UTM UNIVERSITI TEKNOLOGI MALAYSIA

SCHOOL OF COMPUTING
Faculty of Engineering

Network Design for School of Computing Block N28B

SECR1213 Network Communications

Section 12

Lecturer: Dr Firoz bin Yusuf Patel Dawoodi

Group 7

Group Members:

No.	Name	Matric No
1	Chong Tung Han	A20EC0028
2	Tham Chuan Yew	A20EC0166
3	Tay Wei Jian	A20EC0159
4	Tee Jun Hong	A20EC0160

Abstract

This is the report for the project that assigned in subject SECR1213 Network Communication, and it is about the network construction for a new two-story building for the School of Computing at UTM, from floor planning to IP assignment. It would be a collection of all the tasks completed by us, beginning with Task 1 which is drawing a floor plan for the building and ending with Task 5 which is subnetting and IP assignment to each labs and rooms in the building. In summary, our team completes the project while also learning new skills and knowledge along the way. We would like to take a moment to thank Dr Muhalim bin Mohamed Amin, our lecturer and project consultant, for his guidance and valuable ideas to improve and strengthen our project. We are also grateful for the chance to work on such a project that allows us to simulate and utilize the skills we learned in class in a real-world setting.

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Introduction

This project is related to apply knowledge learned from course SECR1213 Network Communication in planning an organization network based on the case study given, in which is the planning of organization network for the new 2-storey building of School of Computing (SC) in UTM.

The main aim of the project is to plan the network system in the 2-storey building which is capable of supporting 4 new labs with at least 30 workstations in each lab and 2 conferencing rooms. The project also aims to enable the new building equipped with a network system that is easy to manage and scale, improving overall performance, providing protection from network breaches, capable of support high-performance to the core backbone, ability to support features such as Quality of Service and security in hardware and enable secure VPN connections from remote locations.

The scope of the project includes planning of the floor plans of the 2-storey building to outline the facilities and hallways as well as specifying the location of the facilities inside the building, finding information related to the network devices and electronic devices required to support the function of each facility housed in the building, researching the information related to the network and end-user devices required as well as determining the device to be used based on the specification and pricing to fulfill the requirements and needs of the organization, and achieve cost-effective in the project. Besides that, the project also includes identifying work areas within the building, arrangement of the network and end-user devices in the building and planning of the cable connections between network and end-user devices such as length and type of cable used in connection and visualizing the connections by using the floor plans created. Lastly, the project includes creating subnets and assigning a unique IP address to each host contained in the building.

The objectives of the project can be described in the list below:

1. To produce floor plans with details related to the location of the labs and video conferencing rooms.
2. To research the network and electronic devices, infrastructure and equipment needed to fulfill the requirements of the case study given.
3. To research the network and end-user devices required in the project and determine the network and end-user devices to be used based on availability, usability, cost and services.

4. To produce the planning of the arrangement of network and end-user devices and the cable connections between the devices in the building.
5. To apply network IP addressing to the hosts available in the building.

Background

The project is initiated due to the request made by SC Chair to support the growth of students and academic staffs in SC in future. A new building equipped with at least 4 new labs and 2 video conferencing rooms is required and each lab should provide at least 30 workstations to support the estimated growth of people in SC in future. The infrastructures housed in the new building is requested to be equipped with high-speed internet connection and cutting-edge technologies as the new building is expected to support learning for the next 20 years.

SC Chair currently has identified the requirements of the network system as well as the necessary infrastructures to be included in the new 2-storey building they wish to construct. For the infrastructures to be included in the building, there are 4 new labs, in which are, 1 general purpose lab, 1 Computer Security lab, 1 Network lab and 1 IoT lab and 2 video conferencing for virtual project meeting purposes. For the requirements of the network system, SC Chair has specified the system should be easy to manage and scale, improvement in overall performance, protection from network breaches such as Internet Worms, DDoS attacks and e-business applications attacks, support to high-performance to the core backbone, ability to support QoS and security in hardware as well as enabling secure VPN connections.

The project is started from planning the floor plans of the building requested as the floor plans of the building have not been finalized. Besides that, the network and electronic devices and infrastructures required to support the requirements mentioned by SC Chair are researched to identify the necessary devices and infrastructures needed to fulfill the needs of SC Chair. Furthermore, the network and end-user devices with different brands and models are researched to identify the most suitable network and end-user devices to be used to support the requirements of the new building based on the specification and pricing of the device. The arrangement of the network and end-user devices in the work areas are identified before planning the cable connections between the devices to build the network connections between the devices. The length and type of cable used in the connections are determined based on the cost and performance of the cable type to support the high-speed internet connection requested by SC Chair. At last, the IP address of each host available in the building and the subnets in the building are determined to complete the organization network in the building required by SC Chair.

Task 1: Project Setup

Floor Plan (Ground Floor)

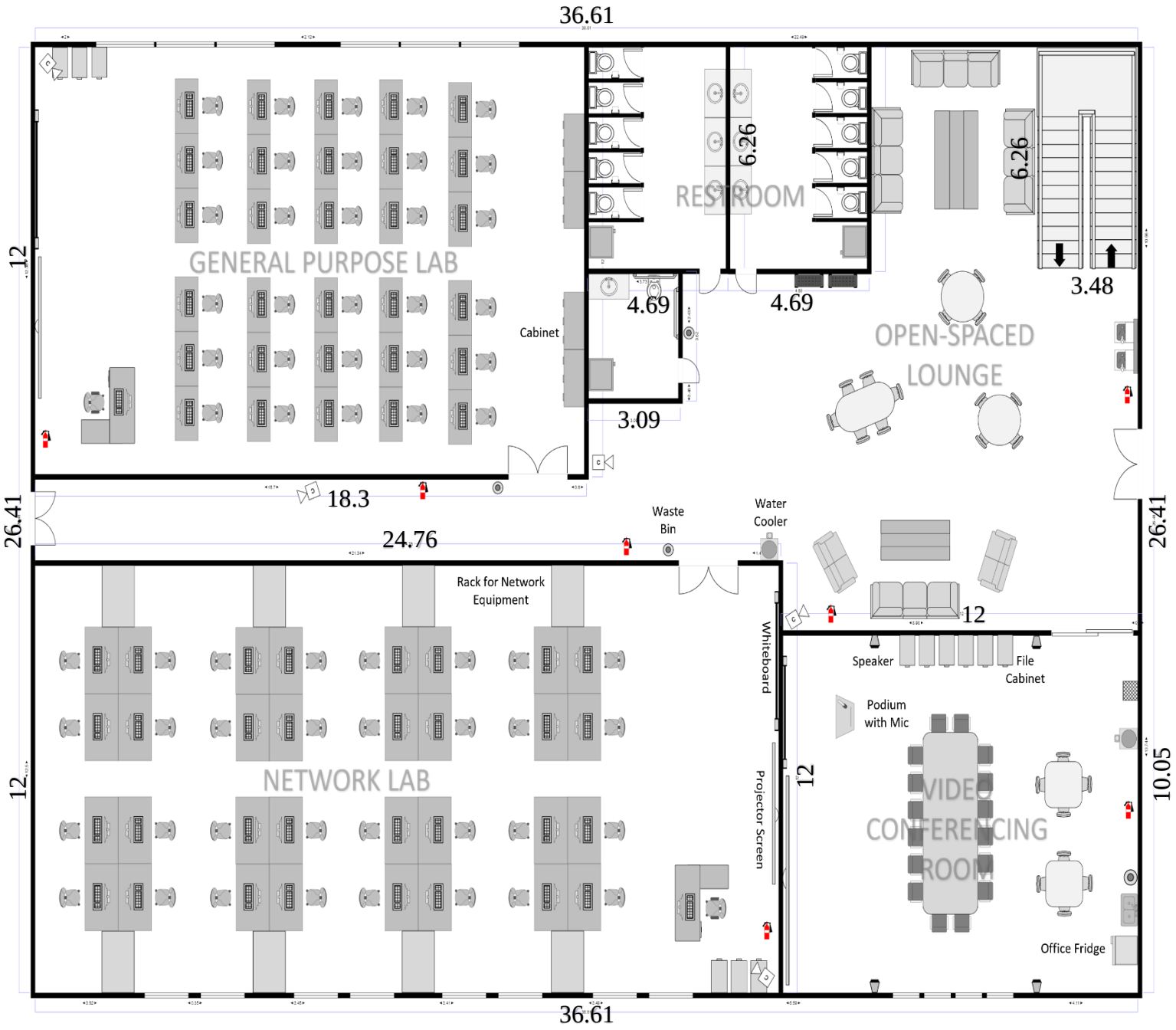


Figure 1: Floor Plan (Ground Floor)

Ground floor consists of one general purpose lab for general purpose teaching, one network lab for teaching network course, one video conferencing room to conduct meeting online or offline, restroom for male, female and an accessible restroom, and an open-spaced lounge

used by lecturers and students during leisure time. There are surveillance cameras and fire extinguishers in the premise for security and safety purposes.

Floor Plan (First Floor)

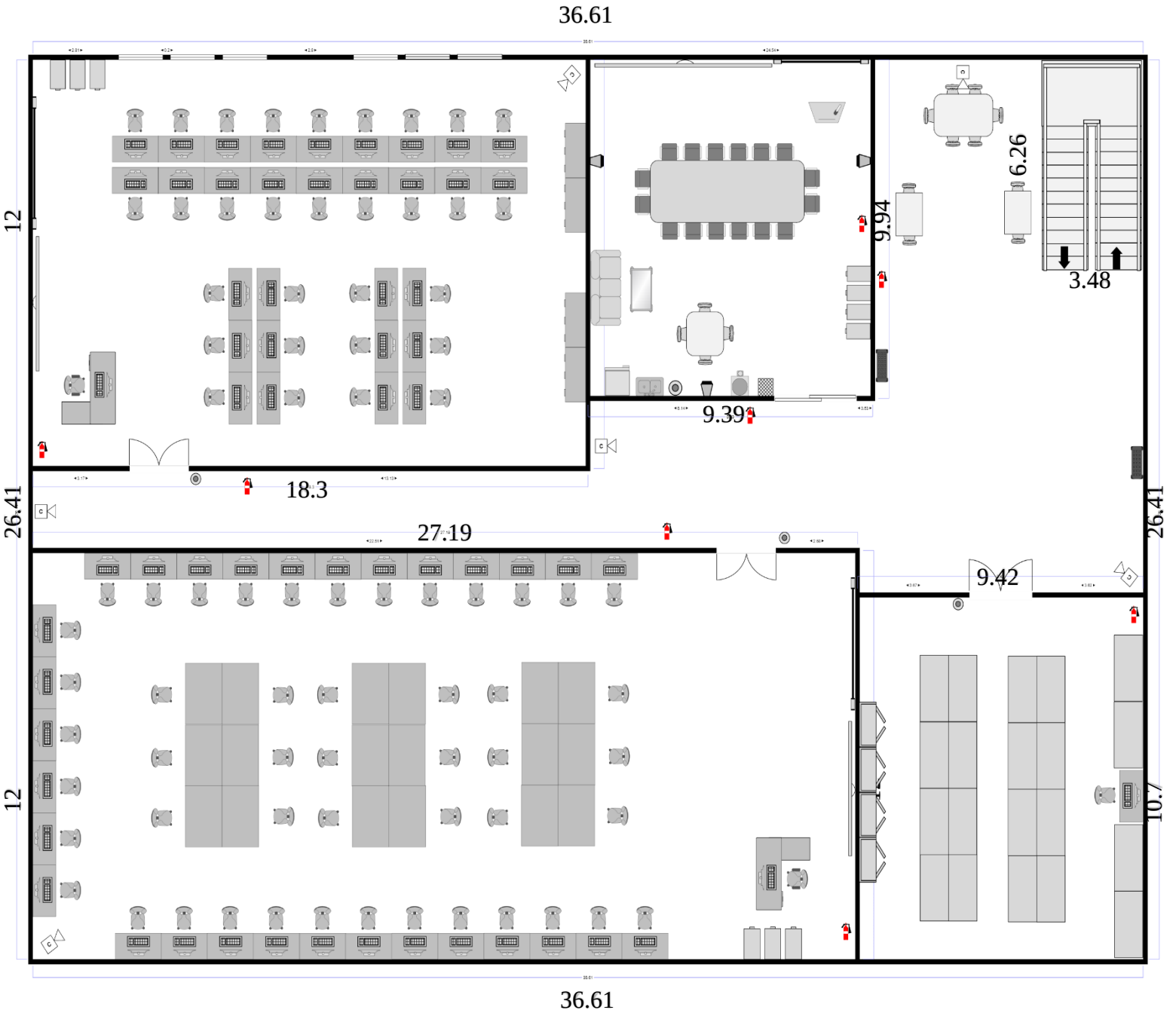


Figure 2: Floor Plan (First Floor)

First floor consists of one internet-of-things lab for teaching IOT-related courses, one computer security lab for teaching computer security courses, one video conferencing room to conduct meeting online or offline, a waiting zone for student to rest and wait while the labs are occupied and a network room to support the network of the whole building. There are surveillance cameras and fire extinguishers in the premise for security and safety purposes.

Task 2: Initial Design – Preliminary Analysis

In this task, we have generated 17 questions which can be researched with regards to the requirements and other information that is necessary to develop a network plan based on the given case study. Alongside the questions are answers and at the end of this section, there is a feasibility study for this project.

1. How many servers will be implemented in this network?
   Answer: 4 multi-terabyte storage servers will be implemented for each lab in this building for sufficiency and sustainability.

2. What is the budget for the whole project?
   Answer: RM 3.0 million, but we may write a request report to apply for more budgets with justification of needs.

3. What is the bandwidth of the cables in the labs?
   Answer: All the pc in the lab will connect to a fast internet network which is 1gb/s. A fibre optic cable that connect the pc to the main router will have a speed of 1gb/s as well. Lastly, the main router will have a fibre port that has a speed of 10gb/s that will go through UTM digital where it is a computer centre that allow almost all the network to meet.

4. What is the size of each lab?
   Answer: Depend on the facilities that needed in the lab and design it logically. Usually UTM digital lab has a size of 14m width x 10m length lab. In our case, the general purpose lab has a size of 12.38m width x 15.70m length; the networking lab has a size of 12.50m width x 24.76m length; the computer security lab has a size of 12.38m width x 15.70m length; the IoT lab has a size of 12.50m width x 27.19m length.

5. What is the equipment in each lab?
   Answer:

Table 1: Equipments Used in each Lab

Lab	Equipment

General purpose lab	A white board and projector screen, 31 personal computers (30 for students, 1 for lecturer), 4 cabinets, 31 computer desks and chairs.
Networking lab	A white board and projector screen, 33 personal computers (32 for students, 1 for lecturer), 8 racks for network equipment such as router and switches, 33 computer desks and chairs.
Computer security lab	A white board and projector screen, 29 personal computers (28 for students, 1 for lecturer), 4 cabinets, 29 computer desks and chairs.
IoT lab	A white board and projector screen, 31 personal computers (30 for students, 1 for lecturer), 3 workstations where each of it are composed with 6 large table and chairs in a group, 31 computer desks and chairs.

6. What kind of security measure that we need to implement in the building?

   Answer:

   a) Installing Surveillance Cameras

   Security cameras have grown in popularity in recent years as people have learned more about surveillance. Surveillance cameras can supplement the physical security measures you already have in place by monitoring and recording events that would otherwise go unnoticed. Aside from that, security cameras help protect the perimeter (such as your parking lot) as well as interior hallways, stairwells, and other areas where visibility is likely to be limited. Security cameras are useful in commercial settings for deterring theft and monitoring situations.

   When it comes to surveillance cameras, we have several options. We can go with CCTV cameras or IP cameras, which are both unique. We can also use a security assessment

to determine which option best meets your specific needs. In our case, we will choose CCTV and implement it in every room in the building.

References: https://inbound.usisecurity.com/blog/4-physical-security-measures-to-consider-in-your-next-security-assessment

b) Equipping Fire Extinguishers

In our case study, there are a large number of electronic devices that have a possibility to cause short circuit and fire in the building. Therefore, if the event of an explosion, fire, or electrical malfunction occurred, the proper control method should be used, which may aid in the preservation of some of the most important items in the building. A solid setup allows us to remain steadfast and reduces the loss of the majority of assets, data, and equipment. Therefore, we decided to put enough amount of fire extinguishers around the building and there will be at least one fire extinguisher outside each room and labs.

References: https://resources.infosecinstitute.com/topic/importance-physical-security-workplace/

c) Pack up the backups

Backing up critical data is critical for disaster recovery, but keep in mind that the information on backup tapes, discs, or discs can be stolen and used by someone outside the company. Many IT administrators keep backups in the server room, next to the server. At the very least, they should be locked in a drawer or safe. Backups should ideally be kept offsite, and you must take care to ensure that they are secure in that location.

Don't forget that some employees may save their work on floppy discs, USB keys, or external hard discs. If this practise is permitted or encouraged, make sure to have policies in place that require backups to be kept locked at all times.

Therefore, a cabinet in the network room will be used for store back up data and it will be locked every time after use, not only that high security lock will be use for the lock of network room and the network room will be locked every day after used to ensure the safety of the backup data.

References: https://www.techrepublic.com/blog/10-things/10-physical-security-measures-every-organization-should-take/

7. What are the measures in place to protect against cybersecurity threats?

   Answer: Antivirus software are installed in all equipment such as personal computers, workstations, and routers. This is to prevent the equipment from being affected by malwares such as spyware, adware and even worms which can interrupt networks.

   References: https://www.titanfile.com/blog/types-of-computer-malware/

8. What is the maximum number of users that will be using this network at once?

   Answer: 500 people including 360 students, 102 lecturers and 38 staffs are estimated to be the maximum number of users that will be connected to the network at any given instance.

   References: https://engineering.utm.my/computing/people/

9. How will the hardware be standardized?

   Answer: Equipment such as personal computers, workstations, and routers will be standardized according to suitable brands. This can reduce costs associated with maintenance, updates, and repairs.

   References: https://smallbusiness.chron.com/five-things-considered-designing-network-35911.html

10. How scalable is the network?

    Answer: The network is expected to be able to handle a 10% increase in users (50 users) or equipment in the future without noticeably affecting the network performance.

11. What is the percentage of uptime and network availability needed?

    Answer: Since this network will be used by students and lecturers for teaching & learning (T&L) purposes, as well as completing projects, the university has low downtime tolerance. Therefore, the network should have a minimum of 99%

availability (14.4 minutes downtime per 24 hours) so as to not interfere with T&L and other important activities.

12. What is the suitable router type for this network?

    Answer: Wireless router is suitable for this network since it can connect to multiple devices wirelessly at once with lag-free results. SC chair can easily create multiple internet networks as there are many labs within the building. Wireless router also grants longer and better ranger wireless network connection with stronger security and encryption.

    References: https://www.europeanbusinessreview.com/15-simple-reasons-why-you-need-a-wireless-router/

13. What type of routing is suitable to implement in this new system?

    Answer: Static routing is suitable for this new system as only administrator can allow routing to particular networks only which adds the security to this new system. Static routing does not require routing overhead for router CPU hence a cheaper router can be chosen to do routing.

    References: https://www.geeksforgeeks.org/types-of-routing/

14. What is the suitable network topology for this new building?

    Answer: Star topology is suitable for this new building as it limits the impact of a single point of failure. When one connecting node goes down, it will not impact the performance of other connecting nodes in the network. Star topology is also cost effective as it provides better performance by prevents the passing of data packets through an excessive number of nodes and it is easy to troubleshoot as it relies on the hub.

    References: http://studiesnote.blogspot.com/2012/10/how-to-build-computer-lab.html

15. What is the target of this project?

Answer: Construct a better network connection for the new SC building to cope with the increasing number of users which are both students and academic staffs by providing sufficient facilities and equipment.

16. What is the function of using switch in network design?

    Answer: Switch is used to connect multiple devices and allow them to communicate with each other in a network. Besides, switch also can be used when more ports are needed.

    References: https://www.cisco.com/c/en/us/solutions/small-business/resource-center/networking/network-switch-how.html#~introduction

17. Does switch has IP address?

    Answer: Unmanaged and layer 2 switches do not have an IP address whereas managed and layer 3 switches do have an IP address. The IP address is used to connect the switch remotely and configure the setting when needed.

    References: https://homenetworkgeek.com/does-a-network-switch-have-an-ip-address/

Feasibility of project

This project is considered feasible as it meets requirements to implement it. Firstly, there is sufficient budget which is RM 3.0 million that will fulfil the requirements of the users and possible to implement the suggestions made by our group. It will produce the most cost-effective network by using star topology and static routing methods.

Apart from that, the new system is capable to handle big number of users as mentioned in the scenario. All the users including students and academic staffs will experience good network usage as the equipment provided is sufficient for them. This will be able to solve the problem of growing users in the upcoming years.

Next, this project is said to be feasible as there are many experienced administrators who are capable to manage and control the static routing of the router with ease. It will be less

tedious and troublesome to manually set up the static routing by adding the routes on their own to achieve better level of security.

Finally, this project is feasible as it scalable and able to improve the overall performance of the network usage compared to the old system. With the appropriate security measures, the building and system will be free from any possible damage to both the hardwares and softwares.

Task 3: Choosing the Appropriate LAN Devices

After making preliminary analysis in the previous task, we now have a good idea of what we need to do. In this task, we looked for devices that are needed to achieve the objective of fulfilling the requirements and needs of the organization. We compared different brands or models for each device to determine the most suitable one for designing a small network.

1. Router

Table 2: Router Comparison

Router	Specification	Price and Quantity
 TL-R600VPN SafeStream Gigabit Multi-WAN Desktop VPN Router	- SPI firewall and DoS defense protects network from most known Internet attacks - Supports IPSec, L2TP/IPSec, and PPTP VPN protocols, Simultaneous supports up to 20 IPsec VPN tunnels, 16 L2TP VPN tunnels and 16 PPTP VPN tunnels - Has professional 4KV lightning protection - Has 1 Gigabit WAN port, 1 Gigabit LAN Port, and 3 Gigabit WAN/LAN ports provide high-speed wired connectivity	Price: RM670.84 / unit Quantity: 10
 Cisco RV340 Dual WAN Gigabit VPN Router	- Has VPN functionality for secure interconnectivity, including standard IPsec, Layer 2 Tunneling Protocol (L2TP) over IPSec, and Cisco Ipsec - TCP throughput up to 900 Mbps - Has 2 WAN ports (RJ-45) for load balancing and resiliency	Price: RM1127.92 / unit Quantity: 10

Both routers have VPN functionality for secured interconnectivity. Both routers also support high-speed connectivity with the available LAN ports. However, the TL-R600VPN SafeStream Gigabit Multi-WAN Desktop VPN Router is the preferred choice because it costs a lot less than the Cisco RV340 Dual WAN Gigabit VPN Router and it also has professional 4KV lightning protection.

1. https://www.tp-link.com/us/business-networking/vpn-router/tl-r600vpn/
2. https://www.cisco.com/c/en/us/products/routers/rv340-dual-gigabit-wan-vpn-router/index.html#~features

2. Switches

Table 3: Switches Comparison

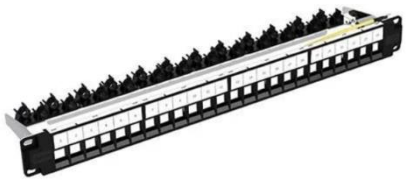
Switches	Specification	Price and Quantity
 Cisco catalyst 2960X-48LPD-L LAN Base Layer 2 stackable switch	- Forwarding performance of 130.9 Mpps - Switching bandwidth of 216 Gbps - 512 MB RAM, 128 MB flash memory	Price: RM16140.18 / unit Quantity: 6
 Aruba 2930F switch (JL558A)	- Throughput up to 112 Mpps - Switching capacity of 176 Gbps - 1 GB DDR3 SDRAM, 4 GB eMMC	Price: RM11969.27 / unit Quantity: 6

The Cisco catalyst 2960X-48LPD-L LAN Base Layer 2 stackable switch is the prefered choice because it has better performance compared to the Aruba 2930F switch even though the Aruba 2930F switch costs less and has slightly bigger memory.

1. https://www.router-switch.com/ws-c2960x-48lpd-l-p-5273.html
2. https://www.router-switch.com/jl558a.html

3. Patch panels

Table 4: Patch Panels Comparison

Patch Panels	Specification	Price and Quantity
 AMPCOM CAT7 24 Ports 1U Keystone Patch Panel	- Fully shielded coupler with 180 angled port connects two Cat7 cables to provide feed-through patching with standard data wall plates - Protective shielded housing reduces EMI/RFI interference - Backward compatible with Cat7,Cat6, Cat5e and Cat5 Lane - Blank Patch Panel is made of cold-rolled thick steel coverd by strong,painting and sanding ABS surface	Price : RM 464.85 / unit Quantity: 20
 Monoprice 107254 Patch Panel	- Black painted steel panel and numbered ports. - White blanks for easy labeling and identification. - Available for Cat6 and Cat5e - Color coded wiring diagram on back. - UL Listed. - 568A/B compatible for 19" wide racks	Price: RM129.90 / unit Quantity: 20

The preferred choice of patch panel is the AMPCOM CAT7 24 Ports 1U Keystone Patch Panel. This is because the AMPCOM CAT7 24 Ports 1U Keystone Patch Panel is compatible with Cat7, Cat6, Cat5e and Cat5 lane while the Monoprice 107254 patch panel is only available for Cat6 or Cat5e. This means the patch panel does not need to be changed should the organization decide to use more Cat7 cables in the future.

1. https://www.amazon.com/exec/obidos/ASIN/B08C52K4SM/ezvid02-20
2. https://www.amazon.com/exec/obidos/ASIN/B0069MHLCS/ezvid02-20?th=1&psc=1

4. Cables

Table 5: Cables Comparison

Cables	Price and Length
 Twisted Pair Cable (Cat6)	Price: RM100.56 / 100 feet Length: 1430 feet
 Fiber Optic Cable	Price: RM146.65 / 100 feet Length: 620 feet

The types of cable that will be used are twisted pair cable of category 6 (Cat6), and fiber optic cable. This is because twisted pair cable performs well over short distance while fiber optic cable performs well over long distances. Furthermore, twisted pair cable is more cost-effective and easier to install compared to fiber optic cable but fiber optic cable is able to support very high bandwidth.

1. https://www.amazon.com/Cable-Matters-Snagless-Ethernet-Black/dp/B007NZKWLC/ref=sr_1_3?_encoding=UTF8&c=ts&keywords=Cat%2B6%2BEthernet%2BCables&qid=1642564390&s=pc&sr=1-3&ts_id=9938478011&th=1
2. https://www.amazon.com/KabelDirekt-Optical-Digital-Theater-Playstation/dp/B07X1J9539/ref=sr_1_3?keywords=fiber%2Boptic%2Bcable&qid=1642567729&sprefix=fiber%2Bop%2Caps%2C401&sr=8-3&th=1

5. RJ-45

Table 6: RJ45

RJ-45	Specification	Price and Quantity
 W-NECTOUN RJ45 UTP CAT6 Connectors	- Corrosion-resistant Contacts with nickel and gold plated, 3 micron-inch gold plated on contact point -Support UTP CAT6 24 to 26 AWG soid and stranded network cables - Compliant with Rohs and REACH standard.	Price: RM62.04 / 100 pieces Quantity: 100 pieces

W-NECTOUN RJ45 UTP CAT6 Connectors is used because it is corrosion-resistant and compliant with Rohs and REACH standard. It is also an affortable option, costing RM62.04 for 100 pieces of connectors.

1. https://www.amazon.com/W-NECTOUN-100-PACK-Connectors-Network-Stranded/dp/B092J3RG6P/ref=sr_1_1_sspa?crid=2PXGH91928JJT&keywords=rj45%2Bconnectors&qid=1642569510&sprefix=rj45%2Bc%2Caps%2C422&sr=8-1-spons&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExVkRJTlpIVkg5VEw0JmVuY3J5cHRlZElkPUEwNjQ1NTcyM0kxTkhSWEdXODNIVyZlbmNyeXB0ZWRBZElkPUEwMjg5MDE0MVZUTTZBOFFUVjUwWiZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU&th=1

6. Projector screen

Table 7: Projector Screen Comparison

Projector Screen	Specification	Price and Quantity

 Venova Motorized Projection Screen 192" X 192"	- Smooth and quiet synchronous motor - Max size of 180” - Can be remote-controlled to stop at any position	Price: RM7099.00 / unit Quantity: 7
 Dopah 8K ALR Tab-Tension Motorized Projection Screen	- Super flat surface - Easy and quick mounting - Supports 8K image quality	Price: RM3999.90 / unit Quantity: 7

The preferred choice of projector screen is Dopah 8K ALR Tab-Tension Motorized Projection Screen because it supports 8K image quality and can be mounted easily. It is also very much cheaper compared to the Venova Motorized Projection Screen 192" X 192".

1. https://projector.my/venova-motorized-projection-screen-192-x-192
2. https://projector.my/dopah-8k-alr-tab-tension-motorized-projection-screen-16-9-long-throw-projector

7. Desktop

Table 8: Desktop Comparison

Desktop	Specification	Price and Quantity

 Lenovo IdeaCentre AIO 3	- Display: 21.5" FHD (1920 x 1080), IPS, Touch, WLED Backlight - Memory: 8 GB SO-DIMM DDR4 2400MHz - Storage: 1 TB 5400 HDD + 256 GB PCIe SSD - Processor: AMD Ryzen™ 5 3500U Processor	Price: RM 3350.50 / unit Quantity: 150
 Dell Inspiron 24 5000 All-in-One Desktop	- Display: 23.8-inch FHD (1920 x 1080) Anti-Glare Narrow Border Infinity Non-Touch Display - Memory: 8GB, 8GBx1, DDR4, 2666MHz - Storage: 256GB M.2 PCIe NVMe Solid State Drive (Boot) + 1TB 5400 rpm 2.5" SATA Hard Drive (Storage) - Processor: 11th Generation Intel® Core™ i5-1135G7 Processor (8MB Cache, up to 4.2 GHz)	Price: RM 3699.00 / unit Quantity: 150

Both desktops are pretty similar in terms of memory and storage capacity.However, the Dell Inspiron 24 5000 All-in-One desktop has a bigger monitor and a newer processor, which is the 11th generation Intel® Core™ i5-1135G7 Processor. This processor performs better than Lenovo IdeaCentre AIO 3's AMD Ryzen™ 5 3500U Processor. Therefore, the Dell Inspiron 24 5000 All-in-One Desktop is the preferred choice.

1. https://www.lenovo.com/my/en/desktops/ideacentre/ideacentre-aio-300-series/IdeaCentre-AIO-3-22ADA05/p/F0EX0008MI
2. https://www.dell.com/en-my/shop/desktop-computers/inspiron-24-5000-all-in-one/spd/inspiron-24-5400-aio/w216015600myw10?gacd=9654369-8020-5761040-272725660-0&dgc=ST&gclid=Cj0KCQiAip-PBhDVARIsAPP2xc12GnvwqCIays5N35cHmAtcHr_gkOVN7WmfX4GDczbBrhQyEmG0BAEaAjamEALw_wcB&gclsrc=aw.ds

8. Firewall

Table 9: Firewall Comparison

Firewall	Specification	Price and Quantity
 Cisco ASA5508-K9 firewall	- Stateful inspection throughput (multiprotocol) of 500 Mbps - Maximum 3DES/AES VPN throughput of 175 Mbps - Supports unlimited users / nodes - Has 8 GB memory	Price: RM5632.84 / unit Quantity: 3
 Huawei USG6320-AC firewall	- Firewall throughput of 2 Gbps - IPS throughput of 700 Mbps - Has 2 GB memory	Price: RM5527.52 / unit Quantity: 3

The Cisco ASA5508-K9 firewall is the preferred choice because it supports stateful inspection throughput of up to 500 Mbps and has 8 GB memory. This firewall also supports unlimited users / nodes.

1. https://www.router-switch.com/asa5508-k9-p-23193.html
2. https://www.router-switch.com/usg6320-ac-p-21485.html

9. Printer / Scanner

Table 10: Printer / Scanner Comparison

Printer/Scanner	Specification	Price and Quantity

 Canon Pixma MG2570s All-In-One Printer	Functions: Print, scan and copy Paper Handling : Plain Paper (A4, A5, B5, LTR, LGL) Photo Paper Plus Glossy II (4 x 6") Glossy Photo Paper "Everyday Use" (GP-501) - 4 x 6" Glossy Photo Paper "Everyday Use" (GP-601) - 4 x 6" Envelope (European DL / US Com. #10) Paper Weight / Cassette: Plain Paper: 64 -105 g/m2, Canon specialty paper: max paper weight: approx. 275 g/m2 (Photo Paper Plus Glossy II (PP-201) Optical Resolution : 600 x 1200 dpi Interface : USB 2.0 Hi-Speed Print Speed : Document: Colour (Approx. 4.0 ipm) Document: B/W (Approx. 8.0 ipm)	Price : RM 209 / unit Quantity : 12
 HP DeskJet 2722 Wireless Wifi All-in-One Printer (7FR53B)	Functions:Print, copy, scan Print colors:Yes Wireless capability:Yes Mobile Print Capability:HP Smart app; Apple AirPrint™ Mac compatible:Yes Input capacity(sheets):Up to 60 sheets Output capacity(sheets):Up to 25 sheets Duty cycle (monthly, A4):Up to 1000 pages Media sizes supported:A4; B5; A6; DL envelope Media types:Plain paper, Photo paper, Brochure paper	Price : RM 219 / unit Quantity : 12

The printer that we are going to use is HP DeskJet 2722 Wireless Wifi All-in-One Printer (7FR53B) because it has the same function to print, copy and scan but it can support wireless connecting. This will make students and lecturers to print their documents easier as they do not need to approach near the printer or scanner to print. Not only that, this printer also only has a RM 10 difference per unit with the other printer with this function added.

1. https://shopee.com.my/Canon-Pixma-MG2570s-All-In-One-Printer-i.5566662.7180154583

2. https://shopee.com.my/HP-DeskJet-2722-Wireless-Wifi-All-in-One-Printer-(7FR53B)-i.82432164.4352909179?sp_atk=238fdfc0-cf4e-4076-ac74-c6e2a413bf89

10. Cabinets

Table 11: Cabinets Comparison

Cabinets	Specifications	Price and Quantity
 Tekkashop SLS200 Full Height Metal Wardrobe Cabinet Storage with 2 Doors	Dimensions: 915W x 457D x 1828H mm Material: Built from high grade cold rolled steel Material: Metal Thickness: 0.6mm cold rolled steel sheet Surface: Electrostatic powder coating Colour : Light Grey	Price : RM 688.88 / unit Quantity : 22

 I-S200 FULL HEIGHT STEEL WARDROBE CUPBOARD/ OFFICE CABINET	Available colour: - Light grey - Brown & Beige - Beige Each unit is provided with heavy duty strengthening frame for added rigidity The cabinet is powder coated for more durability. The cabinet is manufactured with 0.6 mm thick sheet steel. The door have inbuilt metal mastered cam lock with 2 keysAvailable ready assembled Powder coated paint Size : 1828mmH x 915mmW x 525mmD	Price : RM 530 / unit Quantity : 22

The cabinet we choose is I-s200 Full Height Steel Office Cabinet as it comes with larger size and more colour to choose for design purpose. The price of it is also more cheaper than Tekkashop SLS200 Full Height Metal Wardrobe Cabinet Storage.

1. https://www.lazada.com.my/products/tekkashop-sls200-full-height-metal-wardrobe-cabinet-storage-with-2-doors-915w-x-457d-x-1828h-mm-light-grey-i857792723-s2081410856.html?&search=pdp_v2v?spm=a2o4k.pdp_revamp.recommendation_2.6.d3c99f69I1IEHv&mp=1&scm=1007.16389.126158.0&clickTrackInfo=bedbc603-9a87-4ef9-9795-8ccbf963f386__857792723__10000771__trigger2i__202835__0.24__0.24__0.0__0.0__0.0__0.24__5__8__PDPV2V__251__null__null__0____828.72__0.1687421565788204__0.0__0__688.88__110642,141372__null__null__null__3650.16545_3650.16544_955.3632__null__13499__null__0.0__0.0__elp.6_star.5_starplus.4__

2. https://www.lazada.com.my/products/i-s200-full-height-steel-wardrobe-cupboard-office-cabinet-i1894704175-s7600150047.html?&search=pdp_v2v?spm=a2o4k.pdp_revamp.recommendation_2.5.70862be8uK0nv4&mp=1&scm=1007.16389.126158.0&clickTrackInfo=35212ce4-c5bc-43ba-bab5-2faac6170570__1894704175__10000423__trigger2i__202835__0.412__0.412__0.0__0.0__0.0__0.412__4__8__PDPV2V__251__null__null__0____530.0__0.0__0.0__0__530.0__1106

42__null__null__null__3650.16537_3650.16544_955.3632__null__13499__null__0.0__0.0__elp.4_star.3_starplus.10__

11. Network Cabinet Server Rack

Table 12: Network Cabinet Server Rack Comparison

Network Cabinet Server Rack	Specifications	Price and Quantity
 28U Network Cabinet Server Rack soundproof fireproof rack server cabinet with Lock and Wheel	Material: SPCC high-quality cold rolled steel Size: 19 Inch, 28U, 600mm*600mm*1400mm Model Number: 28U Product Name: Floor standing rack cabinet Thickness: Mounting profile 2.0mm/ Mounting angle 1.5mm/ Others 1.2mm PDU: available Door: Single open mesh front, double mesh back door Side panel: removable Surface finish: Degreasing, Pickling, Phosphating, Powder coating Loading Capacity: 800kgs(=1763 lbs) Color: Black	Price : RM 989 / unit Quantity : 28
 RackIT 19" 42U 600x800 Floor Stand Server Rack	Dimension in mm : 2000(H) x 600(W) x 800(W) Internal system base, cable entry on top & bottom frame Flexible front PERFORATED Door c/w cam lock LOCKABLE DETACHABLE LIFT-OFF SIDE PANELS Lockable rear PERFORATED door Lockable detachable quick release side panels Side Vertical Metal Trunking Cable Management Panel 19" server compatible mounting element 40 sets M6 caged nuts & screws Castor wheels with front braking system	Price : RM1494 / unit Quantity : 28

	2 x Equipment Trays 2 x Ventilation Fans 13A power point channel complete with socket * Finished high quality epoxy powder coated (Black)	

The server rack we choose is 28U Network Cabinet Server Rack soundproof fireproof rack server cabinet with Lock and Wheel as it provides fireproof and it is far more cheaper than RackIT 19" 42U 600x800 Floor Stand Server Rack so it can save our cost more.

1. https://www.lazada.com.my/products/19-inch-28u-network-cabinet-server-rack-soundproof-fireproof-rack-server-cabinet-with-lock-and-wheel-i2368415355-s10165545530.html?spm=a2o4k.searchlist.list.10.3bfb74bdYGcyD1&search=1&fastshipping=0&sale=&price=989.00&review=&ratingscore=0&location=Pahang&stock=1&lang=en

2. https://www.lazada.com.my/products/free-shipping-klang-valley-rackit-19-42u-600x800-floor-stand-server-rack-19-rackit-42u-server-rack-i1566570731-s5284774224.html?&search=pdp_v2v?spm=a2o4k.pdp_revamp.recommendation_2.9.1b382349aL8bjI&mp=1&scm=1007.16389.126158.0&clickTrackInfo=7f6abbc2-16da-4e8a-a13b-82807a38f2db__1566570731__108__trigger2i__202835__0.048__0.048__0.0__0.0__0.0__0.048__8__8__PDPV2V__251__null__null__0____1899.0__0.21327014218009477__5.0__1__1494.0__89487,89491,102630,103150,105609,105842,115780,119167,120249,120320,120434,122066,127410,152111__null__null__null__3650.16544_3650.16536_955.3632__null__13499__null__0.0__0.0__elp.2_star.4_starplus.8__

12. Speaker

Table 13: Speaker Comparison

Speaker	Specification	Price and Quantity
	Sensitivity:87db Frequency response:90HZ-20KHZ Line voltage:220V AC Bluetooth VER:Bluetooth 3.0 Rated power:2*20W dual channel stereo Wireless frequency response:Bluetooth audio source/the audio source	Price : RM 343.20 / unit Quantity : 3

QQCHINAPA LBG-5084TS 40W Active Bluetooth Wall Mount Speaker	Radio frequency:796.5/798/799.5MHZ Txransmission power:14DBM-16DBM Distance:8 meters to 15 meters Material:HIPS Dimension(mm):220*150*135 Weight(KG):2.8	
 Sony SS-CS3 Stereo Floor-Standing Speaker	DIMENSIONS (W X H X D): 230 x 922 x 260 mm WEIGHT : 11.5 kg FREQUENCY RESPONSE: 45Hz-50kHz FRONT SPEAKER RATED IMPEDANCE : 6ohms FRONT SPEAKER SYSTEM: 3-way, 4-driver speaker system	Price : RM 599 / unit Quantity : 6

The speaker we choose is QQCHINAPA LBG-5084TS 40W Active Bluetooth Wall Mount Speaker as it is more cost effective and it wall mount feature to reduce space occupation.

1. https://www.lazada.com.my/products/qqchinapa-40w-active-bluetooth-wall-mount-speaker-for-classroomhotel-meeting-roomhomecoffee-barschool-i1787902454-s7039192110.html?spm=a2o4k.searchlist.list.1.7c4e71f6mv20Dx&search=1&freeshipping=1&fastshipping=0&sale=&price=343.20&review=&ratingscore=0&location=Overseas&stock=1&lang=en

2. https://store.sony.com.my/products/ss-cs3?_pos=4&_sid=5f71564ba&_ss=r

13. Microphone

Table 14: Microphone Comparison

Microphone	Specification	Price and Quantity

 Shure SV100 Vocal Microphone	Weight : 244 g Height x Width x Depth : 173.8 × 52.6 × 52.6 mm Frequency Response : 50 Hz – 15 kHz Frequency Response : Tailored Sensitivity : -52.00 dBV/Pa – 2.50 mV/Pa Transducer Type : Dynamic Polar Pattern : Cardioid Switchable low cut : No Attenuator : No Interchangeable Capsule : No Main Functionality : Performance Headphone Output : No Cartridge : Fixed	Price : RM 96.05 / unit Quantity : 6
 Shure SM58S Cardioid Dynamic Vocal Microphone	Frequency response tailored for vocals, with brightened midrange and bass roll-off. Uniform cardioid pickup pattern isolates the main sound source and minimizes background noise. Pneumatic shock-mount system cuts down handling noise. Effective, built-in spherical wind and pop filter. Supplied with break-resistant stand adapter which rotates 180 degrees. Legendary Shure quality, ruggedness and reliability Cardioid (unidirectional) dynamic. On/Off Switch.	Price : RM 725 / unit Quantity : 6

The microphone we choose is Shure SV100 Vocal Microphone because its cost are way lower than the other microphone and we only need the basic functions of the microphone just to let everybody in the room hears the sound of the speaker in front.

1. https://www.lamboplace.com/product/shure-sv100-vocal-microphone

2. https://store.avem.com.my/shure-sm58s-cardioid-dynamic-vocal-microphone-with-on-off-switch?gclid=CjwKCAiAxJSPBhAoEiwAeO_fPyXDbd7rqzxkLCBHGcXv3iIkacYZdcncArOfvx4HSREAw5zmgrpELxoCmSUQAvD_BwE

14. Server

Table 15: Server Comparison

Server	Specification	Price and Quantity
 Synology DS920+ Nas Enclosure Kits	12TB | 18TB | 24TB | 30TB | 36TB | 48TB | 64TB Total Storage Capacity 4 x 3.5"/2.5" SATA HDD/SSD Drive Bays 2.0 GHz Intel Celeron J4125 Quad-Core Default 4GB + ADD ON 16GB Compatible Ram @ 20GB of DDR4 Ram 2 x 512GB NvME SSD Slots | 2 x 1TB NvME SSD Slots 2 x Gigabit Ethernet Ports |2 x USB 3.0 Type-A 1 x eSATA RAID 0, 1, 5, 6, 10, and JBOD Encrypted Reads up to 225 MB/s &Writes up to 225 MB/s Hardware Encryption & Transcoding Engine Synology DiskStation Manager OS	Price : RM 5988.88 / unit Quantity : 5
 QNAP TS-473 4-Bays Diskless NAS Server	4 x 3.5"/2.5" Bays & 2 x M.2 SSD Slots 2.1 GHz AMD RX-421ND Quad-Core 4GB / 8GB /16GB of DDR4 RAM 4 x Gigabit Ethernet Ports 4 x USB 3.0 Type-A Ports 2 x PCIe 3.0 x4 Slots RAID 0, 1, 5, 6, 10, JBOD, and Single Up to 2347 MB/s Reads & 1764 MB/s	Price : RM 4988.88 / unit Quantity : 5

	AES-NI & AES 256-Bit Encryption QTS 4.3.4 Operating System	

The external storage server we choose is QNAP TS-473 4-Bays Diskless NAS Server because it has a better processor, and it is more cost effective compared to Synology DS920+ Nas Enclosure Kits.

1. https://www.lazada.com.my/products/synology-ds920-20gb-12tb-18tb-24tb-30tb-36tb-48tb-64tb-total-storage-capacity-nas-enclosure-kits-i1210114498-s11635503200.html?spm=a2o4k.searchlist.list.39.54c025d0QAV3It&search=1&freeshipping=1&fastshipping=0&sale=&price=5988.88&review=4&ratingscore=4.75&location=Selangor&stock=1&lang=en

2. https://www.lazada.com.my/products/pre-order-qnap-ts-473-eta-30-60-days-qnap-ts-473-4-bays-diskless-nas-server-ts-473-4g-8g-16g-i451303352-s2478330747.html?spm=a2o4k.searchlist.list.37.52b025d0gAEtgj&search=1&freeshipping=1&fastshipping=0&sale=&price=4988.88&review=&ratingscore=0&location=Selangor&stock=1&lang=en

15. Wireless Access Point

Table 16: Wireless Access Point Comparison

Wireless Access Point	Specifications	Price and Quantity
 TP-Link AC1750 Wireless Wi-Fi Access Point (EAP245)	-Simultaneous 450Mbps on 2.4GHz and 1300Mbps on 5GHz totals 1750Mbps Wi-Fi speeds -Supports Seamless Roaming so even video streams and voice calls are unaffected as users move between locations -Free cloud centralized management and Omada app for ultra convenience and easy management -Support Power over Ethernet(802.3at/802.3af)	Price : RM 649 / unit Quantity : 4

	for convenient and affordable installation -Secure guest network along with multiple authentication options (SMS/Facebook Wi-Fi/ Voucher, etc.) and abundant wireless security technologies. -Band Steering Automatically moves dual band devices onto the wider 5GHz band for faster connections -Load balance ensures large numbers of users have smooth network experiences in high density business networks -Supports management VLAN for an enhanced network management	
 TP-LINK EAP660 HD AX3600 Wireless Dual Band Multi-Gigabit Ceiling Mount Access Point	Ultra-Fast Wi-Fi 6 Speeds: Simultaneous 1148 Mbps on 2.4 GHz and 2402 Mbps on 5 GHz totals 3550 Mbps Wi-Fi speeds. High-Density Connectivity: 4× increased capacity to connect more devices simultaneously. Integrated into Omada SDN: Zero-Touch Provisioning (ZTP), Centralized Cloud Management, and Intelligent Monitoring. Centralized Management: Cloud access and Omada app for ultra convenience and easy management. 2.5G Port: A 2.5 Gbps Ethernet port boosts total internet throughput. Seamless Roaming: Even video streams and voice calls are unaffected as users move between locations. PoE+ Support: Supports Power over Ethernet	Price : RM 1599 / unit Quantity : 4

	(802.3at) for convenient deployment and installation. Secure Guest Network: Along with multiple authentication options (SMS/Facebook Wi-Fi/ Voucher, etc.) and abundant wireless security technologies.	

The preferred wireless access point is TP-LINK EAP660 HD AX3600 Wireless Dual Band Multi-Gigabit Ceiling Mount Access Point. Although it has a higher price, but the speed it provide is faster, therefore it is suitable for over 30 workstations in the room. Moreover it is a ceiling mount access point that can help to save up space in the labs.

1. https://shopee.com.my/TP-LINK-EAP245-AC1750-WIRELESS-MU-MIMO-GIGABIT-CEILING-MOUNT-ACCESS-POINT-i.252512310.4451971004?gclid=Cj0KCQiAraSPBhDuARIsAM3Js4p4ol_JC1xeQan2FhJHdA9pN2ekpnfB9i5A6uvWtKUQVc_qKGCDT-oaAsZKEALw_wcB

2. https://shopee.com.my/TP-LINK-EAP660-HD-AX3600-Wireless-Dual-Band-Multi-Gigabit-Ceiling-Mount-Access-Point-i.299734711.11404940409?gclid=Cj0KCQiAraSPBhDuARIsAM3Js4oNHPIQ5OBKfpx3XedOKBvcV2f3-x8MiDfahKpVZPnEGk4bir4PelcaAkr_EALw_wcB

Reflection

Before we began this task, we assumed that finding network components for a university will be a small process requiring a small budget and funds to maintain. It is really unexpected that network components are so costly. A complete networking system requires a variety of items and devices. We used to believe that everything a computer needed to connect to a network was an internet router.

Setting up a network infrastructure inside a building is not an easy process, as we discovered while working on this project. There are several different items and products available that we must explore and evaluate the specifications and costs to select the best devices for our building. Furthermore, we must select the most cost-effective items that are

also of high quality in order for the networking in the lab to operate effectively and without any networking issues, including a poor internet connection, and to keep the costs within our financial plan.

In this project, we are given a budget of RM3,000,000 to spend on designing a small network. Through research, we have chosen suitable devices that cost a total of RM789,929.88. This means we managed to spend within our budget. Needless to say, we were indeed surprised by the price of some items, especially those that are close to or even reaching 5 figures in terms of price.

Task 4: Making the Connections – LAN and WAN

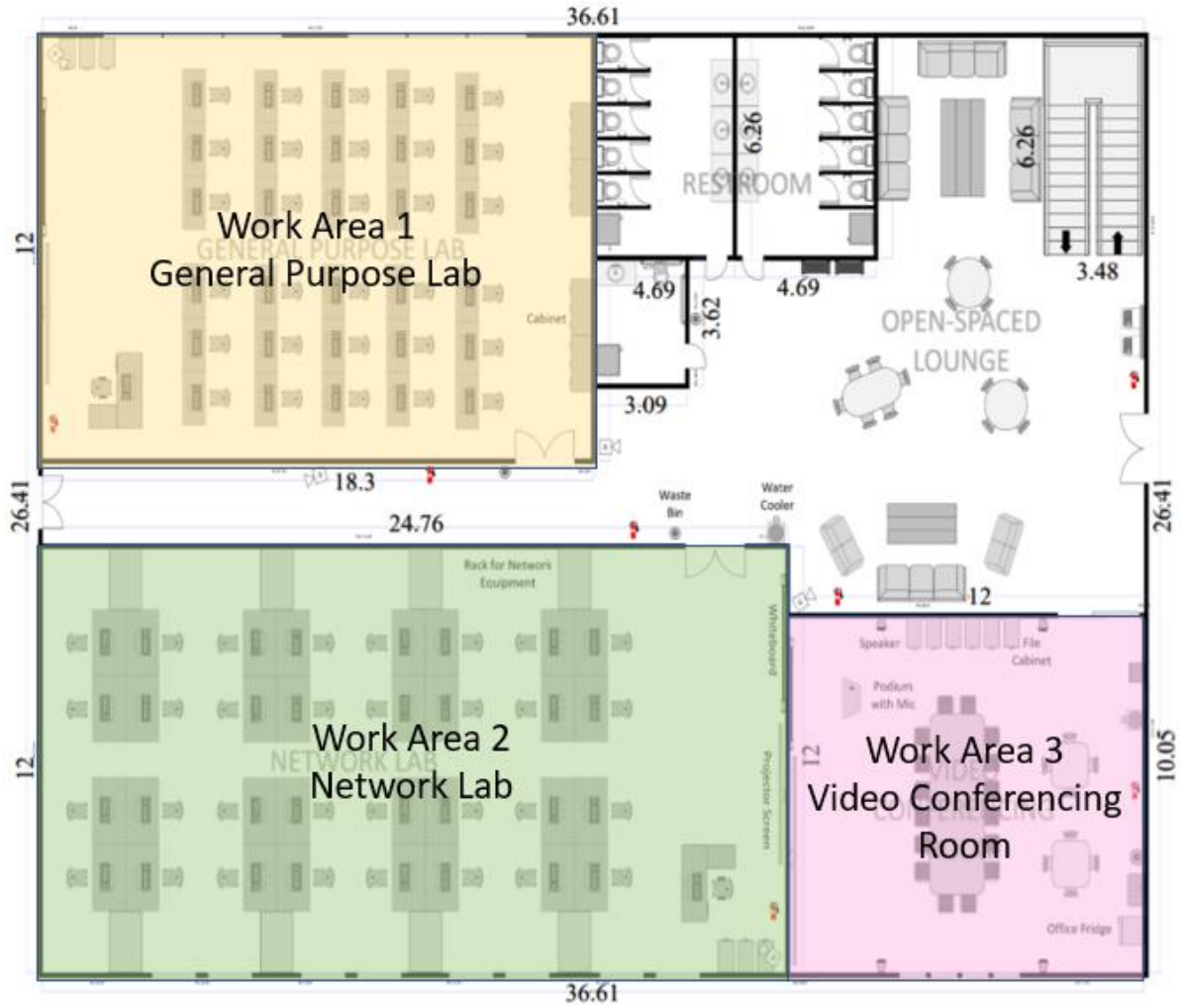


Figure 3: Work Areas in Ground Floor

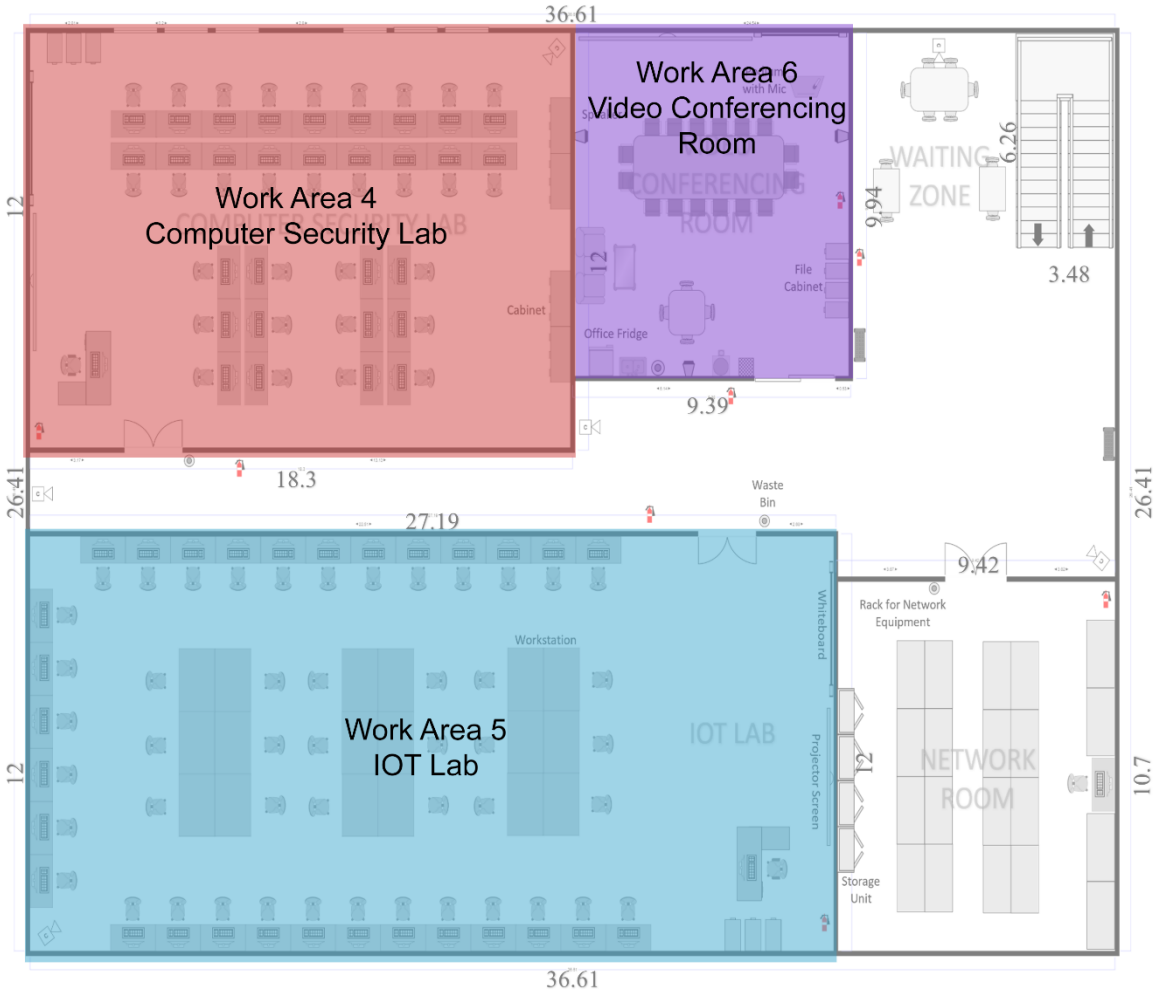


Figure 4: Work Areas in First Floor

Table 17: Number of Connections, Patch Cords and Switch Ports Required

Description	Quantity
Connections (To workstation)	126
Patch Cords	126
Switch Ports	240 (5 Switches Needed)

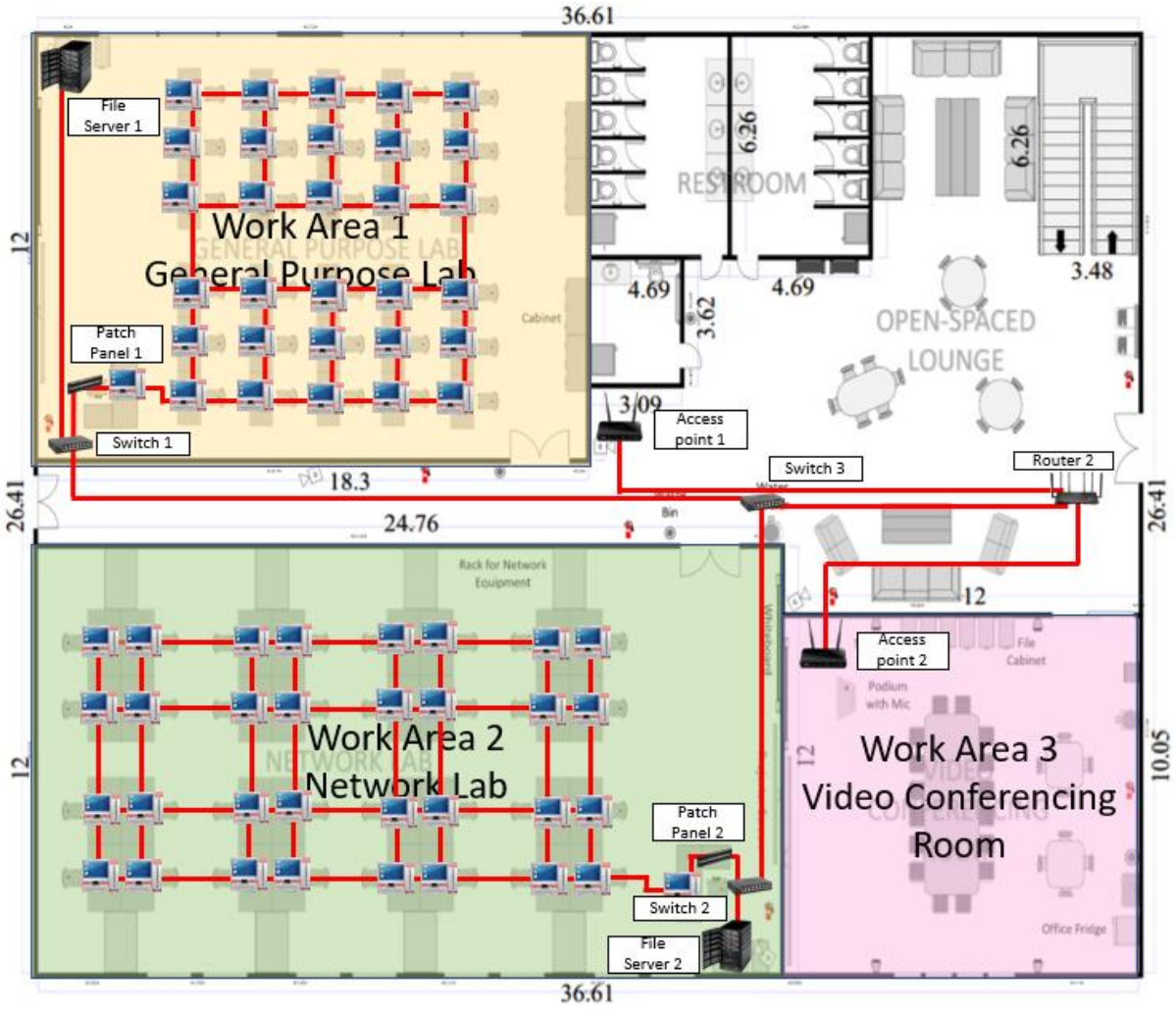


Figure 5: Closed-Up Network in Ground Floor

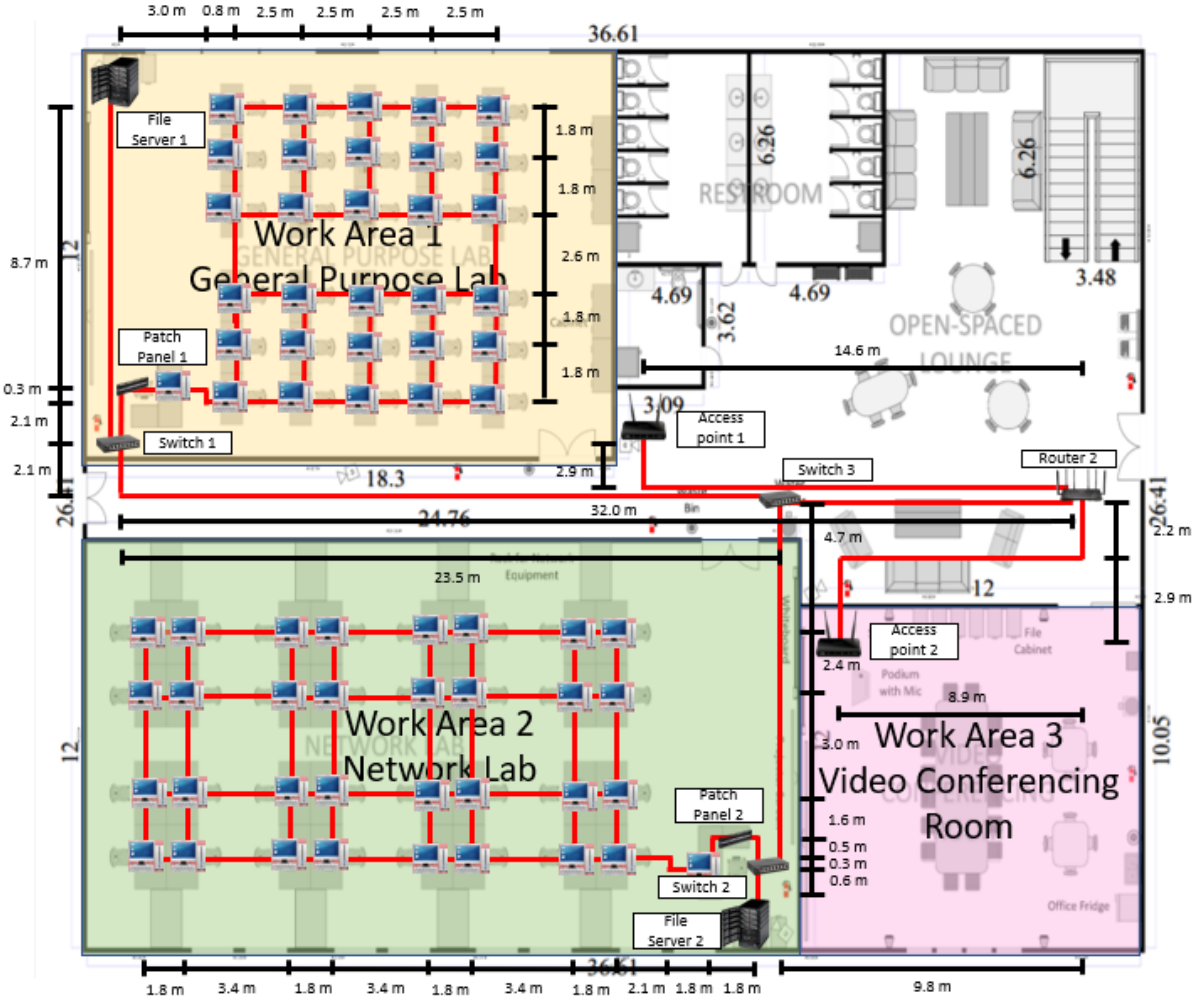


Figure 6: Connection Cables Length Measurement in Ground Floor

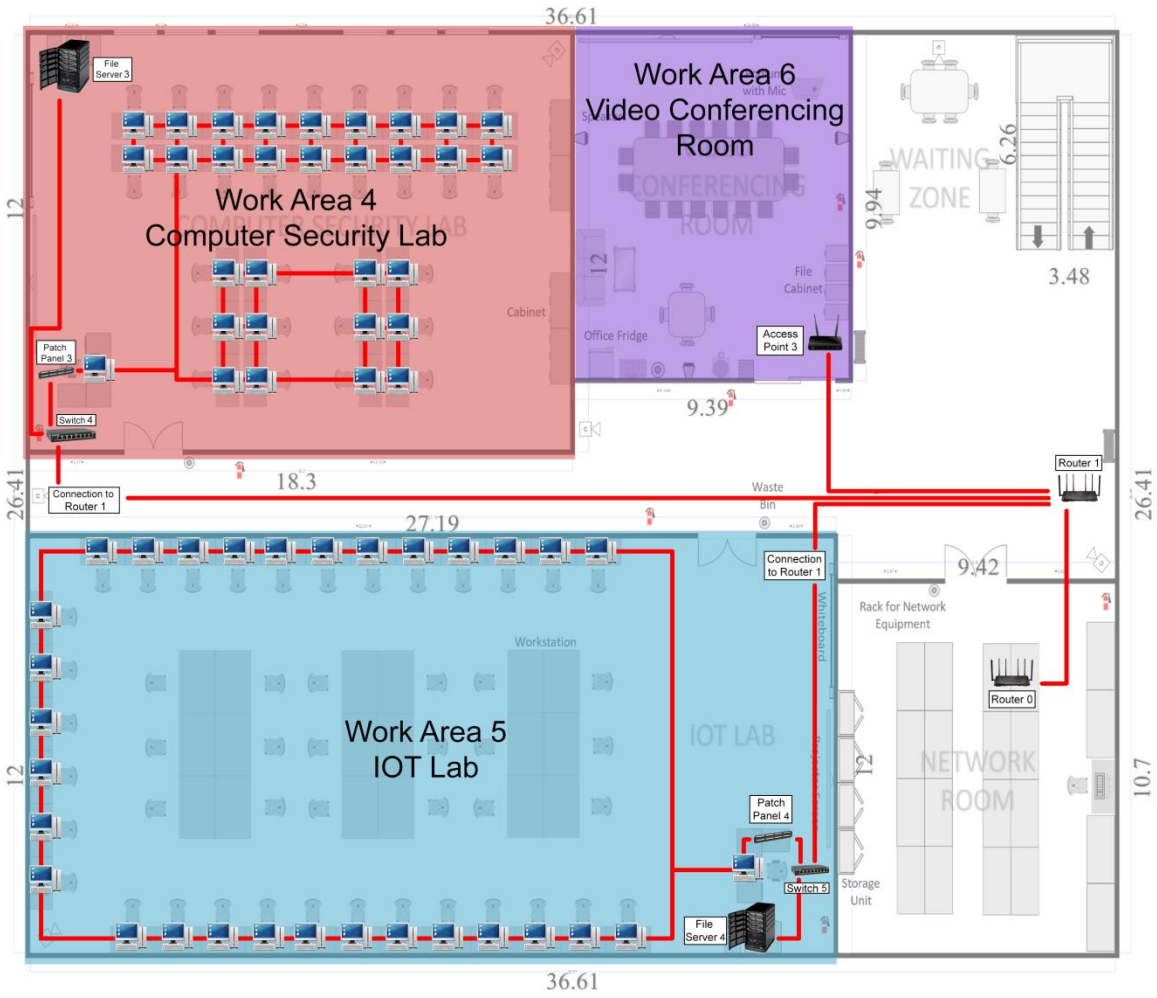


Figure 7: Closed-Up Network in First Floor

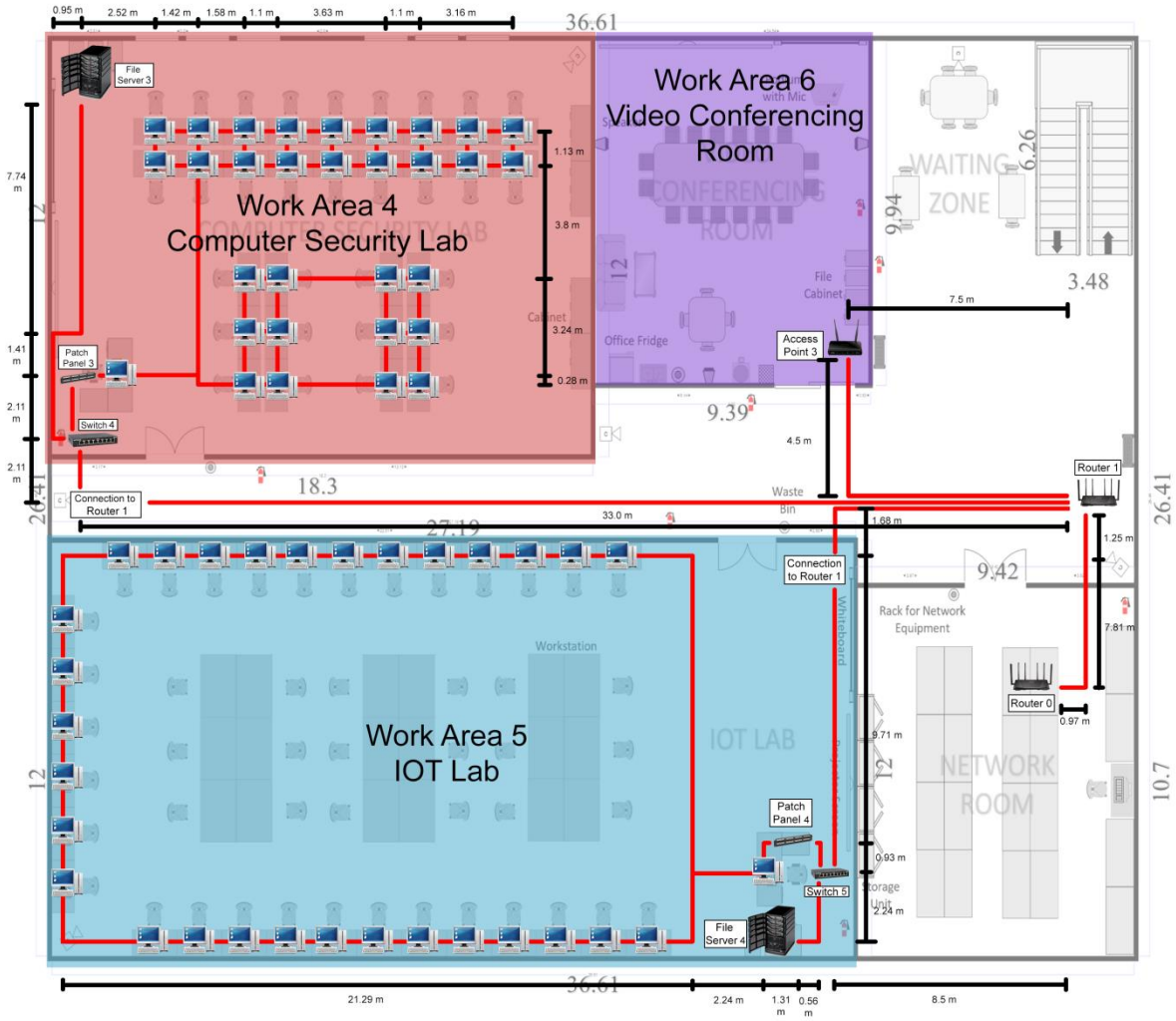


Figure 8: Connection Cables Length Measurement in First Floor

Table 18: Cable Type and Estimated Cable Length

Description	Cable Type	Length (in m)
Ground Floor		
General Purpose Lab (Work Area 1) to Switch 3	Fiber Optic	25.60
Peripheral Connections in General Purpose Lab (Switch, Patch Panel and Server)	Category 6	98.50
Network Lab (Work Area 2) to Switch 3	Fiber Optic	12.50
Peripheral Connections in Network Lab (Switch, Patch Panel and Server)	Category 6	140.20
Video Conferencing Room (Work Area 3 / Access Point 2) to Router 2	Fiber Optic	14.00

Router 2 to Access Point 1	Fiber Optic	17.50
Cables Going Up the Walls (1.0 m for Each Connection between Switches, Access Points and Router)	Fiber Optic	5.00
Router 2 to Switch 3	Fiber Optic	9.80
Total Length – Ground Floor (m):		323.10
1st Floor		
Computer Security Lab (Work Area 4) to Router 1	Fiber Optic	35.11
Peripheral Connections in Computer Security Lab (Switch, Patch Panel and Server)	Category 6	95.00
IoT Lab (Work Area 5) to Router 1	Fiber Optic	20.75
Peripheral Connections in IoT Lab (Switch, Patch Panel and Server)	Category 6	80.00
Video Conferencing Room (Work Area 6 / Access Point 3) to Router 1	Fiber Optic	12.00
Router 1 to Router 0	Fiber Optic	10.50
Cables Going Up the Walls (1.0 m for Each Connection between Switches, Access Points and Routers)	Fiber Optic	5.00
Total Length – 1st Floor (m):		258.36
Backbone Cabling (Router 0 to Router 2)	Fiber Optic	20.00
Total Length (m):		601.46
Total Length (Fiber Optic) (m):		187.76
Total Length (Category 6) (m):		413.70

Task 5: IP Addressing Scheme

IP addressing is crucial in making sure that every host can connect to the network without conflict of addresses. In this task, you need to explore how best to divide the subnetwork from the Network Address assigned to your group.

a) Get the Network Address from your lecturer
b) Divide it in the best possible way for your network – all the different labs and rooms

Since we are group 7, the IP address space that we were given is 192.22.0.0/8.

There are a total of 8 subnets identified from the cable connections in Task 4. The 8 subnets can be tabulated in tables below:

Table 19: IP Address and Subnet Mask Based on Router

Device Name	Interface Connection	Subnet Number	Number of Hosts Required (Minimum)	IP Address	Subnet Mask
Router 0	with Router 1	1	2	192.22.1.1	255.255.255.252
	with Router 2	2	2	192.22.1.5	255.255.255.252
Router 1	with Router 0	1	2	192.22.1.2	255.255.255.252
	with Switch 4	3	34	192.22.2.1	255.255.255.192
	with Switch 5	4	34	192.22.3.1	255.255.255.192
	with Access Point 3	5	30	192.22.4.1	255.255.255.224
Router 2	with Router 0	2	2	192.22.1.6	255.255.255.252
	with Switch 3	6	68	192.22.5.1	255.255.255.128
	with Access Point 1	7	30	192.22.6.1	255.255.255.224
	with Access Point 2	8	30	192.22.7.1	255.255.255.224

Table 20: Network Address, Broadcast Address and Available IP Address of Subnets

Subnet Number	Network Address	Broadcast Address	Available IP Address Range
1	192.22.1.0	192.22.1.3	192.22.1.1 - 192.22.1.2
2	192.22.1.4	192.22.1.7	192.22.1.5 - 192.22.1.6
3	192.22.2.0	192.22.2.63	192.22.2.1 - 192.22.2.62
4	192.22.3.0	192.22.3.63	192.22.3.1 - 192.22.3.62
5	192.22.4.0	192.22.4.31	192.22.4.1 - 192.22.4.30
6	192.22.5.0	192.22.5.127	192.22.5.1 - 192.22.5.126
7	192.22.6.0	192.22.6.31	192.22.6.1 - 192.22.6.30
8	192.22.7.0	192.22.7.31	192.22.7.1 - 192.22.7.30

Table 21: Work Areas Associated with Subnets

Subnet Number	Associated Work Areas	Available IP Address Range
1	-	192.22.1.1 - 192.22.1.2
2	-	192.22.1.5 - 192.22.1.6
3	Computer Security Lab (Work Area 4)	192.22.2.1 - 192.22.2.62
4	IoT Lab (Work Area 5)	192.22.3.1 - 192.22.3.62
5	Video Conferencing Room (Work Area 6)	192.22.4.1 - 192.22.4.30
6	General Purpose Lab (Work Area 1) & Network Lab (Work Area 2)	192.22.5.1 - 192.22.5.126
7	-	192.22.6.1 - 192.22.6.30
8	Video Conferencing Room (Work Area 3)	192.22.7.1 - 192.22.7.30

Ground Floor

General Purpose Lab (Work Area 1) and Network Lab (Work Area 2)

General Purpose Lab is expected to support 33 hosts including 30 workstations for students, 1 workstation for lecturer, 1 managed switch and another 1 for file server. On the other hand, Network Lab is expected to support 35 hosts including 32 workstations for students, 1 workstation for lecturer, 1 managed switched and 1 file server. Another managed switch is shared across these two lab. Since 69 hosts are needed, $2^7 - 2 = 126$. Therefore, 7 bits will be used as host address while the remaining 32 - 7 = 25 bits will be used in network address.

Network Address: 192.22.5.0/25

Broadcast Address: 192.22.5.127/25

Range of Available Address: 192.22.5.1/25 - 192.22.2.126/25 (Up to 126 hosts)

Since currently there are 69 hosts needed only; thus, the remaining 126 - 69 = 57 hosts can be used in future if more devices are needed.

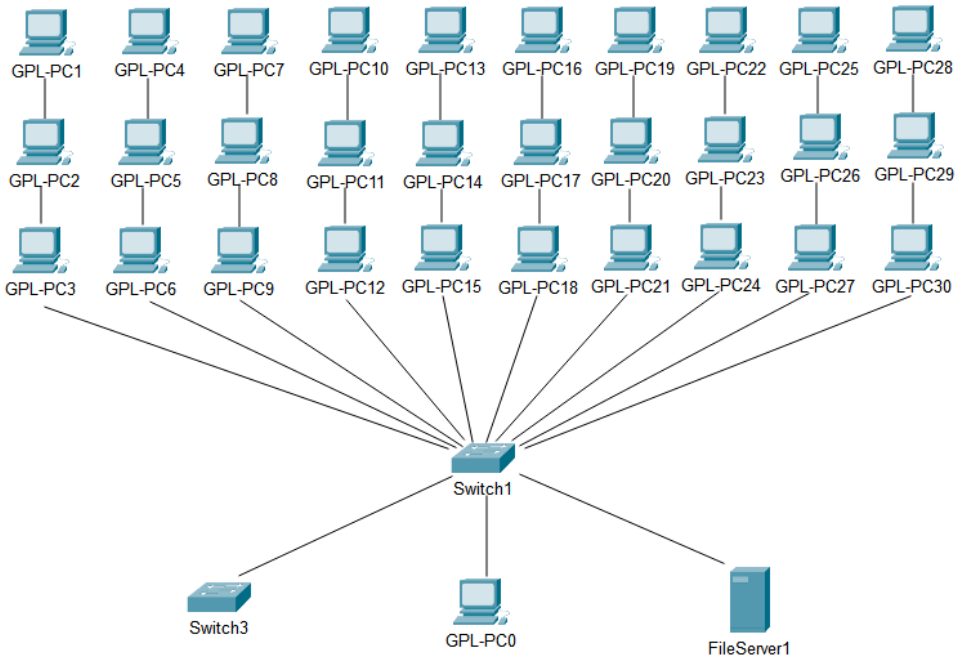


Figure 9: Subnet in General Purpose Lab (Work Area 1)

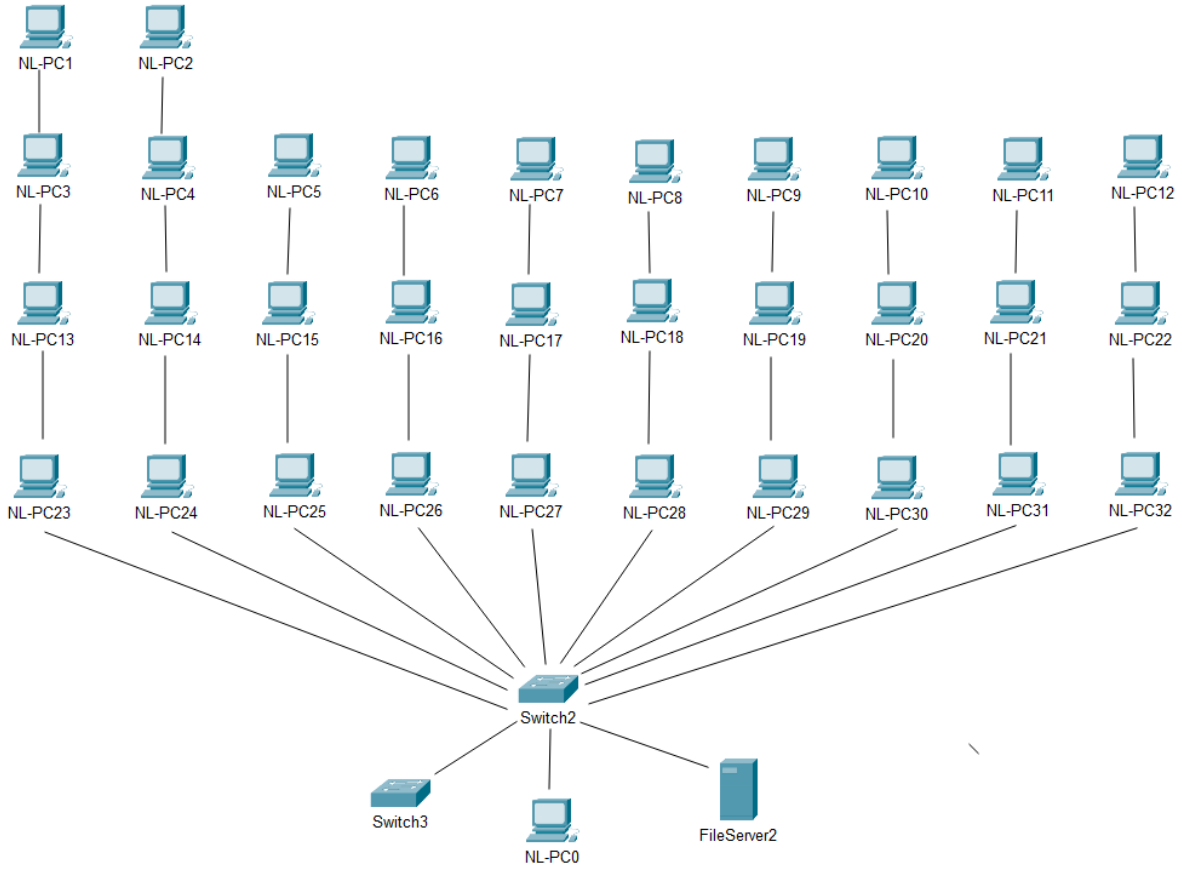


Figure 10: Subnet in Network Lab (Work Area 2)

Table 22: IP Address of Devices Related to General Purpose Lab (Work Area 1) and Network Lab (Work Area 2)

Devices	IP Address
Switch 1	192.22.5.1
Switch 2	192.22.5.2
Switch 3	192.22.5.3
File Server 1	192.22.5.4
File Server 2	192.22.5.5
CSL-PC0 – CSL-PC30, NL-PC0 – NL-PC32	192.22.2.6 - 192.22.2.70

Video Conferencing Room (Work Area 3)

Video Conferencing Room in ground floor is expected to support 30 hosts including up to 28 hosts can be wireless connected to access point, 1 for access point and 1 for router interface. Since 30 hosts are required, $2^5 - 2 = 30$. Therefore, 5 bits will be used as host address while the remaining 32 - 5 = 27 bits will be used in network address.

Network Address: 192.22.7.0/27

Broadcast Address: 192.22.7.31/27

Range of Available Address: 192.22.7.1/27 - 192.22.7.30/27 (Up to 30 hosts)

There will be 2 addresses used for access point and router interface whereas the remaining 28 hosts are used to enable connection of wireless devices to the access point.

Figure 11: Subnet in Video Conferencing Room (Work Area 6)

Table 23: IP Address of Devices Related to Video Conferencing Room (Work Area 6)

Devices	IP Address
Router 2	192.22.7.1

Access Point 2	192.22.7.2
Wireless Connected Devices (Maximum 28 devices)	192.22.7.3 - 192.22.7.30

Outside Work Areas on Ground Floor

Open-spaced Lounge

The open-spaced lounge is expected to support up to 30 hosts including 28 hosts which are connected to access point wirelessly, 1 for access point and 1 for router interface. Since 30 hosts are required, $2^5 - 2 = 30$. Therefore, 5 bits will be used as host address while the remaining 32 - 5 = 27 bits will be used in network address.

Network Address: 192.22.6.0/27

Broadcast Address: 192.22.6.31/27

Range of Available Address: 192.22.6.1/27 - 192.22.6.30/27 (Up to 30 hosts)

Figure 12: Subnet in Open-spaced Lounge

Table 24: IP Address of Devices Related to Open-spaced Lounge

Devices	IP Address
Router 1	192.22.6.1
Access Point 3	192.22.6.2
Wireless Connected Devices (Maximum 28 devices)	192.22.6.3 - 192.22.6.30

First Floor

Computer Security Lab (Work Area 4)

Computer Security Lab is expected to support 34 hosts including 30 workstations for students, 1 workstation for lecturer, 1 for managed switch, 1 for file server and another 1 for router interface. Since 34 hosts are needed, $2^6 - 2 = 62$. Therefore, 6 bits will be used as host address while the remaining 32 - 6 = 26 bits will be used in network address.

Network Address: 192.22.2.0/26

Broadcast Address: 192.22.2.63/26

Range of Available Address: 192.22.2.1/26 - 192.22.2.62/26 (Up to 62 hosts)

However, currently there are 34 hosts needed only; thus, the remaining 62 - 34 = 28 hosts can be used in future if more devices are needed.

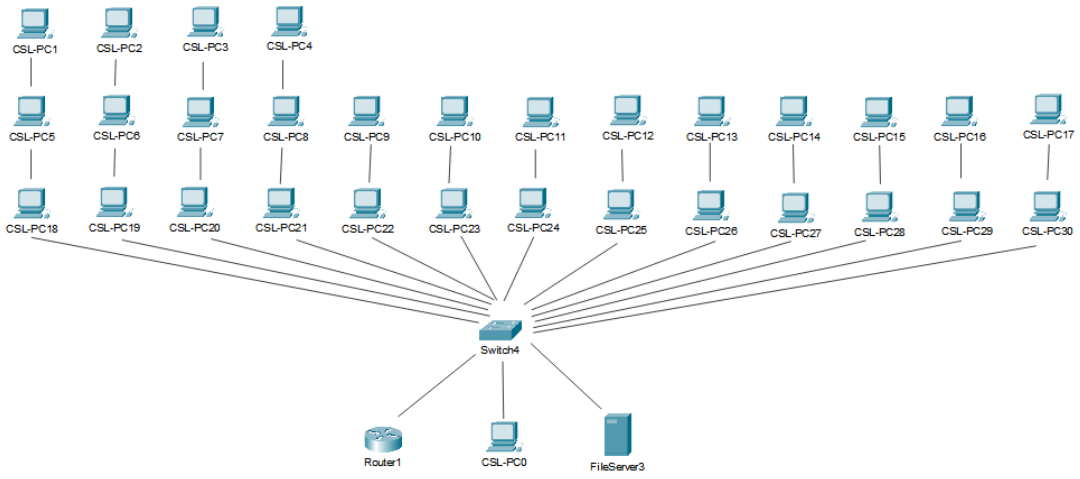


Figure 13: Subnet in Computer Security Lab (Work Area 4)

Table 25: IP Address of Devices Related to Computer Security Lab (Work Area 4)

Devices	IP Address
Router 1	192.22.2.1
Switch 4	192.22.2.2
File Server 3	192.22.2.3
CSL-PC0 - CSL-PC30	192.22.2.4 - 192.22.2.34

IoT Lab (Work Area 5)

IoT Lab is expected to support 34 hosts including 30 workstations for students, 1 workstation for lecturer, 1 for managed switch, 1 for file server and another 1 for router interface. Since 34 hosts are needed, $2^6 - 2 = 62$. Therefore, 6 bits will be used as host address while the remaining 32 - 6 = 26 bits will be used in network address.

Network Address: 192.22.3.0/26

Broadcast Address: 192.22.3.63/26

Range of Available Address: 192.22.3.1/26 - 192.22.3.62/26 (Up to 62 hosts)

However, currently there are 34 hosts needed only; thus, the remaining 62 - 34 = 28 hosts can be used in future if more devices are needed.

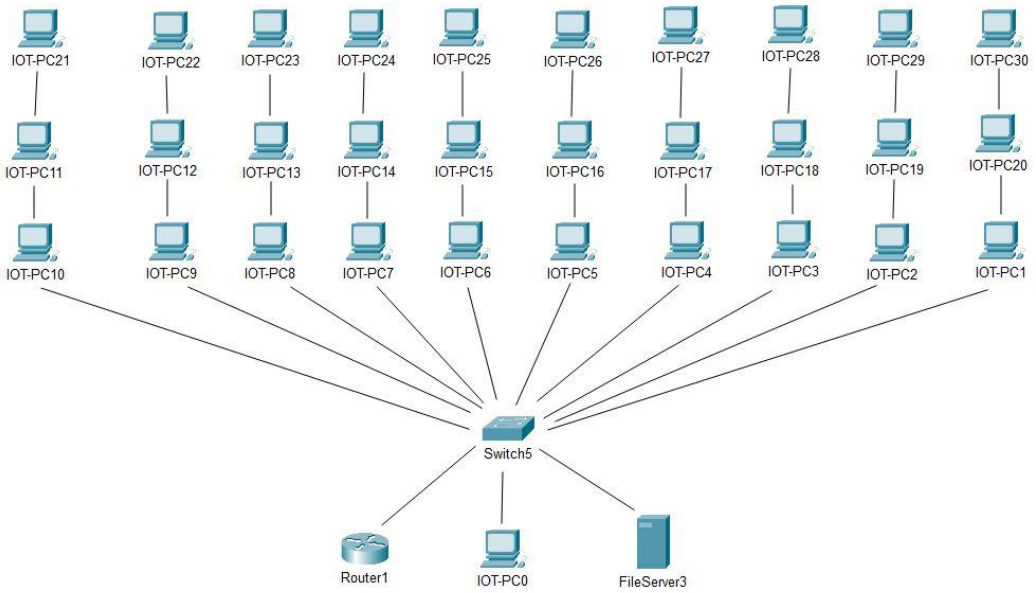


Figure 14: Subnet in IoT Lab (Work Area 5)

Table 26: IP Address of Devices Related to IoT Lab (Work Area 5)

Devices	IP Address
Router 1	192.22.3.1
Switch 5	192.22.3.2
File Server 3	192.22.3.3
CSL-PC0 - CSL-PC30	192.22.3.4 - 192.22.3.34

Video Conferencing Room (Work Area 6)

Video Conferencing Room in first floor is expected to support 30 hosts including up to 28 hosts can be wireless connected to access point, 1 for access point and 1 for router interface. Since 30 hosts are required, $2^5 - 2 = 30$. Therefore, 5 bits will be used as host address while the remaining 32 - 5 = 27 bits will be used in network address.

Network Address: 192.22.4.0/27

Broadcast Address: 192.22.4.31/27

Range of Available Address: 192.22.4.1/27 - 192.22.4.30/27 (Up to 30 hosts)

There will be 2 addresses used for access point and router interface whereas the remaining 28 hosts are used to enable connection of wireless devices to the access point.

Figure 15: Subnet in Video Conferencing Room (Work Area 6)

Table 27: IP Address of Devices Related to Video Conferencing Room (Work Area 6)

Devices	IP Address
Router 1	192.22.4.1
Access Point 3	192.22.4.2
Wireless Connected Devices (Maximum 28 devices)	192.22.4.3 - 192.22.4.30

Outside Work Areas on First Floor

Connection from Router 0 to Router 1

The connection from router 0 to router 1 requires 2 hosts, in which are used for router interface in both router 1 and router 0. Since 2 hosts are needed, $2^2 - 2 = 2$. Therefore, 2 bits will be used as host address while the remaining 32 - 2 = 30 bits will be used in network address.

Network Address: 192.22.1.0/30

Broadcast Address: 192.22.1.3/30

Range of Available Address: 192.22.1.1/30 - 192.22.1.2/30 (Up to 2 hosts)

Figure 16: Subnet in Connection from Router 0 to Router 1

Table 28: IP Address of Devices Related to Connection from Router 0 to Router 1

Devices	IP Address
Router 0	192.22.1.1
Router 1	192.22.1.2

Conclusion

In summary, we are all pleased with the outcome of this project, which we worked hard to accomplish. In this project, we created our own floor plan for the new building, researched network components and chose which to apply, preplanned the network structure, designed the cabling, and eventually assigned IP addresses to each room and lab. We managed to complete our project without exceeding the budgeted amount because we conducted extensive research to determine which network components to include in this project.

Throughout the project's development, we recognised some of our own strengths. We are all willing to collaborate with one another, and we always offer anyone who wants to contribute opinions to the group the chance to do so. We are all always on time because all tasks are distributed fairly among us, and the group leader reminds us of the deadline so that the project can be accomplished on time.

Nonetheless, we ran into a few issues while working on the project. We had some confusion and misunderstanding as during the pandemic, we couldn't have face-to-face meetings, making it difficult to describe our problems to one another. Also, members of the team always rely on the group leader to make decisions and causing delay in the progress of the project. In the future, we hope that everybody can have more contributions in decision making process to help the group leader more.

Anything else that would help a client's decision-making process.

In terms of willing to spend more, the organization would not get a better quality of the outcome as the estimated spending in the project is far from reaching the budget allocated (Estimated spending: RM 789,928.88; Budget allocated: RM 3,000,000) and the network and end-user devices we chose to use in the project are among the top performance. The budget allocated is sufficient to buy all the network and end-users devices required to support the requirements stated by SC Chair.

In terms of having more floors in the building requested by SC Chair, the organization is potential of having a better quality of the outcome as the space available in the building will be increased. More infrastructures can be added to the building such as offices, cafeterias, research rooms and indoor parking lots to provide more features to both students and academic staffs. However, more infrastructures may lead to more spending causing the probability of exceeding the current budget allocated to build the new building. Furthermore, more floors in the building also lead to more expenses required in the construction of the new building.

Team Members and Responsibilities

1. Tay Wei Jian (leader)
    - Task 1: Draw the floor plan
    - Task 2: Generate questions and search for answers
    - Task 3: Give suggestions and check the devices used
    - Task 4: Identify work area, draw the cabling, determine the cable types used and sum the length of the wire used for first floor
    - Task 5: Complete the subnetting and IP assignation for Computer Security Lab and Video Conferencing Room
    - Task 6: Do the introduction, project background and client's decision-making process suggestions

2. Chong Tung Han
    - Task 1: Suggest and give idea of the design of the floor plan
    - Task 2: Generate questions and search for answers
    - Task 3: Give suggestions and check the devices used
    - Task 4: Identify work area, draw the cabling, determine the cable types used and sum the length of the wire used for ground floor
    - Task 5: Complete the subnetting and IP assignation for General Purpose Lab and Access Point 5
    - Task 6: Do the team members and responsibilities and appendices

3. Tee Jun Hong
    - Task 1: Suggest and give idea of the design of the floor plan
    - Task 2: Generate questions and search for answers
    - Task 3: Research for appropriate LAN devices
    - Task 4: Give suggestions and check the connections
    - Task 5: Complete the subnetting and IP assignation for IOT Lab and Video Conferencing Room
    - Task 6: Do the abstract, conclusion and references

4. Tham Chuan Yew
    - Task 1: Suggest and give idea of the design of the floor plan
    - Task 2: Generate questions and search for answers
    - Task 3: Research for appropriate LAN devices
    - Task 4: Give suggestions and check the connections
    - Task 5: Complete the subnetting and IP assignation for Network Lab and Access Point 1
    - Task 6: Do the compile, table of contents and table of figures

References

1. Thomas Momberg, EDUCAUSE (1999). *Campus Network Strategies: A Small College Perspective.* Retrieved from: https://www.educause.edu/ir/library/html/cem/cem99/cem9916.html

2. Sajid Khan Turri (2012). *How To Build Computer Lab.* Retrieved from: http://studiesnote.blogspot.com/2012/10/how-to-build-computer-lab.html

3. Saurabh Sharma, GeeksForGeeks (2021). *Types of Routing.* Retrieved from: https://www.geeksforgeeks.org/types-of-routing/

4. Muhammad Abdullah (2021). *15 Simple Reasons Why You Need a Wireless Router.* Retrieved from: https://www.europeanbusinessreview.com/15-simple-reasons-why-you-need-a-wireless-router/

5. David Weedmark (2019). *Five Things to Be Considered in Designing a Network*. Retrieved from: https://smallbusiness.chron.com/five-things-considered-designing-network-35911.html

6. Tek Tools (2020). *A Comprehensive Guide on Network Topology, Types, and Tools.* Retrieved from: https://www.tek-tools.com/network/best-network-topology-software

7. Corey F. (2017). *Network Cabling Types: Choosing The Right Structured Cabling Infrastructure.* Retrieved from: https://www.ctctechnologies.com/network-cabling-types/

8. Sabine Hikel (2009). *5 Networking Strategies.* Retrieved from: https://www.insidehighered.com/advice/2009/11/20/5-networking-strategies

9. Staff Contributor (2019). *What Is Network Topology? Best Guide to Types and Diagrams.* Retrieved from: https://www.dnsstuff.com/what-is-network-topology

10. Rosenberg, P. (2000). *The basics of structured cabling*. Retrieved from: https://www.ecmweb.com/basics/article/20897067/the-basics-of-structured-cabling

Appendices

Table 29: Agenda

Date	Members	Task	Activity
21/12/2021	Tay Wei Jian	• Draw the floor plan	Task 1
	Chong Tung Han	• Suggest and give idea of the design of the floor plan	
	Tee Jun Hong	• Suggest and give idea of the design of the floor plan	
	Tham Chuan Yew	• Suggest and give idea of the design of the floor plan	
22/12/2021	Tay Wei Jian	• Generate questions and search for answers	Task 2
	Chong Tung Han	• Generate questions and search for answers	
	Tee Jun Hong	• Generate questions and search for answers	
	Tham Chuan Yew	• Generate questions and search for answers	
27/12/2021	Tay Wei Jian	• Give suggestions and check the devices used	Task 3
	Chong Tung Han	• Give suggestions and check the devices used	
	Tee Jun Hong	• Research for appropriate LAN devices	
	Tham Chuan Yew	• Research for appropriate LAN devices	
27/12/2021	Tay Wei Jian	• Identify work area, draw the cabling, determine the cable types used and sum the length of the wire used for first floor	Task 4
	Chong Tung Han	• Identify work area, draw the cabling, determine the cable types used and sum the length of the wire used for ground floor	
	Tee Jun Hong	• Give suggestions and check the connections	
	Tham Chuan Yew	• Give suggestions and check the connections	
21/1/2022	Tay Wei Jian	• Complete the subnetting and IP assignation for Computer Security Lab and Video Conferencing Room	Task 5
	Chong Tung Han	• Complete the subnetting and IP assignation for General Purpose Lab and Access Point 5	

	Tee Jun Hong	• Complete the subnetting and IP assignation for IOT Lab and Video Conferencing Room	
	Tham Chuan Yew	• Complete the subnetting and IP assignation for Network Lab and Access Point 1	
6/2/2021	Tay Wei Jian	• Do the introduction, project background and client's decision-making process suggestions	Task 6
	Chong Tung Han	• Do the team members and responsibilities and appendices	
	Tee Jun Hong	• Do the abstract, conclusion and references	
	Tham Chuan Yew	• Do the compile, table of contents and table of figures	

Pictures of Group Discussion:

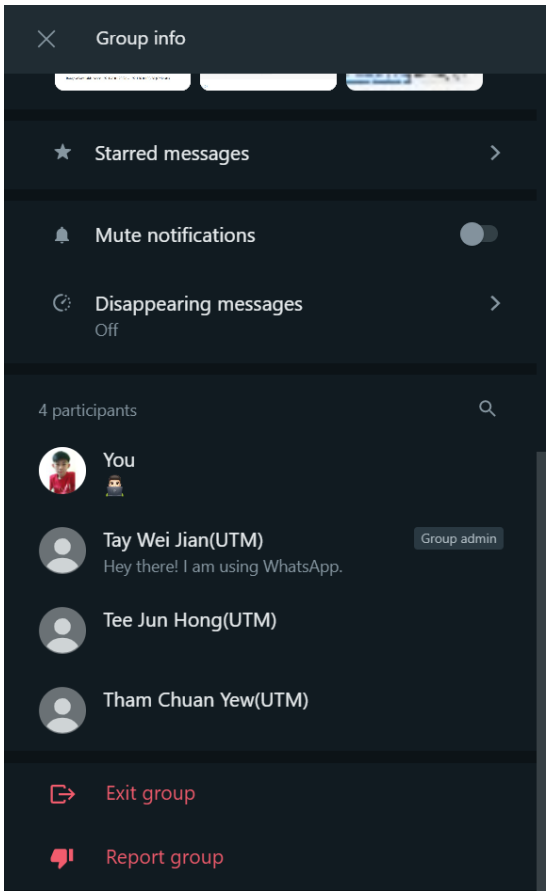


Figure 17: Team Members Involved in the Project

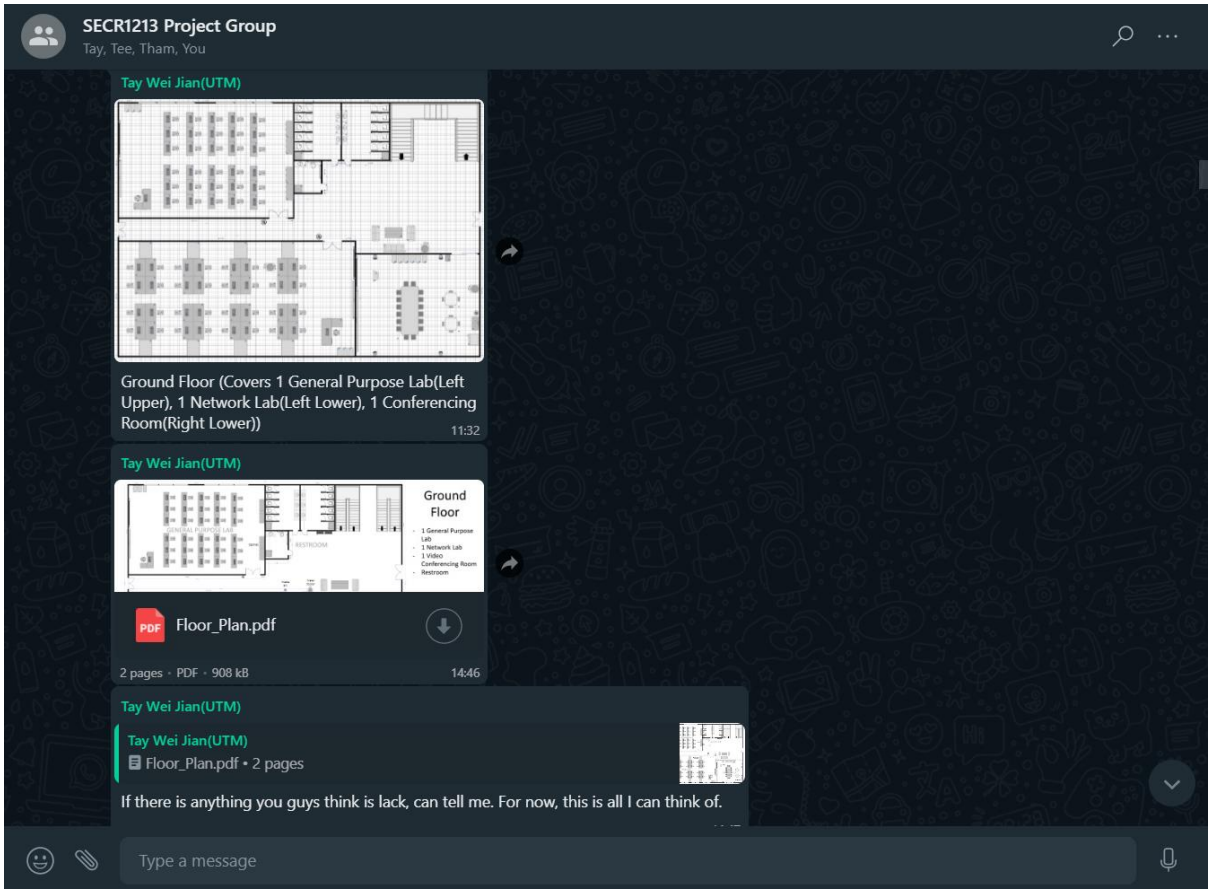


Figure 18: Group Discussion on Task 1

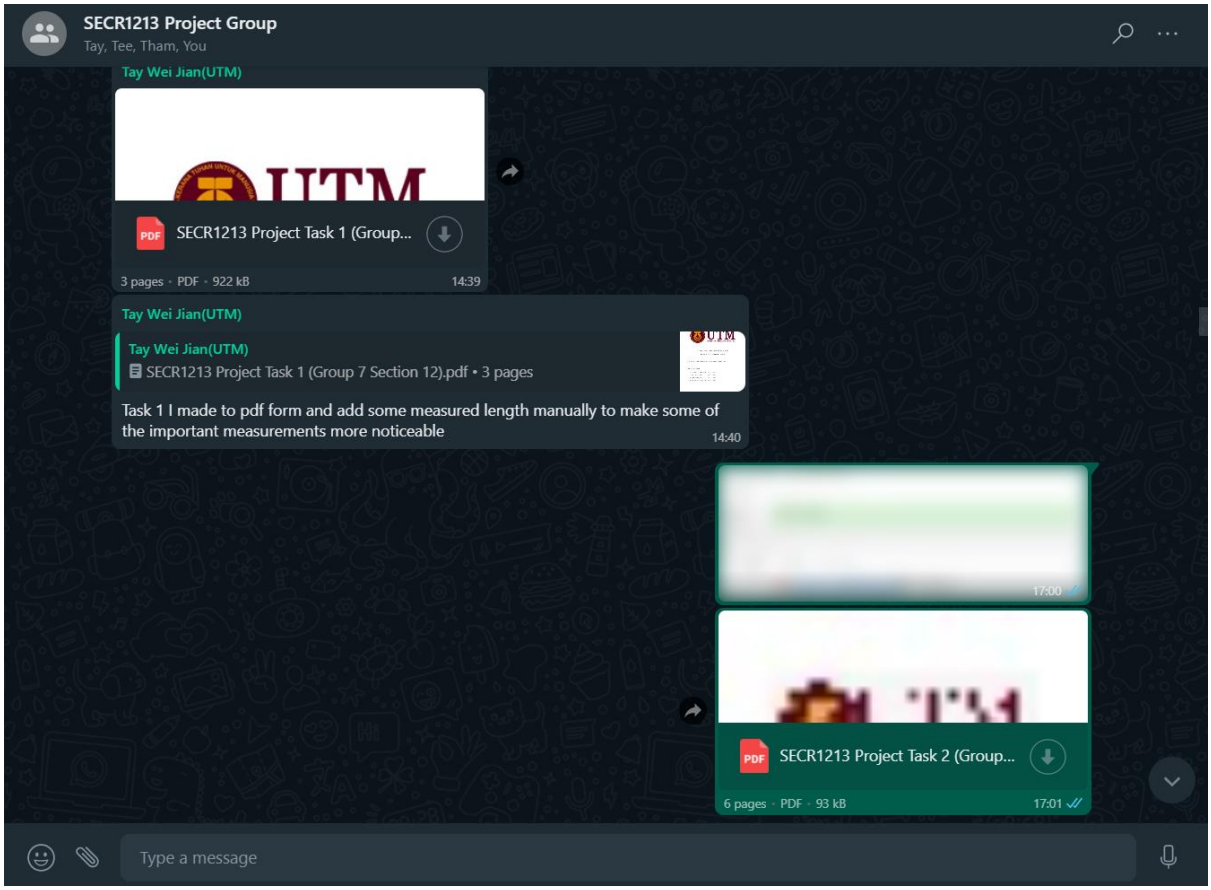


Figure 19: Group Discussion on Task 2

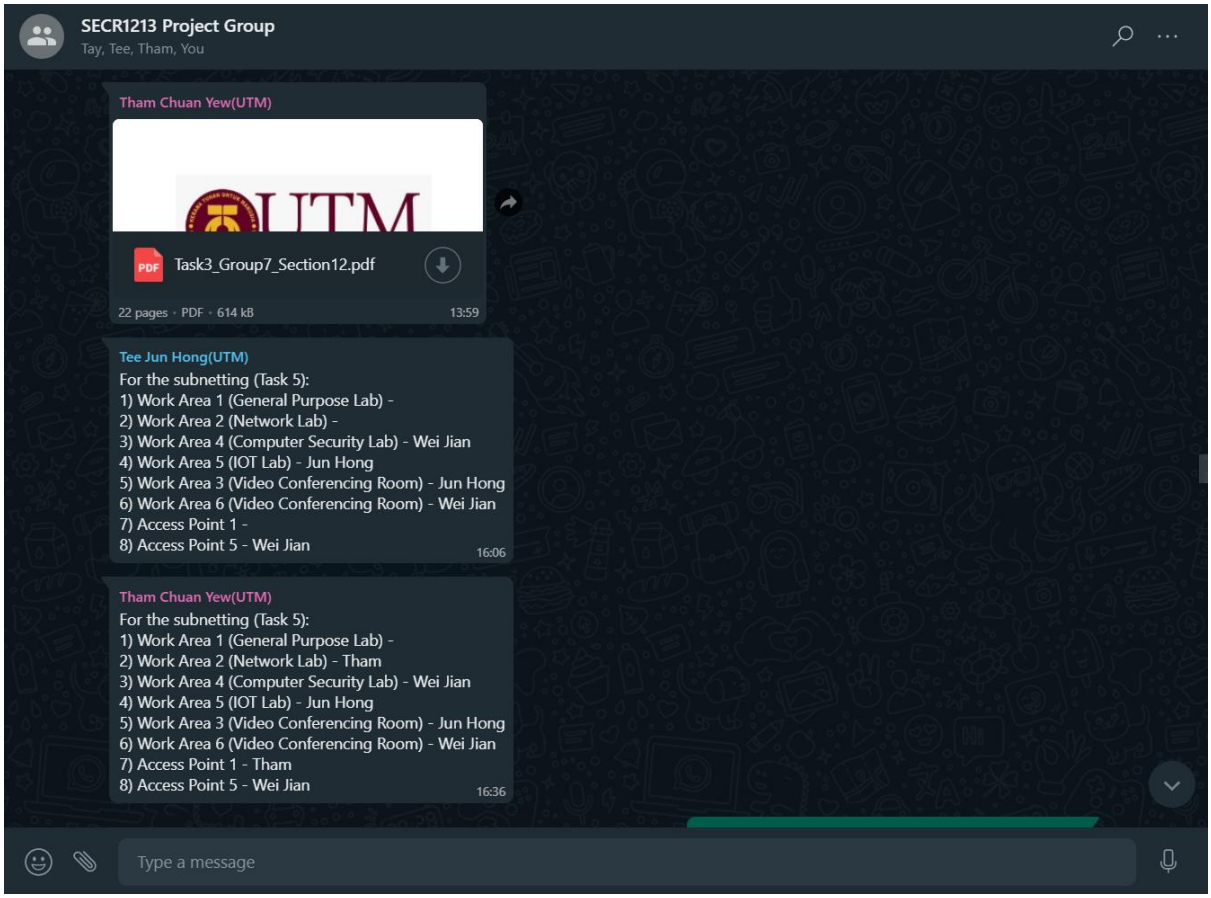


Figure 20: Group Discussion on Task 3

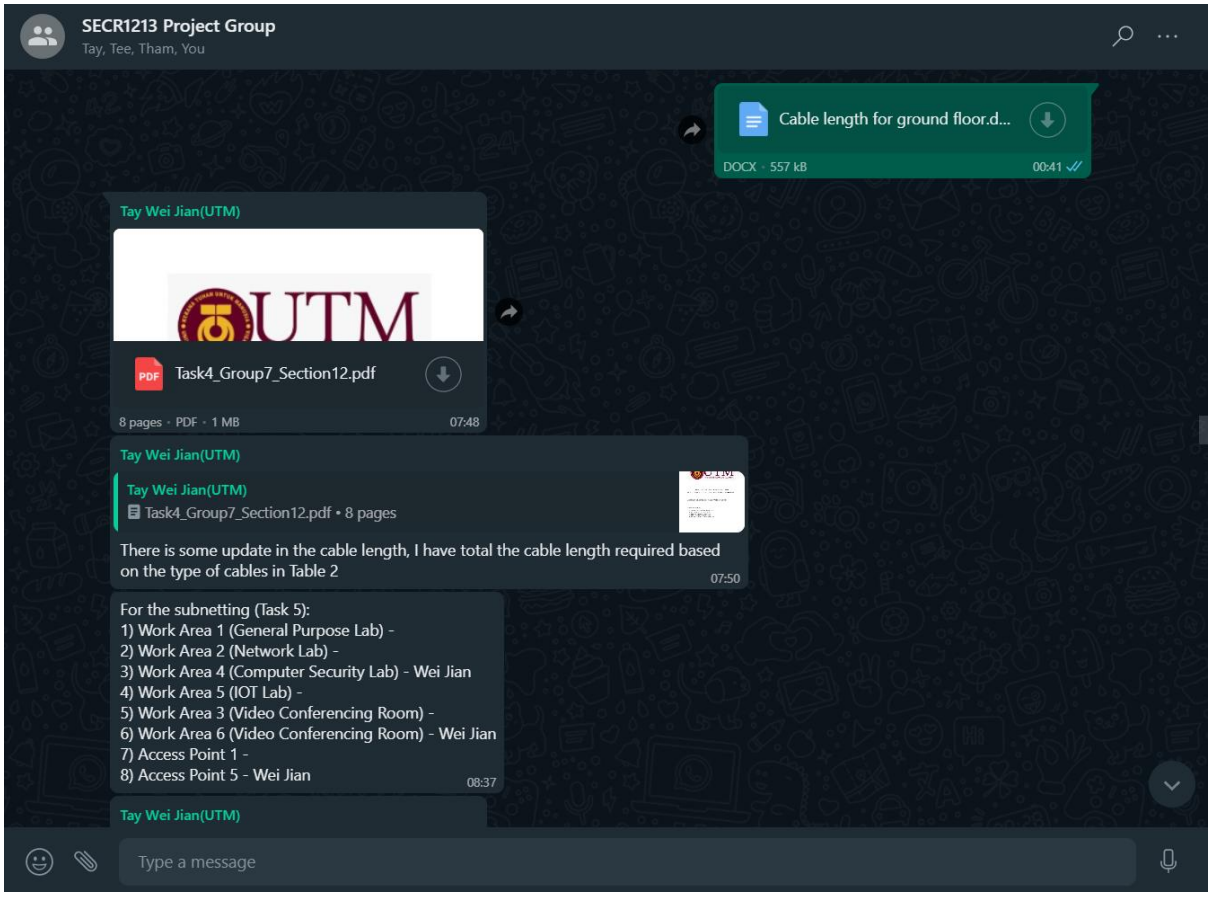


Figure 21: Group Discussion on Task 4

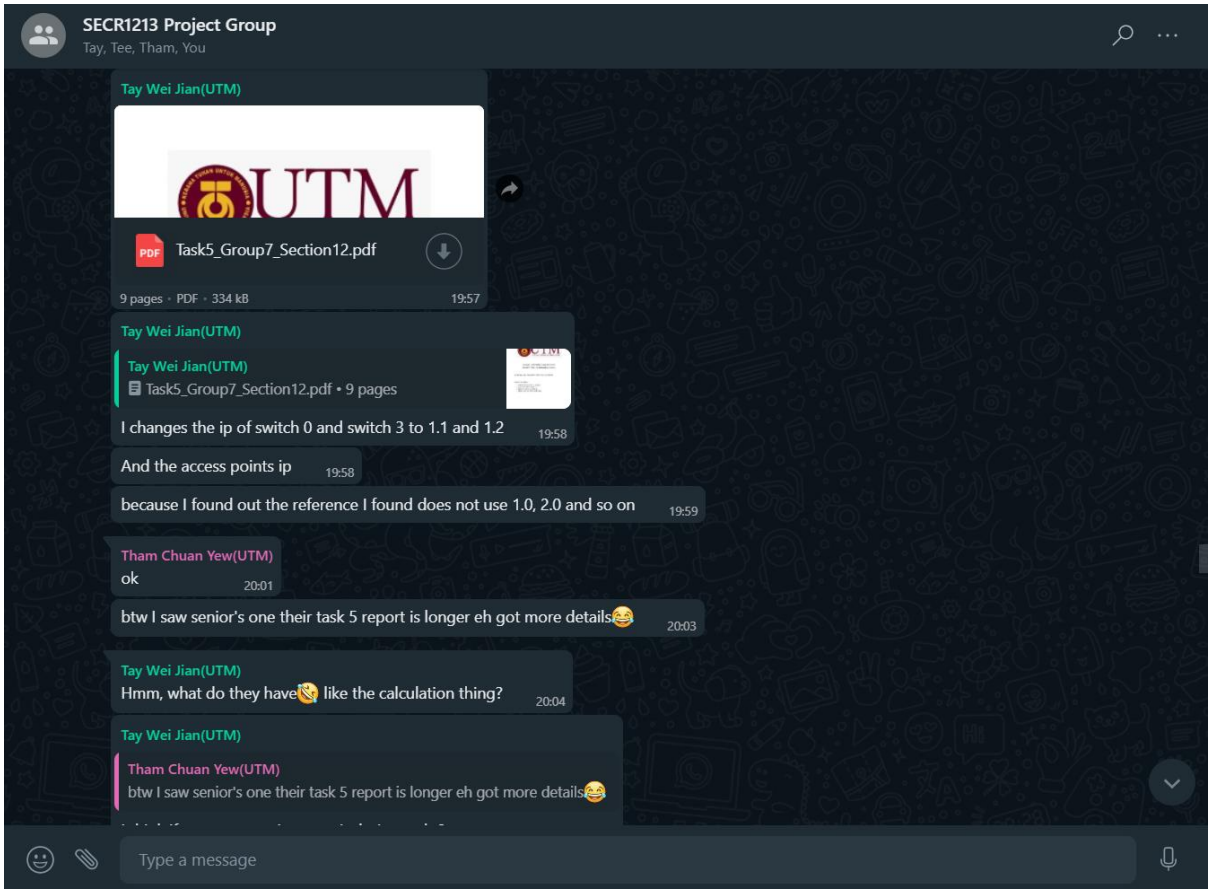


Figure 22: Group Discussion on Task 5

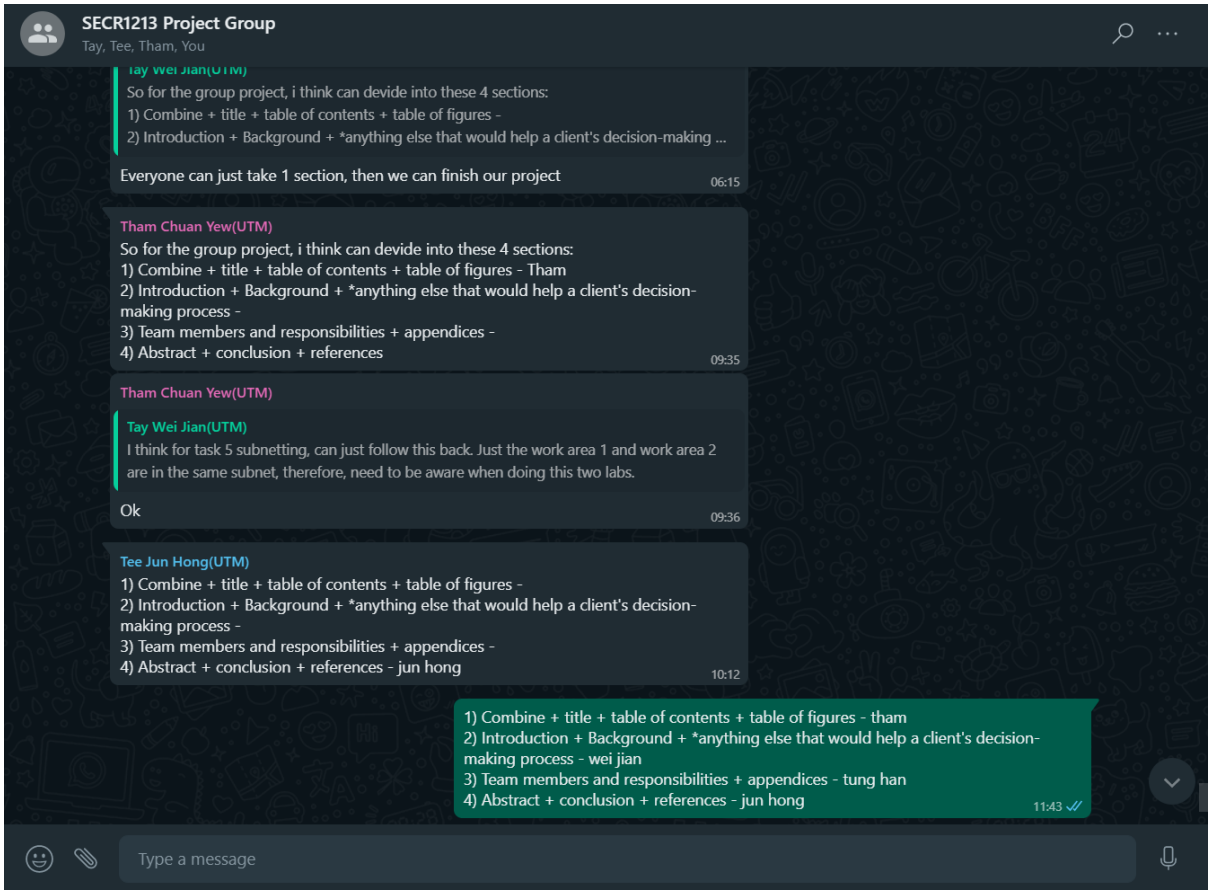


Figure 23: Group Discussion on Task 6

Thank You