

OUTDOOR PROPAGATION PREDICTION AND MEASUREMENT
FOR WLAN APPLICATION

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**A project report submitted in partial fulfilment of the
requirements for a award of the degree of
Master of Engineering (Electrical-Electronics & Telecommunication)**

**Faculty of Electrical Engineering
Universiti Teknologi Malaysia**

MAY 2006

ABSTRACT

Propagation prediction and measurement plays an important role in the design and implementation of outdoor WLAN application. In this project, a three-dimensional (3-D) ray tracing technique: Site Specific Outdoor / Indoor Propagation Prediction Code will be used to predict outdoor propagation effect in Tun Chancellor Hostel, University Technology Malaysia. Propagation prediction will be done within five blocks of building which area covers 215 X 235 meter² consists of 11 locations receiver . The carrier frequencies are 2.4 GHz (IEEE 802.11b) and Patch antenna as a transmitter. Then measurements of signal strength using AirMagnet software will be carried out within the research area.

The objective of this project is to study on the losses of signal strength when it travels through Line of Sight (LOS) and effect on building (NLOS). Then do simulation of signal propagation and signal strength prediction at Tun chancellor Hostel (KTC) building and measurement of signal strength in determines places in KTC. In order to show the Propagation of signal the simulation code will be visualized using Matlab. The Airmagnet tool will be used for the measurements and results between simulations will be compared.

ABSTRAK

Ramalan perambatan memainkan peranan yang penting dalam rekabentuk dan pemasangan system *Wireless LAN* terbuka. Dalam projek ini, perisian jenis 3 dimensi *ray tracing-Site specific Outdoor / Indoor Propagation Prediction Code* akan digunakan untuk melakukan ramalan perambatan dan kekuatan signal pada lima blok bangunan di Kolej Tun Chencellor, Universiti Teknologi Malaysia, dengan keluasan tempat ramalan $215 \times 235 \text{ meter}^2$ mengandungi 11 lokasi penerima. Frekuensi pembawa ialah 2400MHz (IEEE 802.11b) dengan *Patch antenna* sebagai pemancar.

Objectif project ini adalah untuk mengkaji kecekapan dan liputan (*coverage*) bagi kawasan terbuka dan kesan bangunan kepada kekuatan signal. Keputusan yang didapati daripada perisian ini dalam bentuk teks dan dengan menggunakan Perisian *Matlab* perambatan gelombang radio dapat dipaparkan. Kemudian satu pengukuran kekuatan signal akan dilakukan dengan menggunakan perisian *Airmagnet* dan keputusan ramalan dan pengukuran kekuatan signal akan dibuat perbandingan .

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LIST OF ABBREVIATIONS

1G	first generation
2G	second generation
3G	third generation
2D	two-dimensional
3D	three-dimensional
AM	amplitude modulation
AP	access point
BS	base station
DSSS	direct sequence spread spectrum
EIRP	effective isotropic radiated power
FCC	Federal Communication Commision
FM	frequency modulation
GBSBM	Geometricall theory of diffraction
GTD	geomettrical theory protocol
GUI	graphic user interface
I/O	input output
IDU	indoor unit
IEEE	Instituteuf Electrical and Electronics Engineers
IP	Interenet Protocol
ISM	industrial, scientific and medical
LAN	Local Area Network
LOS	line of sight
MAS	Mobile Switching Center
NLOS	non line of sight

ODU	outdoor unit
PDF	probability density function
PSTN	Public Switched Telephone Network
rms	root mean square
SBR	shooting and bouncing ray
UHF	ultra high frequency
UNII	unlicensed national information infrastructure
UTD	uniform theory of diffraction
UTM	Universiti Teknologi Mara
VPL	vertical plane launch
WCC	Wireless Communication centre
WLANS	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Overview

The basic components of the WLAN are access points (AP) and the mobile clients (MC), typically a laptop or a PDA with a WLAN card. To create a wired network infrastructure, Ethernet cables are placed through out the building and then buildings reconnected together using fiber optic cables. With a Wireless LAN, in order to create the network infrastructure APs are placed in various locations throughout a building and even outdoors. Various mobile clients then communicate with each other by first communicating with these access points.

One of the primary principles of WLAN connections is that network data is transmitted as modulated electromagnetic waves using antennas. When the radio waves propagate or travel from one device to another there are several issues has to highlight. The radio energy attenuate when it propagates and the radio signal also attenuated when they pass through obstacles such as trees and buildings. There are three basic

mechanisms that occurred when radio waves propagates reflection, diffraction and scattering. The scattering problem occurs when RF can reflect off many thing and the direct signal combines with the signals have reflected off of object that are not in direct path. This problem usually described as multipath, fading, Rayleigh fading or signal dispersion.

In this project the radio waves propagation for outdoor environments will be investigated using the Wireless LAN 802.11b at the frequency band 2.4 GHz. This project involved the study of the effect on building within the access point install outdoors and than get the propagation prediction and measurements. To determine the electromagnetic interaction with the surrounding environment a ray vertical code employing a modified shoot and bounce ray (SBR) method known as the Vertical Plane Launch (VPL) will be used for the prediction. Software called Matlab will be used to visualize a ray tracing code. The field measurement can be done using AirMagnet Wireless LAN Analyzer than the prediction and measurement result will be compared.

1.2 Objective

The objectives of this research are to investigate the outdoor propagation for WLAN 802.11b application that involved the prediction and measurement of signal strength in an outdoor environment at Kolej Tun Chancellor with taking account of the building effects. In other words this research aim for a site specific signal strength study and then observe effect of obstacle, but here only taking account of building effects.

1.3 Scope of Project

- 1- The physical model is to predict propagation effect in the related site by using ray tracing simulation program based on vertical-plane-Launch (VPL) technique courtesy of Bertoni, Xia, and Liang.
- 2- Collect four types of databases (building, terrain, receiver and antenna radiation antenna radiation pattern) that needed in the simulation.
- 3- The VPL ray tracing code visualized using MATLAB.
- 4- The AirMagnet HANDHELD Wireless Lan Analyzer that installed in Laptop used for field measurement.
- 5- Observe the effect of building to the signal direction in Matlab Visualization as well as signal strength degradation due to building.
- 6- Analyze the signal strength of two methods, prediction and field measurement.

1.4 Layout of Thesis

This section outlines the structure of the thesis.

The first chapter briefly introduces this project by elaborating on the project overview, objectives, and scope of project. Second and third chapter are written based on the findings from the literature. Chapter two discuss the wireless communication

technology and concentrates on Wireless LAN and its application, whereas chapter three discuss about the Radio Wave Propagation and the development ray tracing Modeling.

Chapter 4 contains the methodology process for the propagation prediction and measurements by showing up the detailed diagram of the project methodology and highlights briefly the steps have been taken to meet the objectives of this project.

Chapter 5 discusses the simulation and measurements results. The performance of signal strength between simulation and measurements will be analyzed for LOS and NLOS.

Chapter 6 concludes the topics and suggests recommendation for future works.

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