UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF DOPPLER EFFECT 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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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The following are the members of supervisory committee:

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Mrs. ZAHARIAH BT MANAP

ABSTRAK

Kesan Doppler Shift pada rangkaian LTE dikaji melalui saluran penyebaran berlainan menggunakan perisian simulasi Matlab. Analisis throughput sistem komunikasi wayarles merupakan parameter utama untuk meningkatkan prestasi rangkaian tanpa wayar. Selain itu, 3GPP telah berkembang pada rangkaian 4G LTE baru untuk saluran uplink dan downlink. Dalam saluran downlink, pengukuran parameter adalah penting untuk mengukur prestasi throughput dari stesen pangkalan utama ke stesen bergerak. Kajian ini adalah untuk menganalisis prestasi simulasi dalam tiga keadaan penyebaran EPA, EVA dan ETU berdasarkan Frekuensi Doppler maksimum yang berbeza. Di samping itu, dengan sistem MIMO satu hasil simulasi dibentangkan berdasarkan korelasi yang rendah dan tinggi dalam keadaan penyebaran berbilang. Dari simulasi, prestasi throughput ditentukan berdasarkan nilai SNR dan jumlah antena yang dihantar. Berdasarkan graf simulasi, bilangan antenna dan kolerasi yang rendah mengunakan system MIMO dapat mencapai keadaan throughput yang bagus.Sebaliknya, kekerapan Doppler meningkat menyebabkan prestasi penurunan throughput.

ABSTRACT

In this report, the effect of Doppler Shift on the LTE network is investigated at different propagation channel using Matlab simulation software. The throughput analysis of wireless communication system is a key parameter for increasing the performance of wireless network. As 3GPP has evolved newly 4G LTE network for uplink and downlink channels. In the downlink channels, the throughput measurement is the most important parameter to measure the performance from base station to mobile station. This study is to analyze the simulate throughput performance in three propagation condition of EPA, EVA and ETU based on different maximum Doppler Frequency. In addition, with a MIMO system a simulation result is presented based on low and high correlation in a multipath propagation condition. From the simulation, the throughput performance are specifies based on SNR values and number of antenna been transmitted. It is shown that the graph for throughput performance have reach steady-state as number of antenna increase and low correlation used in MIMO system. Conversely, Doppler frequency increases causing a decrease in throughput performance.

Keywords: Doppler shift, LTE, EPA, EVA, and ETU.

DEDICATION

This humble effort specially dedicated to my beloved parents, family, friends and lecturers whose love can never be forgotten for their support, guidance and encouragement upon completing this project.

Special dedicated to my family

DASUKY BIN MAT DAUD

ROKIAH BT NIK MOHD SALLEH

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3GPP	-	3 Generation Partnership Project
AMC	-	Adaptive Modulation and Coding
ARQ	-	Automatic Repeat Request
BER	-	Bit Error Rate
BPSK	-	Binary Phase Shift Keying
CRC	-	Cyclic Redundancy Check
DLSCH	-	Downlink Shared Channel
ENodeB	-	Evolved Node B or Base Station
EPA	-	Extended Pedestrian A
ETU	-	Extended Typical Urban
EVA	-	Extended Pedestrian A
FDD	-	Frequency Divison Duplex
FRC	-	Fixed Reference Channel
HARQ	-	Hybrid Automatic Repeat Request
LTE	-	Long Term Evolution
MAC	-	media Access Control
MIMO	-	Multiple input Multiple Output
OFDM	-	Orthogonal Frequency Division Multiplexing
PDSCH	-	Physical Downlink Shared Channel
PHY	-	Physical
PUSCH	-	Physical Uplink Shared Channel
QAM	-	Quadrature Amplitude modulation
QPSK	-	Quadrature Phase Shift Keying

RLC	-	Radio Link Control
SC-FDMA	-	Single carrier Frequency Multiple Access
SER	-	Image Blunder Rate
SNR	-	Signal-to-Noise-Ratio
TDD	-	Time Division Duplex
UE	-	User Equipment

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter covers the introduction of the effect of Doppler shift for three propagation channel which are Extended Pedestrian A model (EPA), Extended Vehicular A model (EVA) and Extended Typical Urban model (ETU). In this report also included with background study, problem statement, objective and scope of work to represent multipath delay propagation.

1.2 Background

We live in the time of a versatile information insurgency. From versatile correspondence framework, cell phones, tablets, scratch pad, and smart phones clients request administrations and applications that go a long ways past minor voice and communication. A main impetus for improvement of the up and coming age of remote principles has development in information serious versatile administrations and applications, for example, Web perusing, long range interpersonal communication, music and video spilling. To give the information rates and system limit another standard had turned into an outcome to help overall conveyance of these sorts of rich mixed media application.

To respond to the requirements of this era, LTE is achieving global broadband mobile communications. To realize the goals and objective of this system it involves higher radio access data rates, improved system capacity and coverage, flexible bandwidth operations, significantly improved spectral efficiency, low latency, reduced

operating costs, multi-antenna support, and seamless integration with the Internet and existing mobile communication systems.

This report analyzed the LTE performance in theoretical, measurement and simulation aspect. The aim of this study is to analyze the effect of the Doppler shift on the performance of LTE system in several propagation channel. In 3GPP specification, the model that used to describe the LTE system performance which are Extended Pedestrian A Model (EPA), Extended Vehicular A Model (EVA) and the Extended Typical Urban Model (ETU). This fading profiles have been taken into consideration for the simulation in digital environment. In wireless telecommunication, phenomenon that results in radio signals reaching the receiving antenna by two or more paths are knows as multipath propagation.

In addition, this report focused on analyzing the Doppler Effect in LTE network. Doppler affect occur when data signal change in the frequency due to the movement of the sender of the receiver. The 3GPP has defined several reference channel for LTE network deployment which differ in term of access delay profile. In this simulation, the throughput analysis performance based on A3-2 reference channel are shown in running throughput for all SNR values varying number of frames. Therefore, an analysis on the Doppler affect is very important to investigate the LTE performance in all propagation scenario over a fixed reference channel.

1.3 Problem Statement

Doppler Effect is one of the factor of low throughput performance in LTE network. Doppler affect occurs when data signal change in the frequency due to the movement of the sender of the receiver. The 3GPP has defined several reference channel for LTE network deployment which differ in term of access delay profile. The 5 Hz Doppler is used for the EPA fading profile. The EVA uses 5 Hz as well as the 70 Hz Doppler Effect in fading. ETU is concerned with 70 HZ and 300 Hz only.

The Doppler Effect and its use for different profiles for the LTE have been specified in 3GPP LTE specifications. It is noticeable to say that with the Doppler increase, fading is also incremented. Therefore, an analysis on the Doppler affect is very important to investigate the LTE performance in all propagation scenario over a fixed reference channel.

1.4 Objective

The aim of this project is to analyze the Doppler Effect on the performance of LTE Physical channel in different propagation environment. The objectives are as follows:

i. To simulate the LTE Physical Channel data transmission in pedestrian, vehicular and typical urban propagation environment.
ii. To analyze the performance of the LTE Physical Channel based on the data throughput.

1.5 Work Scope

We focused on fixed reference channel of FRC A3-2 which involves all the propagation scenarios such Extended Pedestrian A (EPA) , Extended Vehicle A (EVA) and Extended Typical Urban (ETU).The main focus in this project is to measure the performance of throughput in detailed. This include in analyzing the throughput vs signal-to-noise ratio (SNR) based on several propagation channel and a fixed channel references of A3-2. The limitation set for this project including the modulation technique as in the simulation result QPSK was used. In addition, the number of frames were limited to 10 frames. For MIMO system, two different correlation were set in low and high to model the correlation between UE and ENodeB of antennas.

1.6 Thesis Organization

This project report consists of five chapter that described the flow of this research in structure. For the first chapter, it contained of the background of this project, problem statement, objectives and the scope of this project.For second chapter contained the literature review that comparing the idea and method or technique of other researcher used to do the analysis on effect of Doppler shift on throughput performance in LTE system. Besides, this chapter discussed several features on LTE system. Other than that, this chapter discussed the other researcher method by apply suitable technique to improve this project.

For third chapter which about research methodology which explicated the method of conducting the analysis of this research. For fourth chapter the result is obtained from the analysis of simulation using Matlab Software. The result explanations made thought the output obtained from the simulation result of this research project made. Lastly, for fifth chapter which the conclusion and summarised all the overall progress from the beginning until the end of the project

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter explains literature review based on the overview of LTE and Doppler Effect, aims and objectives, problem statement and scope research for this project and its outline are discussed.

2.2 Overview of LTE Network

A new standard specified by 3GPP for fourth generation (4G) wireless communications is called Long-Term Evolution (LTE). LTE provides various features like high peak data rates, low latency, reduced operating costs, multi-antenna support, flexible bandwidth operations, improved system capacity and coverage. It operates on technologies like Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input and Multiple- Output (MIMO), robust channel coding, scheduling and link adaptation. In wireless telecommunication, phenomenon that results in radio signals reaching the receiving antenna by two or more paths are knows as multipath propagation.

According to Suarez et all. (2012), LTE is a mobile broadband access technology founded as a response to the need for the improvement of to support the increasing demand for high data rates. An evolution of cellular communications standards is known as LTE which are multi-carrier standard specified by 3GPP that target high peak rates.

2.2.1 LTE Features

As indicated by Jing Zhu, (2011) the empowering advances of the LTE and its development incorporate the OFDM, MIMO, turbo coding, and dynamic connection adjustment strategies. As examined in the last segment, these advancements follow their inceptions to settled regions of research in interchanges and together help add to the capacity of the LTE standard to meet its prerequisites. In the interim, as indicated by Ammar Osman, (2009) the fundamental reasons LTE chooses OFDM and its single-bearer partner SC-FDM are as the essential transmission plans including vigor to the multipath blurring channel, high ghastly proficiency, low-many-sided quality usage, and the capacity to give adaptable transmission data transfer capacities and bolster propelled highlights, for example, recurrence specific planning, MIMO transmission, and obstruction coordination.

2.2.2 OFDM

OFDM is a multicarrier transmission plot. According to Farman Alil et each of the, (2016) the primary thought of OFDM is to adjust information images to different narrowband orthogonal sub-channels knows as subcarrier and it is to subdivide the data transmitted on a wideband direct in the recurrence space. In the meantime, Jose A. et each of the 920an OFDM transmission plan can speak to a recurrence particular blurring channel as an accumulation of narrowband level blurring sub-channels when the recurrence dividing between subcarriers is adequately little. It implies that OFDM give a straightforward route on transmitting the information for evaluating the channel recurrence reaction.

2.2.3 SC-FDM

As per M.Taha, (2012) In uplink transmission, a variation of the OFDM transmission knows as SC-FDM is chosen on the grounds that the outline of complex intensifier is testing. By joining a consistent OFDM framework with a precoding in light of Discrete Fourier Transform (DFT) so SC-FDM is executed. In the mean time, SC-FDM considerably diminishes vacillations of the transmit control.

2.2.4 MIMO

MIMO is one of the key advancements sent in the LTE measures. As indicated by (Takpor et al, 2014) MIMO systems convey to hold up under the upsides of utilizing numerous recieving wires with a specific end goal to meet the goal-oriented prerequisites of the LTE standard as far as pinnacle information rates and throughput. Besides, in portable correspondence MIMO strategy can enhance in two distinctive path which by expanding the unwavering quality of the correspondence interface and by boosting the general information rates. Moreover, in LTE standard the MIMO calculations utilized can be separated into four general classes which to transmit assorted variety, get decent variety, beamforming and spatial multiplexing.

As indicated by John Wiley, (2014) in transmit assorted variety and beamforming, as we transmit excess data on various receiving wires. In that capacity, these techniques don't add to any lift in the achievable information rates but instead influence the correspondences to connect more strong. In spatial multiplexing, be that as it may, the framework transmits free (non excess) data on various radio wires. This kind of MIMO plan can considerably support the information rate of a given connection. The degree to which information rates can be enhanced might be straightly relative to the quantity of transmit radio wires. To suit this, the LTE standard gives different transmit

arrangements of up to four transmit reception apparatuses in its downlink detail.

2.3 Overview of Wireless Standards

From figure 2.1 demonstrates the pattern of different versatile standard to enhance step by step from 2G to 3G to the present 4G.The essential command of the 2G gauges was the help of portable communication and voice applications. Be that as it may, the parcel based information unrest and the help of Internet applications, for example, email, Web perusing, content informing, and other customer server administrations denoted the start of the 3G standard. Besides, the 4G standard will bolster the unstable interest for transmission capacity hungry applications, for example, versatile video-on-request benefits and will highlight all-IP parcel based systems.

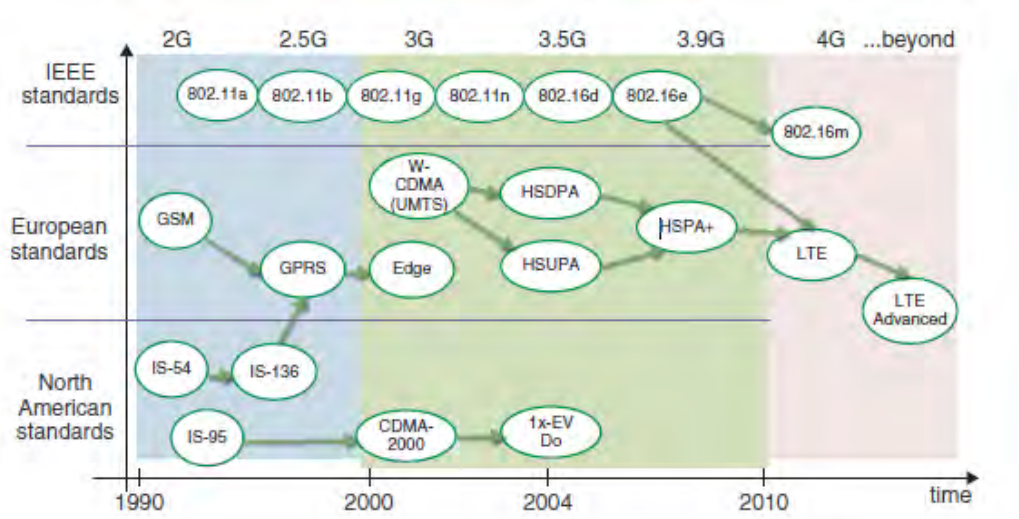

Figure 2.1: Evolution of wireless standards in the last two decades (M.A. Mohamed, 2014)

2.4 Doppler Effect

It is easy to understand and observe the phenomenon of Doppler Effect in our daily life. An example from figure 2.2 is shows of how sound race passes by observer 1 and observer 2. When the car getting closer to observer 2 the sound has higher in pitch. Meanwhile, when the car passes and start going away from observer 1, the pitch suddenly become slower. According to Ajay Kaushik et all, (2016), the Doppler Effect is observed because the distance between the source of sound and the observer is changing. If the source and the observer are approaching, then the distance is decreasing and if the source and the observer are receding, then the distance is increasing. The source of sound always emits the same frequency.

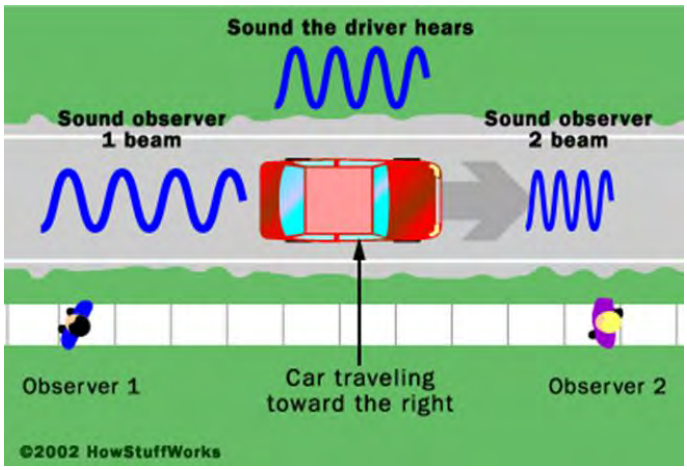

Figure 2.2: Phenomenon of Doppler Effect

(Source: < https://science.howstuffworks.com/science-vs-myth/everyday-myths/doppler-effect2.htm.>)

In this way, for a similar timeframe a similar number of waves must fit between the source and the spectator. On the off chance that the separation is huge, at that point the waves can be spread separated however in the event that the separation is little, the waves must be compacted into the littler separation. From Acosta et each of the (2014) hence, if the source is moving towards the eyewitness, the spectator sees sound waves contacting him or her at a more continuous rate (high pitch). What's more, if the source