

## Abstract

The increasing demand on mobile service providers to support high rate applications has prompted the development of 4G networks. To meet the rising demand, new enhanced technologies should be implemented. LTE Advanced is one of the promising technologies. It has many components to support high data rate. The aim of this project is to study the performance of LTE Advanced Network through relay deployment as a component in LTE Advanced network and mainly use decode and forward (DF) relaying protocol. The Matlab program and WINNER-II are used to introduce different channel model environments, three main simulators were designed in different propagation scenarios. The first uses decode and forward protocol (DF) to study the effect of relay cooperation and the number of relays. Two cooperative relays scenario achieved about 66% BER reduction vs. the less relay scenarios. The next simulator compares between performances of decode and forward protocol and amplify and forward (AF) protocol. For the higher SNR and the lower of BER range the more safe communication the average reduction in BER for DF over AF in typical environments was 37% and in bad environments was 21%. The last simulator studied transmission optimization by using combination of modulation levels in relay link and access link, to optimize the relation between increasing data rate at relay link and BER at UE. Using 64QAM modulation increases data rate at relay, but the

BER is high and constant even with increasing of SNR. By increasing of SNR QPSK performs better than 16QAM but with less data rate at relay and the average reduction of BER of QPSK over 16QAM was 59%.

## المستخلص

إن الطلب المتزايد على مزودي خدمة التطبيقات ذات السرعات العالية سارع بتطور شبكات الجيل الرابع، ولتلبية هذه الرغبات ظهرت تقنيات جديدة محسنة، وتعتبر تقنية التطور طويل الأمد المتقدمة أحادي هذه التقنيات الواعد، ولهذه التقنية عدة مكونات للحصول على السرعات العالية. هدف هذه الرسالة هو دراسة أداء شبكة التطور طويل الأمد المتقدمة من خلال نشر المراحلات - باعتبارها أحد مكونات تقنية التطور طويل الأمد المتقدمة - و باستخدام بروتوكول فك الشفرة والإرسال. تم استخدام برنامج مات لاب و مصدر (مبادرة اللاسلكي العالمي الراديوي الجديد) المتكوب ببرنامج مات لاب وذلك لمحاكاة مجموعة من قنوات الاتصال ذات بيئات انتشار مختلفة. تم تصميم ثلاثة محاكيات في بيئات انتشار مختلفة. في المحاكي الأول استُخدم بروتوكول فك الشفرة والإرسال لدراسة تأثير استخدام المراحلات وعدها، وكانت نسبة تقليل معدل البيانات الخطأ بين السيناريو ذو المراحلين إلى السيناريوهات ذو مرحل واحد دون مرحل 66%. المحاكي الثاني للمقارنة بين أداء بروتوكول فك الشفرة والإرسال و بروتوكول تكبير الإشارة والإرسال، وكانت نسبة تقليل معدل البيانات

الخطأ بين برتوكول فك الشفرة و التكبير 37% في البيانات الإعتيادية، و 21% في البيانات الغير إعتيادية، ونسبة تقليل معدل البيانات الخطأ تتطبق على المدى العالى لقيم قوة الأشارة إلى الصحيح. المحاكي الثالث لدراسة إرسال مستوى التعديل الأمثل بين المصدر والمرحل والمراحل والهدف، وباستخدام التعديل مستوى 64 رباعي المطال رغم الزيادة في تدفق البيانات عند المرحل إلا أن نسبة معدل الخطأ في البيانات كانت عالية. بزيادة نسبة قوة الإشارة إلى الصحيح تفوق التعديل بإزاحة زاوية الطور رباعي على التعديل مستوى 59 رباعي المطال بتقليل معدل البيانات الخطأ بنسبة 16%.

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## **Dedication**

I dedicate my thesis work to:

My dear parents and my family

All my teachers

Every knowledge seeker

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## Abbreviations

4G	4th Generation
ITU-R	International Telecommunications Union Radio communications
IMT-A	International Mobile Telephony - Advanced
3GPP	Third Generation Partnership Project
LTE	Long Term Evolution
QoS	Quality-of-Service
CA	Carrier Aggregation
E-MIMO	Extended-Multiple-Input Multiple- Output
CoMP	Coordinated Multi-Point Transmission
RN	Relay Node
BS	Base Station
UE	User Equipment
AF	Amplify-and-Forward
DF	Decode-and-Forward
GSM	Global System for Mobile Communications
UMTS	Universal Mobile Telecommunications System
HSDPA	High Speed Downlink Packet Access
DL	Down Link
UL	Up Link
CDF	Cumulative Density Function
MBMS	Multimedia Broadcast/Multicast Services
FDD	Frequency Division Duplexing
TDD	Time Division Duplexing
eNB	evolved Node B
CN	Core Network
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak to Average Power Ratio
PA	Power Amplifier
SCFDMA	Power Amplifier Single Carrier-Frequency Division Multiple Access
CDS	Channel Dependent Scheduling

RRC	Radio Resource Control
PCC	Primary Component Carrier
SCC	Secondary Component Carrier
SNR	Signal to Noise Ratio
BER	Bit Error Rate
MAC	Medium Access Control
DeF	Detect-and-Forward
RPC	Relay Per Cell
WINNER	Wireless World Initiative New Radio
SBMRC	Soft-Bit Maximum Ratio Combiner
MLD	Maximum Likelihood Detector
CSI	Channel State Information
QPSK	Quadrature Phase Sift Keying
QAM	Quadrature Amplitude Modulation
SER	Symbol Error Rate
AWGN	Additive White Gaussian Noise
IFFT	Inverse Fast Fourier Transform
CP	Cyclic Prefix
MMSE	Minimum Mean Square Error