



**UTM**  
UNIVERSITI TEKNOLOGI MALAYSIA

**FACULTY OF COMPUTING**  
UTM Johor Bahru

## **SECR1213 : Network Communications**

Semester I 2024/2025

**Dr.Hazinah**

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**Faculty of Computing**

**Project**

Network Design for Faculty of Computing Block N28B

**Prepared by**

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## **1.0 INTRODUCTION**

I have been tasked with designing and implementing system upgrades for the Faculty of Computing to support its expansion and future-proof infrastructure. The faculty was anticipating a 15% growth on both student and staff over the next four years, the need for enhanced facilities and technology has become critical.

This project aims to build a reliable, secure, and scalable network for the new two-story building. The design focuses on planning the layout for labs, classrooms, and shared spaces to make sure they work well for learning and daily activities. Each lab will have 30 workstations and the necessary equipment, like networking devices for the Cisco Lab and tools for the Embedded Lab. Spaces like the hybrid classroom and student lounge will be arranged to support both study and relaxation. The design also includes high-speed internet and the ability to adapt to new technologies in the future.

The main objective is to create a network that meets the current needs while being ready for future upgrades. This includes improving performance, adding strong security, and making it scalable for more users and devices over time. The system should also support wireless connections and remote access to match changes in technology. We assume that the infrastructure will need to adjust to new standards as technology evolves, and this has been considered in the design.

## **2.0 PROJECT BACKGROUND**

As of 2024, the Faculty of Computing serves 1,800 students and employs 100 academic staff and 40 support staff. With a projected 15% growth in the next four years, the current infrastructure will no longer meet the faculty's needs. To address this, a new two-story building will be constructed, featuring four labs, a video conferencing room, a hybrid classroom, and a student lounge.

The labs will include two general-purpose labs, a Cisco Network Lab with networking equipment, and an Embedded Lab with specialized devices for hands-on learning. Each lab will house 30 workstations connected to high-speed internet, aligning with the needs of the Fourth Industrial Revolution (4IR). The hybrid classroom will be designed for flexible teaching, while the student lounge will provide a comfortable space for relaxation and collaboration.

This setup is going to be used for the next 20 years and wants to be 'ready for anything', which means we need the network system to be reliable, efficient, secure and scalable. In order to achieve this, the infrastructure needs to be scalable and easy to manage by FC staff and students. The performance of the system is the first concern, followed by the security of the network. The system should offer protection from network breaches such as Internet Worms, denial-of-service attacks and e-business application attacks. Moreover, future upgrades such as network scalability and wireless connectivity also need to be taken into consideration.

## 3.0 COMPILED SOLUTION

Below is the result of our project compiled into a comprehensive and organized outcome that integrates all aspects of the project into a single, cohesive document or plan

### 3.1 ALL PREVIOUS TASK COMPILED

## 1.0 Floor Plan Design

### 1.1 Floor 1

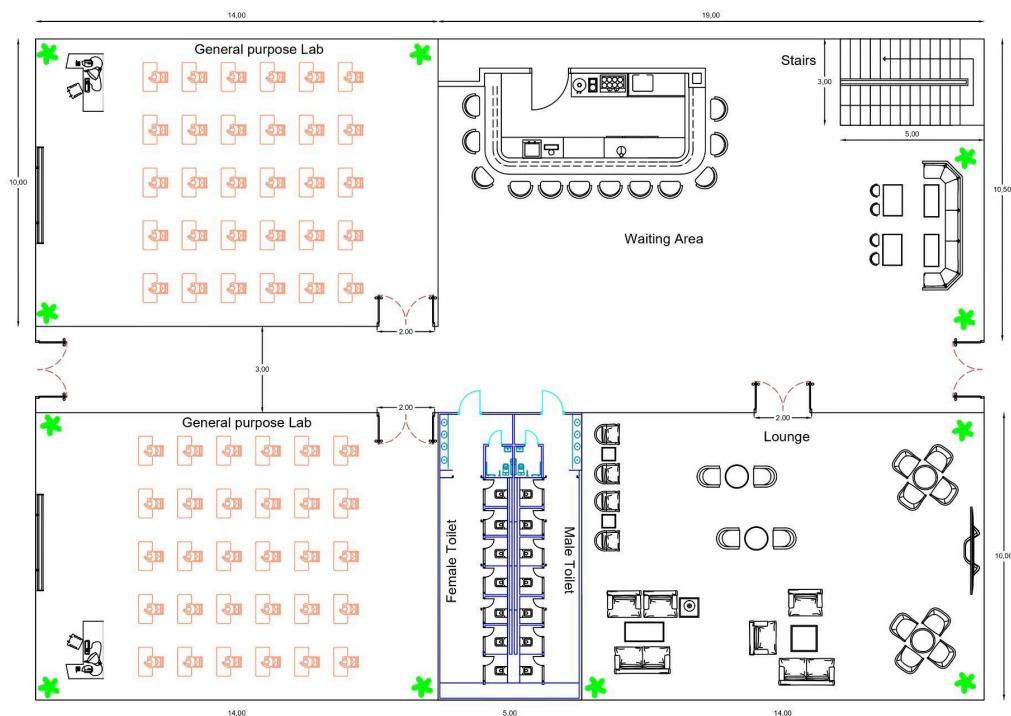
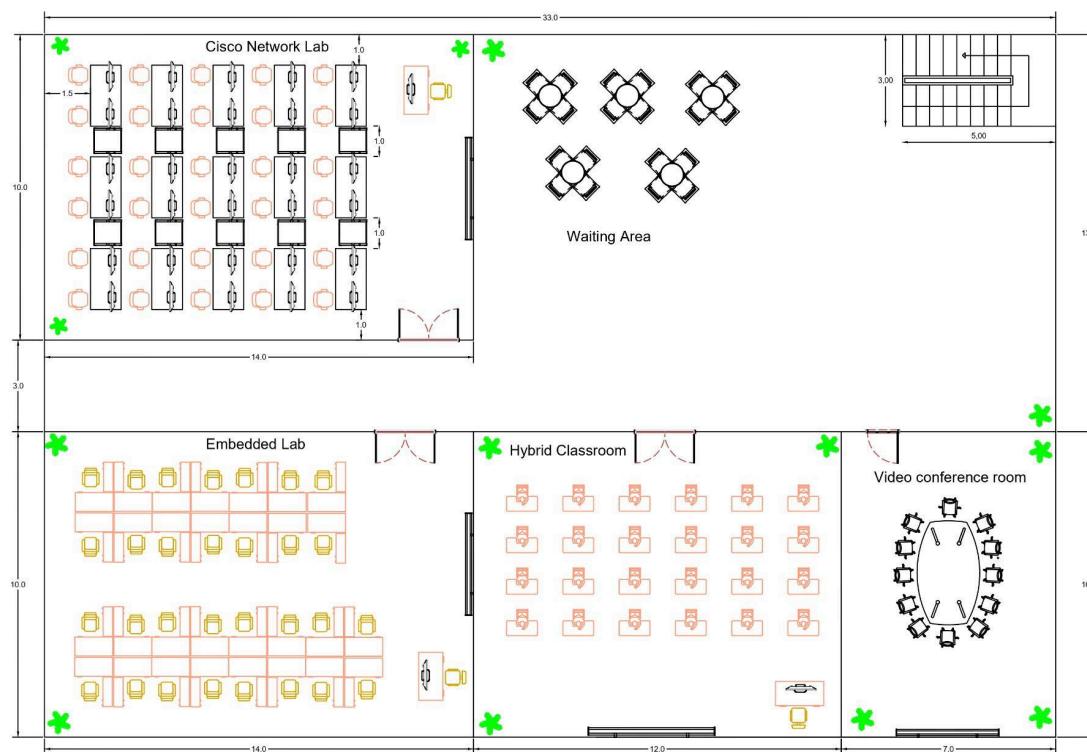


Figure 1.1 : Ground Floor's Floor Plan

This floor plan offers a clear overview of the ground floor, showing the placement of 2 general-purpose labs and student lounges. It helps guide the placement of WAPs (Wireless Access Points) and cabling to ensure the chosen network topology functions

effectively. Following the requirements of Task 1, 30 workstations have been arranged in each general-purpose lab. This setup maximises space, ensures reliable connectivity, and provides comfortable areas for students to work and relax.

## 1.2 Floor 2



*Figure 1.2 : Second Floor's Floor Plan*

This floor plan provides a clear view of the second floor, highlighting key areas: the Cisco network lab, embedded lab, hybrid classroom, and video conference room. It is designed to guide the placement of WAPs (Wireless Access Points) and cabling, ensuring the network setup operates smoothly. As specified in Task 1, 30 workstations have been set up in both the Cisco network lab and the embedded lab. The hybrid classroom and video conference room are equipped with the necessary devices to support their intended functions efficiently.

## 2.0 Floor Scale

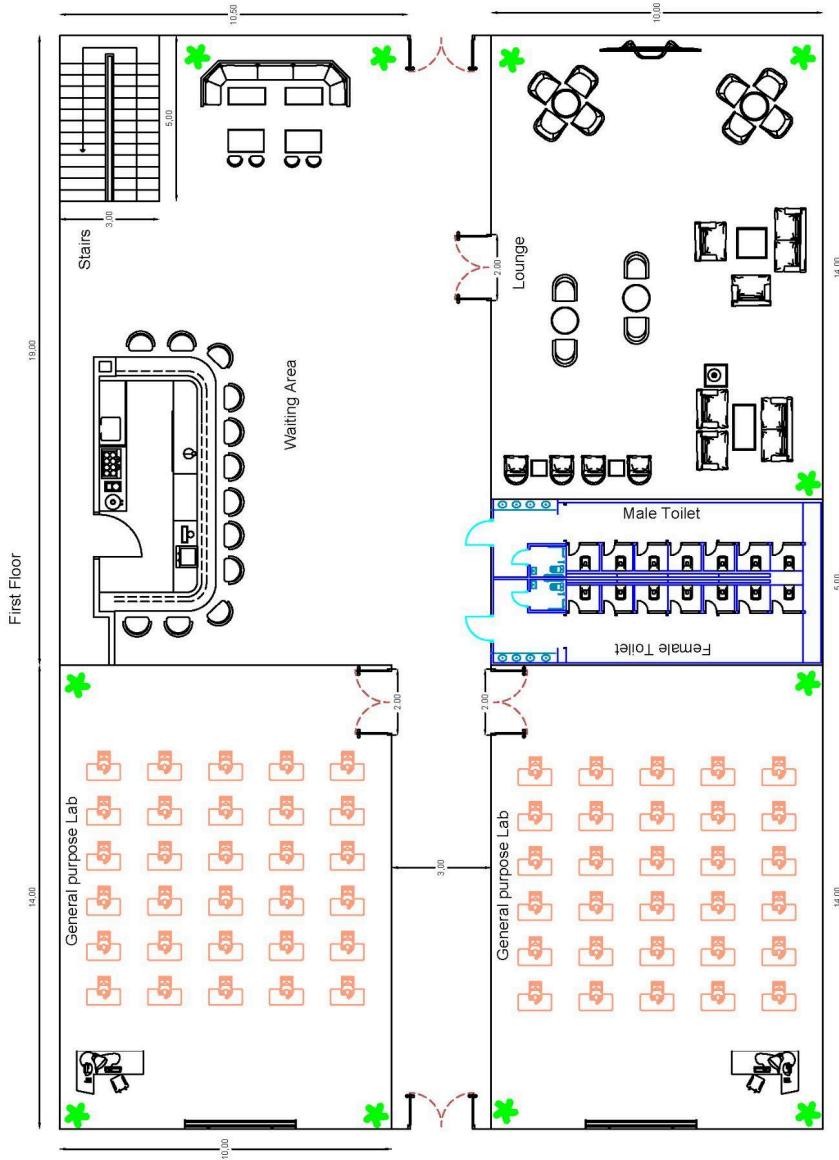
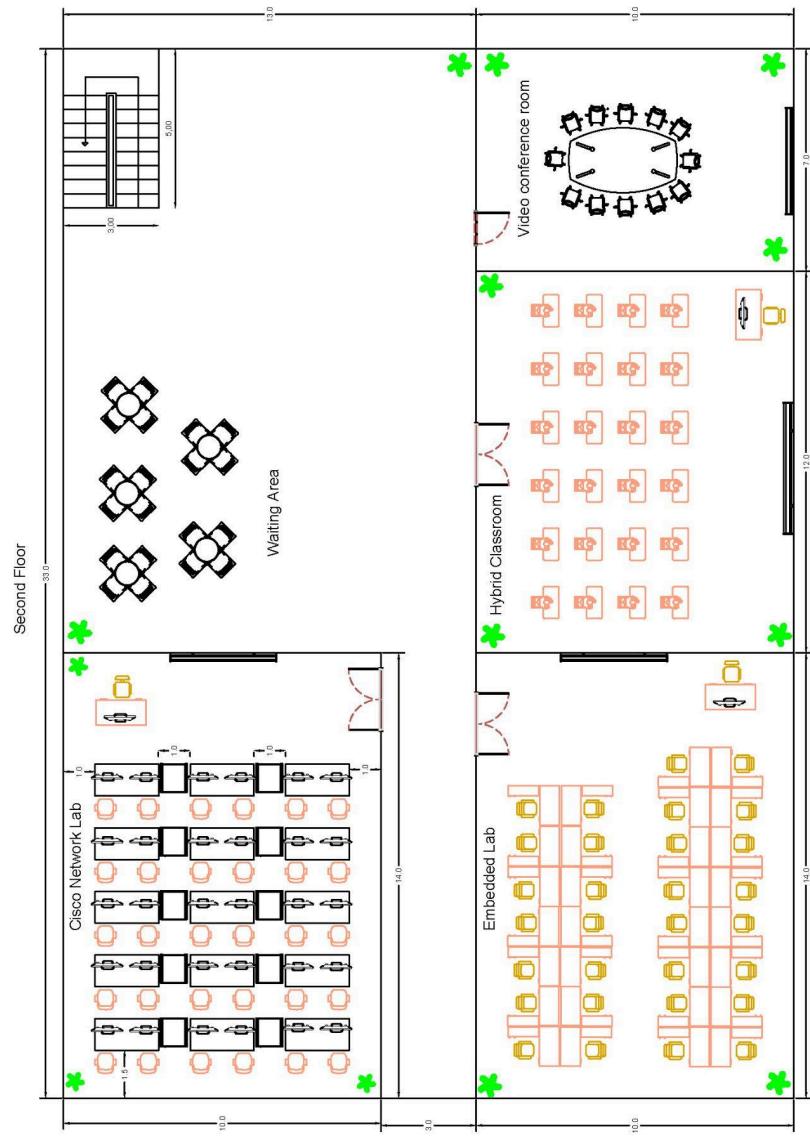


Figure 2.1 : First Floor's Floor Plan Scale

Scale : 0.65cm : 1m

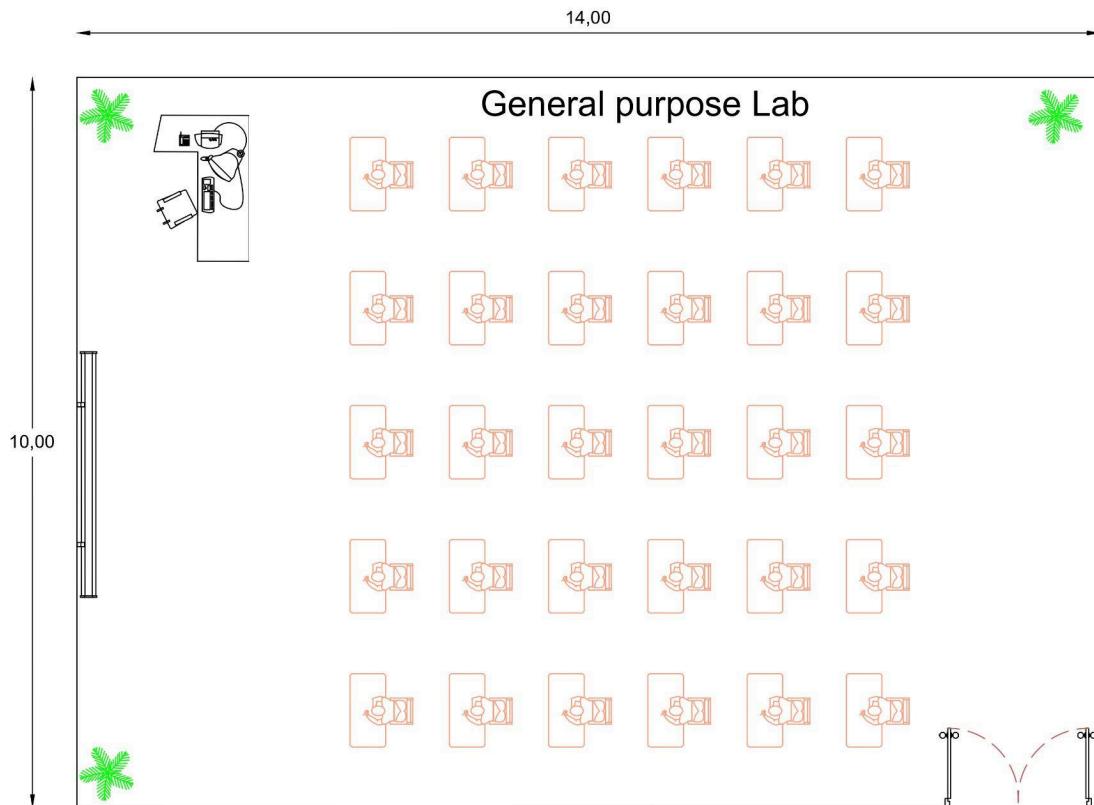


*Figure 2.2 : Second Floor's Floor Plan Scale*

Scale : 0.65cm : 1m

# 3.0 Floor Plan Facilities

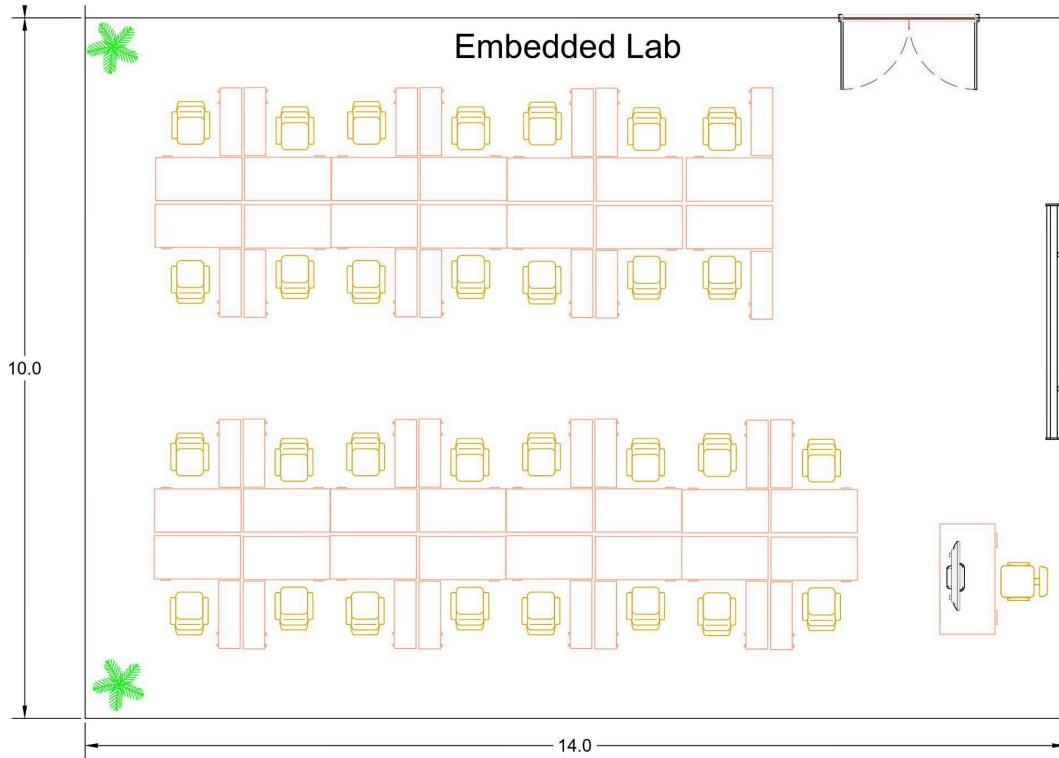
## 3.1 General Purpose Lab



*Figure 3.1 : General Purpose Lab's Floor Plan*

The general purpose lab is a shared workspace where students and faculty can practise programming, work on projects, and run experiments. It's used for hands-on learning during lab sessions, completing assignments, and exploring research. The lab has 30 workstations with specialised software installed to provide resources for student skill development and activities. It supports practical learning and helps students apply theoretical concepts in a real-world setting.

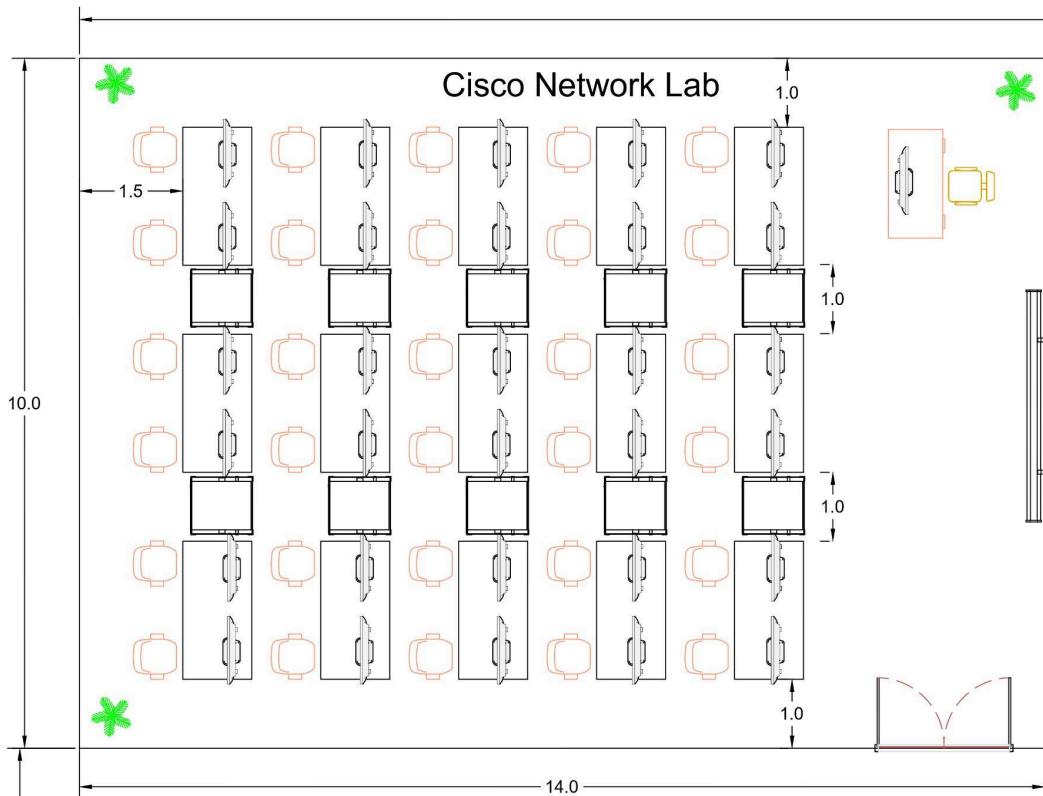
### 3.2 Embedded Lab



*Figure 3.2 : Embedded Lab's Floor Plan*

The Embedded Lab is a space where students learn and work on embedded systems. Small, specialised computers used in devices like robots, sensors, and IoT gadgets. The lab is equipped with 30 workstations, tools and hardware like microcontrollers, sensors, and circuit boards, allowing students to design, program, and test embedded systems. The lab helps students apply concepts from electronics, programming, and system design to create real-world projects like smart devices or automation systems.

### 3.3 Cisco Network Lab



*Figure 3.3 : Cisco Network Lab's Floor Plan*

The Cisco Network Lab is for learning and practising networking concepts using Cisco equipment. The lab is equipped with 30 workstations, routers, switches, and servers. It helps students design, configure, and troubleshoot computer networks, preparing them for certifications like CCNA. The lab is essential for hands-on training in network management, security, and real-world setups like LANs and WANs.

### 3.4 Hybrid Classroom

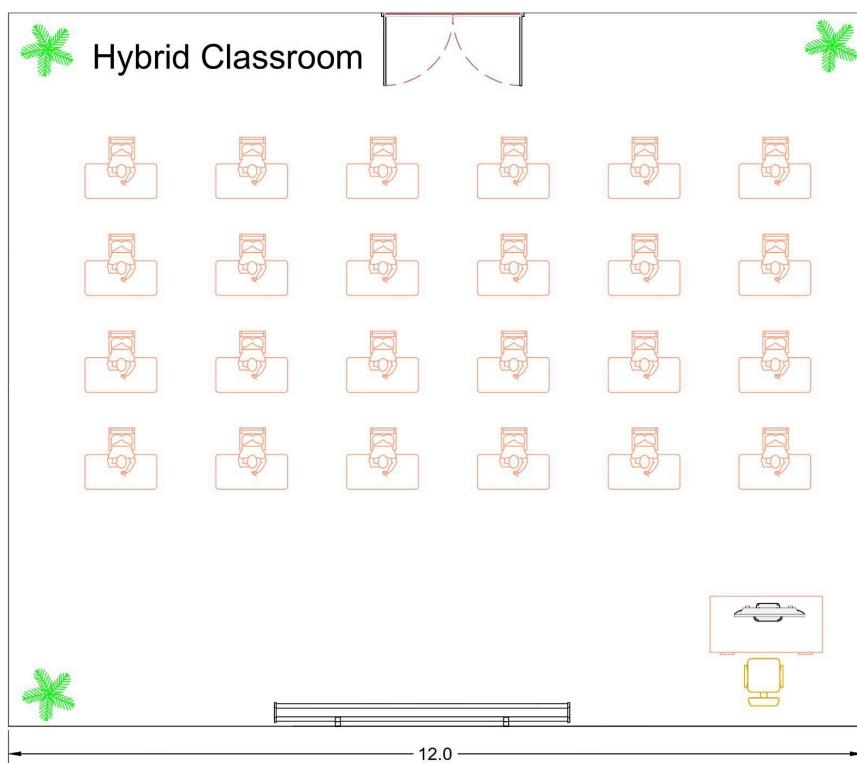
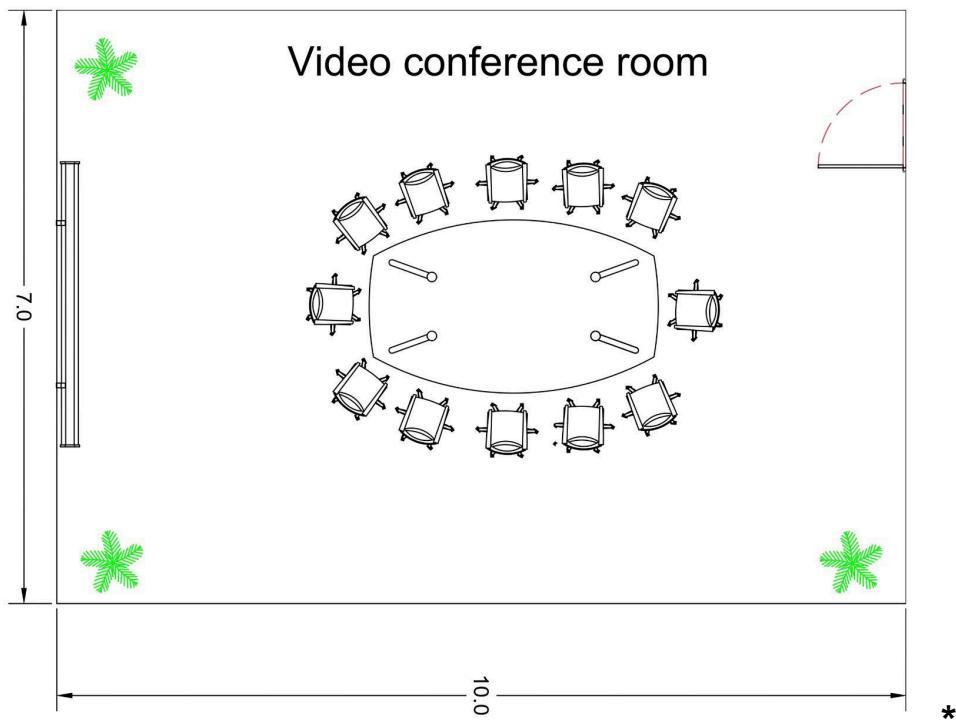


Figure 3.4 : Hybrid Classroom's Floor Plan

The Hybrid Classroom combines in-person and online learning. The classroom is equipped with smart interactive boards, Auto tracking cameras, and microphones. It allows students to attend classes either physically or virtually, making learning flexible and accessible. The setup supports interactive teaching, collaboration, and the integration of digital tools to enhance the learning experience.

### 3.5 Video Conference Room



*Figure 3.5 : Video Conference Room's Floor Plan*

The Video Conference Room is equipped with cameras, microphones, and screens for virtual meetings and events. It is used for hosting online classes, guest lectures, research collaborations, and connecting with experts or teams from around the world. This setup supports seamless communication and enhances learning and collaboration opportunities.

### 3.6 Student Lounge

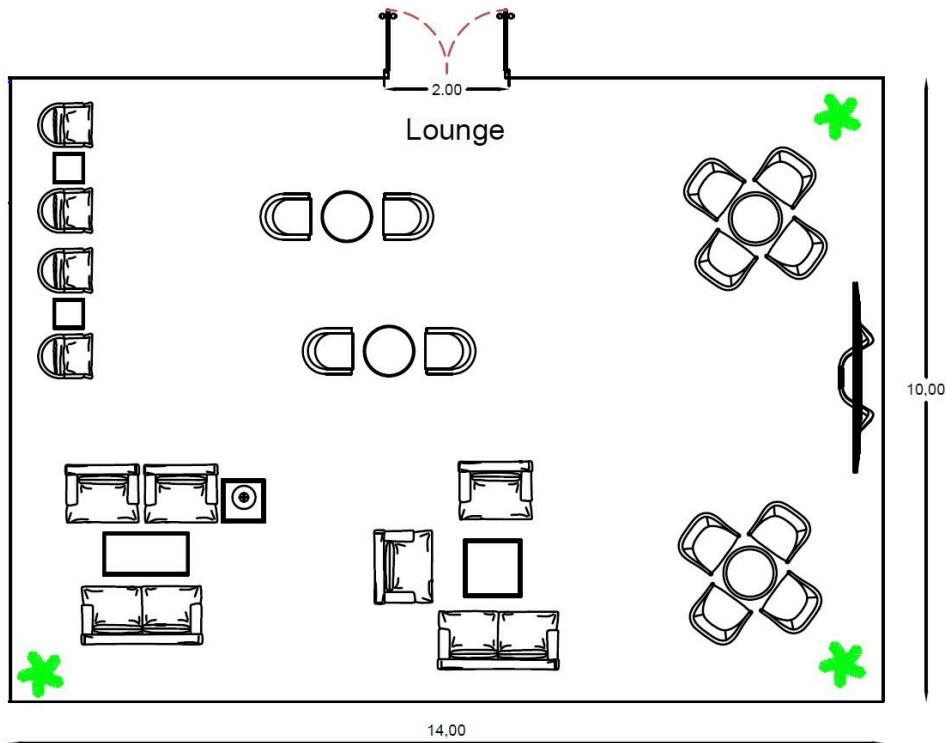


Figure 3.6 : Student Lounge's Floor Plan

The Student Lounge is a facility for students to relax, socialise, and do the work. It is equipped with Wireless Access Point (WAP), Router, charging stations, and multimedia screens, making it ideal for group discussions, casual meetups, or catching up on

assignments. The lounge offers a cozy environment where students can connect & communicate with peers to enhance their campus experience.

## 4.0 Questions

Below is a list of questions formulated based on a preliminary analysis of the building, future requirements, and the types of devices that will be used.

### 4.1 What are the specifications of the computer that are used in the lab room?

The AMD Ryzen 5 series and Intel Core i5 processors provide necessary performance for student activities (Nelson, 2024) that can support multitasking, run resource-intensive applications and support for different operating systems that can run different programming languages for learning. The NVIDIA GTX 1650 Super/Radeon Vega 7 is one of the budget-friendly GPU offering decent performance for its price.(Nishtha, 2024)



Figure 4.1 : Ryzen 5 CPU, Intel i5 CPU & RTX 1650 Super Graphic Card



## 4.2 What devices will hybrid classrooms use?

Install auto tracking cameras for engaging and interactive physical and remote participants. Pro AV solutions with AI auto tracking functions let teachers and presenters move around freely.(Case, 2020) Interactive whiteboards make the class more interactive whether the class is online or offline, large interactive whiteboards make class more engaging and dynamic.(Edmonger, 2022)



*Figure 1.2 : Pro AV solutions Auto tracking Camera & Interactive whiteboard*

### **4.3 What is needed for optimal network coverage?**

Wireless Access Points (WAP) will be installed so they transmit and receive data over the air, convert it to a wired signal, and send it back to the wired broadband router. A WAP that supports Wi-Fi 6 E is recommended because it provides better communication with multiple devices simultaneously and optimises traffic management across those devices more effectively.(Intel, 2024)



*Figure 4.3 : Image of Wireless Access Points (WAP)Image of Wireless Access Points (WAP)*

#### 4.4 What is the range of the access points in the room ?

Access points should have a minimum range of 25 meters to ensure comprehensive coverage and eliminate dead zones within a room. Proper placement, combined with frequency band selection, enhances connectivity and minimizes interference. Studies show that better AP coverage improves user experience and productivity (Wikipedia, 2024). Deploying multiple APs can also optimize performance in larger or more complex environments.

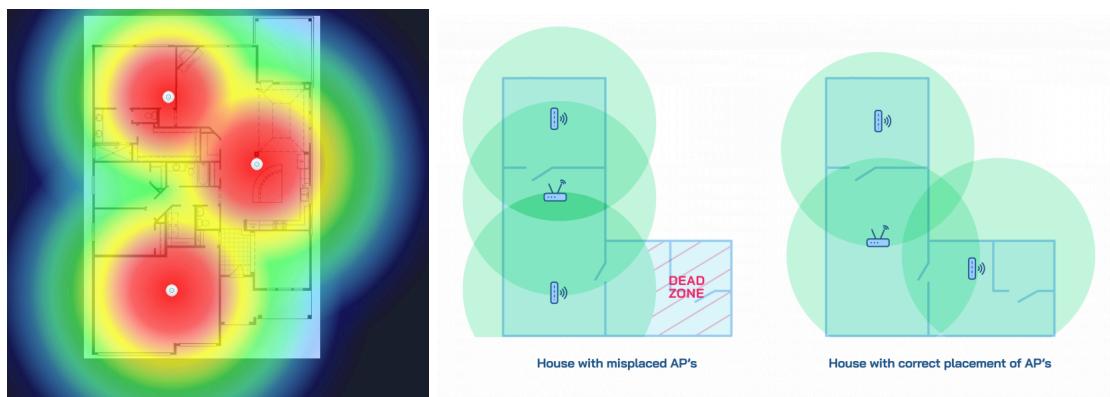


Figure 4.4 : Images of Access Point Coverage Zone

#### 4.5 What type of router should the building use ?

For a building accommodating up to 200 users, it is crucial to use a high-performance router with a robust processor, ample RAM, and multiple LAN ports to handle the load effectively (Hutchinson, 2024). Deploying multiple strategically placed access points further enhances wireless coverage and ensures seamless connectivity (Hill, 2024).



*Figure 4.5 : Image of Cisco ISR 4431 Router*

#### **4.6 What type of switch should we use for the connection ?**

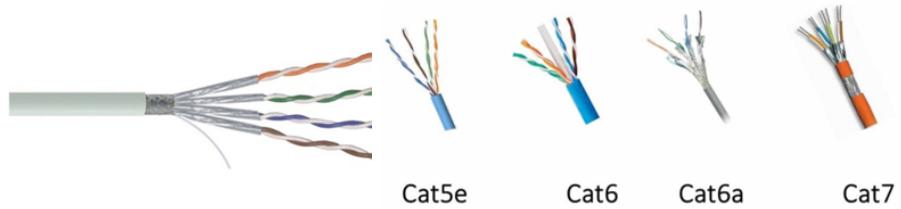
For a room with numerous devices, an enterprise-grade switch with a minimum of 48 ports is essential to ensure efficient connectivity. The Ubiquiti UniFi Switch Enterprise 48 PoE is a suitable option, offering 48 2.5 GbE PoE+ ports and 4 10G SFP+ ports, providing robust performance for high-density environments.(Ubiquiti, n.d.)



*Figure 4.6 : Image of Enterprise Campus Aggregation*

#### **4.7 What cable should the floor use?**

CAT 6A cable because it can maintain 10 Gbps speeds for up to 100 metres, along with less crosstalk and signal loss due to thicker insulation and more tightly wound wires (Keller & Lopate, 2024) compared to other cables. Experts say deploying CAT 6A cables in new buildings may be a good starting place, along with large expo halls and sports stadiums. (Keller & Lopate, 2024)



*Figure 4.7 : CAT 6A cable & Cable Comparison Image*

#### **4.8 What type of front screen display will the Lab and Class use ?**

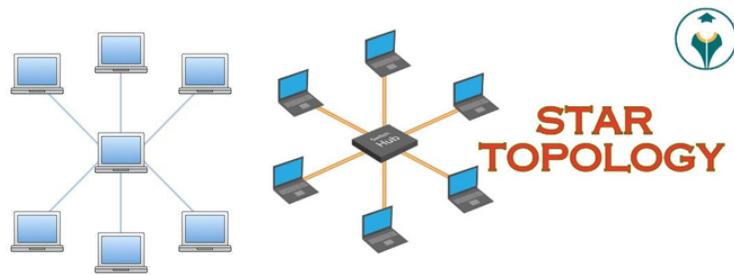
Implementing smart display boards in labs and classrooms enhances efficiency and productivity. To ensure optimal performance, it's essential to have adequate Wi-Fi coverage. (Rahayu, 2024) This approach ensures reliable connectivity for all devices, supporting seamless operation of smart display boards.



*Figure 4.8 : Image of person using Smart Display Board*

#### **4.9 What network topology type is going to be most efficient and suitable for the building?**

Star Topology because Simplifies both network management and troubleshooting. A device failure doesn't damage the entire network. Each device has its own dedicated connection, isolating issues (Anshuman, 2024) & adding or removing devices requires only a single cable connection to the central hub. There is no need to reconfigure the entire network. (Anshuman, 2024)



*Figure 4.9 : Star Topology Position Diagram*

## 4.10 How much router should we use to avoid a single point of failure?

To prevent a single point of failure, deploying multiple routers—ideally more than three—ensures network redundancy, allowing continuous connectivity even if one router fails. This approach, combined with multiple access points, improves wireless coverage and reduces dead zones, enhancing overall performance (Weaver, 2023).

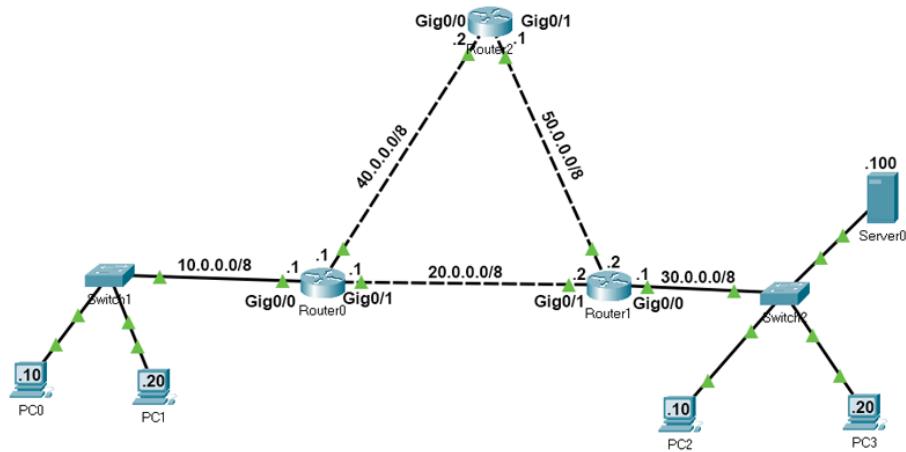


Figure 4.10 : Images of Multiple Router Routing

## 5.0 Feasibility Study

Below is a table presenting the feasibility study, which evaluates the technical, economic, and operational aspects of each room. This analysis provides the viability and functionality of every room in the building.

*Table 5.1 : Feasibility Study*

Room/Area	Technical Feasibility	Economic Feasibility	Operational Feasibility
General Purpose Lab	Requires enough ports and Wi-Fi to connect all devices, compatible with current hardware.	Cost-effective with standard switches, cables, and access points.	Supports up to 30 students comfortably with no technical issues.
Student Lounge	Needs Wi-Fi for casual use like browsing and streaming.	Low-cost, requiring only one access point.	Meets the basic needs of students in a relaxed environment.
Waiting Area	Needs basic Wi-Fi connectivity for light internet usage.	Minimal cost, requiring only one access point.	Provides basic internet for visitors without overloading the network.
Hybrid Classroom	Needs high-speed internet, interactive tools, and robust	Moderate cost for additional tools like cameras and microphones.	Supports both in-person and remote students effectively.

	connections for hybrid learning sessions.		
Video Conference Room	Requires high-speed, stable internet and backup for video calls.	Moderate cost due to cameras and high quality of educational resources	Must ensure uninterrupted meetings, reliability is essential.
Cisco Network Lab	Needs advanced switches and routers for teaching networking skills.	Expensive due to professional-grade equipment like Cisco hardware.	Critical for networking courses, must work perfectly to avoid interruptions.
Embedded Lab	Requires fast and reliable network for IoT devices and microcontrollers, with sufficient Ethernet ports.	Higher costs due to specialized equipment like routers and cables.	Must support multiple projects simultaneously without lag or disconnection.
Server Room	Needs high-speed switches, enterprise servers, and cooling systems, with scalability for	High initial costs for servers, cooling systems, and power backups.	Critical for overall network reliability; must ensure 24/7 uptime.

	future needs.		
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## 6.0 List of Devices

The table below presents a list of devices to be used in the building, along with their quantities, individual prices, and total costs.

*Table 6.1 : Total Price for Devices*

Item	Device	Price (RM)	Qty	Total Price (RM)
Camera	<a href="#">AVer PTC310HWV2 AI Auto Tracking PTZ Camera – SRT Ready</a>	16,473.00	1	16,473.00
Smart Board	<a href="#">ViewSonic IFP7552-1A 75" 4K Ultra HD ViewBoard Interactive Display Flat Panel</a>	20,488.00	5	102,440.00
Monitor	<a href="#">HP 524sw 24" Ultraslim IPS Full HD 100Hz</a>	258.59	131	33,875.29
Keyboard &	<a href="#">HP 150 WIRED MOUSE</a>	55.00	131	7,205.00

Mouse	<a href="#">AND KEYBOARD COMBO</a>			
Workstations (PCs)	<a href="#">ECHO 3 Office Desktop PC - AMD Ryzen 5 5600G / Radeon Vega 7</a>	1,199.00	131	157,069.00
Access Point	<a href="#">LigoWave NFT 2ac Dual-Band 802.11ac Indoor Access Point</a>	1,043.44	7	7,304.08
Router	<a href="#">ISR4431-V/K9 Cisco ISR Routers 4 x GE ports</a>	47,328.34	12	567,940.08
TV	<a href="#">Haier HQLED 4K UHD TV S75EUG (55")</a>	1,999.00	3	5,997.00
Video Conference Device	<a href="#">Owl Bar Video Conferencing Device</a>	10,933.00	1	10,933.00
Switches	<a href="#">Unifi Enterprise Campus Aggregation</a>	17,912.78	6	107,476.68
Circuit Boards	<a href="#">Arduino Uno R3</a>	42.90	30	1,287.00
Sensors and Actuators	<a href="#">Keyestudio 37 in 1 Sensor Kit V3.0</a>	185.00	15	2,775.00
Power Supply	<a href="#">KORAD 3005D Power Supply</a>	277.00	5	1,385.00
Soldering Stations	<a href="#">HAKKO FX888-D</a>	906.75	5	4,533.75

Microcontroller s	<a href="#">ATmega328 NANO V3</a>	13.99	30	419.70
Prototyping Boards	<a href="#">Mini Breadboard LED Jumper Wire Button For Arduino</a>	10.34	30	310.20
Oscilloscopes	<a href="#">RIGOL DS1054Z 50MHz Digital Oscilloscope</a>	2,222.28	2	4,444.56
Practical Switches	<a href="#">Cisco WS-C3750G-24TS</a>	1,609.99	32	51,519.68
Practical Router	<a href="#">Cisco 4331 Integrated Services Router ISR4331/K9</a>	3,509.99	32	112,319.68
Practical Wireless Lan Controller	<a href="#">Cisco 3504 IEEE 802.11ac Wireless LAN Controller (AIR-CT3504-K9)</a>	3,395.00	32	108,640.00
Total Price of All Items				1,304,347.70

## 7.0 Research

This subsection will justify the selection of LAN devices based on our research, assessing whether they meet the faculty's requirements.

### 7.1 Do LAN devices chosen accomplish the needs/requirements of FC ?

#### 1. Wireless Access Point (WAP)

Ligowave NFT 2ac

- Provides up to 128 concurrent clients
- Coverage radius 100 meters (328 ft)
- Interfaces :
  - Ethernet 1: 1000 Base-T supporting 802.3 af/at with passive PoE (37 - 56V)
  - Ethernet 2: 1000 Base-T
  - Ethernet 3: 1000 Base-T
  - DC jack: 37 – 56V
  - Reset button

## 2. Router

Cisco ISR 4431 Router ( ISR4431-V/K9 )

- Support up to 200+ users ( medium-sized enterprises and institutions )
- Aggregate Throughput = 500 Mbps to 1 Gbps
- Integrated hardware encryption
- Amount of Ports :
  - 4x Total onboard WAN or LAN 10/100/1000 ports
  - 4x RJ-45-based ports
  - 4x SFP-based ports
  - 3x NIM (Network Interface Modules) slots
  - 1x Onboard ISC slot

## 3. Switch

Unifi Enterprise Campus Aggregation

- Amount of Ports :
  - 6x 100/40G QSFP28 ports
  - 48x 25/10G SFP28 ports\*
- 1.8 Tbps Total non-blocking throughput

- 3.6 Tbps Switching capacity
- 2.3 Bpps Forwarding rate

#### 4. **Cable**

COMMSCOPE Cat6A Shielded Blue Outer Jacket Cable

- CommScope's Cat 6A solutions adhere to rigorous standards
- Cat6A Shielded Cable: Provides enhanced protection against EMI and crosstalk
- 10 Gigabit Ethernet Support

#### 5. **Practical Switches**

Cisco WS-C3750G-24TS

- 32x for 4 bay in Cisco Room ( 8 devices each bay )
- 24x Ethernet 10/100/1000 ports with IEEE 802.3af and Cisco prestandard PoE
- 4x SFP-based Gigabit Ethernet ports
- 32-Gbps, high-speed stacking bus

## **6. Practical Router**

Cisco 4331 Integrated Services Router ISR4331/K9

- 32x for 4 bay in Cisco Room ( 8 devices each bay )
- Base throughput: 100 Mbps (scalable up to 300 Mbps with licenses)
- Integrated hardware encryption
- Interfaces :
  - 2x integrated Gigabit Ethernet (GE) ports
  - 2x Network Interface Module (NIM) slots
  - 3x integrated Gigabit Ethernet ports

## **7. Practical Wireless LAN Controller**

Cisco 3504 IEEE 802.11ac Wireless LAN Controller (AIR-CT3504-K9)

- 32x for 4 bay in Cisco Room ( 8 devices each bay )
- Wireless LAN standard: IEEE 802.11ac
- Deployment modes: Centralized, Cisco FlexConnect, and mesh (bridge)
- Works with Cisco Wireless Controllers

## **8.0 Report**

This subsection will provide our opinions and reflections on the device prices, including a comparison of our selected devices compared to different brands.

### **8.1 Are you surprised by the prices**

Yes, we are surprised by the prices. When looking at switches and routers, the costs seem high compared to other building infrastructure. However, we understand that these devices come with advanced technology, high performance, and essential features like security and scalability, which contribute to their higher prices. RM 1,304,347.70 is still within our budget which is RM 1,500,000.00

### **8.2 Reflect on cost of devices**

The cost of the devices is justified, as shown in section 2.1. These devices are chosen for their features and suitability in supporting educational purposes. They provide learning experience ensuring students have a comfortable and good learning environment and will produce quality graduates.

### 8.3 Major Difference between the same devices from different brands

The table below highlights the key differences between the device brand chosen by our group and other brands.

*Table 8.1 : Comparison between chosen brand and other brands*

Device	Major Difference	
	Chosen Brand	Other Brands
HP 524sw 24" Ultraslim IPS Full HD 100Hz	<ul style="list-style-type: none"> <li>• Low-Blue light filter</li> <li>• Value for Money</li> </ul>	<ul style="list-style-type: none"> <li>• Good refresh rate</li> <li>• Better screen quality</li> </ul>
ECHO 3 Office Desktop PC (AMD Ryzen 5 5600G)	<ul style="list-style-type: none"> <li>• Good Quality Specs</li> <li>• Value for Money</li> </ul>	<ul style="list-style-type: none"> <li>• Good Quality Specs</li> </ul>
HP 150 Wired Combo	<ul style="list-style-type: none"> <li>• Value for Money</li> </ul>	<ul style="list-style-type: none"> <li>• Better Quality</li> </ul>
Cisco ISR 4431 Router	<ul style="list-style-type: none"> <li>• Supports Layer 3</li> <li>• High Scalability</li> </ul>	<ul style="list-style-type: none"> <li>• Value for Money</li> </ul>
Ligowave NFT 2ac	<ul style="list-style-type: none"> <li>• High Range</li> <li>• High Scalability</li> </ul>	<ul style="list-style-type: none"> <li>• Better Size &amp; Design</li> <li>• 10Gbps Ethernet Ports</li> </ul>
COMMSCOPE Cat6A Shielded Blue Outer Jacket Cable	<ul style="list-style-type: none"> <li>• Superior Shielding</li> <li>• Long-lasting durability</li> </ul>	<ul style="list-style-type: none"> <li>• Lower Prices</li> <li>• Easier Installation</li> </ul>
AVer PTC310HWV2 AI Auto Tracking PTZ Camera	<ul style="list-style-type: none"> <li>• AI Auto-Tracking</li> <li>• 4K Ultra HD Video Quality</li> <li>• Wide Field of View</li> </ul>	<ul style="list-style-type: none"> <li>• Better Pan &amp; Tilt</li> <li>• Lower Prices</li> </ul>

ViewSonic IFP7552-1A 75" 4K Ultra HD ViewBoard Interactive Display	<ul style="list-style-type: none"> <li>• Built-in Android</li> <li>• Multi-Touch Support</li> <li>• HD Resolution</li> <li>• Built in Speaker</li> </ul>	<ul style="list-style-type: none"> <li>• Limited Software Features</li> <li>• Lower Prices</li> </ul>
Unifi Enterprise Campus Aggregation	<ul style="list-style-type: none"> <li>• Enterprise Level</li> <li>• Scalability</li> <li>• High Capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Value For Money</li> <li>• Ease of Use and Setup</li> </ul>
Haier HQL55 4K UHD TV (55")	<ul style="list-style-type: none"> <li>• Value for Money</li> <li>• Smart TV Features</li> <li>• Good Picture Quality</li> </ul>	<ul style="list-style-type: none"> <li>• Better Picture Quality</li> <li>• More Features</li> <li>• Better Sound Quality</li> </ul>
Owl Bar & Owl 4+	<ul style="list-style-type: none"> <li>• 360-Degree Video Coverage</li> <li>• Integrated Audio &amp; Video in One Device</li> <li>• Automatic Framing</li> <li>• Strong Audio Performance</li> </ul>	<ul style="list-style-type: none"> <li>• Better Connectivity Options</li> <li>• Lower Prices</li> </ul>
Arduino Uno R3	<ul style="list-style-type: none"> <li>• Easy to use</li> <li>• Ideal for beginners</li> </ul>	<ul style="list-style-type: none"> <li>• Complex</li> <li>• Requires more setup</li> </ul>
ATmega328 Microcontrollers	<ul style="list-style-type: none"> <li>• Low power consumption</li> <li>• Easy to program</li> </ul>	<ul style="list-style-type: none"> <li>• More complex features</li> <li>• Use by many professionals</li> </ul>
Rigol DS1054Z Oscilloscopes	<ul style="list-style-type: none"> <li>• High-quality performance for</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> <li>• Complex to use</li> </ul>

	<ul style="list-style-type: none"> <li>the price</li> <li>• Reliable and durable</li> </ul>	
Korad KA3005D Power Supply	<ul style="list-style-type: none"> <li>• Affordable</li> <li>• Stable</li> </ul>	<ul style="list-style-type: none"> <li>• More Safety features</li> </ul>
Hakko FX-888D Soldering Station	<ul style="list-style-type: none"> <li>• Excellent temperature control</li> <li>• Durable</li> </ul>	<ul style="list-style-type: none"> <li>• Lack precise temperature control</li> <li>• Very Expensive</li> </ul>
Keyestudio 37 in 1 Sensor Kit V3.0	<ul style="list-style-type: none"> <li>• Includes many sensors for various projects</li> <li>• Compatible with Arduino</li> <li>• Affordable</li> </ul>	<ul style="list-style-type: none"> <li>• Not compatible</li> <li>• More expensive for fewer sensors</li> </ul>
Cisco WS-C3750G-24TS	<ul style="list-style-type: none"> <li>• Power over Ethernet (PoE)</li> <li>• Stackable Configuration</li> <li>• Widely Recognized Device</li> </ul>	<ul style="list-style-type: none"> <li>• Value for Money</li> <li>• Easier Configuration</li> </ul>
Cisco 4331 Integrated Services Router ISR4331/K9	<ul style="list-style-type: none"> <li>• Industry Standard Features</li> <li>• Widely Recognized Device</li> </ul>	<ul style="list-style-type: none"> <li>• Value for Money</li> </ul>
Cisco 3504 IEEE 802.11ac Wireless LAN	<ul style="list-style-type: none"> <li>• High Scalability and Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>• Value for Money</li> </ul>

Controller (AIR-CT3504-K9)	• Enterprise-Grade Features	
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# 9.0 Work Areas

This subsection will highlight the work areas for both floor 1 and floor 2

## 9.1 First Floor

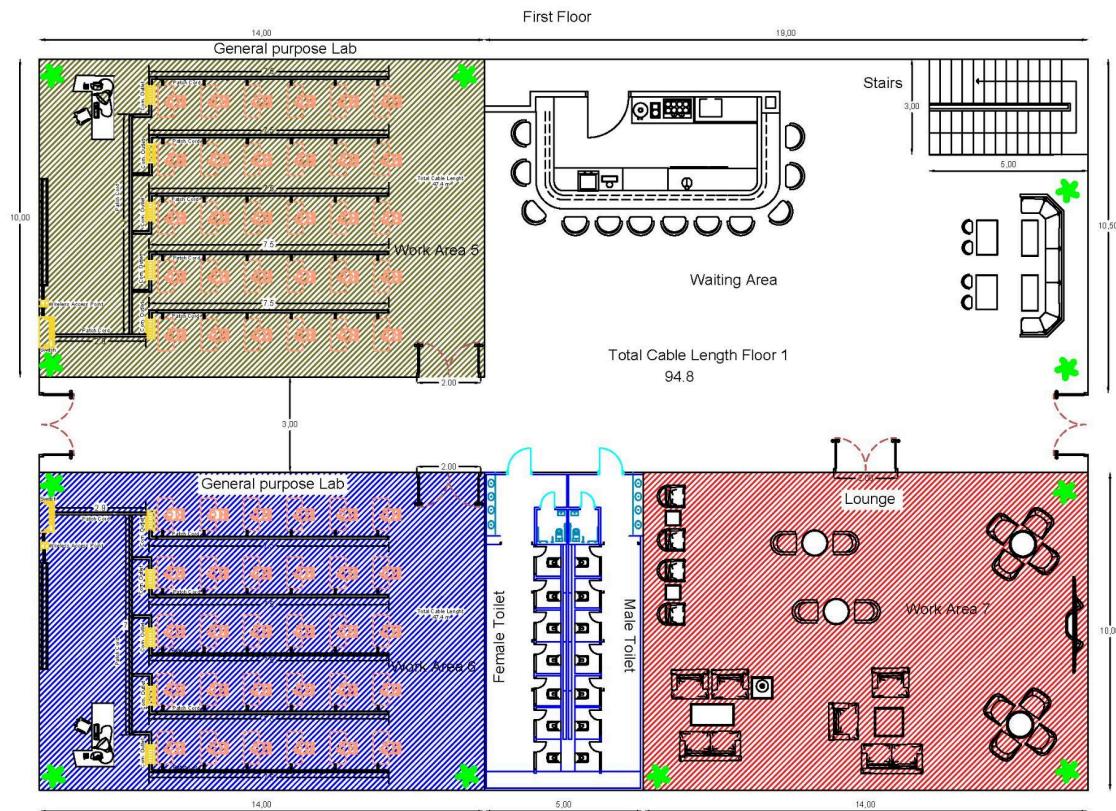


Figure 9.1 : First Floor

There are 3 work areas in floor 1

1. General Purpose Lab 1  
For General Purpose Lab 1, it has 31 workstations and the size is 10m x 14m
2. General Purpose Lab 2  
For General Purpose Lab 2, it has 31 workstations and the size is 10m x 14m
3. Student Lounge

For Student lounge, it has 1 router and 1 access point and the size is 10m x 14m

## 9.2 Second Floor

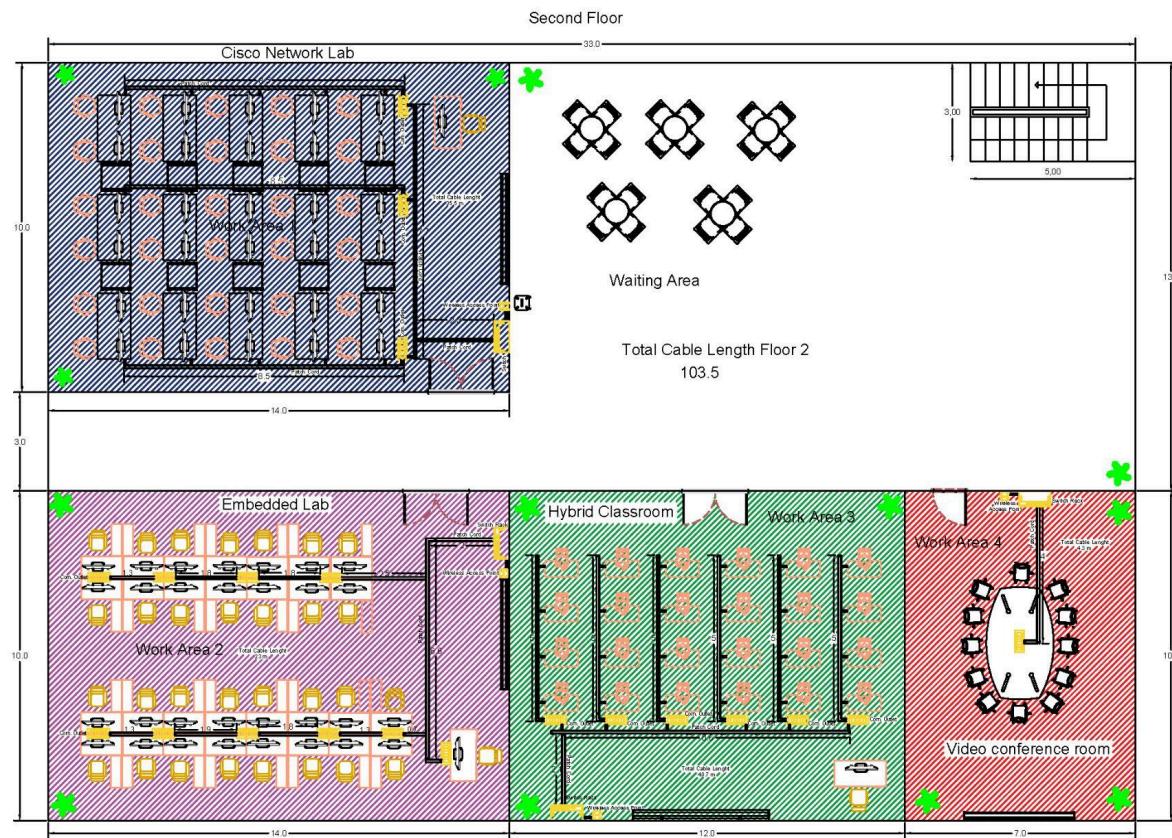


Figure 9.2 : Second Floor

There are 4 work areas in floor 2

### 1. Cisco Network Lab

For Cisco Network Lab, it has 31 workstations and the size is 10m x 14m

### 2. Embedded Lab

For Embedded Lab, it has 31 workstations and the size is 10m x 14m

### 3. Hybrid Classroom

For Hybrid Classroom it has 1 workstation and the size is 10m x 12m

### 4. Video Conference Room

For Video Conference Room it has 1 workstation and the size is 7m x 12m

# 10.0 Connection

## 10.1 First Floor

The images below show the floor wiring layout for each room on the first floor, highlighting communication outlets, cables, switches, access points and routers.

### 10.1.1 General Lab 1

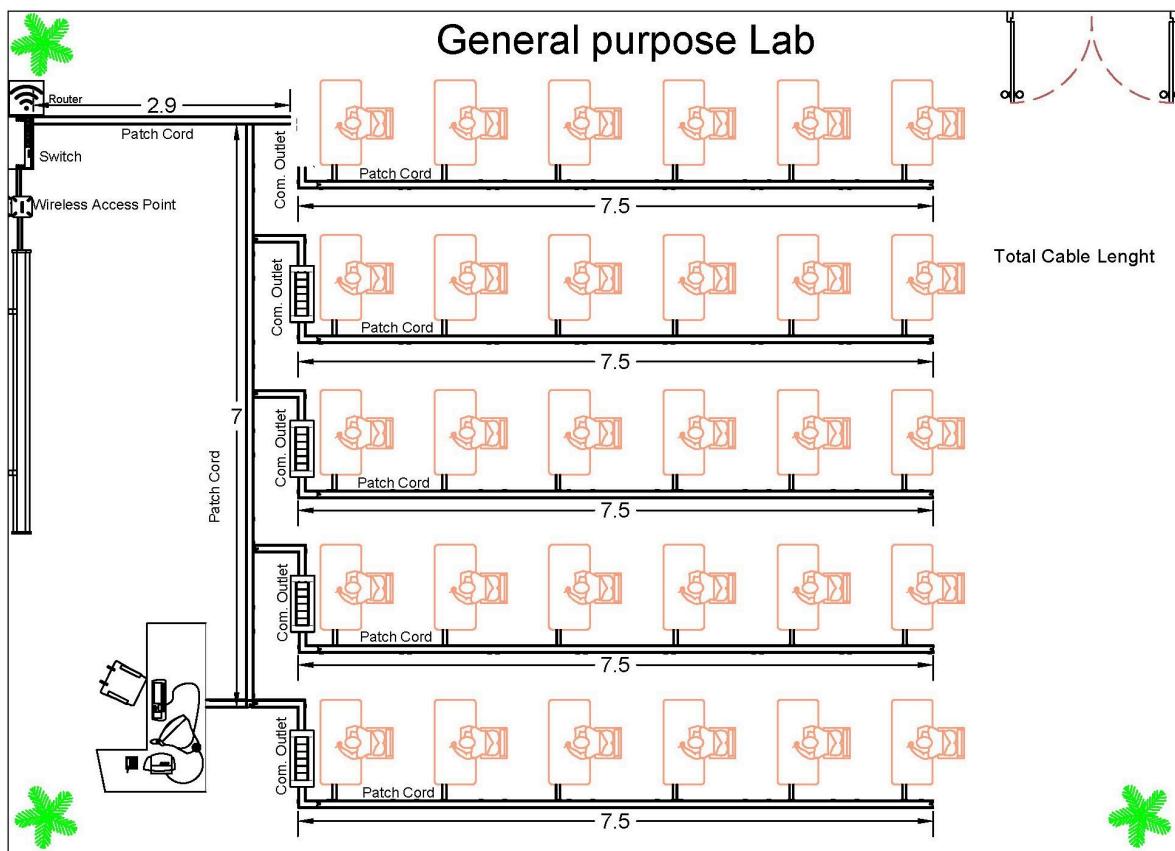
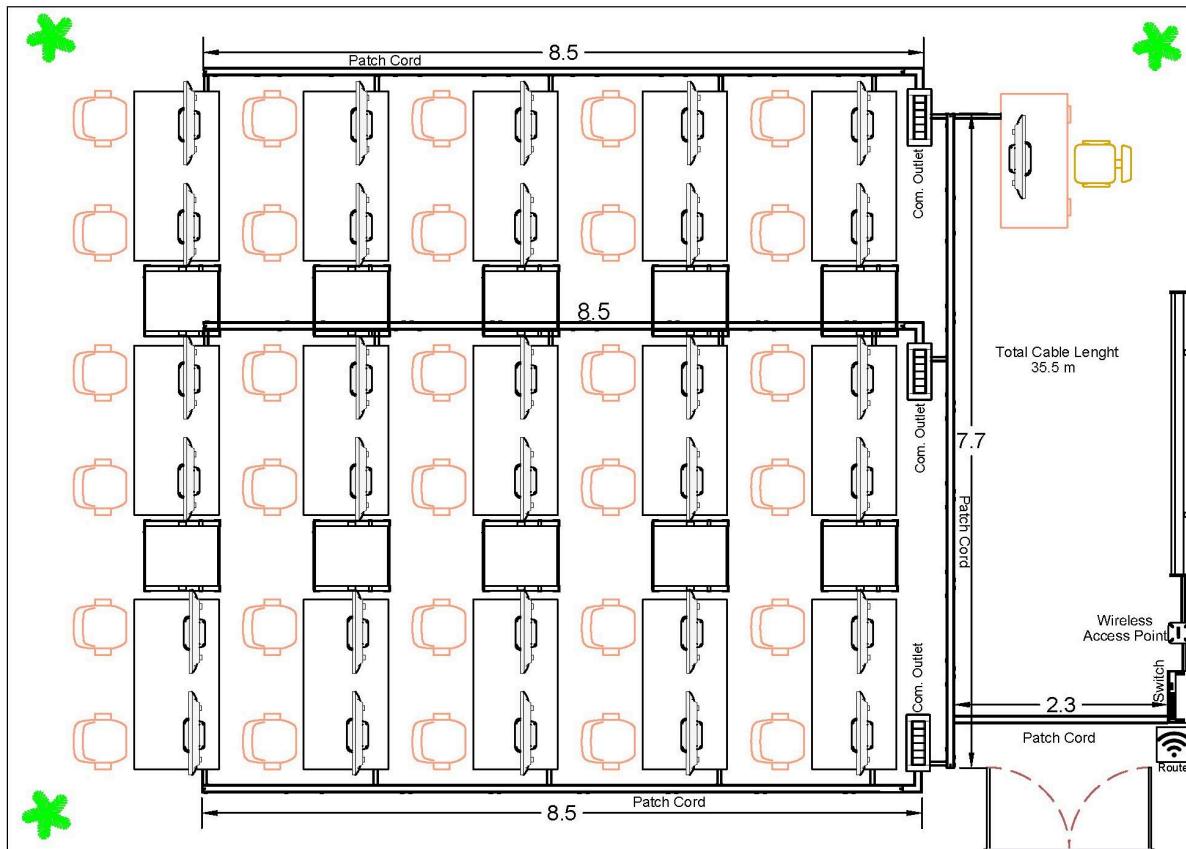


Figure 10.1.1 : General Lab 1

- General Lab 1 has 31 workstations (30 for students, 1 for the lecturer), along with a smart display board.
- A 48-port switch connects all devices, using 34 ports (31 for workstations, 1 for the router, 1 for the smart display board, 1 for the wireless access point).

- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

### 10.1.2 General Lab 2



*Figure 10.1.2 : General Lab 2*

- General Lab 2 has 31 workstations (30 for students, 1 for the lecturer), along with a smart display board. The lab has its own switch, router, and wireless access point.
- A 48-port switch connects all devices, using 34 ports (31 for workstations, 1 for the router, 1 for the smart display board, 1 for the wireless access point).
- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

### 10.1.3 Student Lounge

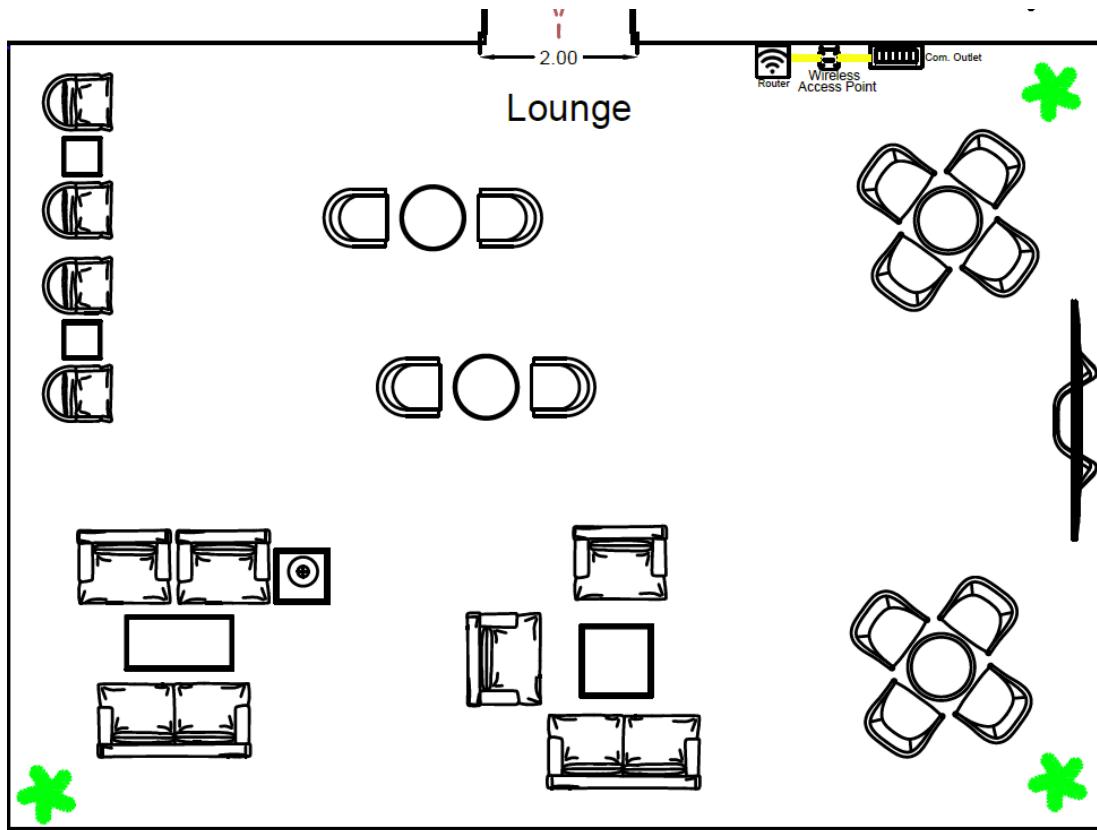


Figure 10.1.3 : Student Lounge

- The Student Lounge has a wireless access point and a router to provide internet connectivity.
- The router is housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

## 10.2 Second Floor

The images below show the floor wiring layout for each room on the second floor, highlighting communication outlets, cables, switches, access points and routers.

### 10.2.1 Embedded Lab

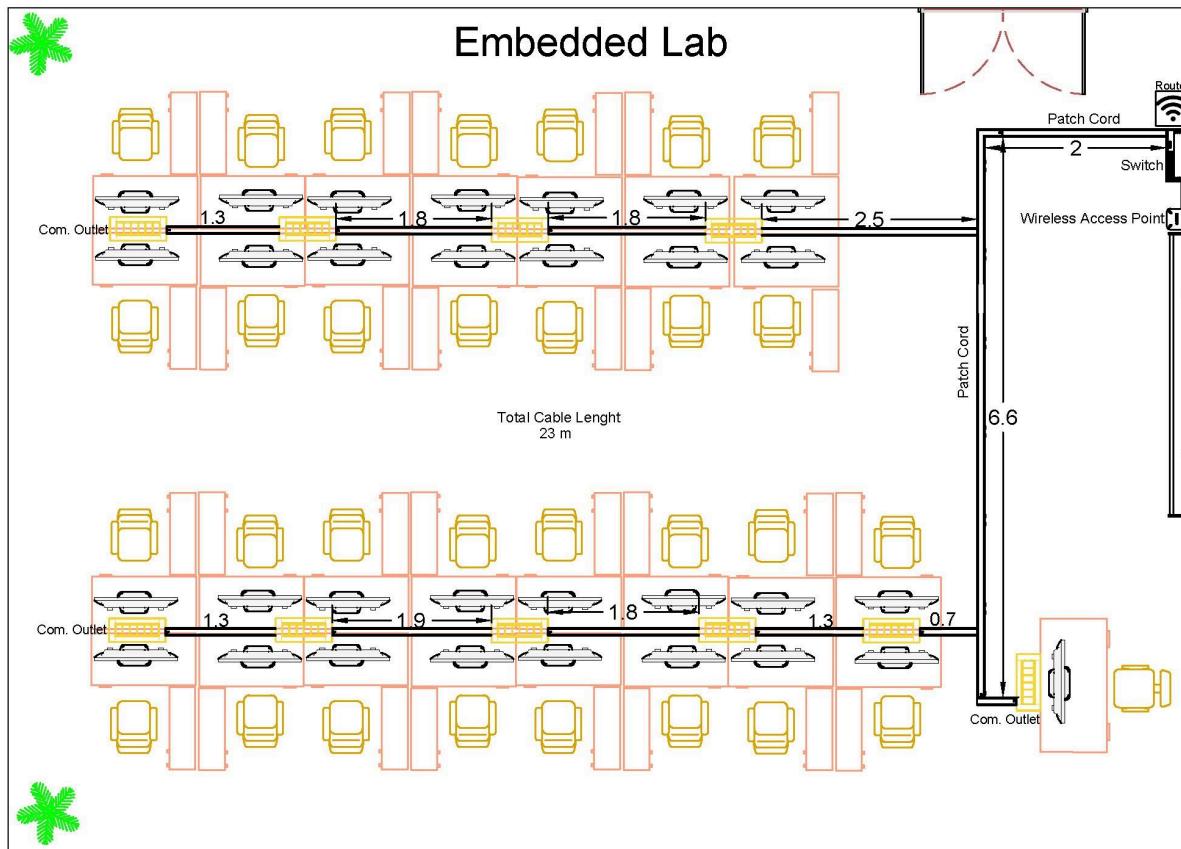


Figure 10.2.1 : Embedded Lab

- Embedded Lab has 31 workstations (30 for students, 1 for the lecturer), along with a smart display board.
- A 48-port switch connects all devices, using 34 ports (31 for workstations, 1 for the router, 1 for the smart display board, 1 for the wireless access point).
- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

## 10.2.2 Cisco Network Lab

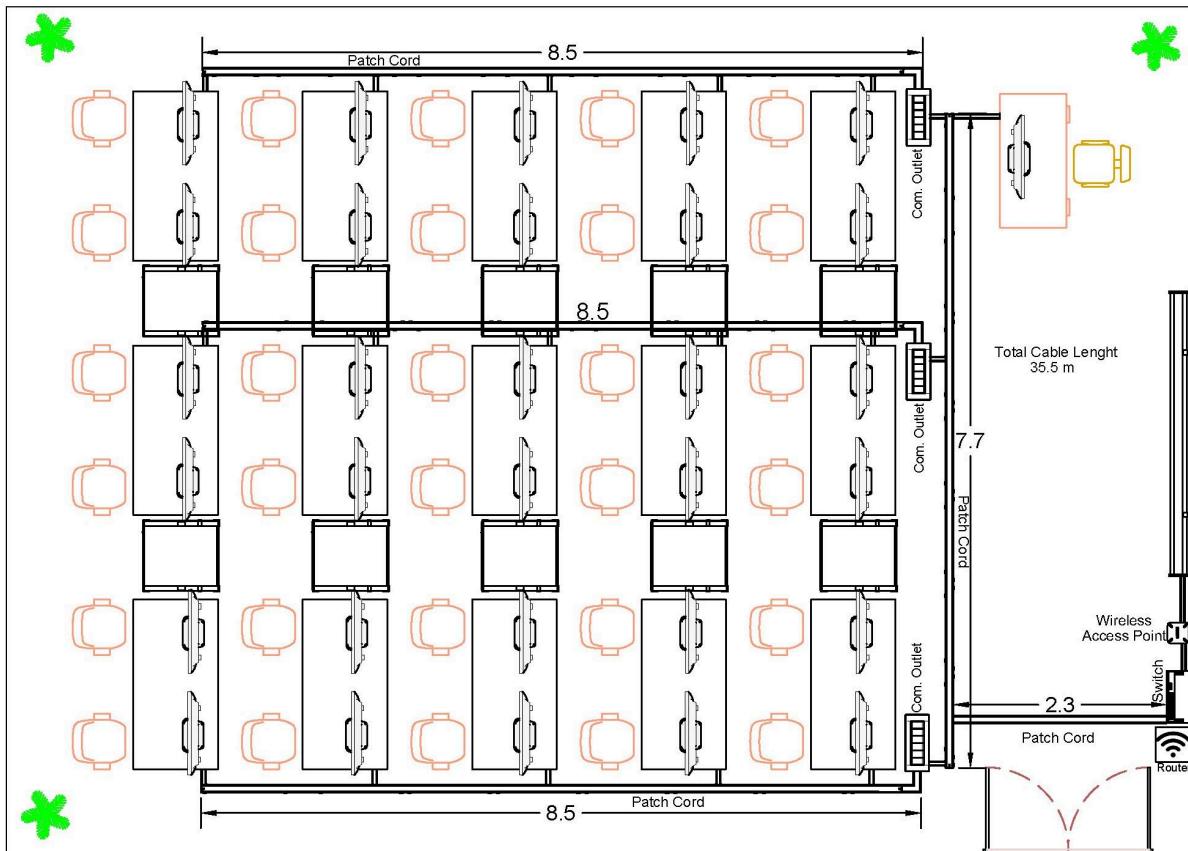


Figure 10.2.2 : Cisco Network Lab

- Cisco Network Lab has 31 workstations (30 for students, 1 for the lecturer), along with a smart display board.
- A 48-port switch connects all devices, using 34 ports (31 for workstations, 1 for the router, 1 for the smart display board, 1 for the wireless access point and).
- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

### 10.2.3 Hybrid Classroom

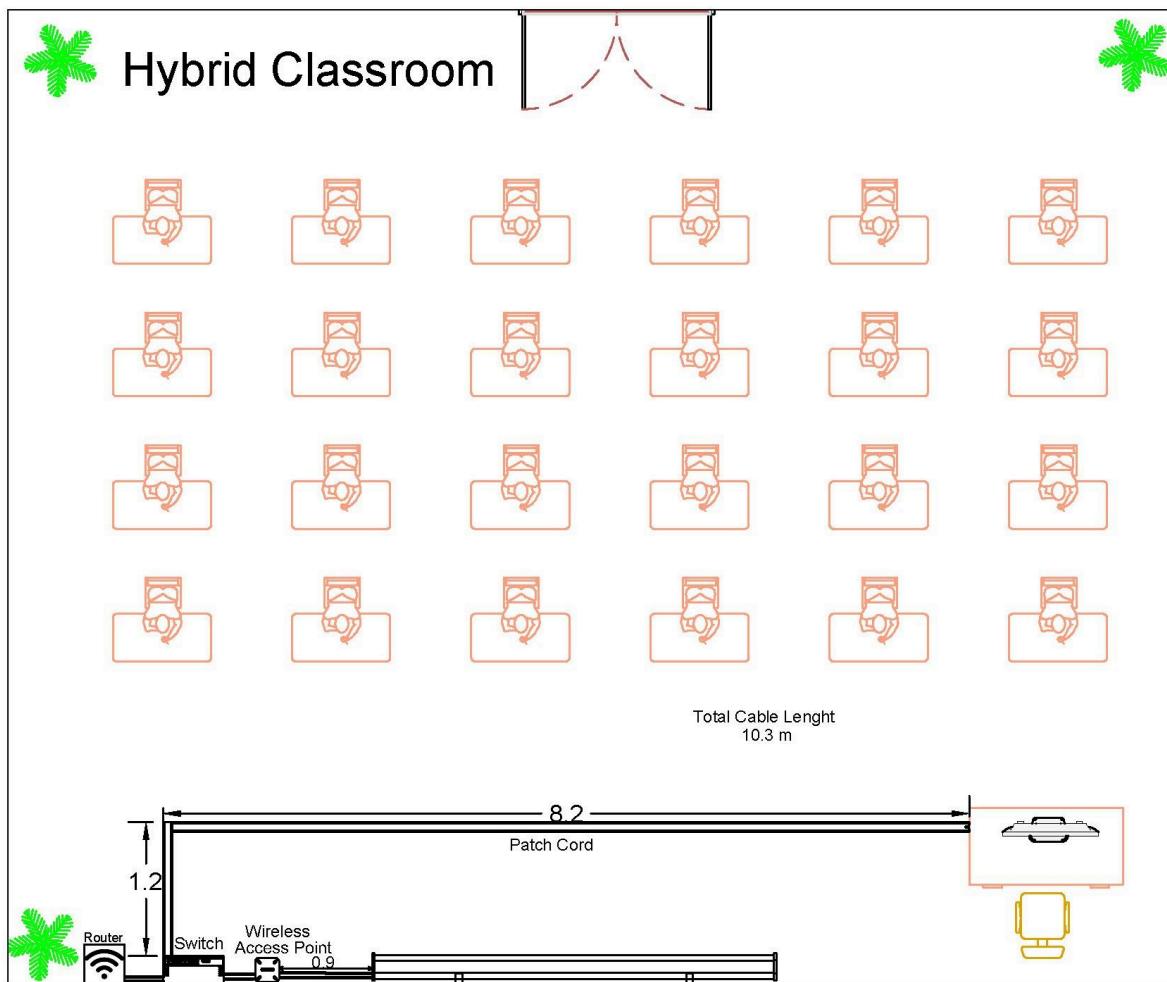


Figure 10.2.3 : Hybrid Classroom

- Hybrid Classroom has 1 workstation for the lecturer and a smart display board.
- A 48-port switch connects all devices, using 4 ports (1 for workstation, 1 for the router, 1 for the smart display board, 1 for the wireless access point).
- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

#### 10.2.4 Video Conference Room

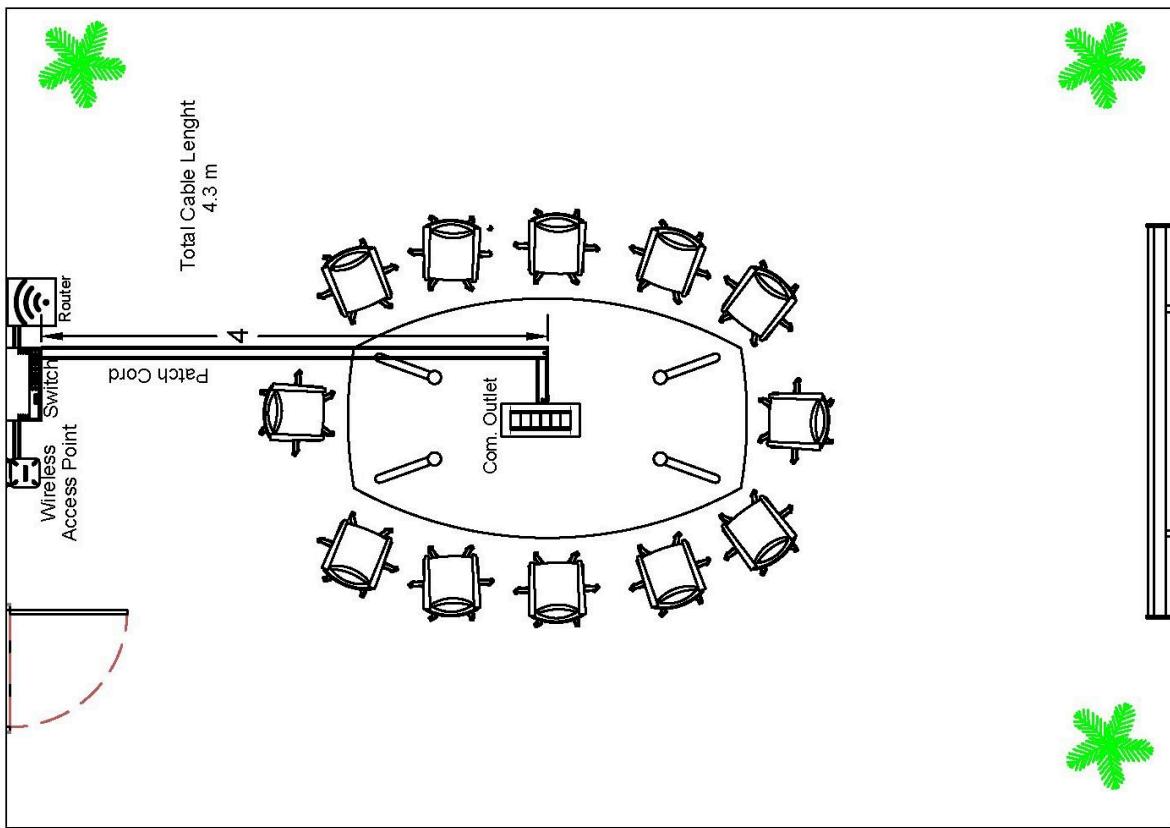
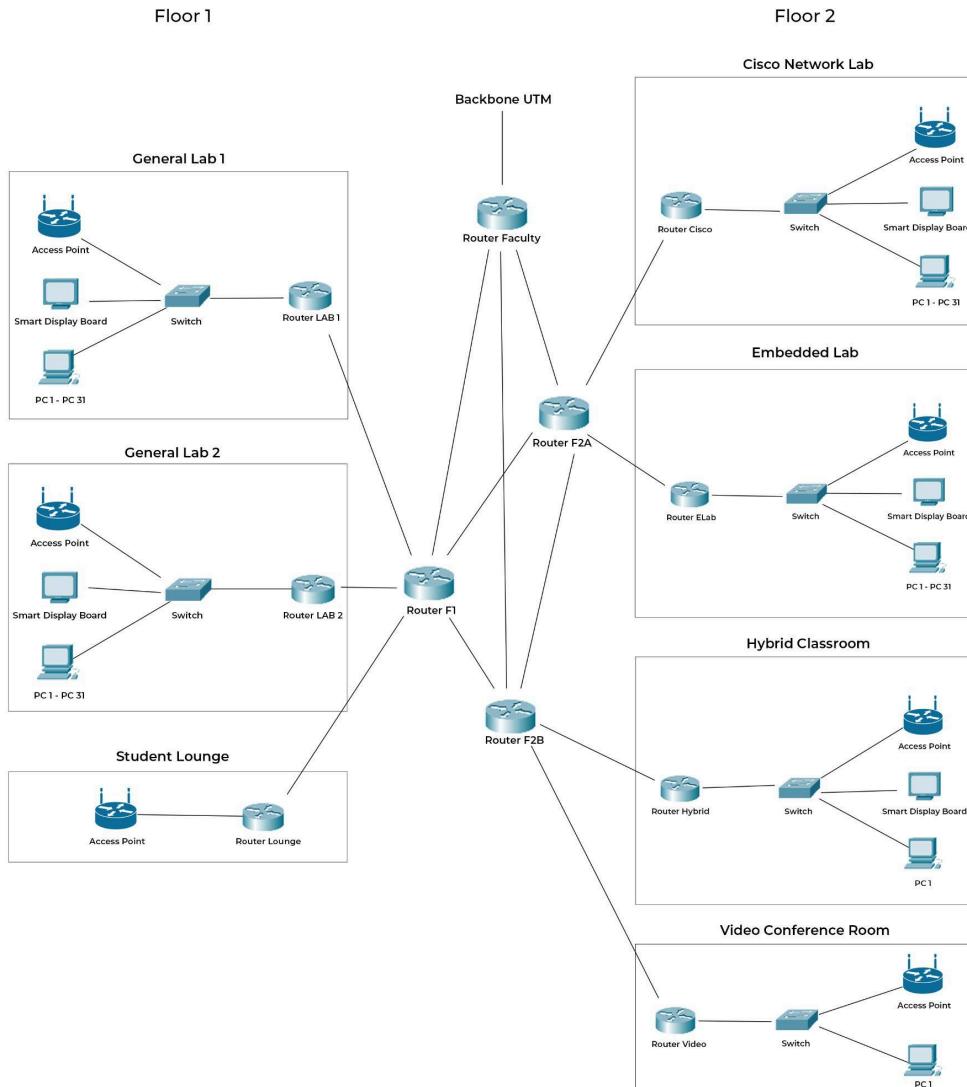


Figure 10.2.4 : Video Conference Room

- Video conference room has 1 workstation for presentation and meeting.
- A 48-port switch connects all devices, using 3 ports (1 for workstation, 1 for the router, 1 for the wireless access point).
- The switch and router are housed in a rack, with the wireless access point placed nearby. The wireless access point can connect up to 128 users

## 10.3 Connection

The images below show the building topology including floor 1 and 2, highlighting the connections between devices.



*Figure*

*10.3 : Faculty Building Topology*

There are 34 connections in General Lab 1 & 2 , 34 connections in Cisco Network Lab, 34 connections in Embedded Lab, 1 connection in Student Lounge, 4 connections in Hybrid Classroom, 3 connections in Video conference room. There are also 3 connections to router F1 at floor 1, 2 connections to router F2A, 2 connections to router

F2B and 6 connections for the routers to connect with each other and finally 1 connection to UTM Backbone. In total there are 158 connections which means a total of 158 patch cords are needed.

## 11.0 Cable Type and Length

This subsection outlines the types of cables used in the building, including their lengths.

### 11.1 First Floor

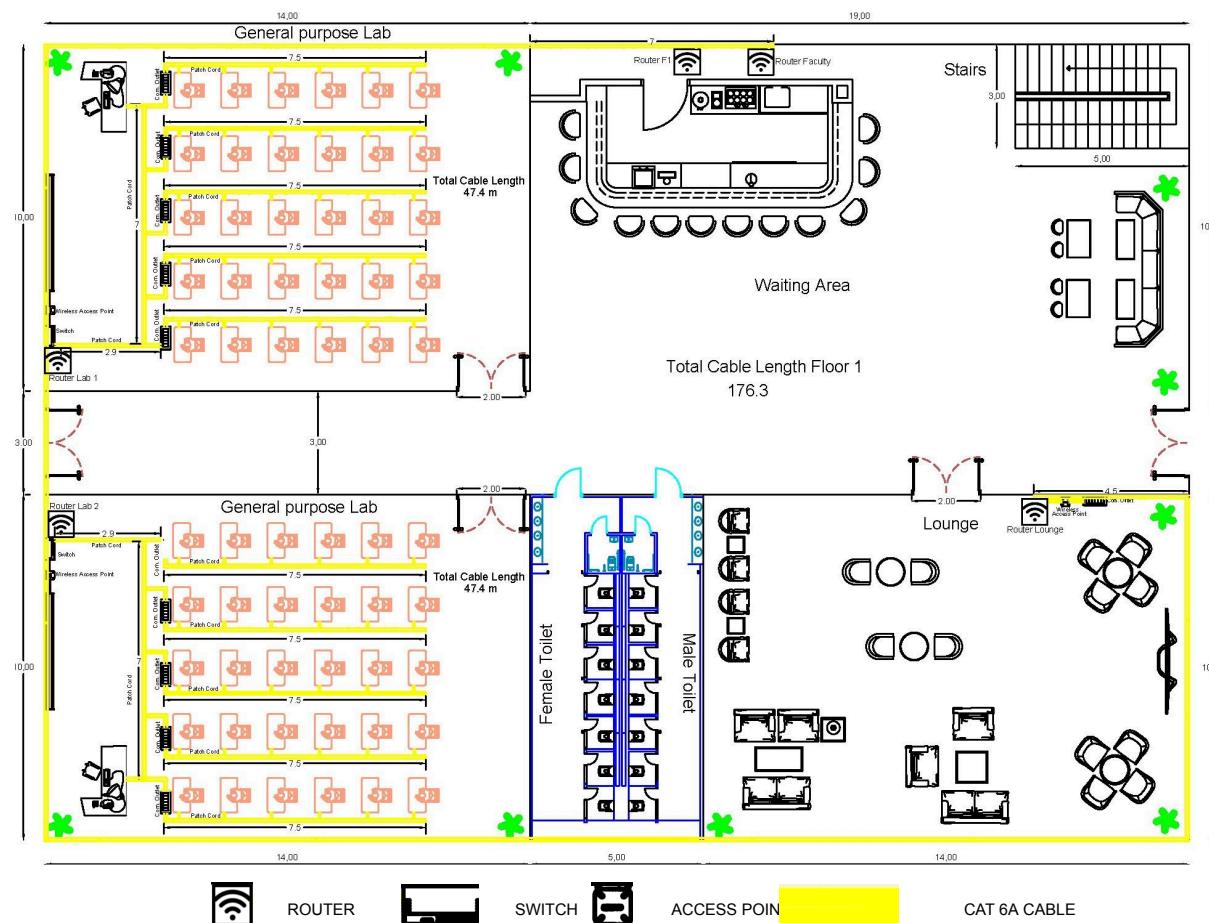


Figure 11.1 :First Floor Wiring

On the first floor, we are using CAT6A cables. The floor plan includes 4 switches, 4 routers, and 4 access points. The estimated total cable length for this floor is:

*Table 11.1 : Floor 1 Cable Length*

Description	Cable Type	Length (m)	
		Horizontal	Vertical
General Purpose Lab 1	CAT 6A Cable	40.4	7
General Purpose Lab 2	CAT 6A Cable	40.4	7
Student Lounge	CAT 6A Cable	4.5	0
Floor 1 Wiring	CAT 6A Cable	54	33
Total Length (1st Floor)		176.3	

## 11.2 Second Floor

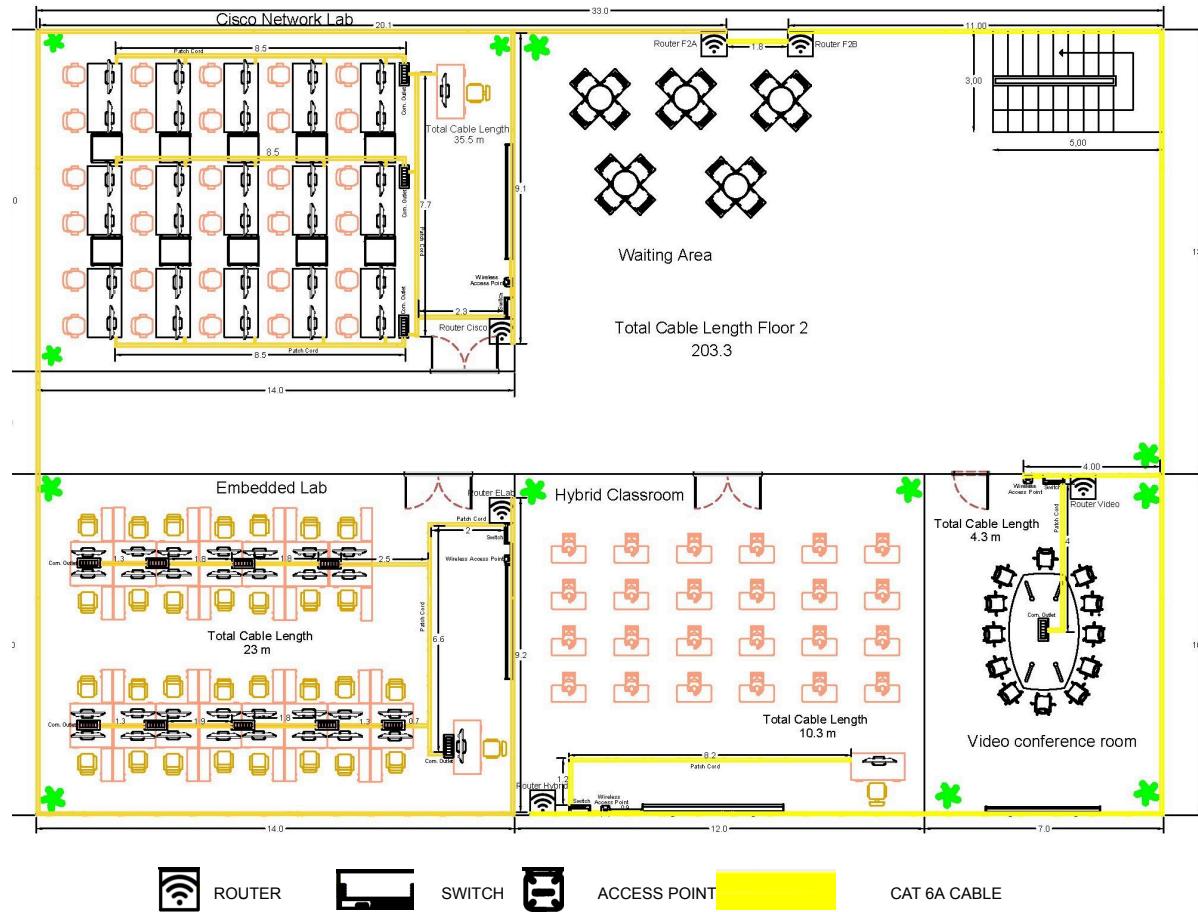


Figure 11.2 : Second Floor Wiring

On the second floor, we are using CAT6A cables. The floor plan includes 4 switches, 4 routers, and 4 access points. The estimated total cable length for this floor is:

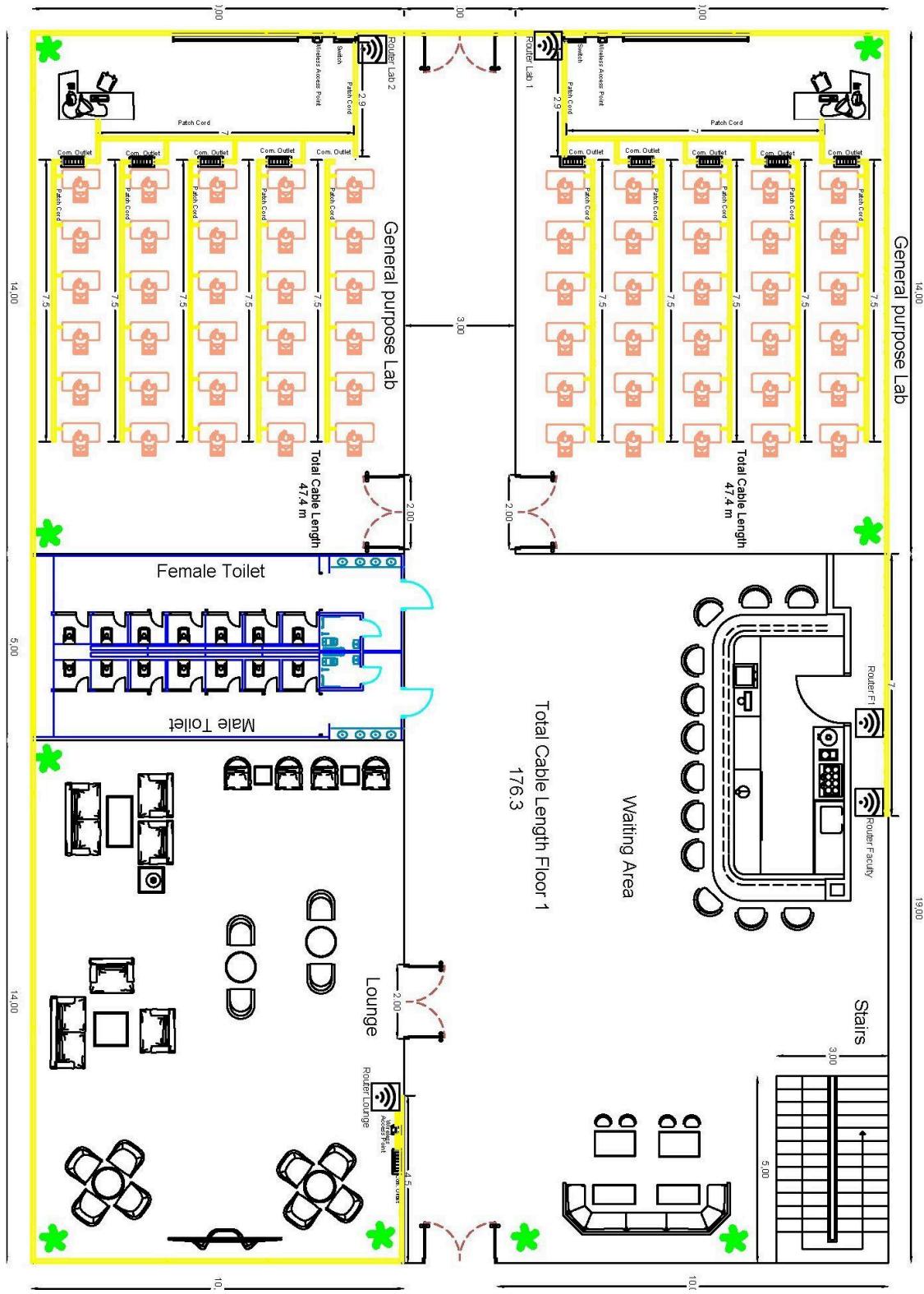
*Table 11.2 : Floor 2 Cable Length*

Description	Cable Type	Length (m)	
		Horizontal	Vertical
Cisco Network Lab	CAT 6A Cable	27.7	7.8
Embedded Lab	CAT 6A Cable	16.4	6.6
Hybrid Classroom	CAT 6A Cable	9.1	1.2
Video Conference Room	CAT 6A Cable	0.3	4
Floor 2 Wiring	CAT 6A Cable	70	60.2
Total Length (2nd Floor)		203.3	

## **12.0 Floor Scale**

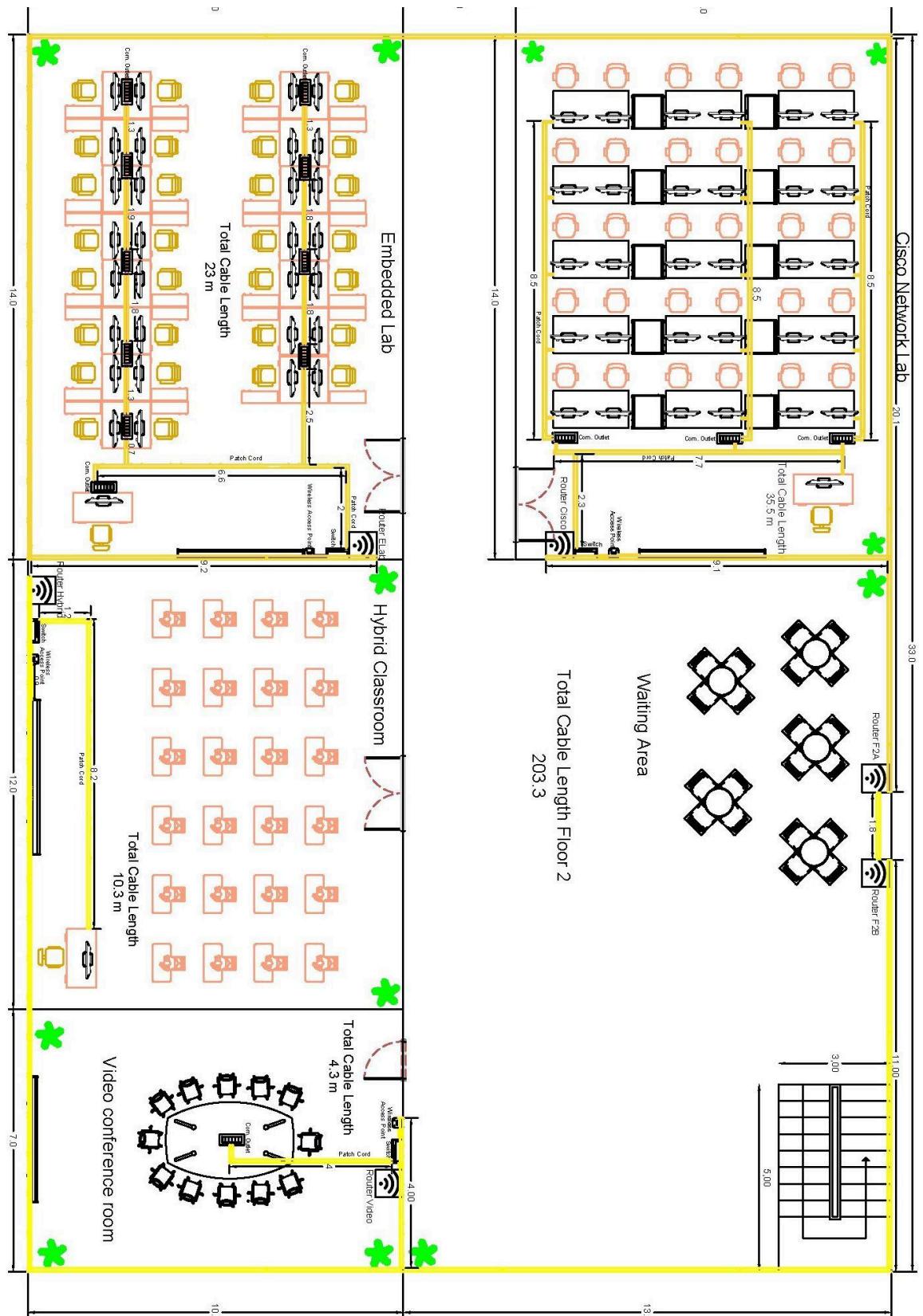
**12.1 First Floor**

1cm : 1m



## **12.2 Second Floor**

1cm : 1m



## 13.0 Group Network Address

IP addressing is important in ensuring that each host can connect to the network without addressing conflict. In this assignment, we will explore the best way to subdivide the subnets from the network address assigned to our group. Below are the available networks listed according to the group and the network address assigned to our group is **172.18.0.0/20 (FYBER)**.

*Table 13.1 : Group Budget Assignment*

	GROUP	BUDGET	NETWORK ADD
1	Dragon Force	900K	172.16.0.0/20
2	ECLIPSE	2.5M	172.17.0.0/20
3	FYBER	1.5M	172.18.0.0/20
4	HI-RES	1M	172.19.0.0/20
5	INCOGNITO	950K	172.20.0.0/20
6	LAN Lords	1.8M	172.21.0.0/20
7	NetMasters	2M	172.22.0.0/20
8	SETUP	1.3M	172.23.0.0/20
9	TALES	2.2M	172.24.0.0/20
10	SATU	1.3M	172.25.0.0/20

**172.18.0.0/20** indicates that our network portion is 20 bits and the host portion is 12. The subnet mask is **255.255.240.0** (11111111.11111111.11110000.00000000). The **network address is 172.18.0.0** and the **broadcast address is 172.18.15.255**. Therefore, the usable IP addresses that can be assigned to end hosts range from 172.18.0.1 to 172.18.15.254.

*Table 13.2 : Subnet Table for FYBER*

Subnet Mask	Network Address	Broadcast Address	Usable Host IP Address
255.255.240.0	172.18.0.0	172.18.15.255	172.18.0.1 - 172.18.15.254

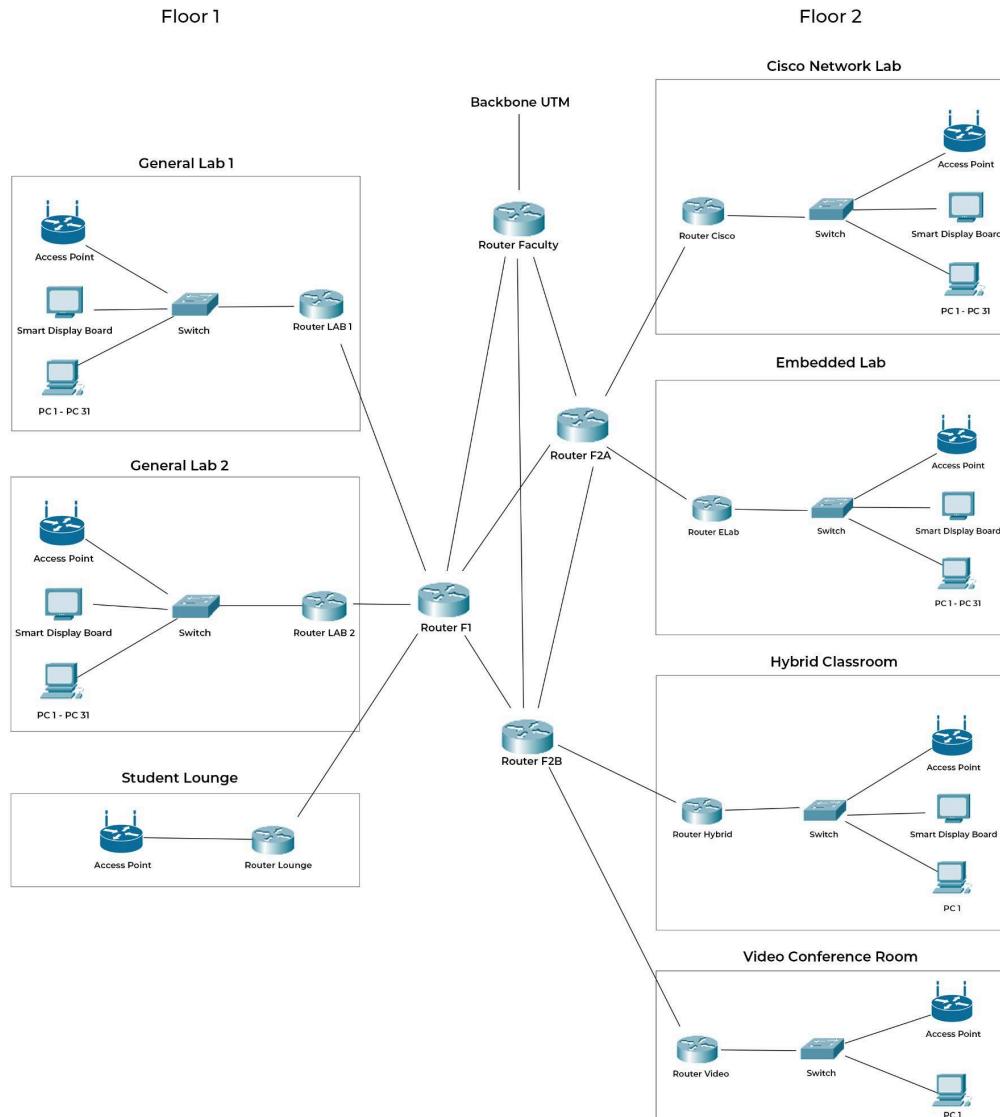
We have 4 labs in total which includes 2 General Purpose Lab, 1 Embedded Lab and 1 Cisco Network Lab, a Student Lounge, a Hybrid Classroom and a Video Conferencing Room. Therefore, Task 5 requires us to divide the IP addresses for the room and the connections from router to router.

# 14.0 IP Division

This subsection will highlight the building topology, room IP Division and Router IP Division

## 14.1 Topology

The images below show the building topology including floor 1 and 2, highlighting the connections between devices.



*Figure 14.1 : Faculty Building Topology*

## 14.2 Total Gateways

The table below shows the total gateway for each area which includes the total devices, maximum access point connection and room router

*Table 14.1 : Total Gateway Table*

Area	Devices	Access Point	Router	Total
General Lab 1	33	128	1	162
General Lab 2	33	128	1	162
Student Lounge	1	128	1	130
Embedded Lab	33	128	1	162
Cisco Network Lab	33	128	1	162
Hybrid Classroom	3	128	1	132
Video Conference Room	2	128	1	131

$2^1 = 2$	$2^9 = 512$
$2^2 = 4$	$2^{10} = 1024$
$2^3 = 8$	$2^{11} = 2048$
$2^4 = 16$	$2^{12} = 4096$
$2^5 = 32$	$2^{13} = 8192$
$2^6 = 64$	$2^{14} = 16384$
$2^7 = 128$	$2^{15} = 32768$
$2^8 = 256$	$2^{16} = 65536$

To determine the subnet, we can find the closest power of 2 that accommodates the total required IPs, including network and broadcast addresses. Then, subtract the number of bits required to represent that total from 32 (the total bits in IP address) to find the subnet mask

### 14.3 Area IP Division

The table below shows the IP Division for every area which includes its list of usable IP Address, Network Address and Broadcast Address

Table 14.2 : Area IP Division Table

Area	Subnet Mask	Usable IP Address	Network Address	Broadcast Address
General Lab 1	255.255.255.0/24	172.18.0.1/24 - 172.18.0.254/24	172.18.0.0/24	172.18.0.255/24
General Lab 2	255.255.255.0/24	172.18.1.1/24 - 172.18.1.254/24	172.18.1.0/24	172.18.1.255/24
Student Lounge	255.255.255.0/24	172.18.2.1/24 - 172.18.2.254/24	172.18.2.0/24	172.18.2.255/24
Embedded Lab	255.255.255.0/24	172.18.3.1/24 - 172.18.3.254/24	172.18.3.0/24	172.18.3.255/24
Cisco Network Lab	255.255.255.0/24	172.18.4.1/24 - 172.18.4.254/24	172.18.4.0/24	172.18.4.255/24
Hybrid Classroom	255.255.255.0/24	172.18.5.1/24 - 172.18.5.254/24	172.18.5.0/24	172.18.5.255/24
Video Conference Room	255.255.255.0/24	172.18.6.1/24 - 172.18.6.254/24	172.18.6.0/24	172.18.6.255/24

## 14.4 Router IP Division

The table below shows the IP Division for all the routers in the building which includes all the rooms on both floors and the Floor Main Routers.

*Table 14.3 : Router IP Division Table*

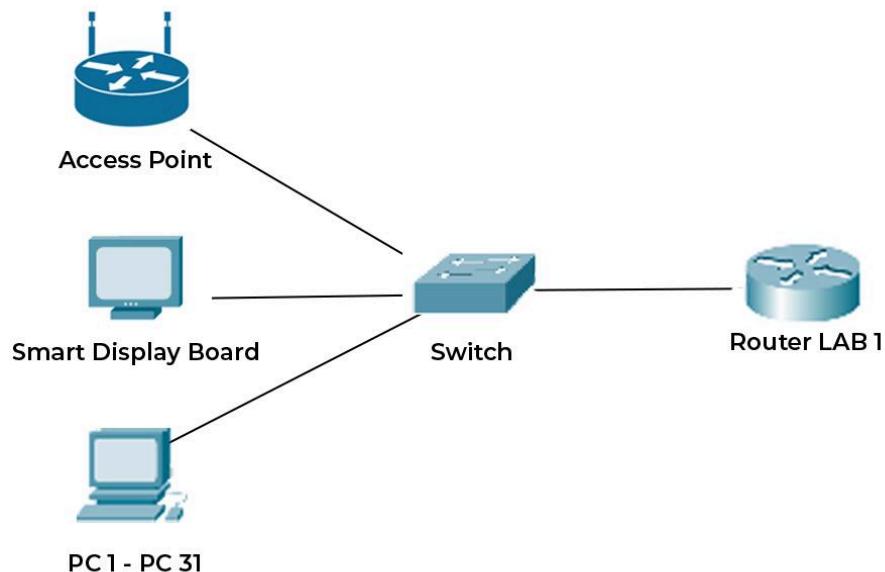
Router	Subnet Mask	Usable IP Address	Network Address	Broadcast Address
F1 to LAB 1	255.255.255.252/30	172.18.7.1/30 - 172.18.7.2/30	172.18.7.0/30	172.18.7.3/30
F1 to LAB 2	255.255.255.252/30	172.18.7.5/30 - 172.18.7.6/30	172.18.7.4/30	172.18.7.7/30
F1 to Lounge	255.255.255.252/30	172.18.7.9/30 - 172.18.7.10/30	172.18.7.8/30	172.18.7.11/30
F1 to F2A	255.255.255.252/30	172.18.7.13/30 - 172.18.7.14/30	172.18.7.12/30	172.18.7.15/30
F1 to F2B	255.255.255.252/30	172.18.7.17/30 - 172.18.7.18/30	172.18.7.16/30	172.18.7.19/30
F1 to Faculty	255.255.255.252/30	172.18.7.21/30 - 172.18.7.22/30	172.18.7.20/30	172.18.7.23/30
F2A to Cisco	255.255.255.252/30	172.18.7.25/30 - 172.18.7.26/30	172.18.7.24/30	172.18.7.27/30
F2A to ELab	255.255.255.252/30	172.18.7.29/30 - 172.18.7.30/30	172.18.7.28/30	172.18.7.31/30

F2A to F2B	255.255.255.252/3 0	172.18.7.33/30 - 172.18.7.34/30	172.18.7.32/30	172.18.7.35/30
F2A to F1	255.255.255.252/3 0	172.18.7.37/30 - 172.18.7.38/30	172.18.7.36/30	172.18.7.39/30
F2A to Faculty	255.255.255.252/3 0	172.18.7.41/30 - 172.18.7.42/30	172.18.7.40/30	172.18.7.43/30
F2B to Hybrid	255.255.255.252/3 0	172.18.7.45/30 - 172.18.7.46/30	172.18.7.44/30	172.18.7.47/30
F2B to Video	255.255.255.252/3 0	172.18.7.49/30 - 172.18.7.50/30	172.18.7.48/30	172.18.7.51/30
F2B to F1	255.255.255.252/3 0	172.18.7.53/30 - 172.18.7.54/30	172.18.7.52/30	172.18.7.55/30
F2B to F2A	255.255.255.252/3 0	172.18.7.57/30 - 172.18.7.58/30	172.18.7.56/30	172.18.7.59/30
F2B to Faculty	255.255.255.252/3 0	172.18.7.61/30 - 172.18.7.62/30	172.18.7.60/30	172.18.7.63/30
Faculty to F2A	255.255.255.252/3 0	172.18.7.65/30 - 172.18.7.66/30	172.18.7.64/30	172.18.7.67/30
Faculty to F2B	255.255.255.252/3 0	172.18.7.69/30 - 172.18.7.70/30	172.18.7.68/30	172.18.7.71/30
Faculty to F1	255.255.255.252/3 0	172.18.7.73/30 - 172.18.7.74/30	172.18.7.72/30	172.18.7.75/30

# 15.0 IP Assigntation

This subsection will show the IP Assigned for every devices in each room and the Subnet Assigned for every router

## 15.1 General Lab 1



*Figure 15.1 : General Lab 1 Device Routing*

This table below shows the IP Assigned for every device in the room based on the figure above

*Table 15.1 : General Lab 1 Device IP Assigntation*

Device Name	IP Address
Router LAB 1	172.18.0.1/24
Smart Display Board	172.18.0.2/24
Workstation (31 Pc)	172.18.0.3/24 - 172.18.0.33/24

Access Point	172.18.0.34/24
Access Point Connection (x128)	172.18.0.35/24 - 172.18.0.162/24

## 15.2 General Lab 2

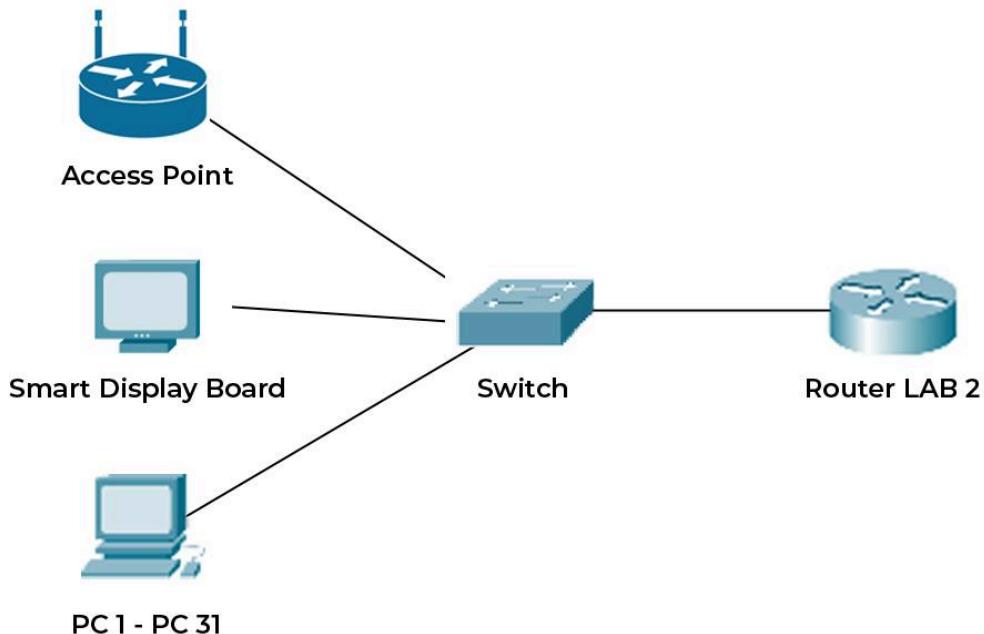


Figure 15.2 : General Lab 2 Device Routing

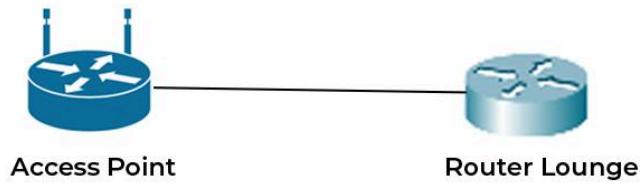
This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.2 : General Lab 1 Device IP Assignment

Device Name	IP Address
Router LAB 2	172.18.1.1/24
Smart Display Board	172.18.1.2/24
Workstation (31 Pc)	172.18.1.3/24 - 172.18.1.33/24

Access Point	172.18.1.34/24
Access Point Connection (x128)	172.18.1.35/24 - 172.18.1.162/24

### 15.3 Student Lounge



*Figure 15.3 : Student Lounge Device Routing*

This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.3 : Student Lounge Device IP Assignation

Device Name	IP Address
Router Lounge	172.18.2.1/24
Access Point	172.18.2.2/24
Access Point Connection (x128)	172.18.2.3/24 - 172.18.2.130/24

## 15.4 Embedded Lab

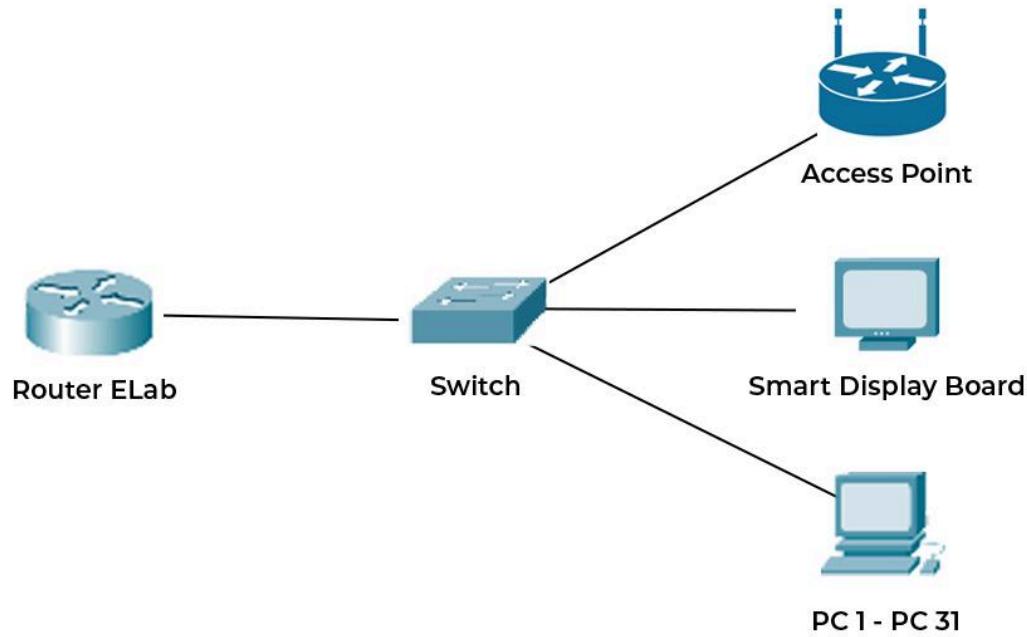


Figure 15.4 : Embedded Lab Device Routing

This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.4 : Embedded Lab Device IP Assignment

Device Name	IP Address
Router ELab	172.18.3.1/24
Smart Display Board	172.18.3.2/24
Workstation (31 Pc)	172.18.3.3/24 - 172.18.3.33/24
Access Point	172.18.3.34/24
Access Point Connection (x128)	172.18.3.35/24 - 172.18.3.162/24



## 15.5 Cisco Network Lab

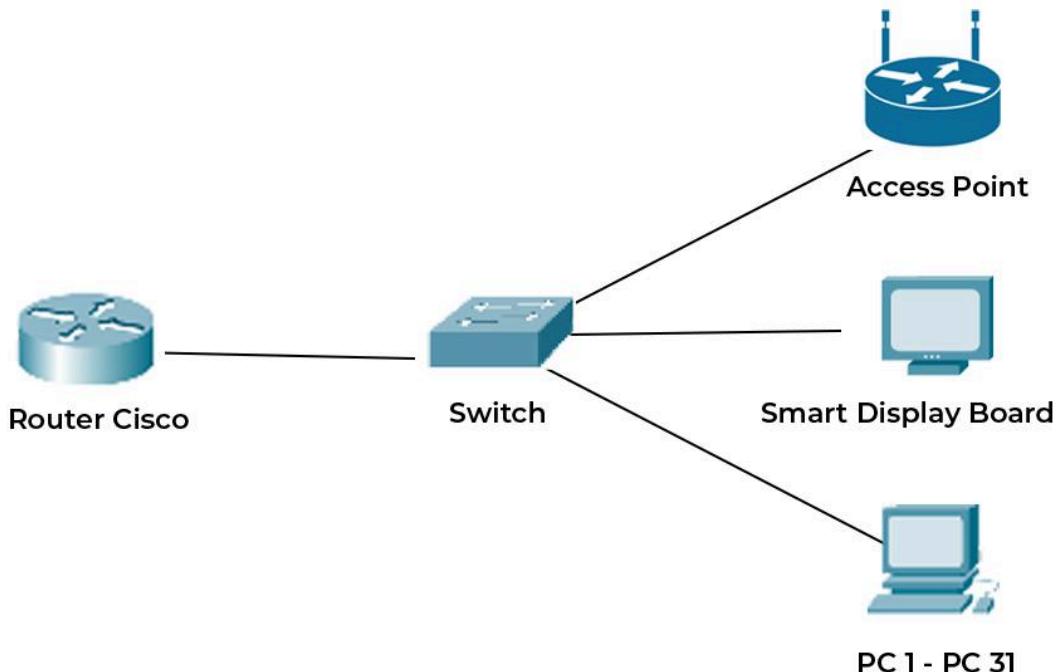


Figure 15.5 : Cisco Network Lab Device Routing

This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.5 : Cisco Network Lab Device IP Assig nation

Device Name	IP Address
Router Cisco	172.18.4.1/24
Smart Display Board	172.18.4.2/24
Workstation (31 Pc)	172.18.4.3/24 - 172.18.4.33/24
Access Point	172.18.4.34/24

Access Point Connection (x128)	172.18.4.35/24 - 172.18.4.162/24
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## 15.6 Hybrid Classroom

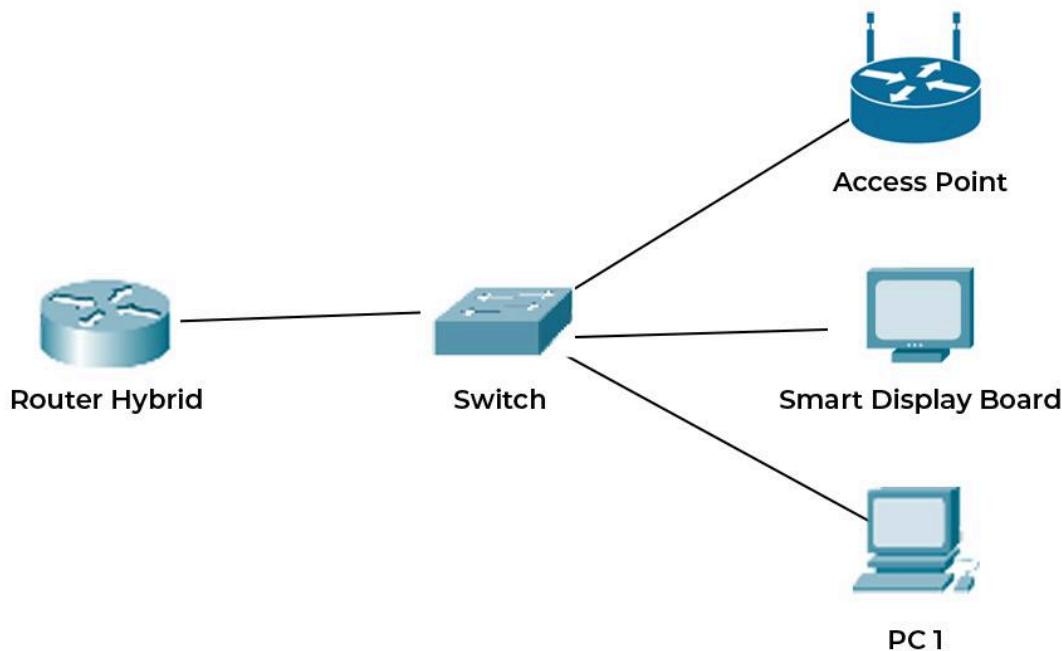


Figure 15.6 : Hybrid Classroom Device Routing

This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.6 : Hybrid Classroom Device IP Assignment

Device Name	IP Address
Router Hybrid	172.18.5.1/24
Smart Display Board	172.18.5.2/24
Workstation (1 Pc)	172.18.5.3/24

Access Point	172.18.5.4/24
Access Point Connection (x128)	172.18.5.5/24 - 172.18.5.132/24

## 15.7 Video Conference Room

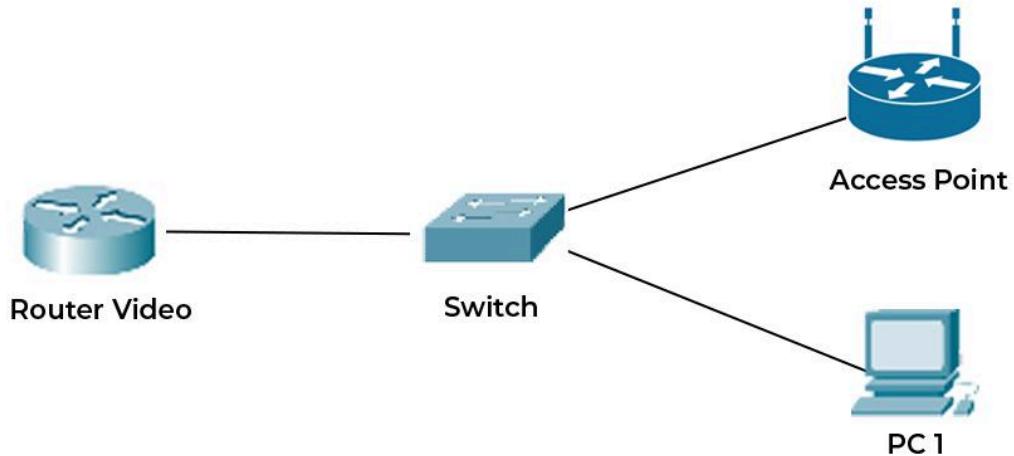


Figure 15.7 : Video Conference Room Device Routing

This table below shows the IP Assigned for every device in the room based on the figure above

Table 15.7 : Video Conference Room Device IP Assignment

Device Name	IP Address
Router Video	172.18.6.1/24
Workstation	172.18.6.2/24
Access Point	172.18.6.3/24

Access Point Connection (128x)

172.18.6.4/24 - 172.18.6.131/24

## 15.8 Routers

This figure below shows every router in the building with its Assigned Subnet

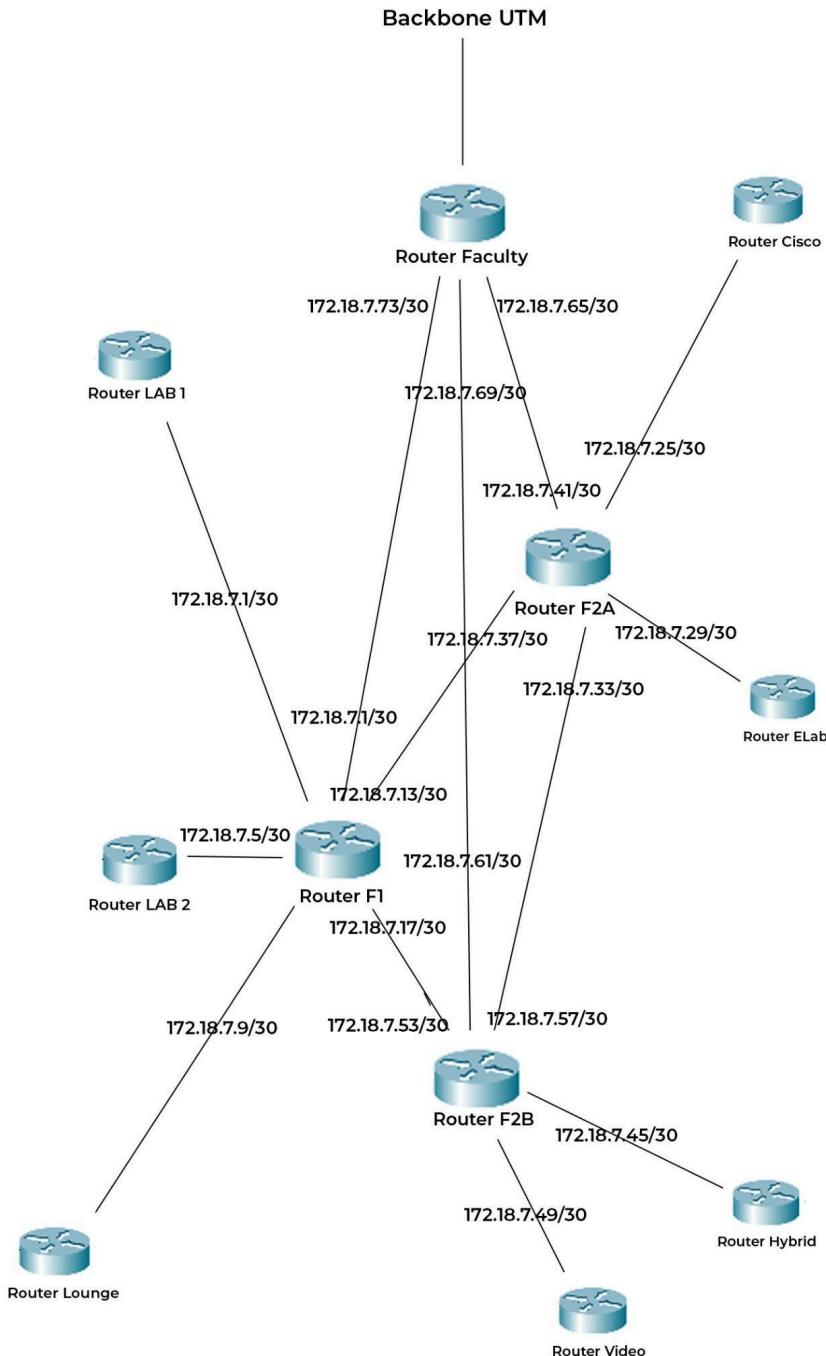


Figure 15.8 : Building Router Topology with Assigned Subnet

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## **3.2 REFLECTION**

### **1. Task 1**

During this task, I learned the importance of planning work areas effectively as it will also affect the placement of the devices. One of the main challenges I faced was organizing the devices in a way that utilized the space efficiently. To overcome this, I conducted research and surveyed a faculty building room, which provided practical insights and inspiration for our arrangement.

### **2. Task 2**

During this task, I was taught to think of questions that I should ask myself from the perspective of a Network engineer. The challenge was the task itself, I was wondering what are the questions that we are supposed to question ourselves. I overcame this by doing online research and the answers we got were mostly related to the LAN devices in the building and the position.

### **3. Task 3**

During this task, I learned the importance of knowing what type of devices that I should buy and was it suitable to accommodate all the users in the building, all of this within the given budget. The problem I had was identifying suitable LAN devices for the building such as the switch, routers and access point. I overcame this challenge by looking at past cases and referring to my Lecturer Ms.Hazinah which brings us to look at the devices capability and grade.

### **4. Task 4**

During this task, I learned the importance of LAN devices placement and cable wiring. There were a lot of challenges but the hardest one was the router placement. I need to add more routers and arrange the topology carefully to avoid the single point of failure which will affect the whole building.

## **5. Task 5**

During this task, I learned the importance of assigning devices IP and subnet. The challenge was to efficiently assign the subnet and IP address to all devices and routers. I overcame this challenge with the help of our lecturer, which is by assigning them according to the number of gateways ( including the WAPS).

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## 5.0 APPENDICES

Item	Device	Price (RM)	Qty	Total Price (RM)
Camera	<a href="#">AVer PTC310HWV2 AI Auto Tracking PTZ Camera – SRT Ready</a>	16,473.00	1	16,473.00
Smart Board	<a href="#">ViewSonic IFP7552-1A 75" 4K Ultra HD ViewBoard Interactive Display Flat Panel</a>	20,488.00	5	102,440.00
Monitor	<a href="#">HP 524sw 24" Ultraslim IPS Full HD 100Hz True-Color Low-Blue Light Filter w/ 99% sRGB 300 nits – Silver &amp; White</a>	258.59	131	33,875.29
Keyboard & Mouse	<a href="#">HP 150 WIRED MOUSE AND KEYBOARD COMBO</a>	55.00	131	7,205.00
Workstations (PCs)	<a href="#">ECHO 3 Office Desktop PC - AMD Ryzen 5 5600G / Radeon Vega 7</a>	1,199.00	131	157,069.00
Access Point	<a href="#">LigoWave NFT 2ac Dual-Band 802.11ac Indoor Access Point</a>	1,043.44	7	7,304.08
Router	<a href="#">ISR4431-V/K9 Cisco ISR Routers 4 x GE ports</a>	47,328.34	12	567,940.08

TV	<a href="#">Haier HQLED 4K UHD TV S75EUG (55")</a>	1,999.00	3	5,997.00
Video Conference Device	<a href="#">Owl Bar Video Conferencing Device — 4K Video Conferencing Bar with Active Speaker Focus</a>	10,933.00	1	10,933.00
Switches	<a href="#">Unifi Enterprise Campus Aggregation</a>	17,912.78	6	107,476.68
Circuit Boards	<a href="#">Arduino Uno R3</a>	42.90	30	1,287.00
Sensors and Actuators	<a href="#">Keyestudio 37 in 1 Sensor Kit V3.0</a>	185.00	15	2,775.00
Power Supplies	<a href="#">KORAD 3005D Power Supply</a>	277.00	5	1,385.00
Soldering Stations	<a href="#">HAKKO FX888-D</a>	906.75	5	4,533.75
Microcontrollers	<a href="#">ATmega328 NANOV3</a>	13.99	30	419.70
Prototyping Boards	<a href="#">Mini Breadboard LED Jumper Wire Button For Arduino</a>	10.34	30	310.20
Oscilloscopes	<a href="#">RIGOL DS1054Z 50MHz Digital Oscilloscope</a>	2,222.28	2	4,444.56
Practical	<a href="#">Cisco WS-C3750G-24TS</a>	1,609.99	32	51,519.68

Switches				
Practical Router	<a href="#"><u>Cisco 4331 Integrated Services Router</u></a> <a href="#"><u>ISR4331/K9</u></a>	3,509.99	32	112,319.68
Practical Wireless Lan Controller	<a href="#"><u>Cisco 3504 IEEE 802.11ac Wireless LAN Controller (AIR-CT3504-K9)</u></a>	3,395.00	32	108,640.00
Total Price of All Items				1,304,347.70