OCDMA NETWORK PERFORMANCE USING VARIOUS DETECTION TECHNIQUES

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DEDICATION

FOR

MY DAD

Encik Harun bin Hj Umar;

MY MOM

Puan Hamidah bte A. Rahim;

MY FAMILY

AND

MY FRIENDS

.

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ABSTRACT

Advancement in fiber optic technology have made long-haul communications systems reach distance that were once unheard of. This long distance communication is made possible by using modulation techniques that do not require a complex link design which best applied in spectral-amplitude coding optical code-division multiple access (SAC-OCDMA) system. Among several kinds of OCDMA systems, SAC scheme attracts more users because multiple access interference (MAI) can be eliminated completely in the system. In this project, the investigation used different detection schemes namely the modified-AND subtraction detection as well as Complementary subtraction and Spectral direct detection for SAC-OCDMA systems. The performance of mentioned techniques which is implemented with Fiber Bragg Grating (FBG) based encoder/decoder is compared via simulation in downstream and upstream access network at point to multipoint (P2MP) configuration.The simulation will be carried out using OptiSystem version 10 and the performance is characterized through the eye diagram, BER and received power at various bit rate and transmission length. The best detection technique is then verified.

ABSTRAK

Perkembangan teknologi gentian optik telah menyebabkan sistem komunikasi jarak jauh mencapai jarak yang diluar jangkaan. Komunikasi jarak jauh tersebut dapat dilakukan dengan menggunakan teknik modulasi yang tidak memerlukan reka bentuk pautan kompleks yang digunakan dalam sistrm SAC-OCDMA. Antara beberapa jenis sistem OCDMA, skim SAC telah menarik minat ramai pengguna kerana gangguan akses pelbagai (MAI) boleh dihapuskan sepenuhnya dalam sistem tersebut. Dalam projek ini, kajian menggunakan skim pengesanan yang berbeza iaitu pengesanan penolakan Modified-AND serta penolakan pelengkap dan tatacara pengesanan langsung untuk sistem SAC-OCDMA telah diaplikasikan. Teknik-teknik pengesahan akan dilaksanakan dengan menggunakan Fiber Bragg Grating (FBG) sebagai pengekod / penyahkod. Seterusnya perbandingan akan dibuat menggunakan simulasi dalam hiliran dan huluan rangkaian akses dengan konfigurasi di titik ke pelbagai titik (simulasi P2MP) configurasi. Simulasi akan dijalankan menggunakan OptiSystem versi 10 dan prestasi dinilai berdasarkan gambar rajah ‗eye', kadar ralat bit (BER), serta kuasa pada penerima pada pelbagai kadar bit and jarak penghantaraan. Ketiga-tiga teknik pengesanan dibandingkan dan teknik terbaik seterusnya akan ditentusahkan.

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LIST OF ABBREVATIONS

OCDMA	-	Optical Coding Division Multiple Access
LAN	-	Local Area Network
MAI	-	Multiple Access Interference
PIIN	-	Phase Induced Intensity Noise
BER	-	Bit Error Rate
TDMA	-	Time Division Multiple Access
WDMA	-	Wavelength Division Multiple Access
QoS	-	Quality of Service
SAC	-	Spectral Amplitude Coding
SPC	-	Spectal Phase Coding
EDW	-	Enhanced Double Weight
SNR	-	Signal to Noise Ratio
FBG	-	Fiber Bragg Grating
bps	-	Bit per second

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CHAPTER 1

INTRODUCTION

This chapter cover the introduction of the project, background study regarding the project topic, project objective, the problem statement involves, and the scope of work of this projects.

1.1 Project Background

A hybrid optical code division multiple access (OCDMA) over wavelength division multiplexing (WDM) system is proposed for supporting large numbers of subscriber for fiber-to- the-home (FTTH) network. OCDMA technique is getting more attractive due to its several features as its ability to support asynchronous access, bursty traffic, secure transmission and effective cost. It also offers to apply for high speed LAN, because they can allow multiple users to access network simultaneously. Therefore it is desirable to develop several detection techniques that provide the multiple access interference (MAI) elimination capability. For basic detection technique, Spectral Direct detection technique, it only desired spectral chip in optical domain is filtered. This technique is only applied to codes, which is the spectral chip is not overlapped with other spectral chips of other channel. This study is to compare performance of different detection technique using OptiSystem software. All the data obtain from the simulation result is compared. The performance of OCDMA network is characterized through BER and received power.

1.2 Problem Statement

In order to accommodate large numbers of user in a same signal, the system suffers from multiple accesses interference (MAI) effects. Therefore, it desirable to develop a detection technique that can provide MAI elimination capability. For the Spectral Direct detection technique, only the desired spectral chip in optical domain is filtered, so the MAI and Phase Induced Intensity Noise (PIIN) does not exist. But this technique only can apply to the code which spectral chips are not overlapped each other at other channel.

1.3 Project Objective

1. To study and investigate various detection technique for OCDMA network performance
2. To simulate Direct Detection, Complementary Subtraction and Modified-AND Subtraction detection techniques using OptiSystem software
3. To evaluate the data obtain from simulation and verify the best technique

1.4 Scope of Work

The scope of project as follows:

1. In this study the detection technique chosen are Spectral Direct detection technique, Complementary subtraction technique and Modified-AND subtraction technique.
2. The performance comparison between these detection techniques (Spectral Direct detection technique, Complementary subtraction technique and Modified-AND subtraction technique) is to see the MAI elimination capability.
3. These detection technique will be compare in OCDMA network performance application
4. The simulation will be carried out using OptiSystem version 10 and the performance is characterized throught the eye diagram, BER and received power at various bit rate and transmission length.

1.5 Thesis Outline

OCDMA network performance using different detection techniques is a project report consist of 5 chapters. The overall topic contain an elaboration and description that includes Introduction, Literature Review, Methodology, Result and Analysis as well as Conclusion and Recommendation.

Chapter 1 is the introduction of this project in the general term. The problem statement of this project is elaborated followed by the objective need to be achieved when conducted this project. Last but not least the explanations of scope of work in order completed this work.

For chapter 2, it consists of literature review involvement for development of detection techniques of OCDMA systems. This chapter describes the literature review of the current existing projects which related to the detection techniques of OCDMA systems. Explanation will be focused on theory and method being used for their project.

Methodology used in this project is explained in Chapter 3. This chapter discuss on how scope of work is being done and implementation of different detection techniques. This chapter also explain about the calculation involves that used to get the expected result in simulation process.

Chapter 4 is Result and Discussion. This chapter explains the result obtained in the simulation process. The different detection performance then is compared and the best performances of detection technique are chosen.

Lastly Chapter 5 is Conclusion and Recommendation. This chapter explains the overall conclusion and further development or future recommendation that can be applied related to this project.

CHAPTER 2

LITERATURE REVIEW

The literature review starts by reviewing the optical fiber communication. Furthermore, OCDMA system is discussed based on its advantages to other multiple access techniques. This will also include the type of coding technique that used in the OCDMA system. Besides that, this chapter also reviews the effect of MAI to the system involved. Most importantly, this chapter covers the detection technique used in the OCDMA system nowadays.

2.1 Optical Fiber Communication

Optical fiber communication is a communication that uses any type of fiber cable to transmit the data. Any optical communication system consists of three major components, a transmitter, a medium (fiber cable) and a receiver. The transmitter functioning to converts the electrical signal into light and sends it down to the fiber cable. The receiver will receive optical signal and converts it back into electrical signal. The transmission speed using optical fiber communication is very fast and stable; it also has many great advantages compared to the conventional communication system using copper cable.

2.2 Optical Coding Division Multiple Access (OCDMA)

In demanding the higher data rates, along with variable QoS and variable bandwidths, the communications technology has led to remarkable advancement. To meet those requirements, whereas the TDMA and WDMA require complex protocols and extensive hardware, the CDMA systems are much simpler and very easy support the above mentioned services. To offer to the field of fiber optic networks, the optical OCDMA or called as OCDMA has been introduced. The real advantages of CDMA network are derived through properly understanding and exploiting the higher-level network concepts and features present in a multicellular multiple access system whose users fully share common frequency and temporal allocations [1].

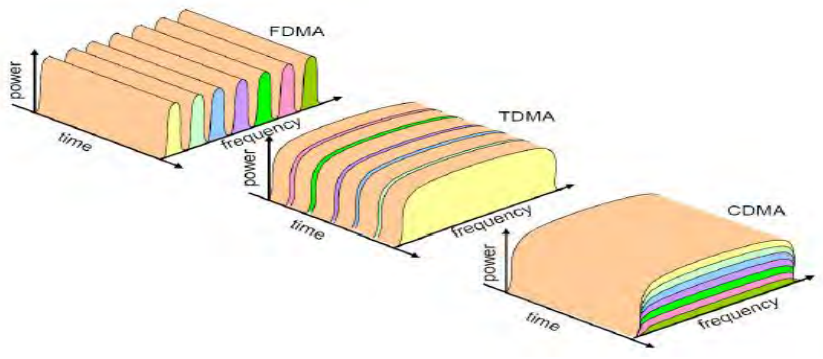

Figure 2.1: Schematic representation of multiple access techniques

OCDMA is a very suitable for multiple access systems. This is because it well suited technology to increase the capacity and the number of users of bursty network due to its _soft blocking' characteristics. OCDMA has potential to enable transmission with variable data rates and variable QoS at the physical layer without use of higher level protocols. OCDMA also has potential to exploit some of the previously untapped bandwidth of the optical fiber, and carry over to the optical domain the benefits CDMA in radio frequency systems such as users sharing spectrum and resistance to detection and jamming.

Due to tremendous interest in applying OCDMA techniques in fiber optic communication, this techniques become popular due to their advantages such as the flexibility in the allocation of the channel, ability to operate asynchronously, enhanced privacy and increased capacity in bursty network, especially direct detection techniques systems that have apply to the high speed LAN because they allow multiple user to access network simultaneously. In the case of data transfer where traffic tends to be bursty rather than continuous, OCDMA can be used for contention-free and zero delay [7].

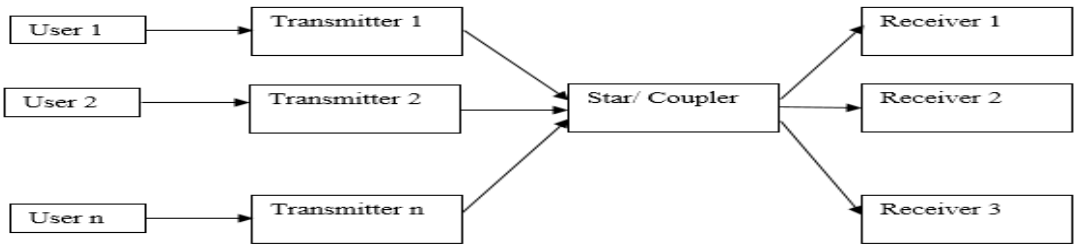

Figure 2.2: General structure of OCDMA system

2.3 Coding Technique

Coding technique operate as the users are assigned unique code which act as the addresses. The codes are unique in the sense that the matched receiver with a matched code word will receive the transmissions correctly whereas the receiver with unmatched code will not be able to listen to the transmission [2]. OCDMA become a suitable multiple access technology where only the desired receiver will be able to listen to the transmission. The codes used as addresses are obtained from the some code family designed to satisfy some basic properties which are off-peak auto-correlation, cross-correlation, code weight and code length so as to yield system performance at the given data rates.

OCDMA systems can be divided into two broad categories based on the way in which particular user‘s code is applied to the optical signal. These classifications are incoherent and coherent OCDMA [3]. In coherent OCDMA systems, a given user‘s code is generally applied via phase coding of the optical signal field, which is often derived from a highly coherent wideband sources such as a mode-locked laser. An incoherent OCDMA system, it typically relies on amplitude-modulated codes rather than directly manipulating optical phase [10].