Pyrex Journal of Computer and Information Systems

Vol 1 (1) pp.1-8 September, 2016

http://www.pyrexjournals.org/pjcis

Full Length Research Paper

Towards improving network installation in Plateau State University Bokkos

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Accepted 21st September, 2016

Abstract

This paper is concerned with the computer networks of few selected Universities in Nigeria. The existing networks of each University will be analyzed and compared in terms of quality of devices and links used on the network, as well as topological layout. The Universities that will be duly considered are Plateau State University Bokkos (PSU), University of Jos (UJ)-only the main campus, and Salem University Lokoja (SUL). Technical Staff of each University will be interviewed for basic information collection, part of which will also be collected and/ or confirmed via observation. Layouts of each University will be designed and simulated for comparative outputs. The design will be done with CISCO Packets Tracer simulator. In the end a suitable requirements will be highlighted for improving installation of computer network in Plateau State University, being a newly established University.

Keywords: Campus Area Network, Network Simulator, Network Design and Simulation, Comparative Analysis.

INTRODUCTION

The performance of any computer network is certainly influenced by the technology, which we adopt in making network interconnections. Network topologies (Banerjee et al, 1999; Cem Erosy and Shivendra PanWar, 1992; C. M. Harris, 2008; D. Bertsekas and R. Gallager, 1992) are the technology for arrangement of various computer elements like links, nodes etc. Basically network topology is the topological structure (Geon Yoon and Dae Hyun Kwan, 2006) of a computer network. In mathematics topology is concerned with the connectedness of objects which is the most basic properties of space. In simple term, network topology refers to the way in which the network of computers (Nicholas F. Maxemchuk and Ram Krishnan, 1993; Bannister, *et al.,* 1990) is connected. Each topology is suited to specific tasks and has its own advantages and disadvantages. A most simple and good example of network topology is a Local Area Network (LAN) (F. Backes, 1988; Li Chiou Chen, 2004). A situation where a node has two or more physical links to other devices in the network, a star topology is described. Which is the most commonly adopted topology in most campuses. In recent days there are basically two categories of network topologies: Physical topologies and Logical topologies. Physical Network Topology emphasizes the hardware associated with the system including workstations, remote terminals, servers, and the associated wiring between assets. Conversely, Logical Network Topology emphasizes the representation of data flow between nodes. This can be represented in a graph model. In this paper, we present the physical topology of the networks under study.

LITERATURE REVIEW

Campus Area Networks (CAN) interconnects LANs with geographically dispersed users to create connectivity (Zubbair S. *et al.,* 2012). Network Topology shows the

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way in which set nodes are connected to each other by links (Qatawneh Mohammed *et al.,* 2015). Network topologies are the technology for arrangement of various computer elements like links, nodes etc. Some of the Technologies used connecting LANs are T1 (William, 1998), ATM (Koichi *et al.,* 1997), ISDN (Jonathan, 2004), ADSL (Michel, 2003), frame relay radio links (Trevor, 1999), amongst others. Technologies are accompanied with various topologies and model of deployment that best suit the technology.

Designing a network for optimal performance and meeting users' need is key in every campus. The imperativeness of properly selecting of equipment's to be deployed after considering the requirements of the users is necessary (Sood, 2007). Evaluating the impact of TCP window size on application performance as against the choice of an increased bandwidth can help boost network (Panko, 2008b). the use of redundant links may also increase performance, implement load balancing and utilise links from say 92% to 55% and response time reduced by 59% (Panko, 2008; Seung-Jae, 2008). From a risk and performance point of view, it is desirable to break a larger campus networks into several smaller collapsed modules and connect them with a core layer (Robert, 1998). Distribution modules are interconnected using layer 2 or 3 core (Tony, 2002). In effect, the layer 3 switches at the server side become a collapsed backbone for any client to client traffic (Graham, 2010).

There could be a limitation of all broadcast and multicast flooding the backbone. A Gigabit Ethernet channel can be used to scale bandwidth between backbone switches without introducing loop. A truncking capacity is necessarily provided into the backbone of any network design (Jerry and Alan, 2009). Hierarchical design is common in practice, when designing campus or enterprise networks (Saha and Mukherjee, 1995; Sami *et al.,* 2002). There is no need to redesign the whole network each time a module is added or removed. Distinct building blocks can be put in-service and taken out of-service with little impact on the rest of the network.

This capability facilitates troubleshooting, problem isolation and network management (Damianos *et al.,* 2002). In a hierarchical design (Saha *et al.,* 1993), the capacity, features, and functionality of a specific device are optimized for its position in the network and the role that it plays. The number of flows and their associated bandwidth requirements increase as they traverse points of aggregation and move up the hierarchy from access to distribution and to core layer (Awerbuch *et al.,* 2000). In network analysis, problems related to network mapping, characterization, sampling, inference and process can be adopted (Eric D. Kolazyk, 2009).

This has to do with identifying the network components; nodes and routing system, which has to do with the analysis of the path. It could also be network mathematical analysis that yields explicit performance expressions (Leonard Kleinrock, 2002).

METHODS

The methods used for survey are questionnaire and observation. After the survey, data collected on the networks will be comparatively analysed for requirements determination, towards improving network installation in Plateau State University. The sample of questionnaire is as follows:

Computer Network Technical Questionnaires

This interview seeks to collect technical Information on the Computer Networks in the various campuses. These shall be Information on LAN Topology, Network Devices Internet Subscription Information, for the selected University Campuses in Nigeria, being administered by Mr. Datukun Kalamba Aristarkus in 2016 to respective technical staff. Your participation in this study is voluntary and will form part of this study and will not identify you as an individual.

Part A- Basic Questions; tick as may apply

1). University: UniJos PLASU ☐ SUL ☐
2). Staff: Technical Administrative ☐ IT ☐

Part B-Survey Interview Questions; tick all that applies

1). Topology of the LAN: Star ☐ Bus ☐ Others ☐
2). Network Devices: Enterprise ☐ Home Basic ☐ Both ☐
3). Network Media: Category ☐ Fiberoptic ☐ State others ☐
4). Bandwidth Subscription: Dedicated ☐ Shared ☐
5). Number of Nodes on Network:50 ☐ 100 ☐ Others, Pleases write Figure
6). Kindly provide the following Information if available on your campus Network: A Network Model or layout, History of Internet Subscription to date. ☐

NB: 1. content coloured red is removed, living only surnames 2, interview questions, taken to last page as appendix 3. These are as specified in reviewers notes

RESULTS

Data collected through survey

DISCUSSIONS

Table 1 below tells us that the type of network on each campus is IP network and IPv4 is what was configured on each LAN installed on the three campuses, which would require upgrade to IPv6, considering the security and other updated advantages. Also, more enterprise devices were used in UJ, then SUL, but, none was used

Table 1. Types of Networks and Devices

Campus	Network Type	IPversion	Types of Devices
UJ (Main Campus only)	IP Network	IPV4	A MODEM, Enterprise Routers, Home basic wireless Routers, access points and Switches
PSU	IP Network	IPV4	A MODEM, Home basic wireless Routers, Access Points and Switches
SUL	IP Network	IPV4	A MODEM, an Enterprise Router and Home Basic wireless Routers, access points and Switches

Table 2. Satellite Connection Equipments, Cables and /or Materials

University	MODEMS USED	Satellite dish	BUC	LNB	Satellite Cable
UJ	Idirect, 3800 series, HNS (Ku-band), Revolution X3	2.4 meters reflector (C-band)	5 watts	2 GHZT	Coaxial
PSU	Revolution X3	1.8 meters reflector (C-band)	5 watts	2 GHZT	Coaxial
SUL	Idirect, 3800 series, Revolution X3, HNS	2.4 meters reflector (C-band)	5 watts	2 GHZT	Coaxial

Table 3: Cabling Materials

University	Category Cable	Fiberoptic Cable	Connectors used
UJ	Category 6 Cable	Used	SC, ST, RJ-45
PSU	Cat 6 and 5e	Not used	RJ-45
SUL	Cat 6 and 5e	Not used	RJ-45 connector

Table 4: Tools or Materials used to carry out Cabling Job

University	Crimping Tools	Land Tester	Conduits/Truncking
UJ	Used	Used	Used
PSU	Used	Used	Use
SUL	used	used	Used

Table 5: Power back up for Internet Service System

University	Inverter	Number of batteries
UJ	Used	Above 10
PSU	Used	About 10
SUL	Used	2

Table 6: History of Bandwidth Internet Subscription in Salem University

ISP/Agent	Bandwidth (U/D)	Link	Band	BUC	Modem	Dish	LNB	Duration
DOPC through Maxfront	256kbps/256kbps-dedicated	VSAT	C-band	5 swatt	Idirect	2.4 Meters Reflector		2008-2009
Maxfront	256kbps/256kbps-dedicated	VSAT	KU-band	5 swatt	Hughes	2.4 Meters Reflector		2009
Sky-Vision through Bologi	128kbps/256-dedicated	VSAT	C-band	5 swatt	Idirect	2.4 Meters Reflector		2010
Lightening Networks	256kbps/512kbps-shared	VSAT	C-band	5 swatt	Idirect	2.4 Meters Reflector		October,2010-December 2010
Vodacom (Gateway)	512kbps/1meg-shared	VSAT	C-band	5 watts	Idirect	2.4 Meters Reflector		June 2011-2012
ASCOM	512/1meg	VSAT	C-band	5 watts	X3 Revolution	2.4 Meters Reflctor		2012-2013
Coolink	3/5MB	VSAT-YASAT	Ka-band		HN9000S	75cm reflector	Norsat	2013

Table 7. History of Bandwidth Internet Subscription in Plateau State University

ISP/Agent	Bandwidth (U/D)	Link	Band	BUC	Dish	LNB	Duration
NCC	128kbps-Shared	VSAT	C-band	2 Watts	1.8 meters reflector		2007-Date

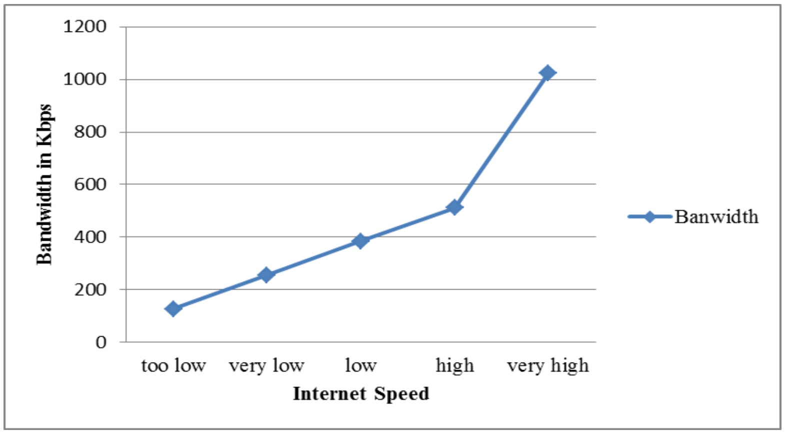

Figure 1. Bandwidth and Internet Speed

Table 8. Straight-through Wire crimping pin arrangements descriptions

Pin Number	Wire colour
Pin1	Orange with White stripes
Pin2	Orange
Pin3	Green with White stripes
Pin4	Blue
Pin5	Blue with White stripes
Pin6	Green
Pin7	Brown with White stripes
Pin8	Brown

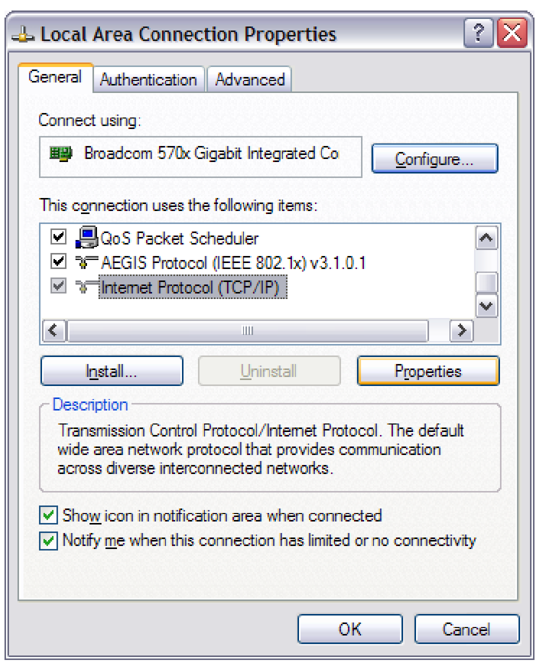

Figure 2. Clients Configuration dialogue

Table 9: Number of Nodes in each University Network

Number of Nodes	Universities	PSU	UJ	SUL
Inter-building nodes		0	15	11
Intra-building Nodes		5	85	39
Total		5	100	50

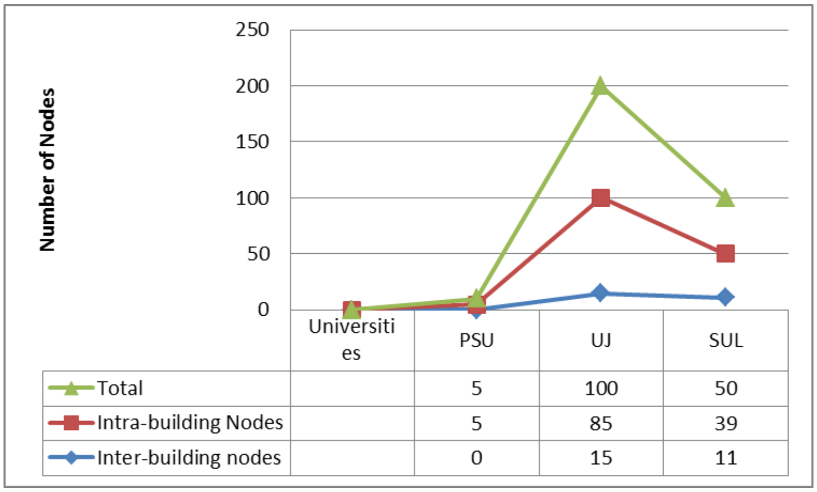

Figure 3. Descriptive graph of Table 9

Table 10. Number of Links in each University Network

Number of Nodes	Universities	PSU	UJ	SUL
Inter-building Links		0	14	10
Intra-building Links		4	85	39
Total		4	99	49

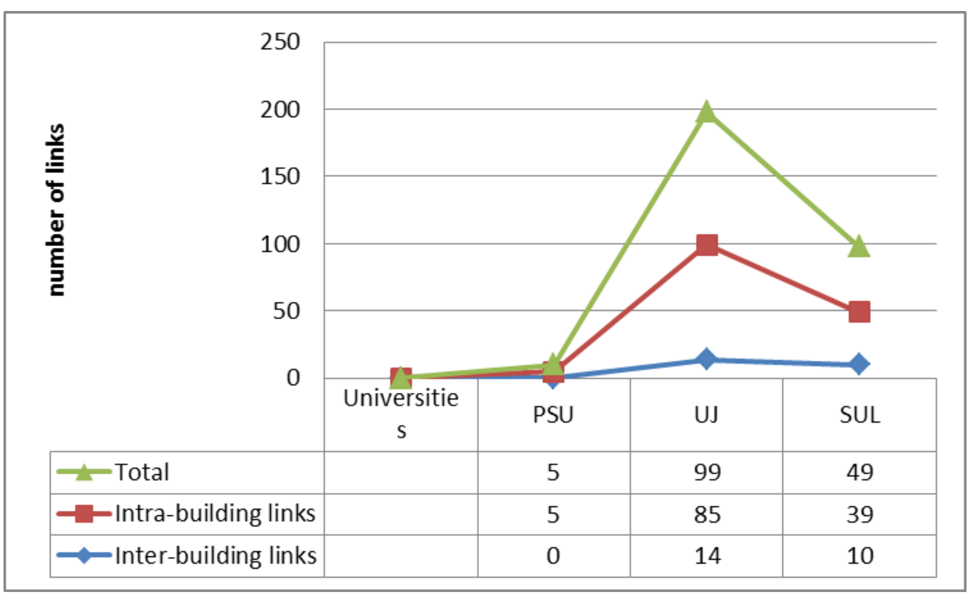

Figure 4. Graphical describtion of table 10

Table 11. Estimated Population

Number of Nodes / Universities	PSU	UJ	SUL
Inter-building Links	200	400	150
Intra-building Links	1200	1500	1100
Total	1400	2000	1250
Approx. Number using Internet at a time	50	200	150

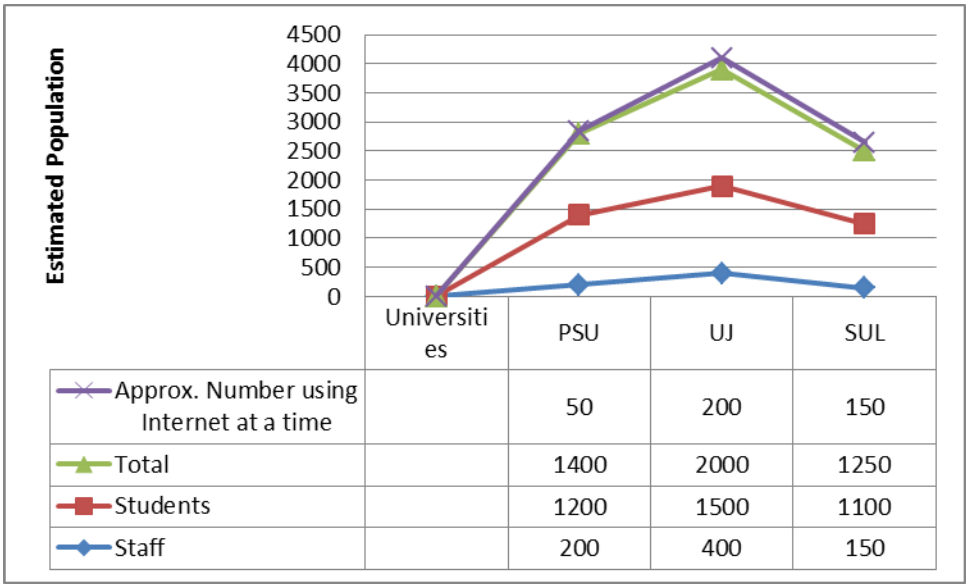

Figure 5. Estimated Population

in PSU. Home basic devices were strictly used in PSU which makes it more susceptible to failure. Table 2 above reveals that the modems used for SAT connection were upgraded already to X3 Revolution with other connection requirements for all the three Universities. C-band dishes, standard BUC and LNB so far were used by the three Universities which was manageable for now, pending subsequent upgrade.

For the cabling system, table 3 describes that cat 6 and 5 were used in all the Universities, but only UJ used fibre optic cable for some inter-building connections of farer distance apart. RJ 45 connectors were used for category cables whereas SC, ST for fibre. PSU need to use fibre also for Inter-building connections of above 100 meters, being maximum required length of category cables, for reliable data transmission across the network. Conduits and trunckings were used for cabling within buildings and short inter-building connections, especially in PSU and SUL as shown in table 4. All the campuses used conduits and trunckings in one way or the other. Also, crimping tools were used to terminate the category cables used while LAN tester used for connectivity tested. All the Universities use battery and inverter as power back-ups as described in table 5. UJ own is more robust, followed by that of PSU and lastly that of SUL.

Table 6 shows us that of SUL, which is more detailed and varying while that of PSU in table 7. From the two tables, we will see that C-band was used by the two Universities, Ku band and Ka by SUL, 2.4 reflector dish by SUL and 1.8 by PSU. We will observe that PSU has been on a very low bandwidth (128Kbps), which has even been shared. But, that of SUL has been changing, whose highest one was 512/1Meg on C-band, giving them the best service, carrying more users, among all their subscriptions. 512Kbps was for upload whereas 1meg for download accordingly. Figure 1 below shows that the higher the bandwidth of an internet subscription, the faster the connection as far as the internet service is concern. When a network topology is good, it will impact the performance of the network reasonably and by implication enhance the internet connectivity. But, Internet bandwidth subscribed at a time determines the connectivity and speed of the Internet, depending also on access load per time. Also, as users increases, the load on the network increases and as the load on a network increases, speed reduces due to congestion. Therefore, bandwidth is a considerable factor in ascertaining the quality of internet service on a network. Here, we say that throughput is an integral part of bandwidth as bandwidth corresponds to entire capacity and through a rate transmissible.

In table 8, wire 1 and 2 transmits signals while wire 3 and 6 receives signals; which are the major wires concerned in making the termination work. This holds for all the Universities in study. The cable crimping for the network links implementation were basically straight-through for all the three campuses. Particularly, category (5e and 6) cables were used with RJ-45 connector. Category 5e or 6 cables can be crimped as either straight-through or crossover cables. Category 5e and/or 6 cable has 8 thin, color-coded wires inside that run from one end of the cable to the other. All 8 wires are used but our major interest will be wires 1, 2, 3 and 6. In a straight-through cable, wires 1, 2, 3, and 6 at one end of the cable are also wires 1, 2, 3, and 6 at the other end. In a crossover cable, the order of the wires changes from one end to the other: wire 1 becomes 3, and 2 becomes 6. Straight-through, being the core interest in the link implementation, it is also feasible to have wires 1, 2, 3, 4, 5, 6, 7 and 8 at one end of the cable also as wires 1, 2, 3, 4, 5, 6, 7 and 8 at the other end.

To determine which wire is number 1, hold the cable so that the end of the plastic RJ-45 tip (the part that goes into a wall jack first) is facing away from you. Face the clip down so that the copper side faces up (the springy clip will now be parallel to the floor). When looking down on the copper side, wire 1 will be on the far left. Below is the tabular form description of arrangement of wires for the termination of straight-through cables according to Cisco standard; the white color is in strip form. In the case of the termination of fibre optic cables, ST and/or SC connectors are of core interest. The IP addressing system currently used on the Campuses' LAN is Class C (ranging from 192….. to 234….), which is the most commonly used on LANs. Specifically, the one in use on the Campuses currently is 192.168.0.1 (gateway), then .2 to .254 for clients on 192.168.0.0 network. Also, SUL and UJ has subnet network containing 192.168.1.1 (used for Internet access), then .2 to .254 for the other segment which is configured on the second Router, running on 192.168.1.0 network.

This connotes that IP addresses are only configured on routers and workstations for unique identification on the Campus Network especially for internet access. A switch is used to extend the network segment length and amplify signals to distant clients but does not have IP addresses.

The DNS IP addresses are; Prefered-212.96.16.61, alternet-212.96.70 from an ISP (Vodacom) in Salem University. Figure 2 describes the clients' configuration based on IPV4. It displays the dialogue box for IP configuration of clients for internet connection. This describe how the IP scheme above is being configured, having installed the network links and nodes. Figure 3 clearly describe table 9, showing the estimated number of nodes in each University under this study while Figure 4 describes table 10, of the estimated number of links, connecting the nodes across the networks. From table 11 and figure 5, we will see that PSU is next to UJ in terms of the estimated population, yet running on less bandwidth compare to SUL as earlier explained. If we assume that the estimated population is equivalent to the expected network load, then PSU ought to have more bandwidth to SUL. But, PSU rather has fewer loads because of the limited bandwidth and because of that, each time more users come on the network, the service goes down.

ACKNOWLEDGMENT

I thank all the Technical staff in each University under study for being patient so far, providing me with relevant information for this research. I also thank my co-authors for all their contributions in gathering and analysing the data of this work.

CONCLUSION

In conclusion, Plateau State University would need the minimum network installation requirements of enterprise devices at router level, then home basic at other levels of network nodes. Fibre optics to be used for inter-building connections and copper for intra-building connections at link levels. 2 meg upload and 1 meg download, dedicated, broadband, c-band, may be manageable for the internet subscription instead of the in-use shared128 Kbps.

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