



Sudan university of Science & technology
College of Graduate Studies

**Bit error rate Performance analysis of WiMAX
PHYSICAL LAYER BY USING REEd SoLomoN Code**

**تحليل الأداء لمعدل خطأ البتات للطبقة الفيزيائية للوأي ماكس
بأستخدام رمز ريد سلمون**

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Submitted By:

Mohamed Elhassan Elamin Mohamed Ahmed

Supervised By:

Dr. Ibrahim Khider Eltaher

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قال تعالى :

وَقُلْ لِعَمَلِكُمْ فَسِيرَى لَكُمْ
عَمَلِكُمْ وَرُسُودَهُ وَالْمُؤْمِنُونَ

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Dedication

To my parents, wife, brothers, sisters, relatives,
friends, teachers and students, I dedicate the
work.



Acknowledgements

I am grateful to my mother, whose blessings have been enormous and her support and encouragement gave me ability and strength to complete this task. I would like to dedicate my thesis work to my father soul and I hope Allah blessing him.

I would like to dedicate my thesis work to my family members. It is a great honor and privilege to thank my honorable thesis supervisor Dr.Ibrahim Khider, who had guided my thesis work with his scholarly advice. Without his guidance and encouragement this task would have been unachievable. I express my heartfelt gratitude to him.

I would like to thank my wife who supported me during my master's thesis.

I would like to thank my friends who supported me during my master's thesis.

مستخلص البحث

كلمة "واي ماكس" هي اختصاراً لعبارة تعني "التعامل المشترك في جميع أنحاء العالم من أجل الوصول بالموجات الدقيقة". أطلق الاسم "واي ماكس" من قبل منتدى "واي ماكس" كوصف للتقنية التي تعتمد على المعيار رقم "802.16" لمعهد مهندسي الكهرباء والإلكترونيات .

في هذه الأطروحة، تم التركيز على الطبقة الفيزيائية للواي ماكس، حيث قمنا بتصميم نموذج متوافق مع المعيار رقم "802.16-2004" لمعهد مهندسي الكهرباء والإلكترونيات الذي يقوم على أساس تقنية المزج بالتقسيم الترددي المتعامد .

النموذج يتكون من جهاز الإرسال، القناة والمستقبل. أخذنا في الاعتبار جميع مراحل الإرسال والاستقبال وكذلك لم ننسى خصائص القناة اللاسلكية مثل الخفوت وفقدان المسار. نموذج القناة المستخدم هو نموذج جامعة ستانفورد، لأنه يتناسب مع خصائص قناة الواي ماكس. قمنا بمحاكاة الطبقة الفيزيائية للواي ماكس باستخدام برنامج الماتلاب .

يستند تحليل أداء الطبقة الفيزيائية للواي ماكس على معدل خطأ البتات كنتيجة للمحاكاة حيث تم رسم النتائج لمختلف مستويات التعديل و الترميز.

و كنتيجة لمحاكاة الطبقة الفيزيائية للواي ماكس ، نجد أن تقنيات التعديل و الترميز ذات المستوى المنخفض تقدم معدلات خطأ بتات أقل , وبزيادة مستوى التعديل و الترميز يزداد معدل خطأ البتات. تعتبر تقنية الترميز و التعديل المتوائمة واحدة من أهم مميزات واي ماكس ، فعندما تكون الوصلة اللاسلكية جيدة يتم استخدام التعديل عالي المستوى "تضمين المطال الرباعي"، وعندما تكون الوصلة الراديوية سيئة يتم استخدام تعديل منخفض المستوى و قوي مثل "تضمين إزاحة الطور الرباعي". المقارنة بين هذه الآثار مع استخدام تقنية التشفير ريد سلumon وإيضاً استخدام التداخل بمعدلات تشفير مختلفة للقناة، أيضاً نوقشت وتحقق منها.

كما أننا توصلنا إلى أن استخدام تقنية الترميز ريد سيلمون والتداخل يقلل من معدل خطأ البتات .

Abstract

WiMAX stands for "**Worldwide Interoperability for Microwave Access**". The name WiMAX was created by the WiMAX Forum to describe IEEE 802.16 based technology.

In this thesis, the focus was on the physical layer of WiMAX. A model was designed that was compatible with the IEEE 802.16-2004 standard which is based on Orthogonal Frequency Division Multiplexing (OFDM). The model consists of the transmitter, the channel, and the receiver. All stages were taken into account of the transmitter and receiver and also did not forget the wireless channel characteristics such as fading and path loss.

The Channel model used is SUI, because it is commensurate with the characteristics of the WiMAX channel.

The physical layer of WiMAX was simulated using MATLAB. The performance analysis of WiMAX physical layer is based on the bit error rate (BER) as result of simulation. The results plotted of for different modulation and coding schemes.

As a result of WiMAX physical layer simulation, founded that low-level modulation and coding schemes offer low bit error rates and High-level modulation and coding schemes increase the bit error rates. One of WiMAX features is Adaptive Modulation and Coding technique; when the radio link is good, a high-level modulation is used (64 QAM); when the radio link is bad, a low-level, but also robust, modulation is used like (QPSK).The comparison between these effects with Reed-Solomon (RS) encoder with convolutional encoder using different rated codes in FEC channel coding will be investigated.

Also founded that the use of the reed Solomon coding and interleaving techniques decreases the BER.

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List of Abbreviations

AAS	Adaptive Antenna System
ADC	Analog to Digital Convertor
ADSL	Asymmetric Digital Subscriber Line
AES	Advanced Encryption Standard
ARQ	Automatic Repeat Request
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BS	<i>Base Station</i>
BSID	Base Station Identifier
BWA	Broadband Wireless Access
CC	Convolutional coding
CP	Cyclic Prefix
CRC	Cyclic Redundancy Check
DAC	Digital-to-Analog Convertor
DIUC	Downlink Interval Usage Code.
DL	Downlink
DSL	Digital Subscriber Line
EAP	Extensible Authentication Protocol
FDD	Frequency Division Duplexing
FEC	Forward Error correction
GF	Galois Field
IEEE	Institute of Electrical and Electronics Engineers
IP	<i>Internet Protocol</i>
ISI	Intersymbol Interference

LDPC	Low-Density Parity Check
LFSR	Linear-Feedback Shift Register
LOS	Line Of Sight
MAC	Media Access Control
MAN	Metropolitan Area Networks
MBS	Multicast and broadcast services
MIMO	Multiple-Input Multiple-Output
MMDS	Multichannel Multipoint Distribution Services
MPDU	MAC Protocol Data Units
MS	Mobile station
MSB	Most Significant Byte
MSDU	MAC SDU
NLOS	Non Line of Sight
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PAPR	Peak-to-Average Power Ratio
PDA	Personal Digital Assistant
PHY	Physical
PKM	Privacy Key Management
PMP	Point-to-Multipoint
PRBS	Pseudo Random Binary Sequence
PS	Physical Slot
QAM	Quadrature Amplitude Modulation
QoS	Quality-of-Service
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency

RS	Reed Solomon
SC	Single Carrier
SDU	Service Data Unit
SNR	Signal to Noise Ratio
SOFDMA	Scale Orthogonal Frequency Division Multiple Access
SS	Subscriber Station
SUI	Stanford University Interim
TDD	Time Division Duplexing
TWG	Technical Working Group (in the WiMAX forum)
UL	Uplink
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area Network
WPAN	Wireless Personal Area Network
WWAN	Wireless Wide Area Network