SIMULATION OF WORLDWIDE INTEROPERABILITY FOR MICROWAVE ACCESS (WiMAX) SYSTEM

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Special dedication to my family, my kind hearted supervisor En. Azahari bin Salleh and to all my dearest friends.

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ABSTRACT

This project presents the simulation of Worldwide Interoperability for Microwave Access (WiMAX) system. Previous technology such as Digital Subscriber Line (DSL) has coverage limitation. WiMAX can solve this limitation. This project only focuses on the Orthogonal Frequency-Division Multiplexing (OFDM) which is adopted by WiMAX on its physical layer. The OFDM is uses adaptive modulation technique for modulator and demodulator. The OFDM model built in this project including the transmitter and receiver. MATLAB software tool is used to build the OFDM model and analysis the performance of WiMAX system. Hence the investigation of the performance of OFDM physical layer in WiMAX system by using different adaptive modulation techniques like Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation is done. The performance analysis is based on the Bit Error Rate (BER), Signal to Noise Ratio (SNR) and Probability Error (Pe). The WiMAX system used 64 QAM at near the base station and followed by 16 QAM and QPSK. BPSK is used at the cell boundary. The WiMAX system has freedom to choose the modulation techniques.

ABSTRAK

Projek ini membentangkan simulasi operasi rentas di seluruh dunia bagi Akses Gelombang Mikro (WiMAX). Teknologi sebelumnya seperti Talian Digital Pelanggan (DSL) mempunyai had liputan. WiMAX boleh menyelesaikan batasan ini. Projek ini hanya memberi tumpuan kepada Pemultipleksan Pembahagian Frekuensi Ortogon (OFDM) yang diterima pakai oleh WiMAX pada lapisan fizikal. OFDM adalah menggunakan teknik modulasi yang adaptif untuk pemodulat dan penyahmodulat. Model OFDM yang dibina dalam projek ini termasuk pemancar dan penerima. Perisian MATLAB digunakan untuk membina model OFDM dan analisis prestasi sistem WiMAX. Oleh itu siasatan daripada prestasi lapisan fizikal OFDM dalam sistem WiMAX dengan menggunakan teknik modulasi yang berbeza yang adaptif seperti Fasa Binari Bit (BPSK), Fasa Kuadratur Bit (QPSK), Kuadratur Pemodulatan Amplitud (QAM) dilakukan. Analisis prestasi berdasarkan Kadar Ralat (BER), Nisbah Isyarat Hingar (SNR) dan Kebarangkalian Ralat (Pe). Sistem WiMAX menggunakan 64 QAM di berhampiran stesen pangkalan dan diikuti oleh 16 QAM dan QPSK. BPSK digunakan di sempadan sel. Sistem WiMAX mempunyai kebebasan untuk memilih teknik modulasi.

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LIST OF ABBREVIATIONS

WiMAX	-	Worldwide Interoperability Microwave Access
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal Frequency Division Multiplexing Access
OFDM PHY	-	Orthogonal Frequency Division Multiplexing Physical Layer
MAC	-	Media Access Control
MSDUs	-	MAC Service Data Units
OSI	-	Open Systems Interconnection
MIMO	-	Multiple Input and Multiple Output
IEEE	-	Institute of Electrical and Electronic Engineers
DSL	-	Digital Subscriber Line
WLAN	-	Wireless Local Area Network
WiFi	-	Wireless Fidelity
UWB	-	Ultra Wide Band

PSK	-	Phase Shift Keying
ASK	-	Amplitude Shift Keying
BPSK	-	Binary Phase Shift Keying
QPSK	-	Quadrature Phase Shift Keying
QAM	-	Quadrature Amplitude Modulation
BER	-	Bit Error Rate
SNR	-	Signal to Noise Ratio
Pe	-	Probability error
PSD	-	Power Spectral Density
WBA	-	Wireless Broadband Access
LOS	-	Line-of-Sight
NLOS	-	Non Line-of-Sight
WiBro	-	Wireless Broadband
QoS	-	Quality of Service
TDD	-	Time Division Duplexing
FDD	-	Frequency Division Duplexing
MS	-	Mobile Station
BS	-	Base Station
MIC	-	Ministry of Information and Communication
ITU	-	International Telecommunication Union
ISI	-	Inter Symbol Interference

ICI	-	Inter Channel Interference
CDMA	-	Code Division Multiple Access
CP	-	Cyclic Prefix
AWGN	-	Add White Gaussian Noise
FDM	-	Frequency Division Multiplexing
TDM	-	Time Division Multiplexing
ATM	-	Asynchronous Transfer Mode
FFT	-	Fast Fourier Transform
IFFT	-	Inverse Fast Fourier Transform
FPGA	-	Field Programmable Gate Array
ASIC	-	Application Specific Integrated Circuit
Mbps	-	Mega Bit per Second
GHz	-	Giga Hertz
dB	-	Decibel
ft	-	Feet
m	-	Meter

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CHAPTER I

INTRODUCTION

1.1 Project Background

The wireless technologies offer to a wide range of customers from having the freedom to pay bills while stuck in traffic, to receiving notification of the change in business while having lunch and to taking English lessons while returning home on the train or bus, the convenience, productivity, and time saving benefits of these advancements are huge. Worldwide Interoperability for Microwave Access (WiMAX) is a technology that enables anywhere, anytime access to information and applications at low cost and with a small investment [1].

The WiMAX technology has attracted significant interests from wireless communication industry in recent years in all the fields including students, researchers, systems engineers and operators. WiMAX is introduced by the Institute of Electrical and Electronic Engineers (IEEE) offers greater range and bandwidth than the other available or soon-to-be available broadband wireless access technologies such as Wireless Fidelity (WiFi) and Ultrawideband (UWB) family of standards. WiMAX technology can reach a theoretical 30 miles coverage radius and achieve data rates up to 75 Mbps, although at extremely long range, throughput is closer to the 1.5 Mbps performance of typical broadband services, similar to that used for wired broadband services [1].

In this project, a simulation model based on Orthogonal Frequency Division Multiplexing-Physical Layer (OFDM-PHY) model in different simulation scenarios with different modulation techniques such as Binary Phase Shift Keying (BPSK) , Quadrature Phase Shift Keying (QPSK) and Quadrature Amplitude Modulation (QAM) (Both 16 and 64) will built to find out the best performance of physical layer for WiMAX Mobile. The performance has been concluded based on Bit-Error-Rate (BER), Signal-to-Noise Ratio (SNR) and Probability of Error (Pe) output through MATLAB Simulation.

1.2 Problem Statement

Digital Subscriber Line (DSL) service is one form of Internet access. The concept of DSL achieves broadband speeds over ordinary phone lines. There are some disadvantages to the use of DSL service which is availability. It's because DSL is distance sensitive, availability is determined by the distance from the provider's central office. The distance sensitivity limitation make the DSL service is often not available in non metropolitan or rural areas but widely in metropolitan areas [2].

Wireless Broadband Access (WBA) via DSL, T1-line or cable infrastructure is not available especially in rural areas. The DSL can covers only up to near about 18,000 feet (3 miles) from the DSL provider's local office or point of precence, this means that many urban, suburban, and rural areas may not served. The WiFi standard broadband connection may solve this problem a bit but not possible in everywhere due to coverage limitations. WiFi networks have limited range. A typical WiFi home router might have a range of 45 m (150 ft) indoors and 90 m (300 ft) outdoors. The Metropolitan-Area Wireless standard which is called WiMAX can solve these limitations [3].

WiMAX can operate in both Line-Of-Sight (LOS) and Non-Line-Of-Sight (NLOS) environments. WiMAX uses OFDM in its physical layer and the OFDM uses adaptive modulation techniques [4].

1.3 Objectives

The main objective of this project is to develop the OFDM model of WiMAX system by using MATLAB Software. The OFDM model which is OFDM transmitter and OFDM receiver is connect with a channel.

The second objective is to analyze the performance of OFDM physical layer in different adaptive modulation techniques such as BPSK, QPSK, 16-QAM and 64 QAM based on the simulation results of Bit-Error-Rate (BER), Signal-to-Noise Ratio (SNR) and Probability of Error (Pe). The modulation technique is applied at the OFDM transmitter and the demodulation technique is applied at the OFDM receiver. The BER,