UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF DOPPLER EFFECT ON THE PERFORMANCE OF LTE DOWNLINK TRANSMISSION USING MATLAB

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

by

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APPROVAL

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ABSTRAK

Pembangunan rangkaian 4G atau evolusi jangka panjang (LTE) berfungsi dengan cepat. LTE mempamerkan kemajuan utama dalam rangkaian komunikasi tanpa wayar untuk memenuhi permintaan yang semakin meningkat untuk perkhidmatan multimedia berkualiti tinggi. 4G adalah pada fasa dalam meningkatkan kualiti perkhidmatan (QOS). Makalah ini adalah untuk menyiasat Kesan Doppler pada LTE dengan model saluran penyebaran berlainan dengan menggunakan perisian simulasi Matlab. Ia menunjukkan analisis melalui saluran pelbagai saluran saluran pembiakan yang digunakan dalam saluran berkongsi fleksibel (PDSCH) sistem LTE fizikal. Model saluran penyebaran pudar yang dipertimbangkan dalam karya ini diperluaskan kepada pejalan kaki Model A (EPA), model kenderaan A (EVA) yang diperluaskan dan model bandar biasa yang diperluaskan (ETU). Kesimpulannya, dengan korelasi MIMO yang rendah untuk Kesan Doppler 5Hz, prestasi terbaik adalah EVA, dan yang paling teruk adalah ETU. Bagi kes Kesan Doppler 70Hz, yang terbaik adalah EVA dan yang paling teruk adalah EPA. Walaupun untuk Kesan Doppler 300Hz semua model adalah sama. Bagi korelasi MIMO yang lebih tinggi, untuk semua kekerapan Doppler, ETU adalah yang terbaik di kalangan EPA dan EVA. Sehingga peningkatan nilai SNR, nilai throughput juga akan meningkat.

ABSTRACT

Development of the 4G network or the Long Term Evolution (LTE) is working very quickly. LTE exhibit a major advance in wireless communication networks to meet increasing demands for high quality multimedia services. 4G is on its phase in improving the Quality of Service (QOS). This paper is to investigate a Doppler Effect on the LTE with different propagation channels model by using Matlab simulation software. It shows the throughput analysis of various fading propagation channels model that was used in Physical Downlink Shared Channel (PDSCH) of LTE system. The fading propagation channels model considered in this paper are Extended Pedestrian A model (EPA), Extended Vehicular A model (EVA) and Extended Typical Urban (ETU) models. It can be observe from the result, with low MIMO correlation for 5Hz Doppler Effect, the best performance was EVA, and the worst is ETU. For the case of 70Hz Doppler Effect, the best was EVA and the worst is EPA. While for 300Hz Doppler Effect all the model is identical. As for the higher MIMO correlation, for all Doppler frequency, ETU is the best among EPA and EVA. So that the increasing the value of SNR, the value of throughput also will be increases.

DEDICATION

This thesis report dedicated to my beloved parents, my supportive supervisor and co supervisor, my lecturers and lastly is to my lovely friends that always are my side. Thanks for unconditionally guidance, support and encouragement. Without whom none of my success would be possible.

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LIST OF ABBREVIATIONS

LTE	Long Term Evolution
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
MIMO	Multiple Input Multiple Outputs
BS	Base Station
BER	Bit Error Rate
MC-CDMA	Multicarrier Code Division Multiple Access
MMSE	Minimum Mean-Square Error
DAB	Digital Audio Broadcasting
DTTB	Digital Terrestrial Television Broadcast
SNR	Signal to Noise Ratio
ICI	Inter Carrier Interference
ISI	Inter-Symbol Interference
CP	Cyclic Prefix
CFO	Carrier Frequency Offset
TDD	Time Division Duplex
FDD	Frequency Division Duplex
RRM	Radio Resource Management
AMC	Adaptive Modulation and Coding
HARQ	Hybrid Automatic Retransmission Request

MSIE	Mean Squared Identification Error
PAPR	Peak to Average Power Ratio
PACE	Pilot Assisted Channel Estimation
EPA	Extended Pedestrian A Model
EVA	Extended Vehicular A Model
ETU	Extended Typical Urban

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter explain more about the background of this research project entitle the analysis of Doppler Effect on the performance of Long Term Evolution (LTE) transmission using MATLAB. The propagation channels that involve in this research are Extended Pedestrian A model (EPA), Extended Vehicular A model (EVA) and Extended Typical Urban (ETU). The background of this research consists, problem statement, research objective, scopes of research and summary of chapter.

1.2 Background

Doppler Effect is known as the effects that were cause by the comparative speed between the elements in the communication system. The effect that occurs by the Doppler is directly proportional to the magnitude of the comparative speed. Hence, this effect can only be deliberated important when the high speed was applied, such as in airplane or radar. Then, through Doppler effects, the signal frequencies move and spread. These Doppler effects cause the phase differences in the received signal strength and wave shape. Doppler Effect is the outward transformation in the frequency of the signal that was affected by reduction or increases of time when the transmitter and the receiver display the relation movement.

The Doppler shift was take place when the transmitter of the signal is moving in relative to the receiver. The relation movements were shifts the frequency of the signals, and that will cause the changed at the receiver than at the transmitter. In other words, the frequency perceived by the receiver is differences from the one that was original produced. Doppler frequency shift is commonly not quite the same as way to way when the signal reaches at the wireless receiver. Therefore the transferred signal frequency will encounter Doppler spreading and is viewed as otherworldly enlarging or expanding in received signal power spectrum. This width of the spectrum is acknowledged as Doppler Spread or fading bandwidth.

The Doppler frequency shift moves the frequencies of the RF carrier, subcarriers, packet, and symbol timing by the equal measurement in an Orthogonal Frequency Division Multiplexing (OFDM) sign or some additional moderated signals. The Doppler Effect also is importance in the performance of LTE downlink and uplink transmission. The collected Doppler spread from the downlink to the uplink in the present global mobile communication systems, such as LTE systems. In the downlink that from a base station to a terminal equipment, the discrete Doppler shift performs to the moveable station equipment receiver as offset balance from the base station carrier frequency of the transmitted downlink signal. The mobile terminal equipment receiver develops the carrierfrequency of the transmitted downlink signal from thereceived downlink signal by frequency approximation approaches, and cannot decide between a frequency counter balance at the base station transmitter and a frequency shift caused by the Doppler Effect.

In the LTE system, the technologies that generally used to recover downlink peak rate, cell analysis and normal cell data is multiple input multiple outputs (MIMO).The Doppler Effect was introduces carrier frequency offset in OFDM system and these outcomes can effect in the performance of degradation. Fading is a difference of attenuation of a signal with different variables which is time and radio frequency. It occurs when the two signals were mix up and resulting an attenuated signal. The attenuated signal is not as good as the original signal. For simulating the effect of multipath fading, the propagation channels that involve to analyzing the effect of Doppler Effect on the performance of LTE are Extended Pedestrian A model (EPA), Extended Vehicular A model (EVA) and Extended Typical Urban (ETU).

1.3 Problem Statement

Doppler Effect is one of the major elements in mobile communication, so that it always involve in transmission of communication. The effect of Doppler in LTE transmission is occur when the carrier frequency is counterbalance by the Doppler frequency which is hang on the movement relation to the axis among transmitter and receiver of the downlink and uplink transmission. The LTE propagation channels which are EPA, EVA and ETU also include describing the performance of LTE.

1.4 Objectives

The objectives of this project are:

1. To simulate the LTE propagation channel in pedestrian, vehicular and typical urban environment.
2. To analyze the performance of throughput for LTE propagation channel.

1.5 Scope of Research

This scope of this study focuses on Doppler Effect on the performance of LTE transmission and the effect that were experienced due to the different Doppler frequency in the orthogonal frequency division multiplexing (OFDM) system communication. It also will focuses on factors of Doppler Effect occur that make the signal in the system change, and test the performance of Doppler Effect in the LTE downlink propagation channel in mode pedestrian, vehicular and typical urban environment using MATLAB software.

1.6 Thesis Structure

These reports contain of five chapters. The first chapter is an introduction of chapter that covers about introduction containing background of the project, problem statement, objective of project, scope of project and thesis structure of report.

The second chapter be responsible for literature reviews which is highlight on the theory of Doppler Effect, LTE uplink and downlink transmission that already been analysed and some previous research journal that related to the project.

The third chapter describes the detailed of methodology that were used in this project. This chapter explains in details the procedures and steps that have been done to complete this project and also the expected result that were get from this research project.

The fourth chapter shows the results that were achieve from the analysis of simulation by using Matlab software. The results were explained in detail for each result that gained from the simulation.

Finally, chapter five conclude all the data and summarize the results of the throughput performance.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter deliberate on the literature review of the previous research and papers that are related to this project. The literature review are discussed later in this chapter is about the analysis of Doppler Effect on the performance of LTE transmission include the technique and system used, the characteristic of the parameter and type of channel communication model used. The techniquel then be compared and analyzed to get improvement in this project.

2.2 Previous Work on Doppler Effect

The Doppler shift was take place when the transmitter of the signal is moving in relative to the receiver. The relation movement cause shifts the frequency of the signals, and that effect the changed at the receiver.

2.2.1 Performance Analysis of Synchronous MC-CDMA in Mobile Rayleigh Channel with Both Delayand Doppler Spreads

This paper is prepared by Jean-Paul M. G. Linnartz from Delft University of Technology, The Netherlands, in year 2001. Firstly, the author examine about Doppler impact or spread in this journal models, the author define about the Doppler spread and enrol its outcome on the bit error rate (BER) for multicarrier code division multiple access (MC-CDMA) transmission and intends it to OFDM. Similarly, they survey as far

as possible per subcarrier to calculate the ability of MC-CDMA and (coded-) OFDM, it fixates on coordinate beneficiaries, particularly those with the Minimum Mean-Square Error (MMSE) worldview.

The OFDM receiver arrangement will agrees moderately the straightsignal that was handling to conflict network delay spreads, where it was a main inspiration that were utilize OFDM modulation techniques in some criteria, the Digital Audio Broadcasting (DAB) the Digital Terrestrial Television Broadcast (DTTB), which is part of the Digital Video Broadcasting standard (DVB), and lately the wireless local area network standard HIPERLAN II is the example of standards in this method.

In DAB, moveable reaction leads to inconvenient channel situations, with both (frequency) spreading and speedy distinctions of the network with time. However, the DVB-DTTB system guarantees to developa rapid distribution device for mobile multimedia and Internet administrations.This includes OFDM gathering over stations with a Doppler spread and the relating time varieties, which recognized to degenerate orthogonally of the OFDM subcarrier waveforms. In this case, between transporter obstructions Inter Carrier Interference (ICI) happens in light of the fact that flag parts from one subcarrier make impedance neighbouring subcarriers.

2.2.2 Channel Models of the Doppler Effect

This paper is prepared by NikolaosTsakalozos, KonstantinosDrakakis and S.Rickard from University College Dublin, Ireland in year 2010. The author said that the Doppler Effect was an outward adjustment in the frequency of a signal that was affected through reduction or increases of time after the transmitter and receiver display the relation sign. The author also state that by reflect the Doppler Effect as a channel

that changes an input signal $s(t)$ into the output signal $w(t)$ that is decreased, deferred, and rescaled form of the input: $w(t) = cs(at¡b)$,where note that the *a; b; c* can possibly be contingent on time.It is clear that author want to mention that the customary explanation of the Doppler Effect as a modest frequency that were variation is too slight for it drives,leaving out of its opportunity the factors *b* (delay) and *c* (reduction). The Doppler Effect may be inferred as an additive frequency shift under the usual ―narrowband assumption" in communications.

2.2.3 Doppler Effect Analysis and Modulation Code Derivation

This paper is prepared by E.A Feukeu, K. Djouani and A. Kurien from Tshwane University of Technology in year 2012. These journal efforts on the investigation of Doppler Effect result on vehicular network performances. The Doppler frequency shift moves the frequencies of the RF carrier, subcarriers, packet, and symbol timing by the same measurement in an OFDM signal or some additionalmodulated signals. The author also analysed the Signal to Noise Ratio (SNR) degradation of an OFDM system, the frequency counterbalance of the local oscillators, and phase noise is occur because of Doppler frequency shift.

The author in reflects a different method for the dimension and adjustment of the Doppler shift (frequency offset) in a received QPSK signal in which the Doppler shift may be very high, the signal or noise ratio very low, and the receiver has no past information of the expected data symbols. As a result shows that dependable communication can be continuous over a wide range of Doppler Shift if the suitable MCS can be carefully chosen in accord to anexact frequency shift.