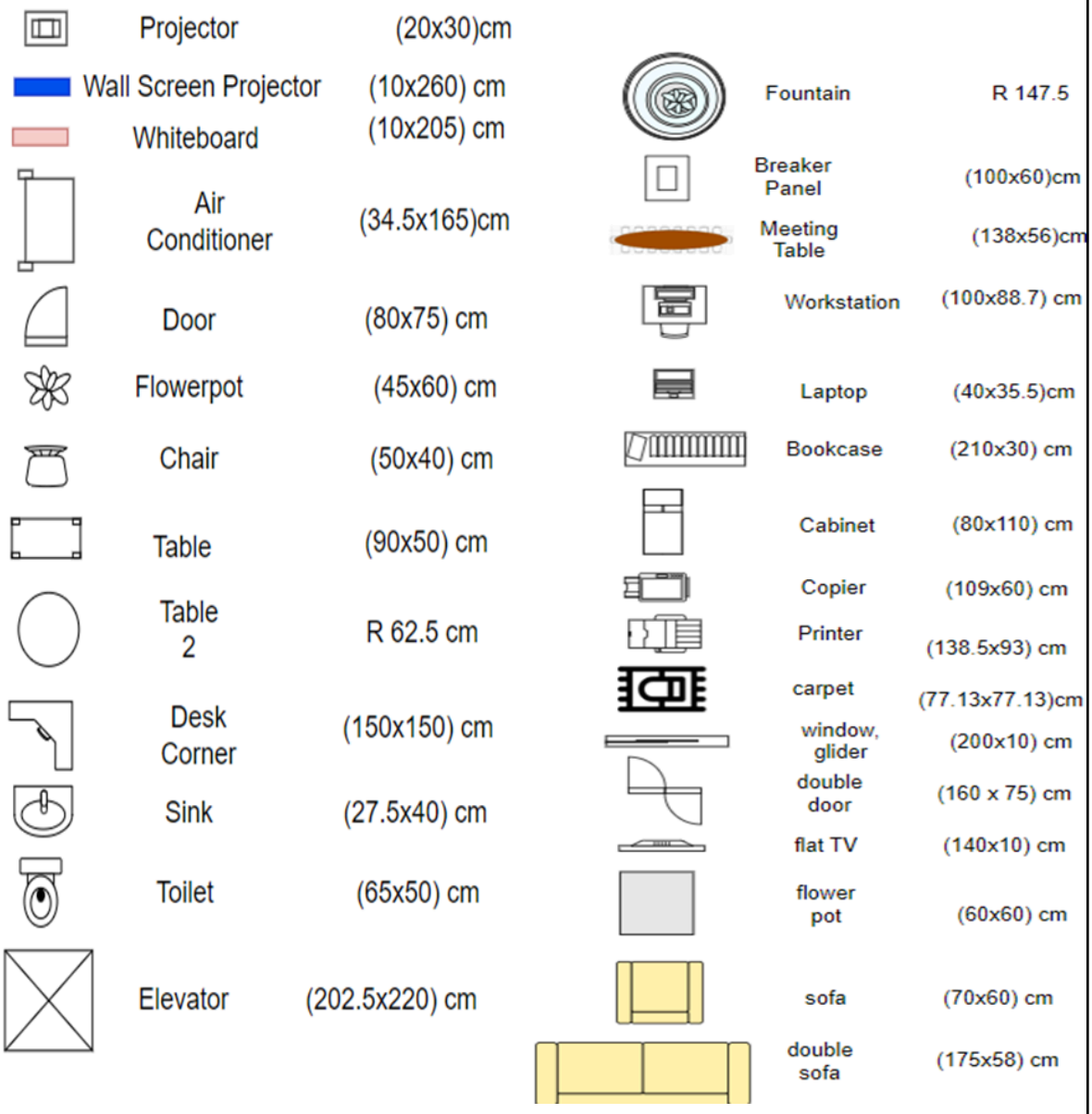


First floor plan Figure 1



Second floor plan figure 2

Symbols:



Symbol and representations figure 3

Design explanation:

The ground floor is a general design containing all the laps, it provides comfortable area for waiting, and large laps that suitable for all students, on the north direction there are two general laps with their workstations with a projector and teacher's working station, on the south we can see the embedded lap which contains a large bookcase and two devices cabinet, the other lap on the south is cisco lap contains a printer and a photocopier to enhance learning and teaching, each lap has two air conditioners and features a technical room that will help wiring and controlling the network while also being able to fix most of the connection problems that might be faced in the future, the technical room give the ability to comfortably control most of the connection, the ground fool also features a restroom for males on the north and for females on the south, and lastly it provides a medium size elevator with a choice of stairs.

The first floor is a general design that host many different rooms, including males' bathrooms on the north and females' bathrooms on the south, a student lounge on the north that can hold many students and can relax, study or do different social activities, also it features a large area containing a medium size praying room, lecturers' room, small waiting room and a server room, which will be main control room for the network and data flow, on the south you will find a video conference room which will install a video projector, and a long flat T.V. , and technical room to control the communication and the network, it also contain a hybrid classroom for advance learning and best performance, with its own control room for controlling its own network.

The design in general focuses on the overall aesthetics like the plants and the fountain, it also focuses on cost-efficiency, and the comfort of all the students and staff, the design will optimize the area for the network so it can be easily distributed and wire while giving maximum connectivity length.

Reflection for Task 1: Floor Plan and Layout

Task 1 focused on analyzing the physical layout of Block N28B and identifying the working areas to ensure an efficient network design. This task required careful planning to allocate spaces for labs, classrooms, conference rooms, and shared areas. By examining the floor plan, we identified key areas for device placement and network connectivity, ensuring minimal cable distances and optimal coverage.

One major strength of this task was our ability to strategically position critical components, such as switches, routers, and patch panels, to reduce cable clutter and enhance accessibility. Additionally, identifying the exact dimensions of each room helped us plan cabling routes and device placement with precision.

However, a weakness in this task was the initial underestimation of the impact of future expansions. For example, the shared spaces and labs may require additional capacity as the faculty grows. This realization led us to revise the layout to include room for scalability.

Overall, Task 1 laid a strong foundation for the subsequent tasks by providing a clear and detailed physical layout. Moving forward, incorporating redundancy and planning for evolving needs will improve the efficiency and scalability of our design.

4.2 Preliminary Analysis

1. Questions and Answers

I. What is the best connection type in terms of cost and outcome in the lab (wired vs wireless)?

- Wired Connections are generally preferred for lab environments as they:
- Provide better and fast connections with less to no interruption.
- Offer superior protection and decrease the signal load.
- Are less expensive from the perspective of their capacity for maintenance in highly used channels.
- Wireless could be added as a second but would provide for very powerful access points thus adding to both the cost and complexity.

II. What is the best cabling system for networking in the labs?

Category 6A Ethernet Cable (Cat6A) is ideal for lab environments due to its:

- Forwarding capability with up to 10 Gbps.
- Minimized noise and inter connections.
- The cost efficiency when performance requirements are high.

Where the need is higher, then fiber optic cables may be used especially for the backhaul connections to other floors or to the server room, though they are pricey.

III. How many people on average will be there at the lounge using the WIFI?

In accordance with the normal number of students and staff in an area like the lounge expects to have an average of fifty to one hundred users busy at any one time. This estimation makes it easier to quantify the density needed for Wi-Fi access points so as to get the right density to support the coverage and speed needed.

IV. The minimum speed required in each of the labs, conference room, and student lounge?

Labs: High internet speed of minimum 1 Gbps per lab is recommended for 30 workstations to be used with multimedia applications. Such speed is desirable for the

use of video streaming, applications hosted on the cloud, and sharing of files, which are general practices in colleges, schools and educational environments.

Conference Room: Video conferencing rooms require the minimum bandwidth of 50- 100 Mbps per user to deal with high-quality video streams. When selecting a server with an estimated 10–15 users stabilized video calls require a speed of at least 1 Gbps.

Student Lounge: It was found that for a high-density area where 50-100 users (students, staff and visitors) may use the rooms simultaneously, the total connectable bandwidth of 1.5-2 GB/sec is suitable for a combination of light browsing, streaming, and light multimedia tasks.

V. What are the best cost-efficient requirements for the lab workstation?

For cost efficiency in workstations, consider:

Processor: Intel Core i5 or AMD Ryzen 5 for everyday use in various jobs.

RAM: Minimum 8GB, recommended should be 16GB for optimum performance when running multiple programs at the same time.

Storage: SSD (250GB) to improve system's performance without straining the firm's budget excessively.

Flat monitor screen between (21–24 inches)

The general computational workload of these specifications is just adequate for usual lab operations such as code writing and data manipulation with moderate levels of virtualization.

VI. What are the devices that should be in the hybrid classroom?

The hybrid classroom should include:

Large flat screen for collaborative viewing of content across the formal and informal classroom.

Short-throw, high-lumens video projectors or overhead multimedia displays for video and computer graphics.

Anything that goes into making video conferencing happen, for instance: Webcams High quality microphones and speakers.

Interface that is used for controlling connected devices such as smart boards and projectors. These components build up a versatile, communicative environment, which is suitable for containing hybrid teaching.

VII. What is the most suitable bandwidth for the network?

The total network bandwidth of the internal data traffic should therefore be around 10 Gbps, based on the various types of high-density and multimedia focused areas. The peak traffic external internet bandwidth must be around 5 Gbps to achieve simultaneous intense usage.

VIII. What are the security measures for the network?

Recommended security measures include:

- For the outer layer security, Firewall with intrusion detection/prevention.
- NAC to avoid any unauthorized devices to communicate with the network.
- Annual security update, patch on all the network equipments.

Multiple VLANs must be created for separate departments in the event that one is compromised by a virus.

Wireless connection (Wi-Fi) secured protocols, known as WPA3.9. What if power backup is compromised by a virus?

IX. How many servers do we need and the most suitable server requirement for the network?

Server Quantity: In this configuration It will be enough to use 1-3 servers:

A single server for both managing the network and controlling access to this network.
One back-end server is required to retain the information in case of failure.

- Additional to that, an option channel, if needed, for mission critical applications such as Video Conferencing.

Server Specs:

- Processor: A perfect choice is again the Intel Xeon or AMD EPYC processors that should have at least 8 cores.

· RAM: Minimum 32GB to work thus expandable to support multitasking.

- Storage: SSD for quicker response time while the NAS or SAN could be used for the scaling up solution.

Network: 10Gb Ethernet for interconnects with fault tolerance and high throughput.

X. Devices' requirements for the wireless network specification?

Access Points: Employ high density Wi-Fi 6 or WIFI 6E enterprise graded access point for better throughput and efficiency.
Controller: A central Wi-Fi for adjusting network parameters, controlling the access of wireless users, and sharing bandwidth throughout the building.
Security Gateway: Interior design should incorporate an enterprise security gateway for wireless security policies and access.

XI. Which types of network devices are necessary for the Cisco Networking Lab to meet educational and instructional needs?

The Cisco lab should be equipped with:

- Managed switches: Layer 3 switches that will enable students set up and manage the networking protocols.
- Routers: At least one router that can run OSPF, EIGRP and BGP, all of which are routing protocols.
- Firewalls: In the case of teaching the network security principles.
- Cabling: Teaching interfaces and required cable connections for practical exposure.
    - Virtual Lab Environment: Lab apparatus including switches and routers for the practical learning activities like Cisco Packet Tracer or GNS3.

XII. What ISP company should be used for planning for connection establishment?

One can think of ISPs who provide fiber connections that are highly dependable, like Telekom Malaysia, TIME Internet, UNIFI ...etc.

Looking for packages offering:

- Broad and stable broadband connection with minimum speed of 1Gbps for quality data connection.
- Service Level Agreements (SLAs) particular to maintenance and availability.
- Additional paid services for managed services support and maintenance supply.

XIII. Is there any network system you would prefer us to reuse/mimic?

If the existing Faculty of Computing network has a scalable, reliable setup, we will consider:

- Using similar ideas about VLAN, IP address and devices brands and models that has been proven to be successful earlier.
- Imitating previously effective security measures in regard to the policy and setup of computer systems.

This will make deployment more efficient and also minimize the number of compatibility problems that are likely to be encountered.

XIV. What are the best network protocols that can be used in the labs?

For lab environments, these network protocols would be suitable:

TCP/IP: For basic network communication and to connect to the world wide web.

- IPv4 and IPv6: Make sure that they both are present in the devices for later compatibility.
- DHCP: Dynamic allocation of IP address, which is effective in the context of the lab environment, where devices often swap.
- HTTPS and SSL/TLS: For internal data communication within the network.
- VLANs: Allow creation of sub logical networks within the same physical domain to improve separation of the networks.

2. Feasibility

The following were viewed as important and informed the network infrastructure for the Faculty of Computing new building.

Key areas of feasibility include:

Cost Structure and 4IR Alignment: A key area of value alignment targets 4IR compliance in terms of system design, that is, optimal of high-performance laboratories and equipment with regard to cost constraints, as well as to match future demand.

Reliable Network Connectivity: Internal 10 Gbps, External 5 Gbps will cater current as well as future needs to specific areas of high traffic such as Labs and Lounges.

Optimal Hardware and Software Selection: Cat6A cables and fiber optic are used to provide fast data transmission, while some mid-range workplaces have been chosen with regard to optimal cost and performance.

Specific choices of devices' requirements to meet the needs for the labs, student lounge and the overall network (workstations, connection point, servers, routers, …etc.) **Secure Infrastructure:** Firewalls and VLANs, along with intrusion systems provide a good level of protection, against internal and external threats.

ISP and Protocol Compatibility: ISP choices and the utilization of standard protocol (TCP/IP, VLAN) ensure reliable service with the downstream potential to accommodate growth and extend the connections to related devices. Each of these considerations guarantee a sustainable, secure and reasonably priced network that meets expectations of the stakeholders, now and in the future, both now and in the future as the academic institution develops.

Reflection for Task 2: Network Topology

In Task 2, we focused on selecting an appropriate network topology for the faculty's needs. After evaluating several options, we chose a hierarchical topology as it offers scalability, reliability, and efficient traffic management. This topology divides the network into layers, including core, distribution, and access, ensuring seamless connectivity across all areas of Block N28B.

One major strength of this task was the logical and structured approach to designing the topology. The hierarchical design simplifies troubleshooting, supports future expansion, and ensures effective data flow between devices. Additionally, the separation of the network into layers reduces congestion and improves performance, particularly for high-demand areas like labs and classrooms.

However, a limitation was the lack of redundancy in the initial design. While the hierarchical topology is efficient, critical links between the core and distribution layers are single points of failure. To address this, we recommended adding redundant connections in future upgrades to enhance reliability and minimize downtime.

Task 2 provided a robust framework for the network, ensuring efficient data handling and scalability. Moving forward, incorporating redundancy and exploring software-defined networking (SDN) could further enhance the performance and reliability of the topology.

4.3 Devices List

Devices

When planning and constructing the networking and lab structures under the allocated of RM 2.00 million of funding, great emphasis should be put on the choice of the devices in terms of offering good performance, reliability and that are relatively cheap in terms of the total budget. The following section includes the required devices, suitable companies, reasons for their choices, and their costs.

Network devices

- **Routers**: At least 2, considering redundancy for core networking.
- **Switches**: 1 per lab (4 labs), 1 for the video conferencing room, and 1 for the student lounge. Total: 6.
- **Wireless Access Points**: Minimum 2 per room for proper coverage (considering the size of 14m x 10m). Total: 12.
- **Cabling**: Approximate length per lab: 2 meters per computer + 20% tolerance, 72 meters for each lab but taking 1000 meters in total considering the size approximation and height, 1000 meters approximately for the network layout.
- **Patch Panels**: 1 per switch for organized cable management. Total: 6
- **Servers**: 1 or 2 for managing resources (mainly 2 considering the network traffic).
- **Firewalls**: 1 high-performance firewall for security

Lab Equipments and Devices

- **Desktop Computers:** 30 per lab, 120 total.
- **Monitors:** one for video conferencing rooms.
- **Keyboards and Mice :** 30 per lab, 120 total.
- **Printers (Networked):** 1 for the cisco lab.
- **Projector:** 1 for each lab, 1 for video conferencing room, and 1 for hybrid classroom.
- **IoT Devices:** Suggestion is Raspberry Pi 1 for each desk, 30 in total.
- **Cameras:** 2 cameras, 1 for hybrid classroom and another one for video conferencing room.

- **Hard drive storage:** 1 for each of the classes, video conferencing room and hybrid **classroom.** Total: 6.
- **Central storage:** 1 for the whole facility.

Device comparison

Network devices

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1. Routers

Feature	 Chosen (Cisco ISR 4331)	 Alternative 1 (Huawei AR2220E)	 Alternative 2 (TP-Link TL-ER6120)
Throughput	Up to 2 Gbps	1.6 Gbps	1.2 Gbps
WAN Options	MPLS, LTE, broadband	MPLS, broadband	Dual-WAN, broadband
Scalability	Modular design for growth	Modular interfaces	Fixed architecture
Security	Cisco IOS Security Suite	Integrated firewall, VPN	VPN support, basic firewall
Energy Efficiency	Moderate	High	Moderate
Price (RM)	25,000	20,000	1,500

Figure 4

Reason for Selection:

The Cisco ISR 4331 was chosen for its modular design, allowing scalability as the institution's requirements grow. Its advanced security and high throughput make it a reliable choice for managing large-scale networks.

Comparison:

While the Huawei AR2220E is a more cost-effective option with decent performance, it lacks the level of modularity and enterprise-grade features offered by Cisco. TP-Link is budget-friendly but suitable only for smaller setups or secondary networks.

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2. Switches

Feature	 Chosen (Cisco Catalyst 2960-X)	 Alternative 1 (Huawei S5700 Series)	 Alternative 2 (TP-Link T2600G-28TS)
Ports	24/48 Gigabit Ethernet	24/48 Gigabit Ethernet	24 Gigabit Ethernet
Layer	Layer 2/3	Layer 2/3	Layer 2+
Energy Efficiency	Advanced	Advanced	Basic
Management	Secure, scalable options	Intelligent stacking	Centralized
Price (RM)	15,000	12,000	2,000

Figure 5

Reason for Selection:

Cisco Catalyst 2960-X provides advanced Layer 3 capabilities, enabling more efficient routing and VLAN support, which are critical for the institution's network infrastructure.

Comparison:

Huawei S5700 offers similar features at a lower price, but its management capabilities are less robust. TP-Link is significantly cheaper but lacks advanced Layer 3 functions, making it less suitable for a demanding network.

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3. Wireless Access Points

Feature	Chosen (Ubiquiti UniFi UAP-AC-PRO)	Alternative 1 (Cisco Aironet 1850 Series)	Alternative 2 (TP-Link EAP245)
			
Wi-Fi Standard	802.11ac	802.11ac Wave 2	802.11ac
Speed	Up to 1300 Mbps	Up to 1.73 Gbps	Up to 1200 Mbps
Management	UniFi Controller Software	Cisco Mobility Express	Omada Controller
MU-MIMO Support	No	Yes	No
Price (RM)	1,000	3,000	600

Figure 6

Reason for Selection:

The Ubiquiti UniFi UAP-AC-PRO was selected for its balance of cost-effectiveness and performance. Its centralized management software and good coverage make it suitable for large spaces like labs and lounges.

Comparison:

Cisco Aironet 1850 offers higher speeds and MU-MIMO support but comes at a much higher cost. TP-Link EAP245 is affordable but lacks advanced features like MU-MIMO, making it less future-proof.

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4. Firewall

Feature		Alternative 1 (Cisco	Alternative 2
			

	Chosen (Fortinet FortiGate 100E)	Firepower 1010)	(SonicWall TZ400)
Throughput	7 Gbps	6 Gbps	1.5 Gbps
Security Features	UTM, IPS, antivirus	Advanced threat protection	VPN, intrusion prevention
VPN Support	Comprehensive	Comprehensive	Standard
Price (RM)	20,000	15,000	10,000

Figure 7

Reason for Selection:

Fortinet FortiGate 100E offers comprehensive security features, including Unified Threat Management (UTM) and high throughput, making it ideal for securing the institution's network.

Comparison:

Cisco Firepower 1010 integrates well with other Cisco devices but has a slightly lower throughput. SonicWall TZ400 is a more affordable option but lacks advanced UTM capabilities.

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5. Patch Panels

Feature	 Chosen (Panduit DP245E88TGY)	 Alternative 1 (Leviton 69586-U24)	 Alternative 2 (Netgear JNP24C)
Ports	24-port, Cat6 compatible	24-port, universal wiring	24-port, fully shielded
Compatibility	Cat6 cabling	Universal compatibility	Cat6 compatibility
Design	Color-coded labeling for easy management	Secure cable retention	Compact design
Durability	High-quality materials	Reliable build	Shielded for reduced interference
Price (RM)	500	400	500

Figure 8

Reason for Selection:

The Panduit DP245E88TGY was chosen for its reliability and ease of cable management,

making it ideal for an academic setup where structured cabling is critical. Its color-coded labeling simplifies organization, which is especially useful during installation and maintenance.

Comparison:

The Leviton 69586-U24 is slightly cheaper and offers universal compatibility but lacks advanced features like shielding for interference reduction. The Netgear JNP24C, while similarly priced, focuses on compact design and shielding but does not offer as much ease of management as Panduit's color-coded labeling.

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6. Servers

Feature	 **Chosen (Dell PowerEdge R650)**	 **Alternative 1 (HPE ProLiant DL360 Gen10)**	 **Alternative 2 Lenovo ThinkSystem SR63**
Processor	Dual Intel Xeon Silver (16 cores each)	Intel Xeon Scalable	Intel Xeon Scalable
RAM	64GB DDR4, expandable	64GB, expandable	64GB, expandable
Storage	4TB NVMe SSD	SSD/HDD options	SSD/HDD options
Price (RM)	50,000	45,000	40,000

Figure 9

Reason for Selection:

Dell PowerEdge R650 was chosen for its high scalability, reliability, and support for NVMe SSDs, which offer superior performance.

Comparison:

HPE ProLiant DL360 Gen10 is a competitive alternative with robust security features but slightly lower storage performance. Lenovo ThinkSystem SR630 is the most cost-effective but may not offer the same level of enterprise support.

Lab Equipments and Devices

1. Desktop Computers

Feature	 Chosen (Dell OptiPlex 7080)	 Alternative 1 (HP EliteDesk 800 G6)	 Alternative 2 (Lenovo ThinkCentre M720)
Processor	Intel Core i7	Intel Core i7	Intel Core i7
RAM	16GB DDR4	16GB DDR4	16GB DDR4
Storage	512GB SSD	512GB SSD	512GB SSD
Ports	Multiple USB, DisplayPorts	Multiple USB, DisplayPorts	Multiple USB, DisplayPorts
Price (RM)	4,500	4,200	4,000

Figure 10

Reason for Selection:

The Dell OptiPlex 7080 was selected for its robust build, enterprise reliability, and excellent after-sales support, making it a long-lasting investment for lab environments.

Comparison:

The HP EliteDesk 800 G6 offers similar performance and slightly enhanced security features at a lower price. The Lenovo ThinkCentre M720 is the most cost-effective but lacks the premium build quality and support Dell provides.

2. Monitors

Feature	 **Chosen (Dell UltraSharp U2419H)**	 **Alternative 1 (HP Z24n G2)**	 **Alternative 2 (Lenovo ThinkVision P24h)**
Screen Size	24 inches	24 inches	24 inches
Resolution	Full HD	Full HD	QHD
Panel Type	IPS	IPS	IPS
Ergonomics	Adjustable stand	Adjustable stand	Adjustable stand
Price (RM)	1,200	1,100	1,300

Figure 11

Reason for Selection:

The Dell UltraSharp U2419H was chosen for its superior display quality, ergonomic design, and long-standing reputation for durability in professional setups.

Comparison:

The HP Z24n G2 is slightly cheaper and offers comparable color accuracy. The Lenovo ThinkVision P24h provides higher resolution (QHD) but is more expensive.

3. Cameras

Feature	 Chosen (Hikvision DS-2CD2387G2-L)	 Alternative 1 (Axis P3245-LVE)	 Alternative 2 (Dahua IPC-HDW2431T-ZS)
Resolution	4K	HDTV 1080p	4MP
AI Features	Motion detection	Forensic WDR	Night vision IR
Weatherproof	Yes	Yes	Yes
Price (RM)	1,500	2,500	1,200

Figure 12

Reason for Selection:

The Hikvision DS-2CD2387G2-L offers 4K resolution and AI-based motion detection at a competitive price, making it ideal for monitoring classrooms and conference rooms.

Comparison:

The Axis P3245-LVE is premium and better in low-light conditions but much more expensive. The Dahua IPC-HDW2431T-ZS provides basic functionality at a lower cost but lacks advanced features.

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4. Projectors

Feature	 Chosen (Epson EB-X41)	 Alternative 1 (BenQ MS560)	 Alternative 2 (Sony VPL-EX430)

Brightness	3,600 lumens	4,000 lumens	3,600 lumens
Resolution	Full HD	Full HD	WXGA
Lamp Life	12,000 hours	10,000 hours	8,000 hours
Price (RM)	2,500	2,200	3,200

Figure 13

Reason for Selection:

The Epson EB-X41 was chosen for its excellent balance of brightness, resolution, and durability, making it ideal for classrooms and conference rooms.

Comparison:

The BenQ MS560 is a more affordable option with higher brightness but shorter lamp life. The Sony VPL-EX430 offers premium features but at a higher price.

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5. Printers

Feature	 **Chosen (HP LaserJet Pro M404dn)**	 **Alternative 1 (Canon imageCLASS LBP226dw)**	 **Alternative 2 (Brother HL-L6200DW)**
Speed	40 ppm	38 ppm	48 ppm
Duplex Printing	Yes	Yes	Yes
Energy Efficiency	High	High	Moderate
Price (RM)	1,500	1,200	1,800

Figure 14

Reason for Selection:

The HP LaserJet Pro M404dn was selected for its high-speed printing, energy efficiency, and reliability, which are critical for a Cisco lab's daily operations.

Comparison:

The Canon imageCLASS LBP226dw is more budget-friendly but offers slightly lower speed. The Brother HL-L6200DW has the fastest speed but is more expensive and less energy-efficient.

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6. Hard Drives

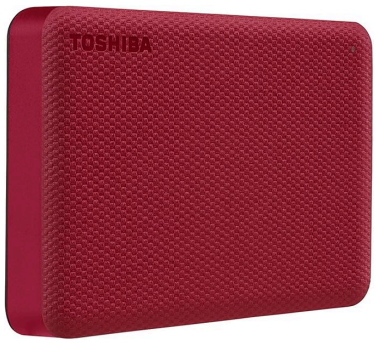
Feature	 **Chosen (Seagate Backup Plus Hub 8TB)**	 **Alternative 1 (WD My Book 8TB)**	 **Alternative 2 (Toshiba Canvio Advance 8TB)**
Storage Capacity	8TB	8TB	8TB
Connectivity	USB 3.0	USB 3.0	USB 3.0
Portability	Yes	Yes	Yes
Price (RM)	1,200	1,000	1,100

Figure 15

Reason for Selection:

The Seagate Backup Plus Hub 8TB offers fast transfer speeds and reliability, ideal for frequent backups in a lab environment.

Comparison:

The WD My Book is cheaper but lacks additional features like the integrated USB hub. The Toshiba Canvio Advance provides similar performance but does not match Seagate's durability.

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7. Central Storage (Class Central Facility Storage)

Feature	 Chosen (Synology DS920+)	 Alternative 1 (QNAP TS-453D)	 Alternative 2 (Asustor AS6604T)
Storage Bays	4	4	4
RAID Support	Yes	Yes	Yes
Network Support	1GbE	10GbE	10GbE
Price (RM)	7,500	7,000	8,000

Figure 16

Reason for Selection:

The Synology DS920+ is reliable, easy to manage, and offers excellent backup and file-sharing capabilities, making it perfect for an academic environment.

Comparison:

The QNAP TS-453D is slightly cheaper and supports 10GbE connections for faster networking. The Asustor AS6604T offers NVMe caching but is more expensive and may exceed the project's needs.

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8. IOT devices

Feature			

	Chosen (Raspberry Pi 4)	Alternative 1 (ODROID-XU4)	Alternative 2 (BeagleBone Black)
Processor	Quad-core ARM Cortex-A72	Octa-core Samsung Exynos 5422	1GHz ARM Cortex-A8
RAM	2GB/4GB/8GB	2GB	512MB
Storage	MicroSD, USB 3.0 support	eMMC, USB 3.0 support	eMMC, USB 2.0 support
Connectivity	Gigabit Ethernet, Wi-Fi	Gigabit Ethernet	10/100 Ethernet
Price (RM)	300–450	400	350

Figure 17

Reason for Selection:

The Raspberry Pi 4 is chosen for its balance of performance, connectivity, and affordability, making it suitable for IoT-focused educational activities.

Comparison:

The ODROID-XU4 offers higher performance with an octa-core processor but comes at a slightly higher cost. The BeagleBone Black is more affordable but less powerful and less suited for intensive tasks.

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9. Keyboard and Mice

Feature	 Chosen (MK120 Corded Keyboard and Mouse Combo)	 Alternative 1 (HP 150 Wired Combo)	 Alternative 2 (Lenovo Essential Wired Combo)
Design	Full-size keyboard and ambidextrous mouse	Full-size keyboard and mouse	Full-size keyboard and ambidextrous mouse
DPI (Mouse)	1600 DPI	1200 DPI	1200 DPI
Price (RM)	90	260	130

Figure 18

Reason for Selection:

The MK120 Combo is affordable, durable, and offers adequate functionality for daily use in a lab environment.

Comparison:

The HP 150 Combo is more expensive but offers a slightly better build. The Lenovo Combo is moderately priced but lacks additional features such as higher DPI.

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10. Cables

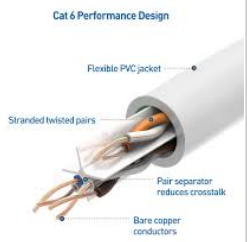
Feature	Chosen (Cable Matters Cat6 and Fiber Optic)	Alternative 1 (Mogami Cat6 and Fiber Optic)	Alternative 2 (Mediabridge Cat6 and Fiber Optic)
			
Cat6 Bandwidth	Up to 550 MHz	Up to 550 MHz	Up to 550 MHz
Fiber Optic Bandwidth	Up to 10 Gbps	Up to 40 Gbps	Up to 10 Gbps
Jacket Material	Durable PVC	Durable PVC	Flexible PVC
Price (RM)	Cat6: 200/100m, Fiber Optic: 300/100m	Cat6: 280/100m, Fiber Optic: 400/100m	Cat6: 250/100m, Fiber Optic: 350/100m

Figure 19

Reason for Selection:

The Cable Matters cables are cost-effective and provide high performance, suitable for both short-range (Cat6) and long-range (fiber optic) connections.

Comparison:

The Mogami cables have higher bandwidth for fiber optics but are significantly more expensive. The Mediabridge cables are moderately priced but offer similar performance to Cable Matters.

Device and Cost Breakdown

Category	Selected Devices	Unit Cost (RM)	Quantity	Total Cost (RM)
Router	Cisco ISR 4331	25000	2	50000
Switch	Cisco Catalyst 2960-X Series	15000	6	90000
Wireless AP	Ubiquiti UniFi UAP-AC-PRO	1000	12	12000
Firewall	Fortinet FortiGate 100E	20000	1	20000
Desktop Computers	Dell OptiPlex 7080	4500	120	540000
Monitors	Dell UltraSharp U2419H	1200	120	144000
Keyboard and mice	MK120 Corded Keyboard and Mouse Combo	90	120	10800
IoT Devices	Raspberry Pi 4	300	30	9000
Printers	HP LaserJet Pro M404dn	1500	1	1500
Servers	Dell PowerEdge R650	50000	2	100000
Patch panels	Panduit DP245E88TGY	500	6	3000
Cables	Cat6 Ethernet + Fiber Optic Cable Matters	-	-	5000
Cameras	Hikvision DS-2CD2387G2-L	1500	2	3000
Projectors	Epson EB-X41	2500	6	15000
Screen	Elite Screens Manual Series	1000	1	1000
Hard Drives	Seagate Backup Plus Hub 8TB	1200	6	7200
Central Storage (NAS)	Synology DS920+	7500	1	7500
Overall Total				RM 1,019,000

Budget Justification

The cost incurred sums up to RM 1,019,000, which is lower than the allocated budget of RM 2,000,000 for the expansion and the contingencies. Spend was kept to bearable levels in order to be able to achieve the desired reliability and performance. Key points include:

1. **Critical Infrastructure (Routers, Switches, Firewall):**
   Using Cisco brand superior models was done deliberately due to the following reasons namely reliability, scalability and durability of the branded devices. Though slightly expensive, they masterfully maintain operations and are essential in future expansion.

2. **Wireless Access Points and IoT Devices:**
   Ubiquiti UniFi APs were selected for its cost-sensitivity and technical compatibility, and the Raspberry Pi $4 BTO costs significantly less while delivering high performance, although at a slightly reduced technical compatibility level.

3. **Storage and Servers:**
   Central storage from Synology and Dell PowerEdge were chosen for their effectiveness in resource management and for their scalability. Although they are a little costly because of their custom-made attributes, they guarantee long spans free from data loss.

4. **Lab Equipment and End-User Devices:**
   Simple yet rugged products that are more affordable were sought out and include the Dell OptiPlex for Desktops and the MK120 products for Keyboard and Mouse.

5. **Cost Savings in Peripheral Devices:**
   There was a deliberate choice of cost-effective materials such as Cable Matters cables for wires and Epson projectors.

In this context, the proposed plan spreads the budget divided and raises as many resources as possible in cost-effective solutions to provide a high-quality, adjusted, and functional network to the institution

Reflection

Are you surprised by the prices? How were you surprised?

Yes, the prices were surprising, especially for premium brands like Cisco, which were significantly higher than alternatives like TP-Link or Huawei. For example, Cisco routers cost RM 25,000, compared to Huawei (RM 20,000) and TP-Link (RM 1,500). Similarly, Cisco switches were RM 15,000, whereas TP-Link was only RM 2,000. While expected for enterprise-grade devices, the stark differences highlighted the trade-offs between cost and advanced features.

Have you ever considered cost as a factor for choosing networking devices?

Cost is always an essential factor, particularly for academic institutions with limited budgets. In this project:

- We prioritized affordable yet reliable devices, such as Ubiquiti APs over Cisco Aironet.
- However, for critical devices like routers and switches, reliability and scalability took precedence over cost, ensuring a robust network infrastructure.

What are the major differences between the same devices from different brands?

The primary differences are in performance, features, and cost:

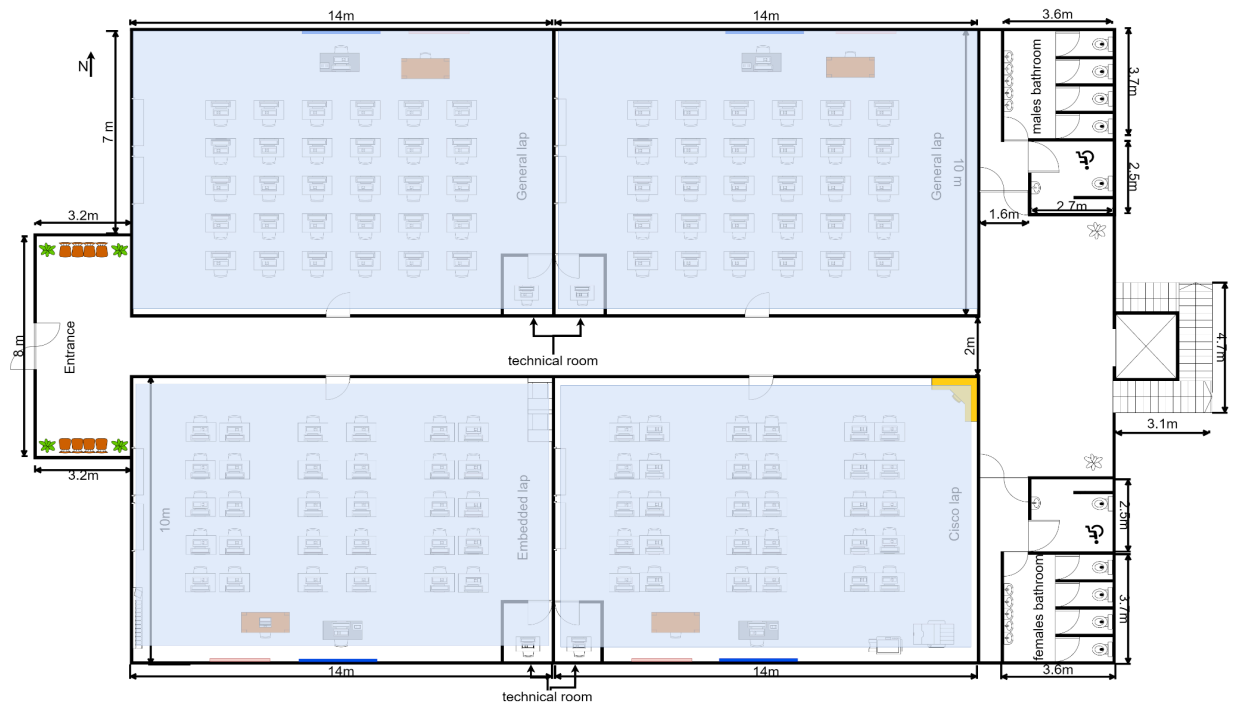
- **Routers:** Cisco offers modularity and enterprise-grade features, Huawei balances cost and performance, and TP-Link focuses on affordability for smaller setups.
- **Switches:** Cisco provides advanced Layer 3 features, Huawei offers similar performance at a lower price, and TP-Link is best for basic setups.
- **Wireless APs:** Ubiquiti balances affordability and performance, Cisco excels in speed and advanced features, and TP-Link suits smaller environments.
- **Storage and IoT:** Seagate and Raspberry Pi provide excellent cost-performance ratios, while QNAP and ODROID offer premium features at higher costs.

These differences reflect trade-offs between cost-efficiency and advanced capabilities.

4.4 Connections & Cabling

Working areas

First Floor Working Areas



First floor working area figure 20

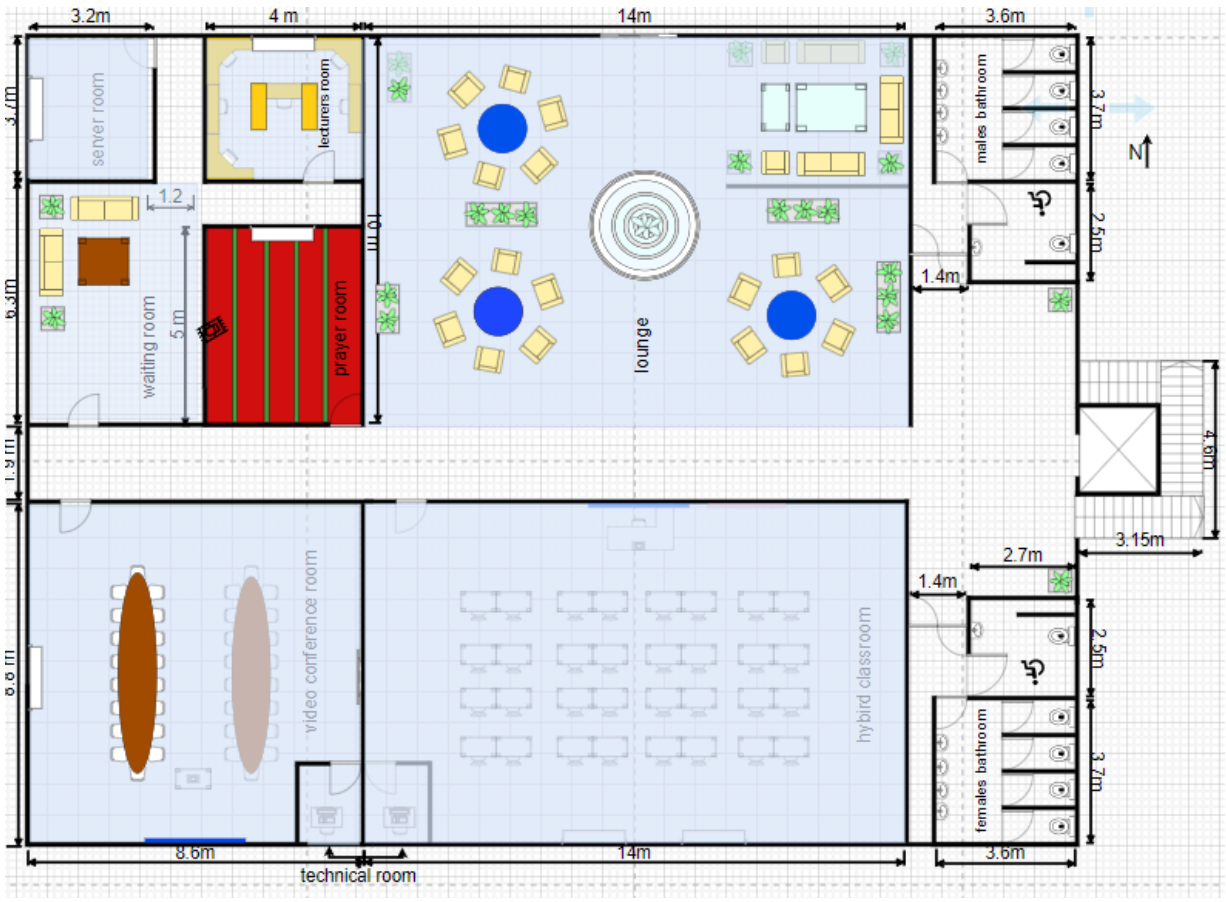
General Labs, Embedded lap and Cisco lap:

- Each lab is designed with 5 rows of workstations accommodating 30 workstations in total (per lab).
- The dimensions of each lab are approximately 14m x 10m.
- These labs are intended for general-purpose computing activities, networking activities and multi-purpose activities for students.
- Each of the labs will have full wifi coverage.

Technical/Telecommunications Rooms (near the center):

- There are small technical rooms, each adjacent to the general labs.
- These rooms will house network devices (patch panels) for distributing connectivity

Second Floor Working Areas



Second floor working area figure 21

- **Student Lounge** where students can sit down and connect their devices to wireless access networks .provided by the WAP that covers the entire area and can hold more than 50 students at the same time, the dimensions are 10m x 14m.
- **Hybrid Classroom** that included a projector and a camera connected to the patch panel

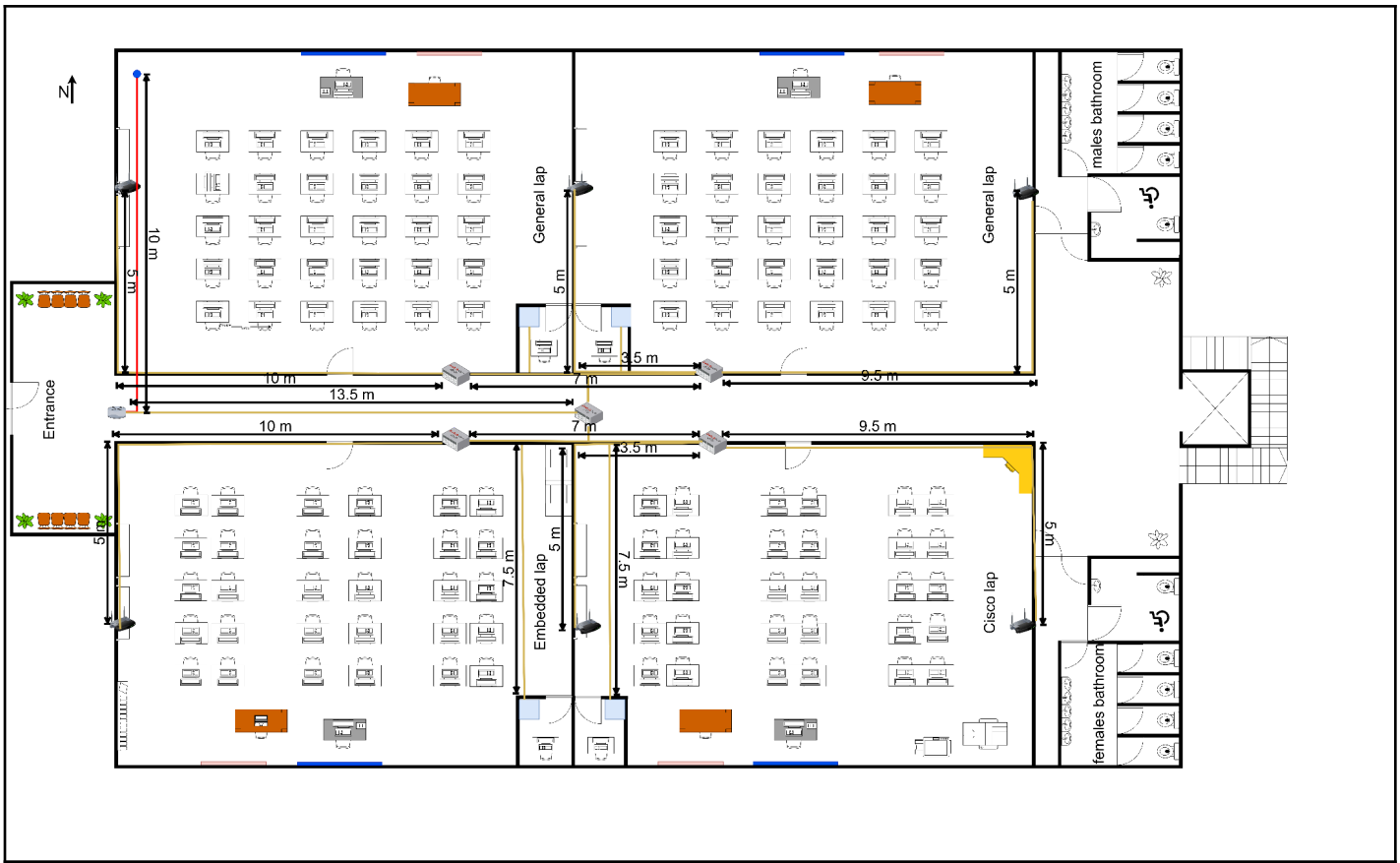
also included full wireless network coverage, the dimensions are 10 x 14 m.

- **Video Conferencing** that has a camera connected to the patch panel and a smart screen that is connected to the patch panel as well, the wifi coverage covers all the video conferencing rooms, the dimensions are 8.8m x 8.6m.
- **Server Room** has two servers that connect the entire building, the dimensions are 3.2m x 3.7 m
- **Other Rooms** include the waiting room and lecturers rooms that have full wifi coverage, the dimensions are (4.4m x 3.6 m for the waiting room), (4m x 3.7m for the lecturer's room).

Network Cabling

Cable Type	Color	Purpose
Vertical Cable	**Black**	Connects floors or devices vertically within the building.
Fiber Optic Cable	**Yellow**	High-speed backbone connections between rooms or labs.
Cat 6 Cable	**Purple**	Connects workstations, switches, and end devices locally.
Double Fiber Optic Cable	**Red**	Redundant high-speed backbone connections for routers topology.

First Floor Cabling Analysis



First floor fibre cabling figure 22

Backbone Cabling

The backbone cabling provides the main horizontal and vertical connectivity between labs, switches, and key network devices. It consists of fiber optic cables for high-speed connections.

Horizontal Backbone Cabling

- The central corridor acts as the main pathway for horizontal cables connecting the switches.
- Switches are strategically located in the hallways near the labs to minimize cable lengths.
- Backbone cables branch into each lab:
    - Main router is connected through the servers by a double connection (~ 20m) and ~13.5m for the switch.
    - The main switch is connected to a router and each switch connects a lab.
    - Each wireless access point is connected by a lap switch through fibre optic.
    - General Labs(2) : Cables run horizontally from the corridor into the labs (14m) and about(5 m - 10 m) for connecting wireless AP.
    - Embedded Lab : Cables run (~14m)horizontally and about(5 m) for connecting wireless AP into the lab.
    - Cisco Lab (Bottom-Right): Cables run ~14m horizontally into the lab and 10m for the wireless AP.

Vertical Backbone Cabling

- Vertical runs connect the network switches to:
    - Technical Rooms in each lab for localized cable management.
    - Connecting the router.

Devices Connected to Backbone Cables

Switches

- Location: 5 switches positioned along the corridor, one central and each lab has its own switch.
- Purpose:
    - Connect all workstations in the labs to the main network.
    - Act as distribution points for local traffic from each lab.

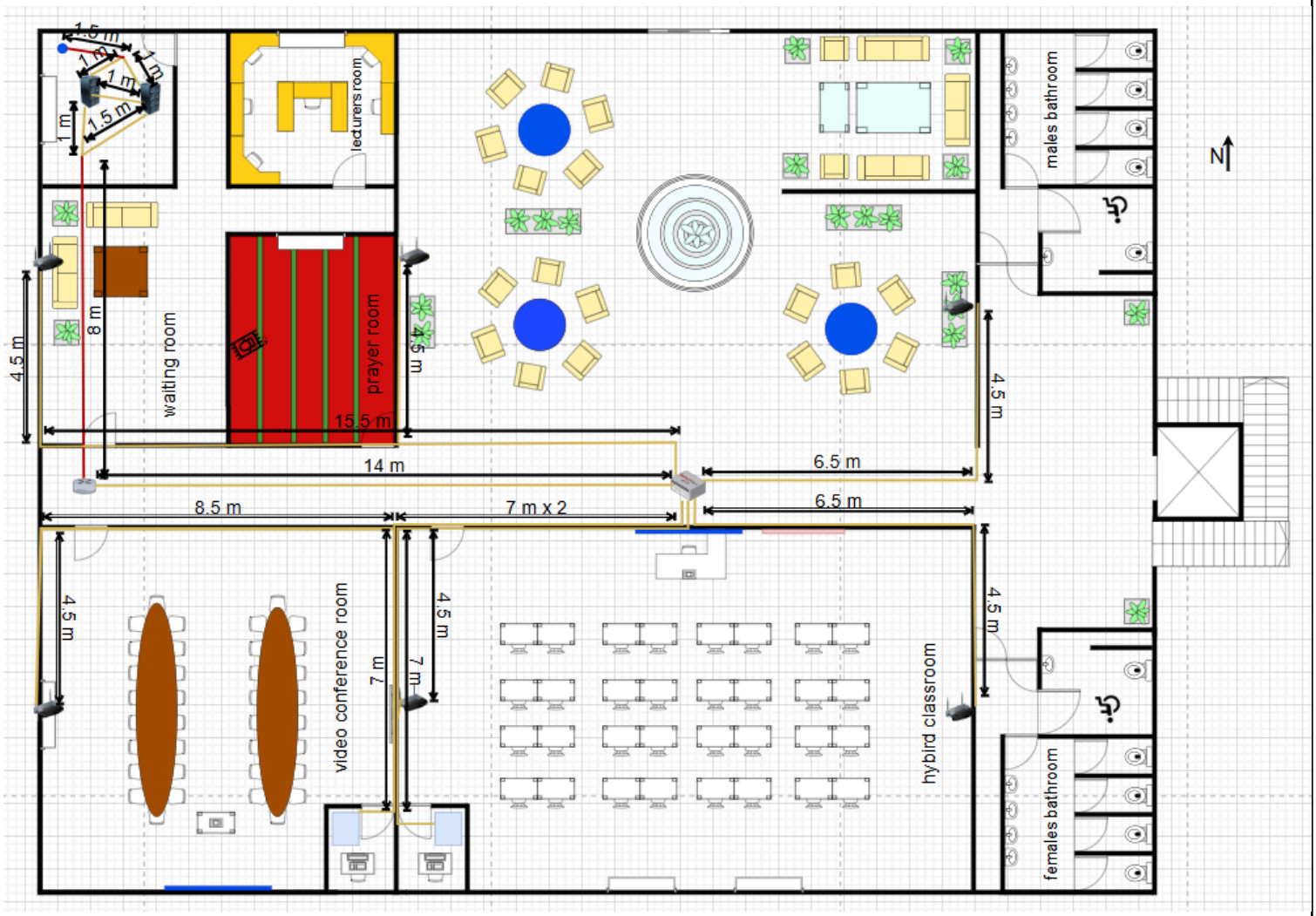
Router

- Location: near the entrance along the middle for forwarding and routing the data.

Wireless Access Point (AP)

- Location: in the middle of each class wall offering full coverage.

Second Floor Cabling Analysis



Second floor fibre cabling figure 23

Backbone Cabling

The backbone cabling provides connectivity across the working areas in the floor plan, with horizontal and vertical connections running throughout the rooms.

Horizontal Backbone Cables

- Cables run along the main corridor horizontally to connect rooms such as the video conference room, hybrid classroom, and lounge.
- Lengths:
    - ~5m (main server connection).
    - ~43m connections branch off into the hybrid classroom and conference room.
    - ~45.5m connection for the wireless AP.

Vertical Backbone Cables

- Vertical connections run within each room to connect local devices to network switches or technical rooms.

Devices Connected to Backbone Cables

Video Conference Room

- Purpose: This room is used for virtual meetings.
- Devices Connected:
    - 2 Conference tables equipped with desktop computers and monitors.
    - Projector at the front for shared presentations.
    - Network Switch: Positioned near the room's edge for connecting all devices.
    - Wireless Access Point (AP): For Wi-Fi coverage.
- Cabling:
    - Backbone cables provide connectivity from the main corridor switch to:
        - Desktop computers
        - Projector
        - Wireless AP

Hybrid Classroom

- Purpose: This room is designed for modern learning with a mix of virtual and in-person teaching.
- Devices Connected:
    - Desktop computers: Positioned for students and teachers.
    - Projector: For instructional presentations.
    - Wireless AP: Ensures Wi-Fi coverage for mobile devices.
- Cabling:
    - Horizontal backbone cables run into the classroom to connect:
        - Network switch
        - Desktop computers

Lounge Area

- Purpose: A recreational and working area for students.
- Devices Connected:
    - Wireless APs: Strategically placed to provide seamless Wi-Fi coverage.
- Cabling:
    - Horizontal cables branch out to connect APs to the backbone switches in the corridor.

Cabling and Connected Devices

First Floor

First floor cabling figure 24

Device Cabling Layout

Type of Cable

- The backbone cabling is **Cat6 Ethernet cables** for high-speed data transmission (up to 10 Gbps).
- It connects each lab patch panel to its computers and projectors.

Horizontal

- Horizontal cables branch out from the corner positioned patch panel into each workstation row.
- These cables distribute network connectivity across the labs.

Vertical

Vertical runs connect devices in each lab.

Breakdown of Devices Connected to the Cables

General Labs

- **Workstations:**
  - The patch panel is the main source of connection.
  - Each workstation (desktop computer) in the rows is connected to the network via **Cat6 cables**.
  - **Cable Length:** Approximately **2.5 meters** per workstation, 9.5m x 5 for lab connection, 7m for the main connection that branches to another computer.
  - The length for the projector and the lecturer's computer is ~7m and ~6m for main branching.

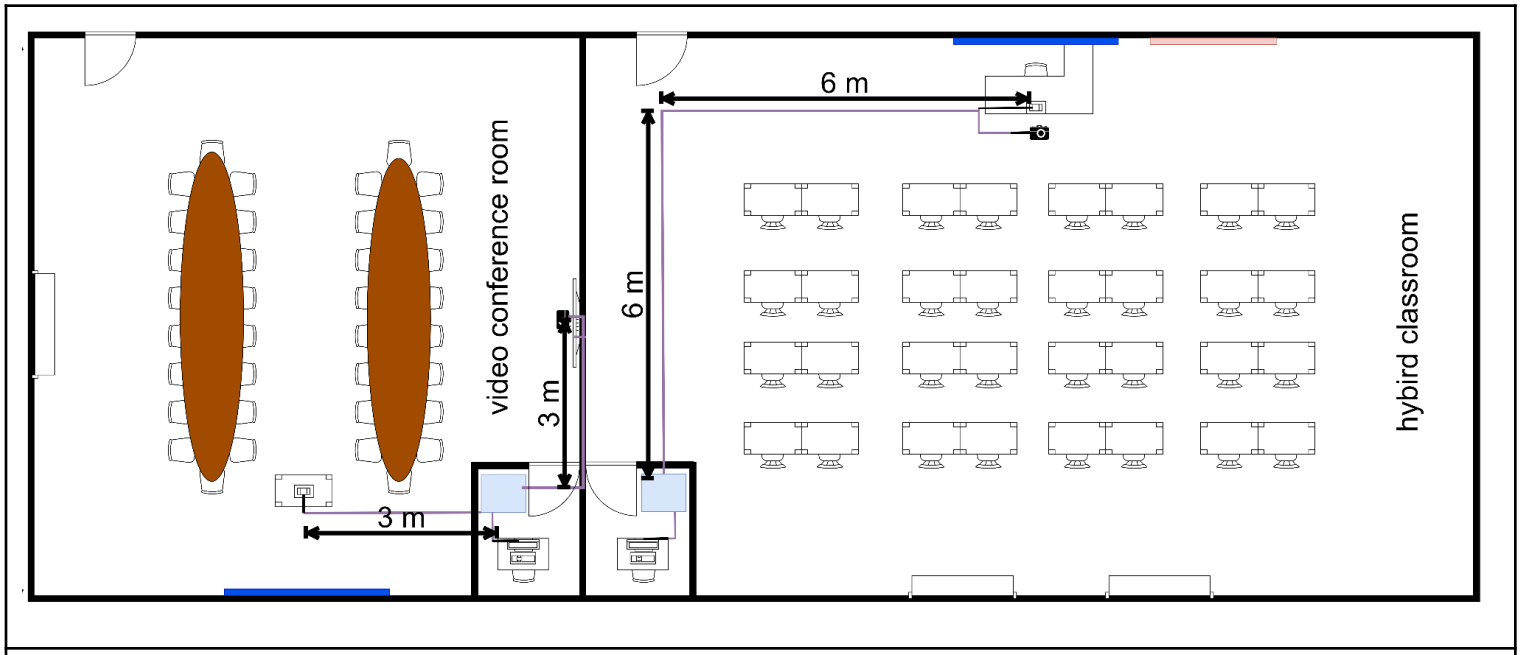
Embedded Lab

- **Workstations:**
  - The patch panel is the main source of connection.
  - Rows of desktop computers connected via **Cat6 cables**.
  - **Cable length:** approximately **2.5** x 12 **meters** per workstation, 5m x 3 for lab connection, 11m for the main connection that branches to another computer.
  - The length for the projector and the lecturer's computer is ~8m.

Cisco Lab

- **Workstations:**
    - The patch panel is the main source of connection.
    - Rows of desktop computers connected via **Cat6 cables**.
    - **Cable length:** approximately **2.5** x 12 **meters** per workstation, 5m x 3 for lab connection, 11m for the main connection that branches to another computer.
    - The length for the projector and the lecturer's computer is ~8m.
    - Additional 3m for connecting the printer.

Second Floor



Second floor cabling figure 25

Device Cabling Layout

Type of Cable

- The backbone cabling is **Cat6 Ethernet cables** for high-speed data transmission (up to 10 Gbps).
- It connects each room patch panel to its computers and projectors.

Horizontal

- Horizontal cables branch out from the corner positioned patch panel into each room.
- These cables share the network connectivity into the room.

Vertical

Vertical runs connect devices in each room.

Breakdown of Devices Connected to the Cables

Hybrid Classroom

- **Devices:**
  - The patch panel is the main source of connection.
  - Connecting a camera, projector and the lecturers' computer(optional).
  - The lecturer's computer, projector and camera is connected to the network via **Cat6 cables**.
  - **Cable Length:** Approximately **12 m** for the lecturer's computer and projector, 3m additional for the camera.

Video Conferencing Room

- **Devicess:**
  - The patch panel is the main source of connection.
  - Connecting a camera, projector and smart screen.
  - **Cable length:** approximately 3 **meters** for the projector, 4 for camera and smart screen connection.

Summary of Connected and Network Devices

First floor:

1. **General Labs (2):**
   - 30 workstations per lab
   - 1 teacher workstation
   - 1 projector
   - 1 switch

- 1 patch panel

2. **Embedded Lab:**
    - 30 workstations
    - 1 switch
    - 1 teacher workstation
    - 1 projector
    - 1 patch panel
3. **Cisco Lab:**
    - 30 workstations
    - 1 switch
    - 1 teacher workstation
    - 1 projector
    - 1 patch panels
    - 1 printer

Total Cables Table

Working Area	Double Fiber (Yellow)	CAT6 (Purple)	Price (Fibre Optic)	Price (CAT6)
General Lab(2)	43m	181m	129 RM	362 RM
Cisco Lab	38m	98m	114 RM	196 RM
Embedded Lab	33m	95m	100 RM	190 RM
First Floor Connection	38m	-	114 RM	
Student Lounge	23m	-	69 RM	
Hybrid Classroom	37.5m	15m	112.5 RM	30 RM
Video Conferencing Room	28m	7.5m	84 RM	15 RM
Waiting and Lecturer's Room	20m	-	60 RM	
Second Floor Connection	40.5m	-	122 RM	
Total	**301m**	**396.5m**	**~ 900 RM**	**~ 800 RM**
Total Price				**~ 1,700 RM**

Total Used Network Devices

Patch Panels: 6

- 1 per lab (3 labs)
- 1 for the video conferencing room
- 1 for the hybrid classroom

Routers: 2

- 1 for the first floor
- 1 for the second floor

Servers: 2

- Centralized servers for managing the entire network connection

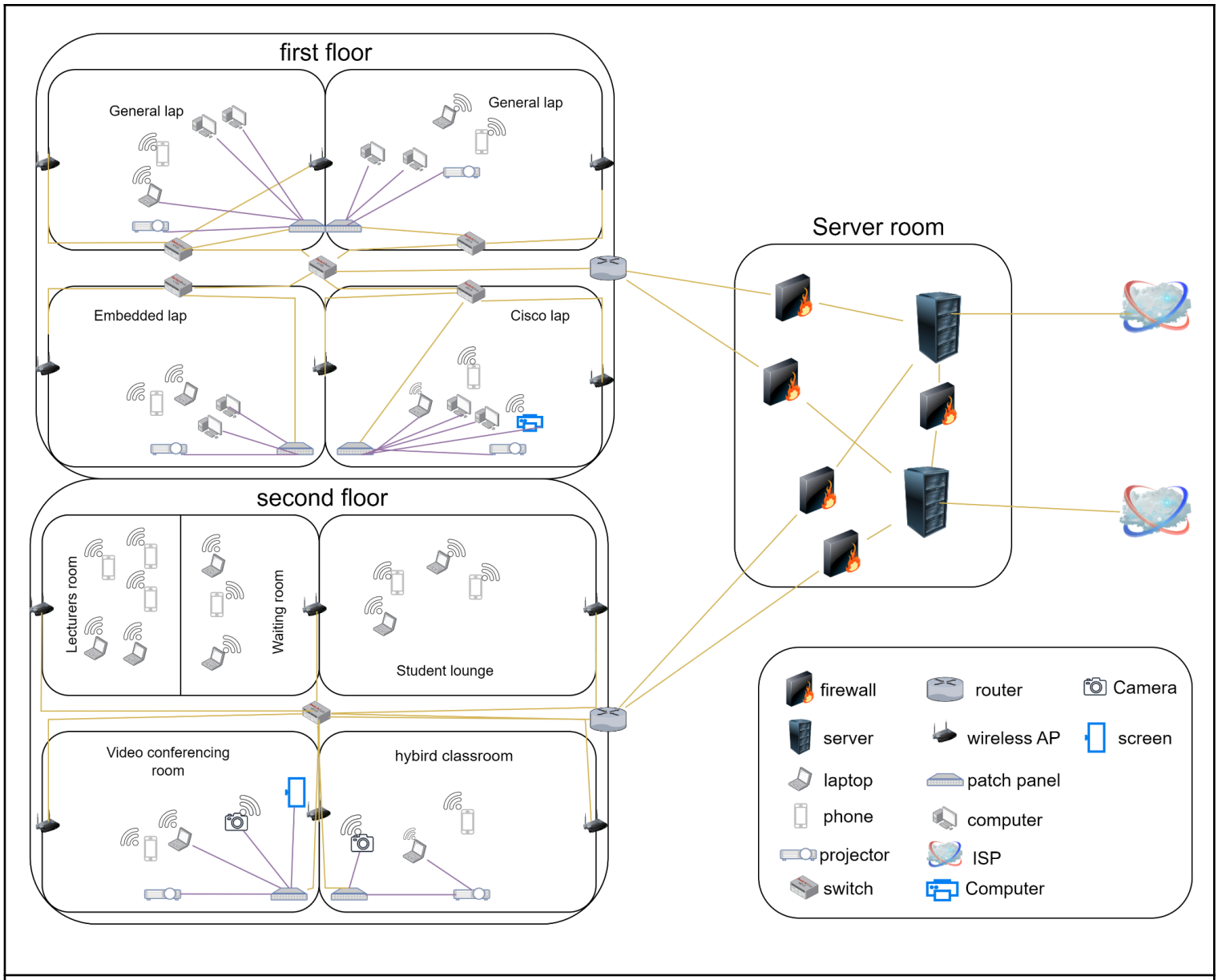
Switches: 6

- 5 on the first floor:
    - 1 central switch
    - 1 switch for each lab (3 total)
- 1 on the second floor

Wireless Access Points (WAPs): 12

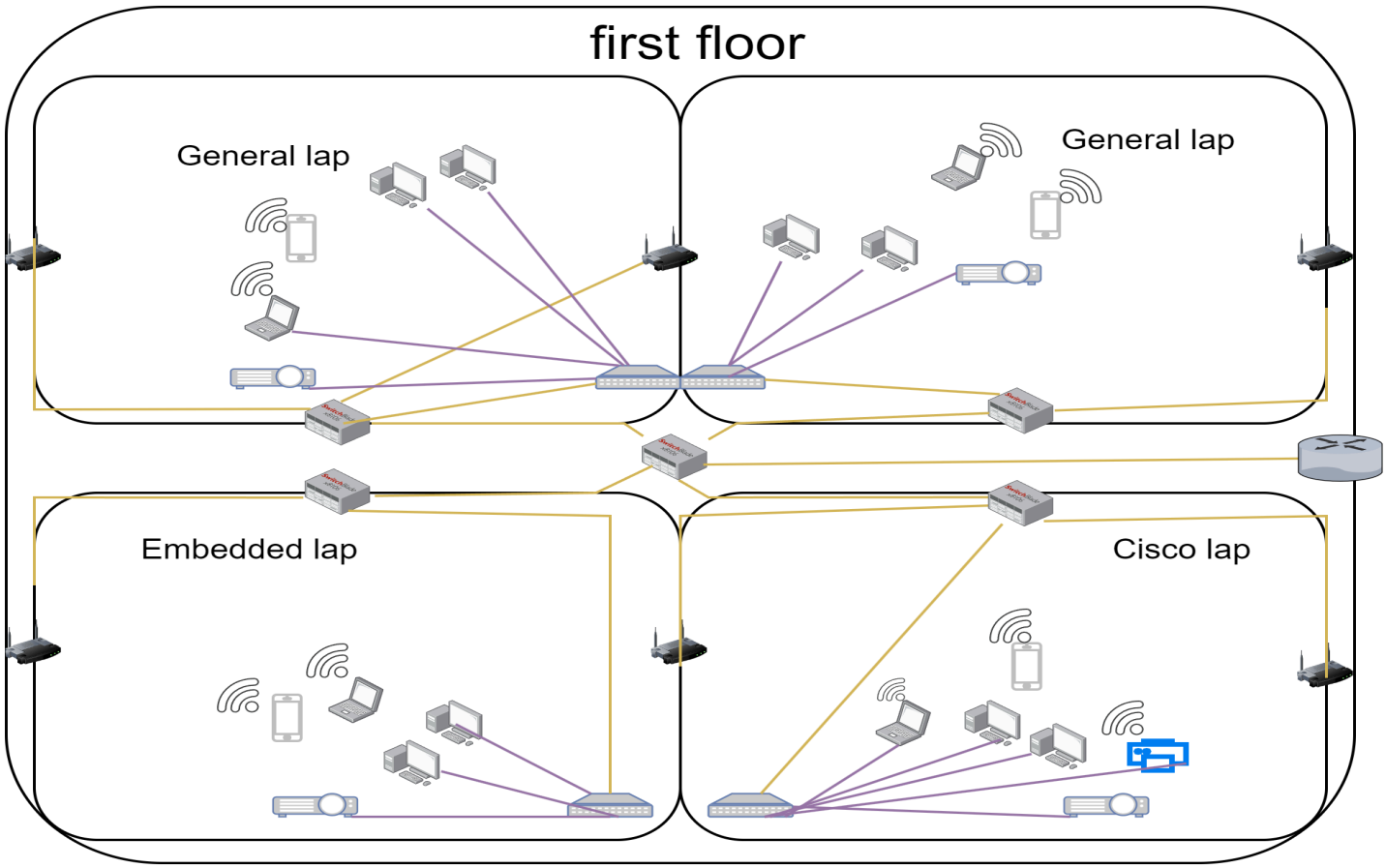
- 6 on the first floor
- 6 on the second floor

Network Layout and Topology



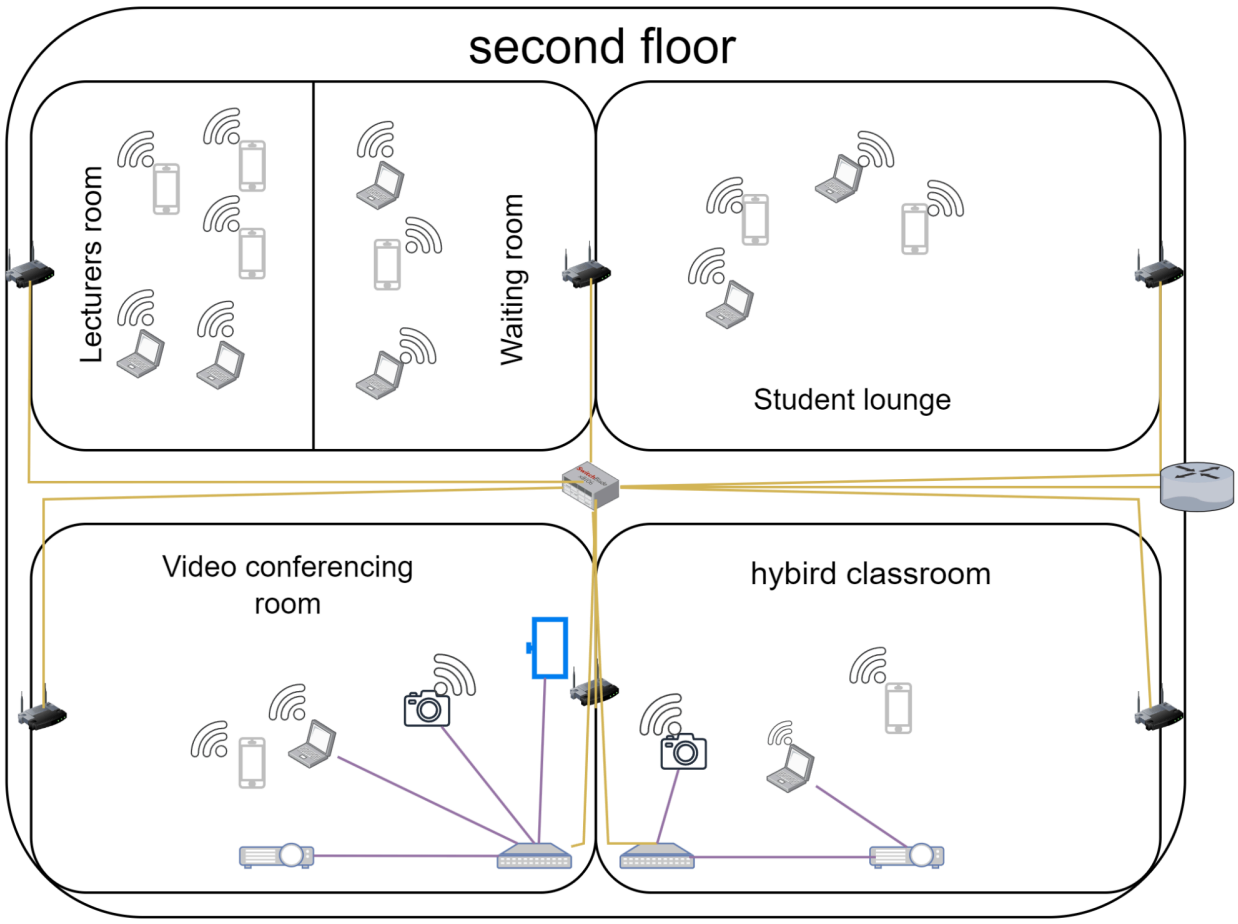
Network topology figure 26

First Floor Layout



First floor layout figure 27

Second Floor Layout



Second floor layout figure 28

Extra information

- Each of the servers is connected to the ISP through fibre optic.
- The chosen local ISP was Telekom Malaysia.
- The routers are not directly connected to each other.
- The number of devices stated in Task3 is still the same regardless of the cable length.
- Devices are connected to the network via CAT6 cables.
- The length of cables used is approximated and the actual length might be a little shorter.

Reflection for Task 4: Network Cabling and Connectivity

Task 4 focused on designing the cabling and connectivity plan to interconnect all devices across Block N28B efficiently. This involved selecting cable types, measuring lengths, and planning routes for horizontal and vertical connections. The structured cabling system was designed to optimize performance, reduce clutter, and ensure seamless communication across all areas.

One strength of this task was the thorough planning of cable types and routes. We selected **Cat6 cables** for short-distance connections, ensuring high-speed data transfer for workstations, and **fiber optic cables** for backbone connections to handle larger traffic volumes. Detailed measurements ensured accurate cable lengths and minimized material wastage. Patch panels were also strategically placed to simplify cable management and troubleshooting.

A limitation, however, was the limited inclusion of redundancy in the cabling plan. While the design met current needs, adding backup connections for critical links between floors and the main server room could improve reliability. Additionally, upgrading more sections to fiber optic cables would provide better scalability and future-proofing.

Overall, Task 4 established a robust and efficient connectivity plan, enabling seamless communication throughout the building. Future improvements should focus on redundancy and leveraging advanced cabling technologies to further enhance network performance and resilience.

4.5 IP Addressing

Subnetting Design

The assigned IP address is 192.19.0.0/23, this IP allows for efficient division of the network onto two floors, the division is performed by taking 1 bit of the host portion and adding it to the network portion for each router.
The new IP will become 192.19.0.0/24, dividing it into 192.19.0.0/24, first floor's subnet, and 192.19.1.0/24 second floor's subnet.
The IP address is a classless IP address allowing for future user's addition and allowing for more network expansion.

3.1 Assigned Network Address

The address is extended for each room to add Wireless hosts assuming approximately (23-32) people are using the Wireless Network at the same time, except for the student's lounge that can take up to 50 people, and that for maximum capacity and efficient distribution of the network.

Each device will be given a unique IP address and the rest of unused IP addresses will be vacant for wireless connection in each of the rooms and labs, and the number of vacant IP addresses varies on the number of possible users in the room.

Area	Hosts Needed	Subnet Mask	Subnet Size (IPs)	Hosts Available
General Lab 1	• 32 Workstations • 2 Wireless access points • 1 Projector	192.19.0.0/24	62	60
General Lab 2	• 32 Workstations • 1 Wireless access points • 1 Projector	192.19.0.62/24	62	60
Embedded Lab	• 32 Workstations • 1 Wireless access points • 1 Projector	192.19.0.124/24	62	60
Cisco Lab	• 32 Workstations • 2 Wireless access points • 1 Projector • 1 Printer	192.19.0.186/24	62	60
Hybrid Classroom	• 1 Workstations • 2 Wireless access points • 1 Camera • 1 Projector	192.19.1.0/24	38	36
Video Conference Room	• 1 Workstations • 1 Wireless access points • 1 Camera • 1 Projector • 1 screen	192.19.1.38/24	23	21
Student Lounge	• 2 Wireless Access Points	192.19.1.61/24	52	50
Waiting Room, Lecturer's Room, Prayer Room	• 1 Wireless Access Points	192.19.1.113/24	32	30

Area	Subnet Address	Usable IP Range	Broadcast Address
General Lab 1	192.19.0.0/24	192.19.0.1 - 192.19.0.60	192.19.0.61
General Lab 2	192.19.0.62/24	192.19.0.63 - 192.19.0.122	192.19.0.123
Embedded Lab	192.19.0.124/24	192.19.0.125 - 192.19.0.184	192.19.0.185
Cisco Lab	192.19.0.186/24	192.19.0.187 - 192.19.0.246	192.19.0.247
Hybrid Classroom	192.19.1.0/24	192.19.1.1 - 192.19.1.36	192.19.1.37
Video Conference Room	192.19.1.38/24	192.19.1.39 - 192.19.0.59	192.19.1.60
Student Lounge	192.19.1.61/24	192.19.1.62 - 192.19.0.111	192.19.1.112
Waiting Room Lecturer’s Room Prayer Room	192.19.1.113/24	192.19.1.114 - 192.19.0.143	192.19.1.144

IP ADDRESS ASSIGNATION

First Floor IP Subnetting

First floor Router : 192.19.0.254

General Lab 1

Subnet Address: 192.19.0.0/24

Broadcast Address: 192.19.0.61

Devices	IP Address
PC1 (Lecturer's PC)	192.19.0.1
PC2 (Technician's PC)	192.19.0.2
PC3	192.19.0.3
PC4	192.19.0.4
PC5	192.19.0.5
PC6	192.19.0.6
PC7	192.19.0.7
PC8	192.19.0.8
PC9	192.19.0.9
PC10	192.19.0.10
PC11	192.19.0.11
PC12	192.19.0.12
PC13	192.19.0.13
PC14	192.19.0.14
PC15	192.19.0.15
PC16	192.19.0.16
PC17	192.19.0.17
PC18	192.19.0.18
PC19	192.19.0.19
PC20	192.19.0.20

Devices	IP Address
PC21	192.19.0.21
PC22	192.19.0.22
PC23	192.19.0.23
PC24	192.19.0.24
PC25	192.19.0.25
PC26	192.19.0.26
PC27	192.19.0.27
PC28	192.19.0.28
PC29	192.19.0.29
PC30	192.19.0.30
PC31	192.19.0.31
PC32	192.19.0.32
Wireless access point 1	192.19.0.33
Wireless access point 2	192.19.0.34
Projector	192.19.0.35

General Lab 2

Subnet Address: 192.19.0.62/24

Broadcast Address: 192.19.0.123

Devices	IP Address
PC1 (Lecturer's PC)	192.19.0.64
PC2 (Technician's PC)	192.19.0.65
PC3	192.19.0.66
PC4	192.19.0.67
PC5	192.19.0.68
PC6	192.19.0.69
PC7	192.19.0.70
PC8	192.19.0.71
PC9	192.19.0.72
PC10	192.19.0.73
PC11	192.19.0.74
PC12	192.19.0.75
PC13	192.19.0.76
PC14	192.19.0.77
PC15	192.19.0.78
PC16	192.19.0.79
PC17	192.19.0.80
PC18	192.19.0.81
PC19	192.19.0.82
PC20	192.19.0.83

Devices	IP Address
PC21	192.19.0.84
PC22	192.19.0.85
PC23	192.19.0.86
PC24	192.19.0.87
PC25	192.19.0.88
PC26	192.19.0.89
PC27	192.19.0.90
PC28	192.19.0.91
PC29	192.19.0.92
PC30	192.19.0.93
PC31	192.19.0.94
PC32	192.19.0.95
Wireless Access Point	192.19.0.96
Projector	192.19.0.97

Embedded Lab

Subnet Address: 192.19.0.124/24

Broadcast Address: 192.19.0.185

Devices	IP Address
PC1 (Lecturer's PC)	192.19.0.127
PC2 (Technician's PC)	192.19.0.128
PC3	192.19.0.129
PC4	192.19.0.130
PC5	192.19.0.131
PC6	192.19.0.132
PC7	192.19.0.133
PC8	192.19.0.134
PC9	192.19.0.135
PC10	192.19.0.136
PC11	192.19.0.137
PC12	192.19.0.138
PC13	192.19.0.139
PC14	192.19.0.140
PC15	192.19.0.141
PC16	192.19.0.142
PC17	192.19.0.143
PC18	192.19.0.144
PC19	192.19.0.145
PC20	192.19.0.146

Devices	IP Address
PC21	192.19.0.147
PC22	192.19.0.148
PC23	192.19.0.149
PC24	192.19.0.150
PC25	192.19.0.151
PC26	192.19.0.152
PC27	192.19.0.153
PC28	192.19.0.154
PC29	192.19.0.155
PC30	192.19.0.156
PC31	192.19.0.157
PC32	192.19.0.158
Wireless access point	192.19.0.159
Projector	192.19.0.160

Cisco Lab

Subnet Address: 192.19.0.186/24

Broadcast Address: 192.19.0.247

Devices	IP Address
PC1 (Lecturer's PC)	192.19.0.190
PC2 (Technician's PC)	192.19.0.191
PC3	192.19.0.192
PC4	192.19.0.193
PC5	192.19.0.194
PC6	192.19.0.195
PC7	192.19.0.196
PC8	192.19.0.197
PC9	192.19.0.198
PC10	192.19.0.199
PC11	192.19.0.200
PC12	192.19.0.201
PC13	192.19.0.202
PC14	192.19.0.203
PC15	192.19.0.204
PC16	192.19.0.205
PC17	192.19.0.206
PC18	192.19.0.207
PC19	192.19.0.208
PC20	192.19.0.209

Devices	IP Address
PC21	192.19.0.210
PC22	192.19.0.211
PC23	192.19.0.212
PC24	192.19.0.213
PC25	192.19.0.214
PC26	192.19.0.215
PC27	192.19.0.216
PC28	192.19.0.217
PC29	192.19.0.218
PC30	192.19.0.219
PC31	192.19.0.220
PC32	192.19.0.221
Wireless access point 1	192.19.0.222
Wireless access point 2	192.19.0.223
Projector	192.19.0.224
Printer	192.19.0.225

Second Floor IP Subnetting

second floor Router : 192.19.1.254

Hybrid Classroom

Subnet Address: 192.19.1.0/24

Broadcast Address: 192.19.1.37

Devices	IP Address
PC	192.19.1.1/17
Wireless Access Point 1	192.19.1.2/17
Wireless Access Point 2	192.19.1.3/17
Camera	192.19.1.4/17
Projector	192.19.1.5/17

Student Lounge

Subnet Address: 192.19.1.61/24

Broadcast Address: 192.19.1.112

Devices	IP Address
Wireless Access Point 1	192.19.1.64/17
Wireless Access Point 2	192.19.1.65/17

Video Conference Room

Subnet Address: 192.19.1.38/24

Broadcast Address: 192.19.1.60

Devices	IP Address
PC	192.19.1.40/17
Wireless Access Point 1	192.19.1.41/17
Camera	192.19.1.42/17
Projector	192.19.1.43/17
Screen	192.19.1.44/17

Waiting Room, Lecturer’s Room ,Prayer Room

Subnet Address: 192.19.1.113/24

Broadcast Address: 192.19.1.144

Devices	IP Address
Wireless Access Point	192.19.1.117

Reflection for Task 5: IP Addressing Scheme

Task 5 of the project aimed at designing and configuring an optimized IP addressing in a structured network in an academic environment. As per the promoted 192.19.0.0/23 network address, this project was able to subnet the network with maximum scalability, logical division and optimal use of IPs. Every floor, laboratory and functional space was designed to eliminate possible IP collisions and incorporate the necessary equipment, including PCs, patch panels, wireless network access points, cameras and projectors.

The rationale followed in implementing the subnetting design entailed proper segmentation and allocation of subnet masks and the details of the IP range, broadcast addresses, and specific IP allocation to devices. To provide clear paths of communication between all devices, addressing schemes gave focus on identification, organization, scalability and security for future expansion.

In written detailed meeting minutes, members report that teamwork supported cooperative efforts in achieving clarity of tasks functions and implementation. The design effect also achieves the current load and additionally lays the groundwork for the network structure of the institution. This makes this network strong and effective for the future calls because it is generalized with capacity to absorb any incoming traffic.

5. Conclusion

It has been a complete and a rewarding project to design and implement the network infrastructure for the Faculty of Computing, Block N28B. By coordination and systematic planning, the team solved the problem of faculty need for a modern, scalable and reliable network. In this report, all building layout analysis to designing the IP addressing scheme for the network making sure that it is an efficient, secure and future ready network is encapsulated.

Achievements

1. Scalable Network Design:
    - It implemented a hierarchical topology that supported the current needs and would address future growth needs for scalability, management ease.
2. Logical IP Addressing:
    - Address conflict avoidance, maximised efficiency, and support for future devices were all part of the design of the subnetting and IP allocation.
3. Cost-Effective Device Selection:
    - To meet the objectives of the project without exceeding financial constraints, a good balance of performance and budget was carefully provided for high quality devices.
4. Comprehensive Cabling Plan:
    - Cat6 was plugged for the short links and fiber optic for the backbone links and thus a structured cabling system that guarantees optimal data transfer speed and reliability was developed.
5. Documentation and Collaboration:
    - It offers detailed documentation in the form of diagrams, tables and financial reports that navigate you on your road map towards implementation of the proposed network.

Strengths

- At project planning level, the project shows good planning, good use of resources and logical and systematic approach.
- The design is modular and scalable and is ready for future expansions.
- Connection from both academic and research as well as the administrative purposes are enhanced through the network infrastructure.

Weaknesses

- Though some areas of the design (such as redundancy for critical links) could be improved to provide fault tolerance, the design itself is proven.

- To take advantage of ever decreasing cabling costs, more sections of the cabling plan could be upgraded to include fiber optic cables.

Suggestions for Improvement

1. **Enhanced Redundancy:** This is making this redundant and adding in additional failover mechanisms, which you can have backup routers, or you can have backup links.
2. **Advanced Wireless Coverage:** Usable wireless access point coverage can then be expanded to higher demand areas.
3. **Device Upgrades:** If it's within the budget, consider replacing key devices like switches to higher performance devices.
4. **Monitoring Tools:** Make use of network monitoring tools, for real time management and troubleshooting.

Finally, the network design meets its prime objectives of furnishing a dependable and scalable infrastructure and problems that can be enhanced further. These improvements will ensure that the proposed network will remain a productive system to the faculty for many years to come.

6. Additional Considerations for the Client's Decision-Making Process

Although the proposed network design is efficient, scalable and cost effective, there are some changes to the client allocation which, although would require a slightly larger budget, would also provide a higher quality of outcome. These further improvements would yet future proof the network and improve overall reliability and performance.

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1. Upgrading to Fiber Optic Cables for Horizontal Cabling

- **Current Design:** Cable Cat6 is used for horizontal connections between labs and rooms.
- **Proposed Enhancement:** If the horizontal cabling in high demand areas like Labs and shared spaces, there is an option of replacing Cat6 with fiber optic cables:
    - Allow for higher bandwidth into the future.
    - Improving connection stability and reducing electromagnetic interference (EMI).
    - To extend the life of the cabling system for network upgrades.
- **Estimated Cost Impact:** They are more expensive than Cat6 but it's better long term than that increased cost.

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2. Advanced Switches Investments

- **Current Design:** To strike a balance between performance and budget, mid range switches were chosen.
- **Proposed Enhancement:** If the current scenario calls for upgrading from active network switches into advanced switches which have Layer 3 features, such as VLAN routing as well as PoE (Power over Ethernet) functionality, then:
    - It simplifies network management by supplying advanced routing between subnets.
    - Overade helps in providing additional power for things like WAPs and IP cameras, thus removing the need for an external power supply.
- **Estimated Cost Impact:** The network currently has today's best investment in long term scalability, and some reduction in maintenance costs, if higher performance switches were used.

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3. Increasing Wireless Access Point Coverage

- **Current Design:** It was seen that 12 WAPs were placed adequately to keep adequate coverage.

- **Proposed Enhancement:** Solving the problem could involve adding more WAPs or using high end Wi-Fi 6 access points but can be fixed by any of these solutions.
    - Driving the speeds needed for modern devices.
    - In high traffic areas such as labs, meeting rooms and conference rooms.
- **Estimated Cost Impact:** Wi-Fi 6 APs increase cost but future proofs the network as device capabilities evolve.

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4. Redundancy for Critical links

- **Current Design:** It's rather redundant, but only on core connections..
- **Proposed Enhancement:** If they purchased additional backup routers, they would also add in redundant cabling for the main router connections and the backbone.:
    - To guarantee uninterrupted service when failing hardware or when the cable is damaged.
    - Increase reliability for essential academic and administrative operations.
- **Estimated Cost Impact:** The cost of redundancy is relatively small compared to the operational stability it offers.

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5. Network Monitoring Tools Introduction

- **Proposed Addition:** There are tools like Solarwinds, PRTG, that implement network monitoring software. to:
    - Offer real time insights to network performance.
    - With easy to interpret results, quickly diagnose and fix bottlenecks or hardware fails.
- **Cost vs. Benefit: It costs very little more than the monitoring tools themselves enable it to be so much more efficient and so much less down time.**

7. Team Members and responsibilities

Member	Responsibility
Abdalla Ali Abdalla Ali	Formatting, Proofreading, Facilitate discussion,
Mohammed Abdelgawwad Abdelghani Moustafa Hassan Daoud	Research, Innovation, Assign responsibilities
Nouredin Mamdouh Mohamed Eldesouky Elnamla	Work Compilation, Methodology, Implementation

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9. Appendices

The Financial Budget

The given use of 2m ringgit to initialize a labs ,classrooms, and working areas for network use and utilization, the amount is spent on best cost-effective distribution, The budget taken for the necessary lab equipment, cabling and network infrastructure is happen to be 1.019m ringgit, taken out from the overall budget there is almost 50% is left and will be utilized for mainly the maintenance of the system and device, also for future uses and updates.

Given that most of the budget was spent on workstations taking 67% of the spent budget, given that most expensive device are

- Routers: 2 cost 50000 to give each floor a subnet and a good routing given large traffic.
- Servers: 2 cost 100000 to give the own network the fastest connection to the ISP and maximum security.
- Switches: 6 cost 90000 to divide the network evenly given the large number of connections.

Meeting minutes #1:

Date/time	**11/10/2024, 8:30 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	1. **Discussing the task.** 2. **Discussing the floor plan construction** 3. **Drawing application** 4. **Tasks division** 5. **Next meeting**
Meeting MC	**Abdalla Ali Abdalla Ali**

Attendance

Name	**Time**	**Reason of absence**
1- Abdalla Ali Abdalla Ali	**8:30**	**---**
2- Nouredin Mamdouh	**8:30**	**---**
3- Mohammed abdelgawwad	**8:30**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The given task.**	Noureldin thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Nouredin Mamdouh (8:30 – 8:39)
2.	**the floors' plan.**	**Each member gave a rough sketch of his plan, and then a brief discussion about the most suitable combination of designs, in terms of cost and aesthetics, Abdalla drew a good illustration of the design and explained it can be the most suitable.**	**Abdalla Ali (8:47 - 8:59)**

3.	**Drawing application**	Abdalla suggested to use adobe illustrator as a drawing tool, Noureldin and Mohammed suggested trying different tools due to lack of experience and being hard to edit designs, Mohammed Abdelgawwad suggested using Drawio website, both Abdalla and Nouredin tried to test the website, and both approved of the tool.	Mohammed abdegawwad (9:00 – 9:13)
4	**Tasks division**	Each member obtained a copy of the floor design file and everyone can work on the same design from his device, Nouredin as a group leader explained the parts for the members. Each member has an idea about his role in the designing phase.	Nouredin Mamdouh (9:15 – 9:20)
5	**Next meeting**	Mohammed suggests to finish the whole design and report and meet again to discuss how it will look in the final.	Mohammed Abdelgawwad (9:20 – 9:22)
Meeting ended		9:22	

Meeting minutes #2:

Date/time	**13/10/2024, 8:00 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	1. **The interior design** 2. **What devices will be added** 3. **Colouring and aesthetics** 4. **Team motivation**
Meeting MC	**Abdalla Ali Abdalla Ali**

Attendance

Name	**Time**	**Reason of absence**
1- Abdalla Ali Abdalla Ali	**8:00**	**---**
2- Nouredin Mamdouh	**8:00**	**---**
3- Mohammed abdelgawwad	**8:00**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The interior design**	Abdalla suggested adding workstation and technical room, other members approved.	Abdalla Ali (8:00 – 8:11)
2.	**What devices will be added**	**Nouredin briefly explained that in task 1, no devices should be added and could be added in next tasks.**	**Nouredin (8:11 – 8:21)**
3.	**Colouring and aesthetics**	**Mohammed suggested a small change in the lounge design to be more appealing and Nouredin suggested colouring**	Mohammed abdegawwad 8:21 – 8:30)
4.	Team motivation	Mohammed Abdelgawwad said that our collaborative work will result in good consequences(God Willing).	Mohammed Abdelgawwad (8:30 – 8:33)
Meeting ended		8:33	

Meeting Minutes #3

Location	Google Meet (online)
Meeting discussion task	1. The task. 2. The suggest idea. 3. The source of information. 4. Next meeting.
Meeting MC	Abdalla Ali Abdalla Ali

Attendance			
Name		Time	Reason of absence
1	Abdalla Ali Abdalla Ali	8:00	N/A
2	Nouredin Mamdouh	8:00	N/A
3	Mohammed abdelgawwad	8:00	N/A

Minutes			
No	Item discussed	Result	Person in charge/Time
1.	The task	Noureldin thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Nouredin Mamdouh (8:00 pm - 8:19 pm)
2.	The suggested idea.	Mohammed suggested to briefly think about all aspects of the network in a step-by-step approach, as network engineers and designers, and what we supposed to do.	Mohammed abdelgawwad (8:20 pm - 8:29 pm)

2.	The resources of the information	Abdalla suggested to firstly try to come up with simple questions by analyzing the tasks, and discussing basic questions first then getting into more complex question to discuss with the FC representative.	Abdalla Ali (8:29 pm - 8:35 pm)
3.	Next meeting	Next meeting said Noureldin to be held at Sunday after we all gathered question to be discussed	Nouredin Mamdouh (8:35 pm - 8:39 pm)
Meeting Ended			8:39 pm

Meeting Minutes #4

Location		Google Meet (online)	
Meeting discussion task		1. The suggested questions	
Meeting MC		Abdalla Ali Abdalla Ali	
Attendance			
Name		Time	Reason of absence
1	Abdalla Ali Abdalla Ali	9:00 pm	N/A
2	Nouredin Mamdouh	9:00 pm	N/A
3	Mohammed Abdelgawwad	9:00 pm	N/A
Minutes			
No	Item discussed	Result	Person in charge/Time
1.	The suggested questions	Nouredin discussed his questions, while discussing which is appropriate and which is not. Mohammed also did the same. And Abdalla did the same, the member gathered their questions to discuss with the FC representative.	Nouredin Mamdouh (9:00 pm - 9:19 pm) Mohammed Abdelgawwad (9:19 pm -9:32 pm) Abdalla Ali (9:32pm - 9:44 pm)
Meeting ended			9:45 pm

Meeting minutes #5:

Date/time	**25/11/2024, 8:30 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	**1. The task.** **2. The suggested idea.** **3. Brand of the devices.** **4. Task division.**
Meeting MC	**Abdalla Ali Abdalla Ali**

Attendance

Name	**Time**	**Reason of absence**
1- Abdalla Ali Abdalla Ali	**8:30**	**---**
2- Nouredin Mamdouh	**8:30**	**---**
3- Mohammed abdelgawwad	**8:31**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The task.**	Noureldin thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Nouredin Mamdouh (8:32 pm – 8:55 pm)
2.	**The suggested idea.**	Mohammed suggested to briefly think about all the devices that should be included in the report, Abdalla named few devices that could be used in the labs	Mohammed abdelgawwad (8:55 pm – 9:17 pm)

Meeting minutes #6

Date/time	**14/12/2024, 9:02 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	**1. The task.** **2. The suggested idea.** **3. The drawing tool.** **4. Task division.** **5. Working on the project.**
Meeting MC	**Abdalla Ali Abdalla Ali**

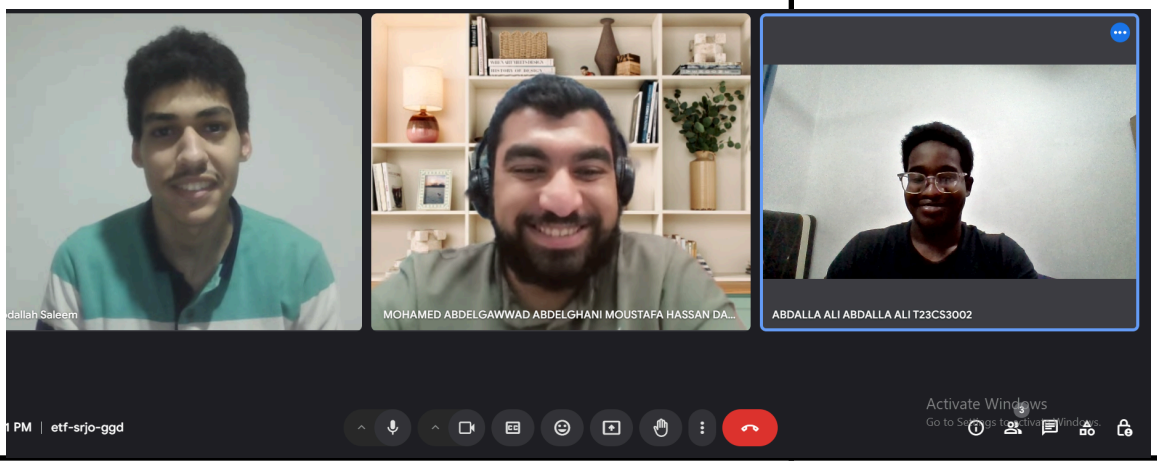
Attendance

Name	**Time**	**Reason of absence**
1- Abdalla Ali Abdalla Ali	**9:02**	**---**
2- Nouredin Mamdouh	**9:06**	**---**
3- Mohammed abdelgawwad	**9:02**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The task.**	Noureldin and Abdalla thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Nouredin Mamdouh (9:06 pm – 9:18 pm) Abdalla Ali(9:18 pm - 9:24 pm)
2.	**The suggested idea.**	Mohammed talked about what should be done in this phase, what are the available resources, and the amount of work to be done	Mohammed abdelgawwad (9:25 pm – 9:42 pm)

3.	**The drawing tool.**	Nouredin discussed which tools are most suitable, Abdalla and Mohammed gave their opinions and options on which tools are suitable, Abdalla suggested Adobe illustrator, Mohammed suggested Draw.io because it's easy and everyone knows how to use the tool.	Abdalla Ali (9:43 pm – 9:50 pm) Mohammed abdelgawwad (9:51 pm - 9:59 pm)
4.	**Task division.**	Nouredin suggested that each part of the design should be taken by a member with Abdalla taking the responsibility to review the work on the finished designs, Mohammed will take most part of the report while taking some part of designing, Nouredin will focus on the report design and participate in the floor and cable designing.	Nouredin Mamdouh (9:33 pm – 9:59 pm)
5.	**Working on the project**	Each member started doing the task assigned to him and the meeting kept open for further collaboration and communication.	Abdalla Ali (9:59 pm – 11:50 pm) Mohammed abdelgawwad (9:59 pm - 11:50 pm) Nouredin Mamdouh (9:59 pm – 11:50 pm)
Meeting Ended			**11:51 PM**



Meeting minutes#7

Date/time	**23/12/2024, 9:21 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	**1. The task.** **2. The appropriate subnetting.** **3. The devices on each floor.** **4. Task division.** **5. Working on the project.**
Meeting MC	**Abdalla Ali Abdalla Ali**

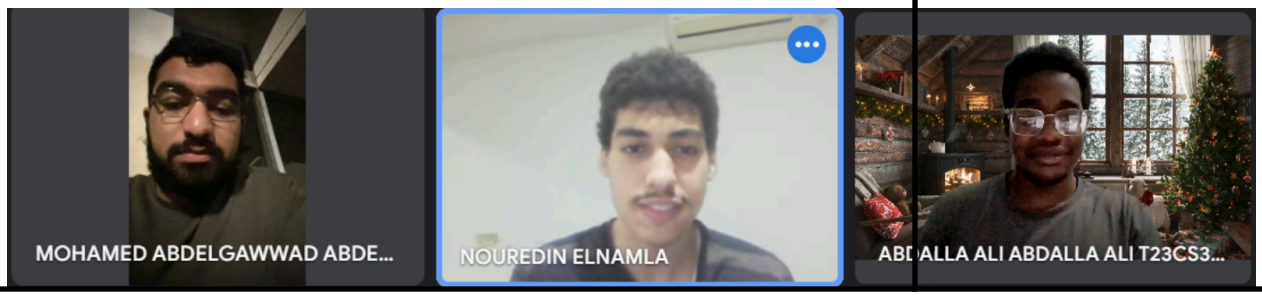
Attendance

Name	**Time**	**Reason of absence**
1- Abdalla Ali Abdalla Ali	**9:21**	**---**
2- Nouredin Mamdouh	**9:22**	**---**
3- Mohammed abdelgawwad	**9:22**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The task.**	Mohammed and Abdalla thoroughly read the task and explained each part in details, while explaining some terms, the team had a good understanding of the overall task.	Mohammed Abdelgawwad (9:23 pm – 9:40pm) Abdalla Ali (9:42 pm - 9:50 pm)
2.	**The appropriate subnetting.**	Abdalla talked about what should be done in this phase, what are the appropriate subnetting divisions for each floor and room, and he explained about IP addressing, and how to divide it between the rooms.	Abdalla Ali (9:51 pm – 10:17 pm)

3.	**The devices on each floor.**	Nouredin suggested counting the devices that should have an IP to determine the range of usable IP addresses, subnet address and the appropriate subnet mask.	Nouredin Mamdouh (10:17 pm – 10:20 pm)
4.	**Task division.**	Nouredin suggested that he will take a part of the first floor and second floor IP addressing, while Mohammed will take part of the first floor and second floor IP addressing also, Abdalla will focus on the subnetting, formatting the document, and revision of the project.	Nouredin Mamdouh (10:24 pm – 10:27 pm)
5.	**Working on the project**	Each member started doing the task assigned to him and the meeting kept open for further collaboration and communication.	Abdalla Ali (10:27 pm – 12:39 pm) Mohammed abdelgawwad (10:27 pm – 12:39 pm) Nouredin Mamdouh (10:27 pm – 12:39 pm)
Meeting Ended			**12:41 PM**



Meeting minutes#8

Date/time	**05/01/2024, 9:00 p.m.**
Location	**Google Meet (online)**
Meeting discussion task	**1. The task.** **2. Task division.** **3. Working on the project.**
Meeting MC	**Mohammed Abdelgawwad**

Attendance

Name	**Time**	**Reason of absence**
1- Mohammed abdelgawwad	**9:00**	**---**
2- Nouredin Mamdouh	**9:02**	**---**
3- Abdalla Ali Abdalla Ali	**9:01**	**---**

Minutes

No	**Item discussed**	**Result**	**Person in charge/Time**
1.	**The task.**	Abdalla read the task and thoroughly explained the ongoing process of the project and what should be done.	Abdalla Ali (9:03 pm - 9:18 pm)
2.	**Task division**	Mohammed gave Abdalla the formatting and meeting minutes, Nouredin was given the task of task collection and compilation, while Mohammed was responsible for managing and editing errors and doing some of their work as well.	Mohammed Abdelgawwad (9:18 pm – 9:23 pm)
3.	**Working on the project**	Each member starts working on their task until it's very late or the project is finalized.	Abdalla Ali (9:23 pm – 12:39 pm) Mohammed abdelgawwad (9:23 pm – 12:39 pm) Nouredin Mamdouh (9:23 pm – 12:39 pm)

Meeting ended	12:30 A.M.