UTM

UNIVERSITI TEKNOLOGI MALAYSIA

NETWORK COMMUNICATION
SECR1213

SECTION 06

LECTURER: DR. RAJA ZAHILAH

PROJECT
TASK 5

GROUP : 3

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1.0 Overview of the Group

Group Name :	Pulse LTD
GROUP MEMBERS	
RAMI YASSEIN ELTAYEB	
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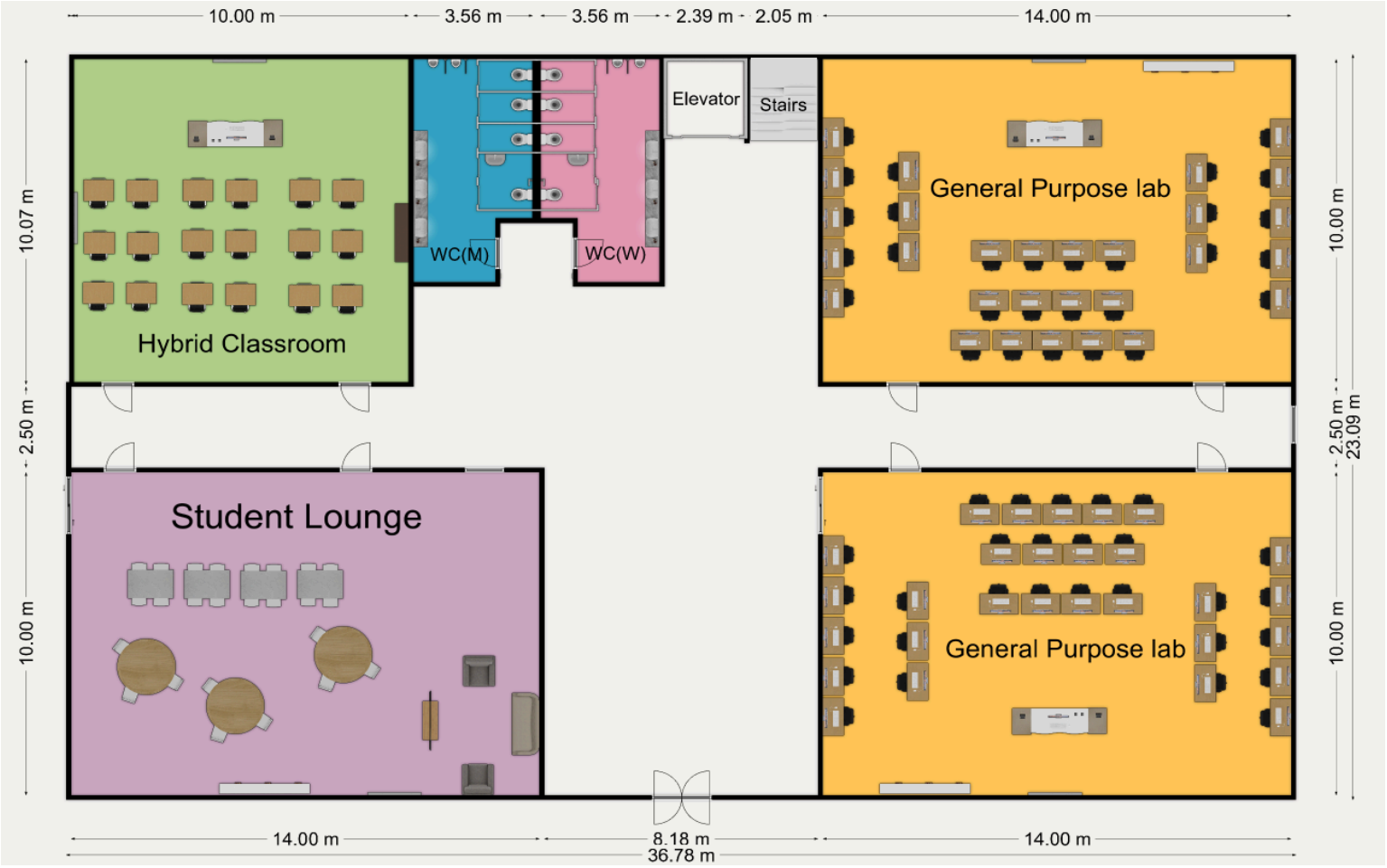
2.0 Design Layout for the building



2.1 First storey

2.2 Second storey

3.0 Preliminary Analysis

After some discussion, we had identified 10 questions regarding the requirements and other information that is necessary to develop a network plan based on the case study.

3.1 Questions

1.How many access points will be required to provide adequate Wi-Fi coverage on each floor?

The placement and number of our access point depends on many factors, including our floor size and expected user density in each area. This plan is based on **Wi-Fi standard 802.11ax**, for its good range and coverage, backward compatibility and enhanced security.

First Floor:

1. General Purpose Labs:

Since we expect our labs to demand higher bandwidth, we will place an access point in the center of each of the computer labs; this ensures good coverage for high data consumption activities during the lab.

2- Hybrid Classroom

We will place an access point in the center of the hybrid classroom, since it is an area that is susceptible to the use of different devices by the students, such as laptops, tablets, or other wireless devices, by placing an access point in the center, we ensure uniform coverage for the whole classroom

3. Student Lounge:

We will place an access point in this area since it is susceptible to high traffic as most students stay in this area during breaks to study or to hangout and relax.

4- Corridor and Common Areas:

We will place an access point in the middle of the common area, to ensure that students and staff maintain good connectivity when roaming between rooms.

Second Floor:

1- Cisco Lab:

We will place an access point in the center of the Cisco lab to maximize the bandwidth since it is susceptible to high data demands like networking simulations and networking training.

2- Embedded Lab:

We will place an access point in the center of the embedded lab to maximize the bandwidth since it is susceptible to high-speed connections for hardware simulations, microcontroller programming and IoT, placing it in the center also ensures a stable connection throughout the lab.

3- Video Conferencing Room:

Since the video conferencing room will require high bandwidth to support smooth video streaming, we will place an access point near the front where the main video streaming activities will likely occur.

4- Corridor and Common Areas:

We will place an access point in the middle of the common area, to ensure that students and staff maintain good connectivity when roaming between rooms.

Total access points: 9

2.Which service provider are we planning to use? Why?

We are planning to choose TIME as our Service provider since it meets our requirements and since TIME would be able to provide a connection that is fast, secure and efficient. The connection is MEF 3.0 certified as this certification ensures high availability, reliability, and robust security. We are considering choosing the dedicated internet as it provides a bandwidth up to 10Gbps suitable for FC's students and faculty staff. Some of its features include a private leased line through the Metro-E network and advanced DWDM mesh for near-perfect uptime (99.999%). We also considered the climatic condition in Johor is mostly rainy. We need a fiber based connection that is uninterrupted due to any kind of climate disruptions so TIME solves the issue by providing a fiber-based connection. FC does not want to spend money for the next 20 years so getting a fiber based cutting edge technology would assure it can easily adapt to technology upgrades, providing long-term value. TIME also provides a feature of Virtual Router. Since FC already has some existing connection, migrating to a virtual router via Network Functions Virtualization infrastructure (NFVi) can significantly cut costs and simplify network management.

3.What type of cabling are we planning to use?

Since the FC wants cables that will be capable of supporting high-performance to the core backbone , Fiber optic cables would be the best option to consider . Due to their High bandwidth which allows for fast data transmission of large files like research datasets and the immunity to electromagnetic interference which is essential for reliable data transfer especially in the labs with alot of high-power equipment which may lead to corrupted data . Fiber optic cables will also be very suitable because of their resistance to moisture and lighting.

4.What are the specifications of the computer in the class and lab?

The FC wants to step into the latest cutting-edge technology, but is not ready to be paying for long years if it is too expensive . So a cost effective solution has to be made .

Cisco Lab (Networking Lab)

For a Cisco lab focused on networking and cybersecurity, high-performance but specialized machines are essential.

Suggested Specs:

- **Processor:** Intel Core i7 or AMD Ryzen 7 (multi-core for virtualization and network simulation)
- **RAM:** 32 GB to support virtual machines and network simulations (Cisco Packet Tracer, GNS3)
- **Storage:** 512 GB SSD for fast load times, with a 1 TB HDD if additional storage is required
- **Graphics Card:** Integrated graphics that comes with the cpu
- **Networking Hardware:** Each computer should have high-quality NICs (Network Interface Cards), supporting up to 10 Gbps speeds
- **Operating System:** Windows 11 Pro or Ubuntu Linux (dual-boot recommended for flexibility in training)

Embedded Lab (Hardware/Software Integration Lab)

For embedded labs, where students work with microcontrollers, IoT, and real-time systems, the emphasis should be on hardware support and compatibility with embedded tools.

Suggested Specs:

- **Processor:** Intel Core i5 or AMD Ryzen 5 (low power consumption and sufficient for hardware simulations)
- **RAM:** 16 GB (20 GB or higher if handling complex simulations)
- **Storage:** 512 GB SSD to support fast processing

- **Graphics:** Integrated graphics, unless specific simulations require dedicated graphics
- **I/O Ports:** Multiple USB ports (preferably USB 3.0), serial ports, and potentially GPIO headers for hardware interfacing with microcontrollers (Raspberry Pi, Arduino)
- **Operating System:** Windows 11 Pro, with Linux as an option, as many embedded platforms are Linux-based Hybrid Classrooms

Hybrid Classrooms

For hybrid classrooms, where students engage in both in-person and online learning, the focus should be on versatility, multimedia capability, and efficient software support.

Suggested Specs:

- **Processor:** Intel Core i5 or AMD Ryzen 5 for standard usage, Core i7 or Ryzen 7 if handling more multimedia tasks
- **RAM:** 16 GB (enough for presentations, virtual lectures, and occasional programming tasks)
- **Storage:** 512 GB SSD (for faster application performance and quick boot times)
- **Graphics:** Integrated graphics or entry-level dedicated GPU if video editing or graphics design is part of the curriculum
- **Connectivity:** Wi-Fi 6 and Ethernet compatibility, essential for stable online interactions
- **Peripherals:** HD webcam, quality speakers, and microphone for online sessions; touch-enabled monitors may add value for interactive presentations
- **Operating System:** Windows 11 Pro, allowing full access to the Microsoft Office suite and virtual classroom tools .

5.What bandwidth capacity will be provided to each room to support high-demand areas like labs and the video conferencing room?

First Floor:

1. **General Purpose Labs:**

- **Recommended bandwidth capacity:** 500 Mbps to 1 Gbps per access point.
- **Reasoning:** since each lab will host multiple students working with data-intensive applications such as coding, simulations, or data analysis. We require a high internet connection to ensure efficient performance across all devices.

2. Hybrid Classroom:

- **Recommended bandwidth capacity:** 500 Mbps to 1 Gbps per access point.
- **Reasoning**: we chose this bandwidth since this classroom is a high-demand area, used for in-person and online learning. Real-time collaboration, video streaming, and multimedia use require low latency and high throughput to ensure a smooth learning experience.

3. Student Lounge:

- **Recommended bandwidth capacity:** 500 Mbps per access point.
- **Reasoning:** since it is not as demanding as the labs, the student lounge will have moderate to high traffic from students accessing the internet, streaming, and browsing.

4. Common Areas and Corridor:

- **Recommended bandwidth capacity:** 300 Mbps to 500 Mbps per access point.
- **Reasoning:** since this area is not as bandwidth-intensive as the labs, we chose a bandwidth strong enough to support mobile devices which is what mostly be used in this transitioning area.

Second Floor:

1- Cisco Lab:

- **Recommended bandwidth capacity:** 1 Gbps per access point
- **Reasoning:** high demand area, with multiple users running activities that demands high throughput and low latency.

2- Embedded Lab:

- **Recommended bandwidth capacity:** 1 Gbps per access point.
- **Reasoning:** high demand area, with multiple users running activities that demands high throughput and low latency.

3. Video Conferencing Room:

- **Recommended bandwidth capacity:** 500 Mbps to 1 Gbps per access point.
- **Reasoning:** since the video conferencing requires real-time sharing and video streaming during meetings, it requires a high bandwidth to ensure a smooth experience without delays.

4. Common Areas and Corridor:

- **Recommended bandwidth capacity:** 300 Mbps to 500 Mbps per access point.
- **Reasoning:** since this area is not as bandwidth-intensive as the labs, we chose a bandwidth strong enough to support mobile devices which is what mostly be used in this transitioning area.

6.What kind of firewall should we use and why ?

Given the requirement for robust security against potential network breaches, such as Internet Worms or denial-of-service attacks (as noted in the case study), an NGFW (Next-Generation Firewall) is ideal. NGFWs provide essential features, such as deep packet inspection, intrusion prevention, and application awareness, which are critical for safeguarding FC's network. Additionally, NGFWs offer simplified management, allowing the IT team to efficiently handle security threats while aligning with FC's goal of creating a "secure and easily managed" network.

7.The Layers of Security to be implemented?

For efficient data transmission across labs and the hybrid classroom, Layer 3 managed switches are recommended. These switches will enable internal routing, reducing network latency and optimizing traffic flow, which is critical for the "high-performance to the core backbone" objective stated in the case study. With Layer 3 capabilities, these switches can support future network expansion by managing increased traffic and providing more flexible configurations for VLANs, ensuring scalability for anticipated growth in students and staff.

8.What type of switching to be used , in order to transmit data?

We will use packet switching for data transmission considering a big faculty like FC since packet switching breaks down the data into small chunks of packets and transmits them. It chooses the most efficient route to transmit the data chunks. When compared to circuit switching which decides on a route first then only follows a certain path till the end allowing no room for flexibility.

9.What kind of data policy to be used ?

Implementing a Role-Based Access Control (RBAC) policy would best support FC's need for a secure, manageable system that meets access requirements for diverse user groups. This policy will define access permissions for students, faculty, and support staff, ensuring only relevant resources are available to each group. RBAC aligns with FC's goal of a "reliable, efficient, and secure" network by limiting access to sensitive data and minimizing potential security

vulnerabilities. This approach also supports cost-effectiveness by simplifying user management without the need for extensive custom configurations.

10.How are we planning to reduce Access link utilization?

We also analyzed that FC is a large faculty so the chances of the network getting congested is very high and so we decided to come up with a plan to solve this issue. We are planning to set up a local web cache in our faculty as the cache will store frequently accessed data locally. This will reduce the number of times data is directly fetched from the server ultimately leading to reduced use of access link ensuring it is faster and avoiding any congestion.

11.Does the faculty operate on a cloud-based system or a local server?

The faculty runs on a hybrid system that uses both **c**loud-based services and a local server. The cloud offers scalability and accessibility, which is ideal for non-critical tasks like document storage and email. Whereas, the local server ensures low latency and data control for high-demand activities in labs.

3.2 Feasibility

For the feasibility of the project we would like to consider technical, operational and financial feasibility. Taking into note that FC wants cutting-edge technology but don't want to be paying for the next 20 years

Operational feasibility:

We are expecting a need for regular maintenance of the Internet connection hence we chose TIME as it provides customer support and services included with the plan. We also require a dedicated technician for FC to fix and maintain the lab equipment and fix any minor issues.

Technical feasibility:

The project is technically feasible based on the existing infrastructure within FC. With well-established labs and a pre-existing network setup, the technical requirements align well with the technology already in place. Our choice of equipment and network connection, security and data policy will seamlessly integrate into the existing infrastructure, offering the capacity and scalability needed for our anticipated growth. We also have 9 access points and a NFVi based network which can be easily upgraded if a need comes in the future.

Financial feasibility:

We were allocated a budget of RM 2.2 million which is more than enough to equip the new building with cutting edge technology and be future ready. We are planning to buy the latest equipment which will last for more than 20 years and also under the budget. We will make good use of the budget and buy equipment with high grade quality ensuring longevity and durability.

4.0 List of Devices

Type of devices	Usage	Description	Quantity	Price/Unit (RM)	Total (RM)

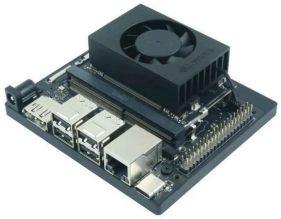
Switch Juniper - EX4100-F Ethernet Switch 	A switch enables connected devices to share information and talk to each other.	**Port Density:** 12, 24, or 48 x 1GbE access ports, with options for PoE+ or non-PoE configurations. **PoE Power:** Up to 740W PoE budget for the EX4100-F-48P model, with 30W per port. **Switching Capacity:** Delivers up to 256 Gbps for high-throughput network environments. **AI-Driven Management:** Integrated with Juniper Mist AI for cloud-based provisioning, monitoring, and performance optimization. **Virtual Chassis Support:** Allows up to 10 EX4100-F switches to be interconnected and managed as a single device for seamless scalability. **Microsegmentation:** Group-based policies (GBP) for granular security and endpoint control, leveraging EVPN-VXLAN.	6	17,000 (48 port)	102,000
Router Cisco - ISR4451-X/K9 	Connect to the internet link (ISP/modem) for network access	**Aggregate Throughput:** 1 Gbps to 2 Gbps **Total onboard WAN or**	2	34,250	68,500

		LAN 10/100/1000 ports: 4 **RJ-45-based ports:** 4 **Modular slots:** 3 NIM slots, 1 onboard ISC slot **Memory:** up to 16GB DDR2 ECC DRAM and flash memory 8 GB flash memory, expandable to 32 GB **Power Specifications:** 450W maximum power (no PoE) and up to 1450W with PoE boost			
Access Point Juniper - AP45 Access Point 	Used for extending the wireless coverage of an existing network and for increasing the number of users that can connect to it.	**Wi-Fi Bands:** Tri-band (6GHz, 5GHz, 2.4GHz) **Maximum Data Rates:** Up to 4800 Mbps. **Radios:** Dedicated fourth radio for monitoring, security, and analytics. **AI-Driven Optimization:** Automates Wi-Fi 6 features, optimizes RF, and improves performance. **IoT Support:** TWT and Bluetooth 5.1 for extended IoT device battery life.	8	6,400	51,200
Lysymixs 48 Port RJ45 Patch Panel Cat6 Feed Through, Coupler	Manage and organize network	**LAN Category:** Cat6 **Number of Ports:** 48	4	325	1,300

Network Patch Panel 	cables	**Connector type:** RJ45 **Cable Type:** Ethernet **Shield type:** STP **Rack:** 2 rack, IU, mountable **Connectivity:** 10 Gbps transmission performance			
Cat6 28AWG Snagless Unshielded (UTP) PVC CM Slim Ethernet Network Patch Cable 	Provide an internet connection, and connect devices to a local network	**Data Rate Support:** Up to 1G/10G-T **Standard Bandwidth:** Up to 550 MHz **PoE Compatibility:** Supports PoE, PoE+, and PoE++ (IEEE 802.3af/at/bt) **Wire Scheme:** Wired T568B **Cable Jacket:** Snagless Narrow Boot Design **Connectors:** RJ45 Modular Plugs with 50µ" Gold-plated contacts **Conductor Type:** Pure bare copper, stranded	122	18	2,196
30M OM3 LC to LC Fiber Patch Cable,	For connecting the	**Fiber type:** Multimode	8	83	664

10Gb Multimode Jumper Duplex LC-LC UPC 50/125um 	two floors, the cisco lab server and for uplink connections between switches and routers to ensure it is not a bottleneck	**Diameter:** 50/125µm **Optical Source:** VSCEL **Connector Type:** Lc/Upc to Lc/Upc **Bandwidth:** 2000MHz*km			
Video conferencing bar Owl labs - Owl bar 	Used for enhancing the video conferencing experience with smart switching and framing. Better audio and video	**Camera**: 4K Ultra HD, 30 MP, automatic framing, and intelligent switching. **Audio**: 18 ft pickup, 4 beamforming microphones, high-fidelity speaker, expandable mic support. **Compatibility**: Works with Zoom, Teams, Meet, Slack, and other video conferencing platforms. **Connectivity**: USB 3.0 (Type-C & Type-A), wireless pairing with Meeting Owl devices.	1	13000	13000

TV for Video Conferencing HUAWEI - IdeaHub S2 Interactive Display, 86" 	Used for projection and also for video conferencing. Compatible with video conferencing bar.	**Join Meetings Easily:** We can easily bring our meetings from our personal devices to the Huawei IdeaHub S2 with just a simple transfer. **Effortless Screen Sharing:** Sharing our screen is effortless—one step using Wi-Fi 6, and there's no need to be on the same network. **Collaborate Seamlessly:** We can collaborate seamlessly with features like multi-window views and an enriched office ecosystem. **Crystal-Clear Video:** The professional 4K video camera ensures our video is sharp and lifelike, thanks to advanced AI technology. **Immersive Audio Experience:** With AI-powered audio, we can hear and be heard clearly, even from 12 meters away, with no background noise.	1	40000	40000

HP ProOne 440 G9 Complete work station 	Used as complete workstation for general purpose labs and work station video conference and hybrid classes	**All-in-One PC** **Processor:** 14th generation Intel® Core™ i5 **Memory:** 16 GB **DDR5-4800 MHz RAM** **Storage**: 512 GB SSD **Display:** 23.8" FHD screen **Graphics:** Intel® UHD Graphics 770 **Peripherals:** Integrated 5 MP IR camera and HP Wired Keyboard/Mouse Combo	122	4,575	558,150
NVIDIA Jetson Xavier NX Developer Kit Embedded development platform 	Can be used in the embedded lab. Perfect for projects in AI, computer vision, and robotics.	**GPU:** NVIDIA AmpereTM architecture with 1024 x NVIDIA CUDA Cores 32 x Tensor Cores **CPU:** 6-core Arm Cortex-A78AE v8.2 64-bit CPU 1.5 MB L2 + 4 MB L3 **Memory:** 8GB, 128-bit, LPDDR5, 68GB/s **Storage:** External through microSD slot ExternaNVMe SSD through M.2 Key-M	30	2,550	76500

PowerEdge R760 Rack Server 	Can be used in cisco lab to handle heavy simulation and it is very reliable	Dual Intel Xeon Platinum 4th Gen processors. Up to 6 TB of DDR5 RAM. PCIe Gen 5 support for NVMe storage.	1	95,508	95,508
Total					1,009,018

4.1 Reflection

Analysis of required devices

We have a total of five general labs, each equipped with 30 workstations, making a total requirement of 122 workstations and 122 monitors for all the labs , conference room and hybrid class. Additionally, we will need one powerful Cisco server dedicated to the Cisco lab, along with 30 embedded development kit devices for specialized development tasks. To ensure network connectivity, we included 122 Cat6 Ethernet cables to connect each workstation to the network. These cables will link the devices to patch panels, which will then connect to the appropriate switches. We have a total of 6 switches, one in each of the labs and one in the hybrid classroom and one in the conference room to ensure that each device is connected via the switch to the router. Each of the four labs will be equipped with a patch panel, each having 48 slots, to organize and manage the connections between workstations and switches.

For high-speed and reliable connections, we included eight OM3 fiber optic cables. One will connect the networks across the two floors, six will link the switches to the routers to avoid bottlenecks in the uplink connections, and one will connect the Cisco server to the network to handle resource-intensive tasks shared across the labs. The network is designed to ensure seamless communication, with switches and routers placed strategically on each floor for optimal traffic management. This setup prioritizes

efficiency, scalability, and reliability to meet the needs of the labs.

Are you surprised by the prices?

Yes, even though we did a lot of research beforehand, we were startled by the prices of some of the devices, while we expected others to cost more; However were not very surprised by the price of each device as much as we were surprised by how much it all added up in the end for only a LAN setup, we never expected that a two storey LAN network would cost up to 1 million Malaysian Ringgit.

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

Of course cost was always a factor, since we started working on this project. Since we have a fixed budget of 2.2 Million Malaysian Ringgit, which is quite good and comfortable to work with, we wanted to use the best devices we could find that fits our network needs, while also fitting our budget, since things can add up later on if we are not very careful with it.

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

The biggest difference we noticed between some of the same devices from different brands was the price and the reputation of that brand or how popular it is between buyers. Mostly, we could find two similar devices from different brands but what differed was only some other minor differences, for example, Cisco 4451-X and Juniper J6350 Router, while they shared most of the functionalities, the Cisco router had an integrated security feature, while Juniper's security was integrable, they also differed in scalability, and we noticed that Cisco covered most of our needs for the network while Juniper was able to scaled to fit our needs, overall, both brands were good, and we chose the one that could cover all of our needs easily while also fitting our budget.

4.2 References

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10. Server: https://www.server2u.com/shop/r760-xg6430-dell-poweredge-r760-2u-rack-server-2xxg6430-32gb-480gb-55357?gad_source=1&gclid=CjwKCAiAjKu6BhAMEiwAx4UsAlARJxKvuW2UOHMzw6E8MBvBW97AeBoE369JffwTFv7PF8kiT8N8tBoCwFkQAvD_BwE#attr=

5.0 Work Area

5.1 Network Topology

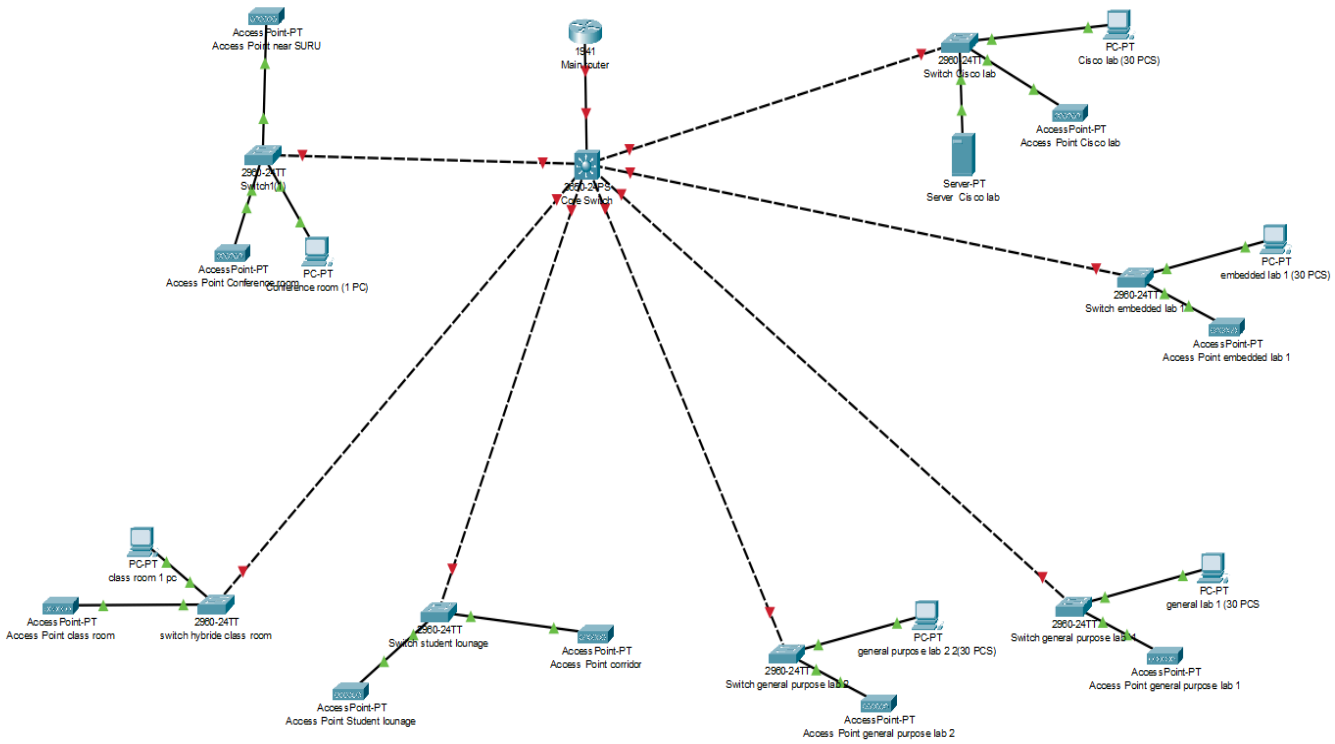


Figure 5.1.1 - Overall Network Topology

Figure 5.1.1 illustrates the network topology for the faculty lab building, showcasing the various network areas and their interconnections. The core of the network is managed by a **Main Router** , which provides centralized control and serves as the gateway to external networks. From the main router, connectivity is distributed through the **Core Switch** , which acts as the backbone for the entire network, facilitating communication across different areas.

Several network segments are depicted, including specific **labs, classrooms, and common areas** such as the student lounge, hybrid classroom, general-purpose labs, embedded labs, and the Cisco lab. Each of these areas connects to a **dedicated switch**, which in turn connects to access points (APs) and devices like PCs and servers.

The network incorporates **access points** strategically placed in each area to ensure wireless connectivity, while the switches provide wired connections for critical devices. Overall, the topology demonstrates a well-structured and hierarchical design that ensures efficient data flow and robust connectivity across all zones.

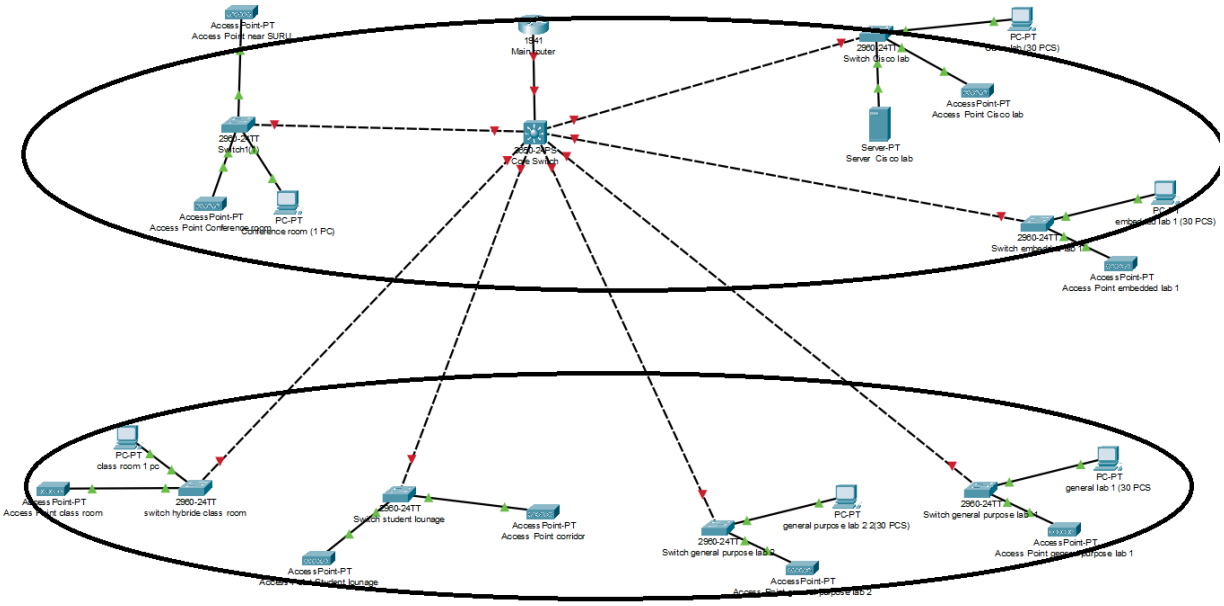


Figure 5.1.2 - Floors Separation

figure 5.1.2 provides a detailed view of the network topology, showcasing the network devices and configurations distributed across the two floors.

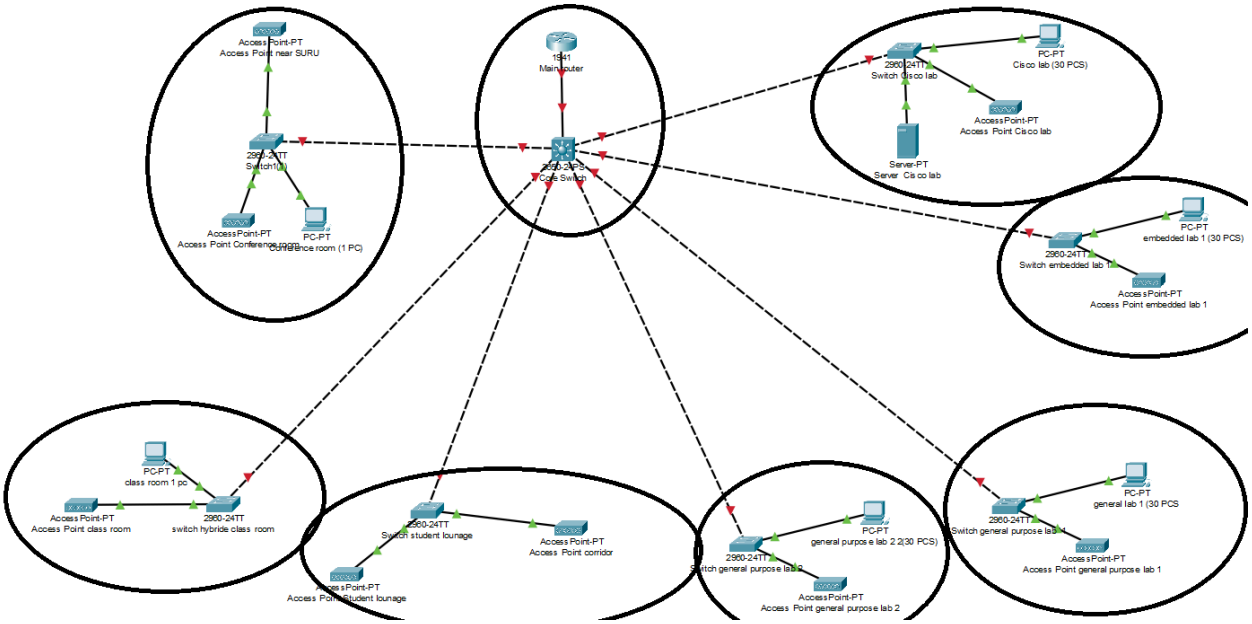


Figure 5.1.3 - Rooms Separation

Figure 5.1.3 provides a focused view of the network segmentation, where each **logical area** represents a room in the building or area.

5.2 Identification of Each Work Area

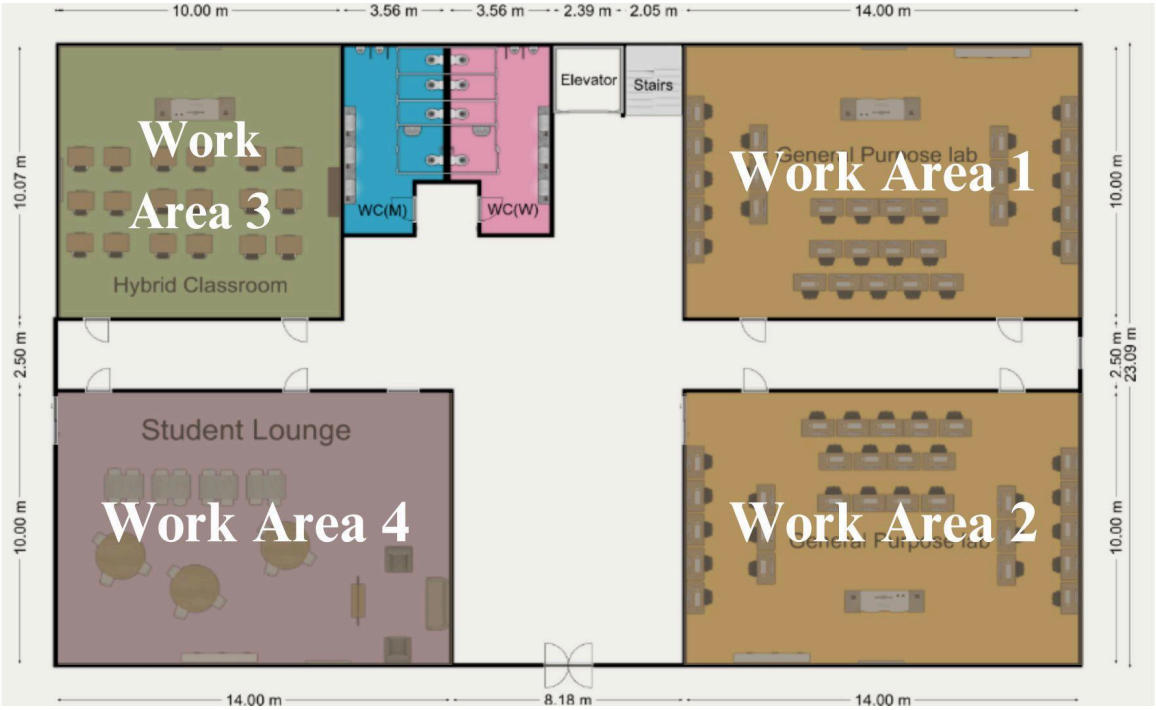
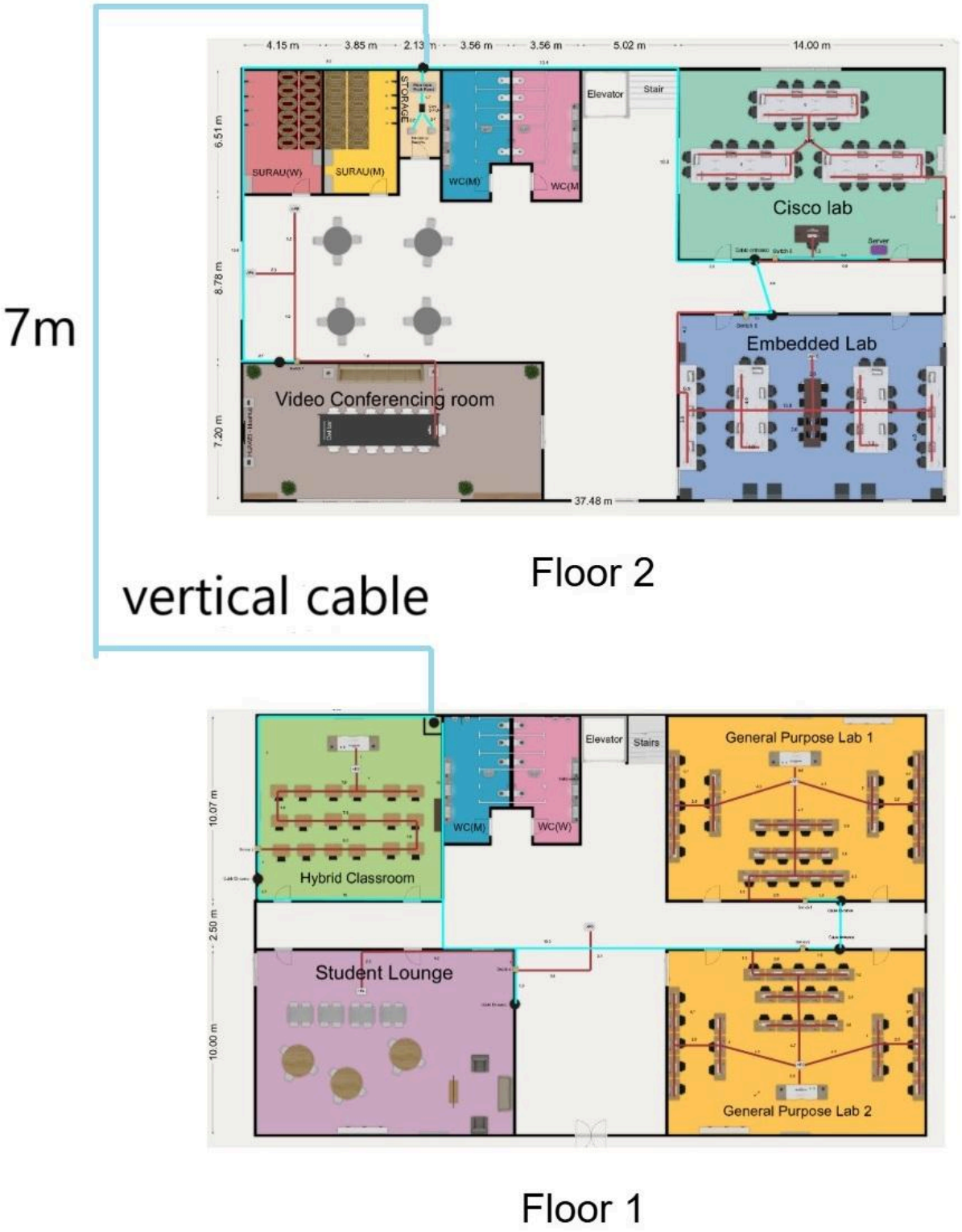


Figure 5.2.1 - Work Areas for Floor 1

Figure 5.2.2 - Work Areas for Floor 2

1. **Storage area**:
    - The **Main Router** and the **Core Switch** are centrally located, acting as the backbone of the entire network, distributing connectivity to all areas.
2. **Cisco Lab**:
    - Connected through a dedicated switch , the Cisco lab hosts **30 PCs** and a **server**. An **access point** ensures wireless access within the lab.
3. **Embedded Lab:**
    - This segment includes a **switch**, an **access point**, and **30 PCs**, providing wired and wireless connectivity.
4. **Conference Room**:
    - Equipped with a **single PC** and an **access point** for small-scale wireless connectivity, connected via a dedicated **switch**.
5. **Hybrid Classroom**:
    - Contains a **switch**, an **access point**, and a **PC** to support both wired and wireless users.
6. **Student Lounge and Corridor**:
    - This area has an **access point** and a **switch** providing coverage for open spaces like the student lounge and corridor.
7. **General Purpose Labs 1 & 2**:
    - Each lab is equipped with **30 PCs**, a **dedicated switch**, and **access points** for seamless wired and wireless connectivity.

6.0 Floor plan



Indicators for the floor plan

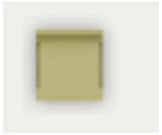
server

Core switch

Cable entrance

Access point

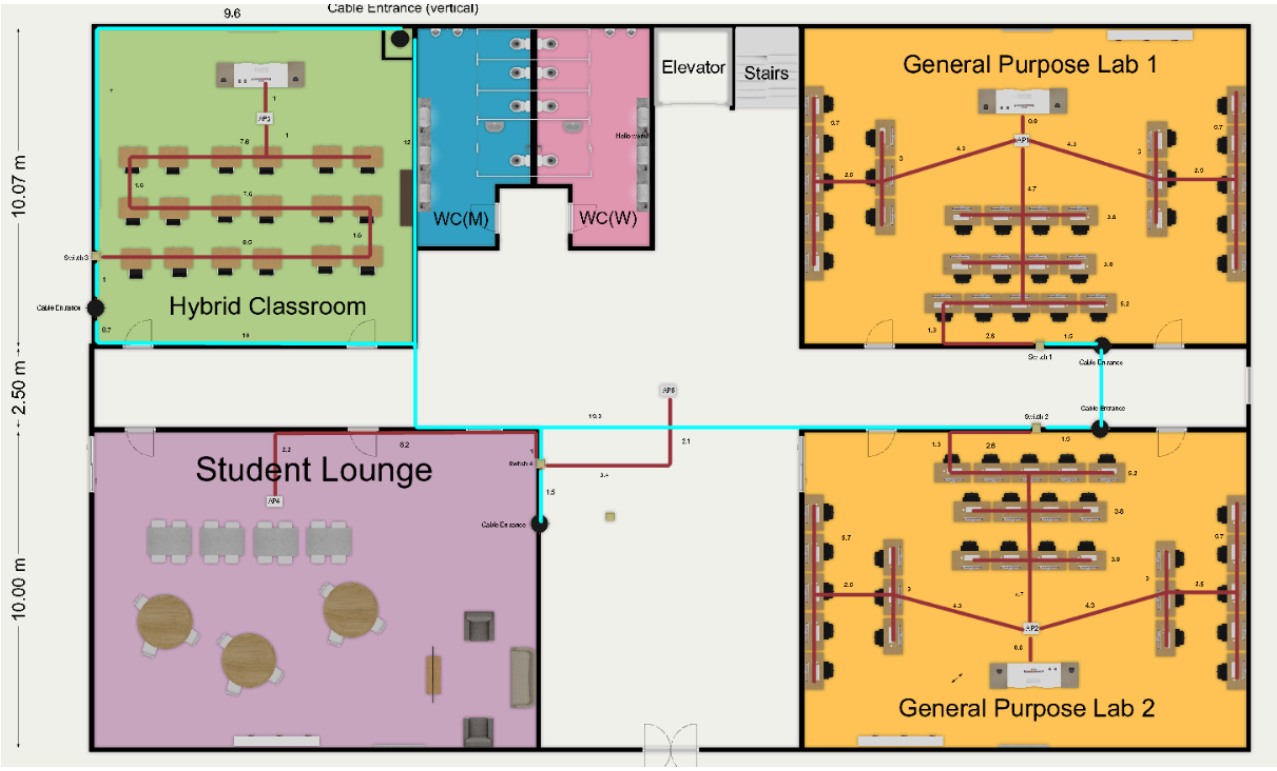
Access switch



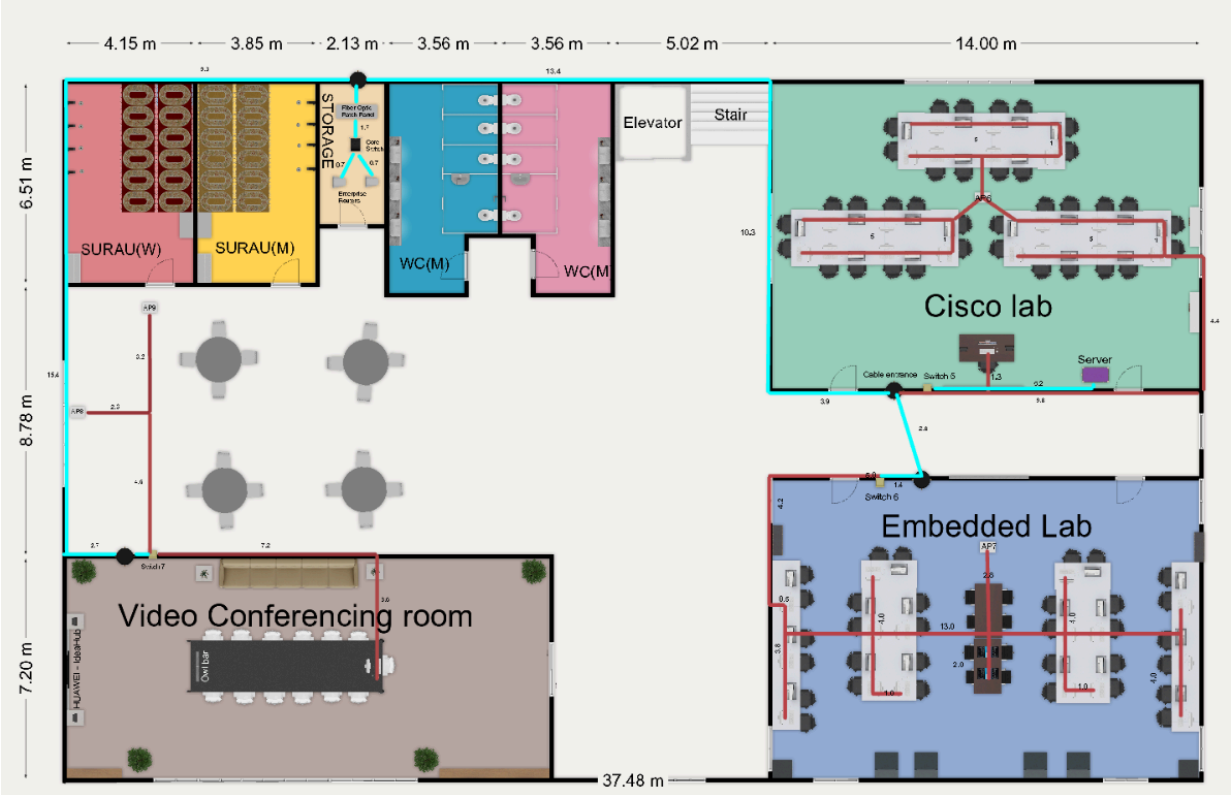
Fiber optics OM3 cable

Cat6 copper cable

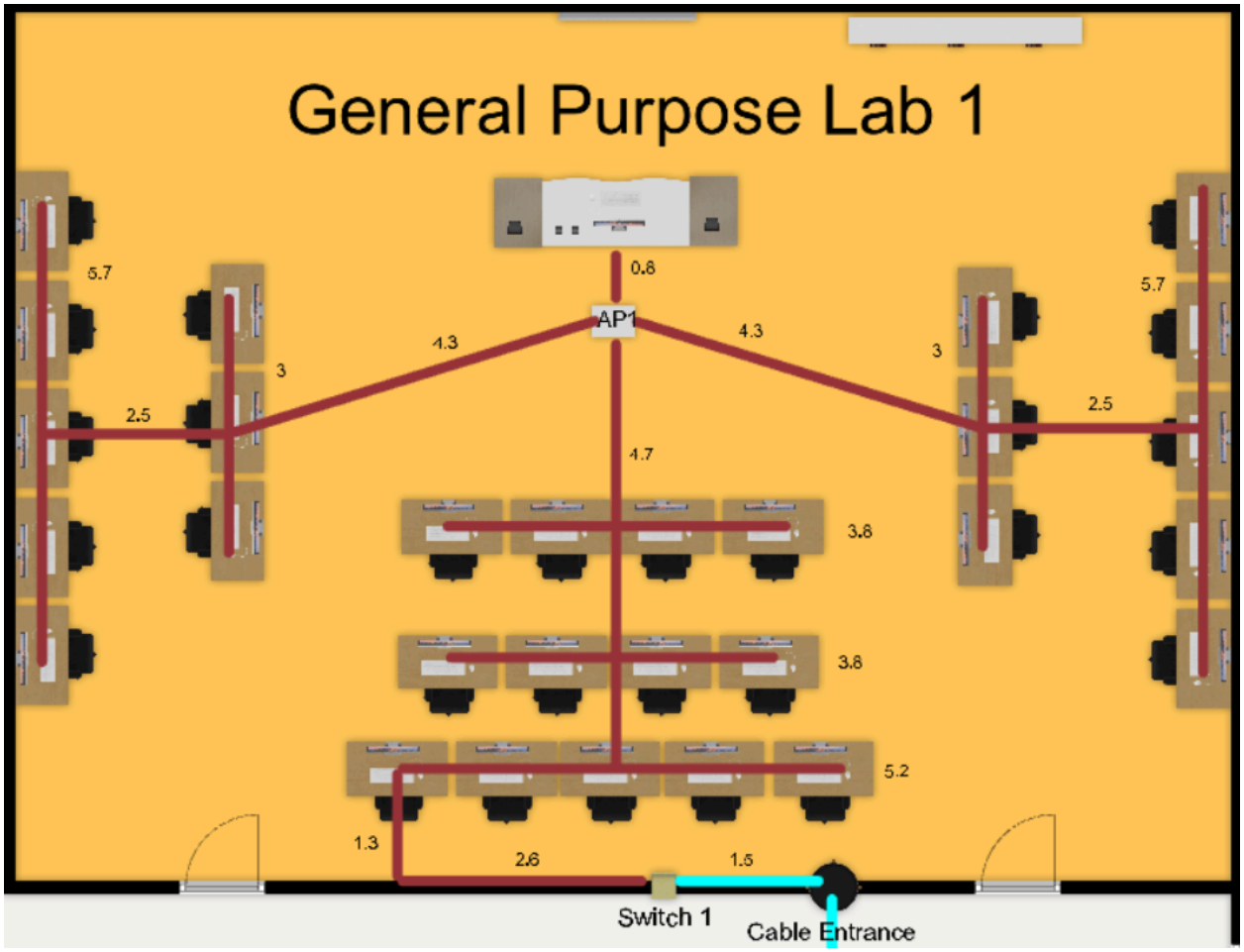
Floor One:



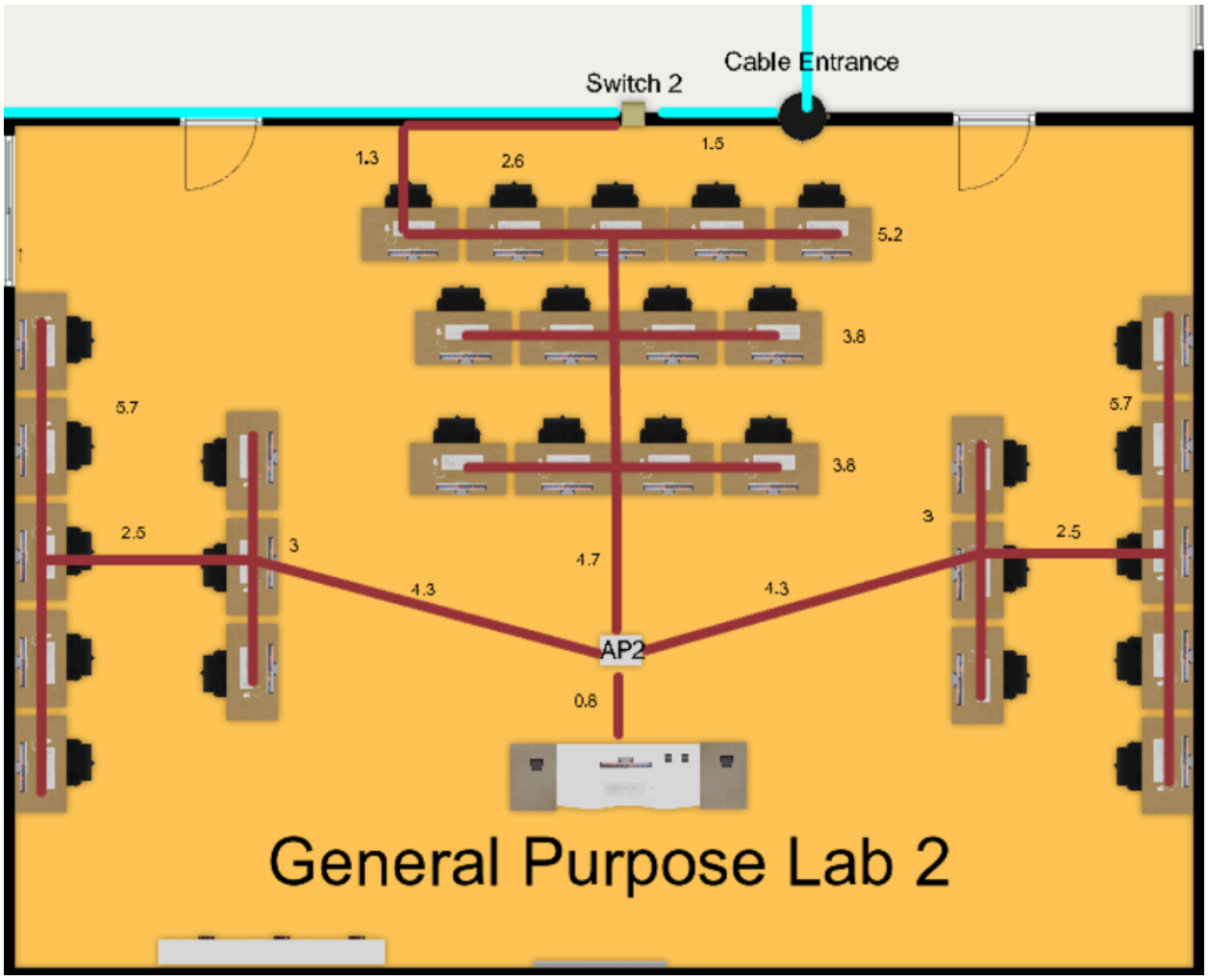
Floor Two:



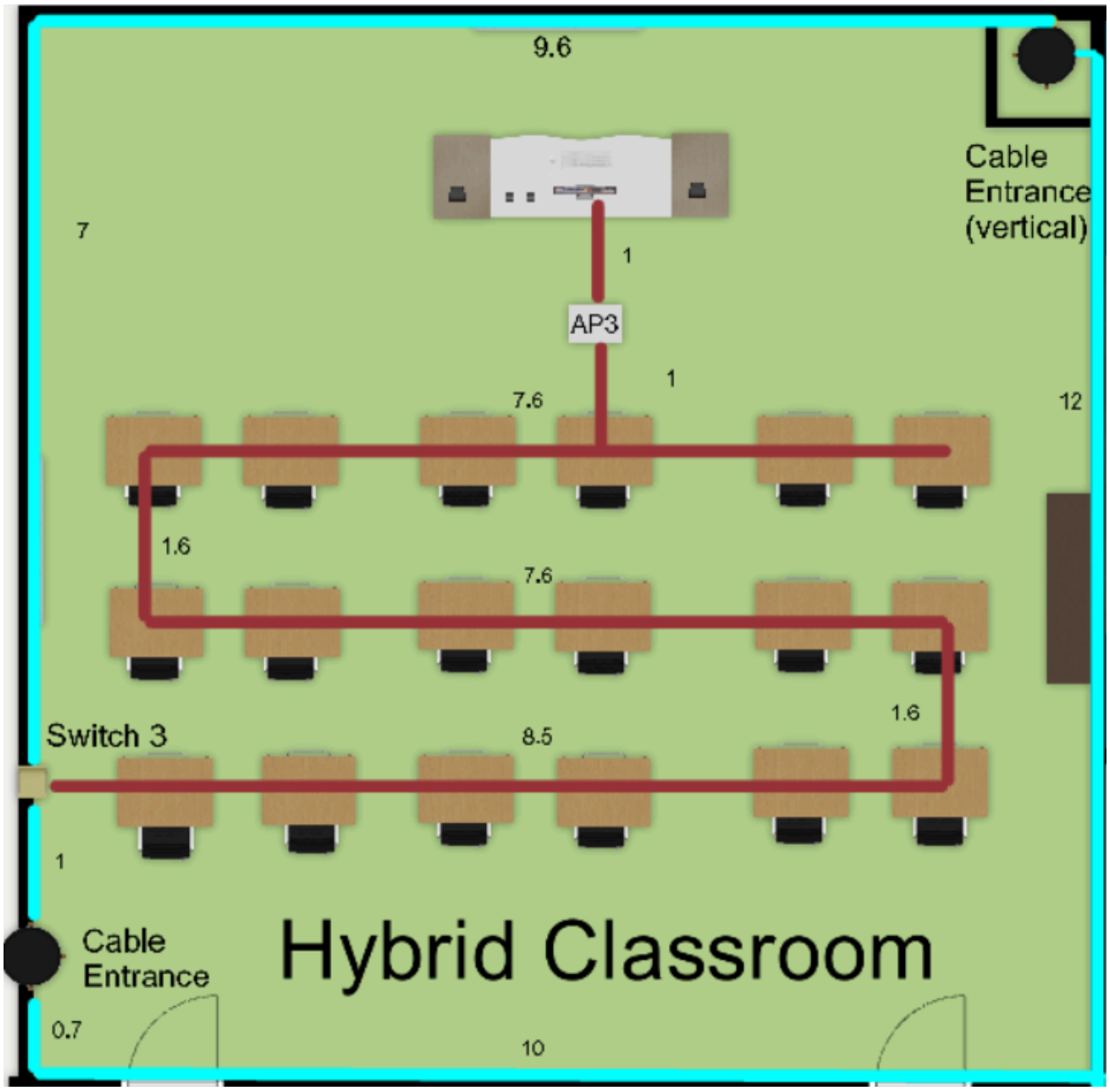
6.1 General Purpose Lab 1



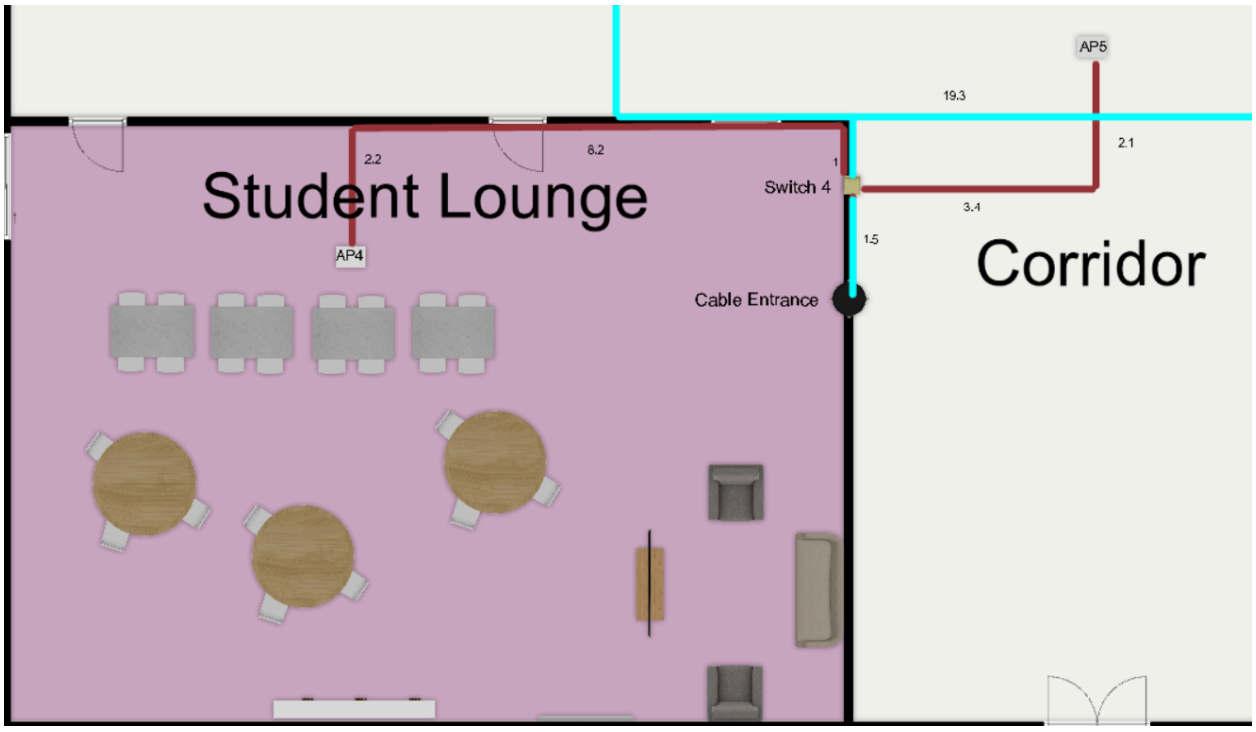
6.2 General Purpose Lab 2



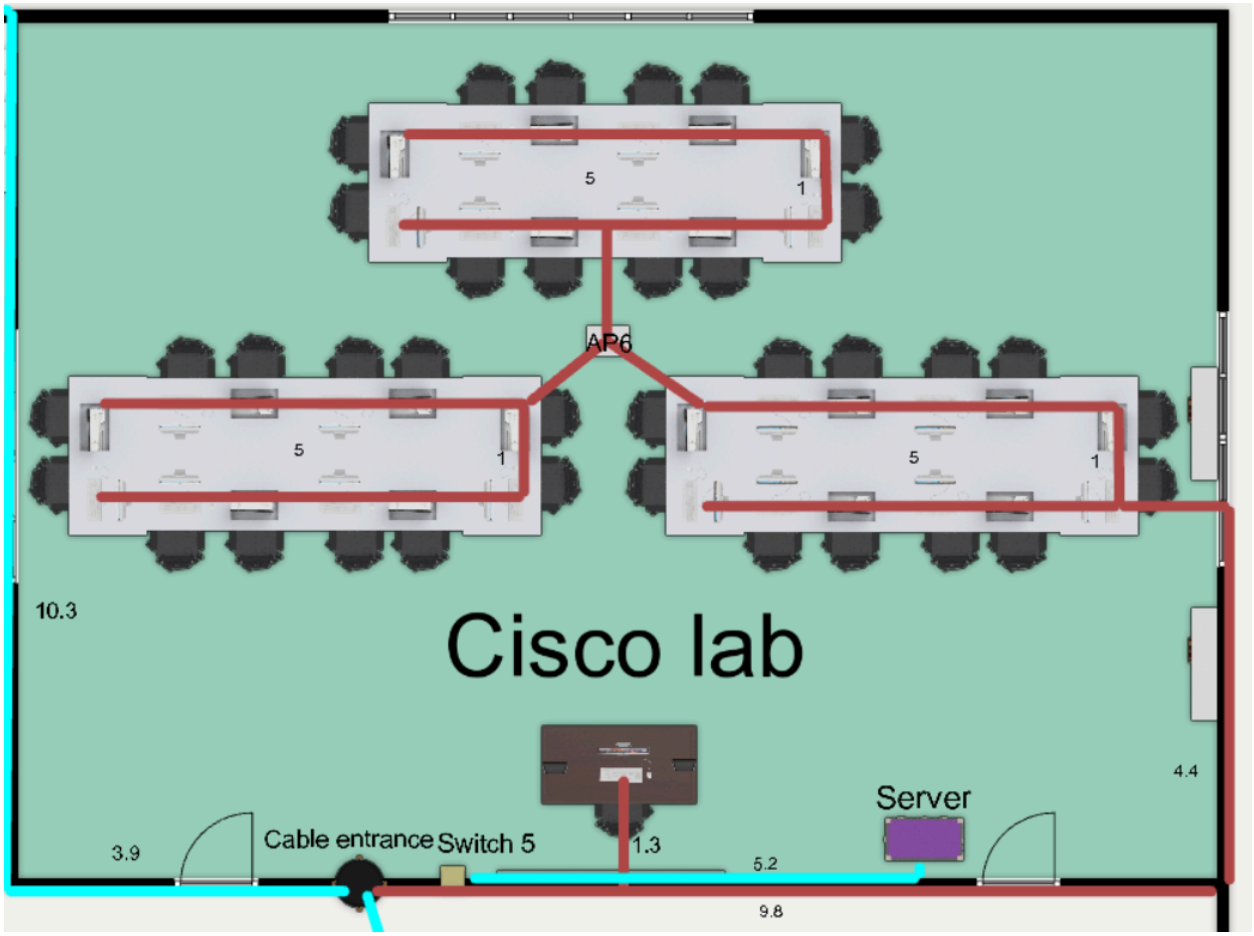
6.3 Hybrid Classroom



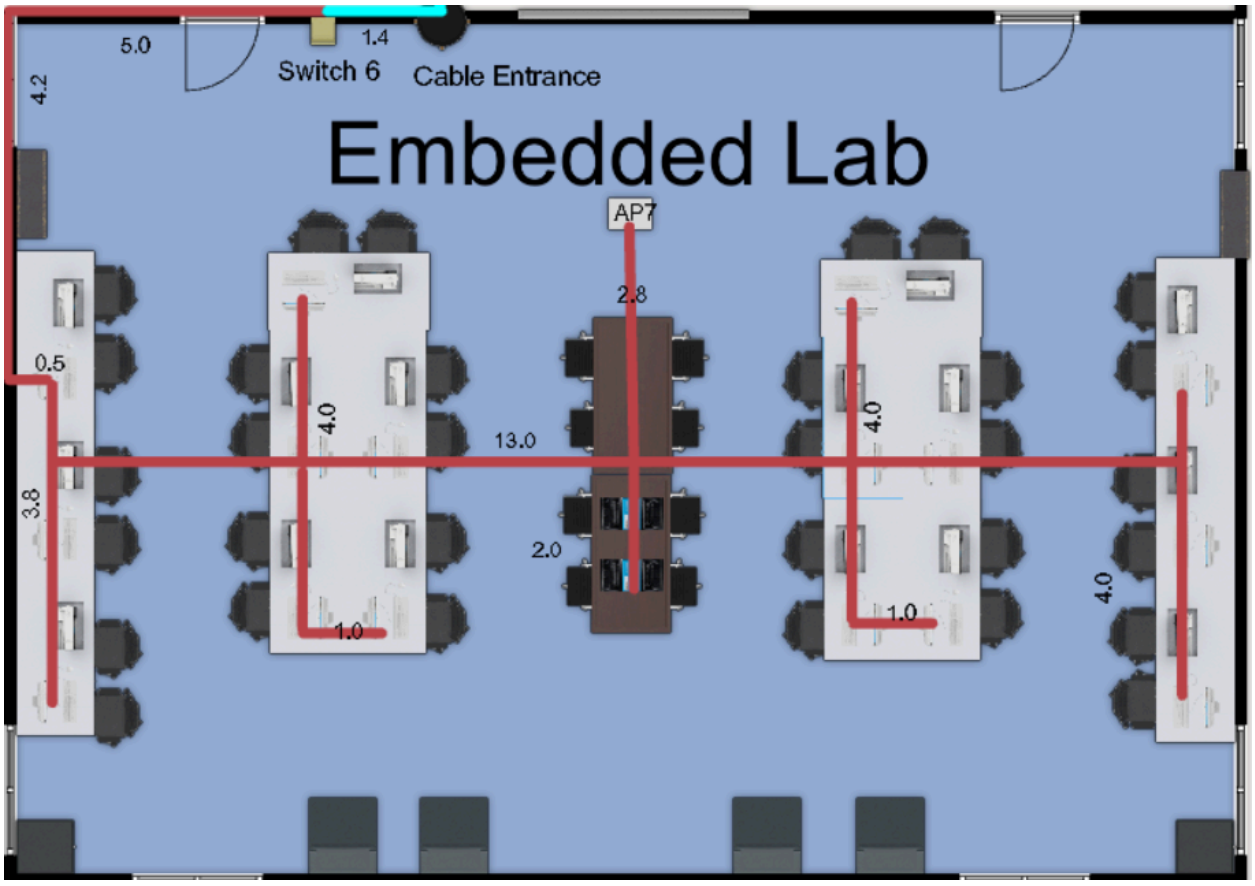
6.4 Student Lounge



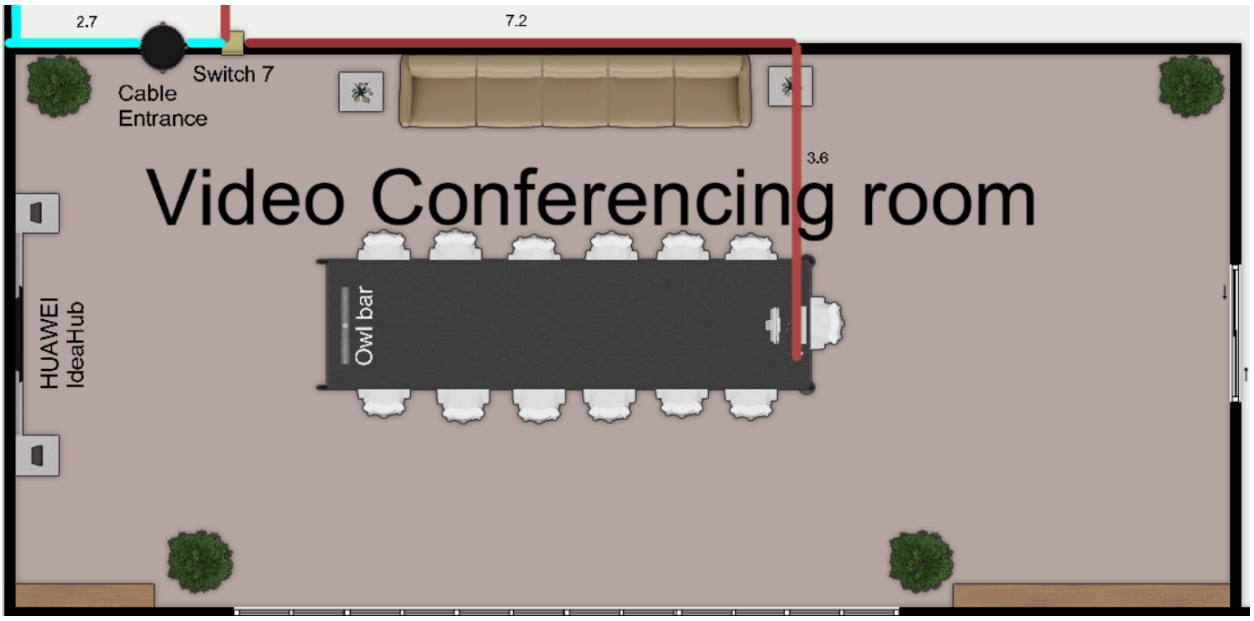
6.5 Cisco Lab


5
1
AP6
5
1
5
1
10.3
Cisco lab
4.4
Server
3.9
Cable entrance
Switch 5
1.3
5.2
9.8

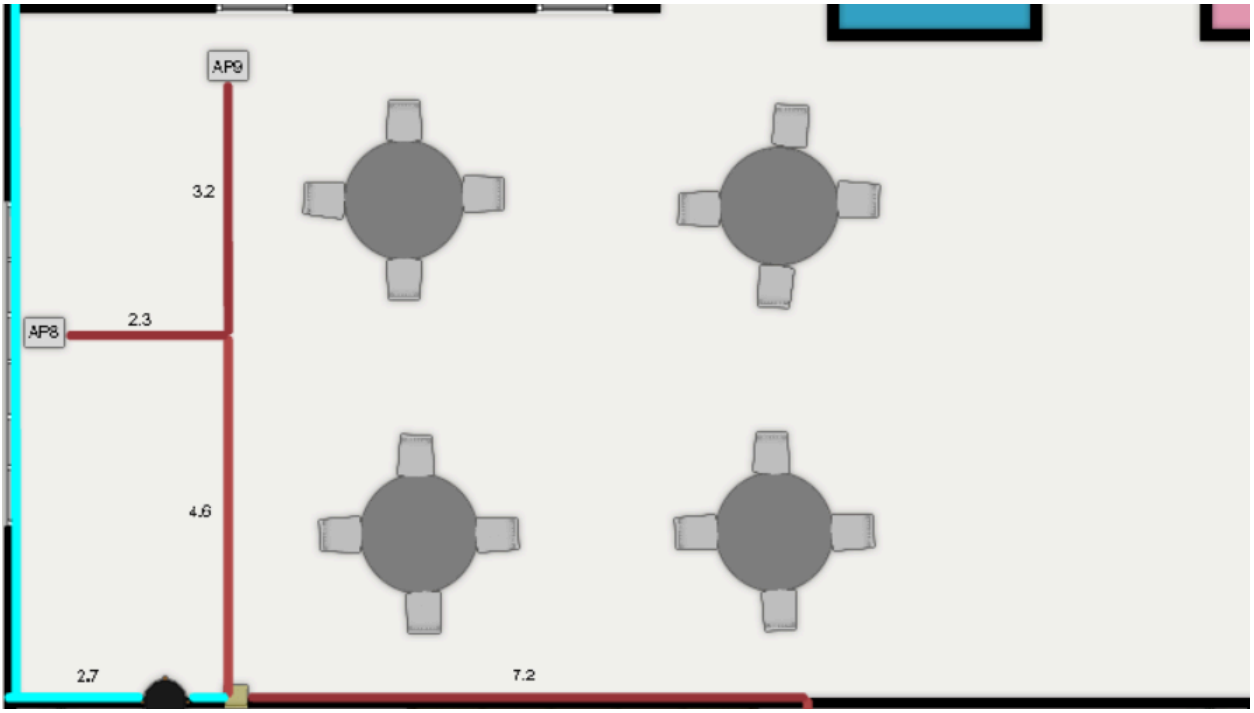
6.6 Embedded Lab



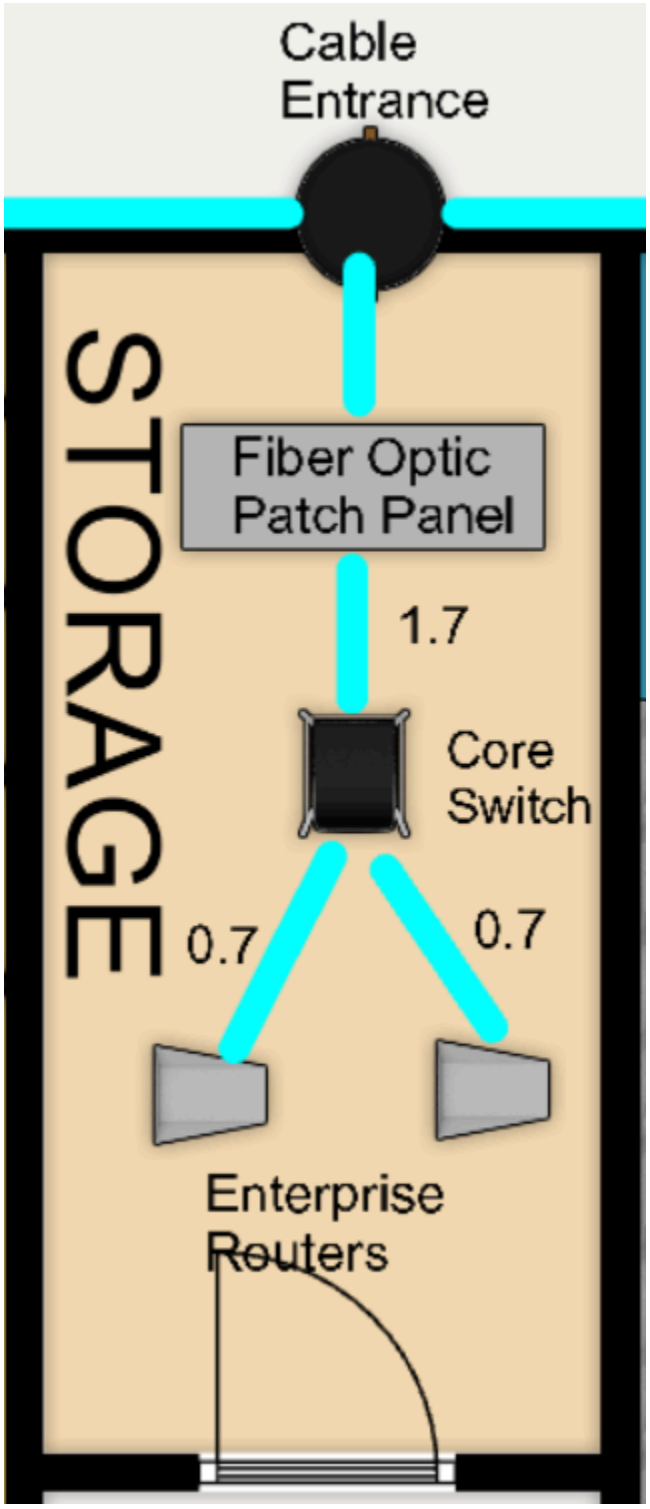
6.7 Video Conferencing room



6.8 Corridor



6.9 Storage Room



7.0 Connections, Patch Cords and Switch Ports

7.1 Cable lengths and Types

Description	Cable Type	Cable Length
1st Floor		
General Purpose Lab 1	Cat6 28AWG	48.2 m
General Purpose Lab 2	Cat6 28AWG	48.2 m
Hybrid Classroom	Cat6 28AWG	36.5m
Student Lounge	Cat6 28AWG	11.4m
Connection to access point corridor	Cat6 28AWG	5.5m
Total length floor 1		149.8
2nd Floor		
Cisco Lab	Cat6 28AWG	48.2m
Embedded Lab	Cat6 28AWG	38.6m
Video Conferencing Room	Cat6 28AWG	10.8m
Access point near surau	Cat6 28AWG	6.9m
Total length for floor 2		104.5
Connection between access switches - core switch		
Connection to main router (horizontal) floor 1	OME3 fiber optics	66.1m
Connection to main router (horizontal) floor 2	OME3 fiber optics	64.4m
Connection to main router (vertical)	OME3 fiber optics	Approx 7 m
Total length for fiber connection		137.5
TOTAL LENGTH OF ALL USED CABLE		391.8

7.2 Patch Cords and Switch Ports

Description	Quantity	Total Ports
Core Switches	1	2
Access Switches	7	75
Patch Panel	1	1

8.0 IP Addressing Scheme

8.1 IP Subnetting

Our group is assigned a network address 192.18.0.0/8, we will be dividing this into the best possible way for all our labs, classroom and conferencing room.

From this Address we infer the,
Network portion: 8 bits
Host portion: 32-8 = 24 bits

Now we will be dividing this into 8 subnets i.e 2^3 meaning that we will be borrowing 3 bits from the host part to define 8 different subnets for all our network areas.

Calculation:

Subnet No.	Address in Decimal	Network portion (in bin)	Host Portion (in bin)
Subnet 0	192.0.0.0/11	1100 0000	**000**0 0000 0000 0000 0000 0000
Subnet 1	192.32.0.0/11	1100 0000	**001**0 0000 0000 0000 0000 0000
Subnet 2	192.64.0.0/11	1100 0000	**010**0 0000 0000 0000 0000 0000
Subnet 3	192.96.0.0/11	1100 0000	**011**0 0000 0000 0000 0000 0000
Subnet 4	192.128.0.0/11	1100 0000	**100**0 0000 0000 0000 0000 0000
Subnet 5	192.160.0.0/11	1100 0000	**101**0 0000 0000 0000 0000 0000
Subnet 6	192.192.0.0/11	1100 0000	**110**0 0000 0000 0000 0000 0000
Subnet 7	192.224.0.0/11	1100 0000	**111**0 0000 0000 0000 0000 0000

8.2 Areas in the building

No.	1st Floor
1	General Purpose Lab 1
2	General Purpose Lab 2
3	Hybrid Classroom
4	Student Lounge
	2nd Floor
5	Cisco Lab
6	Embedded Lab
7	Video Conferencing Room
8	Storage

8.3 Range of IP address, network and broadcast address for subnet

Subnet	Area	Range of IP	Network Address	Broadcast Address	Usable IP Address
1	General Purpose Lab 1	192.0.0.0-192.31.255.255	192.0.0.0	192.31.255.255	192.0.0.1 - 192.31.255.254
2	General Purpose Lab 2	192.32.0.0 - 192.63.255.255	192.32.0.0	192.63.255.255	192.32.0.1 - 192.63.255.254
3	Hybrid Classroom	192.64.0.0 - 192.95.255.255	192.64.0.0	192.95.255.255	192.64.0.1 - 192.95.255.254
4	Student Lounge	192.96.0.0 - 192.127.255.255	192.96.0.0	192.127.255.255	192.96.0.1 - 192.127.255.254
5	Cisco Lab	192.128.0.0 - 192.159.255.255	192.128.0.0	192.159.255.255	192.128.0.1 - 192.159.255.254
6	Embedded Lab	192.160.0.0 - 192.191.255.255	192.160.0.0	192.191.255.255	192.160.0.1 - 192.191.255.254
7	Video Conferencing	192.192.0.0 - 192.223.255.255	192.192.0.0	192.223.255.255	192.192.0.1 - 192.223.255.254

	Room				
8	Storage	192.224.0.0 - 192.255.255.255	192.224.0.0	192.255.255.255	192.224.0.1 - 192.255.255.254

8.4 Range of IP addresses allocated for user types based on the area

1. **General Purpose Lab 1**

Device	**IP Address**
Switch 1	192.0.0.1
Access Point 1	192.0.0.2
PC (30)	192.0.0.3 - 192.0.0.43

2. **General Purpose Lab 2**

Device	**IP Address**
Switch 2	192.32.0.1
Access Point 2	192.32.0.2
PC (30)	192.32.0.3 - 192.32.0.43

3. **Hybrid Classroom**

Device	**IP Address**
Switch 3	192.64.0.1
Access Point 3	192.64.0.2
PC (19)	192.64.0.3 - 192.64.0.32

4. **Student Lounge**

Device	**IP Address**
Switch 4	192.96.0.1
Access Point 4	192.96.0.2
Access Point 5	192.96.0.3

5. **Cisco Lab**

Device	**IP Address**
Switch 5	192.128.0.1
Cisco Server	192.128.0.2
Access Point 6	192.128.0.3
PCs (30)	192.128.0.4 - 19.128.0.33

6. **Embedded Lab**

Device	**IP Address**
Switch 6	192.160.0.1
Access Point 7	192.160.0.2

7. **Video Conferencing room**

Device	**IP Address**
Switch 7	192.192.0.1
Access Point 8	192.192.0.2
Access Point 9	192.192.0.3
PC (1)	192.192.0.4

8. **Storage**

Device	**IP Address**
Router 1	192.224.0.1
Router 2	192.224.0.2
Core Switch	192.224.0.3

9.0 Appendix

A. Meeting Minutes

Meeting minutes Task 1:-

DATE/TIME		11th October 7:30 pm MYT	
LOCATION		Virtual in Google meet	
AGENDA		TASK 1	
Meeting MC		ANJUM SIDDIQUA TANVEER SIDDIQUI	
ATTENDANCE			
NAME	**TIME**		**REASON FOR ABSENCE**
Rami	7:37		
Anjum	7:30		
Mathaba	7:37		
MINUTES			
NO	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	Software tool to use for drawing	Rami Suggested to use Figma , canva , floor planner or smartdraw.io . ended up choosing floorplanner	Rami (11/10)

DATE/TIME		11th October 7:30 pm MYT	
2	Rough Ideas for the floor plan	-Anjum suggested that the building should have the 2 general labs next to each other for future better network connection along with student lounge being in the first storey and the hybrid class , she also sketch an idea of how the design should look like	Anjum(11/10)
3	dividing work	- Mathaba suggested how the work should be divided . one person do the sketching and the other designing one storey each - Ended up settling with Anjum sketching a prototype , rami and mathaba designing each floor	Mathaba(11/10)

Meeting minutes Task 2:

DATE/TIME	26th October 10:20 pm MYT
LOCATION	Virtual in Google meet
AGENDA	TASK 2

Meeting MC		MATHABA HASSAN MOHAMED HASSAN	
ATTENDANCE			
NAME	**TIME**		**REASON FOR ABSENCE**
Rami	10:20		
Anjum	10:22		
Mathaba	10:23		
MINUTES			
NO	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	The type of questions required for the preliminary analysis and feasibility.	Rami discussed the type of questions to be used for the interview and filtered out irrelevant topics. Rami suggested we get a rough idea about the network devices to be included before doing the feasibility.	Ram(26/10)
2	Rough ideas for suitable questions and their answers	- Anjum and Mathaba gave ideas for some topics to be considered when generating the questions. - Anjum suggested we focus on the security part of things, while Mathaba suggested we focus on the connectivity and bandwidth to be used. - Overall both were important, so we decided to include both.	Anjum(26/10) Mathaba(26/10)

3	Dividing work	- Rami suggested how the work should be divided. - Ended up settling with Anjum and Mathaba generating suitable questions and then dividing the questions between all members to research and discuss suitable answers, the feasibility done by Anjum and compiling done by Rami.	Rami(26/10)

Meeting Minutes Task 3:

DATE/TIME	16th November 9:30 pm MYT	
LOCATION	Virtual in Google meet	
AGENDA	TASK 3	
Meeting MC	MATHABA HASSAN MOHAMED HASSAN	
ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
Rami	9:30	
Anjum	9:34	
Mathaba	9:32	
MINUTES		

NO	ITEM DISCUSSED	IDEAS/SUGGESTIONS AND PERSON GIVING IT	PERSON IN CHARGE & DATE
1	The objective of task 3 and the devices required to be included	Mathaba explained the objective of task 3 and ended up concluding that the research will include all the networking devices required for our network, with additional devices in case our budget allows it.	Mathaba(16/11)
2	Budget discussion and example networks	Anjum discussed some example networks she researched and discussed the approximate expected budget for the devices.	Anjum(16/11)
3	Task division and teamwork strategy	Rami suggested that we start researching the fundamental devices for a network first like routers, switches and cables, divide them between us and implement add-as-we go strategy, by adding any necessary devices we need along the way and dividing the work between us as we go, and decided to all write the reflection after discussing and seeing each devices price and quantity, ended up with: - Rami researching the Computer hardware for the labs, embedded lab kit and cisco lab server. - Anjum researching the switch for the lab, access points, and video	Rami(16/11)

		conferencing bar. - Mathaba researching the router, cables and patch panel. - Reflection: discussed and done by the whole team	

Meeting Minutes Task 4:

DATE/TIME	15th December 2:00 pm MYT		
LOCATION	Virtual in Google meet		
AGENDA	TASK 4		
Meeting MC	Rami Yassein Eltayeb		
ATTENDANCE			
NAME	**TIME**		**REASON FOR ABSENCE**
Rami	1:50		
Anjum	2:14		
Mathaba	2:00		
MINUTES			
NO	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	The requirements that need to be implemented in task 4	Rami : expressed different ideas on the layout of the report and how to get the requirements that is needed for task 4 , like the	Rami(15/12)

		wire lengths and number of access points etc	
2	Discussion about the location of different devices	Gave a detailed plan regarding where to put each device and how to connect the cable . and suggested the software used to show this	Mathaba(15/12)
3	Task division and teamwork strategy	Mathaba suggested that we use our old design for floor plan and add the cable lengths and devices sketch on top of it , Rami suggested on how to divide the work: - Rami draw the work area and show topology - Mathaba design and show the cabling and devices in floor 1 - Anjum design and show the cabling and devices in floor 2	Anjum(15/12)

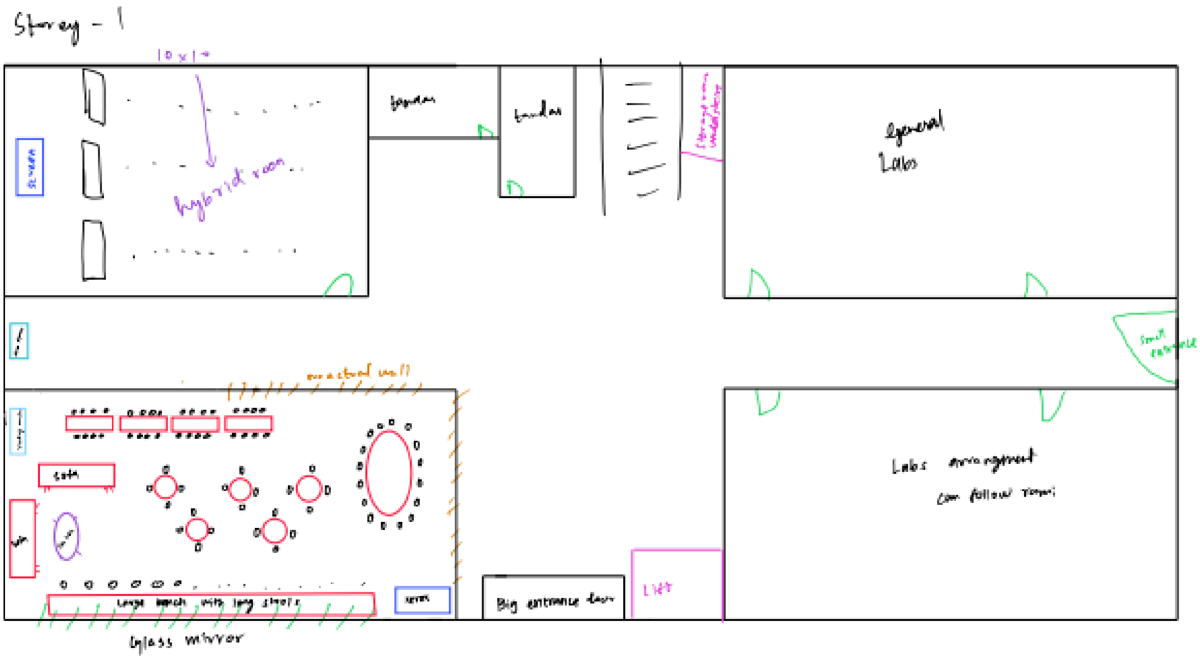
Meeting minutes Task 5:-

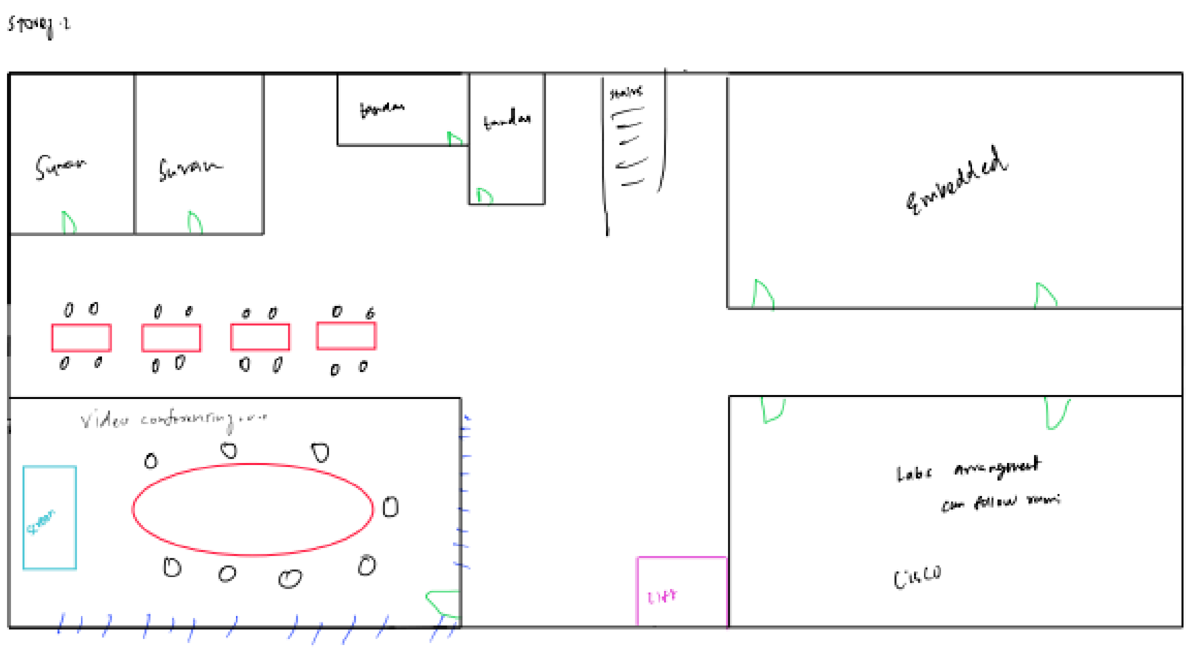
DATE/TIME	20th December 11:30 pm MYT	
LOCATION	Virtual in Google meet	
AGENDA	TASK 5	
Meeting MC	ANJUM SIDDIQUA TANVEER SIDDIQUI	
ATTENDANCE		
NAME	**TIME**	**REASON FOR ABSENCE**
Rami	11:32	

DATE/TIME		20th December 11:30 pm MYT	
Anjum	11:30		
Mathaba	11:35		
MINUTES			
NO	**ITEM DISCUSSED**	**IDEAS/SUGGESTIONS AND PERSON GIVING IT**	**PERSON IN CHARGE & DATE**
1	The objective of task 5	Anjum explained the objective of task 5 and the deliverables that should be included in the report	Anjum (20/12)
2	Subnet division	Then the discussion continued about the subnet division. Anjum suggested that the subnet to be divided into 8. Mathaba agreed and explained that since we have 8 different areas it is logical to divide like that. Rami continued that since our Network address is /8 . we borrow 3 bits from the 24 bit host portion	Mathaba (20/12)
3	Task division	Mathaba suggested that we divide the work according to work areas. Anjum further added that we also show the main calculation before proceeding with IP Addressing for each area. Rami wrote down the areas to be focused and also added each	Rami (20/12)

DATE/TIME		20th December 11:30 pm MYT	
		and every deliverable in a detailed manner in the report. - Anjum : General purpose lab 1 & 2 , Hybrid classroom - Rami : Embedded lab , video conferencing room , student lounge - Mathaba : Cisco lab, Corridor, storages	

B. Sketch


Storey - 1
hybrid room
General Labs
Labs arrangement
Big entrance door
Lift
glass mirror
sofa


Storey 2
Embedded
Labs arrangement
Cisco
Lift
Video conferencing
stairs
screen