International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

Design and Simulation of a Campus Network that Utilizes Redundant Links (A Case Study of Auchi Polytechnic, Auchi)

Usman Abdul-Rasheed O.[1] Kebiru Abu[2], Nwogbunyama Emeka [3]
[1,3]Department of Electrical/Electronic Engineering Technology, Auchi Polytechnic, Auchi, Edo State, Nigeria
[2]Department of Electronic and Computer Engineering, Nnamdi Azikiwe University Awka, Nigeria

Date of Submission: 01-10-2020 Date of Acceptance: 19-10-2020

ABSTRACT: With the emerging trend of information technology, research has focused on taking advantage of information technology to bring fast and scalable network thereby meeting the increasing demand for services in campus network. Various network designs have been proposed and implemented. However redundancy remains a missing gap in many of the designs. Hence this project proposes the design and simulation of a campus network model that utilizes redundant links with Auchi Polytechnic, Auchi as a case study. A top down methodology was employed in this research paper. A survey of the organizational structure and analysis of technical goals of Auchi Polytechnic was carried out. From the result of the survey, a network model was designed using the hierarchical network design model with three structured layers; The core layer serves as the backbone of the network and the distribution layer which carries majority of the traffic was implemented with redundancy as a major consideration. Redundancy was implemented using a rapid per VLAN Spanning Tree Protocol. The access layer provides connectivity to end users. To ensure security to end users, data and voice traffic were configured on different networks with the help of Virtual LAN. This design was simulated using Packet Tracer 6.2 and Matlab2013B for performance evaluation of packet loss and Round Trip Time (RTT). The results obtained shows that RTT increases when switch interval increases with packet loss at 0%.

KEYWORDS: Switch, Auchi polytechnic, packet Tracer, Campus Network, Router

I. INTRODUCTION

The development of the personal computer brought about tremendous changes for business, industry, service and education. A similar revolution is occurring in data communications and networking. Technological advances are making it possible for communications links to carry more and faster signals. As a result, services are evolving to allow use of this expanded capacity. For example, established telephone services such as conference calling, call waiting, voice mail and caller ID have been extended. Research in data communication and networking has resulted in new technologies. One goal is to be able to exchange data such as text, audio and video from all points in the world. We need to access the internet to download and upload information quickly and accurately at any time [1].

In view of taking advantage of the enormous benefit of communication network for campus environment, various designs have been proposed and implemented. However these designs did not put redundancy into consideration thus, reducing reliability in cases of link failure. This forms the bases for the motivation of this research. With the increasing demand for a fast and reliable service delivery on our campus, communication network remain inevitable. A lot of network have been designed and implemented to bridge the gap between these increasing demand and reliable communication; however, redundancy was not put into consideration. Lack of redundancy in a network can lead to total network failure in cases of link failure. This problem forms the basis for the motivation of this work.

There shall be availability of the infrastructures necessary for the full digitalization of Auchi Poly's academic records, a complete network resource for exchange of ideas and research information. Hence this research provides a platform for quick and effective dissemination of information to students. This paper design includes web-servers for accessing and hosting various Auchi Polytechnic websites. Email Servers are also included for electronic mail communication between lecturers and students [2]. With the emerging trend of information technology, research has focused on taking advantage of information technology to bring fast and scalable network thereby meeting the increasing demand for services in campus network. Various network designs have been proposed and implemented. However, redundancy remains a missing gap in many of the design. The work aims at designing a Campus Network Model that utilizes redundancy at the distribution layer. This paper provides a data communication network solution that is capable of handling and supporting the school's services as well as the transfer of staff and student's information to various departments and units when the need arises.

This rest of the paper is structured as follows: Section II presents an overview of Data communication and network model; Section III describes the design methodology adopted in the course of this research of data collection employed. Data presentation and results are presented in Section IV. Section V concludes the paper.

II. LITERATURE REVIEW

2.1 Data Communication

The word data refers to information presented in whatever form that is agreed upon by the parties creating and using the data. Data communication involves the exchange of data between two devices (a source and a receiver) via some form of transmission medium such as a wire cable. For data communications to occur the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

The effectiveness of a data communications system depends on five fundamental characteristics: delivery, accuracy, timeliness, jitter and reliability

- **Delivery:** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
- **Accuracy**: The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.
- **Timeliness:** The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.
- **Jitter:** Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 30ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result [3].
- **Reliability:** The system must have reliability properties that provide notifications with respect to the delivery of data to the intended recipient.

2.1.1 Components of Data Communication System

A data communications system has five components, which are as listed below:

- **Message:** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
- **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
- **Receiver:** The receiver is the device that receives the message. The location of receiver computer is generally different from the sender computer. The distance between sender and receiver depends upon the types of network used in between.
- **Transmission medium**: The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fibre-optic cable, and radio waves.
- **Protocol:** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese. Figure 1 shows the interrelation between the components of data communication

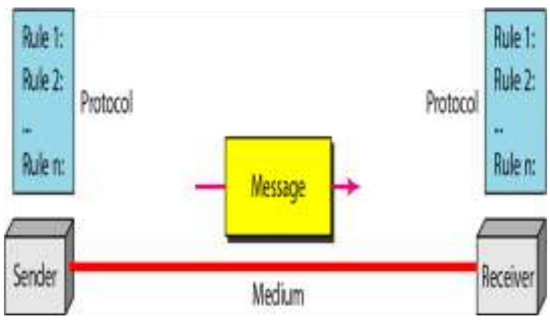

Fig 1: Five Components of Data Communication [3]

2.1.2 Mode of Data Transmission

Mode of data transmission between two Communicating devices can be simplex, half-duplex, or full-duplex.

- **Simplex**: In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive. Keyboards and traditional monitors are examples of simplex devices. The keyboard can only introduce input; the monitor can only accept output. The simplex mode can use the entire capacity of the channel to send data in one direction.
- **Half-Duplex:** In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa. This mode of data transmission is like a one-lane road with traffic allowed in both directions. When cars are travelling in one direction, cars going the other way must wait. In a half-duplex transmission, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time. Walkie-talkies and CB (citizens band) radios are both half-duplex systems. It is used in cases where there is no need for communication in both directions at the same time; the entire capacity of the channel can be utilized for each direction.
- **Full-Duplex:** In full-duplex mode, both stations can transmit and receive simultaneously. The full-duplex mode is like a two-way street with traffic flowing in both directions at the same time. Signal going in one direction share the capacity of the link: with signals going in the other direction. This sharing can occur in two ways: Either the link must contain two physically separate transmission paths, one for sending and the other for receiving; or the capacity of the channel is divided between signals travelling in both directions. One common example of full-duplex communication is the telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time. This mode of data transmission is used when communication in both directions is required all the time. The capacity of the channel, however, must be divided between the two directions [4].

2.2 NETWORK MODEL

A network is a combination of hardware and software that sends data from one location to another. The hardware consists of the physical equipment that carries signals from one point of the network to another. The software consists of instruction sets that make possible the services that we expect from a network [3].

For devices of different manufacturer and underlying proprietary software to communicate without causing any changes to the underlying circuitry system there is need for an agreed standard and model.

2.3 OSI MODEL

The OSI model is a layered framework for the design of network systems that allows communication between all types of computer systems. It consists of seven separate but related layers, each of which defines a part of the process of moving information across a network. The OSI model is composed of seven ordered layers: physical (layer 1), data link (layer 2), network (layer 3), transport (layer 4), session (layer 5), presentation (layer 6) and application (layer 7).

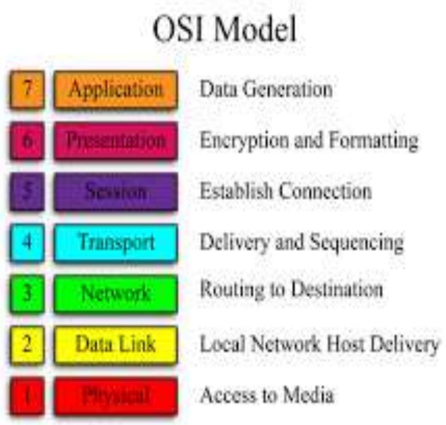

Fig. 2: OSI Model

Within a single device (node), each layer calls upon the services of the layer just below it. Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4. Between devices (nodes), layer x on one device communicates with layer x on another device. This communication is governed by an agreed-upon series of rules and conventions called protocols. The processes on each device that communicate at a given layer are called peer-to-peer processes. Communication between devices is therefore a peer-to-peer process using the protocols appropriate to a given layer [3].

2.4 Local Area Network

Local Area Network (LAN) refers to a group of interconnected computers that is under the same administrative control. In the past, LANs were considered to be small networks that existed in a single physical location. Although LANs can be as small as a single local network installed in a home or small office, over time, the definition of LANs has evolved to include interconnected local networks consisting of many hundreds of hosts, installed in multiple buildings and locations [2].

2.4.1 LAN Topologies and Architecture

Topologies and architectures are building blocks for designing a computer network. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another. There are two types of LAN topologies: physical and logical.

A physical topology describes how devices are physically cabled together, while a logical topology describes how devices communicate across the physical topology. The physical and logical topologies are independent of each other. For example, any variety of Ethernet uses a logical bus topology when devices communicate. This means that in Ethernet, you might be using cat-6 cable with a physical star topology to connect devices together; however, these devices are using a logical bus topology to communicate There are four basic topologies possible: mesh, star, bus, and ring [5].

2.4.2 LAN Architecture

LAN architecture is the overall structure of a computer Network or communication system and determines the capabilities and limitations of the system. LAN architectures are designed for a specific use and have different speeds and capabilities. It describes both the physical and logical topologies used in a network. These are the three most common LAN architectures [2].

- Ethernet
- Token Ring
- Fibre-Distributed Data Interface (FDDI)

2.5 Review of Related Works

In the long run, innovative technology solutions have take over some tasks of the health care personnel if they provide reliable health information adapted to the patient's health, emotional and psychosocial status. This section gives a review of similar work.

In an earlier study [6] designed and implemented a network with data protection where network segmentation was used as a protection mechanism that result in production segment called VLANs for data and voice traffic which restrict access segments. Trucking was also implemented in the VLAN design to enable inter switching; inter VLAN communication between device in the network using the truck ports. Segment isolate and secure different traffic as it traverses the wired network. The work increases the security as the access layer. However security at the Core was not taken into consideration.

The work in [7] designed and simulated an enterprises campus network using OPNET simulator. The voice system design uses a voice over IP (VOIP) which enables the use of routers in transporting voice traffic over an IP network and as well enables voice intercommunication service both locally and remotely without going through public switch network. However, redundancy was not taken into consideration which means failure in an active can result to breakdown of the entire network.

[8].This paper proposed and implements a measure for health care system that control patients flow through the system. The system was evaluated from four perspective which are macro, regional, center, and department wise, in each case reduction of patients delay depends on improving interfaces as patients are transferred to other facilities. The basic tool for resolving delay at interface is through mapping a process where patients are served. They further stated that clinicians and administrators can collaborate to reduce health care delays. Success depends on an ability to understand health care as a system, including the many interactions between patients, clinicians, support services and other resources. Success also depends on an ability to pinpoint the bottlenecks and system failures, particularly with respect to interactions among departments as patients flow through the system

[9]. This paper designed and simulated an enterprise network for a micro-finance bank. The design topology, protocol, configuration, and the network addressing system specified were based on the hierarchical design model which provides an effective connectivity result for both voice traffic and data across an enterprise's network. This provides an assurance for interoperability and correlation to network technologies and protocols. However, a single switch at the distribution layer was used, which means that a failure in the switch can result to break down of the entire network.

.

III. DESIGN METHODOLOGY

The design methodology employed in this research work, is a top-down methodology. Top-down network design is a methodology for designing networks that begins at the upper layers of the OSI reference model before moving to the lower layers. The top-down methodology focuses

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

on applications, sessions, and data transport before the selection of routers and routing protocols, switches and media that operate at the lower layers. This network design process includes exploring organizational and group structures to find the people for whom the network will provide services and from whom the designer should get valuable information to make the design succeed (requirements analysis before technology and protocol selection).

The overall objective of this method of network design is to make the work convenient by dividing it into modules that can be more easily maintained and changed. Network design methodology is discussed as follows;

3.1 Survey

This involves meeting with the client, so as to know the organizational structure and goals. This helps in identifying applications and service requirements of the network to be designed.

Auchi Polytechnic, Auchi is a frontline polytechnic in Nigeria, located in the northern part of Edo State. It has six principal staffs including the Rector and approximately 10,000 staffs and students. There are various activities carried out in the school which requires a well flexible and scalable campus network; Post Office activities, Admission, File Transfer, etc Figure 3 depicts the organogram of Auchi Polytechnic, Auchi.

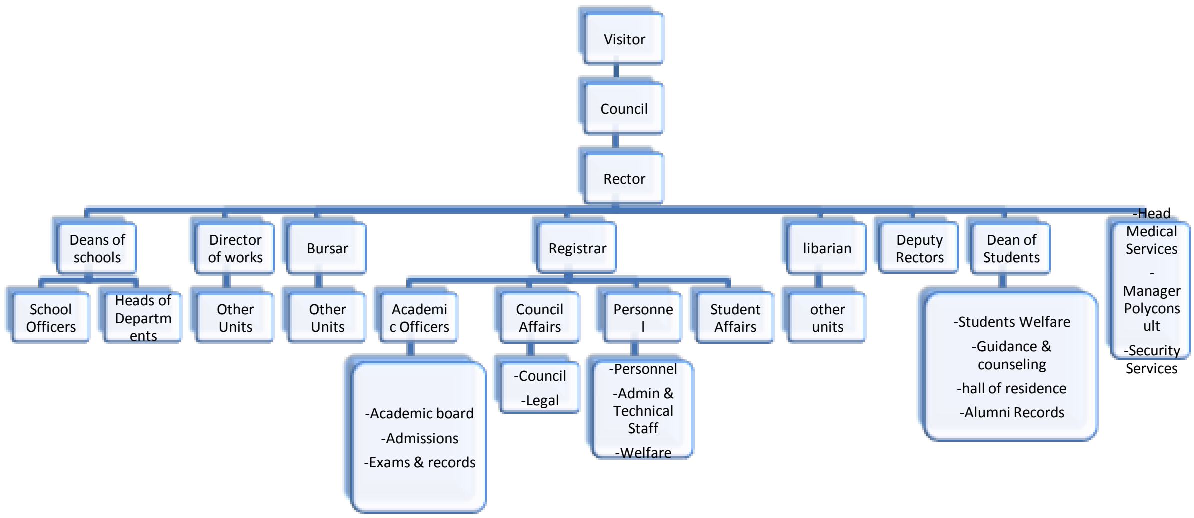

Fig. 3: Organogram of Auchi Polytechnic, Auchi.

With these activities, we deduced that the required services are as follows;

- Web services/Internet – Post office activities, admission, payment portals
- File and Mail Servers – sending and receiving files as well as mails

Making an allowance for population growth, the school requires an IP addressing scheme which can cater for 15000 people easily, to achieve this, the school is divided into eight (8) areas; MIS, Administrative Building, Schools of Engineering, Business, ICT, Environmental, Art & Industrial Design and Applied Sciences.

This division was done based on the estimated population of the area. Each area is assumed to have 1875 people. We do this in order to realize the actual bandwidth to acquire for the purpose of segmentation.

Having met and discussed with the management team of the school with the purpose of obtaining the required services expected of the network, the obtained response was used in analyzing the technical goals of the network.

3.1.1 Analysis of Technical Goals

Network users generally do not think in terms of the complexity of the underlying technology of the communication network. They think of the network as a way to access the applications they need, when they need them without delay. The information obtained from the survey of the network user was used in the analysis

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

of technical goals expected of the network. This helps in knowing which technologies are needed to be considered in the design in order to meet goal of the network user.

Inferentially, when examined carefully, the requirements of the network user translate into five fundamental network design goals which include:

- **Scalability**: This implies that the designed network should be able to grow to include new user groups and remote sites and support new applications without impacting the level of service delivered to existing users.
- **Availability**: Availability refers to the amount of time a network is available to users. This implies that the network needs to deliver consistently with a reliable performance. In addition, the failure of a single link or piece of equipment should not significantly impact network performance; this can be achieved by using redundancy techniques.
- **Redundancy**: Redundancy in a network is a process through which additional or alternate instances of communication mediums are installed within network infrastructure. It ensures network availability in case of failure.
- **Security**: Security is a key technical goal and security design is one of the most important aspects of campus network design. Increased threats from both inside and outside the campus network require the most up-to-date security rules and technologies.
- **Manageability:** No matter how good the initial network design is, the available network staff must be able to manage and support the network. A network that is too complex or difficult to maintain cannot function effectively and efficiently. This brings about the need to ensure the simplicity, modularity and flexibility of the designed network.

3.2 NETWORK DESIGN TOPOLOGY (Logical & Physical Design)

A topology is the map of an internet work that indicates network segments, interconnection points, and their respective user communities. The designed network topology indicates each department has a LAN segment, with all various segment connected to the school campus.

To meet the five fundamental design goals identified earlier, the network needs to be built on an architecture that allows for both flexibility and growth. The design architecture with which this network topology will be built is the hierarchical network design model.

- **Logical Network Design:** This phase of the network design methodology, involves designing of network layer addressing and naming, switching and routing protocols.
- **Physical Network Design:** During the physical design phase, specific technologies and products that realize the logical design are selected. It also involves selection of most appropriate LAN technology that is suitable for the hospital with reference to ACMC hospital network campus design as a reference model.

3.2.1 The Hierarchical Network Design Model

Hierarchical network design model is used in grouping devices into multiple networks. The networks are organized in a layered approach. This help in developing a topology with discrete layers structures, Each layer focusing on specific functions, this in turn gives the opportunity of choosing the right systems and features for each layer.

There are three (3) basic layers that define hierarchical network design model:

- **The Core Layer:-** used as Backbone and Connection of distribution layer devices
- **The Distribution Layer:-** Interconnects the smaller local networks and provides routing
- **The Access Layer:-** Provides connectivity for network hosts and end devices

The three-layer model permits traffic aggregation and filtering at three successive routing or switching levels. This makes the three-layer hierarchical model scalable [9].

3.2.1.1 Core Layer Design Consideration

The core layer is the backbone of the network because all other layers rely on it. It is responsible for transporting large amounts of data quickly and reliably. The only purpose of the core layer of the network is to switch traffic as fast as possible with least possible manipulation, no intensive ACLs, QoS or firewalls is used here, it employs high throughput, high bandwidth switching, high redundancy, duplicated devices or other sites. Below are the design factors considered in designing the core layer network?

- **Fault Tolerance**: this involves elimination of a single point of failure so as to achieve the goal of availability. The core layer is made fault tolerant by using redundant components and technologies
- **Load Sharing**: this allows two or more interfaces or paths to share traffic load, to achieve this, IP routing protocols that support

load sharing across parallel links, even when the cost is unequal is required.

- **High Speed:** the core layer of the network is responsible for transporting large amounts of traffic to all users across the enterprise network, therefore required high bandwidth data transfer with least possible data manipulation.

3.2.1.2 Distribution Layer Design Consideration

The distribution layer represents a routing boundary between the access layer and the core layer. It also serves as a connection point between remote sites and the core layer. The distribution layer of the network is the separation point between the access and the core layer of the network. Below are the distribution layer design considerations:

- Filtering and management of traffic flows
- Access control policy enforcement
- Route summarization
- Routing between access layer VLANs

3.2.1.3 Access Layer Design Consideration

The access layer provides users on local segments with access to the internet. Access layer services and devices of this network reside inside each faculty (school) in the campus network, with a remote site and server farm that make provision for a client and server services. Below are the design considerations at this layer:

- Network access
- Power over Ethernet

3.3 Design of Network Layer Addressing Model of the Network

The Network layer (also called layer 3) manages device addressing, tracks the location of devices on the network, and determines the best way to move data, which means that the Network layer must transport traffic between devices that aren't locally attached. In order to provide effective communication between hosts or stations across networks, each station must maintain a unique identity. This is achieved with the use of IP address [9].

3.3.1 Network Layer Addressing Consideration

In designing the naming and addressing model the following considerations were made:

- Design of a structured model for addressing before assigning any addresses.
- Expandability in the addressing model. To enable future growth in the network.
- Assignment of blocks of addresses in a hierarchical fashion to foster good scalability and availability.
- Assignment of blocks of addresses based on the physical network, not on group membership, to avoid problems when groups or individuals move.
- Usage of dynamic addressing for end systems, in order to maximize flexibility and minimize manual configuration.
- Usage of private addresses for local communication with Network Address Translation for public addressing, in order to maximize security and adaptability.

3.3.2 I P Addressing Model and Assignment

Scalability, Faster routing-protocol convergence, Optimized performance, Support for easy troubleshooting, upgrades, and manageability are all reward of the hierarchical network topology, in order to achieve all of these, there is need for hierarchical naming and addressing model. Hierarchical model of addressing is adopted as the addressing model of the network due to the fact that it facilitates hierarchical routing, which is a model for distributing knowledge of a network topology among intra-network routers. With hierarchical routing, no single router needs to understand the complete topology. Table 1 represents the analysis of user in some department while table 2 represents the analysis of department and their IP address range.

Table 1: Analysis of Users in Various Departments

Faculty	No of Host	Data	Voice	Expansion	Total Expansion
Art & Design	1556	900	50	10%	1712
ICT	1000	800	40	10%	1100
Applied Science	1200	800	32	10%	1320
Environmental	800	500	24	10%	880
Engineering	1600	1000	60	10%	1760
Business Studies	1625	1200	62	10%	1788
Total			256		8560

From table 1, we observe the total number of voice and data users to be 256 and 8560 users respectively.

So we use IP network address of 10.0.0.0 and subnet mask 255.0.0.0 while for voice users' network address of 192.168.10.0 and subnet mask 255.255.255.0

3.3.3 Selection of Switching and Routing Protocol

All faculties have various departments and units. With each faculty forming a separate data VLAN and all the voice traffic forming a separate VLAN in a switched network, the switches need to ensure that traffic meant for a particular VLAN goes to that VLAN and not to any other VLAN. This was accomplished by tagging frames with VLAN information using the IEEE 802.1Q standard. To ensure inter VLAN routing there is need for a layer 2 VLAN trucking protocol. Table 2 below shows selections of LAN technologies and devices.

Table 2: Selection of LAN Technologies and Devices

LAN Technology	Layer of the Network	Devices
Gigabit Ethernet	Distribution	Routers or layer 3 switches
Fast Ethernet	Access	Switches

3.4 DESIGN OF THE PREMISES DISTRIBUTION SYSTEM

This phase of the top-down design methodology involves the design of the network cabling system, with which station nodes (e.g. computers, printers) connects with host equipment (e.g. servers). The prime objective of the Premises distribution system design is to provide uniform wiring capable of supporting both voice and data traffic, thus capable of minimizing the need to modify wiring as the user requirement changes or when technology upgrades are justified.

The premises distribution system design carried out in this project consist of six (6) cabling subsystems which conforms to commercial building telecommunications cabling standard ANSI/TIA/EIA-568-B.1.Below are the six (6) cabling subsystems that make up the premises distribution system design

- Horizontal cabling
- Backbone cabling
- Work area
- Telecommunication room
- Equipment room
- Entrance facilities

3.5 CONFIGURATION AND SIMULATION

The final step in the network design process involves configuration, simulation of protocols and network technologies using packet tracer.

3.6 NETWORK DESIGN FLOW CHART

The network design algorithm represents a structured approach to analyzing user's requirement and developing a network design to suit the needs of the organization, putting into consideration the various phases of the design methodology. Figure 4 present the network design flow chart.

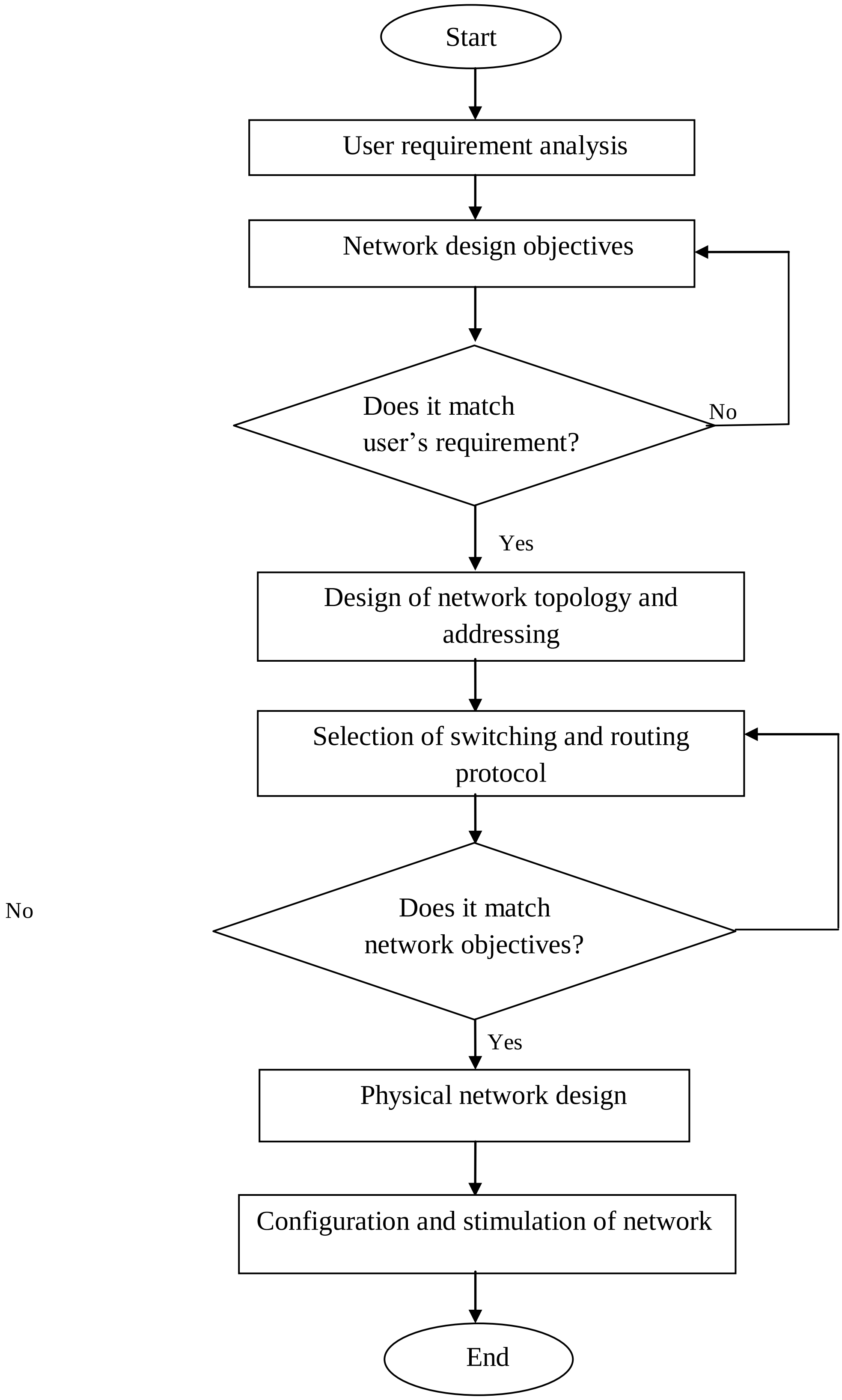

Fig.4: Network Design Flow Chart

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

IV. RESULTS AND DISCUSSION

4.1 Proposed Network Architecture

This section presents the proposed network model, configuration, simulation and results of the network model simulated using packet tracer 6.2 and performance, such as Packet Loss and Routing Trip Time was reported.

Figure 5 depicts the network architecture used for this research.

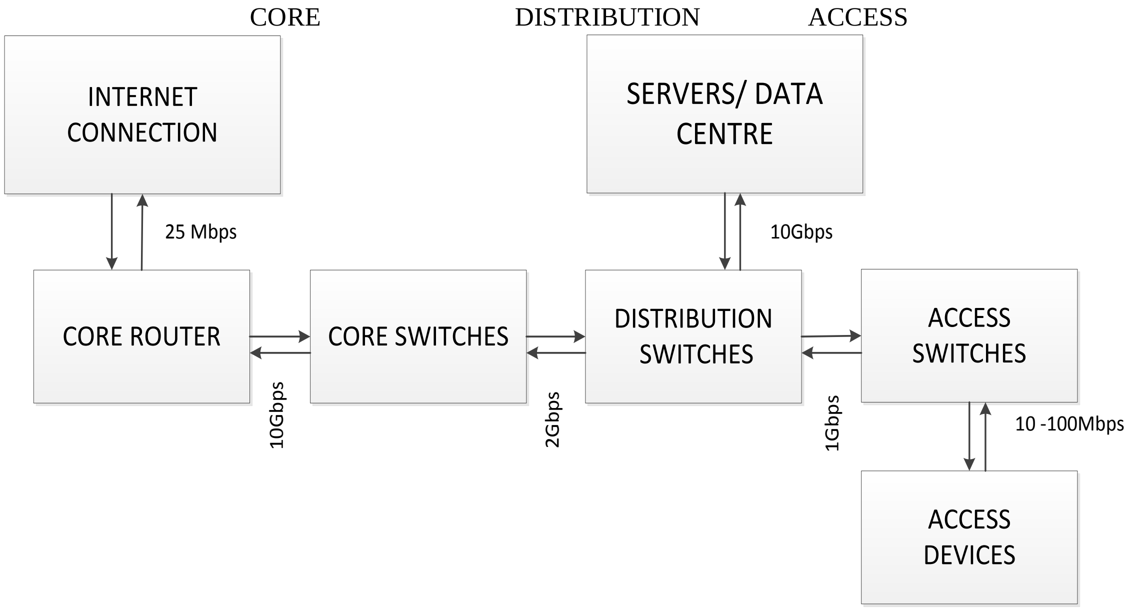

Fig. 5: Network Architecture

The hierarchical design topology consists of three layers; core layer, distribution layer and access layer. The core layer contains one (1) router, two (2) core switches and is capable of switching packets as fast as possible. The distribution layer contains eight switches capable of VLAN switching and defining faculty (school) work group and multicast domain. Access layer is where the end-users (staffs and students) are allowed into the network.

To achieve the functionalities of this layers of hierarchical network model the following devices were used;

Web Server – 1
FTP Server – 1
Mail Server – 1
DNS Server – 1

Core layer

1. Cisco Router 2811 model – 1
2. Cisco Multi-layer Switch – 2

Distribution layer

Cisco Multi-layer Switch – 3
IP phones – 5
PCs – 5

Access layer

Cisco Multi-layer Switch -
IP phones – 23
PCs – 42

4.2 Configuration Information of Router and Switches

The topology used for simulation comprises of administrative block (MIS) and eight faculties with a router also serving as the distribution backbone of the entire network with a layer three switch being used as the access layer network device. Figure 6 shows the Configuration information for router, switches and network topology.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

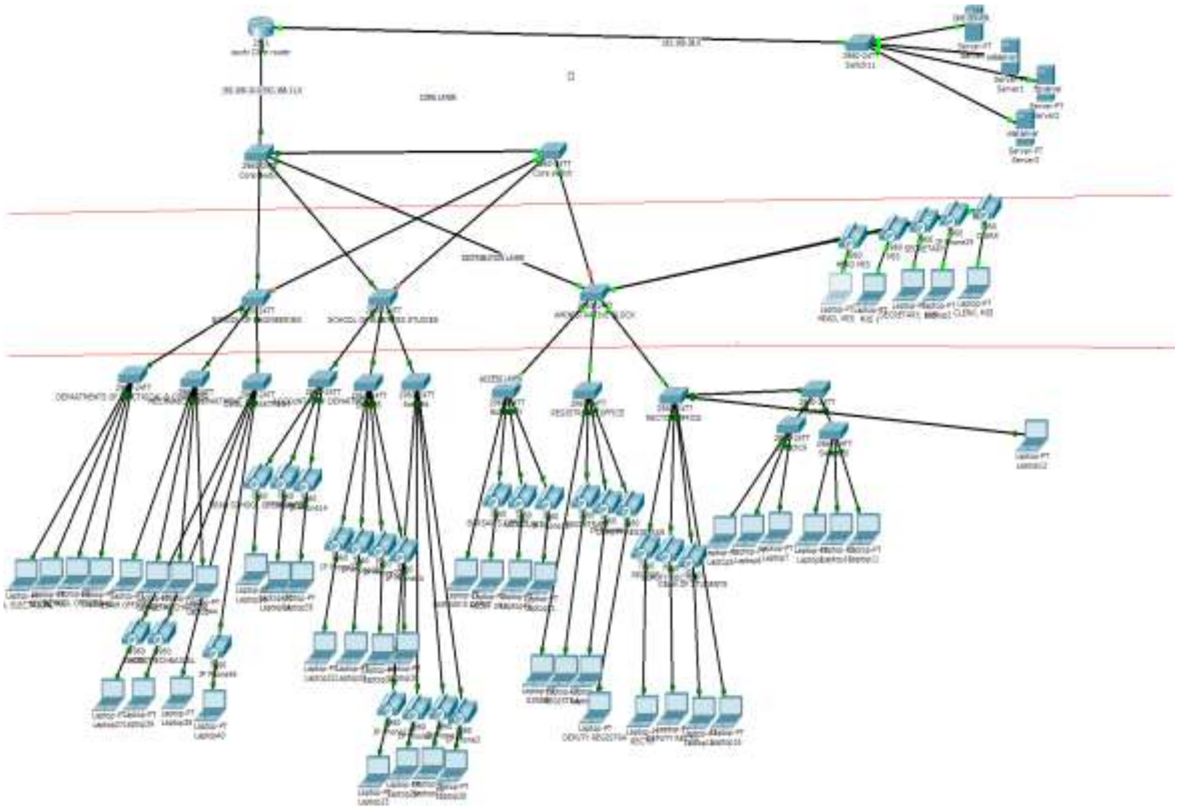

Fig. 6: The designed topology of the Network

4.2.2 Simulation of Proposed Campus Network

The topology simulated has a total of 3 faculties and 10 departments that comprises of the local area network. The network comprises of a data center which houses the entire needed server that provides the core layer service to all department of the school, with the different department of the school group into virtual local area network (VLAN). Each department in the network represents a VLAN of which one is voice traffic and data that cut across the entire department. In order to ensure inter-VLAN traffic goes to the correct interface it was sent to frame were tagged to VLAN traffic using IEEE802.1Q standards. In case of urgency, fast response and communication are required between each department for their services, due to such cases a dynamic addressing system are designed to obtain layer three (3) dynamic addressing for the system and phone directory numbers to address such cases. The network router was configured using static routing protocol.

4.2.3 Server and Data Communication

By means of network design using hierarchical network topology, all the faculties connect to the school campus data center for all server services such as DNS, WEB, HTTP, MAIL and FTP. The figures 7-11 are the results of the server based communication across the school campus network obtained in packet tracer.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

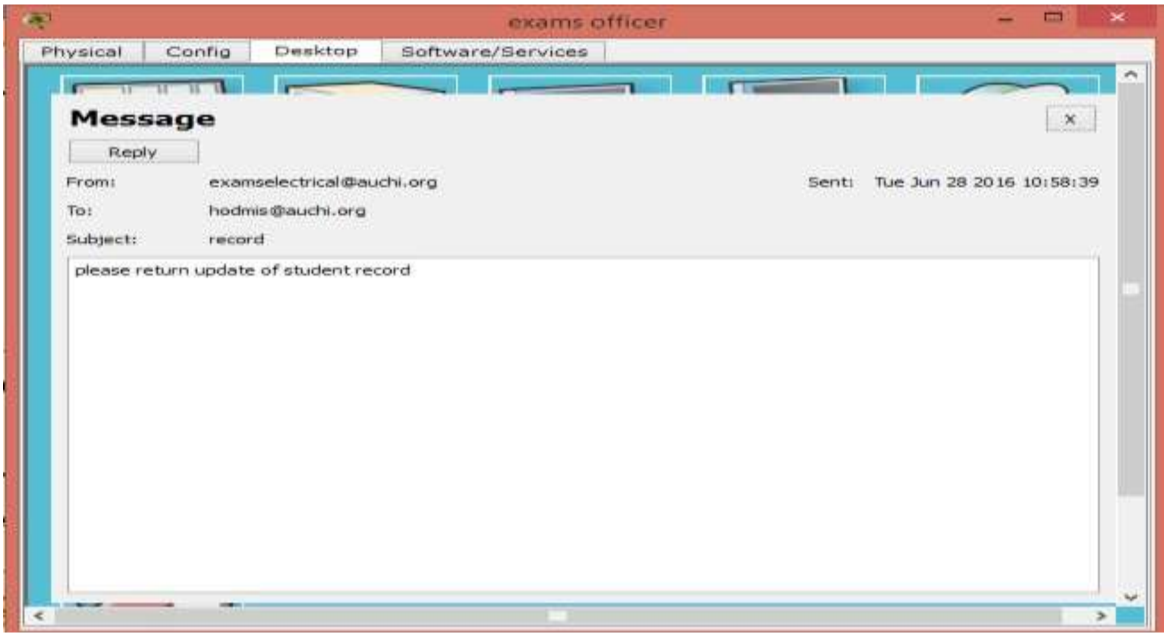

Fig. 7: Mail Sent to the MIS from the Exams Officer

Fig. 8: Configure IP phone (Rector calling the Dean of School of Business Studies)

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 785-799 www.ijaem.net ISSN: 2395-5252

Fig. 9: Dean of Business Receiving the Rector's call

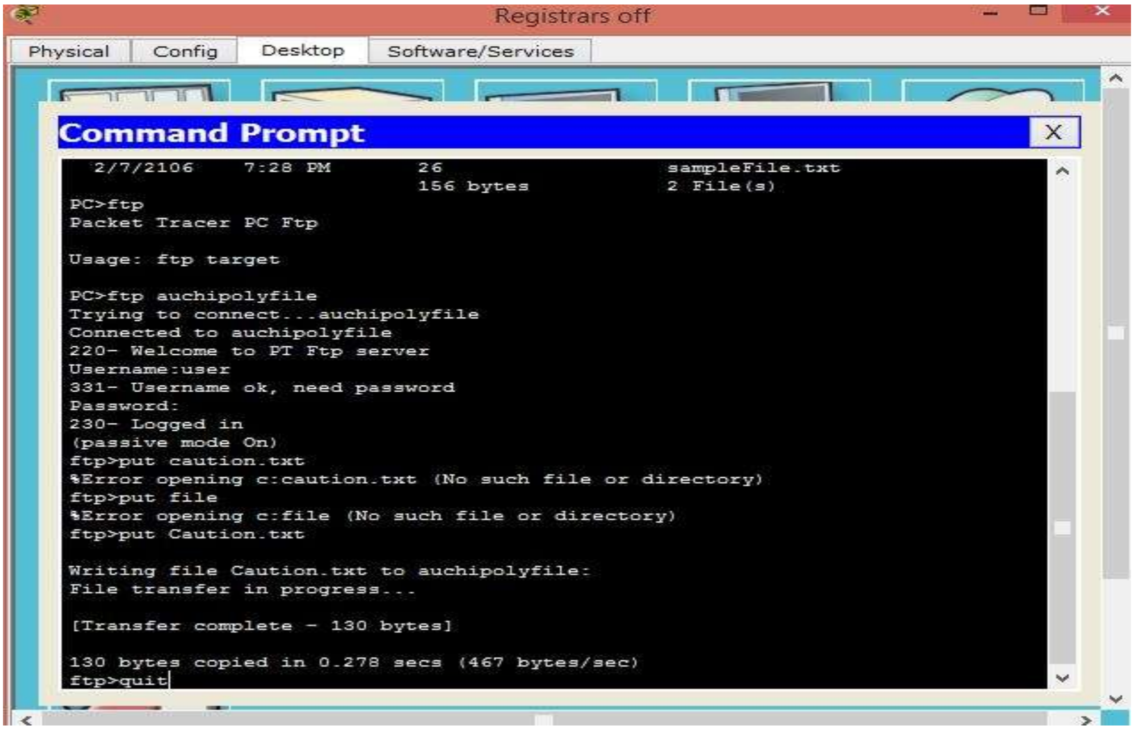

Fig. 10: File Uploaded To the FTP Server

Fig. 11: Snap Shot of a User Surfing the Web/Internet Services

The table below shows the performance results of the system using Packet Loss, Round Trip Time (RTT) and Interval (Switch);

Table 3: Results of Packet Loss, Round Trip Time & RTT.

Interval (Switch)	Packet loss	RTT (milli-secs)
2	0%	9.5
3	0%	10.5
4	0%	15.5
5	0%	21.5

Figure 12 depicts the graph plotted using Matlab2013B and it shows that as the number of

Switch interval increase so does the Round Trip Time (RTT).

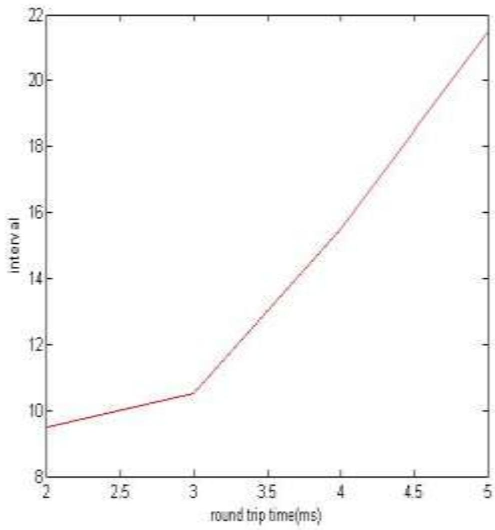

Fig. 12: Graph of RTT Performances (Switch Interval against RTP)

V. CONCLUSION

Communication has grown to become indispensable, especially in the areas of education and business. Indeed considerable numbers of Polytechnics in Nigeria do not currently have stable campus LAN. The benefits of an implemented Campus Network for Auchi Polytechnic, Auchi are numerous. There shall be availability of the infrastructure necessary for the digitization of academic records. A complete network resource for exchange of ideas required for research and hence a platform for quick and effective dissemination of information to students as well as website and email facilities for staffs and students. The network was designed and simulated using packet tracer 6.2 and the Round Trip Time (RTT) of the network was plotted using MATLAB 2013B. From the result obtained the network model shows good performance in terms of RTT and reliability. Hence, this model is expected to showcase good performance for campus environment.

REFERENCES

[1]. Forouzan, B. A. (2007). Data Communications and Networking (4th ed.). New York: McGraw-Hill Higher Education.
[2]. Adedokun S. and Adebola A. A. (2015). “Impact Factors of ICTs in Education. pp 1-7
[3]. Behrouz , (2007). Data communication and networking
[4]. Behrouz. A.F, and. Firouz M. (2012). Computer Network Top Down Approach.
[5]. Tom Olzak (2006, May). “Strengthen data protection with network access controls”. Retrieved October 6, 2020 from https:// www.researchgate.net/publication/228635953
[6]. Jing. Z., (2010). Modeling and Simulation of Campus Network based on OPNET. Msc. Thesis. Xian University of Architecture and technology China.
[7]. Randolph H., David B., Pavan M., and Maged D., (2014). "Modeling patent flows through the Healthcare system. Retrieved October 6, 2020 from https:// www.researchgate.net/ publication/226464688.
[8]. Abdulquradri M.L, (2015). Design and simulation of an enterprise network. Electrical and Computer Engineering. Ahmadu Bello University, Zaria. unpublished.
[9]. [9] Blackhole. (2012). Cisco Certified Network Associate Training Guide.