CHAPTER ONE

INTRODUCTION

1.1 Background

A communication system transmits information from one place to another, whether separated by a few kilometers or by transoceanic distances. Information is often carried by an electromagnetic carrier wave whose frequency can vary from a few megahertz (MHz) to several hundred TeraHertz (THz). Optical communication systems use high carrier frequencies (~100THz) in the visible or near-infrared region of the electromagnetic spectrum. They are sometimes call lightwave systems to distinguish them from microwave systems, whose carrier frequency is typically smaller by five orders of magnitude (~1GHz). Fiber optic communication systems are lightwave systems that employ optical fibers for information transmission. Optical communication systems differ in principle from microwave systems only in the frequency range of the carrier wave used to carry the information. An increase in the information capacity of optical communication systems by a factor of up to 10 000 is expected simply because of such high carrier frequencies used for lightwave systems. This increase can be understood by noting that the bandwidth of the modulated carrier can be up to a few percent of the carrier frequency. Taking, for illustration, 1% as the limiting value, optical communication systems have the potential of carrying information at bit rates ~1Tb/s. It is this enormous potential bandwidth of optical communication systems that is the driving force behind the worldwide development and deployment of lightwave systems. Current state-of-the-art systems operate at bit rates ~10Gb/s, indicating that there is considerable room for improvement.

Figure 1.1: Generic optical communication system

Figure 1.1 above shows a generic block diagram of an optical communication system. It consists of a transmitter, a communication channel and a receiver; the three elements common to all communication systems. Optical communication systems can be classified into two broad categories: *guided and unguided*. As the name implies, in the case of guided lightwave systems, the optical beam emitted by the transmitter remains spatially confined. Since all guided optical communication systems currently use optical fibers, the commonly used term for them is fiber optic communication systems. The term *lightwave system* is also sometimes used for fiber optic communication systems, although it should generally include both guided and unguided systems.

In the case of unguided optical communication systems, the optical beam emitted by the transmitter spreads in space, similar to the spreading of microwave. However, unguided optical systems are less suitable for broadcasting applications than microwave systems because optical beams spread mainly in the forward direction (as a result of their short wavelength). Their use generally requires accurate pointing between the transmitter and the receiver. In the case of terrestrial propagation, the signal in unguided systems can deteriorate considerably by scattering within the atmosphere. This problem, of course, disappears in free-space communications above the earth atmosphere (e.g., intersatellite communications). Although free-space optical communication systems are needed for certain applications and have been studied extensively, most terrestrial applications make use of fiber optic communication systems.

The application of an optical fiber communications is in general possible in any area that requires transfer of information from one place to another. However, fiber optic communication systems have been developed mostly for telecommunications applications. This is understandable in view of the existing worldwide telephone networks which are used to transmit not only voice signals but also computer data and fax messages. The telecommunication applications can be broadly classified into two categories; *long haul and short haul*, depending on whether the optical signal is transmitted over relatively long or short distances compared with typical intercity distances (~100km). Long haul telecommunication systems require high capacity trunk lines and benefit most by the use of fiber optic lightwave systems. Indeed, the technology behind optical fiber communication is often driven by long haul applications. Each successive generation of lightwave systems is capable of operating at higher bit rates and over long distances. Periodic regenerations of the optical signal by using repeaters is still required for most long haul systems. However, more than an order-of-magnitude increase in both the repeater spacing and the bit rate compared with those of coaxial systems has made the use of lightwave systems very attractive for long haul applications. Furthermore, transmission distances of thousands of kilometers can be realized by using optical amplifiers.

Short haul telecommunication applications cover intracity and local loop traffic. Such systems typically operate at low bit rates over distances of less than 10km. the use of single-channel lightwave systems for such applications is not very cost-effective, and multi-channel networks with multiple services should be considered. The concept of a broadband integrated-services digital network requires a high-capacity communication system capable of carrying multiple services. The asynchronous transfer mode (ATM) technology also demands high bandwidths. Only fiber optic communication systems are likely to meet such wideband distribution requirements.

1.2 Problem Statement

Long haul transmission system requirements needed in analyzing links are; the maximum (or possible) transmission distance, the data rate or channel bandwidth and the bit rate error (BER). Based on these requirements, optical communication systems are designed to ensure that the desired performance level can be maintained over the expected system lifetime without over-specifying the component characteristics.

The problems of previous techniques in OCDMA systems might be used in many ways such as using variety codes and another technology for the devices of the system. The disadvantaged of using another codes compared to Modified Double Weight (MDW) code is using too much filter in the design while the MDW code used less than others. Same with the technology used to implement the encoders and decoders which can be implemented using any types of optical filtering technology, including thin-film filters, Fiber Bragg Gratings (FBG's), or free-space diffraction but some of the mention technology might be in high cost.

Therefore, this project is concentrated on the design of encoder and decoder modules of OCDMA system which used MDW code. The encoders and decoders are implemented using the Fiber Bragg Gratings (FBG's). The same types of components used in DWDM systems are useful, with suitable adjustment of the specifications to optimize their performance in an OCDMA system. Encoder/Decoder (Encodec) is a pair of devices or sub-systems required in an OCDMA transmission system; encoder at the transmitter, decoder at the receiver. The function of the encoder is to amplitude-spectrally encode the source according to the specific code it uses.

1.3 Objective of Project

The main goal of this report is to develop an OCDMA encoder and decoder modules to improve the performance of optical network in communication systems. The objectives of this research project are:

a) To develop the encoder and decoder modules by using FBG's.
b) To study the parallel and serial configurations of encoder and decoder modules.
c) To study the performance of newly proposed encoder and decoder modules.

1.4 Scope of Work

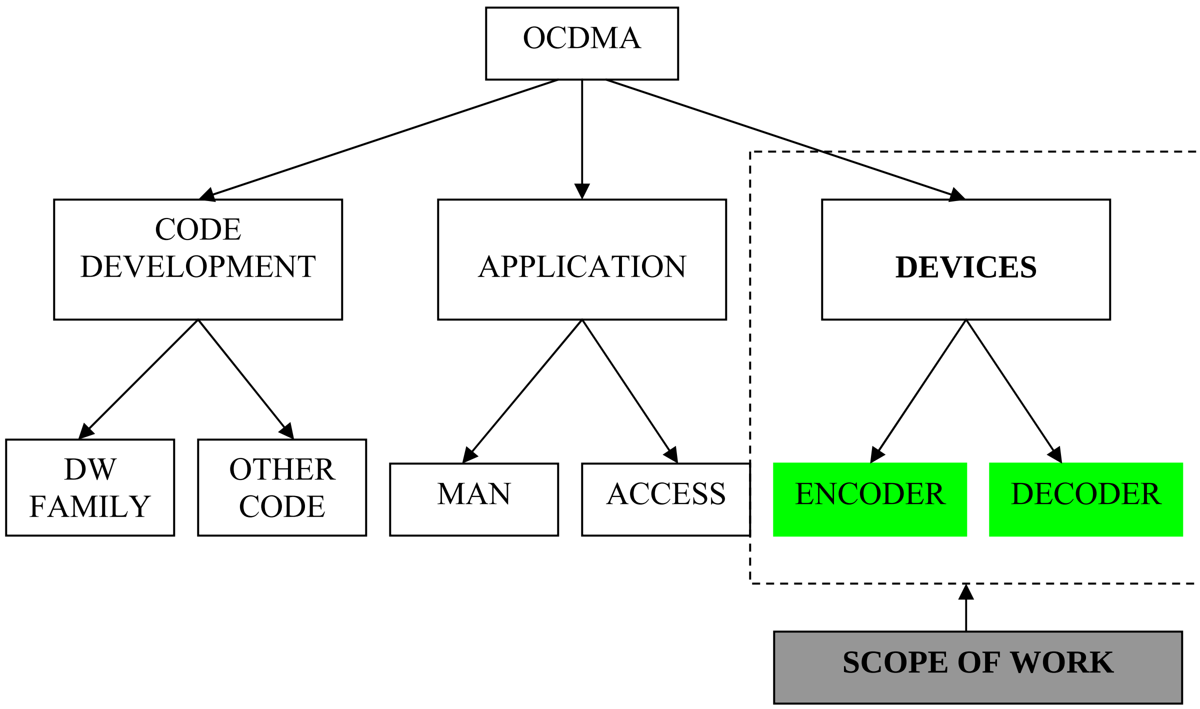

Figure 1.2: A General Study Model of OCDMA System

There are parts in OCDMA system which shows in the Figure 1.2 above. This research project focuses on the device part of OCDMA system. The scope of this study is generally on designing and developing the new OCDMA encoder and decoder modules. The encoder and decoder modules are developed in parallel and serial configuration for a system modulated at 622Mbps with the fiber length 10km.

The study is mainly focusing on the effects of the input power from the power sources and the effect of the bit rate on BER results. The results show that the system will achieve the best system performance when the input power increases. The comparison between parallel and serial configuration's performance are shows in this report.

1.5 Report Overview

This report is divided into five chapters which cover introduction, literature reviews, methodology, results and discussion and conclusion. The backgrounds, problem statement, the scope of work and objectives of this research project have been explained earlier in this chapter.

Chapter Two covers the literature review that explains about the system used in optical communication which is Optical Code Division Multiple Access (OCDMA). Chapter Three focuses in methodology which covers for designs, developments and simulation processes of the parallel and serial configurations of encoder and decoder modules by using the simulation software, OptiSystem Version5.

Chapter Four consists all simulation results from the designing and simulating process covers in previous chapter. It includes the performance graphs and eye diagram from the simulation process. For the last chapter therefore Chapter Five concludes and discusses all the processes from the earlier stages and proposal for the future project in this field.