UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of Computer Science and Information Systems

NETWORK COMMUNICATIONS

Section 07

Network Design for School of Computing Block N28B"

by National Software Incorporation

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Lecturer: Dr. Muhalim Mohamed Amin

Abstract of our project

As a student of computer science, we had to learn Network Communication course. It is one of the basis courses as a computer science student we had to take. Network communication is a course that will help us a lot in the future. Here we learned how to make a proper network process and setting up a basic communication among network devices. It helps with making the simplest network and communication process with any budget budget and also teamworking, and how we will be choosing the devices we want in the future.

In this course we were Introduced to some programs that helped us understanding this subject more, one of the programs called Cisco Packet Tracer and it helped us doing the networking simulation, we were able to estimate what we need do on the next time and checking if we did the networking correctly or not.

Now we are doing a project that tells us to design building from the beginning to implementing a networking process specifically IP addressing. This project helped us understanding the networking process better that before. The great thing is that the project is asking us to act as a real network designer so we can learn the full experience of the real network designers.

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2.0 Introduction

This network communication project is about how we implement the network communication subject in real life. What we are doing in this project is designing a building for our client. our client asked us to design a new building for the campus. This building requires 4 labs and 2 video conference rooms for the main thing. our budget for the project is RM1.500.000. Our plan is to make a 2-level building that is 3,192m cubic. there will be 8 rooms for each floor and we will include some additional rooms to the building. We will also design the cabling system on each floor. From everything we learnt in this subject we are sure that our design is the best for this budget and requirement that he gave us. We hope from this project we could know better to network communication subjects and also implement it to the real world such as in the industry.

We gave each of us a role for this project as:

Muhammad Aqila Karindra Daffa as a project manager.
Zeiad Wael Mohamed as a finance manager.
Ahmad Kemal Aushaf as a logistics advisor.
Savero Fajri Sutiono as a facility manager.

3.0 Project Background

Our client asked for a new building for the school of computing. In this building he asked for 4 main labs and 2 video conference rooms to be specific the labs are IoT lab, Network lab, general purpose lab, and computer security lab. Didn’t forget about the networking that we will do in this building. We already learnt a lot in the network communication subject from the basics to the details of the subject from what is a router to the routing process itself using the cisco packet tracer.

Our plan for the building is to make a 2 level building, in the first building it will include 2 rooms for Video Conference and 1 room for General Purpose lab. and the second floor will include the other 3 labs; Network lab, Security lab, and IOT lab. We also add some additional rooms for the building such as a prayer room, cafeteria, front office etc. Our client also gave us our IP address for the building which is 192.21.0.0/18. from this address we will get the subnet mask 255.255.192.0. we will pull the cable from the server room to each area. some specific areas need to have a faster internet speed than the other such as the Video Conference room area and the Network lab area. For the safety part our building has a fire extinguisher in each corner and we also don't forget to make an emergency stair in case of something bad happens. this building will also be made with Japanese technology so it is an anti-earthquake building. We also have a good irrigation system so food won't be a problem.

4.0 Floor Plan

1st floor:

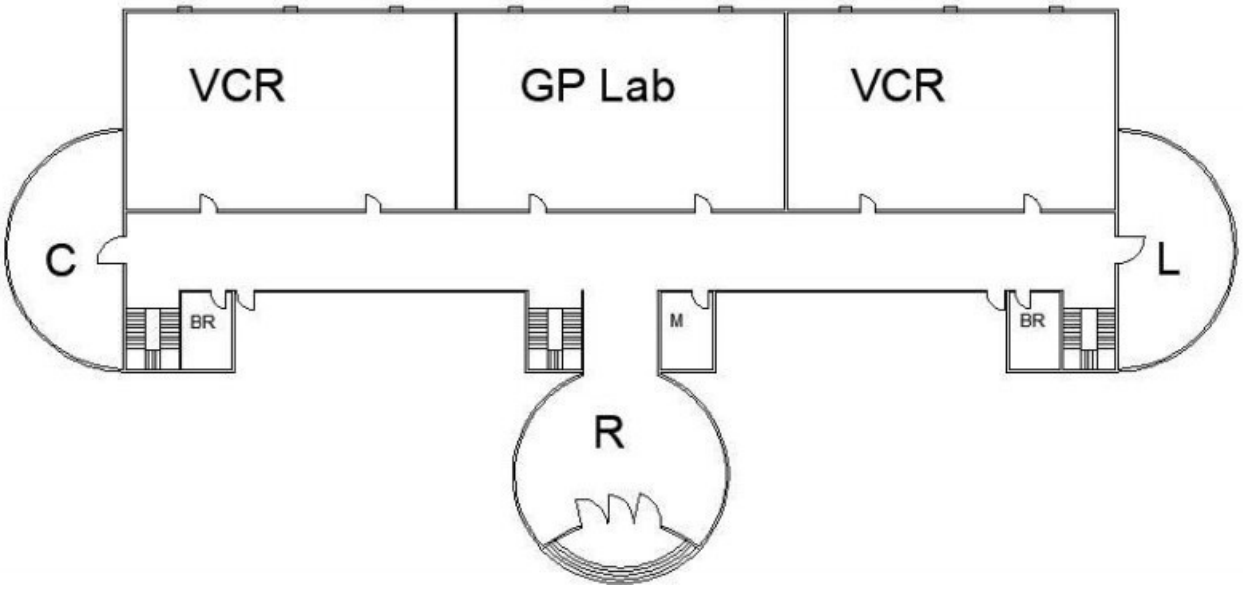


Figure 1

2nd floor:

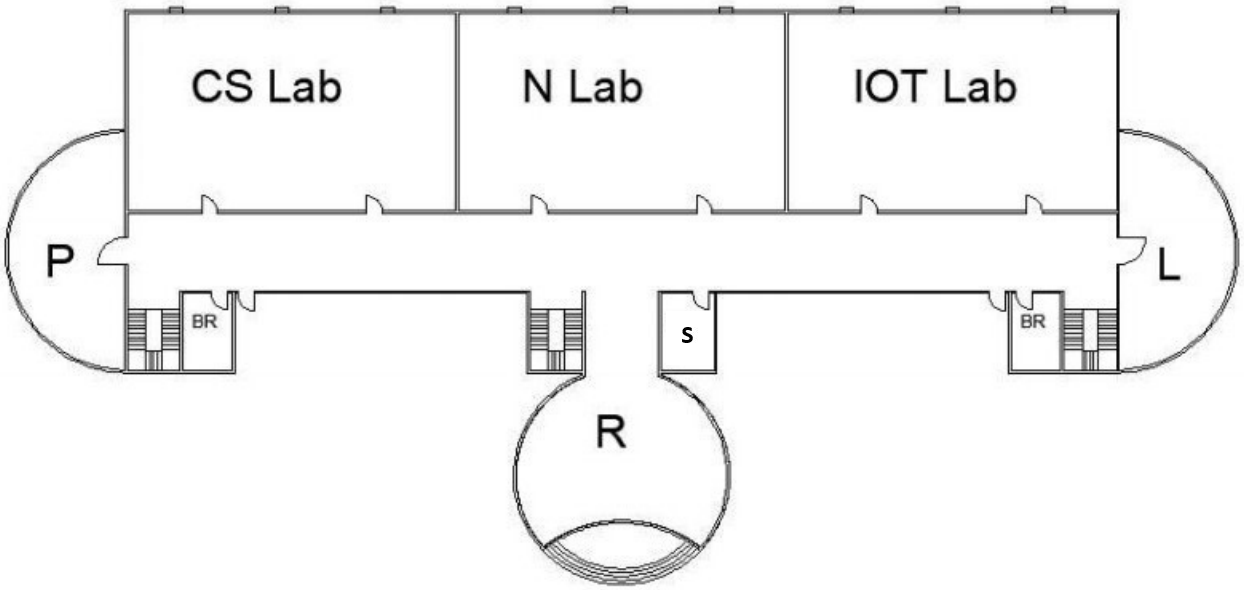


Figure 2

Symbol List:

GP Lab = General purpose lab
CS Lab = Computer security lab
IOT Lab = IOT lab
VCR = video conferencing room
N Lab = Network lab
R = Reception
M=Management
S = Server
BR = Bathroom
L = Library
C = Cafeteria
P = Prayer room

Note: For the library it will have inside stairs so it will be a big library, and as for the reception it will be one big room that will take both floors so there will be no roof in the first floor and the roof will be in the shape of dome in the second floor.

Floor Plan Explanation:

We were asked to design our own floor plan. So, we have decided to list down the rooms which meet the requirement and also the room that we think it's necessary. Firstly, our building has a unique shape, it's a rectangle with two half circles on each side and a full circle in the front.

So here in our floor design.

At the first floor we have:

Two Video Conferencing Room

General Purpose Lab

Library

Reception

Cafeteria

Two Bathrooms

Management Room

At the second floor we have:

Computer Security Lab

Network Lab

IOT Lab

Two Bathrooms

Server Room

Library

Prayer Room

Scaling:

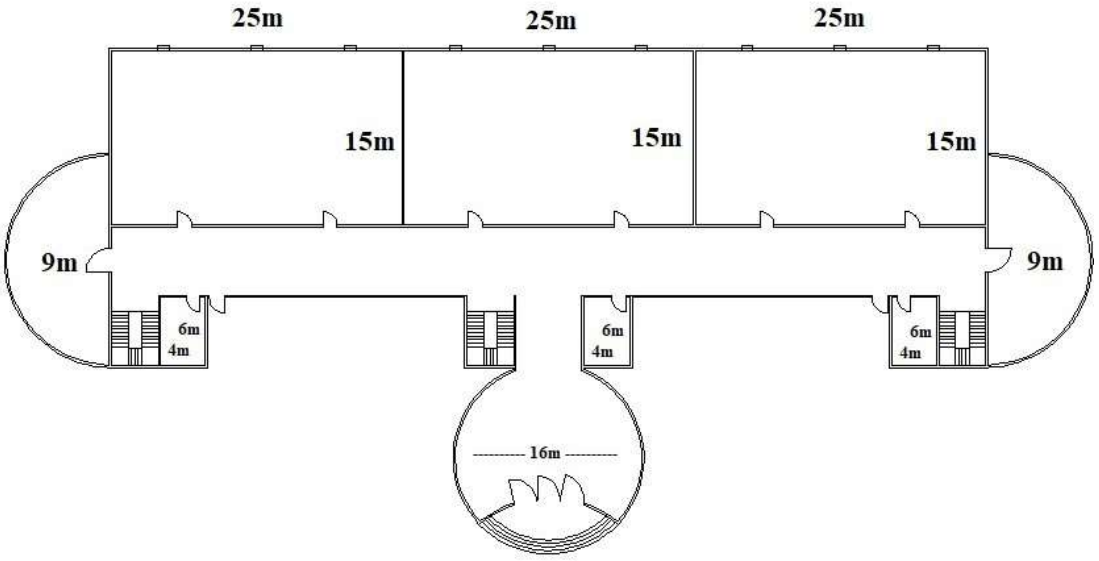


Figure 3

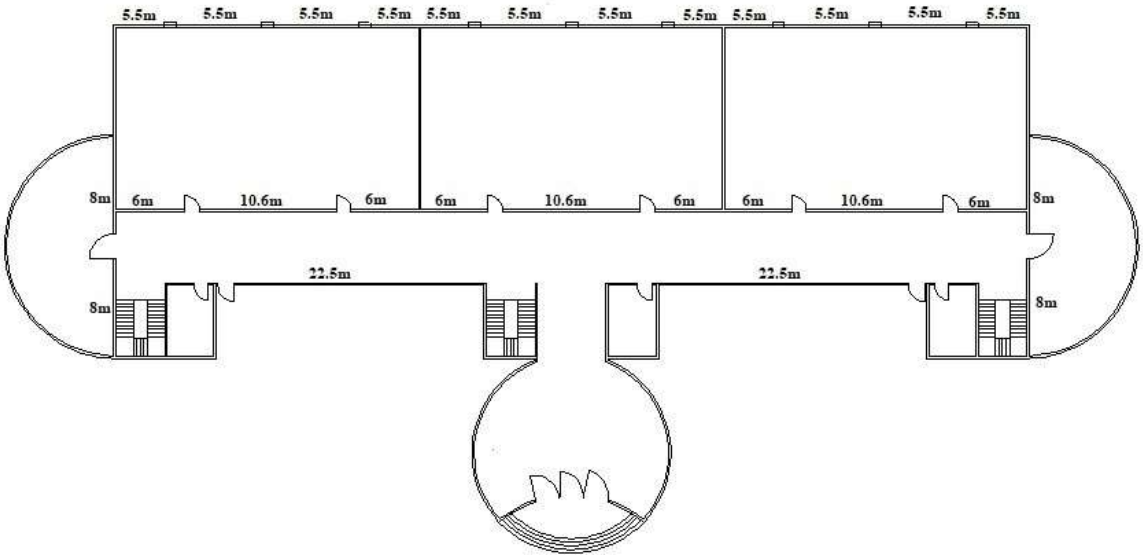


Figure 4

As we can see the top three rooms are all 25×15m each, the two half circles in the sides will each have a half radius of 9m, the complete circle will have a 9m as will, we also have three stairs and three small rooms each will be a 6×4m, the hall way will be 75×6m, all the sizes will be the same as the floor.

5.0 Preliminary Analysis

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

1. What kind of cables are we going to use, and why?

We thought about using either CAT5e or CAT6, we thought about using CAT5e known as Category 5 Enhanced because CAT5e offers a lot of improved performance over the old CAT5, including up to 10 times faster speeds and a significantly greater ability to traverse distances without being impacted by crosstalk, CAT5e cables are normally 24-gauge twisted pair wires, which can support Gigabit networks at segment distances up to 100m, and as for CAT6, it came out only a few years after CAT5e, CAT6 cables are twisted pair cable for Ethernet that is backward compatible with CAT5/5e and CAT3 cable standards, CAT6 cables can support Gigabit Ethernet segments up to 100m like CAT5e but they alsoallow for use in 10-Gigabit networks over a limited distance, now there are some differences between CAT5e and CAT6 are that CAT6 cables are designed for operating frequencies up to 250 MHz, but CAT5e cables are designed for operating frequencies up to 100 MHz, this means that a CAT6 cable can process more data at the same time, another difference is that CAT6 cables offer speeds up to 10GBASE-T or 10-Gigabit Ethernet but CAT5e cables can support up to 1GBASE-T or 1-Gigabit Ethernet another difference is that CAT6 cables are more expensive than CAT5e cables by 10-20%, so after going throw all we concluded that we are going to use CAT6.

2. Why is the size of the rooms are 25x15m?

To answer that we need to know the size of each pc disk and the space that the user will need to have a comfortable place, so for the size of each desk we said it will be 2x1m and will give for the space that the user will need 1m beside the disk so in total we will need 2x2m space for each user for 30 pc disk, the figure below explains the scaling so that the 25x15m will be more than enough for each room.

Figure 5

3. what approach do we use in the making of the project?

In the other subject (SADM) we have learned about types of approaches to make a project. the approach that we use is the prototype approach because we can see that the prototype approach has many advantages in doing this project. First, our customers could see the parts of our project earlier as they can see it on the map floor. The second advantage is with this approach we could detect errors much earlier and save a lot of effort and cost. Missing functionality will also be easy to figure out. Thereby we are using this approach.

4. which part is the most expensive is it necessary? why?

So far, the most expensive parts are the labs, our labs consist of high-tech equipment which is expensive and hard to find. It is also important to maintain our lab temperature below 24 or we could say we need extra cost for its own maintenance.

5. what will happen if that part (the most expensive part) was removed?

Laboratories are a facility that supports students to do scientific or technological research. This facility will be very important for students. in here the students are allowed to experiment with things they never did before. laboratories are places for students to reach beyond the limit. without this facility, students will have limitations in their experiment. in that case, it would be hard for the students to develop. and that is why this is very important and cannot be removed.

6. What is the different between the 4 labs (IoT, Network, Computer Security, and General-Purpose lab)?

We have 4 different labs and each one of them has its own function.

The first is IoT lab, IoT Lab is a research platform exploring the potential of crowdsourcing and the Internet of Things for multidisciplinary research with more end-user interactions.

The second is Network lab, The Network lab is a virtual cluster of multiple networking devices, including servers, clients, routers, switch, and firewalls.

The servers and network devices are Microsoft and Cisco- based respectively.

The third is Computer Security lab, The Computer Security is facilitating space in which students can safely engage in cyber related activities, including malware detection and deactivation, and penetration testing.

The fourth is General Purpose lab, General Purpose Lab is a laboratory for testing and complete project development solution with core equipment.

7. Do we need ethernet switch in the building? and why?

Yes, we need the ethernet switch in this building because the ethernet switch is a central network that creates a network and the router allows for connection between network, it means the ethernet switch is used for connecting the computers and every other wired device to each other.

8. Do the 4 labs (IoT, Network, Computer Security, and General-Purpose lab) have their own functions? And what are them?

Yes, the 4 labs (IoT, Network, Computer Security, and General-Purpose lab) have their own functions. They are:

- IoT lab = facilitates the full control of network nodes and direct access to the gateways to which nodes are connected, allowing researchers to monitor the energy consumption and network-related metrics of nodes. For example, end-to-end delay, throughput or overhead.

- Network lab = facilitates the process of education in the field of information and communication technologies concerning the problem of computer networks, their design, administration, and management.

- Computer Security = facilitates experiences for students who study in field of computer security technologies and serves as a testbed for projects and also gives a space in which students can safely engage incyber related activities, including malware detection and deactivation, and penetration testing.

- General Purpose lab = for testing and complete project development solution with core equipment like Signal and Spectrum Analyzers, Logic Analyzer, Oscilloscopes, Bench Multi-meter, Soldering Bench, Power Supplies and General-Purpose Tools.

9. What are the things that would affect the internet speed connection?

Here are multiple factors that affect speed and internet quality, such as transfer technology (depends on the network technologies available in the area and feature of user's device), location (the speed may vary because the signal depends on coverage area), and number of people that share connection within (during certain hours.

10. What constitutes a system that "easy to manage"?

It lets network engineers manage a network's independent components inside a bigger network management framework and performs several functions. It could identify, configures, monitors, update, and troubleshoots network devices both wired and wireless in an enterprise network. And could also control application then displays the performance data collected from each network, allowing network engineers to make the change as needed.

11. What causes can affect the network security of the building?

The unknown asset of the network. To make sure our network is secure firstly we have to know all of the assets are on our network. Conduct a review of all devices on our network and identify all platforms they run. We can know all the access points and which are the ones that most need security updates. And then lack defense in depth. How much damage this attacker will be capable of depends on how the network is structured.

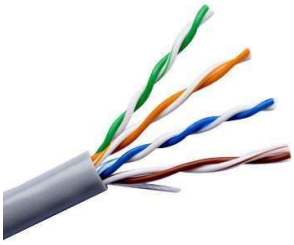
6.0 Determine Feasibility

After what we have discussed and revised, we can come to a conclusion that our floor plan and design are fulfilled the requirements. So, with that we can proceed this project to the next step with what we have now.

We are given RM. 1,500,000 to build this project and we think the budget is enough for this building, but we will analysis the benefits to see how good or bad the project with the budget given, we will also try to finish our project at the duration given by measuring the time so we won't be late, we will also will not forget to do the project without conforming the legal and ethical requirement, we also added some rooms beside required rooms for our building, so in total we have 4 different labs (IOT, Network, Computer Security, and General Purpose lab) and 2 video conference rooms, and the additional rooms with certain purposes are 2 level of library, 1 level of reception room but it contain both floors, server room, prayer room, management room, 4 bathrooms, and a cafeteria.

7.0 List of Devices

DEVICES	FEATURES	BRANDS	PRICE/PCS	QUANTITY	TOTAL AMOUNT
Switches	-2 x 10 Gigabit -Ethernet with SFP+ uplinks -24 POE+ ports -Fixed 640 WAC default AC power supply -390W available PoE power	Cisco Catalyst 3650 - 24 PDM 	10,000MYR	2	20,000 RM
Generator	-Input Voltage: 230V -Output voltage note: 230V -Output power capacity (VA): 5000 VA -Output power capacity (Watts): 4.5k Watts -Emergency Power Off (EPO): Y	APC Smart-UPS SRT 5000VA 230V 	15,000MYR	3	45,000 RM

Switches	-2 x 40 Gigabit -Ethernet with QSFP+ Uplinks -48 UPOE Ports -1100 WAC Default -AC power supply Supports Catalyst -Multigigabit technology	Cisco Catalyst 3650-48 FQ 	19,000MYR	2	38,000 RM
Switches	-48 × 1G port models -4 × 10G SFP+ uplinks -Stack up to 8 units 160 Gbps of physical stacking	Cisco Meraki MS350 Series 	13,000 MYR	3	39,000 RM
Cable UTP Cat5e	-High Performance Data Communication Cable -Suitable for 350MHz High- Speed Data Applications -Suitable for Gigabit Ethernet, Fast Ethernet and -AWG24 Solid Annealed Bare Copper Conductor	Belden Grey LSZH Cat5e Cable SF/UTP 	4MYR/meter	1200 meters	4,800 RM

Routers	-10 GE SFP+, PoE GE/SFP, GE/SFP -Integrated WAN ports -10-Gbps+ performance -7-Gbps encrypted throughput	Cisco ISR 4461 (integrated services routers) 	31,208.68 MYR	2	62,417.36 RM
Routers	-Power supply: AC,PoE -Rack units:1 RU -Redundant power: No -RJ 45 based ports: 2	Cisco ISR 1921 (integrated services routers) 	6,913 MYR	2	13,824 RM
Access Point	-Four radios: 2.4 GHz (4x4), 5 GHz (4x4), Cisco RF ASIC and BLE/IoT -Cisco Flexible Radio Assignment and Cisco Clean Air Technology -Internal and external antenna -Wi-Fi 6 certified Embedded wireless controller	Cisco catalyst 9120 	6,933 MYR	4	27,732 RM

Optical Fiber Cable	- it's able to run 40/100GB up to 150 meters utilizing a MPO connector - developed specifically for VCSEL laser transmission and allows 10 Gig/s link distances of up to 550m compared to 300M with OM3 - Bandwidth: 4700MHz*km - Can handle 2000 meters fast ethernet	OM4 patch cord ST FC OM4 fiber optic multimode ST-FC OM4 duplex 	75 MYR/10 meters	50 Pcs (500 meters)	3,750 RM
TOTAL AMOUNT					254,523.36 RM

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

Well, this is the first time for us making this project. we didn't have any specific expectations on the price really, so as long as it does not exceed our budget, we wouldn't get surprised. But it does kind of exceed our expectations, at first, we expected the price for the devices would be just around 100.000RM to 120.000RM which turn out to be more than that. But still not that surprised, we might be getting more surprised if the price went up to 1.000.000 just for the devices, we don't know if it's possible to reach that kind of price.

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

Yes, we considered cost as a factor of choosing everything, not just networking devices, everybody has their own budget and different budgets means different kinds of devices, different building materials etc. for our team to get a huge budget like 1.500.000 RM we felt luckily because we could get the best of the best for the device, design and materials.

- What are the major differences between the same devices from different brands? For example, Cisco and Huawei Routers.

When we compare two devices but from different brands, we can't just say this one is better or not, but instead we have to look to our budget and the usage of that devise that we need, so of course we will find what we want either in Cisco or Huawei it's just that we have to choose what we feel comfortable with and what we used to work with, in our case we all used to have cisco devices in our life, so when we had to choose a brand for our devices, we chose Cisco without second thoughts.

- Does LAN devices chosen accomplish needs/requirements?

Yes, we do believe that all the devices we gathered are more than enough for our project and its meet all the requirements that were given to us.

8.0 Network Topology

Our network design is using tree topology. Tree topology is a combination of star and bus topology. This topology is mostly used on larger networks. The tree network has some advantages such as it is highly flexible, scalable and it provides easy fault detection in a network that is why network management is very easy. And the disadvantages of this topology is that it is difficult to configure, there is a single point of failure if the hub device fails the entire network will shut down. Tree network is used to share information across the network and allow users to have many servers on the network. It is the best topology because the signals that are transmitted by the root nodes are received by all the computers at the same time.

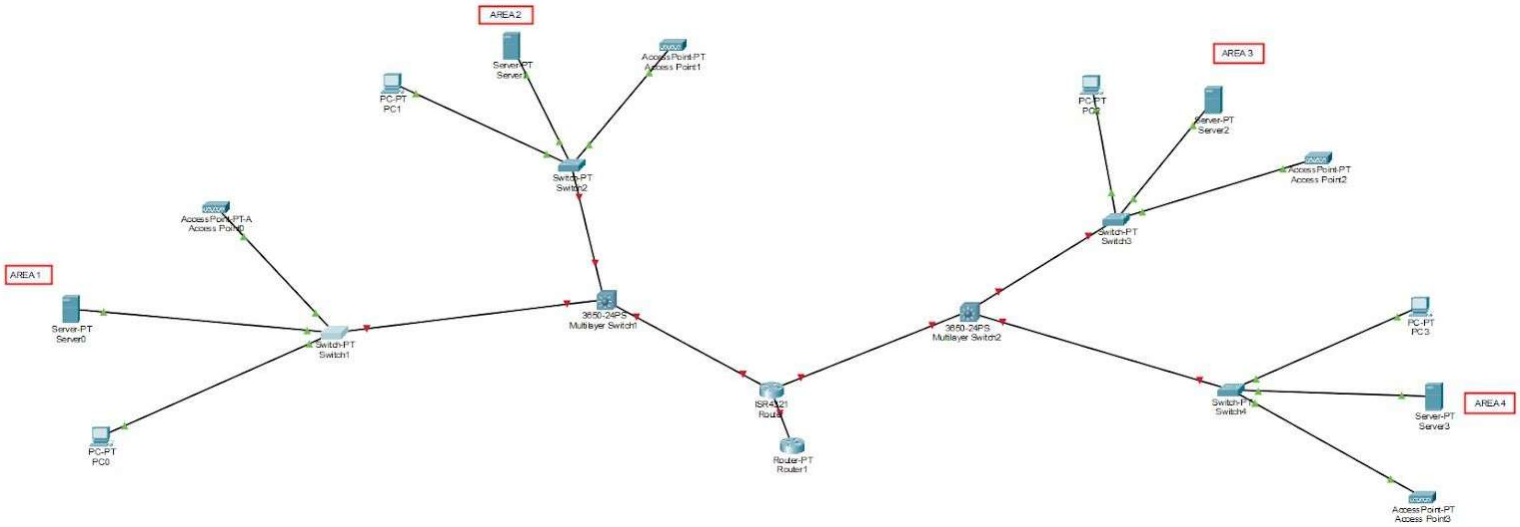


Figure 6

9.0 Work Areas

Work area 1:

Work area 1 is located on the west side of the building that contains VCR and CS Lab on both floors (1st and 2nd floor). There are 2 switches of (24 PS) connected to end-user (PC0), Server 0, and Access point 0.

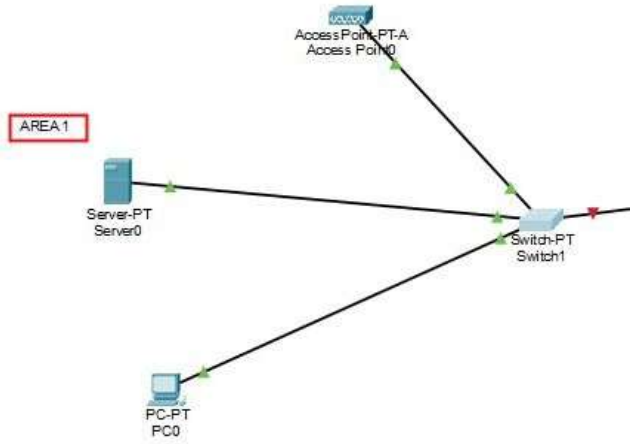


Figure 7

Work area 2:

Work area 2 is located at the center of the building that contains GP Lab and N Lab on both floors (1st and 2nd floor). The switches are (24 PS) connected to end-user (PC1), Server 1, and Access point 1.

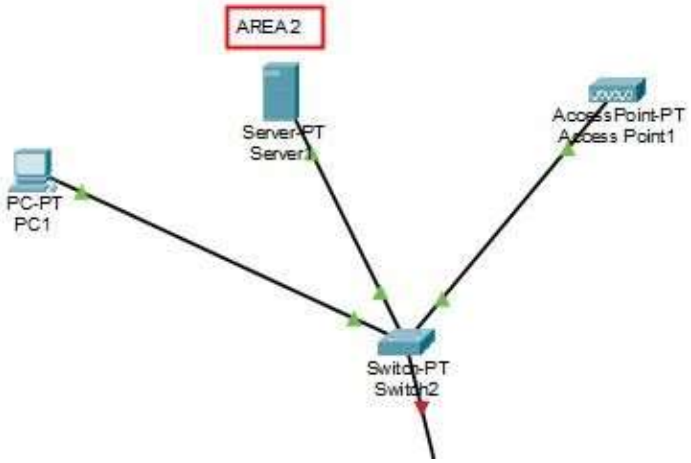


Figure 8

Work area 3:

Work area 3 is located on the east side of the building that contains VCR and IOT Lab plus library on both floors (1st and 2nd floor). The switches are (24 PS) connected to end-user (PC2), Server 2, and Access point 2.

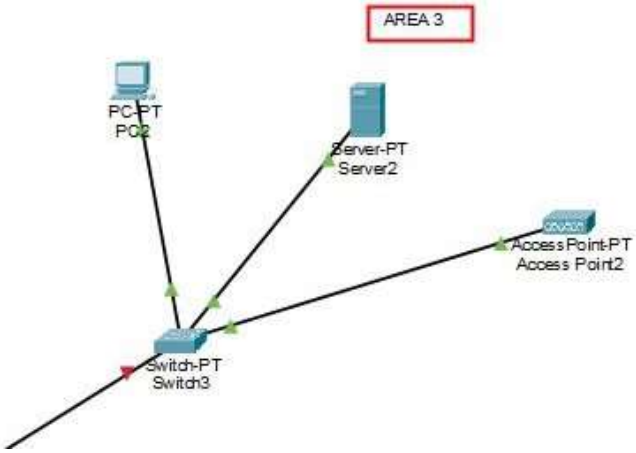


Figure 9

Work area 4:

Work area 4 is located on the east side of the building that contains the Library on both floors (1st and 2nd floor). The switches are (24 PS) connected to end-user (PC3), Server 3, and Access point 3.

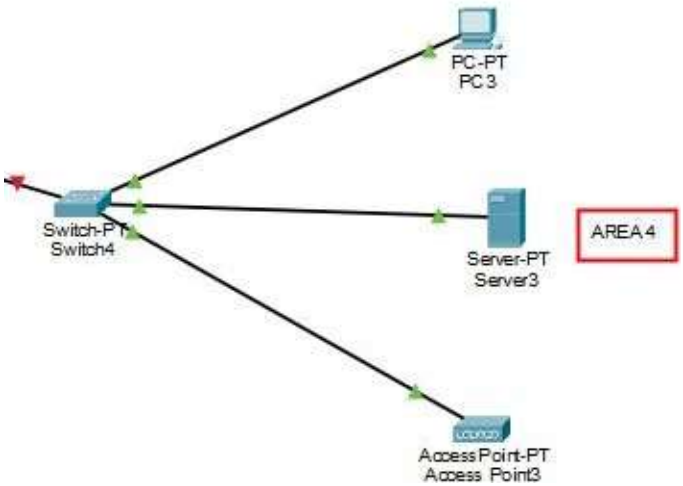


Figure 10

10.0 Wired LAN Cable Structures

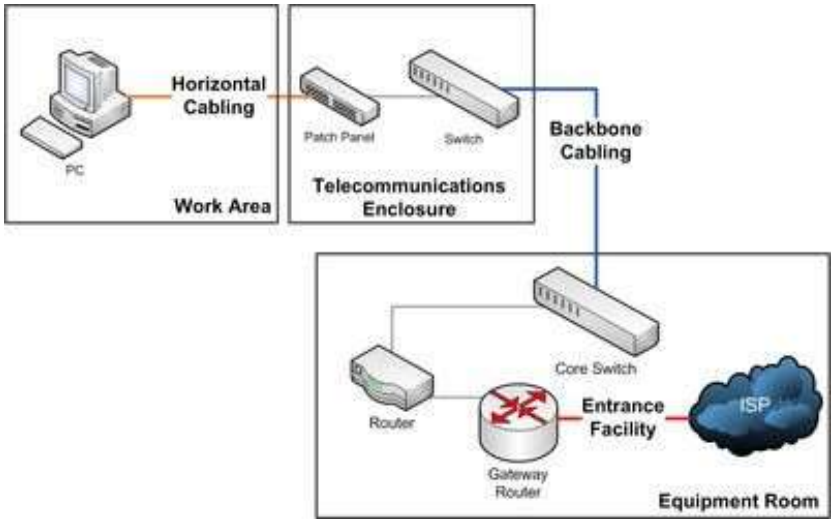


Figure 11

11.0 Cable Type and Length

Backbone cabling

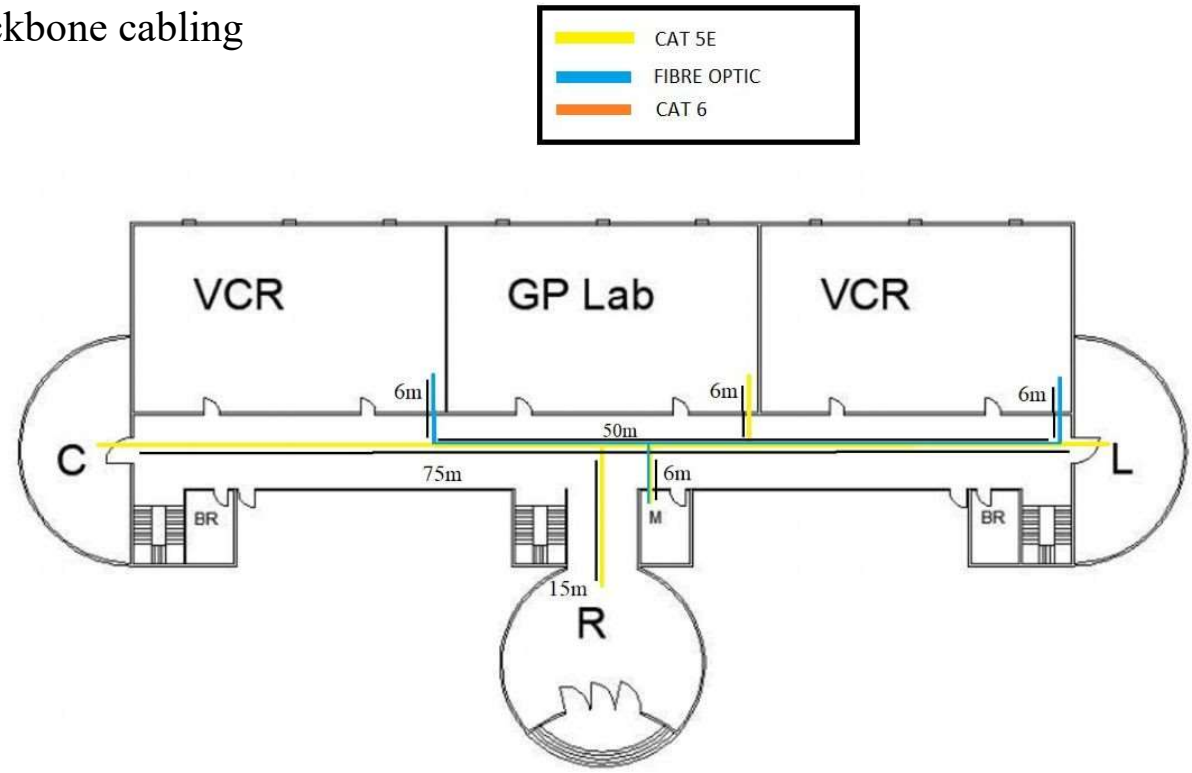


Figure 12

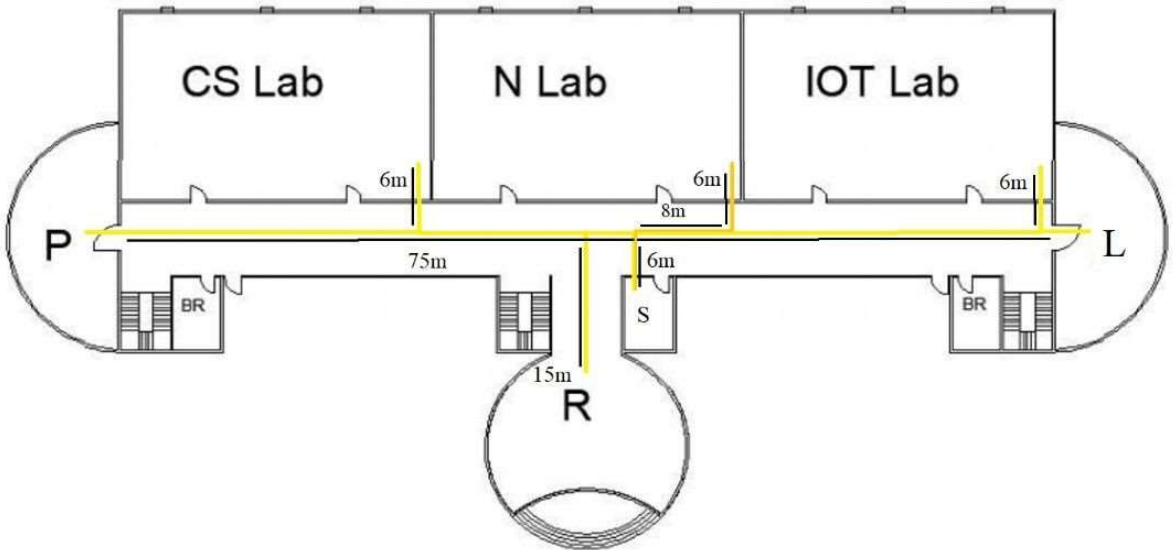


Figure 13

We are using vertical cabling or also known as “backbone”, by using category 5e cables to fulfill the needs of the GP lab, cafeteria, library, CS lab, and IoT lab. We are also using category 6 cable for the network lab, and fiber optic cables for both of the video conference rooms. The purpose of these 2 high speed cables is to get the higher performance for either labs or the video conference room. We don't want our client to experience a lag during an important video conference or other important things in the Network lab.

Category 5e cable will consume the total of 470m. 198m is for us to pull from floor to floor but we are going to take 200m for spare and the other 270m are for inside the labs. For the category 6 cables we will need the length of 110m, 90m inside the lab and the other 20m is to pull from floor to floor. The last thing is 84m of fiber optic cable, 16m for inside the both video conference rooms and 68m to pull from floor to floor.

Access Point, Switch, Router, and Access Point Range

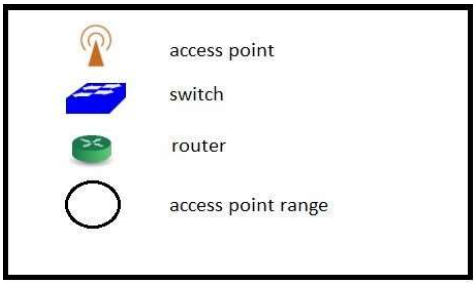


Figure 14

This diagram also represents for the 1st floor

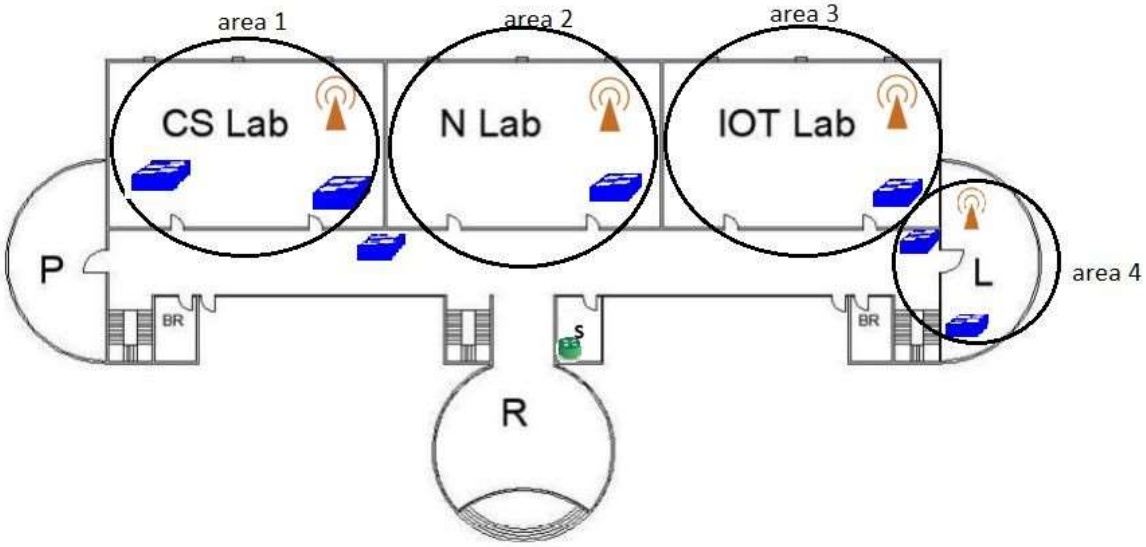


Figure 15

This diagram is based on the topology “A)” there are 7 switches, 4 access point 1 routers and 4 areas with the diameters; (area 1,2&3=25m, area 4=15m).

Labs:

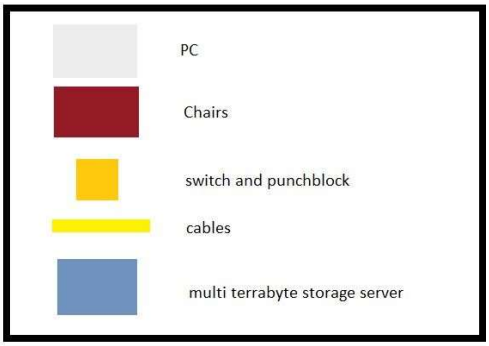


Figure 16

This diagram applies to all of the labs

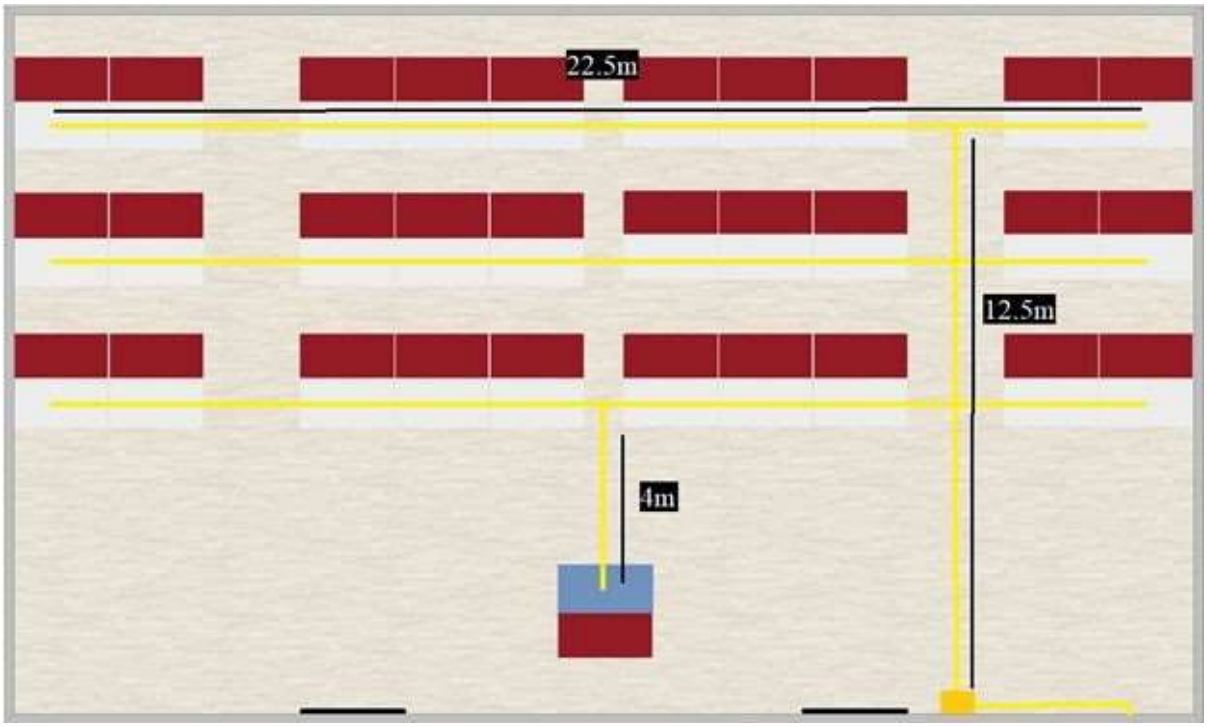


Figure 17

length of cables for each lab: 4m+12.5m+(22.5x3) = 84m but we are going to get 90m just for sure. so, there are 3 labs using the category 5e cables, 90mx3= 270m. and one lab uses category 6 cable. so, the labs consume 270m of category 5e cable and 90m of category 6 cables.

Video Conference Room:

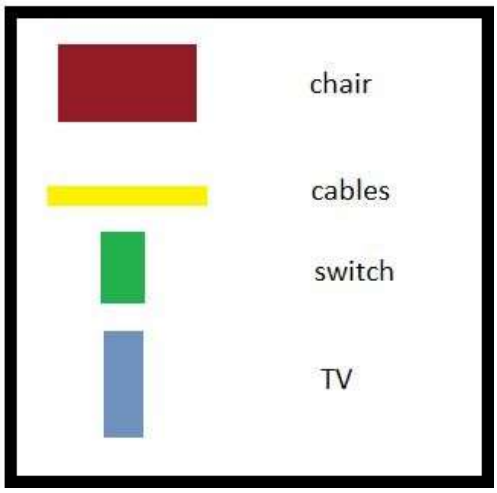


Figure 18

This diagram applies to both of the video conference room

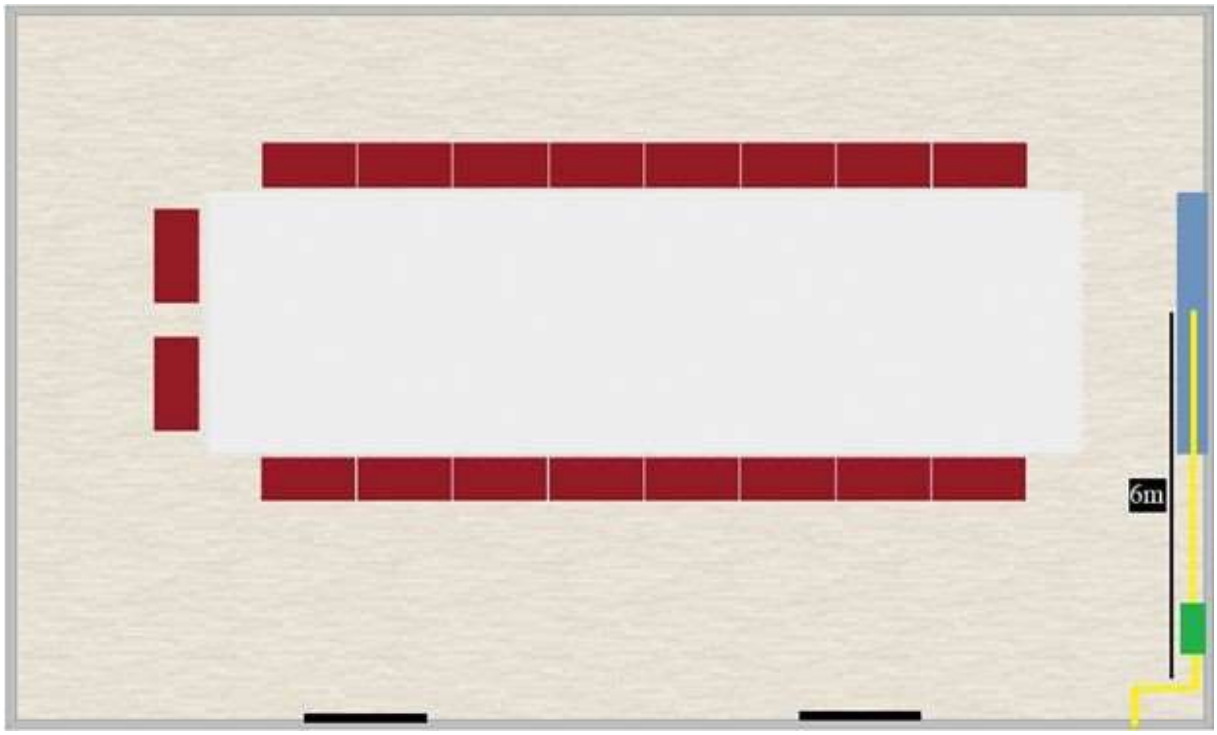


Figure 19

Video conference room uses a fiber optic cable of 6m each room but to be sure we are going to get 8m. so we will need 16m of fiber optic cables for the video conference room.

12.0 IP Addressing Scheme

IP Addressing:

lass A bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask bits
1	255.128.0.0	2	8388606	/9
2	255.192.0.0	4	4194302	/10
3	255.224.0.0	8	2097150	/11
4	255.240.0.0	16	1048574	/12
5	255.248.0.0	32	524286	/13
6	255.252.0.0	64	262142	/14
7	255.254.0.0	128	131070	/15
8	255.255.0.0	256	65534	/16
9	255.255.128.0	512	32766	/17
10	255.255.192.0	1024	16382	/18
11	255.255.224.0	2048	8190	/19
12	255.255.240.0	4096	4094	/20
13	255.255.248.0	8192	2046	/21
14	255.255.252.0	16384	1022	/22
15	255.255.254.0	32768	510	/23
16	255.255.255.0	65536	254	/24

Figure 20

IP Address: 192.21.0.0/18 (Classless) 11000000.00010101.00000000.00000000

Subnet part Host part

Subnet Mask: 255.255.192.0 11111111.11111111.11 000000.00000000

Classes: Class C 11111111.11111111.11000000.00000000

Class A Class B Class C

Subnet Address = IP AND Subnet Mask

= 192.21.0.0 AND 255.255.192.0

= 192.21.0.0/18 11000000.00010101.00000000.00000000

Network Address: 192.21.0.0/18 11000000.00010101.00 000000.00000000

Broadcast Address: 192.21.63.255/18 11000000.00010101.00 111111.11111111

Host Minimum: 192.21.0.1/18 11000000.00010101.00 000000.00000001

Host Maximum: 192.21.63.254/18 11000000.00010101.00 111111.11111110

Rooms	Switches	The Start of The Area - The End of The Area	Router
First Video Conference Room	192.21.1.0	192.21.1.1 - 192.21.1.2	192.21.1.3
Computer Security Lab	192.21.1.4	192.21.1.5 - 192.21.1.35	192.21.1.36
General Purpose Lab	192.21.2.0	192.21.2.1 - 192.21.2.31	192.21.2.32
Network Lab	192.21.2.33	192.21.2.34 - 192.21.2.64	192.21.2.65
Second Video Conference Room	192.21.3.0	192.21.3.1 - 192.21.3.2	192.21.3.3
IoT Lab	192.21.3.4	192.21.3.5 - 192.21.3.35	192.21.3.36
1st Floor Library	192.21.4.0	192.21.4.1 - 192.21.4.11	192.21.4.12
2nd Floor Library	192.21.4.13	192.21.4.14 - 192.21.4.24	192.21.4.25

A) Router Interface Connection:

1. Router 1 to Area 1 (VCR 1 and CS Lab) switch:
   1.1. First Video Conference Room switch = 192.21.1.3
   1.2. Computer Security Lab switch = 192.21.1.36
2. Router 2 to Area 2 (GP Lab and N Lab) switch:
   2.1. General Purpose Lab switch = 192.21.2.32
   2.2. Network Lab switch = 192.21.2.65
3. Router 3 to Area 3 (VCR 2 and IOT Lab) switch:
   3.1. Second Video Conference Room switch = 192.21.3.3
   3.2. IoT Lab switch = 192.21.3.36
4. Router 4 to Area 4 (the Library on both floors) switch
   4.1. First Floor Library switch = 192.21.4.12
   4.2. Second Floor Library switch = 192.21.4.25

B) Switches

I. First Video Conference Room (Area 1) = 192.21.1.0
II. Computer Security Lab (Area 1) = 192.21.1.4
III. General Purpose Lab (Area 2) = 192.21.2.0
IV. Network Lab (Area 2) = 192.21.2.33
V. Second Video Conference Room (Area 3) = 192.21.3.0
VI. IoT Lab (Area 3) = 192.21.3.4
VII. 1st Floor Library (Area 4) = 192.21.4.0
VIII. 2nd Floor Library (Area 4) = 192.21.4.13

C) Hosts

I. Video Conferencing Room 1:

1 Computer = 192.21.1.1

1 Storage server = 192.21.1.2

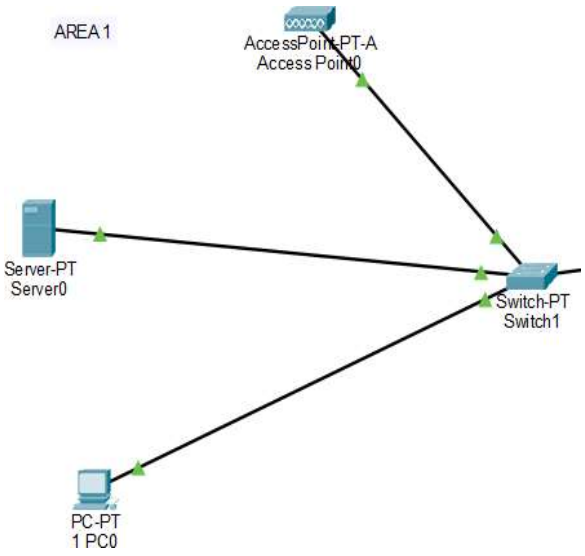


Figure 21

II. Computer Security Lab:

30 Computers = 192.21.1.5 - 192.21.1.34

1 Storage server = 192.21.1.35

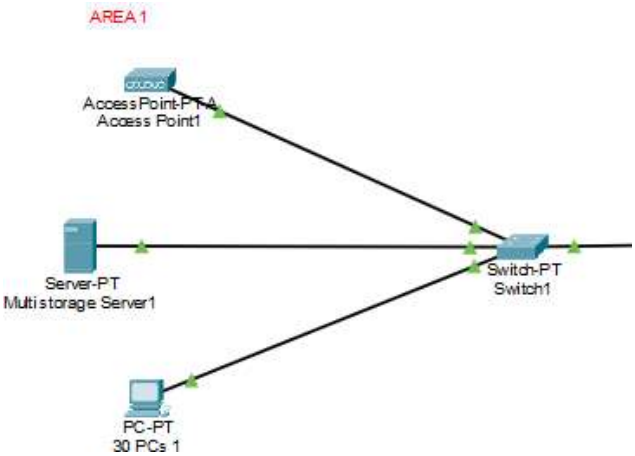


Figure 22

III. General Purpose Lab:

30 Computers = 192.21.2.1 - 192.21.2.30

1 Storage server = 192.21.2.31

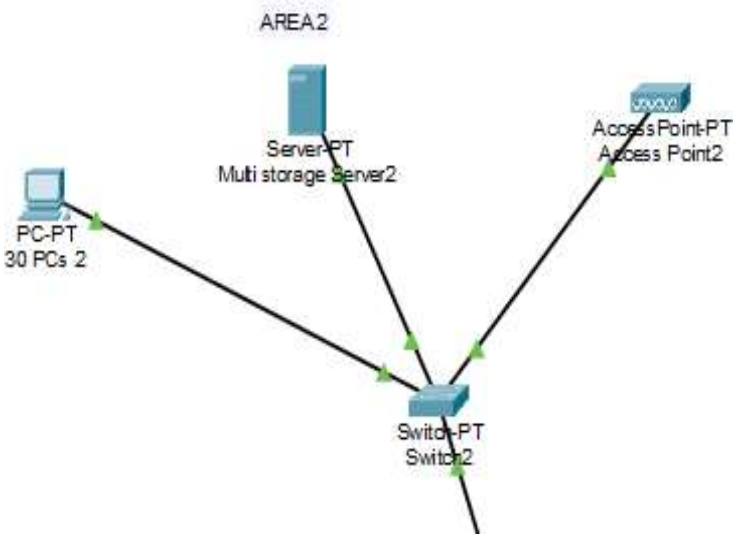


Figure 23

IV. Network Lab:

30 Computers = 192.21.2.34 - 192.21.2.63

1 Storage server = 192.21.2.64

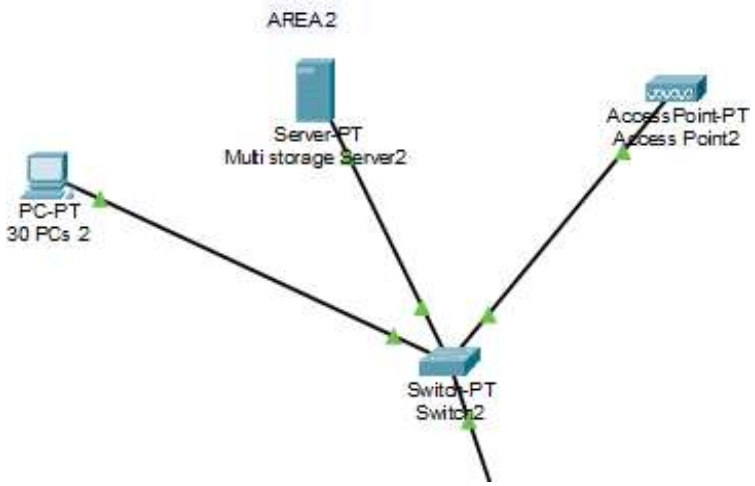


Figure 24

V. Video Conferencing Room 2:

1 Computer = 192.21.3.1

1 Storage server = 192.21.3.2

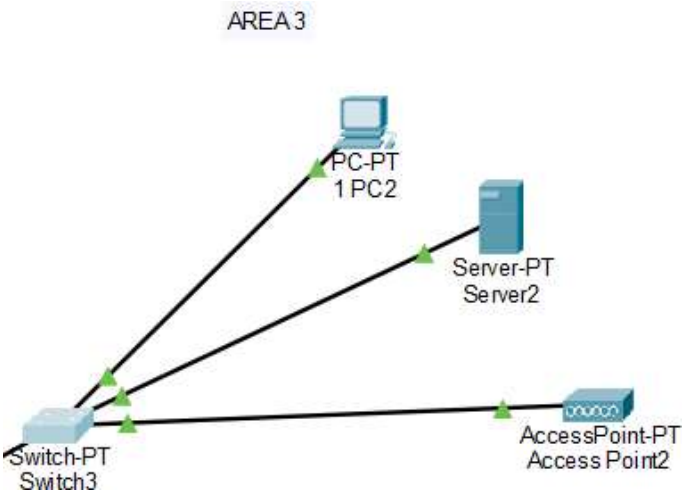


Figure 25

VI. IoT Lab:

30 Computers =192.21.3.5 - 192.21.3.34

1 Storage server = 192.21.3.35

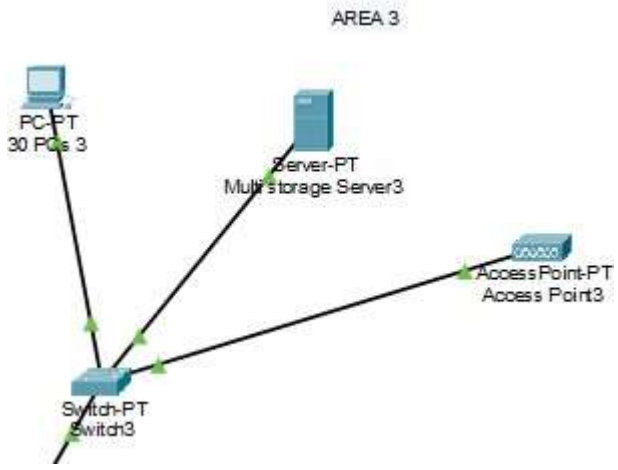


Figure 26

VII. Library (1st floor):

10 Computers = 192.21.4.1 - 192.21.4.10

1 Storage server = 192.21.4.11

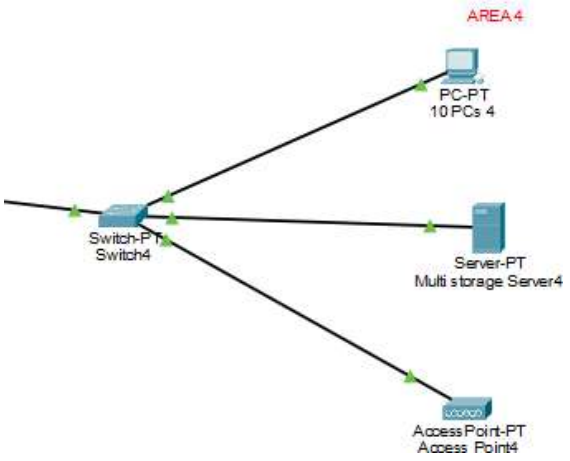


Figure 27

VIII. Library (2nd floor):

10 Computers = 192.21.4.14 – 192.21.4.23

1 Storage server = 192.21.4.24

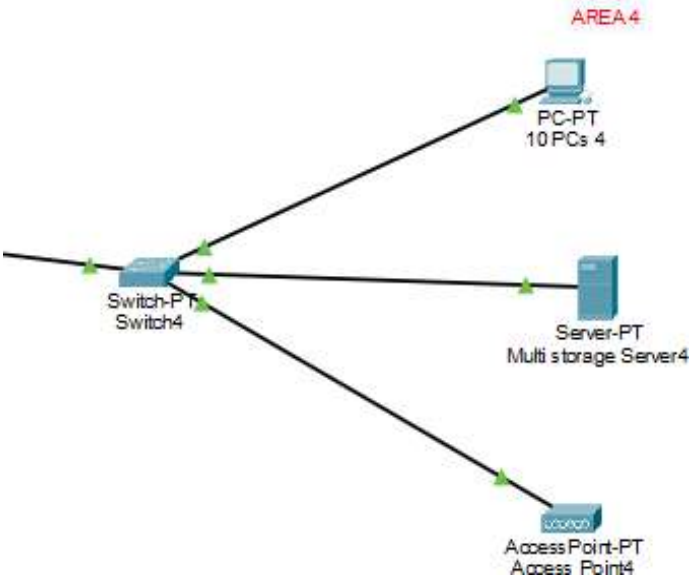


Figure 28

13.0 Reflections

We started our first task by discussing how are we going to fit the requirement rooms in a building in a way that it will be unique and good. After some discussing we came up with a unique design building that has everything we wanted. After that we discussed more about the scales of the rooms. At first, we thought about really big numbers but after some analyzing we knew that 25x15m is more than enough, it is not so big so we wouldn't have empty space and it is not too small to not fill the pcs and the other requirement. Now we moved to the next task, task 2. Here we were really lost, we didn't know what are the right questions to be asked. So, we decided that we will ask some simple questions but important. On the next meeting each of us provided some questions and we chose between them what we saw was good. In the next task, task 3. we get to know the details of the description and features of the device that we chose. We also learnt about other devices. While doing the research of these devices we came across other useful devices that we didn't choose for our project. we now know that cisco, juniper, alcatel, hp etc. are big companies in this sector (networking). As for task 4 we did this task without any real problem. We need to determine what topology that would suit our floor design the best. After that, we have to make and realize the cabling which are the cable types and length, and also the range of each of our devices. So, our building is using Tree network topology which is a combination of star and bus topology, because this tree topology has a lot of upside. Our working areas are divided into 4 working areas and we use 5e and 6e cables and a fiber optic cable. And finally, task 5. For this task we gave an IP to every device in our labs, video conference room, and libraries. And we also gave the IP to our routers and switches because it refers to our network topology that we made before. After that we calculated our IP address to determine the network, broadcast, and subnet address. Our IP address is 192.21.0.0/18 so our subnet mask is 255.255.192.0 then we determine all the addresses in this task with those IP addresses and subnet mask.

14.0 Conclusion

After going through 5 tasks, from designing the floor plan that has 2 floors , including library, 4 new labs with 30 working stations for each lab and 2 video conferencing rooms that can contains up to 97 academics and 35 supporting staff this is a very important part because it is a fundamental part to continue our project, and then doing preliminary analysis that we managed to gain 11 questions and answers that were much needed to gather our feasibility, after that we are choosing appropriate LAN devices we have to be efficient and outsmart the market in this task choosing devices and deciding which brand we should go with. We eventually chose Cisco brand and bought all the devices with the total amount is 254,542.36 MYR, next step is making the WAN and LAN connections where we have to make connections within the building and determine the cable length and we use vertical cabling or "backbone" by using 5e cables that consumes total of 470m and category 6 cables using total of 220m, and fiber optic cable using the total of 168m and the last task IP addressing schema where we have divide and assign our IP address the best possible way for all the rooms and labs. We are now building a 2-floor building for the School of Computing within the budget given by the client and using an easy to manage system, improving overall performance, with the capability to support high-performance to the core backbone while addressing future issues such as scalable network and wireless connectivity for future growth.

15.0 Team Members and responsibilities

Members	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Ahmad Kemal Aushaf (A19EC3002)	Determine the scale and the position of the rooms.	Found 3 questions and answered it	Chooses and considers Routers and Switches.	Determine wired LAN and cable structure.	Determine the router interface connection for each room.	Determine the references and the conclusion.
Muhammad Aqila Karindra Daffa (A19EC3010)	Giving some ideas of the new rooms besides the requirement.	Found 3 questions and answered it	Chooses and considers Generator, Access Point, and cable.	Determine the network topologies for each room.	Determine and Calculate the IP addresses, subnet mask, IP classes, subnet address, network address, and broadcast address.	Determine the appendices, table of figures, and the team members and responsibilities.
Savero Fajri Sutiono (A19EC3016)	Designed the construction of the new building.	Found 3 questions and answered it	Giving explanation about the stuff that we chose.	Determine the length and type of the cables.	Determine the switches connection for each room.	Make the introduction and background of the project.
Zeiad Wael Mohamed (A19EC9047)	Designed the construction of the new building.	Found 2 questions and answered it, did the feasibility	Giving explanation about the stuff that we chose.	Determine the switch, router, and access point range for the building	Determine the host's connection for each room.	Make the abstract and compile the file of the tasks.

16.0 References

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17.0 Appendices

Since we all are all over the world, we choose to do our meetings on discord for an easy and fast communication. Our meetings are usually done in two steps. The first step is to discuss about the task and distribute the work between us, usually this meeting is on the weekend before the task submission. The second step is that we meeting again a day before the submission to compile and fix any errors we face. That being said our first meeting was on Friday, 23 October 2020. We stayed most of the day talking about the floor plan. Our meeting was about 6 hours. The next meeting was on Tuesday, 27 October 2020. Here we fixed some errors and that was pretty much it, so this meeting was about 1 hour. Next meeting was on Friday, 6 November 2020. Here we talked about what types of questions we are going to ask and answer. This meeting was not long because we worked individually on the answer and the meeting was about 1hour. The next meeting was on Tuesday, 10 November 2020. Here we chose the best questions and answers and did the feasibility, it took about 1 hour. The next meeting was on Friday, 27 November 2020. We discussed about the devices we will be using and we done some researches about them. It took about 5 hours. The next meeting was on Tuesday 1 December 2020, here we didn't take mush we just combined out work and it took 1 hour. Next meeting was on Friday 18 December 2020. I took about 4 hours to talk about the task and how are we going to do it. the next meeting was on Friday 25 December 2020. We compiled the work and we found some errors so we tried to fix them, this meeting was about 2 hours. Next meeting was on Friday 1 January 2021, we took about 3 hours discussing and doing the task. The next meeting was on Tuesday 5 January 2021, we checked our final result and changing a bit of it and it took 1 hour. The next meeting was on Friday 22 January 2021, we discussed and distributed the work and it took 1 hour. The final meeting was on Tuesday 26 January 2021, we compiled the work and made some changes and it took 1 hour to finish.

Here are some photos of our discussions we had.

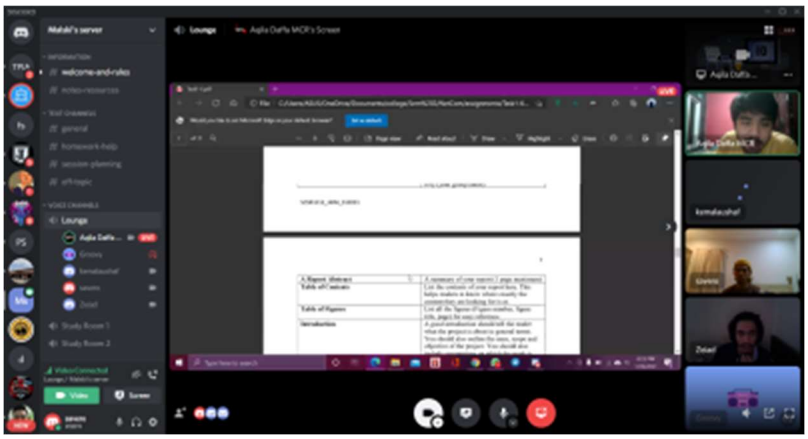

Figure 29

Figure 30