SIMULATION OF MULTIPATH CHANNEL RADIO IN WIRELESS LOCAL AREA NETWORK (WLAN)

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This report is submitted in partial fulfilment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours

Faculty of Electronics and Computer Engineering

Universiti Teknikal Malaysia Melaka

MAY 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

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Sesi Pengajian	:	2004-2008

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Special thanks for my loving family, supervisor and friends

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to Allah s.w.t because I have finally completed this project for Bachelor of Electronic Engineering (Telecommunication Electronics). Thanks also for my loving mother and father, **Puan Rogayah bt Ngah** and **En Abd Rahman Mahmud** for their support in completing this course .Without them, this project cannot be achieved easily.

Special thanks to my supervisor, **En Muhammad Syahrir b Johal** from Faculty of Electronics and Computer Engineering (FKEKK) for his support, lessons, advice, ideas and his valuable contribution for this project.

I also wish to thank to all lecturers and staff from Universiti Teknikal Malaysia Melaka (UTeM) especially from FKEKK for teaching me during my responsibilities as a student of Bachelor of Electronic Engineering (Telecommunication Electronics) .With knowledge when I study here, I have used to make this thesis a success.

Finally, many thanks to all my friends for their ideas, critics, moral support during this project and my study here. I never forget their assistance during the completion of this thesis.

ABSTRACT

A wireless local area network (WLAN) is the linking of two or more computers without using wires. WLAN utilizes OFDM modulation technology based on radio waves to enable communication between devices in a limited area. This gives users the mobility to move around within a broad coverage area and still be connected to the network. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, such as that used by wireless devices. It assumes that the magnitude of a signal that has passed through such a transmission medium (also called a communications channel) will vary randomly, or fade, according to a Rayleigh distribution. In other words, the signal offered to the receiver contains not only a direct line-of-sight radio wave, but also a large number of reflected radio wave that arrive at the receiver at different time. Delayed signals are a result of reflections from terrain features such as trees, hills, mountains, vehicles, or building .These reflected delayed wave with the direct wave will cause intersymbol interference (ISI), which cause significant degradation of the network performance. So, a wireless network must be designed in such a way as to minimize these adverse effects.

ABSTRAK

Satu Rangkaian Kawasan Setempat Tanpa Wayar (Wireless Local Area Network) menghubungkan satu atau lebih komputer tanpa menggunakan wayar sebagai perantaraan. WLAN mengaplikasikan teknologi modulasi OFDM berpandukan gelombang radio untuk membolehkan satu komunikasi berlaku pada kawasan yang terhad. Ini membolehkan pengguna untuk bebas bergerak dalam kawasan yang diliputi rangkaian dan boleh berhubung ke rangkaian. Saluran pemudaran Rayleigh ialah satu model statistik untuk kesan pengerakan persekitaran pada isyarat radio, seperti yang terdapat dalam perantaraan tanpa wayar. Ini mengandaikan magnitud pada signal yang telah melepasi media perantaraan (juga dipanggil saluran komunikasi) akan bergerak secara bebas atau rawak bergantung kepada pecahan saluran Rayleigh. Dengan kata lain, Isyarat yang disampaikan kepada penerima bukan sahaja berada dalam satu laluan gelombang radio yang lurus, tetapi juga satu jumlah gelombang radio yang besar yang mengalami banyak keciciran dan halangan yang akan diterima oleh stesen penerima pada masa yang berbeza. Isyarat – isyarat yang telah dilambatkan adalah kesan keciciran dari halangan-halangan seperti pokok,gunung,bukit,kereta atau bangunan. Gelombang yang telah dilambatkan akan memyebabkan berlakunya *intersymbol interference* (ISI) , dimana boleh melemahkan satu rangkaian. Oleh sebab itu, satu rangkaian mesti direka dengan pelbagai cara untuk mengurangkan kesan-kesan keciciran ,halangan dari terus berlaku.

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LIST OF ABBREVIATIONS

AWGN	-	Additive White Gaussian Noise
BSS	-	Basic Service Set
BER	-	Bit Error Rate
BPSK	-	Binary Phase Shift Keying
CDMA	-	Code Division Multiple Access
ESS	-	Extend Service Set
IEEE	-	Institute of Electrical and Electronics Engineers
IFFT	-	Inverse Fast Fourier Transform
ISI	-	Intersymbol Interference
LAN	-	Local Area Network
OFDM	-	Orthogonal Frequency Division Multiplex
PER	-	Packet Error Rate
PSK	-	Phase Shift Keying
QAM	-	Quadrature Amplitude Modulation
QPSK	-	Quadrature Phase Shift Keying

SNR	-	Signal to Noise Ratio
WLAN	-	Wireless Local Area Network

CHAPTER I

INTRODUCTION

1.1 Brief Technical Overview

The goal of this project is to design a simulation of multipath radio channel in Wireless Local Area Network, a phenomenon which exists in mobile wireless radio channel. Multipath fading occurs when mobile devices receive several reflected rays (called multipath components) of a transmitted radio signal. Movement of the receiver causes the number of multipath components, as well as their phases and propagation delays, to vary with time. The multiple signals can add constructively or destructively, causing the power level, and hence the signal-to-noise ratio (SNR), at the receive antenna to fluctuate over a large dynamic range. This fluctuation causes an increased bit error rate (BER) relative to the classical additive white Gaussian noise channel. The performance of the multipath will also be tested for different types of standard data rates.

1.2 Statement of Problem

Electromagnetic wave propagates from base station to wireless receiver and travel through free space undergoing absorption, refraction, reflection, diffraction, and scattering. They are greatly affectedly by the ground terrain, the atmospheric, and the

object in their path, like floor, wall building material etc. These multiple phenomena are responsible for most characteristic features of the received signal.

1.3 Objectives

i) To study and understand the characteristic of type of fading (Rayleigh Fading and Rician Fading)
ii) To learn and design a numerical simulation channel with different types of fading by using Matlab R2007a software.
iii) To analyze the performance of WLAN in different types of fading (Rayleigh fading and Rician fading).

1.4 Outlines of The Project

For this simulation design, it covers several stages to achieve previous objectives. First stage covers about operation of wireless transmitter base station to receiver. This includes determining the process; encoding the signal using OFDM system with QPSK modulation technique. Second stage is about analysis of multipath effect on data signal transmission in communication channel. This stage includes determining and applying Rayleigh fading and Rician fading to analyze the performance. Measure and simulate to get the value for Additional Gaussian White Noise, Noise + Rayleigh, Signal to Noise Ratio and Noise Power. Last stage covers analysis and performance of received data signal for transmitter stages. This stage includes the OFDM system, QPSK demodulation and FFT technique to decode received data signal from communication channel to the original data.

1.5 Project Methodology

This PSM project is fully designed using MATLAB R2007a software to analyze the multipath effects on the signal transmission from base station to receiver for WLAN. There are some stages included in my project to make these PSM objectives achievable, that are:

i. Knowing and understanding about characteristic of Wirelesses LAN system – definition, application, and benefits, how WLANs work, and WLANs configurations.
ii. Knowing and analyzing the multipath effect from transmitter to receiver WLANs, path attenuation – Rayleigh fading.
iii. Collecting data, statistic, calculation, measurement and analysis of noise power, SNR, noise + Rayleigh.
iv. Learning and design programming by using MATLAB software
v. Upgrade the programming.
vi. Testing the simulator – Testing and troubleshooting Matlab programming to fix and detect any error.
vii. Results and analysis of simulation – this step will discuss the overall result and analysis which include BER, SNR and comparison with the theoretical results.
viii. Submit the initial report to supervisor.
ix. Submit to faculty.

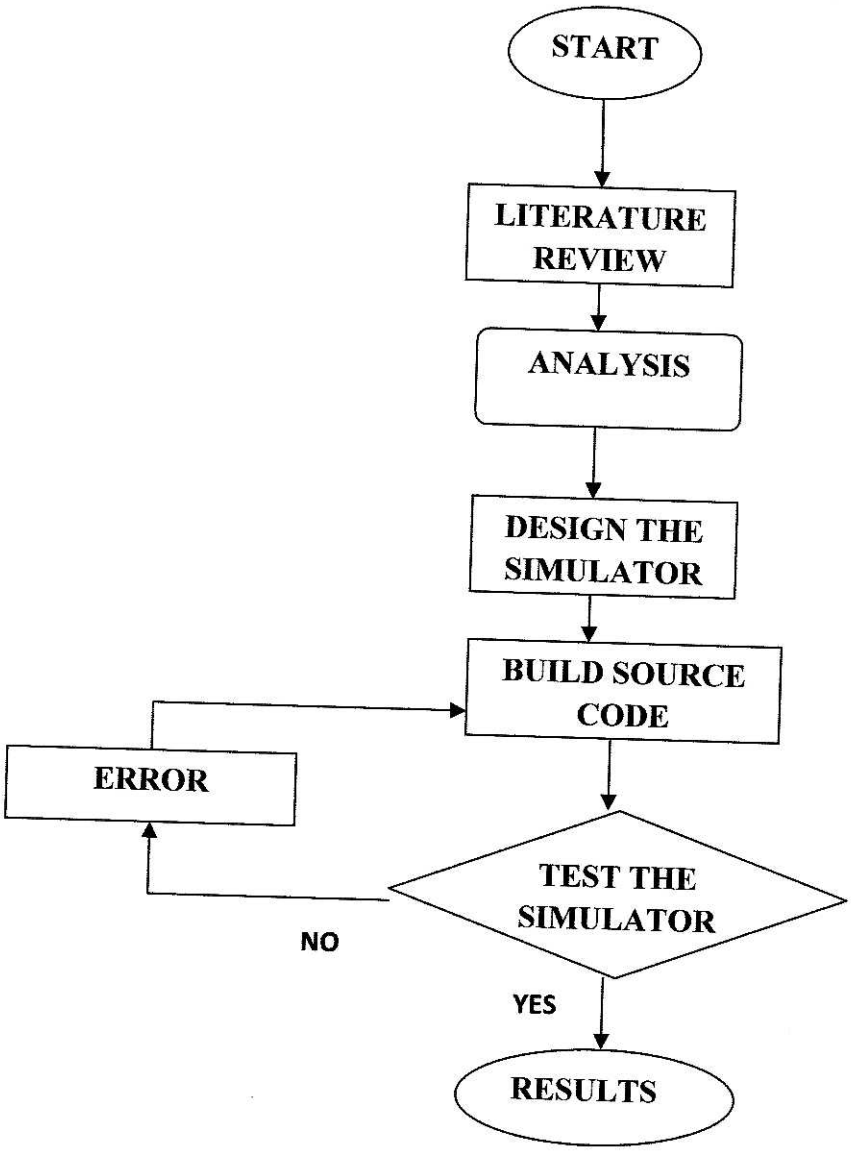

Figure 1: Flowchart for simulation of multipath radio channel in Wireless Local Area Network

1.6 Summary

Chapter I describes general introduction of this thesis includes brief technical overview, statement of problem, objectives, and outlines of the project, project methodology and flow chart of design simulation programming.

Chapter II presents detail about literature review of this project. This chapter describes the introduction of WLAN, type of WLAN, protocol of WLAN, configuration of WLAN. This chapter also describes detail about Rayleigh fading, phenomena occurred in transceiver. The orthogonal frequency division multiplexing (OFDM) transmission scheme, which can reduce the influence of multipath fading and realize broadband communication while retaining high-frequency utilization efficiency is also explained in this chapter. The QPSK modulation scheme is also described here. This includes formula and calculation for performance analysis of bit error rate.

Chapter III presents the project methodology to design simulation using Matlab 2007a, a good software simulation tool. Therefore, the variables and key parameter are described. The frequently used commands, function and the methods are also summarized to create hierarchical program, in addition to the methods of programming function blocks, which are commonly used to evaluate all communication systems.

Chapter IV presents analysis and performance of design simulation of OFDM system. This includes performance of bit error rate, packet error rate, signal power, attenuation, transmission data performance, received data performance and addition AWGN. All simulation results are compared with theoretical results using function BERtool in Matlab.

Chapter V presents conclusion and suggestion for this project. This includes the implementation to improve the quality of this project. The appendix attached to this thesis includes source code of main program ofdm2.m and several sub function.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

A WLAN is a wireless local area network, which is the linking of two or more computers without using wires. WLAN utilizes spread-spectrum or OFDM modulation technology based on radio waves to enable communication between devices in a limited area, also known as the basic service set [5]. This gives users the mobility to move around within a broad coverage area and still be connected to the network.

For the home user, wireless has become popular due to ease of installation, and location freedom with the gaining popularity of laptops. Public businesses such as coffee shops or malls have begun to offer wireless access to their customers; some are even provided as a free service. Large wireless network projects are being put up in many major cities.

WLAN standards are discussed in this thesis. The results are verified by comparing them with the existing industrial benchmarks .This thesis concludes with a discussion on the possible extension of this project. IEEE 802.11 is a set of standards for wireless local area network

(WLAN) computer communication developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands [6].

Table 2.1: Summary of protocol WLAN

Protocol	Release Date	Op. Frequency	Throughput (Typ)	Data Rate (Max)	Modulation Technique	Range (Radius Indoor) Depends, # and type of walls	Range (Radius Outdoor) Loss includes one wall
Legacy	1997	2.4 GHz	0.9 Mbit/s	2 Mbit/s		~20 Meters	~100 Meters
802.11a	1999	5 GHz	23 Mbit/s	54 Mbit/s	OFDM	~35 Meters	~120 Meters
802.11b	1999	2.4 GHz	4.3 Mbit/s	11 Mbit/s	DSSS	~38 Meters	~140 Meters
802.11g	2003	2.4 GHz	19 Mbit/s	54 Mbit/s	OFDM	~38 Meters	~140 Meters
802.11n	June 2009[3] (est.)	2.4 GHz 5 GHz	74 Mbit/s	248 Mbit/s		~70 Meters	~250 Meters
802.11y	June 2008[3] (est.)	3.7 GHz	23 Mbit/s	54 Mbit/s		~50 Meters	~5000 Meters

Table 2.2: IEEE 802.11 a

Release Date	Op. Frequency	Data Rate (Typ)	Data Rate (Max)	Range (Indoor)
October 1999	5 GHz	23 Mbit/s	54 Mbit/s	~35 m

The 802.11a standard uses the same core protocol as the original standard, operates in 5 GHz band with a maximum raw data rate of 54 Mbit/s, which yields realistic net achievable throughput in the mid-20 Mbit/s [6].

Since the 2.4 GHz band is heavily used to the point of being crowded, using the relatively un-used 5 GHz band gives 802.11a a significant advantage. However, this high carrier frequency also brings a slight disadvantage: The effective overall range of 802.11a is slightly less than that of 802.11b/g; 802.11a signals cannot penetrate as far as those for 802.11b because they are absorbed more readily by walls and other solid objects in their path [3].