ORAL

PSE002

TOWARDS A PROPOSED PASSIVE OPTICAL LAN MODEL FOR FACULTIES IN UNIVERSITY OF BENIN

Osa Edosa.
Electrical/Electronic Engineering
University of Benin, Benin City Nigeria
edosa.osa@uniben.edu.
'2348168307508, +23458813708.

Abstract

Due to the ever increasing number of activities in Nigerian Universities be it academic or non- academic over the present ICT driven infrastructures, it is imperative that University faculties have the most efficient and available networks available. In order to foster activities such as research, e -learning and other state of the art communication processes that present day technology has to offer there should be at least a gradual if not total migration of present ICT infrastructures to more resilient and bandwidth capable networks in Nigerian universities. This paper presents a proposed model for optical LAN networks in University of Benin on a faculty basis.

1.0 Introduction

1.1 Legacy Ethernet Network

The traditional networks existing in the faculty of the University of Benin are Ethernet based. Communication over Ethernet could either be half duplex (10mbps) or full duplex (100mbps) though actual throughput is usually a maximum of about 40% the theoretical capacity due to overhead (Todd L. 2013). The University of Benin has most networks deployed using copper Ethernet technology with sparse fibre connections (typically from the ISP or a few data transmission lines from the University Data Centre to distribution layers). A basic Ethernet local area network is shown in Fig 1.

2.0 Statement of Problem

Whereas Ethernet LAN solutions serve various connectivity purposes, there still are significant demerits as highlighted (but not limited to) below.

1. High initial and running cost of core/distribution network components.
2. Cost of cooling heavy duty components in Network Operating Centre (NOC).
3. Distance limitation/restriction (max. distance for Ethernet is 100m).
4. Low capacity for evolution technologies (such as cloud computing, video/audio conferencing, webinars, distance learning, etc.)
5. Requires separate cables to carry different types of data.
6. Can readily be tapped by an intruder without notice leading to security issues.
7. Scalability issues (Bourgeois 2015).

In order to militate against the above challenges and deploy more robust and beneficial networks there is the need to deploy optical LANS (with gigabit passive optical network technology) in the University of Benin.

3.0 Passive Optical Networks

A Passive Optical LAN (POL) shown in Fig 2. is a network model leveraging optical fibre in which unpowered optical splitters are used to allow a single-mode fibre to serve multiple end-users. It consists of an optical line terminal (OLT) in the main equipment room with a number of optical network terminals (ONTs) near the end users. POL reduces the amount of cable and overall equipment required, when compared to conventional Ethernet standards. It uses fibre-optic cable instead of copper and the Gigabit Passive Optical Network (GPON) transmission protocol. GPON is used to deliver commercial and mission critical broadband services to millions of users worldwide (Le Van-Etter 2013). Passive optical LANs are dramatically faster, more efficient, sustainable, cost effective, scalable and adaptable to future requirements than traditional copper-based infrastructure. Optical LANs eliminate the distance constraints, power requirements and heat dispersion issues of copper. They deliver increased network security, performance and operational efficiency (Tellabs 2015).

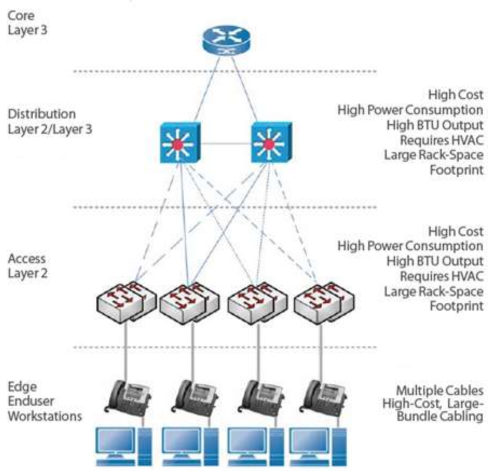

Fig 1.Typical Ethernet LAN Topology.

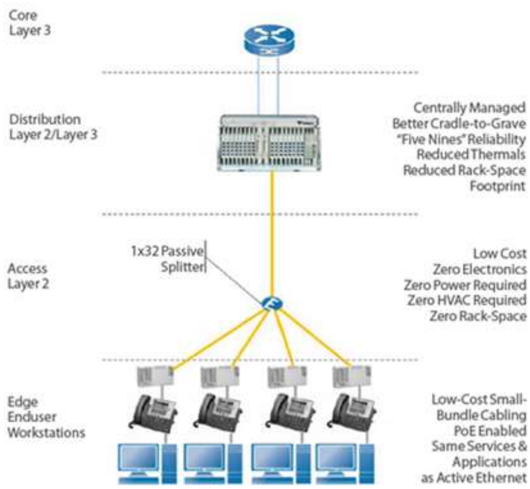

Fig 2. Passive Optical LAN Architecture

3.1 Operation of Passive Optical LAN

Rather than using active switches connected on a multi-link system via fibre backbone cabling and copper horizontal cables to each network device, a POLAN originates at an optical line terminal (OLT) in the main equipment room. Downstream passive optical splitters then split the signal from one single-mode fibre into multiple single-mode fibres that connect to optical network terminals (ONTs) located at work areas. Upstream, signals are combined back to one single-mode fibre, enabling bidirectional communication. The optical signals are transmitted simultaneously in both directions using wavelength division multiplexing (WDM) technology that combines multiple signals over a single fibre using different wavelengths. Downstream signals are transmitted at the 1490 nm wavelength and upstream signals at 1310 nm. The ONUs then distribute the signal wirelessly or via twisted pair data cable to a variety of Internet protocol (IP) enabled devices, such as computers, wireless access points (WAPs), Voice-over-IP (VoIP) phones, etc. Based on bandwidth needs, optical loss budget, density and redundancy, optical splitters are available in several split ratios: 1:8, 1:16, 1:32, 2:8, 2:16 and 2:32. Splitters with lower split ratios offer higher bandwidth per user; splitters with two inputs support redundancy (Bourgeois 2015). Passive optical networks outperform Ethernet in many key criteria such as:

1. **Capacity:** GPON theoretically delivers 2.5 Gbps upstream and 1.2 Gbps downstream (as against 10mbps, 100mbps or 1gbps for Ethernet) on each fibre as such it is possible to converge separate networks (i.e voice, video and data).
2. **Cost:** POL is both cheaper to install and cheaper to run than an Ethernet LAN.

3. **Security:** GPON provides military-grade security using 128bit AES encryption and carrier-grade reliability thus reducing the risk of hacking.
4. **Power Requirement:** A POL network does not require any active components on any floor or even in each building.
5. **Cooling:** Reduced HVAC requirements and costs for cooling racks of active electronics compared to Ethernet infrastructure.
6. **Cabling**: Instead of installing the typical two to four home-run copper cables from the communications closet to every work area, now only one lightweight, small-diameter single-fibre cable can be installed to the ONT (Le Van-Etter 2012).

4.0 Aim/Objective

The aim of this paper is to showcase the inherent benefits of deploying passive optical networks in faculties of University of Benin. This is done by carrying out the objective of designing a proposed passive optical LAN model.

5.0 Methodology

Figure 3. shows the proposed optical network model for faculties in the University of Benin. The model shows six departments but this number can be adjusted as per the number of departments in a particular faculty.

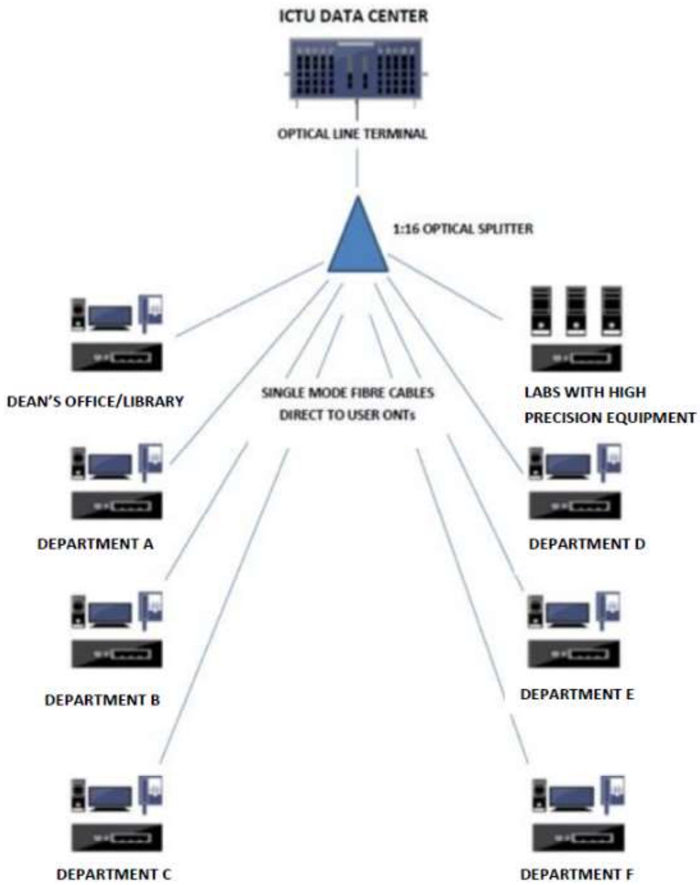

Fig 3. Proposed Optical LAN Model for UNIBEN Faculties.

With the proposed architecture there will be less equipment to operate in the NOC hence less management and cooling required, the distribution layer switches are replaced with a passive 1:16 optical splitter (8 splits are proposed to be operating while 8 more are reserved for expansion or redundant connections) thus reducing operating cost and energy consumption by about 60% (Tellabs 2015) while utilizing space. Each fibre connection to the various departments will have a maximum reach of 12miles (more than enough to overcome any distance limitation) and can carry voice, video and data concurrently thus providing a converged solution. The fibre connection to the laboratories would provide the bandwidth capacity necessary for heavy duty research and data analysis. The connection to the library will provide enough capacity for an enhanced digital library that could accommodate real-time interactions with international correspondents via the web amongst others. In addition the fibre connection to the various departments will provide bandwidth capacity for functions such as video/audio conferencing, webinars, interdepartmental meetings/seminars, etc. This will reduce the necessity for meetings requiring physical presence and as such fatigue level is reduced, it also will provide more than enough capacity for the various departments to create their own internal databases for results, project works, memos, records of seminar activities and other functions. Also the ONTs being of smaller physical structure and less power requirement than the former switches will take up less space and consume less power.

6.0 Conclusion

It is hoped that the university will consider implementation of the model so as to enhance ICT operations in the various faculties and the larger university community.

7.0 References

1.Bourgeois S.,2015 "How You Can Optimize Passive Optical LAN Through Structured Cabling, Belden Inc. Passive Optical LAN Solutions 2015.

2.Nokia, 2016, Nokia Passive Optical LAN for Universities white paper.

3.Le Van-Etter L., 2012, Technology and business drivers for passive optical LANs, 3M Communication Markets Division, Lightwave white paper.

4.Le Van-Etter L.,2013,Design and Installation Challenges and Solutions for Passive Optical LANs White Paper,3MCommunication Markets Division.

5. Techopedia Inc.2016,Local Area Network , http://techopedia.com, Retrieved May 7,2016.

6.Tellabs 2015," Optical LAN Overview white paper.

7.Todd L. 2013, CCNA Switching and Routing Guide, John Wiley & Sons, Inc., Indianapolis, Indiana.

8.**3M** 2015, Passive Optical LAN Solutions, 3M Science Applied to Life.