Taraba State University Campus LAN

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Abstract

This research is necessitated because of under-utilization of computing resources due to lack of a campus local area network in Taraba State University (TSU), Jalingo. Related literatures on design and implementation of campus local area network were reviewed. A hybrid Bus-Star topology and hierarchical model were in the design. This was achieved using Edraw Max 7.9 Network Design Software, AutoCAD, Global Positioning System (GPS) and Google Earth Pro. The research presented a comprehensive TSU–Campus LAN and recommendation for implementation to facilitate enhanced e-learning, online applications and multimedia communication services for all campus residents in TSU, Jalingo.

Keywords: Campus, LAN, Edraw, Topology, TSU

1. Introduction

The increasing trends of development in IT have moved us to information age and the growth in resource sharing has made the world a paperless society (Baha & Ayuba, 2013). The interconnection of computers and devices to enable them communicate has become the trend all over the world today. The scope and sphere of communication has increased significantly with advanced improvement in the last two decades. The expansion in communications technology would not have been possible without the proportional development in computer network. Computer networks mostly, if not all the time, support applications such as data exchange, access to the Internet and the World Wide Web; shared use of software application, storage devices and servers. Other devices supported are fax machines, printers, and use of email applications. The increasing demand for high network performance has challenged network researchers to design network architectures capable of delivering a high quality of service to end users (Mulyawan, 2011).

Mbaocha (2012) designed and developed a workable network model for the Federal of Technology Owerri (FUTO). He outlined the benefits of an implemented Campus Network as digitization of FUTO's academic records, a platform for quick and effective dissemination of information to students, hosting different websites and email facilities for lecturers and students among others. Kachalia (2010) in Mbaocha (2012) stressed that a network should offer secure, reliable, highly available data connections and be scalable for agility to adapt to future requirements. Mulyawan (2011) designed and implemented a campus network using top down approach to meet the need of the increasing range of services needed to enhance LAN in Tarumanagara University. In the design, researcher developed both the logical and physical network designs, which defined the Naming Convention, Layer 2 Design, Layer 3 Design, Network management and performance capability of the enhance system. Onwuemelu (2011) designed and deployed LAN infrastructure in Ahmadu Bello University (ABU), Zaria. The research provided a LAN infrastructure that increased bandwidth and network convergence, which could be relied upon across the 3 campus sites with over 35km radius. The researcher also deployed a Cisco Borderless Network architecture at Ahmadu Bello University, Zaria. The Cisco optic-fibre campus network linked the faculties, halls of residence, digital laboratories and libraries of ABU's three major campuses, Shika, Samaru and Kongo, with a minimum of 2GB connectivity. The new infrastructure enabled ABU to deliver high-speed Internet and intranet access to more than 40,000 students and staff as well as facilitate enhanced e-learning, online applications and multimedia communication services for all campus residents.

The design of TSU Campus LAN is necessary because of the present structures in the university. It has been estimated that in an organization such as tertiary educational community, information is highly essential for correct students' record and examination data (Emmanuel & Choji, 2012). Organizations share data from their database servers in order to facilitate quick business transactions (Baha & Isaac, 2013). Business transactions of university include students and staff records, lecture materials, communication within and outside faculties, and so forth. These business transactions need to be shared through efficient and effective campus LAN. The current system in Taraba State University is a combination of network devices that serve or render poorly available internet service for the usage of a limited number of staff within the Administrative Area of the campus. Figure 1 shows the data flow paths of the network block diagram in the existing system.

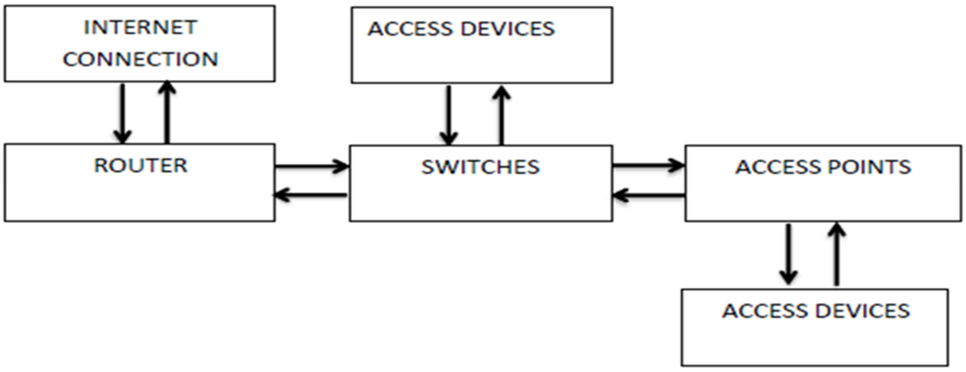

Fig. 1. Network Block Diagram, Showing Data Flow Paths in the Existing System

The existing system is obsolete, ill-equipped, isolated and paper-based manual system. The current system is meant to meet specific purposes of examination conduct for external students, student registration and records only without platform for other academic on-line activities. The benefits of a network environment are unavailable in the current system and hence the need to design a campus LAN for Taraba State University, Jalingo.

2. Materials and Methods

The study used a hierarchical model to break the design into modular layers, which would allow each layer focus on specific function and also simplified deployment and management of the design. These modular layers are access, distribution and core. Two sets of hardware devices to form workable network are:

- Cisco Catalyst 6500 VSS 4T, Cisco Catalyst 4507R+E Switch, Cisco Catalyst 4500 E-Series (10/100/1000 Ethernet, 100-Megabit fibre, gigabit fibre, and 10-Gigabit fibre), HP Mini Tower desktop computers, Cisco 7960 IP phones for offices. (Cisco Inc, 2013); Ubiquiti PicoStation M2 – HP Wireless N-Access Point
- Brocade ICX 7450 (access layer switches) Brocade ICX 7750 and FastIron SX (aggregation layer switches) Brocade MLX (core switches), Ubiquiti PicoStation M2 – HP Wireless N-Access Point

The Plan-Design-Implement-Operate-Optimize network life cycle was used as the algorithm of the proposed system to described the multiple phases of network. The conceptual framework, data source and implementation procedures are detailed in the rest of the section.

2.1 Conceptual Framework

The conceptual framework of the design consists of logical network, physical network and network services. The logical network shows how the data flows in the physical infrastructures. The wired network structure within several buildings should be connected logically through the core Ethernet switches to create a single virtual LAN (VLAN). The design has substantial number of globally routable IPv4 addresses, which are grouped into subnets of varying sizes with each VLAN assigned an IP subnet. One core router acts as the internet gateway, routing traffic to the internet. A core switch or router controls traffic within each VLAN and route IPv4 traffic among the subnets. The host database register all devices attached to the TSU Data Network (TSU-DN), allocates IP addresses as need arises and keep records of the client. This record is use to build data files for Domain Name Service (DNS) and other services. Host database block services to devices that would degrade or disrupt network.

The TSU-DN is wiring of the internal building, fibre optic cabling and network core devices. The design is an Ethernet collapsed backbone to be installed at the TSU central computer centre (TSU-CCC), which connects fibre optic hub sites on the main campus. These fibre hub sites are located centrally at each of the designated and delineated campus network map areas. A typical network plan within a building is described as follows: Ports of Ethernet wall-box connect through copper wires to Ethernet switches in wiring closets, which connects via fibre optic to an aggregated Ethernet switch within the building and then to the TSU-CCC through a grounded fibre optic connection. Wireless network located in most buildings would provide service to wireless clients via wireless access points. The access points uplink to the Ethernet within the building.

The network services, alongside others, to be provided within the campus in the design include:

i. Domain Name Service (DNS) - This translates between names and IP addresses;
ii. DHCP Services – This provides network configuration information to devices;
iii. The RADIUS, which performs admission control to the wireless networks; and
iv. Network Time Protocol (NTP) – this allows devices to synchronize their clocks.
v. TSU Static IP Service – This registers devices attached via Ethernet Service; it provides an unchanging IP address and DNS name to a device.
vi. TSU Mobile IP Service – give a transitory IP address and DNS name (via DHCP) to devices outside their home subnets, those using TSU Wireless Service, and those needing no static IP address.
vii. TSU Wireless Service – gives service to registered wireless devices

2.2 *Data Source*

The source of data acquired for the implementation of the network map was derived from (i) the use of GPS (Global Positioning System) to get the location coordinate of the buildings on campus (ii) physical measurement of the perimeter of the buildings in relation to their location and (iii) the use of Google Earth Pro 7.1.5.1557 software to get the imagery of the landscape and structures on the campus. The Edraw Max 7.9 Network Design Software was used for the design.

These instruments were used to aid in the design of the network map of the campus. The actual distances of the path and cabling of the Network Campus Backbone (NCB) and Campus Building Distribution (CBD) are given in Table 1 and 2.

Table 1: Distances of Network Campus Backbone to various buildings

Building		Length (M)
NCB	Zenith Hall	1608.23
NCB	Faculty of Agric	1071.97
NCB	Medical School	190.64
NCB	Senate	70.30
NCB	Integrated Classroom	205.46
NCB	Fac. Of Science	56.05
NCB	Restaurant	117.92
NCB	Central Library	76.61
NCB	Faculty of Education	58.25
NCB	University Clinic	71.53
NCB	Student Affairs	60.31
NCB	Staff School	130.77
NCB	Admin Block	77.96
NCB	Academic Block	54.56
NCB	Fac. Of Engineering	84.73
		3935.29
	Cable Slack at 10m per run	150.00
	Total	4085.29m
		4.09km

Table 2: Distance of Campus Building Distribution (CBD) Cabling

Building		Length (M)
CBD	Medical School	131.09
CBD	Integrated Class Room	80.47
CBD	Mass Com Studio	108.37
CBD	Prof. Office FAG	38.73
CBD	FAG 1	49.53
CBD	FAG 2	64.49
CBD	CBTE	126.69
CBD	Senate Building	58.67
CBD	Work department	56.36
CBD	Faculty of Engineering	42.80
CBD	Entrepreneur Center	67.72
CBD	Integrated Classroom E	51.44
CBD	Lab Complex E	62.31
CBD	Twin Theater E	56.58
CBD	Central Library	62.78
CBD	Science Lab H	63.92
CBD	Security Office	56.67
CBD	Sa’ad Hall	86.65
CBD	Language. Lab	20.91
CBD	Student Affairs	59.73
CBD	Workshop	154.84
CBD	UNIV Staff School	46.68
CBD	FASS 1	151.64
CBD	FASS 2	101.29
CBD	FASS 3	55.00
CBD	UNIV. clinic	96.30
CBD	PROF Office FED	21.34
CBD	Fac. Of Educ. (FED) 1	13.85
CBD	FED 2	15.95
CBD	Large Hall D	33.53
CBD	E-Library	31.80
CBD	PROF. Office FSC	102.67
CBD	Fac. Of Science(FSC)	33.11
CBD	SIWES	94.96
CBD	New Library	134.54
CBD	Lecture Hall D	43.03

CBD	Academic Block	40.19
CBD	Admin Block	54.76
CBD	Mini Computer Center	84.32
		2655.71
	Cable Slack at 10m per run	390.00
	Total	2945.71
		2.95km
	Network Campus Backbone	4085.29m
	Campus Building Distribution	2954.71m
	Total	7031.00 (7.03kms)

2.3 Implementation Procedure

A GPS system was used to take correct positioning of structures/buildings on the campus. Google Earth Imagery and AutoCAD were also used to draw and develop the network map of the institution. Figure 2 shows the structure of cabling used.

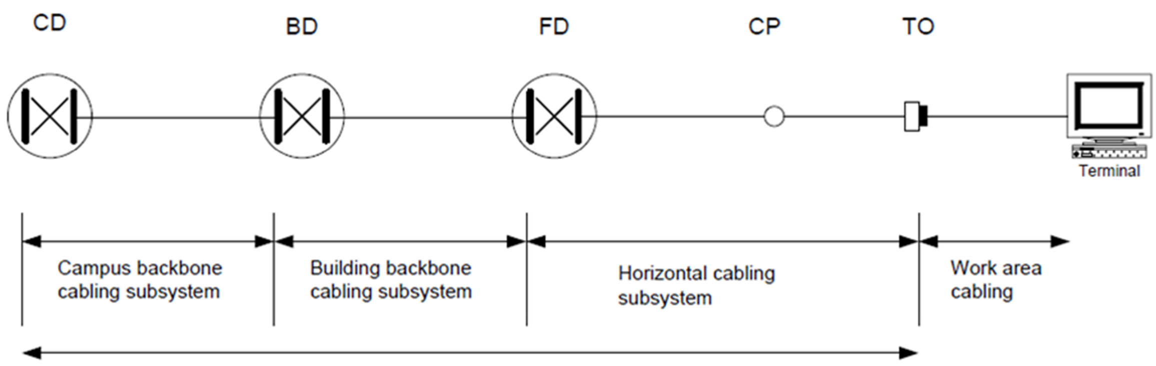

Figure 2: Structure of Cabling (source: Blackbox.Com)

Key: CD: Campus Distributor, BD: Building Distributor, FD: Floor Distributor, TO: Telecommunication Outlet

The deployment details are outlined as follows:

Campus Backbone

(a) Configuring the Core – Routers/Switches

1. Configure the platform
2. Configure LAN switch universal settings
3. Configure the core switch global settings
4. Configure IP Multicast routing
5. Connect to distribution layer

(b) Recommendation: At least two optical fibre cores/strands be provided for every application to be served by the campus Backbone.

A growth factor of 100% for expansion should be provided.

Application:	Fibre Count:
Voice	2
Video (Security)	2
Video (Interactive)	2
LAN (10BASE-F)	2
LAN (FDDI)	4
Data Mux (3 applications)	6
Others	2
Growth	20
Total	**40**

A 40-fiber campus Backbone cable is recommended.

Campus Building Distribution Backbone

(a) Configuring the Distribution Layer

1. Configure the platform
2. Configure LAN switch universal settings
3. Configure distribution global settings
4. Configure IP unicast routing
5. Configure IP Multicast routing
6. Configure IP Multicast RP
7. Connect to access layer
8. Connect to LAN core or WAN router

(b) Cable laying – Fibre-optics

Recommendation: At least two optical fibre cores/strands be provided for every application to be served by the building Backbone.

A growth factor of 100% for expansion is introduced.

Application:	Fibre Count:
Voice	2
Video (Security)	2
LAN (10BASE-F)	2
Others	2
Growth	8
Total	**16**

A 16 - fibre building Backbone cable is recommended.

Building Backbone

Configuring the Access Layer – Switches / Routers

1. Configure the platform
2. Configure LAN switch universal settings
3. Configure access switch global settings
4. Configure client connectivity
5. Connect to distribution or WAN router

The detailed campus network layout of LAN and wireless access of Taraba State University main campus is shown in figure 3.

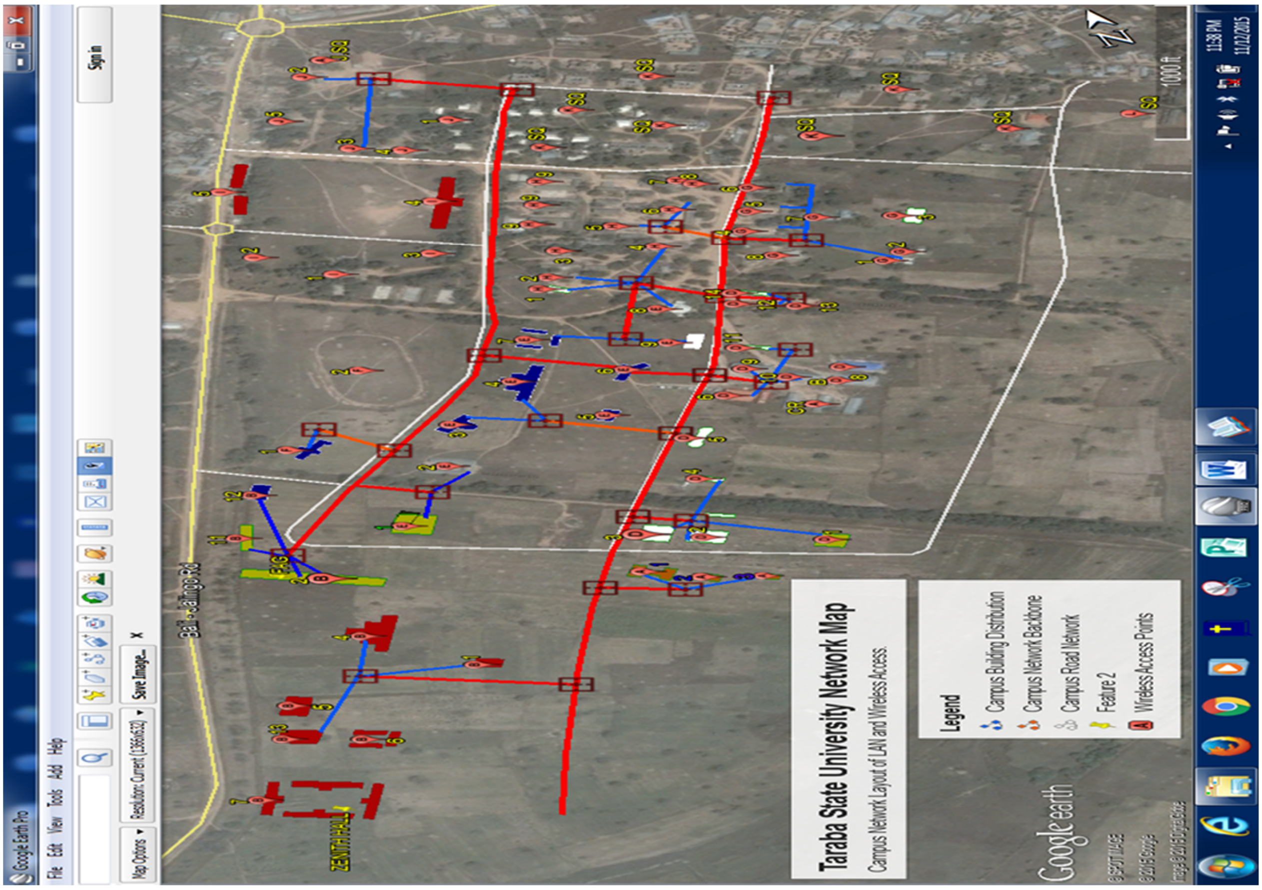

Figure 3: Taraba State University, Jalingo Main Campus Network Map

3. Discussion & Summary

This research work covered the logical and physical design of the campus LAN network of the university. The design used four fundamental technical requirements of network design of scalability, availability, security, and manageability to develop the network. Three distinct steps were taken: Characterization of the existing network, Identification of the requirements of the propose network system, and design and development of the new network system.

The campus land scape was divided into several areas. This enabled and enhanced the use of a Hierarchical Design model. This consisted of three modular layers – Access layer, Distribution layer and Core layer. The University Computer Centre was remodelled to accommodate both the space elements and system requirements of the campus network. The Network Design flow was from University Computer Centre to the Campus Network Core. The campus backbone led to the various Fibre-optics Hubs in the delineated campus areas. The Fibre-optic gave rise to the Network Campus Building Distribution that would connect to the building structures in the area. Floor Distributor Closet, Vertical Floor Distribution cabling, Horizontal Floor Distribution cabling and the Outlet Device Connection emanated from the Campus Building Distribution for the access devices. Wireless LAN could be deployed to give the full coverage of the campus to allow flexibility and unhindered access. Pathways and channels for cabling was incorporated with the choice of appropriated cables, fibre-optics, twisted pairs, connectors etc., in the design. Network devices such as routers, switches, access points, racks and access devices was widely employed in the development of the design.

To eliminate or minimize the challenges envisage in near future, the following deployment strategies have proposed.

- A bus – star hybrid topology.
- 115 switches across the LAN on campus.

- 225 Access points placed at strategic buildings and areas to cover the campus. These are 'clouds' of service in densely populated areas of usage and not a stream everywhere.
- About 7.5km of fibre-optic cables and an estimated 30km of twisted pair cables to covered the existing structures with room for 100% expansion capability.
- Class 3 of the cable structure administration was selected.
- Selected cables are single mode fibre-optics - 1000BASE-LH 1 - Gbps Ethernet over single-mode fibre up to 100 kilometres.
- The category 6A of twisted pair – 10/100/100BASE – T Networks and 10GBase – T Networks can be run on cables up to 100m in length.
- Details of the devices for each building on campus is listed.

4. Conclusion

A full-campus network is one of the most important features of a university infrastructure, which must change and grow continually at a much different pace than other infrastructures in the university. A campus network need to be viewed as a "consumable" like library books, football uniforms, dormitory furniture, electricity, and water. This requires a regular, consistent, predictable source of funding, not just a one-time budget infusion to lay cable.

The paper presented a design of TSU campus LAN, which builds on the previous and existing network layout. We used physical survey methods, simple data flow diagrams, a Global Positioning System (GPS), Edraw Max 7.9 Network Design Software and Google Earth software to accomplish the design. Finally, we demonstrated the need for the implementation and applicability of the design to support teaching and learning process on campus.

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