UNIVERSITI PUTRA MALAYSIA

CHARACTERISTICS OF WLAN TRANSMISSION IN AN INDOOR ENVIRONMENT

CHENG EE MENG

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CHARACTERISTICS OF WLAN TRANSMISSION IN AN INDOOR ENVIRONMENT

By

CHENG EE MENG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

To my lovely parents, Brothers……

and

In memorial: Grandfather

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

CHARACTERISTICS OF WLAN TRANSMISSION IN AN INDOOR ENVIRONMENT

By

CHENG EE MENG

September 2006

Chairman: Zulkifly Abbas, PhD

Institute: Mathematical Research

This thesis describes the study of a deterministic model for WLAN system in indoor environment. The measurement system consists of a spectrum analyzer and a log-periodic antenna. A computer program has been developed to acquire measured field strength data from the spectrum analyzer by using Agilent VEE and analyzed the data by using MATLAB software. Both line-of-sight (LOS) propagation (empty room or corridor) and non-line-of-sight (NLOS) propagation (furnished room) have been investigated. The measured path losses have been compared with deterministic model, namely Geometrical Optics (GO) and Uniform Theory of Diffraction (UTD) with the aid of image theory. The predicted results show good agreement with measurement data for the NLOS environment with absolute mean error ranging between 1.61 dB and 3.07 dB. However, the multiple reflections (third order of multiple reflections estimated the highest order in all cases) and direct ray condition which estimated significant in Instrumentation Laboratory (periodical structural ground) gave poor result when compared with the measured path losses. A typical mean relative error and absolute mean error of direct ray model was found to be

within 55.04 % and 7.47 dB, but was further reduced to less than 7.43 % and 0.69 dB after optimization.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

CIRI-CIRI TRANSMISI WLAN DALAM PERSEKITARAN DALAMAN

Oleh

CHENG EE MENG

September 2006

Pengerusi: Zulkifly Abbas, PhD

Institut: Penyelidikan Matematik

Tesis ini memperihalkan pengajian model berketentuan untuk sistem WLAN dalam persekitaran dalaman. Sistem pengukuran tersebut terdiri daripada penganalisis spektrum dan antena berkala log. Program komputer telah dibina dengan menggunakan Agilent VEE untuk memperolehi data pengukuran bagi kekuatan medan dari penganalisis spektrum dan menganalisis data tersebut dengan menggunakan perisian MATLAB. Kedua-dua rambatan garis pandangan (bilik kosong atau koridor) dan juga keadaan pandangan bukan garis lurus (bilik berperabot) telah dikaji. Pengukuran kehilangan-kehilangan lintasan telah dibandingkan dengan model berketentuan yang bernama optic bergeometri (GO) dan teori pembelauan seragam (UTD) dengan bantuan dari teori imej. Keputusan dari ramalan tersebut bersetuju dengan data pengukuran dalam keadaan pandangan bukan garis lurus dengan ralat min mutlak berjulat antara 1.61 dB dan 3.07 dB masing-masing. Walau bagaimanapun, pantulan berganda (pantulan berganda peringkat ketiga dianggap peringkat yang tertinggi untuk semua kes) dan keadaan sinaran terus yang dianggap ketara dalam persekitaran pandangan garis lurus (bilik kosong) menunjukkan keputusan yang tidak diingini dalam Makmal Instrumentasi (lantai berstruktur kala) apabila berbanding dengan pengukuran kehilangan lintasan. Ralat

relatif min dan ralat min mutlak yang tipikal bagi model sinaran terus didapati wujud dalam linkungan 55.04 % dan 7.47 dB, dan kemudian telah dikurangkan sehingga niali peratusan yang kurang daripada 7.43 % dan 0.69 dB selepas kerja pengoptimuman dilakukan.

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I certify that an Examination Committee has met on 28 September 2006 to conduct the final examination of Cheng Ee Meng on his Master of Science thesis entitled "Characteristics of WLAN Transmission in an Indoor Environment" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Univeristi Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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CHENG EE MENG

Date:

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LIST OF ABBREVIATIONS

WLAN	Wireless Local Area Network
IT	Information Technology
PCS	Personal Communication System
LAN	Local Area Network
3G	Third-generation
IR	Infrared
DSSS	Direct Sequence Spread Spectrum
FHSS	Frequency Hopping Spread Spectrum
FCC	Federal Communications Commission
ISM	Industrial Scientific and Medical
LOS	line-of-sight
NLOS	non-line-of-sight
GO	Geometrical Optics
GTD	Geometrical Theory of Diffraction
UTD	Uniform Theory of Diffraction
LP	log periodic
RF	Radio Frequency
IEEE	Institute of Electrical and Electronics Engineers
FDMA	Frequency-Division Multiple Access
TDMA	Time-Division Multiple Access
CDMA	Code-Division Multiple Access