PERFORMANCE ANALYSIS OF WIRELESS OPTICAL BROADBAND ACCESS NETWORK (WOBAN)

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To my beloved mother, Rohaizah bt Hj Mohd Kassim, my siblings,

and all my lovely friends

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ABSTRACT

This paper presents the study of performance analysis of wireless optical broadband access network. The length of the optical fiber will give an effect to the performance of WOBAN and hence, the investigation of the optimum length is done. WOBAN is the most effective access network because it provide high bandwidth and good scalability with cost effectives. Optiwave Optisystem software tool is used to accomplish the design and performance analysis of WOBAN. The performance analysis is analysed in terms of Power Received, Q factor, Eye Diagram and eye height, and Bit Error Rate (BER).

ABSTRAK

Kertas kerja ini membentangkan kajian analysis mengenai prestasi rangkaian wayales jalur lebar optik *(WOBAN).* Panjang gentian optik akan divariasikan untuk melihat kesan kepada prestasi rangkaian wayales jalur lebar optic *(WOBAN)* dan oleh itu penyisasatan optimum akan dilakukan terhadap system *WOBAN*. *WOBAN* adalah rangkaian akses yang paling berteknologi kerana ia menyediakan jalur lebar yang tinggi, skala yang tinggi dan kos yang berkesan. Perisian Optiwave Optisystem akan digunakan untuk mereka litar *WOBAN* dan menganalisis prestasi *WOBAN*. *WOBAN* akan dianalisis dalam bentuk *Power Received, Q factor, Eye Diagram* dan *eye height*, dan *Bit Error Rate (BER).*

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3G	-	Third-generation
AWG	-	Array Wave Guide
BER	-	Bit Error Rate
BS	-	Base Station
BPON	-	Broadband Passive Optical Network
CO	-	Central Office
DAM	-	Dual Arm Modulator
DFB	-	Distributed Feedback Laser
EPON	-	Ethernet Passive Optical Network
FTTH	-	Fiber To The Home
FTTC	-	Fiber To The Curb
FTTB	-	Fiber To The Building
Gbps	-	Gigabits per Second
GFP-PON	-	Generic Framing Procedure Passive Optical Network
GPON	-	Gigabit Passive Optical Network
HSPA	-	High Speed Packet Access
IEEE	-	Institute of Electrical and Electronic Engineering
ISI	-	Intersymbol Interference
LED	-	Light Emitting Diode
LOS	-	Line of Sight
MAN	-	Metropolitan Area Network
Mbps	-	Megabits per Second

MMF	-	Multi Mode Fiber
NLOS	-	Non Line of Sight
NRZ	-	Non Return to Zero
OFDM	-	Orthogonal Frequency Division Multiplexing
OLT	-	Optical Line Terminal
ONU	-	Optical Network Unit
IL	-	Optical Interleaver
Ps	-	picosecond
PS/C	-	Passive splitters / combiner
PON	-	Passive Optical Network
RZ	-	Return Zero
RF	-	Radio Frequency
RN	-	Remote Node
SMF	-	Single Mode Fiber
SNR	-	Signal to Noise Ratio
TDM PON	-	Time Division Multiplexing Passive Optical Network
WDM PON	-	Wavelength Division Multiplexing Passive Optical Network
WiFi	-	Wireless Fidelity
WiMAX	-	Wordwide Interoperability for Microwave Access
WMN	-	Wireless Mesh Network
WOBAN	-	Wireless Optical Broadband Access Network

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CHAPTER 1

INTRODUCTION

The emerging demand for multimedia communication such as voice, data pictures, video services and internet streaming require for the realization of broadband distribution system. During the past decade, the use of optical fiber as a transmission line experience an enormous growth due to the wide bandwidth it can provide. Wireless Optical Broadband Access Network, (WOBAN) is one of the broadband access networks that use optical fiber as a transmission line from the optical backhaul to the wireless mesh network. The basic purpose of WOBAN is to eliminate wired dropped at every wireless router at end user and the used of fiber optic which give an advantages because it does not need to penetrate to the end user. Moreover, the architecture of WOBAN is a combining of wireless and optical where at the back end is a wired optical network and at the front end is manage by wireless connectivity.

At the back end of the network, optical line terminal (OLT) resides in the central office (CO) and is connected via optical fiber to multiple optical network units (ONU)

[1]. Remote node (RN) will distributed data to the ONU via optical links. At the front end, a set of wireless nodes (routers) forms a wireless mesh network (WMN) [1]. End users are connected to the network through these nodes where the locations are fixed in a wireless mesh network (WMN). A number of selected routers are connected to the ONU which is also mean connected to the optical backhaul. End users send packets to a nearby wireless node and travel through the wireless mesh and reach the OLT via the gateways.

Before WOBAN is developed, the recent trends of the optical access network are a Passive Optical Network (PON). PON is a point to multipoint optical network. In this configuration, it used a different wavelength of channel for upstream and downstream from the central office (Optical Line Terminal) to the Optical Network Unit (ONU). A traditional PON also known as TDM PON which indicate a time division multiplexed where the number of ONU‟s is limited by the splitting loss and by the bit rate of the transceiver in the OLT‟s and ONU‟s. Next is WDM PON which is developed by the high demand of end users as the bandwidth can be very low because it is share by all end users. WDM PON provides excellent stability and may not suffer power splitting loss. In comparison to the traditional PON, WDM PON used multiple wavelengths that can support both upstream and downstream direction. WDM PON creates a point to point link between OLT and each ONU.

1.1 Objectives

The purpose of this paper is to construct WOBAN circuit by using Optiwave OptiSystem. The next objective is to analyze the performance of the Wireless Optical Broadband Access Network by developing a WOBAN circuit by using Optiwave OptiSystem software. To compare between different fiber length as a transmission line between the front end and back end of the network. Finally, the performance of the WOBAN with the best fiber length will be discussed.

1.2 Problem Statement

Due to the high demand from the customers or end users, they are asking for more cost effective communication system that can support anytime, anywhere and any media they want. Moreover, the users of wireless communications are demanding more capacity and therefore higher frequencies. Other than that, since WOBAN is a combining of optical and wireless communications, it presents a compelling solution that optimizes the best of both worlds.

In addition, running optical fiber to every end user may be costly due to the expensive installation cost. Moreover, providing wireless access from CO to every end user may not be possible because of limited spectrum [2]. The users of wireless communications are demanding more capacity, bandwidth and high frequencies [2]. Therefore, the investigation on the effect of optimum optical fiber length towards a better performance in wireless mesh network is required.

1.3 Work Scope

The work scope of this research is to study the architecture of the block diagram of WOBAN. Next, the parameters of the optical backhaul and wireless front end of the network are examined. Moreover, this research concentrates on the performance analysis of wireless optical broadband access network by varying the fiber length of the transmission line of the network. Lastly, the results are analysed based on Power Received, Q factor, Eye Diagram and eye height and Bit Error Rate (BER).

1.4 Thesis Outline

There are five chapters consist in this thesis; Introduction, Literature Review, Methodology, Result and Discussion and Conclusion and Recommendation. Chapter 1 briefly explains the introduction of Wireless Optical Broadband Access Network (WOBAN) and also the objectives of the project that need to be achieved at the end of this project. Problem statement and work scope are also included in this chapter which help the overflow of simulation and thesis writing.

Chapter 2 defines WOBAN for the optical wireless network and Wireless access network. This chapter also explores WOBAN architecture which includes Optical Link Terminal (OLT), Remote Node (RN) and Optical Network Unit (ONU). Other than that, the advantages of WOBAN over the wireline optical are summarized in this chapter. Fiber optic also discussed in this chapter which involves the type of fiber and its comparison, dispersion effect, optical length effect and the advantages of using optical fiber over copper wire. All the information in this chapter is gathered from related journals and fiber optic books with citation.

Chapter 3 focused on methodology of the project. Flowchart and K-Map of the project help the flow of the simulation design and also which parameter needs to be focused. The proposed scheme is introduced in this chapter which define the bit rate used for backhaul and wireless part. Optical fiber length is varied to analyze the performance of WOBAN. In addition, the simulation process of developing WOBAN circuit is included in this chapter. The process involved are by starting OptiSystem, setting the layout, adding component, connecting component, setting the component parameter, setting the parameter sweep, running the simulation and lastly viewing the result.

Chapter 4 explores the result and discussion obtained from the simulation circuit. The results are observed for 15km, 20km and 25km fiber length in term of power received, Q factor, eye diagram and eye height and bit error rate (BER).In this session, the results gained are analysed by referring to the parameter set earlier in the circuit.

Chapter 5 conclude the overall thesis. The best length with the least bit error rate and the best data rate at both optical backhaul and wireless network are explained in this chapter. Recommendations for this circuit are also included.