SIMULATION OF WCDMA RADIO OVER FIBER TECHNOLOGY

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Dedicated to my loving husband & family, ABG HAKIM & MAMA, ANGAH, NINI, AISHAH and my adorable baby HAZIQ.

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ABSTRACT

The demand for broadband services has driven research on millimetre wave frequency band communications for wireless access network due to its spectrum availability, and compact size of radio frequency devices. However, the mm-wave signals suffer from severe loss along the transmission as well as atmospheric attenuation. In other words, upcoming wireless networks will use a combination of air-interface methods in different channels and in different cells that can be changed dynamically to meet variations in traffic conditions. One of the solution to overcome these problem is by using low-attenuation, electromagnetic interference-free optical fiber. Radio over Fiber (RoF) is integration of optical fiber for radio signal transmission within network infrastructures that is considered to be cost-effective, practical and relatively flexible system configuration for long-haul transport of millimetric frequency band wireless signals. This project is about to simulate WCDMA Radio Over Fiber using Matlab Simulink. By doing so, the efficiency can be measured by the performance of BER (Bit Error Rate). The finding of this project is the WCDMA RoF is suite with 3G and 4G application along with increasing users every year whole the world. The conclusion is the simulation of WCDMA RoF was success developed throughout objective.

ABSTRAK

Permintaan yang semakin tinggi dalam perkhidmatan jalur lebar telah membuka ruang para penyelidik untuk mengkaji dan menyelidik dalam bidang komunikasi jalur frekuensi gelombang milimeter untuk rangkaian penyampai tanpa wayar yang bergantung pada ketersediaan spektrum dan saiz kompak sesuatu alat radio frekuensi itu. Walau bagaimanapun, isyarat gelombang milimeter ini terancam kepada gangguan sepanjang proses penghantarannya seperti gangguan atmosfera. Dengan kata lain, perkembangan rangkaian tanpa wayar menggunakan kombinasi kaedah ruang hubungkait udara dalam saluran yang berlainan dan sel-sel yang berlainan yang boleh berubah secara dinamik untuk variasi penyesuaian dalam kondisi bebanan. Antara jalan penyelesaian untuk mengatasi masalah tersebut ialah menggunakan pengecilan yang rendah, gentian optik bebas gangguan elektromagnetik. Isyarat radio menggunakan gentian diintegrasikan dari gentian optik untuk penghantaran isyarat radio dalam rangkaian infrastruktur yang mempertimbangkan kos-efektif, praktikal dan sistem konfigurasi fleksibel secara relatif untuk penghantaran jarak jauh isyarat jalur frekuensi tanpa wayar. Projek ini berkisar dengan simulasi WCDMA isyarat radio dalam gentian menggunakan perisian Matlab Simulink. Dengan itu, keberkesanannya boleh diukur melalui kadar kesalahan bit (BER) yang diperolehi dari simulasi tersebut. Projek ini menemukan penggunaan WCDMA isyarat radio dalam gentian ini sangat sesuai digunakan bagi pembangunan sistem 3G dan 4G dengan pertambahan pengguna setiap tahun di seluruh dunia. Kesimpulannya, simulasi ini berjaya dibangunkan mengikut objektif projek.

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AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BS	Base Stations
DWDM	Dense Wavelength Division Multiplex
EDFA	Erbium Doped Fiber Amplifier
FDD	Frequency Division Duplex
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile Communications
IF	Intermediate Frequencies
IMDD	Intensity Modulation and Direct Detection
ITS	Intelligent Transport Systems
IVC	Inter-Vehicle Communication
LAN	Local Area Network
MBS	Mobile Broadband System
MS	Mobile Station
MVDS	Multipoint Video Distribution Services
OFDM	Orthogonal Frequency Division Multiplexing
OTDM	Optical Time Division Multiplexing
POF	Polymer Optical Fiber
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying

RAP	Radio Access Point
RF	Radio Frequency
RFI	Radio Frequency Interference
RHD	Remote Heterodyning and Detection
RIN	Relative Intensity Noise
RS	Remote Station
ROF	Radio Over Fiber
RVC	Road-to-Vehicle Communication
SC	Switching Centre
SMF	Single Mode Fiber
TDD	Time Division Duplex
UMTS	Universal Mobile Telecommunication Systems
UTRA	Universal Terrestrial Radio Access
WBMCS	Wireless Broadband Mobile Communication Systems
WCDMA	Wideband Code Division Multiple Access

CHAPTER 1

INTRODUCTION

1.1 Introduction

Radio over Fiber (RoF) application has attracted much attention recently because of the increasing demand for capacity/coverage and the benefits it offers in terms of low-cost base station deployment in macrocellular system. RoF systems are now being used extensively for enhanced cellular coverage inside buildings such as office blocks, shopping malls and airport terminal. RoF is fundamentally an analog transmission system because it distributes the radio waveform, directly at the radio carrier frequency, from a central unit to a Radio Access Point (RAP). Note that although this transmission system is analog, the radio system itself may be digital such as GSM.

Mainstream optical fiber technology is digital. Telecommunication networks use synchronous digital hierarchy transmission technology in their cores. Fiber-based data networks such as fiber distributed data interface and gigabit Ethernet all use digital transmission. Fiber transmission links to base stations in mobile communications systems are digital. Digital optical fiber transmission links are therefore ubiquitous in telecommunications and data communications, constituting a high volume market worth billions of dollars worldwide.

Wideband Code Division Multiple Access (WCDMA), air interface can now is regarded as a mature technology ready to provide the basis for the third generation wireless personal communication systems, known as 'Universal Mobile Telecommunication Systems' (UMTS). These systems will make extensive use of microcells and picocells in order to deliver high bandwidth services to customers. WCDMA also known as third generation systems. The systems are designed for multimedia communication can be enhanced with high quality images and video and access to information and services on public and private networks will be enhanced by the higher data rates and new flexible communication capabilities of third generation systems. This together with the continuing evolution of the second-generation systems will create new business opportunities for manufacturers, operators and the providers of content and applications using these networks.

In the standardization forum, WCDMA technology has emerged as the most widely adopted third generation air interface. Its specification has been created in 3GPP (the 3rd Generation Partnership Project), which is the joint standardization project of the standardization bodies from Europe, Japan, Korea, the USA and China. Within 3GPP, WCDMA is called UTRA (Universal Terrestrial Radio Access), FDD (Frequency Division Duplex) and TDD (Time Division Duplex). The name of WCDMA being used to cover both FDD and TDD operation.

The benefit of using RoF for WCDMA distributed antenna systems is expected to be even more important, partly because of their higher frequency and bandwidth requirements.

In this project, the simulation of WCDMA RoF using Matlab Simulink had successful developed. In this simulation, the fiber was represented by gain and 3rd order

polynomial was represented laser diode. The complete simulink block successfully run and get BER performance to rate it.

1.2 Objective of Study

Objective of this research is to simulate a WCDMA radio over fiber (RoF) for microcellular mobile communication systems using Matlab Simulink.

To achieve this objective various simulink blocks are developed such as with AWGN Channel, polynomial as laser diode and gain is present fiber using MATLAB SIMULINK.

From the research, main cause of using RoF is to shift the system complexity away from the remote base station antenna and toward centralized radio signal processing installation. In a RoF link, laser light is modulated by a radio signal and transported over an optical fiber medium. The laser modulation is analog since the radio-frequency carrier signal is an analog signal. The modulation may occur at the radio signal frequency or at some intermediate frequency if frequency conversion is utilized.

The basic configuration of an analog fiber optic link consists of a bi-directional interface containing the analog laser transmitter and photodiode receiver located at a base station or remote antenna unit, paired with an analog laser transmitter and photodiode receiver located at a radio processing unit. One or more optical fibers connect the remote antenna unit to the central processing location.

1.3 Scope Of Project

The works undertaken in this project are limited to the following aspects:

i) Literature review.
Reviews on the WCDMA using RoF technology by specific parameters of WCDMA .

ii) Modeling and simulation of the WCDMA downlink system with RoF using suitable parameters for laser diode, fiber and photodiode.

iii) Perform a simulation works by using a MATLAB/Simulink to observe BER.

iv) Compare the performance of the normal AWGN channel and different length of fiber by setting different value of gain that present fiber.

1.4 Research Methodology

The methodology of this research is shown in the flow chart in Figure 1.1 below:-

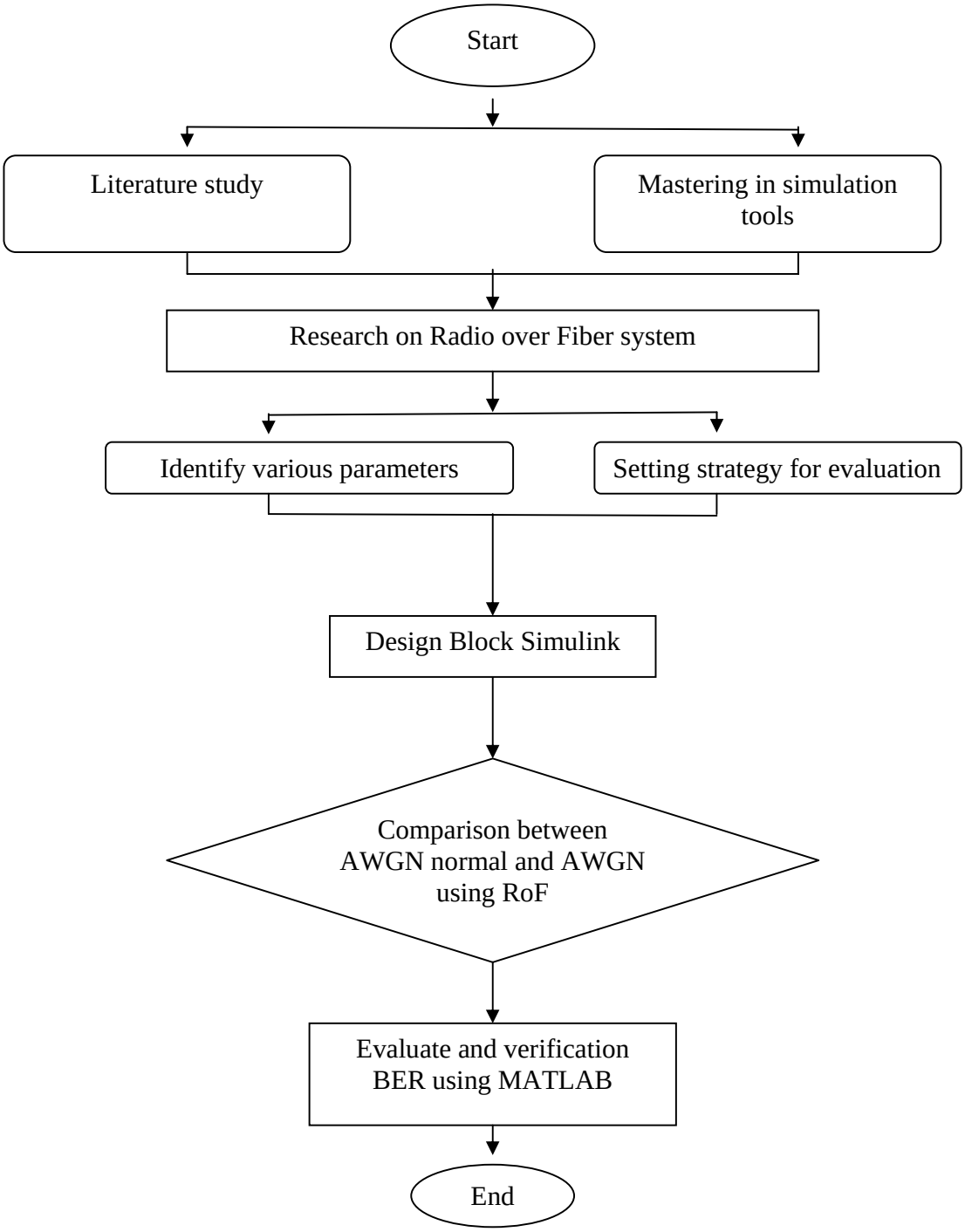

Figure 1.1 Research methodology flow chart

In the beginning, there are two tasks that need to be done simultaneously. Besides of doing literature review, exercises and tutorials need to be done for mastering the simulations tools and some preliminary simulations need to be carried out as well.

Then, the problem of this research will be stressed with radio over fiber system that an alternative to increasing base station complexity is to move the complex portions of the network to a central processing location where the number of expensive signal processing elements can be reduced by greater sharing among users.

Thus, identify various parameters and set the strategy for evaluation that can be used to develop the block simulink.

After the preliminary research, the design of block simulink are developed and tested by several of parameters.

Then, comparison between normal case and new case is done to get the result. All simulink is using MATLAB SIMULINK.

Finally, the proposed block simulink will be evaluated with BER (bit error rate) to determine the performance.

1.5 Thesis Outline

The thesis is structured as follows. The Chapter 1 discusses the general introduction of this project.

Chapter 2 outlines the project background of this project, which is including the basic introduction of RoF (Radio over Fiber) and further knowledge about RoF and their characteristics.

Chapter 3 outlines the literature review of this project that is introduce more to WCDMA technologies and characteristics.

Chapter 4 contains simulation and result.

The conclusion of the results and recommendation for future works will be presented in Chapter 5.