NETWORK DESIGN PROPOSAL FOR A UNIVERSITY

FINAL PROJECT REPORT

BACHELOR OF ENGINEERING
IN
COMPUTER SCIENCE & ENGINEERING

Submitted to: **Submitted By:**
Prabhjot Kaur   (Prashant Sharma, Sagar Singh
                                                                19bcs2340)

                                              NAME: Prashant Sharma
                                              UID: 19BCS2333

Mentor Signature

(Name & E-code)

Dr. Sumedha Arora & 9941

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Chandigarh University, Gharuan

University Institute of Engineering, Chandigarh University
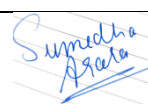# Department of Computer Science & Engineering

Date: 06-02-2021

SUMMARY SHEET

PHASES	Date of Submission	Marks	Outcome Achieved	Remark and Signature by Mentor	Remarks & Signature by Project Teacher
Project Proposal	22-02-21	4			
Synopsis	19-03-21	6.5			
Project Design and Modeling	19-040-21	6			
Project Implementation	24-04-21				
IEEE Paper/patent for (PIE)	24-04-21	4.5			
Final Project Assessment					

University Institute of Engineering, Chandigarh University
Department of Computer Science & Engineering

Date: 06-02-2021

S. No	Project Proposal (5 Marks)	Synopsis (8 Marks)	**Project Design and Modeling (8)**	**Project Implementation (12)**	**IEEE Paper/ Patent/ H/w Product (7)**	**Final Project Assessment +Viva (20)**	Mentor Signature
19bcs 2333	4	6.5	6		4.5		*Sumedha Arora*
19bcs 2340	4	6.5	6		4.5		

Project Teacher Signature

Dr. Meenu Gupta, Dr. Sumedha Arora
Assistant Professor and Project Coordinator
Email: Project.cse@cumail.in

University Institute of Engineering, Chandigarh University
Department of Computer Science & Engineering Project Proposal

Date: 15-02-2021

Project Title

Network Design Proposal for the University/Campus/etc.

Project Team

Team Designation	Name	UID	Section
Lead	PRASHANT SHARMA	19BCS2333	CSE-11/B
Member1	SAGAR SINGH	19BCS2340	CSE-11/B
Member2			
Member3			

Project Objective

Its main objective to Design a Network for the University affordable and scalable and whole project design on the cisco certified software that is CISCO POCKET TRACER.

Project ID (If selected from project basket)									
Project Outcome (Tick the Column)	Patent		Journal Paper	YES	S/W Project		H/W + S/W Project		Other

Remark of Supervisor

Name of Supervisor	Sumedha Arora		Signature	
S.No.	Signature of the Students	Contact No.		Signature
1.	PRASHANT SHARMA	7351301506		prashant
2.	SAGAR SINGH	9056698882		sagar
3.				
4.				

Signature

(Project Teacher)

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                                       NAME: Prashant Sharma
                                       UID: 19BCS2333

Mentor Signature

(Name & E-code)

Dr. Sumedha Arora & 9941

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Chandigarh University, Gharuan

Introduction

The purpose of this project is to design a suitable network system for the universities. The main aim is to design a network with high-quality security and low cost, in such a way that network devices of universities in developing countries, will meet the standards associated with universities. This project enhances the education in networking world.

There are many devices that is used in designing the network, such as routers, switches, servers, pcs etc. All devices are connected to each other to make integrated network system and configured by putting IP addresses to all devices. The budget for this design network was low, it needed to have a high level of security.

All devices in the network are secured by passwords and these passwords are encrypted to be more secure. The server used for this network design are DHCP server and DNS servers. This presentation and design included additional components such as a web server, mail server, etc.

A computer network represents a component, especially on how it enhances the functional performance in different fields and organizations, such ad connecting students with the university, faculty, and the library. So, Computer network plays a vital role in the education area by providing efficient communications for the university environment.

Feasibility Study

We know that technology has reached peak of development in making life smart and easier for the people. Technology is very important part or our life. So the computer network represents a component, especially on how it enhance the functional performance in different fields and organizations, such as companies and universities.

A universities network performs many functions, such as connecting students with the university, faculty, and the library.
Most universities today use network to provide online education by connecting widely dispersed students with their faculty members directly.

Installing networks in a university relies on the university's budget, which differ by institution and from country to country.
Especially this design will be focus on factors that will enhance computer network for universities in developing countries.

The main goal of this project to design a Local Area Network Design suitable for universities. This project will help these universities to design a network that employs low-cost solutions with unacceptable compromises in security or quality.

The main significance of the project is to face the intense pressure form utilization. This network is design for more user population and if user access the network, it will be able to scale. It is properly scalable Network.

Methodology/Planning of work

This is fully based on computer software application in which we used topologies, routers, Switches, Pc's etc. This is the diagram and all departments which we used in the project and design a LAN for university scalable and affordable.

In this we work on CISCO certified application that is cisco packet tracer application and design a whole network of the university we design step wise and start from Recaption to Guest House included many departments in the universities and there is one Internet service provider.

In this we design a secure network which will have login passwords, firewall, routers and switches and then we configure all by IP address and connect all by on wired and wireless network.

Cisco Packet tracer application is very intelligent and useful software which also used on large scale network. We design our network after the study of all configurations of devices and we will try to design a network more secure and scalable for the university.

In this we will do the Encryption of passwords, and also use DNS, Work on Firewall and also back-up and recovery, each have individual hosts and separate server room and also work on TCP/IP models and DHCP etc by the help of these technologies we design a more secure network for university.

Module & Team Member wise distribution

We have two members in our team so we will divide our work.

Our project is fully based on cisco packet tracer application software.

So, we will divide our project in three phases:

1. Design a flaw chart of our network proposal.
2. Learn the configuration of the Devices.
3. Implement the Proposal on Cisco Packet Tracer.

So, we also divide our work on this project one will complete the documentation and one will complete the configuration on cisco packet tracer after the whole concept is clear about networking.

According to first phase we will both design a flow chart that how will design and how we include the departments, hostels, reception, Guest room etc. we use topologies to connect the departments and all in topologies concept.

And now coming to second phase we configure the devices which we will use in this project er required better knowledge in this and we will be clear that what and how we can configure securely our devices such as routers, switches, pc, ISP, DHCP, server etc. Finally, at the end of this phase we will be able to implement our project.

Now coming to final Phase in this after clearing all concept we implement on software named as Cisco packet tracer in this we configured our network proposal for the university in this phase we complete our project Network design proposal for the university.

Innovation in Project

Innovation in this project is that how we design a network flexible means afford a very efficient computer network in low budget also with the help of new devices.

In this project factors include such as adaptability, integration, resilience, security, and the most important factor cost.

Installing networks in a university relies on the university's budget, which differs by institution and from country to country.

There are many countries whose universities do not have financial capability for designing the perfect and ideal network.

In this Project we will use the new network technologies come in market and also use wireless network which will be the best network technology who help in more secure and fast network.

So, we will try to design that type of computer network which will help who need to have good quality and more secure network at less cost.

One of the main feature of our project that it is scalable and affordable for any universities at a normal cost and also for security reasons it is very efficient so this is all things which we include in the prat of innovation.

Software and Hardware Requirements

In this project we used many devices and this project based on application software. So, Software and hardware which we used in these projects are:

1. ## Cisco Packet Tracer:

   This is application software effective, interactive environment for learning networking concepts and protocols. It helps to create their own virtual "network worlds" for exploration, experimentation, and explanation of networking concepts and technologies.

2. ## Routers:

   It is used to transfer data packets between networks.

3. ## Switches:

   A switch is a device in a computer network that connects other devices together.

And also many devices which is used in this project some as pc's, ethernet cable, wired and wired-less devices , VLAN, Servers, Access point IP address Firewall, Cables etc.

By the help of these devices, we design a scalable and secure network for the university. So, this is all about the devices which we will used in this project.

Bibliography

1. **Basics of Networking**

   (https://www.geeksforgeeks.org/basics-computer-networking/

2. **Network Information Related Websites**

   (https://blogs.cisco.com/networking)

3. **Concept of Cisco Packet tracer**

   (https://www.netacad.com/courses/packet-tracer)

University Institute of Engineering, Chandigarh University

Department of Computer Science & Engineering Weekly

- Project Log Report

Project Title

Network Design Proposal for The University

Meeting Number	1	Meeting Date	22/02/2021		

Name of Students	UID	Status of the Work (Filled by Supervisor)				
		Absent	Not done anything	Not Satisfactory	Need Improvement	Satisfactory
Prashant Sharma	19BCS2333					yes
Sagar singh	19BCS2340					yes

Project Completion status (Filled by Students)

I have completed the project proposal and synopsis of our project and continue with learning and implementing.

Remark of Supervisor

Seen

Name of Supervisor	Dr. Sumedha Arora	Signature	

S.No.	Signature of the Students	Contact No.		Signature
1.	Prashant Sharma	7351301506		Prashantsharma
2.	Sagar Singh	9056698882		Sagarsingh
3.				
4.				

Project Lab-Teacher Name	Prabhjot Kaur	Signature	

University Institute of Engineering, Chandigarh University

Department of Computer Science & Engineering

Weekly - Project Log Report

Project Title	
	Network Design Proposal for The University

Meeting Number	2	Meeting Date	19/03/2021

Name of Students	UID	Status of the Work (Filled by Supervisor)				
		Absent	Not done anything	Not Satisfactory	Need Improvement	Satisfactory
Prashant Sharma	19BCS2333					yes
Sagar singh	19BCS2340					yes

Project Completion status (Filled by Students)
I have completed the First Progress Report of our project and continue with learning and implementing.

Remark of Supervisor
They need to address the changes told by me.

Name of Supervisor	Dr. Sumedha Arora	Signature	

S.No.	Signature of the Students	Contact No.	Signature
1.	Prashant Sharma	7351301506	Prashant Sharma
2.	Sagar Singh	9056698882	Sagar Singh
3.			
4.			

Project Lab-Teacher Name	Prabhjot Kaur	Signature	

University Institute of Engineering, Chandigarh University

Department of Computer Science & Engineering

Weekly - Project Log Report

Project Title

Network Design Proposal for The University

Meeting Number	3	Meeting Date	19/04/2021

Name of Students	UID	Status of the Work (Filled by Supervisor)				
		Absent	Not done anything	Not Satisfactory	Need Improvement	Satisfactory
Prashant Sharma	19BCS2333					yes
Sagar singh	19BCS2340					yes

Project Completion status (Filled by Students)

I have completed our project implementation.

Remark of Supervisor

 Approved

Name of Supervisor	Dr. Sumedha Arora	Signature	

S.No.	Signature of the Students	Contact No.	Signature
1.	Prashant Sharma	7351301506	Prashant Sharma
2.	Sagar Singh	9056698882	Sagar Singh
3.			
4.			

Project Lab-Teacher Name	Prabhjot Kaur	Signature	

University Institute of Engineering, Chandigarh University

Department of Computer Science & Engineering

Weekly - Project Log Report

Project Title						
Network Design Proposal for The University						

Meeting Number	4		Meeting Date	24/04/2021		
Name of Students	**UID**	**Status of the Work (Filled by Supervisor)**				
		Absent	**Not done anything**	**Not Satisfactory**	**Need Improvement**	**Satisfactory**
Prashant Sharma	**19BCS2333**					yes
Sagar singh	**19BCS2340**					yes

Project Completion status (Filled by Students)

I have completed the Final Report of our project and IEEE paper.

Remark of Supervisor

They need to address the changes told by me.

Name of Supervisor	Dr. Sumedha Arora	Signature	

S.No.	Signature of the Students	Contact No.	Signature
1.	Prashant Sharma	7351301506	Prashant Sharma
2.	Sagar Singh	9056698882	Sagar Singh
3.			
4.			

Project Lab-Teacher Name	Prabhjot Kaur	Signature	

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Chandigarh University, Gharuan

Table of Contents

1.Abstract

The purpose of this project is to design a suitable network system for universities. The aim was to design a network with high-quality security and low cost, in such a way that network devices of universities, will meet standards associated with the universities. This project will help to enhance education.

There are many devices that were used in designing the network, such as routers, switches, backup, firewall, and servers. All devices were connected to each other to make integration network system and configured by putting IP addresses to all devices. Although the budget for this design network was low, it needed to have a high level of security. Accordingly, it incorporated several mechanisms including a firewall device that prevents any unfavorable data from entering into the network. Additionally, all devices in the network were secured by passwords, and these passwords were encrypted to be more secure. Moreover, each computer in the network was secured by antivirus programs and a backup system.

1. Introduction

Technology has reached its highest peak of development, especially in making life easier for people. Well implemented technology is faster than human in processing calculation and is more accurate. Technology has become an important concept in our life. It assists in connecting communities together. Obviously, people have started to use technology in every field of life including education, health, the military, etc.

The computer network represents a component, especially on how it enhances the functional performance in different fields and organizations, such as companies and schools. A school's computer network performs so many functions, such as connecting students with the university, faculty, and the library. Most universities today use the network to provide online education by connecting widely dispersed students with their professors directly. For this reason, computer networks play a vital role in the education area by providing efficient communications for the university environment.

However, the design of computer networks differs from one university to another. This is as a result of many factors which determine the differences. Such factors include; adaptability, integration, resilience, security, and cost. Installing networks in a university relies on the university's budget, which differs by institution and from country to

country. For instance, there are many countries whose universities do not have the financial capability for designing the 'perfect' or ideal network. Yet these universities from these third world countries still need to have good quality and more secure network equipment with less cost. This is because these schools aspire to deliver capability in line with the leading prestigious universities despite low budgets. Therefore, this design will be focusing on factors that will enhance computer network for universities in developing countries to be able to compete favourably with another computer network in modern country universities.

2. Objectives

The main goal of this project is to present a Local Area Network design suitable for universities in developing countries. Many universities in developing countries are searching for ways to integrate networks that have security, backup, and other features available in a university network in a developed country. The universities in developing countries are faced with challenges in designing a network that is equal in the standards used by developed countries. The main problem developing countries face deals with a profound budget deficit. This research will help these universities to design a network that employs low-cost solutions without unacceptable compromises in security or quality.

3. Capacity

This is the ability of the network to withstand intense pressure from utilization. Most times, the networks are mainly crowded by

many users that the network capacity could not handle. It is very important to design a network in such a way to handle many users without failure. This network is designed for a user population of 5075. If more users access the network, it will be able to scale.

4. Reliability

Reliability refers to the ability of the computer network's hardware and software component to consistently perform according to its specifications. This project's network will be highly reliable in performance because its components will be chosen from Cisco company, a major and well-regarded manufacturer.

Reliability of the security in the network is in high level. This is because there are many powerful devices used to secure data like the firewall device that is used in filtering data entering into the network. If any issue happens to the data, there is a way of restoring the data from backup servers. Each computer in the network has anti-virus to protect users' data. Also, all router and switches are protected by passwords and encryptions.

5.Equipment and Design Selection

5.1 Network Topology

A network topology defines how hosts are connected to a computer network. It characterizes how the PCs and other hosts are organized, and linked to each other. There are many types of network topology such as Point-to-Point, Bus, Star, Ring, and Mesh topology. Each type has a different set of advantages and disadvantages.

5.1.1 Point to Point Topology

Point to Point topologies connect two computers together with a single line connection. The advantage of Point-to-Point Topology is that it gives a faster connection, and it is also less expensive than other topologies. The strength of this topology is more than other kinds of connection. However, Point-to-Point topology is mainly used for small networks, and the computers must be near to each other for a better connection.
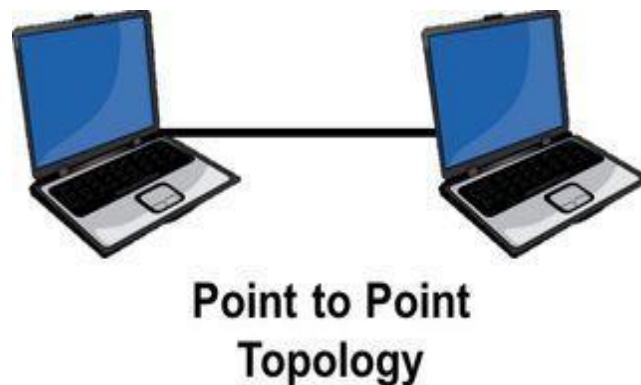

Figure 1 Point to Point Topology

5.1.2 Bus Topology

Bus topology, with the inexpensive configuration, many computers are connected by a single line of cable. Each side of the main cable must be connected to terminals. This type of network topology is small and very easy to connect devices together to making the network. The bus topology uses one main cable for all the connection, and it's usually seen in smaller networks. If the main cable is broken, there will be a network failure such as that seen at a local office level.
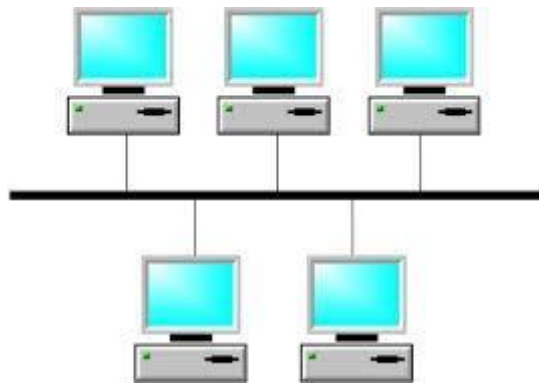
Figure 2 Bus topology

5.1.3 Ring Topology

Another topology is the ring topology, which uses a connecting computer in a circle shape. The source computer sends information to the cable ring, and this information searches for its destination by accessing each computer on the ring until it gets its destination node. According to the article "A review of Network Topology" by Jiang, "Adjacent pairs of workstations are directly connected. Other pairs of workstations are indirectly connected, the data passing through one or more intermediate nodes.
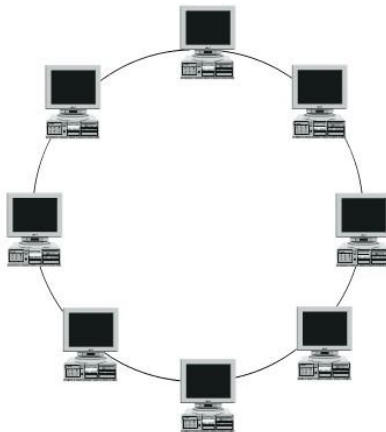
Figure 3 Ring topology

5.1.4 Mesh Topology

The mesh topology requires each computer to be connected directly to multiple computers, with more than one line connecting all

computers to each other. One good thing about this topology is that if one line fails or cut, it will use the other paths to send information to the destination. This reduces the probability of a total network failure. Mesh topology is faster compared to other kinds of topology, but it is very expensive.
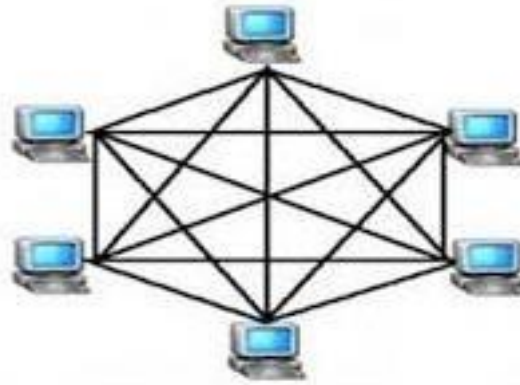
Figure 4 Mesh topology

5.1.5 Star Topology

The star topology is generally used for all networks whereby each device or computer is connected to a center hub by a direct line. The center hub can be a switch, router, or server. Each computer connects directly to the center device such as the hub, router, and server. A star topology is designed with each node connected directly to a central network hub, switch, or concentrator. It is easy to add and remove a computer from the network without affecting the network. Computers in the network, and it is less expensive than mesh and ring topology and easy to install.
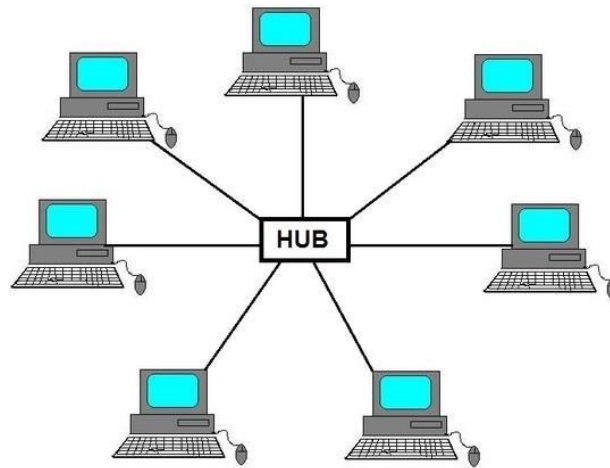
Figure 5 Star topology

5.2 Choose the Equipment

Each network must have a media for transferring information from one node to another, or from one device to other devices. These media play a significant role in determining the transmission speed of the network, maximum distance, shielding against interference, and the cost of the network. There are two options for general use: One of them is a physical connection, and the other one is wireless.

5.2.1 Physical Connections

Cable networks are hardware materials used for connecting network devices together such as routers to switches, computers to switches…etc. There are many kinds of network cables used to connect devices. Such cables include optical fiber, coaxial and twisted pair cable. These cables differ from each other in terms of cost of the network, way to install, the distance between devices, and speed.

5.2.2 Wireless

Wireless is used to depict media communications in which electromagnetic waves transfer the sign over part or most of the transmission path, so there is less need for cable. There are many advantages in wireless transmission when compared to wire. This

includes the easy network installation with less time because "Wireless networks save money on cabling costs and are easier than wired networks to install, operate, and maintain (Tao, 2003).
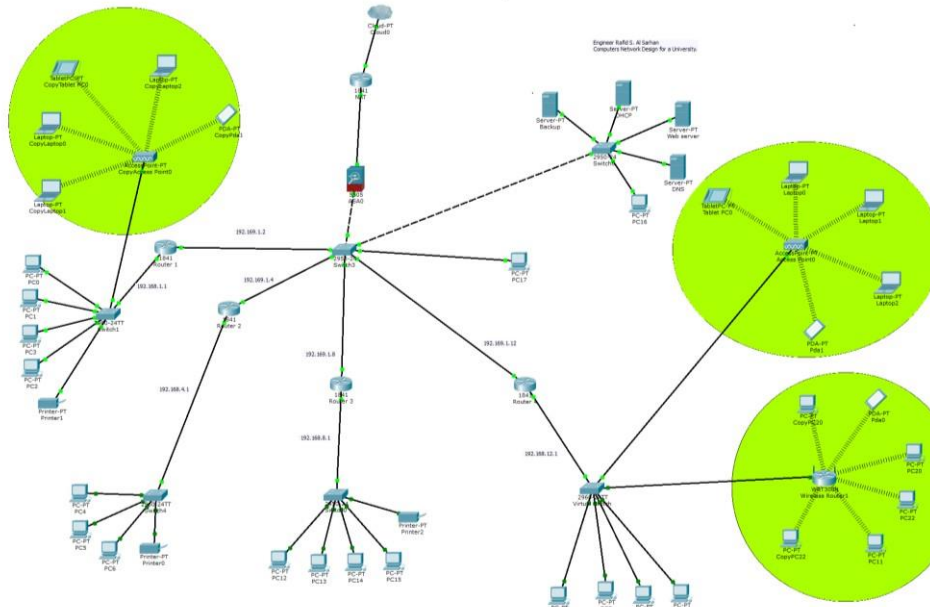

Figure 6 Different types of wireless is used

5.3.1 Ethernet Cable

Ethernet is a way to connect devices together that is usually used for installing connected Local Area Network (LAN). For connecting twisted pair cable between computers and Switches, each computer must have Network Interface Card (NIC). The cable used is UTP because it is the cheapest. UTP cable has eight wires inside of it. Each two wires are twisted with each other making it four twisted pairs altogether. Each wire has a different color. The twisted pair of wire has two different colors. One of them is a solid color, and another one is striped color, as shown in the figure below.
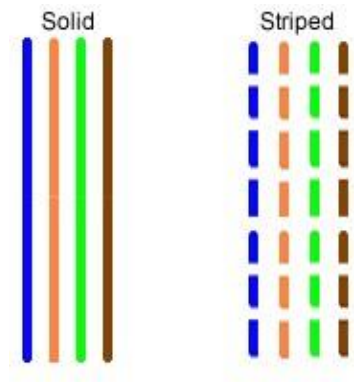
Figure 8 UTP cable Solid and striped

5.3.2 Ethernet Straight Wired Cable

The straight wire cable usually connects different devices together. The devices use straight cables to connect the computer to the switches, the switch with the router, and server with the switch, etc. The figure below shows the devices connected by straight cable
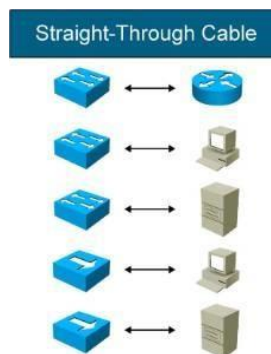

Figure 10 Devices connected by straight cable

In order to connect straight cable for both sides, each pin is connected to the same pin on the other side. For example, connecting pins (1, 2, 3, 4, 5, 6, 7, 8) to the same pins numbers (1, 2, 3, 4, 5, 6, 7, 8). The figure below describes a straight cable connection.
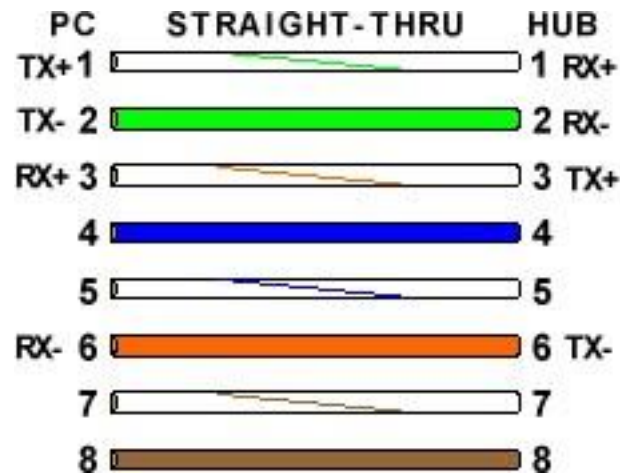
Figure 11 Straight cable connection

The Wi-Fi is one type of wireless communication device used for connecting to a network. It is imperative for daily life's communication. Wi-Fi signal must be made available to connect inside all buildings at the University. This is because all students and faculties make good use of the Wi-Fi connection with their tablets, phones, and laptops, etc. The wireless local area network (WLANs) that will be used in this project network design is (802.11).
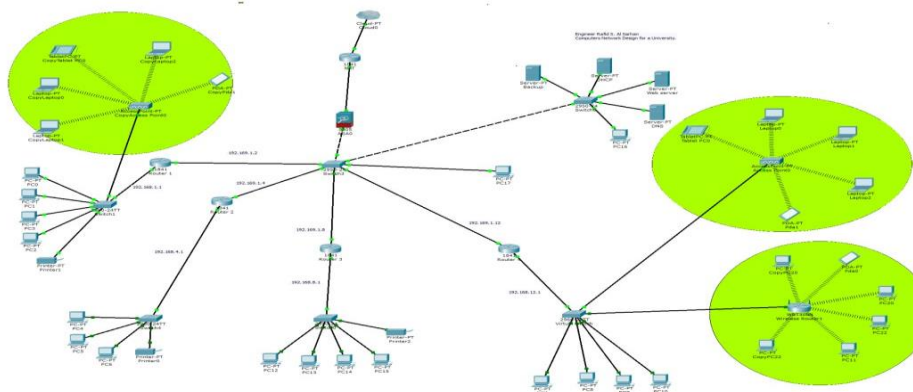

Figure The access point is star topology.

15

6. Security

Due to the constant development of software programs which has led to the increase in the theft and the number of cyber security attacks, security has become important for all hosts on a network. Network security must protect all information and users supplied by a network. Security involves a pro-active prevention process to avert any danger or attack in a network. A computer administrator must be present in order to enforce the security of data access in the network. In terms of securing the network, there are three major aspects to consider. These include Infrastructure, Individual Systems/Components, and Individual Hosts:

6.1 Infrastructure

Infrastructure powers all functions on the network. They include all base devices in the network. When all base devices are protected, the network system will be secured. This is because the data passing from the outside of the local network must pass through those devices into the local network. The devices used for infrastructure in this network design are a virtual switch, back-up systems, firewall, and DNS.

6.1.1 Virtual Switch

A virtual switch or (vSwitch) is a software application that permits correspondence between virtual machines. A virtual switch accomplishes more than simply forward information bundles. It keenly coordinates the correspondence on a network by checking information parcels before moving them to a destination.   In this network design, the Switch is used between the access point and the personal computers as shown in figure
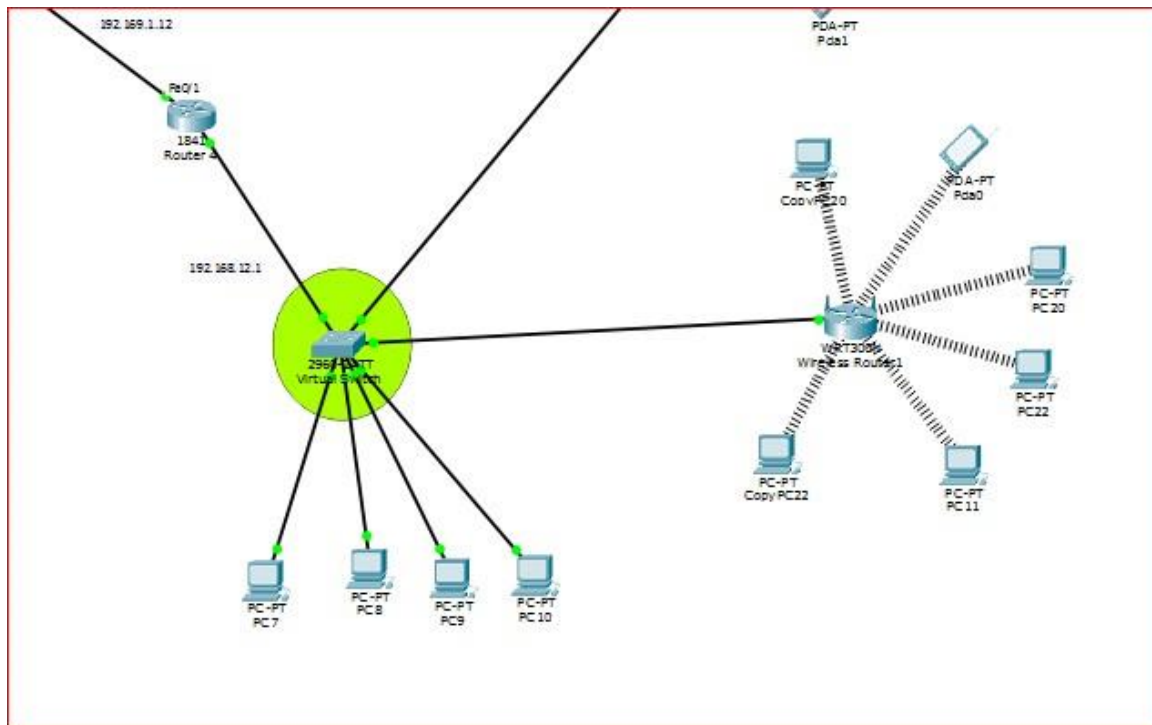
.

Figure 13 Virtual Switch

6.1.2 Firewall

A firewall is a device or software designed to secure the network and its resources from external threats. The firewall is usually deployed where the network is linked to a Wide Area Networks (WAN). Firewall devices will be connected to the Local Area Network (LAN) and NAT system. The firewall prevents external users from gaining access to the network resources and local data.
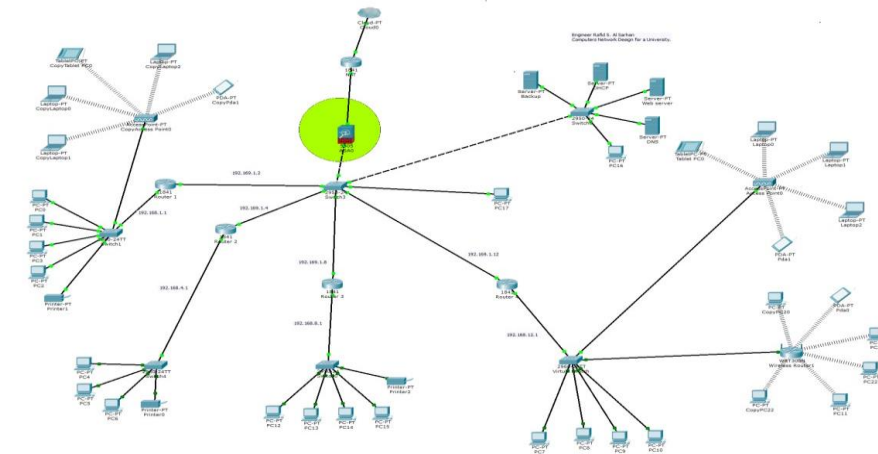
Figure 15 Firewall device

6.1.3 DNS

It is hard for people to remember numbers or the normal form of IP addresses easily. Human readable host name, be that as it may, are much less demanding to utilize, yet require a technique to take steps to the genuine address of the server or remote computer. The Domain Name System (DNS), was produced to direct local and Internet movement to the proper goal by performing real-time look-ups of Internet address with different DNS servers situated on the Internet.

6.2 Individual Systems/Components

All devices in the network system must have a tool for security. This is because each device has an important data. When some devices in the network do not have any tools of security, that device will affect other devices in the network. This is because all devices are connecting to each other.

Figure 17 standard rack for secure internet devices

7. Background Information On TCP/IP

7.1 The Internet Protocol (IP) Address

The internet protocol (IP) address is a 32-bit number. It is divided into two components. The first one is a network address, and the other one is a host address. The name of this division is called subnet mask or slash (/ + number) such as this IP 255.255.224.0/19 which has subnet mask (/19). When changing the subnet from decimal numbers (Human numbers) to binary numbers (Machine numbers), it will become 11111111.11111111.11100000.00000000.

7.2 DHCP (Dynamic Host Configuration Protocol)

DHCP allows each computer to get its IP address automatically from a pool of addresses with said pool being established by the network administrator and managed by a DHCP server. Companies and organizations use this kind of IP configuration most often due to the ease of setup.

7.3 Switches

Switches are devices used on the network to transmit and receive data from one device to another or to many devices depending on the

message intended. A switch provides the full bandwidth of the
network to each port, thereby reducing collisions on the network.
Switches also perform functions from the Data Link Layer (Layer 2
on the OSI [Open Systems Interconnection] Model). If the switch
also performs routing capabilities, then it is considered to be a Layer 3
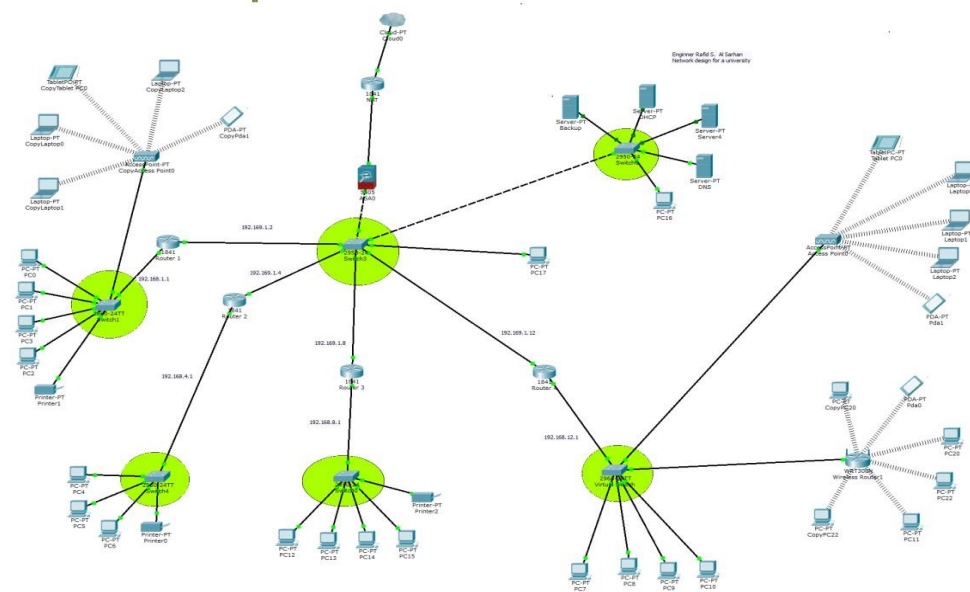switch.

.

Figure 19 Switches in the network

7.4 Routers

A router is a networking device that forwards data packets
between computer networks. The router chooses the best path to
transfer data packets to their destination in the most efficient manner.
Think of a router as a traffic cop at a busy intersection. This traffic
cop makes determinations on which vehicles get through, which
vehicles are not permitted on the path and the destination that the
vehicles may take. The router will control switches in a hyper-star
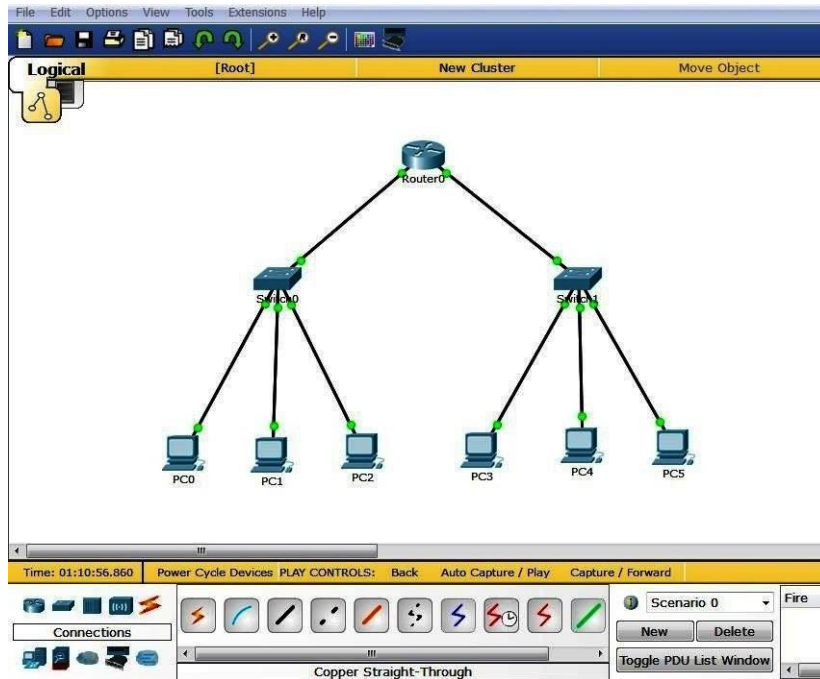topology and computer as shown in the Figure A below.

Figure 20 Hyper-star topology

The figure below clearly shows the Routers configuration

Figure 21 Routers configuration

Static routing is a kind of routing that occurs when a router uses a physically configured routing entry, as opposed to information from a dynamic routing traffic.

Information will not pass through the router to outside the network until the router is configured as a static route. The figure below shows the static route configuration.
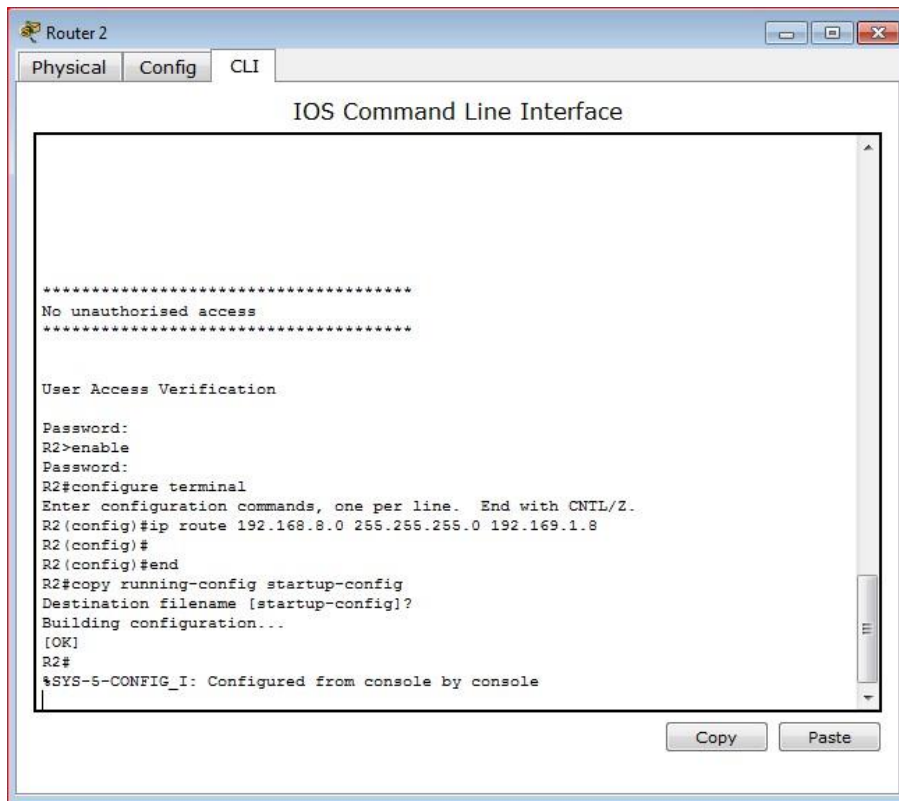
Figure 22 Static route configuration

7.5 Wireless Access Point

An access point is a wireless service device used for networks. Wireless access point service plays a significant role in this design and is very important for educational institutions. The universities must have a wireless network available. This is because it is an important part of communication in education. Students, staff, and faculty make use of wireless services such as the Internet for their laptops, printers, tablets, and smartphones, in a bid to support effective learning and better communication.
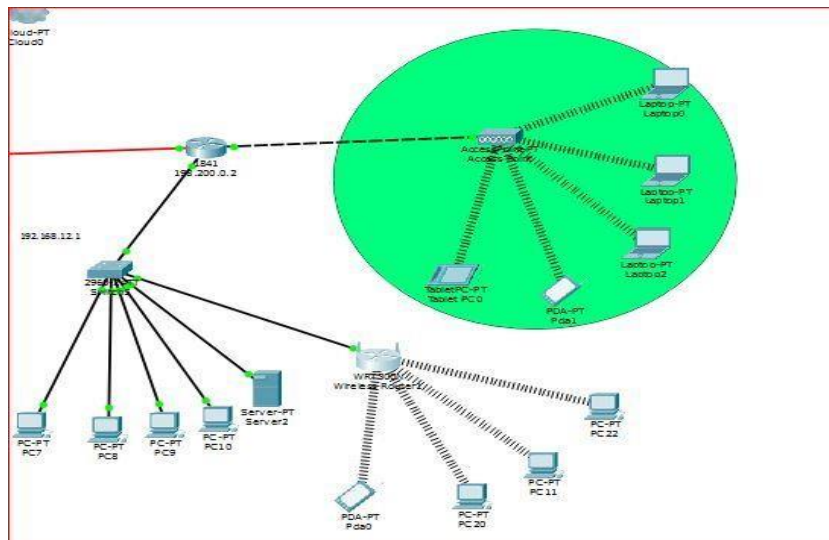
Figure 24 Access point connected with the router

7.6 Servers

The term server refers to a device or a computer program that supports other devices or programs which are called clients. This is known as the client-server model; one server can support many clients and can give different functionalities or characteristics to different clients.

7.6.1 DHCP Server

Dynamic Host Configuration Protocol (DHCP) server will be connected to the switch device in order to connect to many computers. Each computer that is connected to the network needs an IP address. The DHCP will distribute the IP address to each computer (see page 39). Cisco DHCP server is used because it is easy to configure the DHCP device using packet tracer simulation program, as shown below in figure below.
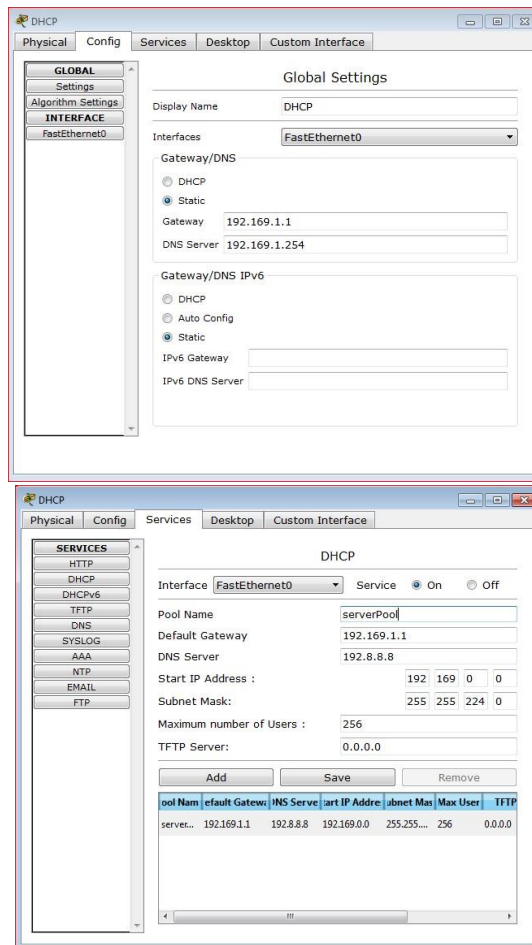
Figure 28 DHCP device configuration

7.6.2. DNS Server

The Domain Name System (DNS) is a server service that maps a domain name to

IP addresses. DNS server translates a domain name to the IP address.

IP address contains 32 bit. Since people cannot easily memorize all

numbers of IP addresses, it is easier for them to memorize domain

names of IP addresses.

9. Conclusion

In this network design, an integrated network design for universities has been presented. This network design is composed of many sections. First, we started to explain the design constraints. Many universities are eager to design a network that meets standards of developed countries but has always been faced with cost implementation barrier. Secondly, this design accounts for challenges that will be faced when designing network in developing countries due to the lack of a rich economy like developed countries. Another challenge that developing countries have is equipment availability, requiring careful selection of components. Also, security is an important section in this network design. Strong security solutions are detailed including as firewall, backup, virtual switch and DNS server options. This configuration includes some software applications, such as antivirus, password, and encrypted passwords.

This design allows for future expansion, as universities using this design can connect 3115 additional hosts, allowing for per host costs, like cabling. The additional hosts can be included without exhausting the available IP address. Also, if there are high budget, they can develop the network system to become more powerful, have a high level of security and many servers can be added to the network.

Lastly, as cheap and effective as the methods of designing a network in this research are, it is not limited to only developing countries. Developed countries that are trying to cut cost in any of their network design projects can also adopt the methods used in this network design.

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