UNIVERSITI TEKNOLOGI MALAYSIA, JOHOR BAHRU
SCHOOL OF COMPUTING,
SEMESTER 1, SESSION 2021/2022

SECR1213-02 NETWORK COMMUNICATION

GROUP PROJECT

NETWORK DESIGN FOR SCHOOL OF COMPUTING BLOCK N28B

BY GROUP M&N

NO.	NAME	MATRIC NUMBER
1	MADINA SURAYA BINTI ZHARIN	A20EC0203
2	NAYLI NABIHAH BINTI JASNI	A20EC0105
3	MADIHAH BINTI CHE ZABRI	A20EC0074
4	MAIZATUL AFRINA SAFIAH BINTI SAIFUL AZWAN	A20EC0204

ABSTRACT

The School of Computing (SC) in Universiti Teknologi Malaysia (UTM) analysed a 10% growth in both students and academic staff over the next three years. Therefore, SC intends to construct a new building to support this expansion. This new building is proposed to have two floors equipped with complete equipment in order to assure convenience to all students and staff. Besides, SC also expects this construction is a long term investment as they desire to move forward with cutting-edge technology without paying for it for the next 20 years.

As this building required to have four labs and two video conferencing rooms, thus the most crucial item that we as a network student need to consider is the network and connections between hardware and software. As a result, this project required us to ensure that all networking in the lab runs properly in order to meet the needs of the stakeholders. In addition, we also wish that the facilities provided in the building will ease their work and are always utilised by the students and staff.

To meet the elements that are proposed by SC to have an upgrade to their system that will allow them to utilise the elements that would help their business, therefore we need to provide a system that is manageable and scalable. This system needs to have a common workflow and good user experience, so that they will get used to it in a short time. Besides, we need to provide protection to avoid network breaches such as Internet Worms, denial-of-service (DoS) attacks and e-business application attacks.

Next, the overall performance also needs to be improved and capable to support high-performance to the core backbone. The system also must be able to support features such as Quality of Service and security in hardware via access control lists (ACLs) and can enable secure VPN connections from remote locations. Last but not least, we must also consider the system to have wireless connectivity and have a scalable network for future growth. To conclude, we need to do a lot of research and understand what we learn in the class to be able to apply it successfully in every task in this project.

TABLE OF CONTENT

TABLE OF FIGURES

INTRODUCTION

This project is about designing the network for School of Computing Block N28B. It aims to build a complete network from scratch by following divided tasks, from task 1 to task 6. The objective of this project is to let us get experience as it is almost like a real-life situation. Hence, it will give benefits to us especially in our future when applying for a job. Besides, this project taught us to explore more outside the class and to self study which is the skills that would be very helpful in our working-life.

Basically, this project is divided into six tasks. We are able to see the project outline since we are assigned to this project. However, we started each of the tasks right after we had learned the related topic and each of the tasks needed to be completed and submitted in a certain time. For task 1, we need to design a floor plan with 4 labs, 2 conferencing rooms and other basic facilities that a building should have. In this task, we used Autocad software to assist us doing the task online.

Then, task 2 required us to conduct preliminary analysis on current and future requirements. We need to analyse and list all the questions and answers, thus we need to elaborate the feasibility study from that analysis. For task 3, it required us to list our selected local area network (LAN) devices, its information and details. In this task, the hardware that we chose needs to be reasonable as we need to spend within the budget given. After that, we are required to make connections among the devices considering four physical areas in task 4.

In the next task, a network address is assigned to us by our lecturer, thus we are required to divide the subnetwork into a few equal subnets. Last but not least, we need to do documentation of this project, containing all of the tasks mentioned as our reference in the future.

PROJECT BACKGROUND AND AN OVERVIEW OF THE CLIENT'S CURRENT STATUS AND ISSUE

1981 was the starting point for the establishment of the Faculty of Computing (FC) when it was introduced as the Department of Computer Science, under the supervision of the Faculty of Science at UTM Gurney Road Kuala Lumpur. This department officially operated when they received the first batch or intake of students for the Computer Science Integration Programme. The department was renamed Institute of Computer Science in 1984, and divided into two which consists of Academic Unit and Administrative Computing Unit. The Institute was then separated from the Administrative Computing Unit and given the faculty status which makes it known as Faculty of Computer Science and Information Systems in 1991. In 1995, the faculty was moved to UTM Skudai, Johor due to certain reasons such as increasing in number of students and staff.

In this project, the client, School of Computing (SC), requires major upgrades on a new 2-storey building that is set to be built due to the high capacity of students as well as academic and supporting staff. The client also expected that there will be at least 10% growth of the number of students and staff for the next 3 years. To captivate this expected growth, SC planned to host 4 new labs with 2 video conferencing rooms in the new building. The new 4 labs consist of 1 general purpose lab, 1 Computer Security lab, 1 Network lab and 1 Internet of Things (IoT) lab and must be supplied with high-speed internet connection as preparation for the 4th Industrial Revolution (4IR) learning era. It is also important that this building should be economical, prepared for anything such as improvement in technologies and networks, as well as it is occupied with dependable, efficient and protected networks that are easy to be managed.
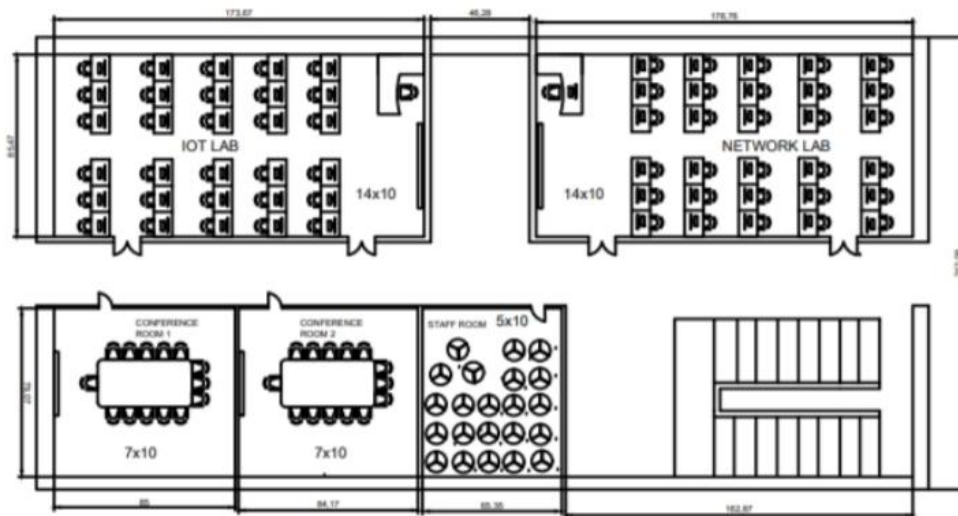
TASK 1

Project Setup

FLOOR PLAN
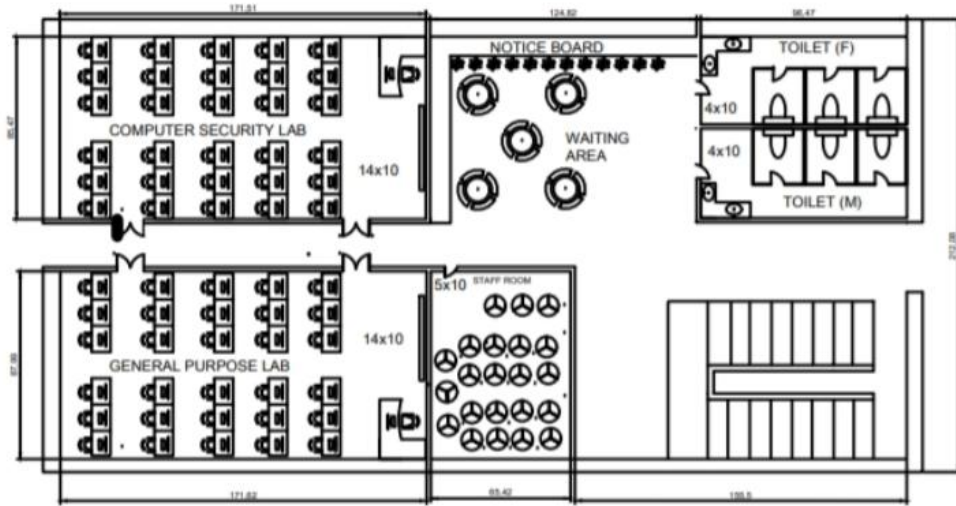
GROUND FLOOR

FIRST FLOOR

Figure 1: Floor Plan of the Building

Reflection on Task 1

Throughout this task, we had learnt how to design a floor plan as planning is important before we do something. Besides, we also learnt how to use Autocad, how to draw the shape in Autocad such as chairs. We also learnt the basic things that a building should have. In this task, we also need to determine the area of each workplace. After all, this task helps us to get a big picture about this project.

TASK 2

Initial Design - Preliminary Analysis

List of Questions and Answers

1. **Which access network do you want to use for this network plan?**

   The access network that needs to be used is '**Enterprise Access**'. Since this new 2-storey building needs to hold thousands of people under the School of Computing in an institution, end systems need to be connected to edge routers via Local Area Network (LAN). Ethernet is by far the most prevalent LAN access technology in large areas such as universities and companies..

2. **Which physical media do you want to use for this network plan?**

   We will use both, guided and unguided media.
   - Guided media or generally being called a **wired connection** is being used to access networks using ethernet cables. Ethernet connection provides greater reliability and security as it is fast. Generally, Ethernet could provide speeds as high as 10 Gbps and more. In terms of security, it is safer as data is being transferred physically by cable which is connected between devices. The cable, which is 'Twisted-Pair Copper Wire' is also not too expensive as it is commonly being used and usually, 'Unshielded Twisted Pair (UTP)' is the one.
   - Unguided media or generally being called as **wireless network** or WiFi is being used as it is convenient. Users could move freely from different workstations as it provides seamless access anywhere as long as the device is connected to the internet. Hence, transferring files could be easier.

3. **What is the best Internet Service Provider (ISP) that you want to use?**

   ™ Unifi is good broadband in Malaysia as it has the widest coverage in the entire country. It could also speeds of up to 800Mbps with no real bandwidth cap. Hence, the devices inside the building, students and staff could access the internet easily.

4. **Which operating system will you use for all laboratories?**

It depends on the types of equipments or computers used, there are 3 types well-known operating system such as:-

- Linux OS
- Microsoft Windows
- Apple OS X

Microsoft Windows, which is known as one of the popular options for others. Same goes for Linux, known as a free open source operating system that is usually used for a budget computer lab that we will use too.

5. **What devices are needed to build the network?**

We will use switches , routers

- Switches and Hubs
    - Used to connect all the computers in each lab in order to be able to communicate with each other. The switches which work on the data link layer will overcome the limitations of the hubs that work on the physical layer.
- Routers
    - Used for Internet connection and to connect to the switches.

6. **What should be done to prevent unauthorised devices in the network?**

There are a few ways to prevent this from happening. It can be listed as shown below:-

- Password Management as a protection barrier for the network from unauthorised devices. This can be powerful if it is regularly checked and updated as it would be harder for the unauthorised users to access the network.
- Use IEEE 802.1X to secure the network authentication. When using LAN ports in confidential areas, without IEEE 802.1X authentication, any device can gain access to the network. By using the IEEE 802.1X authentication, only verified users that are recognized by RADIUS Server can access the network.

7. What kind of network topology is used?

The network topology that will be used is star topology as all devices are connected to a central switch. With this star topology, it is easy to add/remove nodes without having to take the network offline and administer it as the entire network can be managed from one location. Besides, it provides a high speed of data transfer which is the crucial thing for students and the staff to be able to complete their work.

8. Type of network protocol that will be used?

For network protocol, there are 3 main types that need to be known which are network management protocol, network communication protocol and network security protocol.

- Network communication protocols
    - This protocol is essential for computer networks to function. It defines the regulations for transmission of datas, messages between computers, identification and error detection and others. Two most popular protocols are HTTP and TCP. HyperText Transfer Protocol (HTTP) allows the communication between browsers and servers. For TCP, it separates the data into packets that will be sent to other devices.

- Network management protocols
    - This protocol specifies the policies and steps which will be used to manage, maintain the computer network, and also help the needs to communicate across the network to make sure the communications are stable and the performances are optimal. One of the protocols is Simple Network Management Protocol (SNMP), which allows the administrator to view and monitor the network.

- Network security protocols
  - This protocol ensures the safety and security of data in transit across connections of networks. It also can protect data from unauthorised parties to inspect or extract the data, so all services or devices will be safe from unauthorised users. The protocol that we will use is Secure Hypertext Transfer Protocol (HTTPS) which is the secure version of HTTP. All of the data that is sent between the browsers and servers will be encrypted to ensure protection and safety.

9. **What are the compulsory softwares required in each lab?**

In general each lab needs to have documentation softwares, browsing softwares, pdf filing purposes software and basic coding software. These are the universal softwares that should be in each workstation in every lab.

- Documentation Softwares - Microsoft Office 2019 (includes Word, Powerpoint, Excel, and so on)
- Browsing Softwares - Google Chrome, Mozilla Firefox, Microsoft Edge
- Pdf Filing - Adobe Acrobat Reader DC
- Basic Coding Software - Dev-C++

For Network Computer Lab there is one additional software that should be included which is Wireshark.

Computer Security Lab should have CrypTool 2.0, Ophcrack 3.0, Wireshark and Google Gruyere Application (optional).

The Internet of Things (IoT) Lab should have more coding softwares from various languages. It can have Sublime Text, JavaScript, Python and more.

10. **What are the minimum hardware specifications for every workstation?**

- **Processor:** Intel Core i5/ i7 or higher
- **Operating System:** Windows 10, 64 bits
- **Memory:** 16 GB RAM
- **Storage:** 500 GB
- **Monitor/Display:** 14" LCD monitor or higher, resolution of 1600 x 900 or higher

11. **What is the antivirus software installed on each PC?**

TotalAV - Total Security

Feasibility Study

Today, technology has revolutionised our daily life, becoming easier and faster. As the Internet has become a necessity all over the world, therefore this paper proposed an overview of the requirements to develop a network plan for a new building that is about to be established in the School of Computing, UTM Skudai. The objectives of this project are to see whether it is possible for us to develop this project within the budget besides prioritising the security, scalability, information processing, integration and updates.

Security is the most crucial thing especially for large organisations like the School of Computing, so that their confidentiality can be ensured and their clients will be assured to use the service. The security that we plan to provide includes the installation of a trusted security application, thus it can prevent unauthorised users from accessing it. Besides, we also plan to use antivirus protection software to keep the PC's safe from any malware and online threats.

Next, we are aiming to have an improved way of processing all sorts of forms of information in the building suitable according to the use of the labs as well as the conference room. Information processing should be accurate and efficient since the target clients are expected to be in a large number as they might access the network at the same time simultaneously. In order to avoid any losing situation to the clients, the network should be able to recover, process, save and store all the information including all the text, audio, graphics and many more in any devices that are connected with the same network.

Every system and networking need to be maintained. Maintenance is an important key to an efficient and excellent network system. The maintenance should cover all components from the slightest to the biggest components because each one of them are related to each other. In order to avoid any network interruption, the maintenance is supposed to be performed once a year because the usability capacity is high all year long. The maintenance can include some updates if needed according to the newest specifications on that certain time. Maintenance can ensure the users that the network is reliable and can be functioning properly almost all the time.

Last but not least, the design of the building and the arrangement of each equipment also play an important role to build a new building especially for the School of Computing. As for computer laboratories, they must be thoughtfully designed, constructed and serve the reason for which they were created. The layout of a computer lab determines the effectiveness and enhances user's pleasure which justifies the lab's cost and aids in the future. Every design and layout has their own advantages and disadvantages. For example, traditional computer lab architecture gives a great exposure for the students since all of the students can easily take a look at the lecturer and the slides in front of them.
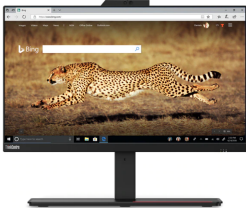
Reflection on Task 2

Throughout completing this task, we are able to analyse the requirements and other information that is necessary to develop a network plan based on the case study. After that, we had listed all the questions and their answers by researching those questions. Lastly, we are also to determine the feasibility of the project. After all, we had gained more knowledge regarding the requirements on our project after completing this task.

TASK 3

Choosing the Appropriate LAN Devices

LIST OF DEVICES

Type of devices	Usage	Description	Quantity	Price/unit (RM)	Total (RM)
PC Desktop: <u>ThinkCentre M90a AIO PC</u>	Used as a learning device for students in the lab	**Processor:** 10th Generation Intel® Core™ i5-10400 Processor (6 Cores / 12 Threads, 2.90 GHz, up to 4.30 GHz, 12 MB Cache, 65W, DDR4-2666) **Operating System:** Windows 11, 64 bits **Memory:** 16 GB SO-DIMM DDR4 2666MHz **Monitor/Display:** 23.8" up to FHD IPS Privacy Guard (1920 x 1080, 350 nits); Touchscreen available on other panels + Keyboard & Mouse +Microsoft Office Home and Student 2021	120	3586.99	430438.80
D-link 48-Port Gigabit + 4-Port SFP L2 Smart Switch (DGS-1210-52)	Used to connect all the computers in order to be able to communicate and share information with each other.	**Ethernet standard:** 10/100/1000 Base-T **Network cables:** -UTP Cat.5, Cat.5e, Cat.6 -EIA/TIA-568 100-ohm STP **Transmission method:** Store and forward **Full/Half duplex:** Full/half duplex for 10/100Mbps speeds Full duplex for Gigabit speed **Media Interface Exchange:** Auto MDI/MDIX adjustment for all twisted-pair ports +Support IEEE 802.1Q VLAN traffic segregation +Access Control List (ACL) feature to enhances network security	8	1929.00	15432.00

		+Auto Surveillance VLAN for easy integration with IP-based surveillance systems +Loopback detection (LBD) and broadcast storm control to avoid network downtime +Quality of Service (QOS) and bandwidth control to ensure smooth operation +Support Web-based GUI, Smart Console , Network Assistance Utility Cable diagnostics function to help troubleshooting wiring problem +featuring D-Link Green 3.0 technology. +allows more flexibility in power allocation for a variety of powered devices with affordable installation costs.			
Cisco ISR4331-SEC/K9 Enterprise Router	Used to improving internet connection	**Total onboard WAN or LAN 10/100/1000 ports:** 3 **Memory DDR3 ECC DRAM:** 4GB **Flash Memory:** 4GB **Aggregate Throughput:** 100Mbps-300Mbps	2	12091.44	24182.88
Dell PowerEdge R740 Rack Server (4214R, 16GB, 600GB, PERC H730P RAID Controller)	Used to store data and provide specification services for each lab	**Server Processor:** Intel Xeon Silver 4214R Processor - 2.4GHz, 16.5M Cache, 12 Cores - Max Turbo Frequency 3.5GHz **Server Memory:** 16GB RDIMM, 2666MT/s, Dual Rank **Server Storage:** 600GB 10K RPM SAS 12Gbps 512n 2.5in Hot-plug HDD **Server Optical Drive:** DVD+/-RW **Server Slots:-** - Front Ports: 1 x	4	15739.00	62956.00

		Dedicated iDRAC direct USB 2 x USB 2.0 1 x USB 3.0 (optional) 1 x VGA - Rear Ports: 1 x Dedicated iDRAC network port 1 x Serial 2 x USB 3.0 1 x VGA **Server Raid:** PERC H730P RAID Controller, 2Gb NV Cache			
Ubiquiti Networks UniFi nanoHD Access Point	Used to extending the wireless coverage of the existing network as well as increasing the number of users that can connect to it in one time	**WiFi Standard:** 802.11ac Wave 2 **Data Throughput:** 1733 Mb/s **MIMO:** 4x4 MIMO on the 5 GHz Band and 2x2 MIMO on the 2.4 GHz Band **Number of Gigabit Ethernet Port:** 1 **PoE Compliant:** 802.3af **WiFi Encryption:** WEP/WPA/WPA2	7	2228.42	15598.94
Fibre Optic Cable UniFi TIME Maxis Modem Router	Used to transmit light between the two ends of a fibre, they are widely used in fibre-optic communications, offering transmission over greater distances and at higher bandwidths	Connector: SC connector Work wavelength: 1310nm, 1550nm Fibre type: Singlemode (9/125) Application: ● Telecom and Datacom ● Storage Network ● CATV & Multimedia Application ● Systems integration for Long Haul, Metro and Access Network ● Fibre to the Indoor (FTTX) Test	8	63	504

	than electrical cables.				
Cat6 Snagless Unshielded (UTP) PVC CM Ethernet Network Patch Cable	Used to connect a computer to a router, a switch or hub for signal routing.	**Data Rate Support:** 1000Base-T and Maximum to 10GBase-T **Standard Bandwidth:** 250MHz **PoE Compatibility:** PoE/PoE+/PoE++ **Wire Scheme:** T568B, Straight **Operating Temperature:** -20 to +75°C (-4 to 167°F) **Installation Temperature:** -10 to +50°C (14 to 122°F) **Cable Jacket:** PVC CM (Round) **Length:** 35ft (10.7m) (Including Plugs) **Connectors:** RJ45(Male) **Conductor Type:** Stranded Pure Bare Copper **Gauge (AWG):** 24(7/0.20mm)	120	42	5040
Wall Faceplate 4 Ports Keystone RJ45 RJ11 Toolless CAT6 CAT7 Faceplate CAT5 CAT3 CAT8 Jack Four Port Malaysia	Used to protect the components of a device and to improve the device's design and look.	**Material:** ABS **Modular Type:** Keystone jack, Inline coupler	11	60	660
	Used to protect the network by	**Wireless Type:** 802.11a/b/g/n **Connectivity Technology:** Bluetooth	1	1860	1860

FORTINET FortiGate-60E / FG-60E Next Generation (NGFW) Firewall Appliance, 10 x GE RJ45 Ports	filtering traffic and blocking outsiders.	**Number of Ports:** 10 **Data Transfer Rate:** 150 Megabits Per Second			
RS PRO Cat5e 24 Port RJ45 RJ Patch Panel STP 1U Black	Used to to keep large numbers of cables organised	**LAN Category:** Cat5e **Number of Ports:** 24 **Interface Type:** RJ45 **Shield Type:** STP **Rack Height:** 1U **Height:** 44.45mm **Width:** 483mm **Depth:** 115mm **Colour:** Black	6	387.24	2323.44
TOTAL					RM 558966.06

REFLECTION

Are you surprised by the prices?

Surely at first we were startled by the prices of these devices as the figures could turn up to tens of thousand for some devices when we did the research on these devices. Before we did the research, we expected that the figures would only turn to a couple of thousands and never thought that it would cost more than that for some devices. This shows that before we did the research, we were not particularly acknowledged how much does it cost to have these LAN devices. However, these situations where these devices cost us more than we expected are very common when we continue to do some deeper research on them.

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

Yes, it is because cost is one of the most important elements when choosing network equipment to install in a new building. The entire cost of the devices we purchased is RM 558966.06, which is quite pricey but we managed to work within the budget which is less than 1.5M. We think the total cost is well worth it considering that we would be using them for a long time. Fortinet, HUAWEI, Dell, and D-Link are among the most commonly used brands, and they all represent a better quality. As a result, we could guarantee that the client might not have to spend anything more for the next 10 to 20 years.

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

The major difference between the same devices from different brands are the popularity and the rating of the product. Devices or products that are produced by big companies or well-known brands are easy to gain more popularity no matter how high the quality of the products are. Thus, the rating and reviews of the products or devices from those brands are high due to many buyers and users.

Reflection on Task 3

While working on this task, there are actually many things to pay attention to, especially quality of the devices and prices. Each device has their own usage and specifications which leads to advantages and disadvantages of the devices. Expensive products do not guarantee the best quality to the users and meet the users' requirements. This is because the majority of the devices can be found at an affordable price with the best quality. Other than that, since there is a budget given for this project, we need to evaluate and spend money on the devices wisely. Even though there are many models and types, we must choose the best that is suitable and compatible with our requirements.
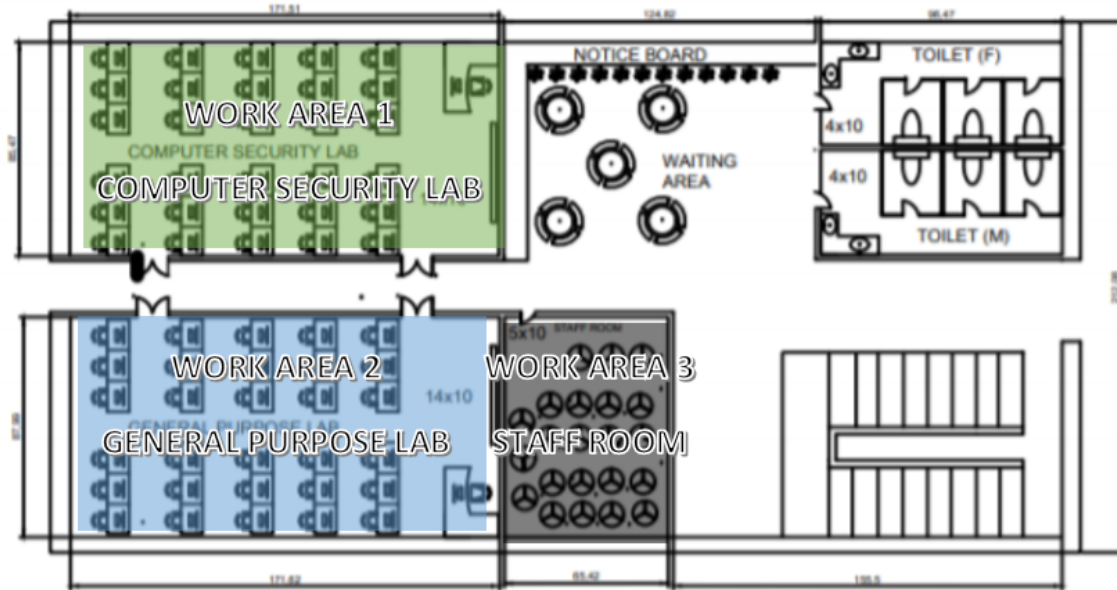
TASK 4

Making the Connections - LAN and WAN

These are the indicators that we will be using throughout the task

	PC	Rack server
	Router	Access point
	Switch	Firewall appliance
	Patch Panel	
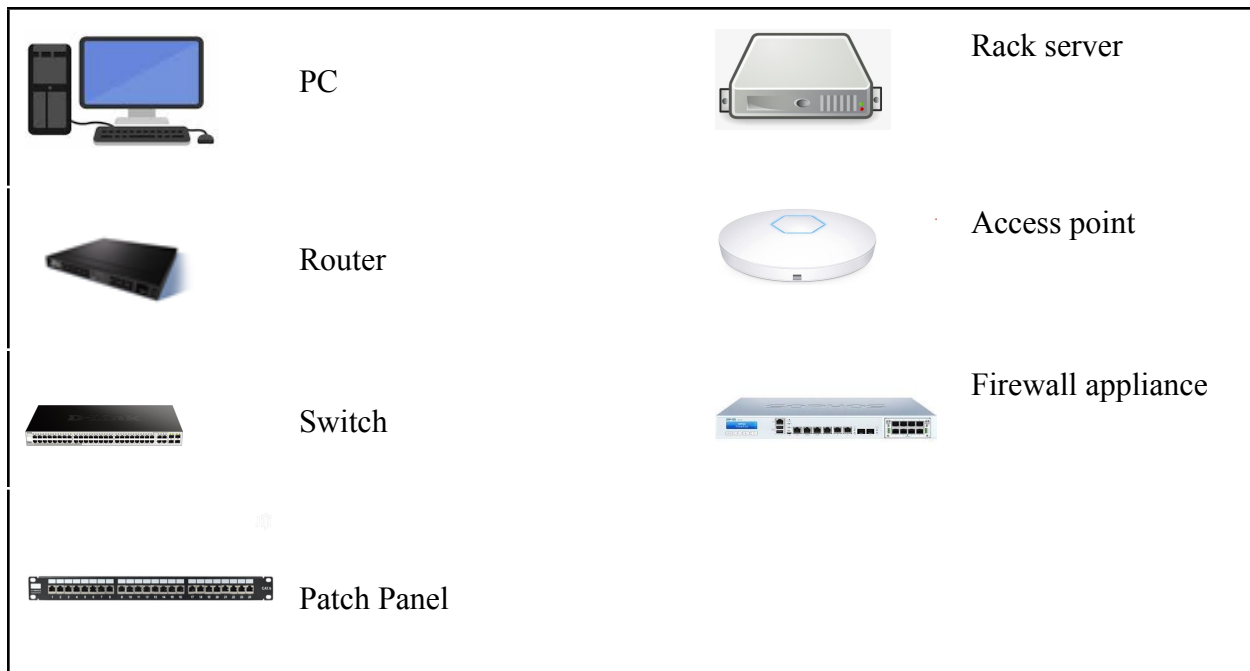
Identification of the Work Areas

GROUND FLOOR

Figure 2: Work Area Ground Floor

FIRST FLOOR

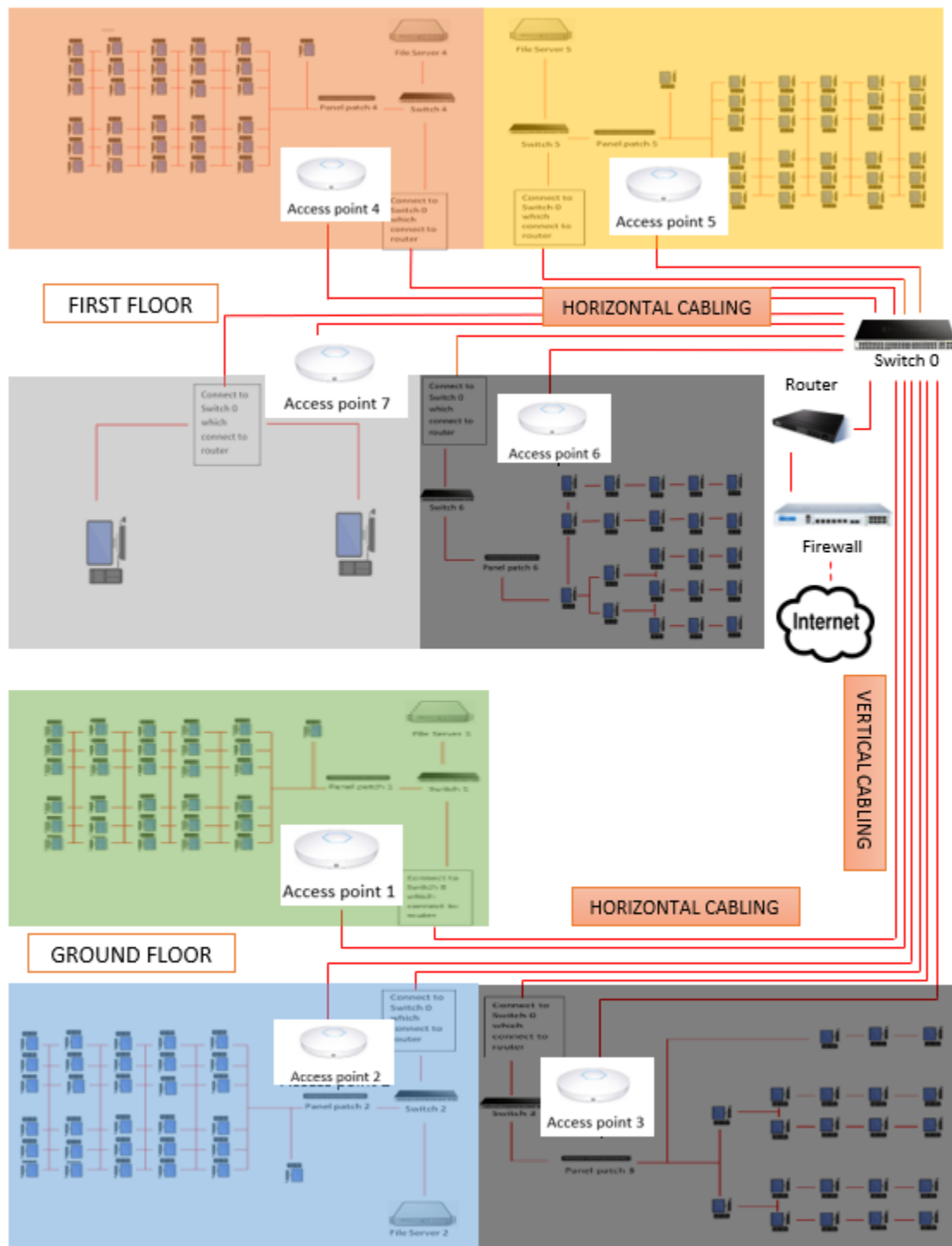Figure 3: Work Area First Floor

Overall Network Diagram
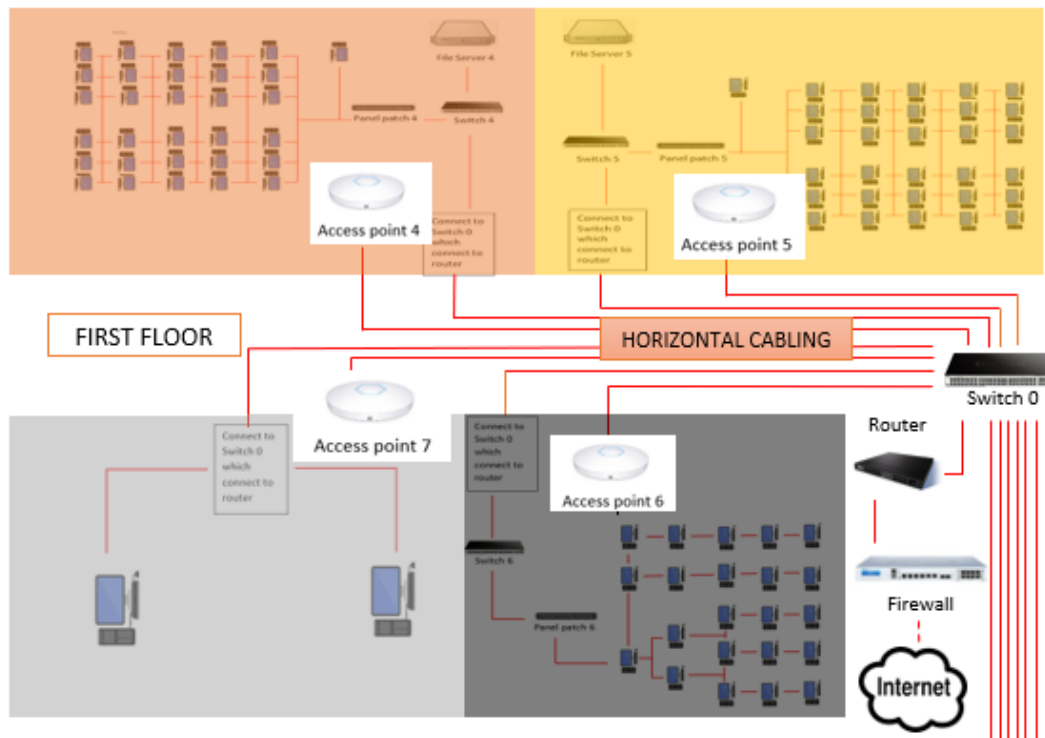

Figure 4: Overall Network Cable Connection

Closed-up Network Diagram
First Floor
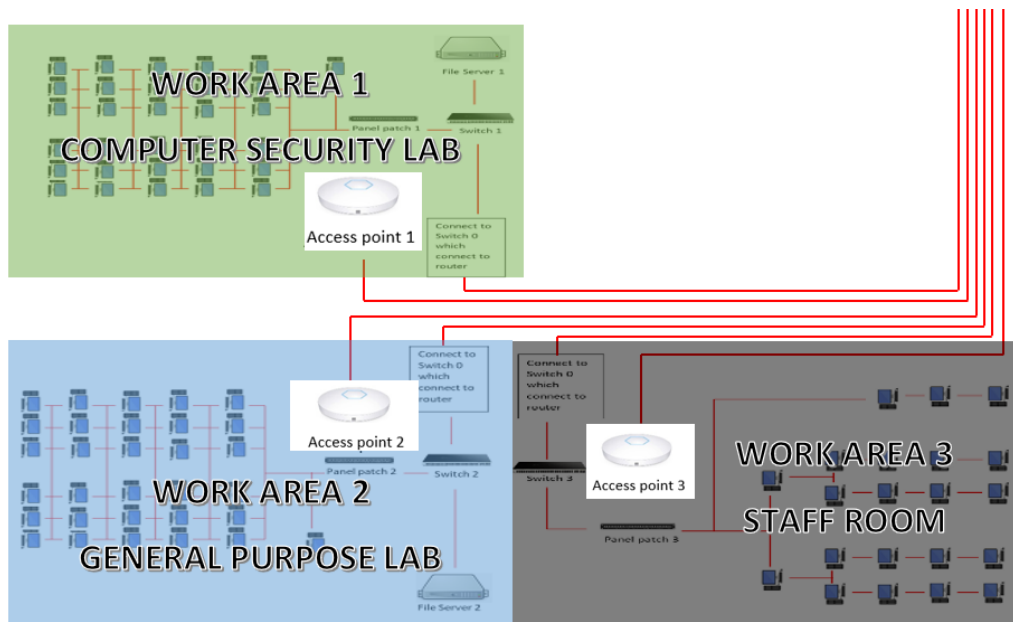

Figure 5: Closed-up Network Connection on First Floor

Ground Floor

Figure 6: Closed-up Network Connection on Ground Floor

Network Distribution

Ground Floor
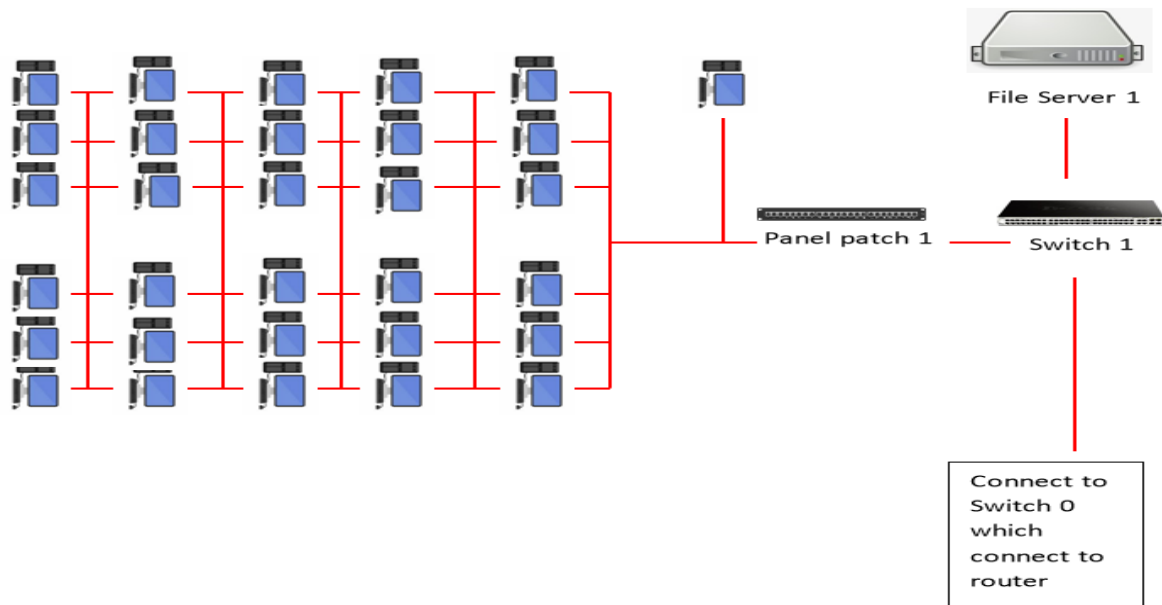
Work Area 1 - Computer Security Lab

Figure 7: Computer Security Lab Network Distribution

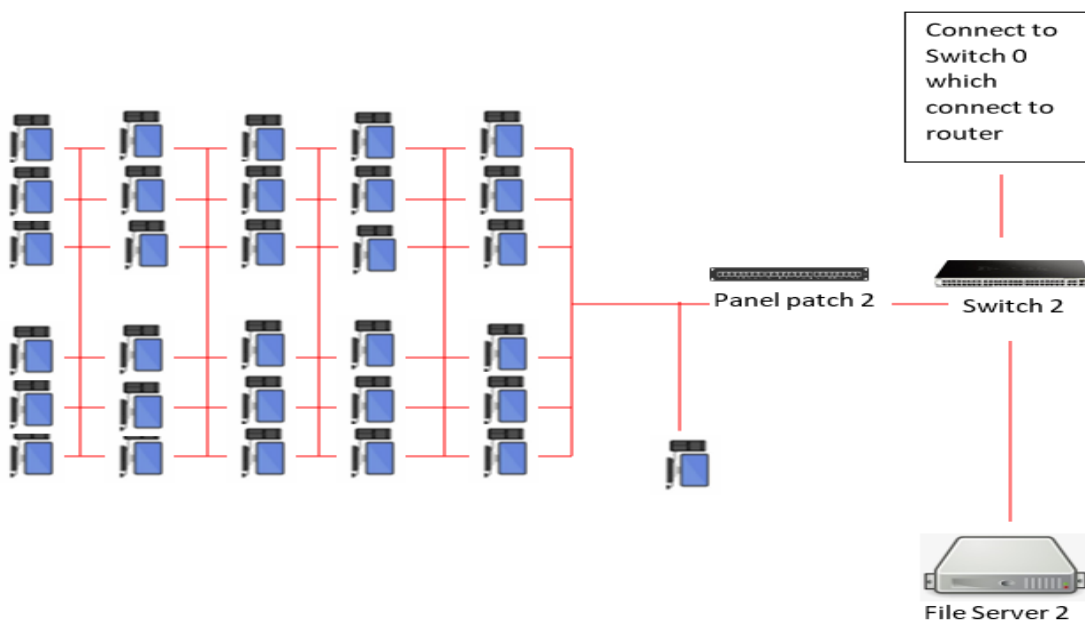Work Area 2 - General Purpose Lab

Figure 8: General Purpose Lab Network Distribution
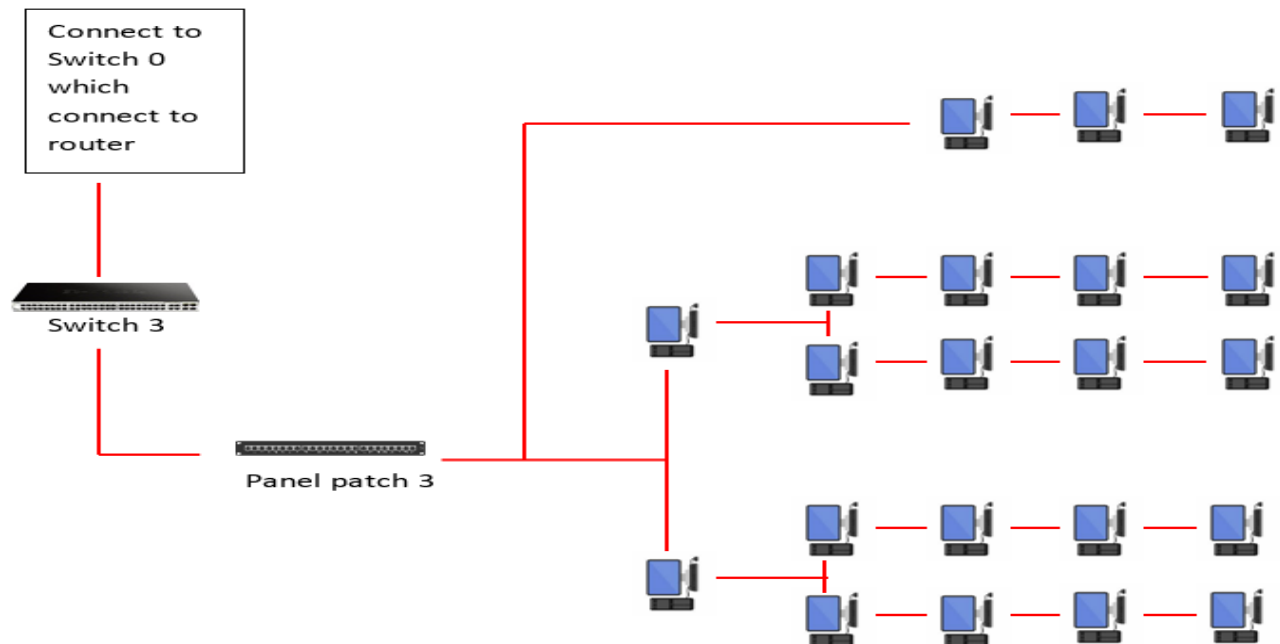
Work Area 3 - Staff Room

Figure 9: Staff Room Network Distribution (Ground Floor)

First Floor
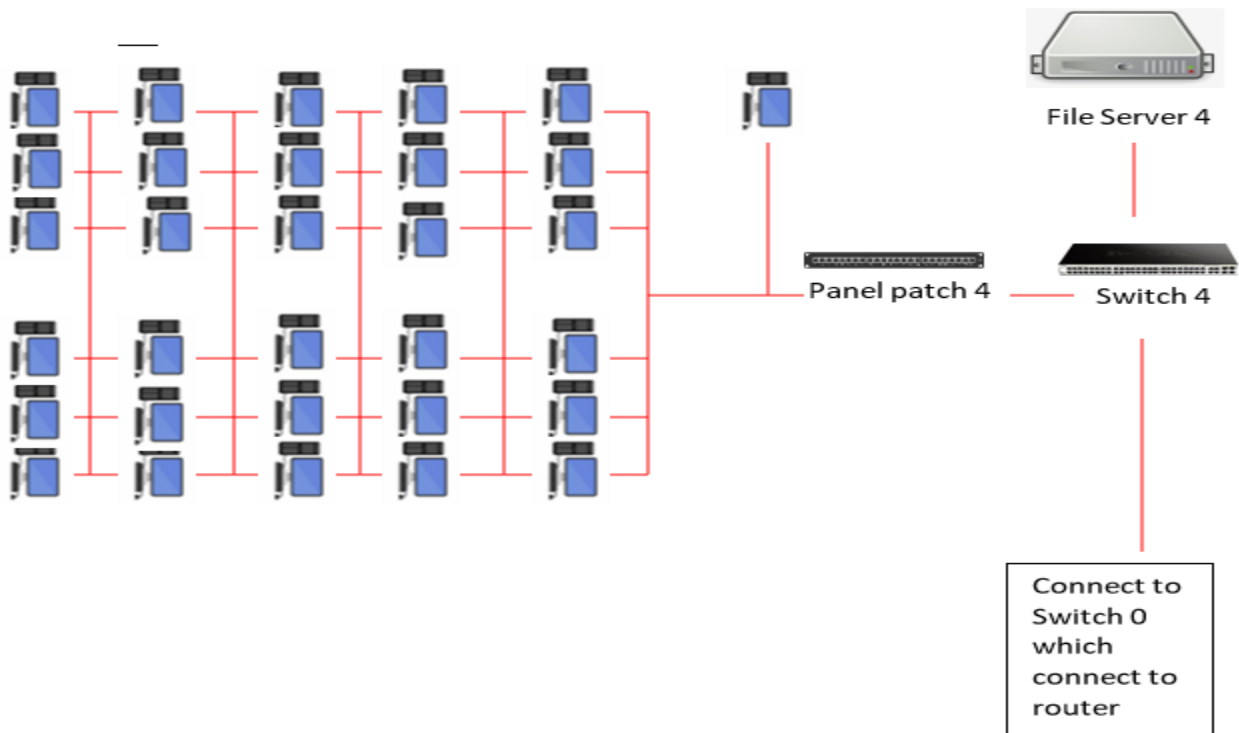
Work Area 4 - IOT Lab

Figure 10: IOT Lab Network Distribution

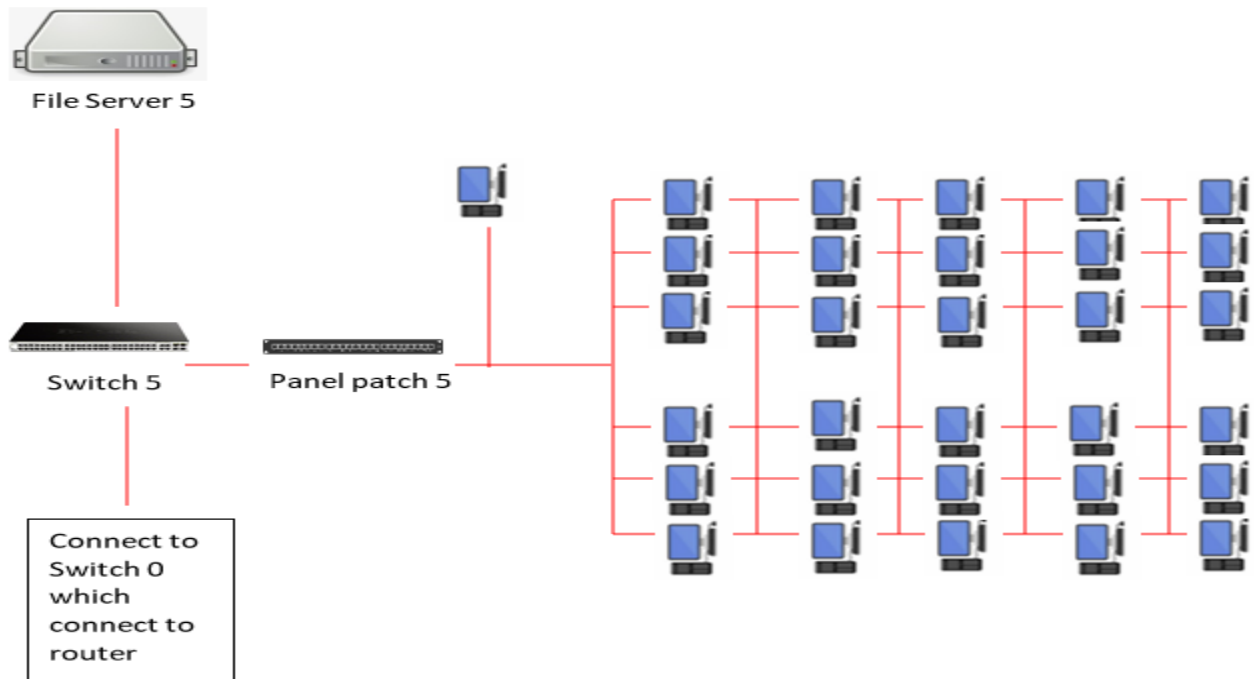Work Area 5 - Network Lab

Figure 11: Network Lab Network Distribution

Work Area 6 - Staff Room
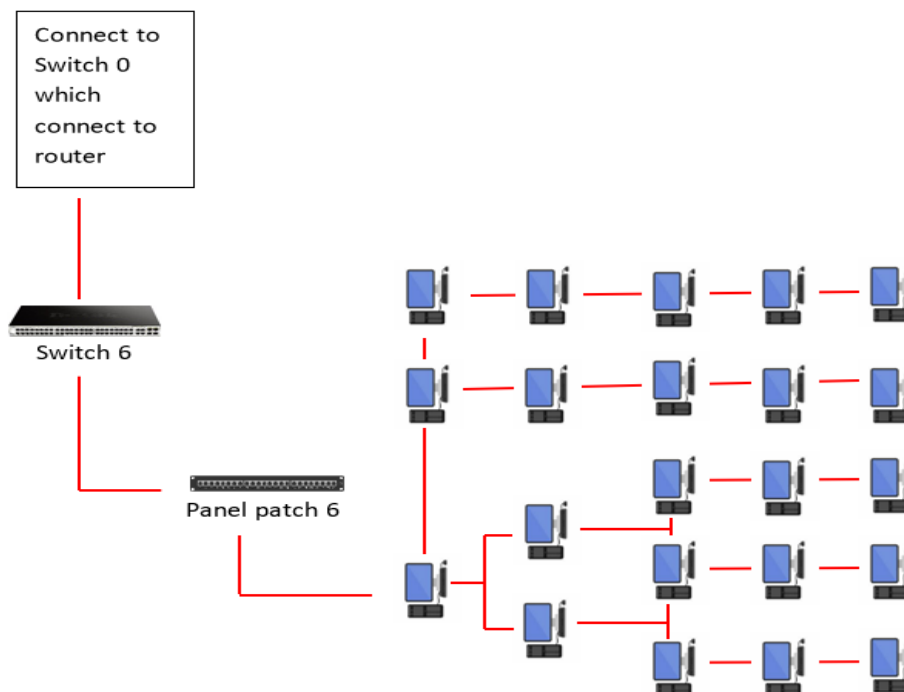
Figure 12: Staff Room Network Distribution (First Floor)
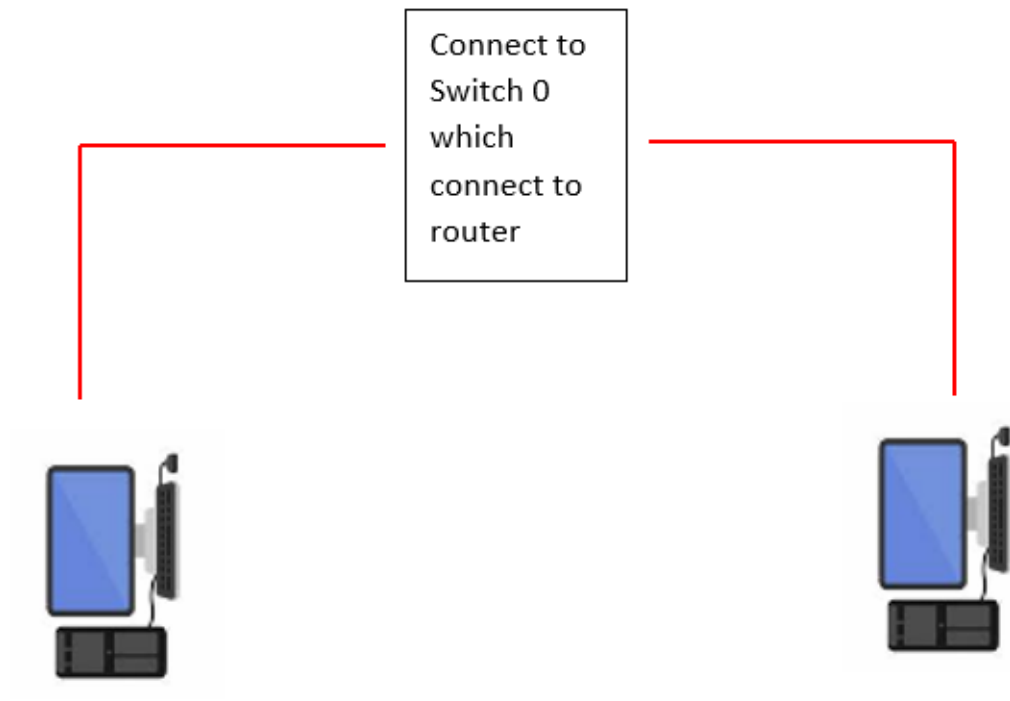
Work Area 7 - Video Conference Room

Connect to
Switch 0
which
connect to
router

Figure 13: Video Conference Room Network Distribution

Cables & Connections

GROUND FLOOR

FIRST FLOOR

Figure 14: Cables and Connections

Cable lengths

According to the planning the types of cables that are going to be used are Cat 6 cable and fibre optic cable. As shown in the figures above, both cables are applied in all of the floors. These cables are installed all over the building's labs in order to connect the servers.

Description	Cable type	Length(m)
Ground Floor		
General Purpose Lab	Cat 6 Cable	90.8
Computer Security Lab	Cat 6 Cable	90.8
Staff Room	Cat 6 Cable	58.0
Corridors/Walking Areas	Cat 6 Cable	3.0
Peripheral Connections(Switches, routers, patch panels, servers)	Cat 6 Cable	300.0
Total Length-Ground Floor		542.6
1st Floor		
IOT Lab	Cat 6 Cable	90.8
Network Lab	Cat 6 Cable	90.8
Conference Room 1	Cat 6 Cable	4.0
Conference Room 2	Cat 6 Cable	4.0
Staff Room	Cat 6 Cable	58.0
Corridors/Walking Areas	Cat 6 Cable	61.3
Peripheral Connections(Switches, routers, patch panels, servers)	Cat 6 Cable	340.0
Total Length- 1st Floor (m)		648.9
Total Length (horizontal/distribution cabling) - All Floor		1191.5

Fibre Optic cable	Fibre Optic cable	100.0
Total Length (vertical/backbone cabling) - All Floor		100.0
Total Length of All Used Cable		1291.5

Description	Quantity	Total Ports
Switch	7	336

The total length of cables used on the overall floor plan are 1291.5 metres while the number of ports used by switches are 336 ports.

The patch cable also known as patch cord is used to link up the switch or router to peripheral devices such as computers and printers. It can also be used as Ethernet cable. Usually, patch cables use Cat 6 cable as it is a more standardised twisted pair cable.

The switch ports are layer-2 only interfaces associated with a physical port. Switch ports are used to manage physical interfaces and associated Layer 2 protocols. Based on this network, each of the switches use 48 ports, thus 7 switches will require 336 ports.

Identifying Cable Lengths & Type

Cat 6 Cable

Cat 6 is a short term of category 6, which defined only a few years after Cat5e cables. For horizontal cabling, we have chosen Cat 6 cables as it can support Gigabit Ethernet segments up to 100m just like Cat 5e cables, however Cat6 cables also allow for use in 10-Gigabit networks over a limited distance. Besides, Cat 6 can handle speeds up to 1000 Mbps (1Gbps), which is more than enough for the common speed of most internet connections. As they are designed for operating frequencies up to 250 MHz, therefore we are sure that they can process more data. Furthermore, Cat 6 cables provide speeds up to 10GBASE-T as they perform up to 250MHz.

Fibre Optic Cable

Fibre optic cable is an advanced type of network connection that provides much better bandwidth and data transmission than previous metal conductor versions. It contains strands of glass fibres in the insulated container. They are made for long distance, high performance data networking and telecommunications applications. Fibre optic lines have a higher bandwidth than conventional cables and it also can carry data across longer distances. There are a few services that are supported by fibre optic connections such as Internet, television's cables, medical applications, LED lighting and others.

Wireless

A wireless network allows devices to stay connected to the network while roaming without the need for cords. It provides a lot of flexibility, which means they can be set up quickly. Wireless networks connect users to an existing network using a variety of stations. For example, a computer can be far away from a router and still be connected to the network.

Reflection on Task 4

In this task, we are required to make a physical connection between all devices that have been chosen in task 3 into a place. There are some important things that need to be considered such as how many rooms needed, how much cabling needed and how to connect all devices from each floor into one. Other than that, we also need to choose the best type of media or wiring needed to make sure the best connection could be done between all devices considering the device's own capabilities and limitations.

Since we can't really see or imagine how certain devices are interconnected in the faculty lab, we do some research and try to implement it into this task. We have found that in order to connect all devices from each floor, we need to have a main switch where all access points from each room / lab are interconnected. After that, the switch will be connected with the router, firewalls, and also internet. Since the capacity needed for each room is a lot, we also need to have a proper planning by also considering the amount, type, or length of cables needed.

Therefore, we get to learn how to organize devices and cables according to our floor plan and budget. Budgeting is the most crucial thing when dealing with clients. Thus, this task / project gives us an early and better approach for future use.

TASK 5

IP Addressing Scheme

IP Subnetting

Based on the network address that has been assigned for our group, which is, 161.139.60.0/19, in this part, we are going to divide it into several subnetworks for each room and space.

We are going to use IP address 161.139.60.0 with subnet mask 255.255.224.0 or /19.

IP address(Decimal):	161.	139.	60.	0
IP address (Binary):	10100001	10001011	00111100	00000000
Subnet Mask (Decimal):	255.	255.	224.	0
Subnet Mask (Binary):	11111111	11111111	11100000	00000000

1. The IP address will be divided into the network portion indicated by subnet mask which is, /19, and the host portion is determined by the remaining bits.

   Network portion: 19 bits
   Host portion: 32 bits - 19 bits = 13 bits

2. Subnet IP Address is calculated by performing a bitwise AND operation on the host IP address and subnet mask. AND operation works as shown below:

   $1 + 1 = 1$
   $1 + 0 = 0$
   $0 + 1 = 0$
   $0 + 0 = 0$

IP address (Decimal):	161.	139.	60.	0
IP address (Binary):	10100001	10001011	00111100	00000000
Subnet mask (Binary):	11111111	11111111	11100000	00000000
Subnet address (Binary):	10100001	10001011	00100000	00000000
Subnet address (Decimal):	161.	139.	32.	0

   Subnet Address: 161.139.32.0/19

3. We will use class B address, which borrows 3 bits from the host for subnetting and we will reserve 10 bits for defining hosts.

IP Address	Network portion (19 bits)	Subnet (3 bits)	Host portion (10 bits)
Subnet address 161.139.32.0/19	10100001 10001011 001	000	00 00000000
Subnet 0 161.139.32.0/22	10100001 10001011 001	000	00 00000000
Subnet 1 161.139.36.0/22	10100001 10001011 001	001	00 00000000
Subnet 2 161.139.40.0/22	10100001 10001011 001	010	00 00000000
Subnet 3 161.139.44.0/22	10100001 10001011 001	011	00 00000000
Subnet 4 161.139.48.0/22	10100001 10001011 001	100	00 00000000
Subnet 5 161.139.52.0/22	10100001 10001011 001	101	00 00000000
Subnet 6 161.139.56.0/22	10100001 10001011 001	110	00 00000000
Subnet 7 161.139.60.0/22	10100001 10001011 001	111	00 00000000

4. Set the remaining host portion (10 bits) as all zero(0) to get network address

    10100001.1000 1011.001[000 | 00 00000000]

    Network address of Subnet 0: 161.139.32.0

    Set the remaining host portion (10 bits) as all one(1) to get broadcast address

    10100001.1000 1011.001[000 | 11 11111111]

    Broadcast address of Subnet 0: 161.139.35.255

Subnet IP Address	Network Portion (19 bits)	Subnet (3 bits)	Host Portion (10 bits)		IP Address
Subnet Address 161.139.32.0/19	10100001 1000 1011 001	000	00 00000000		
Subnet 0 161.139.32.0/22	10100001 1000 1011 001	000	00 00000000	**Network Address**	161.139.32.0
			11 11111111	**Broadcast Address**	161.139.35.255
Subnet 1 161.139.36.0/22	10100001 1000 1011 001	001	00 00000000	**Network Address**	161.139.36.0
			11 11111111	**Broadcast Address**	161.139.39.255
Subnet 2 161.139.40.0/22	10100001 1000 1011 001	010	00 00000000	**Network Address**	161.139.40.0
			11 11111111	**Broadcast Address**	161.139.43.255
Subnet 3 161.139.44.0/22	10100001 1000 1011 001	011	00 00000000	**Network Address**	161.139.44.0
			11 11111111	**Broadcast Address**	161.139.47.255
Subnet 4 161.139.48.0/22	10100001 1000 1011 001	100	00 00000000	**Network Address**	161.139.48.0
			11 11111111	**Broadcast Address**	161.139.51.255

			00 00000000	**Network Address**	161.139.52.0
Subnet 5 161.139.52.0/22	10100001 1000 1011 001	101	11 11111111	**Broadcast Address**	161.139.55.255
Subnet 6 161.139.56.0/22	10100001 1000 1011 001	110	00 00000000	**Network Address**	161.139.56.0
			11 11111111	**Broadcast Address**	161.139.59.255
Subnet 7 161.139.60.0/22	10100001 1000 1011 001	111	00 00000000	**Network Address**	161.139.60.0
			11 11111111	**Broadcast Address**	161.139.63.255

IP Assignation

Subnet addresses are assigned according to 8 areas in the building. There are 4 switches and 1 router on the first floor and 3 switches on the ground floor.

Subnet	Interface	Network Address	Broadcast Address	Range of usable address	Subnet mask
0	**First Floor** Switch 4 (IOT Lab)	161.139.32.0/22	161.139.35.255	161.139.32.1 to 161.139.35.254	/22 255.255.252.0
1	**First Floor** Switch 5 (Network Lab)	161.139.36.0/22	161.139.39.255	161.139.36.1 to 161.139.39.254	/22 255.255.252.0
2	**First Floor** Switch 6 (Staff Room)	161.139.40.0/22	161.139.43.255	161.139.40.1 to 161.139.43.254	/22 255.255.252.0
3	**First Floor** Switch 0 (WAP for north and south)	161.139.44.0/22	161.139.47.255	161.139.44.1 to 161.139.47.254	/22 255.255.252.0
4	**First Floor** Router (For north and south)	161.139.48.0/22	161.139.51.255	161.139.48.1 to 161.139.51.254	/22 255.255.252.0
5	**Ground Floor** Switch 1 (Computer Security Lab)	161.139.52.0/22	161.139.55.255	161.139.52.1 to 161.139.55.254	/22 255.255.252.0
6	**Ground Floor** Switch 2 (Computer Security Lab)	161.139.56.0/22	161.139.59.255	161.139.56.1 to 161.139.59.254	/22 255.255.252.0
7	**Ground Floor** Switch 3 (Staff Room)	161.139.60.0/22	161.139.63.255	161.139.60.1 to 161.139.63.254	/22 255.255.252.0

Reflection on Task 5

Throughout this task, we gain new knowledge on the IP addressing scheme which is an identifier to locate a device on the IP network. The identifier is a unique address which allows the users and applications to identify specific hosts with which to communicate after we distribute the address. To get a clear idea on how IP distribution works, we can use a software called Cisco Packet Tracer where it can simulate to us how it works.

TEAM MEMBERS AND RESPONSIBILITY

Name	Responsibility according to task
Madina Suraya Binti Zharin	**Task 1**: Design a floor plan using collaboration in autocad.
	Task 2: Decide the best access network, physical media and internet service providers (ISP) needed for network plan.
	Task 3: Find the best router, access point, ethernet cable and firewall.
	Task 4: - Identifying work areas - Design overall and closed-up network diagram - Design network connection for each floor
	Task 5: IP assignation for every area in the buildings
	Task 6: - Reflection task 4 - Appendices / Meeting minute
Madihah binti Che Zabri	**Task 1**: Design a floor plan using collaboration in autocad.
	Task 2: - Question 5,7 and 11 - Feasibility study paragraph 1 and 2.
	Task 3: PC Desktop, switch and router.
	Task 4: - Cable length description - Explanation Cat 6 Cable.
	Task 5: IP Subnetting question number 3.
	Task 6: - Abstract

	- Introduction - Compilation - Reflection task 1 and 2.
Maizatul Afrina Safiah Binti Saiful Azwan	**Task 1:** Design a floor plan using collaboration in autocad.
	Task 2: - Questions 4, 8 and 10 - Last paragraph of Feasibility Study
	Task 3: - Description of Patch Panel - Reflection and explanation on same devices but different brands
	Task 4: - Calculate cable length used all over the building's labs - Explanation on Fibre Optic Cable - Explanation on Wireless
	Task 5: IP Subnetting question no. 4
	Task 6: - Reflection for task 3 - Reflection for task 5 - - References
Nayli Nabihah Binti Jasni	**Task 1:** Design a floor plan using collaboration in autocad.
	Task 2: - Question 6 and 9 - Feasibility study paragraph 3 and 4
	Task 3: - Find an enterprise router, rack server and survey the best access point. - Reflection first question
	Task 4: - All cables and connections from the floor plan - Determine some of the length of cables
	Task 5: IP subnetting question 1 and 2

	Task 6: - Project Background and an Overview of the Client's Current Status and Issue - Conclusion

CONCLUSION

Based on every task that we have done throughout this project, we can summarise that we have planned the most appropriate, comfortable, convenient labs and conference rooms for the building. Considering the area of each lab and room, we had provided the most suitable floor plan for all of the requirements stated by the client. As for the process of choosing the appropriate network devices, we can say that we had done quite decent surveys on the devices based on its functionality, costs and specifications. We picked the most efficient considering all of these aspects as long as it is under our budget and does not relegate the quality. We also managed to determine the subnet addresses from the given IP address without any conflict for all the labs and conference rooms.

The strong point that can be outlined based on our floor plan for this project is that every lab is comfortable to be working at and the wirings are also well-planned since it is spacious. Every workstation is occupied with their own PC makes it more cosy and enjoyable to perform work on it. The arrangement on the conference rooms is specially made for the suitability for the purpose of online video conferencing events. The tables used in the conference rooms are selected significantly for the intention to ease the discussion process. The wiring in this building is drawn that way so that it is easier to be repaired and maintained at any time.

The flaw that can be pointed out from our floor plan is that the staff room is not revised in detail. As it can be seen, the staff room is compact as it has too many tables and can be too tight as each table has 3 workstations. Other than that, based on our experience on doing this project, the biggest challenge that we had to face is that we cannot do any face-to-face discussions with our team members since we are not together in one place. However, we still managed to complete this project with satisfaction as we always communicate with each other to help ourselves and with some guidance from our lecturer.

REFERENCES

ComputerNetworkingNotes (2018, January 19). *Computer Networking Devices Explained with Function*. ComputerNetworkingNotes. Retrieved November 17, 2021, from

https://www.computernetworkingnotes.com/networking-tutorials/computer-networking-devices-explained-with-function.html

D-LINK 48 PORT GIGABIT + 4 PORT SFP L2 SMART SWITCH (DGS-1210-52). Shopee.com.my. (2021). Retrieved December 13, 2021, from https://shopee.com.my/amp/D-LINK-48-PORT-GIGABIT-4-PORT-SFP-L2-SMART-SWITCH-(DGS-1210-52)-i.44569675.1288055035

Enterprise Router. router-switch.com (n.d.). Retrieved December 16, 2021, from https://www.router-switch.com/cisco-isr4331-sec-k9-p-23213.html?utm_source=product_pdf&utm_medium=links&utm_campaign=pdf

Enterprise, S. (2019, March 23). *What is the difference between a WIFI and ethernet connection?* Spectrum Enterprise. Retrieved November 17, 2021, from https://enterprise.spectrum.com/support/faq/network/what-is-the-difference-between-wifi-and-ethernet-connection.html.

Faceplate. Lazada.com.my. (n.d.). Retrieved December 15, 2021, from https://www.lazada.com.my/products/schneider-cat6-network-faceplate-i1931230383-s7771558341.html?exlaz=d_1%3Amm_150050845_51350205_2010350205%3A%3A12%3A12288259352%2112041O246831%21%21%21pla-299902682079%21c%21299902682079%217771558341%21338205015&gclid=Cj0KCQiAweaNBhDEARIsAJ5hwbcJl0JEKMjFp7RpJPSatS8Hu1CgXs6o4cJkiQvZn0bkdGQTlMjl4MEaAmReEALw_wcB

Fiber Optic Cable. Lazada.com.my. (n.d.). Retrieved December 15, 2021, from https://www.lazada.com.my/products/3m-5m-10m-20m-30m-50m-sc-sc-fiber-optic-cable-unifi-time-maxis-modem-router-i435095719.html

Firewall. Malaysia. (n.d.). Retrieved December 15, 2021, from https://www.ubuy.com.my/en/catalog/product/view/id/3715623/s/fortinet-fortigate-60e-fg-60e-next-generation-ngfw-firewall-appliance-10-x-ge-rj45-ports?gclid=CjwKCAiA-9uNBhBTEiwAN3IlNElsBES00ek8FgPReYXej55tHG3dWIzA1sGRAkF_fyWmNPEqTKtiehoC0gUQAvD_BwE

Fs. (n.d.). *7ft cat6 snagless unshielded ethernet patch cable, blue*. FS Singapore. Retrieved December 15, 2021, from https://www.fs.com/sg/products/70619.html

Garger, J. (n.d.). *The Four Best Computer Laboratory Layouts for Schools*. Bright Hub.
https://www.oerafrica.org/FTPFolder/guyana/Guyana/Guyana/resources/KD/KD%20M04U01%
20Docs/Computer%20Laboratory%20Layouts%20for%20Schools.htm

Introduction to Wireless Networking. (n.d.). *Engineering Education (EngEd) Program | Section*.
Available at: https://www.section.io/engineering-education/introduction-to-wireless-networking/

John (2020). *Ethernet Switch Port Types: What Are They?* Available at:

https://community.fs.com/blog/ethernet-switch-port-types-overview.html

Linksys Official Support - The two types of dual-band routers. Linksys. (n.d.). Retrieved
December 13, 2021, from https://www.linksys.com/ca/support-article?articleNum=138078

Pramatarov, M. (2018, November 8). *Hub vs. switch. What should you use for your network?*

ClouDNS Blog. Retrieved November 17, 2021, from

https://www.cloudns.net/blog/hub-vs-switch-lan-network/

*Recommended & Minimum Computer Configurations for Students (Windows) | UMass Amherst
Information Technology | UMass Amherst*. (n.d.). UMassAmherst.
https://www.umass.edu/it/support/hardware/recommended-minimum-computer-configurations-w
indows

Rack Server. Techhypermart.com. (n.d.). Retrieve December 14, 2021, from
https://www.techhypermart.com/dell-poweredge-r740-rack-server-4214r-16gb-600gb-perc-h730
p-raid-controller

Richardson, S. (2021). *Different Types of Switch Ports - CCIE*. Cisco Certified Expert. Available

at: https://www.ccexpert.us/ccie-2/different-types-of-switch-ports.html

Shim, T. (2019, December 13). *TM Unifi Review: 6 Pros & 4 Cons of TM Unifi Fibre
Broadband*. Bitcatcha. Retrieved November 17, 2021, from
https://www.bitcatcha.com.my/broadband/tm-unifi/#:~:text=It%20is%20a%20contract%2Dfree,l
ittle%20goes%20a%20long%20way.

Security check. (n.d.). Pix4d.
https://support.pix4d.com/hc/en-us/articles/202557289-System-requirements-Minimum-and-reco
mmended-computer-specifications

ThinkCentre M90a | Powerful 23.8 inch secure all-in-one desktop PC | Lenovo Malaysia. Lenovo Malaysia (n.d.). Retrieved December 13, 2021, from https://www.lenovo.com/my/en/desktops/thinkcentre/m-series-aio/ThinkCentre-M90a/p/WMD00000403

Types of Network Protocols. (n.d.). Types of Network Protocols. Retrieved 2021, from https://www.cdw.com/content/cdw/en/articles/networking/types-of-network-protocols.html

Techopedia.com. (n.d.). *What is a Category 6 Cable (Cat 6 Cable)? - Definition from Techopedia*. Available at:

https://www.techopedia.com/definition/17070/category-6-cable-cat-6-cable

What does 10/100/1000 Base-T mean?. Lowery, B. (2019). Retrieved December 13,2021, from https://www.truecable.com/blogs/cable-academy/10-100-1000-base-t
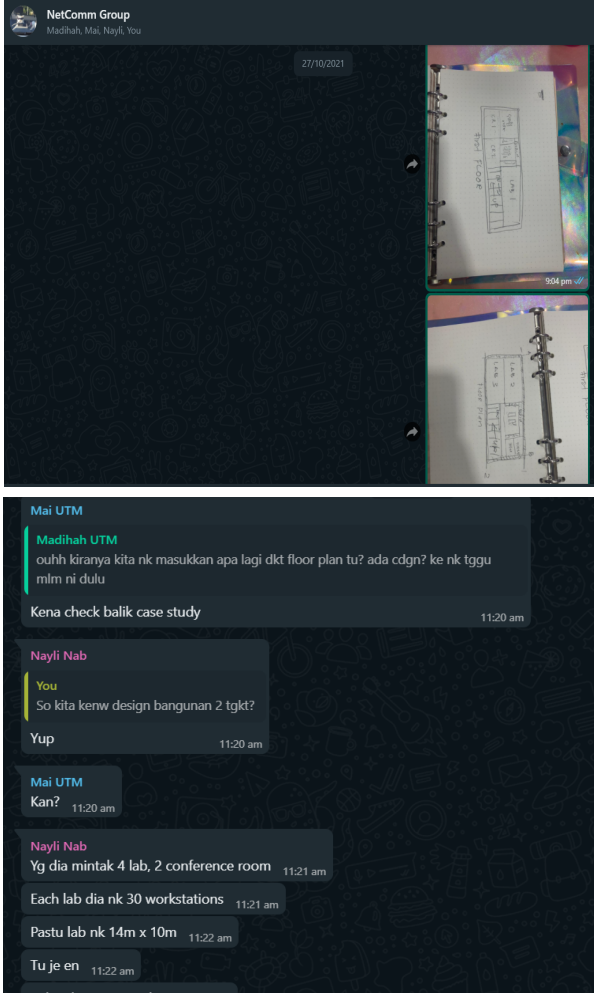
Wireless Access Point. Bhphotovideo.com. (n.d.). Retrieve December 14, 2021, from https://www.bhphotovideo.com/c/product/1408369-REG/ubiquiti_networks_uap_nanohd_3_us_unifi_ac_ap_compact.html?ap=y&smp=y

www.blackbox.co.uk, B.B.U. (n.d.). *7944 - What's the Difference between CAT5e and CAT6?* Black Box. Available at:

https://www.blackbox.co.uk/gb-gb/page/43869/Resources/Technical-Resources/Black-Box-Explains/Copper-Cable/Category-5e-And-6

APPENDICES

Meeting minutes

Since the online class, we have discussions mostly through Whatsapps. Here, we attached some screenshots and descriptions for each meeting according to task.

Task	Evidence	Descriptions
1		From this meeting, we discussed which software to use for the floor plan and we have decided to use online autocad for collaborative works. Other than that, we also plan the position of each room, length and devices according to the case study.
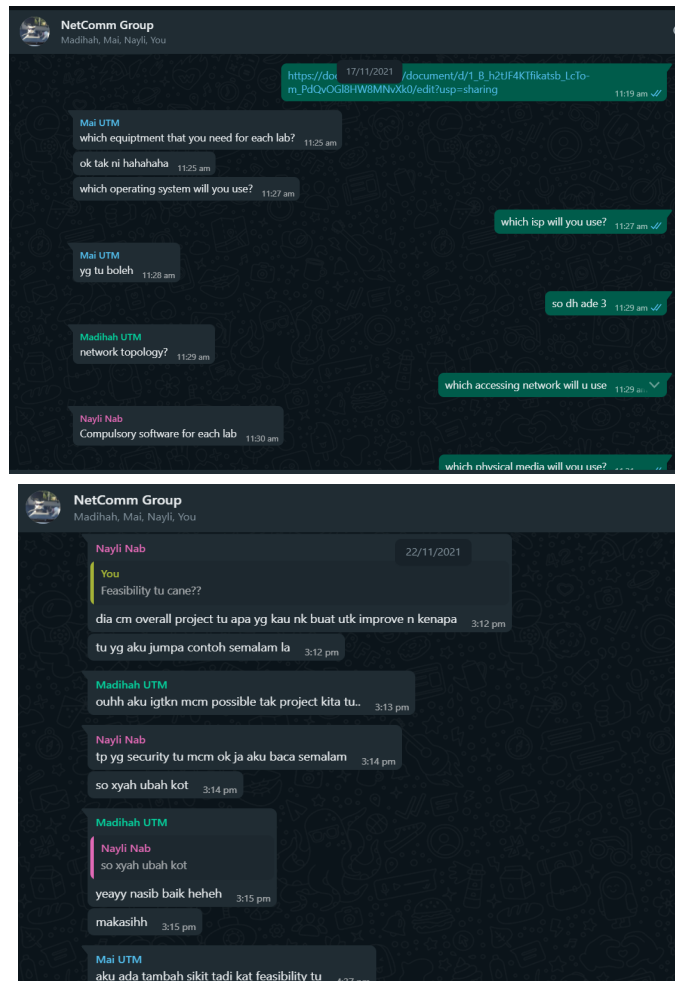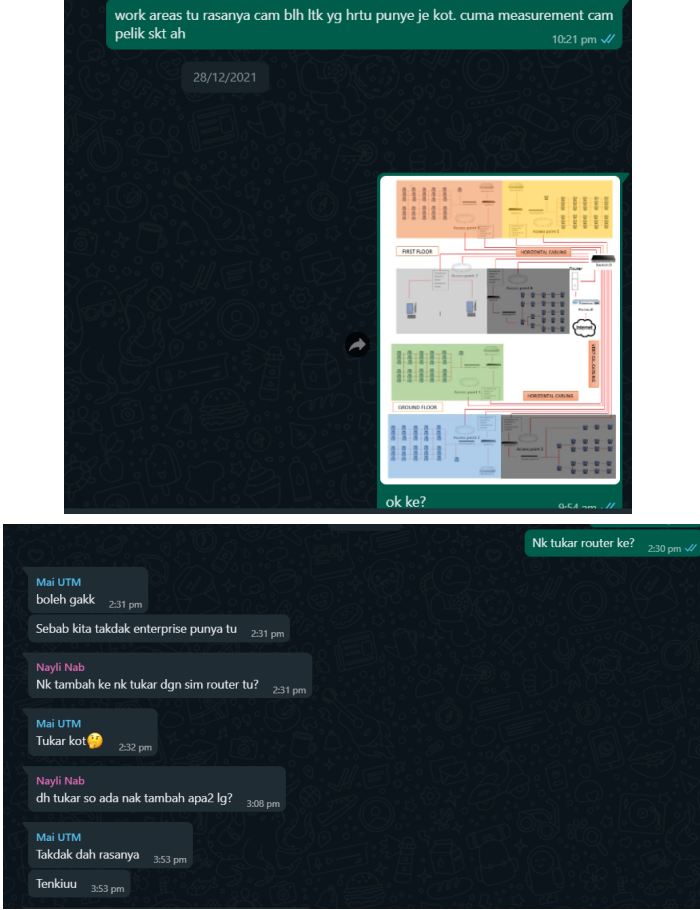
2		From this meeting, we discussed some suitable questions needed for proper planning. Each member proposed their own questions and found the answers. Other than that, we also discuss the feasibility study .
3		For task 3, we do collaborative works in google docs and do some research on our own. If we have doubts on certain things, we will ask in the group for others' opinions.
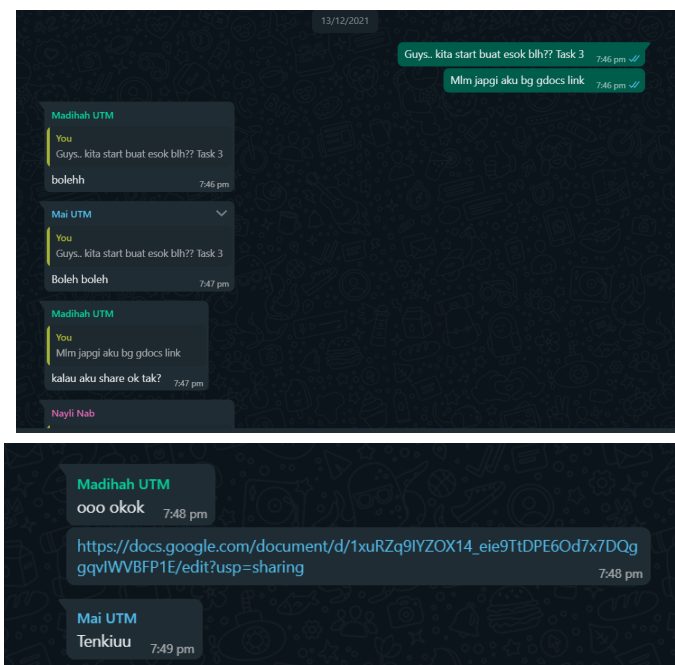
4		For this task, we mainly discuss the overall networking design, estimate the length of cables and decide what other peripherals devices needed. If we have doubts in certain things, we will ask in a group and decide the solutions together.
5		For task 5, we divide the task equally and decide which subnet class that will be used together. If we have doubts we will do some research from the internet and ask the other team members' opinion.

6		For task 6, we mainly discuss how to divide the task equally between all team members since task 6 is about compiling all the tasks done before with reflection.