UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS ON THE EFFECT OF INTER-CELL INTEREFENCE IN LTE BY USING MATLAB

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

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I hereby, declared this report entitled "The Effect of Inter-cell Interference in LTE by using Matlab" is the results of my own research except as cited in references.

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Date	:	18th JANUARY 2018

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

………………………………

(Pn Zahariah Binti Manap)

ABSTRAK

Gangguan dia antara dua sel terjadi apabila pengguna dari sel bersebelahan menggunakan frekuensi yang sama dalam masa yang sama. Gangguan di antara sel akan menyebabkan penurunan kadar kekacauan yang melampau dalam terma (BER) diamna akan mengurangkan kaseluhan prestasi rangkaian tersebut. Objektif di dalam project ini adalah untuk mengkaji kesan teknik modulasi, jumlah pennghantaran frame dan penyumbang utama kepada gangguan (DIP) di dalam rangkaian truput dengan kehadiran ganggunag dari sel berhampiran. Keputusan akhir menunjukkan QPSK mengatasi prestasi AM dengan kadar minimum 12 peratus dalam terma truput. Tambahan lagi, apabila jumlah kerangka penyusunan meningkat, truput dalam rangkain berkurang. Sementara itu, parameter DIP menunjukkan mempunyai kadar pengaruhan yang paing tidak ketara. Oleh itu, kami dapat simpulkan dengan pilihan teknik modulasi menunjukkan perubahan yang ketara dimana dengan menganalisa teknik modulasi dapat menjamin kualiti servis dalam kehadiran gangguan di dalam sel.

ABSTRACT

Inter-cell interference (ICI) occurs when users in different adjacent cells attempt to use the same frequency at the same time. ICI may cause severe degradation in terms of the bit error rate (BER) which in turn reduces the overall network performance. This project aims to investigate the effect of modulation techniques, number of transmitted frames and dominant interferer proportion (DIP) on the network throughput in the presence of ICI. The results show that QPSK outperforms QAM by at least 12% in terms of the network throughput. In addition, it is shown that when the number of frames increases, the network throughput decreases. Meanwhile, the DIP parameter is found to have less influence on the network throughput. Therefore, we concluded that the choice of technique of modulation is very crucial to guarantee the quality of service especially in the presence of ICI.

DEDICATION

To my family..

To my Supervisor..

To my friends..

ACKNOWLEDGEMENT

I would like to thank ….

I must first and foremost thank my thesis advisor, Madam Zahariah Binti Manap, who was most responsible for helping me make this work a success. Her encouragement and guidance combined with a superior, in depth knowledge of the mobile field have enabled me to complete this thesis. Her positive influence on my remaining education was more than she will ever know.

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3GPP	-	Third Generation Partnership Project
3GPP2	-	Third Generation Partnership Project 2Million
4G	-	Fourth Generation of Cellular Technology
AWGN	-	Additive White Gaussian Noise
BCH	-	Broadcast Channel
CDD	-	Cyclic Delay Diversity
CDMA	-	Code Division Multiple Access
CP	-	Cyclic Prefix
CRC	-	Cyclic Redundancy Check
DCI	-	Downlink Control Information
DFT	-	Discrete Fourier Transform
DL	-	Downlink
DL-SCH	-	Downlink Shared Channel U
ENodeB	-	Enhance Base Station
E-UTRAN	-	Universal Terrestrial Radio Access Network
EVA	-	Extended Vehicle A
FDD	-	Frequency Division Duplexing
HARQ	-	Hybrid automatic repeat request
HSPA	-	High Speed Packet Access
IBI	-	Inner Block Interface
ICI	-	Inter-Cell Interference
IETF	-	Internet Engineering Task Force
ISI	-	Intersymbol Interference
LTE	-	Long Term Evolution
MAC	-	Media Access Control
MCH	-	Multicast Channel

MIMO	-	Multiple Input Multiple Output
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal frequency division multiple access
PAPR	-	Peak to Average Power Ratio
PCH	-	Paging Channel
PDCCH	-	Physical Downlink Control Channel
PDSCH	-	Physical Downlink Shared Channel
QAM	-	Quadrature Amplitude Modulation
QCI	-	Quality of Service Class Identifier
QoS	-	Quality of Service
QPP	-	Quadratic Permutation Polynomial
QPSK	-	Quadrature Phase Shift Keying
RE	-	Resource Elements
RSC	-	Recursive Systematic
SC-FDMA	-	Single Carrier Frequency Division Multiple Access
SINR	-	Signal to Interference plus Noise Ratio
TDD	-	Time Division Duplexing
TFP	-	Traffic Forwarding Policy
UE	-	User Equipment
UL	-	Uplink
UL-SCH	-	Up link shared channel
Wimax	-	Worldwide Interoperability For Microwave Access

CHAPTER 1
INTRODUCTION

1.0 Introduction

In this chapter, the overview of LTE and ICI, aims and objectives, problem statement and scope research for this project and its outline are discussed.

1.1 Project Background

In order to serve the increase of mobile broadband usage, Third Generation Partnership Project (3GPP) started releasing fourth generation of cellular technology (4G) in the form of Long Term Evolution (LTE). LTE is an evolution of the third generation (3G) system, which can improve the system performance. LTE system capable of producing a downlink maximum data speed of 150Mbps and in uplink 75Mbps (Arunabha G.,2010) meanwhile, the capacity of the cell produced 2 to 3 greater than High Speed Packet Access (HSPA+) and Worldwide Interoperability For Microwave Access (Wimax) technology. LTE is designed to meet carrier needs for high speed data and media transport as well as high capacity voice support well into the next decade. It encompasses high speed data, multimedia unicast and multimedia broadcast service.

Aggressive utilization of the spectrum turns to be an enhancement of Inter-Cell Interference (ICI) in the LTE network infrastructure creates congested. Sharing out the frequency in the adjacent cell declines the performance of ICI. Therefore, this issue needs analyze to solve so that the network performance can increase for real time application.

Orthogonal frequency division multiple access (OFDMA) has been recently implemented as the multiple access scheme for the LTE. One of the advantage of OFDMA is elegant solution to multipath interference (Arunabha G., 2010).The critical challenge to high bit rate transmission in a wireless channel is ICI caused by users in different neighbor cells attempt to use the same resource at the same time.

The orthogonal criteria among the subcarriers per cell, makes the intra-cell interference almost negligible. However, with universal frequency reuse among cells and assume all cells use the same set of subcarriers, the ICI at each subcarrier may cause severe degradation in the network performance.

In Orthogonal Frequency Multiple Access (OFDMA) networks, the subcarriers are allocated adaptively among users per cell based on a predefined scheduling scheme. Moreover, each subcarrier is allocated to only one user per cell assuming Base Station (ENodeB) are equipped with a single antenna and, thus, the number of interfering users on each subcarrier is rather limited. In comparison to downlink, the nature of uplink ICI is different in various aspects that include, due to the implicit symmetry and fixed locations of the eNodeB in the typical grid-based downlink network models, the number of significantly contributing interferers typically remains the same irrespective of the position of the mobile receiver. Also, it has been shown in (S. Plass, X.G. Doukopoulos, and R. Legouable, 2006) that the strongest interference is generated by two closer interfering ENodeBs irrespective of the mobile receiver location. However, thenumber of significantly contributing interference the uplink cannot be quantified at a given instant due to the highly varying locations of the interfering mobile transmitters.

Conditioned on the location of the desired mobile receiver within a cell, the exact distance of the interfering eNodeB can be calculated in the typical grid based downlink network models. However, knowing the location of the ENodeB receiver in the uplink does not help in determining the exact location of the interfering mobile users. In the uplink, cell edge and cell center mobile users are subject to the same amount of interference on a given subcarrier, which is the interference received at the ENodeB whereas the same is not true for the downlink in which cell edge users experience higher interference coming from the nearby ENodeB. Based on the above mentioned studies, there are limited studies, in particular, on how ICI impacts on the throughput. Therefore, in this project, a comparative study has been done on the effect of performance throughput in ICI.

1.2 Problem statement

Emergence of mobile usage has been evident over the last year and LTE is believed to deliver and satisfy the growing demand. In LTE, ICI is one of the most important fields of studies, which has been explored in a greater change. It is significant to study how the performance of throughput impacted the receiver when the eNodeB 1 and ENodeB 2 frequencies are overlapped which causes ICI. Therefore analysis and simulation is very important to investigate the system performance over a variety of deployment scenario. Besides, the analysis of LTE Physical layer will assist future research to implement in their project.

1.3 Project Objective

The main focus in this project is to measure the effects of ICI based on average throughput percentage. This include in analyzing the throughput vs simulated subframe based on the Extended Vehicle A (EVA) delay profile and several reference channels and using the properties of Matlab.

The objective of the project:-

i. To simulate the inter-cell interference in vehicular propagation environment by using Matlab.
ii. To analyze the effect of the inter-cell interference on the throughput performance in selected LTE propagation channel of LTE.

1.4 Work scope

The scope of project is very important in order to support in the build and development process of this project. The main focus in this project is to measure the performance of throughput in detailed. This include in analyzing the Throughput vs simulated subframe based on the Extended Vehicle A (EVA) delay profile and several channel references.

1.5 Organization of the Report

The outline of this project is organized as follows. In chapter 1, consist of introduction, project background, problem statement, aims and objectives are discussed. It also discusses about the scope of this project. Chapter 2**,** we discusses about the literature studies of Long Term Evolution (LTE), Different layer architecture and Inter-cell Interference (ICI). Next in chapter 3 discuss about the research methodology of the simulation in the network while in chapter 4 is dedicated to illustrate the simulation results and analyze the. The last chapter, chapter 5 we conclude the research works with possible future work.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides an overview of the basic concepts of an LTE network then, a synopsis of interference related aspects, including a brief state of the art, and a study of services and applications, and their related traffic models, are provided.

2.1 LTE Background

Nowadays, in the era of a mobile revolution with the mass market growth of smartphones, laptops, notebook and user demand from mobile communication system that passes beyond in both voice and telephony. An expansion in data intensive mobile service and applications like social network, music and video streaming has be the reason of evolution of next generation of wireless standards. Therefore, latest standard are being develop to supply the data rates and network capacity to hold up the worldwide delivery of these types of rich multimedia application. This chapter consists of two major sections. Section 1 gives and overview of LTE features and information and the other one is about inter-cell interference in LTE network.

2.2 Evolution of Cellular Network

In the previous two decades we have seen the presentation of different mobile standards, from 2G to 3G to the present 4G, and we anticipate that the pattern will proceed with (see Figure 2.1). The essential man date of the 2G guidelines was the help of mobile communication and voice applications. The 3G principles denoted the start of the parcel based information upset and the help of Internet Third Generation Partnership Project 2 (3GPP2) was the institutionalization body that built up specialized particulars and measures for 3G mobile system in light of the development of Code Division Multiple Access (CDMA) innovation.

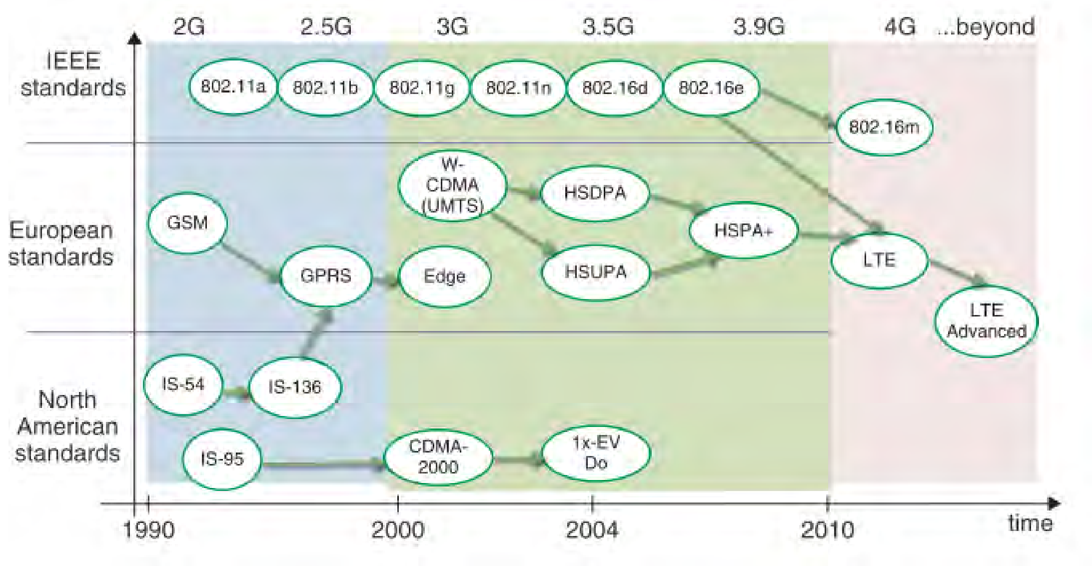

Figure 2.1 Evolution of wireless standards in the last two decades(Arunabha G.,2010)

2.3 Long Term Evolution (LTE) Overview

The 3GPP introduces LTE represents a major advance in cellular technology. LTE is designed to meet carrier needs include improves system capacity and coverage, high-speed data and media transport as well as high-capacity voice support well into the next decade, reduce operating cost, multi-antenna support, flexible bandwidth operations and seamless integration with existing system. It also encompasses high-speed data, multimedia unicast and multimedia broadcast services. Although technical specifications are not yet finalized, significant details are emerging.

In table 2.1, 3GPP developed the widely used Universal Mobile Telecommunication Service (UMTS), Wideband Code Division Multiple Access (WCDMA), High Speed Packet Access (HSPA) 3G standards, also developed LTE. Release 8 was completed in 2010, followed by release 9. Available now, release 10 defines LTE-Advanced (LTE-A).

Multiple cell-phone technologies designated by generations have led to LTE-A. The first generation was analogue technology, which is no longer available. The second generation (2G) brought digital technology with its benefits to the industry. Multiple incompatible 2G standards were developed. Only two, GSM and Code Division Multiple Access (CDMA), have survived.

LTE was created as an upgrade to the 3G standards. The cellular industry recognized its major benefits, and virtually every mobile carrier has embraced it as the next generation. All cellular operators are now on the path to implementing LTE. While 3GPP still defines LTE as a 3.9G technology, all of the current LTE networks are marketed at 4G. The real 4G as designated by 3GPP is LTE-A.

The overall objective for LTE is to offer an extremely high performance radio access technology which offers complete vehicular speed mobility and that can readily coexist with High Speed Packet Access (HSPA) and earlier networks. LTE supports DL peak data rates up to 326 Mbps with 20 MHz bandwidth and Uplink peak data rates up to 86.4 Mbps with 20 MHz bandwidth. LTE also supports scalable