بسم الله الرحمن الرحيم

قال تعالى: ﴿و يرى الذين أوتوا العلم الذي أنزل إليك من ربك هو الحق و يهدي إلى صراط العزيز الحميد (٦)﴾

سورة سبأ

يتوق كل من يؤلف كتابا إلى المدح و الثناء .....

أما من يقدم بحثا فحسبه أن ينجو من اللوم .

DEDICATION

We would like to dedicate this important thesis to our families and those who stand with us and motivated us toward the accomplishment of this important and hard work, especially my mother and father who were always helping us and wishing us the best (may ALLAH bless them).

Last but means not least, dedication goes to all those teachers in faculty of Electronics Engineering (SUST) who helped us during these years.

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This project is by far the most significant accomplishment in our life and it would be impossible without the help of God “ALLAH” who helped us.

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Abstract

This thesis studies the different aspects of the communication technology Long Term Evolution (LTE) which are its capabilities, system performance as well as spectrum flexibility.

Also it studies different types of interference that occur in LTE networks in general and focus on the inter cell interference specifically

The project deals with interference reduction in long term evolution (LTE) . There many algorithm reviewed and analyzed. Those algorithms are Fraction frequency reused (FFR), soft frequency reused (SFR), Least Mean Square (LMS) for smart antenna and Dynamic Fraction frequency reused (DFFR).

Then a MATLAB code has been written to evaluate (SFR), (LMS) and (DFFR). The MATLAB code is based on two cells Scenario, the simulation results shows the (DFFR) has better performance.

مستخلص البحث

هذا البحث تناول دراسة مفاهيم مختلفة للجيل الرابع في تقنية الاتصالات من حيث كفاءة وأدائية النظام .

وأيضا تمت دراسة أنواع مختلفة من التداخلات التي تحدث في شبكات الجيل الرابع LTE) (حيث تمت دراستها بصورة عامة ومن ثم تم التركيز ICI و الذي يؤثر بصورة كبيرة على جودة الخدمة .

في هذا البحث تم تناول تقليل التداخل في ال (LTE) و هناك عدة خوارزميات تم استعراضها و تحليلها لتقليل التداخل من نوع (ICI) مثل (FFR, SFR, DFFR & LMS) , و من ثم تمت كتابة شفرة هذه الخوارزميات (SFR, DFFR & LMS) باستخدام برنامج MATLAB لتقليل التداخل الذي يحدث بين خليتين و بعد ذلك تم عرض نتائج المحاكاة مما أوصلنا إلى تحديد أفضل خوارزمية من حيث الأداء لتقليل التداخل في (LTE) و هي (DFFR).

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Abbreviations

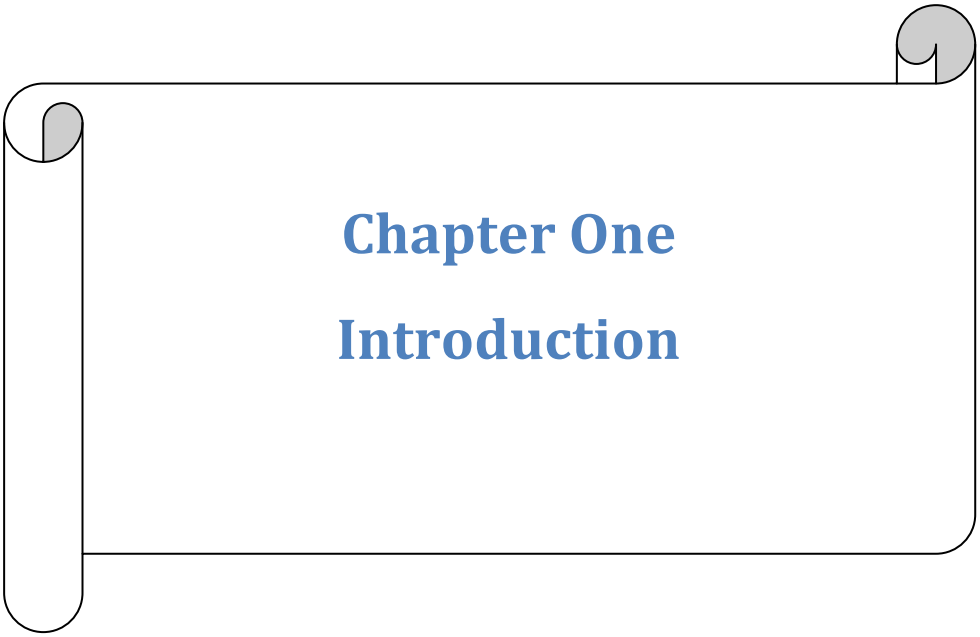
3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
AWGN	Additive White Gaussian Noise
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BER	Bit-Error Rate
BPSK	Binary Phase-Shift Keying
BS	Base Station
BSC	Base Station Controller
BTS	Base Transceiver Station
CDM	Code-Division Multiplexing
CDMA	Code-Division Multiple Access
DCCH	Dedicated Control Channel
DFR	Diffraction Frequency Reuse
DFT	Discrete Fourier Transform
DL-SCH	Downlink Shared Channel
DRX	Discontinuous Reception
DTCH	Dedicated Traffic Channel
DTX	Discontinuous Transmission
EDGE	Enhanced Data rates for GSM Evolution, Enhanced Data rates for Global Evolution
EGPRS	Enhanced GPRS
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN

FDD	Frequency Division Duplex
FDM	Frequency-Division Multiplex
FDMA	Frequency-Division Multiple Access
FFR	Fractional Frequency Reuse
FFT	Fast Fourier Transform
GP	Guard Period (for TDD operation)
GPRS	General Packet Radio Services
GSM	Global System for Mobile communications
HSDPA	High-Speed Downlink Packet Access
HSPA	High-Speed Packet Access
HS-SCCH	High-Speed Shared Control Channel
IDFT	Inverse DFT
IFFT	Inverse Fast Fourier Transform
IP	Internet Protocol
ITU	International Telecommunications Union
LMS	Least Mean Square
LTE	Long-Term Evolution
MIMO	Multiple-Input Multiple-Output
MSC	Mobile Switching Center
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency-Division Multiple Access
PSK	Phase Shift Keying
PSTN	Public Switched Telephone Networks
QAM	Quadrature Amplitude Modulation
QOS	Quality-of-Service
QPSK	Quadrature Phase-Shift Keying
RF	Radio Frequency

RX	Receiver
SFR	Soft Frequency Reuse
SINR	Signal-to-Interference-and-Noise Ratio
SIR	Signal-to-Interference Ratio
SNR	Signal-to-Noise Ratio
TD-CDMA	Time-Division Code-Division Multiple Access
TDD	Time-Division Duplex
TDM	Time-Division Multiplexing
TDMA	Time-Division Multiple Access
TTC	Telecommunications Technology Committee
TX	Transmitter
UE	User Equipment
UL	Uplink
UL-SCH	Uplink Shared Channel
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
VoIP	Voice-over-IP
WCDMA	Wideband Code-Division Multiple Access

Symbols

$y(n)$	The weighted sum of the received signals
$W^H(n)$	The hermitian transpose of the weight vector W
$x(n)$	The received signal at the array elements
$W_k(n)$	The array weights
$d(n)$	Reference signal
a_θ	The desired steering vector
$a(\theta i)$	The interference steering vector
$i(n)$	The interference signal
$n_k(n)$	The noise signal
$e\ (n)$	The error signal
y(n)	The filter output
u(n)	The transmitted signal
$\omega(n)$	The update function for the LMS algorithm
μ	The rate of adaptation
λ_{max}	The largest eigen value of autocorrelation matrix
m_{ij}	The number of sub-carriers
p_{ij}	The amount of power
z_{ij}	Binary - (0; 1) random
c	The sub-band capacity
p	The total power



Chapter One

Introduction

1.1 Background :

The basic definition of communication is transfer of information, e.g., data, voice or videos, from one place to another one. If information is transmitted through wireless medium it is then called wireless communication.

The wireless communication concept was first introduced by Guglielmo Marconi in 1897. It was quickly improved and deployed over the entire world. Started from the 1rst generation, now it is on the door of the four generation.

1.1.1 This is a list of mobile phone generations

1G: (Or 1-G) refers to the first generation of wireless telephone technology (mobile telecommunications). These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The main difference between the two mobile telephone systems (1G and 2G), is that the radio signals used by 1G networks are analog, while 2G networks are digital.

2G: (or 2-G) is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991.[1] Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted; 2G systems were significantly more efficient on the spectrum allowing for far greater mobile phone penetration levels; and

2G introduced data services for mobile, starting with SMS text messages. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multimedia messages). All text messages sent over 2G are digitally encrypted, allowing for the transfer of data in such a way that only the intended receiver can receive and read it.

3G: Short form of third generation, is the third generation of mobile telecommunications technology.[2] This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union.[3] 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.

3.5G: It is a grouping of disparate mobile telephony and data technologies designed to provide better performance than 3G systems, as an interim step towards deployment of full 4G capability. The technology includes:

- High-Speed Downlink Packet Access
- Evolved HSPA
- 3GPP Long Term Evolution, precursor of LTE Advanced

4G: provides, in addition to the usual voice and other services of 3G, mobile broadband Internet access, for example to laptops with

wireless modems, to smart phones, and to other mobile devices. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing.

4.5G: It is a grouping of disparate mobile telephony and data technologies designed to provide better performance than 4G systems, as an interim step towards deployment of full 5G capability. [4] The technology includes:

- LTE Advanced
- MIMO

5G: denotes the next major phase of mobile telecommunications standards beyond the current 4G/IMT-Advanced standards.

NGMN Alliance or Next Generation Mobile Networks Alliance defines 5G network requirements as:

- Data rates of several tens of Mb/s should be supported for tens of thousands of users.

- 1 Gbit/s to be offered, simultaneously to tens of workers on the same office floor.

- Several hundreds of thousands of simultaneous connections to be supported for massive sensor deployments. Spectral efficiency should be significantly enhanced compared to 4G.

- Coverage should be improved.

- Signaling efficiency enhanced.

- Latency should be significantly reduced compared to LTE.[5]Next Generation Mobile Networks Alliance feel that 5G should be rolled out by 2020 to meet business and consumer demands.[6] In addition to simply providing faster speeds, they predict that 5G networks will also need to meet the needs of new use-cases such as the Internet of Things as well as broadcast-like services and lifeline communications in times of disaster.

LTE is designed to increase data rates and cell edge bitrates, improve spectrum efficiency (unicast as well as broadcast) and allow spectrum flexibility (1.25, 2.5, 5, 10, 15 and 20 MHz) for flexible radio planning. LTE has also to reduce packet latency, the main restriction for real-time services, such as VoIP or videoconferencing, reduce radio access network cost as well as cost-effective migration from earlier 3GPP releases and simplify its network to a flat all-IP packet-based network architecture where all the user plane radio functionalities are terminated at the eNodeB [2].

Throughout time, people have and will continue to use communications at an ever-increasing pace in an interference environment. We are now living through the mobile revolution. With a lot frequencies travelling over the wireless medium, interference is the main obstacle that affect the quality of the signals. It is why we need to get rid of this phenomena or at least control it in such way that it becomes negligible.

There are two categories of interference. Those caused by natural phenomena which we cannot control and those called manmade which, with an effort, can be controlled.

Our thesis is the study of mobile telephone network under the influence of interference, by interference we meant the second category which, are manmade interference and specially those due to the use of same frequency in different cells (co-channel interference) [2].

1.2 Problem statement:

The increasing demand for more transmission speed as well as more capacity made an urgent need to increase the bandwidth utilization to meet that demand. Increasing bandwidth utilization by reducing the reuse factor result a in high inter-cell interference which degrades the performance of the communication system.

1.3 Proposed Solution:

Making the cells talk to each other during the allocation of resources to allocate resources that are far from the interfering with the other cells enhance dramatically the performance of the communication system while keeping the bandwidth utilization high and this process is called inter-cell interference coordination

1.4 Objectives of research :

Study the performance of LTE mobile network under the influence of interference.

Researchers will start by studying the reducing the inter cell interference (ICI) on LTE by using two types of algorithms.

1.5 scope of study :

The scope of our thesis is to implement a modeling for Long term evolutions LTE Advanced communication downlink system under inter cell interference.

1.6 Methodology:

A(MATLAB) code will be developed to implement these different types of algorithms to reduce inter cell interference.

1.7 Outline of thesis :

The thesis consist of five chapters

- Chapter one contains a background for our subject, problem statement, objectives and scope of researches, methodology and outline of thesis.
- Chapter two contains an introduction of mobile system, literature review for LTE, technology used in LTE, Interference and type of interference.
- Chapter three provides the methodology.
- Chapter four presents the figures, MATLAB codes and output result.
- Chapter five contains the conclusion of thesis and recommendation for the future related searches and references.