AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

Electronics and Communications Engineering Department

Channel Modeling in UMTS for better Multimedia data transfer

A Thesis

Submitted in partial fulfillment of the requirements of the degree of
Master of Science in Electrical Engineering

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B.Sc. of Electrical Engineering
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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this Thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

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ABSTRACT

Marwa Farouk Ibrahim Ibrahim, Channel Modeling in UMTS for better Multimedia Data Transfer

This thesis is concerned with Channel Modeling for UMTS System in order to enhance and improve its performance in data transfer. The main objective of this thesis is to search for methods of channel models proper for simulation to be used in UMTS systems when investigating the effect of different parameters that affect its performance and in the same time reduces the simulation time.

The thesis starts with a summary on the history of mobile communications starting from first generation and ending with 3G.

This thesis is mainly concerned with Channel models so a good study is presented starting from physical phenomena that affects any mobile communications channel model and ending at presenting many mobile communications models whether statistical or deterministic.

A deep study is done on Independent Rayleigh Faders Model (considered as deterministic model) used in simulation trying to improve its performance from many points of view such as accuracy, simulation time and complexity.

Another study is done on Gans Fading Model (considered as statistical model) and finally a comparison is held between Rayleigh Independent Faders Model and Gans Fading Model is presented.

An approximated model to that of Independent Rayleigh Faders Model which is called Triangular Model is also studied. A new proposed model which is called Approximated Piecewise Linear Model is also presented. And at the end a comparison is held between the two approximated models.

Key words: Mobile Communications, Mobile Channel, Universal Mobile Telecommunications System (UMTS), Third Generation (3G), Channel Model, Rayleigh Fading.

ACKNOWLEDGEMENT

This thesis is the result of two and half years of work whereby I have been accompanied and supported by many people. I would like to express my gratitude to all those who gave me the possibility to complete this work starting with my supervisor Prof. Salwa Hussein El-Ramly for her great help, patience and guidance through all the trip I take to be prepared to write this thesis. She was a great scientific and emotional support.

I would like to thank my friends and colleagues Shimaa Ali Mohamed, Khaled Abou Zeid, Suzan Elshaer, Sameh Ahmed, Omar Saad, who were a great support for me all the way.

I would like to express my deep and sincere gratitude for my guarding angel, my closest friend and the most important person in my life, my loving mother, Faten Shaheen. I would like to thank her, my compassionate, generous, kind-hearted father Farouk Ibrahim and my brothers Emad and Hisham for their great patience and emotional support through all my life. May this thesis make them proud of me and deserve all their suffering because of me through the past years.

ABSTRACT

Marwa Farouk Ibrahim Ibrahim, Channel Modeling in UMTS for better Multimedia Data Transfer

This thesis is concerned with Channel Modeling for UMTS System in order to enhance and improve its performance in data transfer. The main objective of this thesis is to search for methods of channel models proper for simulation to be used in UMTS systems when investigating the effect of different parameters that affect its performance and in the same time reduces the simulation time.

The thesis starts with a summary on the history of mobile communications starting from first generation and ending with 3G.

This thesis focuses on UMTS where a good study is presented on UMTS concerning its frequency spectrum, System Architecture, Handover, Transport, Logical and physical channels.

Also duplex techniques, Modulation techniques, Multiple access and power control in UMTS is also presented.

As this thesis is mainly concerned with Channel models so a good study is presented starting from physical phenomena that affects any mobile communications channel model and ending at presenting many mobile communications models whether statistical or deterministic.

A deep study is done on Independent Rayleigh Faders Model used in simulation trying to improve its performance from many points of view such as accuracy, simulation time and complexity.

A brief study is done on Gans Fading Model and finally a small comparison between Rayleigh Independent Faders Model and Gans Fading Model is presented.

An approximated model to that of Independent Rayleigh Faders Model which is called Triangular Model is also studied and a new proposed model which is called Approximated Piecewise Linear Model is also presented. And at the end a comparison is held between the two approximated models.

Key words: Mobile Communications, Mobile Channel, Universal Mobile Telecommunications System (UMTS), Third Generation (3G), Channel Model, Fading, Rayleigh.

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List of Abbreviations

1G	First Generation
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
ACF	Auto Correlation Function
ACTS	Advanced Communication Technologies and Services
AMPS	Advanced Mobile Phone Service
ARIB	Association of Radio Industries and Businesses
BMC	Broadcast and Multicast Control
BPSK	Binary Phase Shift Keying
BSC	Base Station Controller
BTS	Base Transceiver Station
CAC	Call Admission Control
CCF	Cross Correlation function
CCTrCH	Coded Composite Transport Channel
CDMA	Code Division Multiple Access
CN	Core Network
CTS	Cordless Telephone System
D-AMPS	Digital Advanced Mobile Phone Service
DCH	Dedicated Channel
DCS	Digital Cellular System
DECT	Digital Enhanced Cordless Telecommunications
DL	Downlink
DS	Direct Sequence
DS-CDMA	Direct Sequence Code Division Multiple Access
DTC	Digital Traffic Channel
DWPTS	Downlink Pilot Tone Slot
EDGE	Enhanced Data Rates for Global Evolution
EGPRS	Enhanced General Packet Radio Services
E-GSM	Enhanced Global System for Mobile
ERC	European Radio Communications Committee
ETSI	European Telecommunications Standards Institute
EURO-COST	European Co-operative for Scientific and Technical research
EV-DO	Evolved Data Optimized
FAF	Floor Attenuation Factors
FDD	Frequency Division Duplex
FER	Frame Error Rate
FEC	Forward Error Correction
FMA	Frames Multiple Access
FPLMTS	Future Public Land Mobile Telecommunications Systems
FSK	Frequency Shift Keying
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile Services Switching Centre

GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Services
GTP	GPRS Tunnel Protocol
GSM	Global System for Mobile
HDR	High Data Rate
HLR	Home Location Register
HO	Handover
HSCSD	High Speed Circuit Switched Data
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
JDC	Japanese Digital Cellular
LLC	Logical Link Control
LOS	Line of Sight
MAC	Medium Access Control
MAP	Mobile Application Part
ME	Mobile Equipment
MSC	Mobile Services Switching Centre
NMT	Nordic Mobile Telephone
OBS	Obstructed Sight
OMC	Operations and Maintenance Centre
OSI	Open System Interconnection
OVSF	Orthogonal Variable Spreading Factor
PCS	Personal Communications System
PDC	Personal Digital Cellular
PDCP	Packet Data Convergence Protocol
PHS	Personal Handy Phone System
PSK	Phase Shift Keying
QPSK	Quaternary Phase Shift Keying
RACE	Research on Advanced Communication Technologies in Europe
RAN	Radio Access Network
RCS	Radar Cross Section
RLC	Radio Link Control
RNC	Radio Network Controller
RRC	Radio Resource Control
SIR	Signal to Interference Ratio
SGSN	Serving GPRS Support Node
SMG	Special Mobile Group
TACS	Total Access Communications System
TBS	Transport Block Set
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TF	Transport Format
TTI	Transmission Time Interval
T-R	Transmitter Receiver
UF	Urban Factor
UL	Uplink

UMTS	Universal Mobile Telecommunications System
UpPTS	Uplink Pilot Tone Slot
USIM	UMTS Subscriber Identity Module
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
VLR	Visitor Location Register
WAP	Wireless Application Protocol
WARC	World Administrative Radio Conference
WCDMA	Wideband Code Division Multiple Access
WRC	World Radio Conference

List of Symbols

$\Gamma\|$: Reflection Coefficient.
θ_B : Incident Angle.
C/I : Carrier to Interference Ratio
C_u : The interface occurs between the USIM domain and the mobile equipment domain.
ε_1 : Permittivity of first medium.
ε_2 : Permittivity of second medium.
ε_r : Relative Permittivity.
E_b/N_0 : The ratio of energy per bit to noise power spectral density.
f_c : Carrier Frequency
I_{up} : An interface to communicate over the CN with neighboring RNCs.
L_u : The interface is located at the gateway from the access network domain to the serving network domain.
L_{ub} : An interface to connect Node B with the RNC.
N : Spreading Factor.
R_b : The rate of the bit stream.
R_c : The rate of the chip sequence.
S/N : Signal to Noise ratio.
λ : Signal wavelength.
U_u : The interface occurs between the terminal and the RAN.
C_{nk} : represents the amplitude of the *n*th complex sinusoid in the *K*th fader.
ω_{nk} : represents the frequency of the *n*th complex sinusoid in the *K*th fader.
ϕ_{nk} : represents an uniformly distributed random phase of the *n*th complex sinusoid in the *K*th fader
υ : The velocityof a moving receiver.
ω_M : Is the maximum Doppler frequency shift.
$\omega_{M\tau}$: Is defined as the normalized time delay.
α_{nk} : denotes the *nth* arrival angle in the *Kth* fader.
Δ : The excess path length Which is the difference between the direct path and the diffracted path.
h : The effective height of an obstructing screen in calculating Fresnel Zone Geometry.
d1: The distance between obstructing screen and the transmitter in calculating Fresnel Zone Geometry.
d2: The distance between obstructing screen and the receiver in calculating Fresnel Zone Geometry.
ϕ : The corresponding phase difference to the excess path length in calculating Fresnel Zone Geometry.
υ : Fresnel Kirchoff diffraction parameter .