STUDY ON COEXISTENCE AND SHARING BETWEEN DVB-T AND LTE SYSTEM

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of the requirements for the award of the degree of
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"To my beloved mother and father, Ashraf Sadat Chelangar and Noor Ali Sangtarash
for their support and care"

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ABSTRACT

Coexistence and sharing between DVB-T and LTE-OFDM, at the same frequency band (662 - 742 MHz) with CR and without CR are presented. By increasing convention of digital TV, TV white spaces (TVWS) which are free spectrums after switch over will be remaining. Based on the opportunity of using these free spectrums for secondary users, we investigated the possibility of use them for LTE-OFDM. Our studied has shown that for coexistence and sharing between DVB-T and LTE-OFDM, probability of interference is high and large protraction guard distance is needed. However when we apply CR technique, it can avoid from harmful interference from secondary system and improve spectrum efficiency. CR technology is able to sense the spectrums over a frequency band, and detect the existence/absence of primary users, and base on detect the free spectrum; use that spectrum without harmful interference with primary users. So, the spectrum usage can be enhanced by making a secondary user access into the spectrum holes or spectrum parts that in an exacting position and time have not dedicated by a primary user. Our result shows that the probability of interference with CR will be decrees and the guard distance will be less than before. Also base on detection threshold (DT) (when we use CR technique), the number of active white space devices (WSDs) or secondary users changed when we use variable detection threshold. IN addition, the behavior of the LTE CR in downlink is closely to that of the measurement that has been introduced for uplink. The proposed project showed improvement of system with CR. Since the number of LTE users is growing and it is needed more spectrum and there are limitation in amount of spectrum, LTECR can be used by application as a future wireless communication system.

ABSTRAK

Kewujudan bersama dan perkongsian antara DVB-T dan LTE-OFDM, pada jalur frekuensi yang sama (662 - 742 MHz) dengan CR dan tanpa CR dibentangkan. Oleh konvensyen digital TV, TV ruangan putih (TVWS) yang spektrum bebas selepas suis lebih akan baki. Berdasarkan peluang menggunakan spektrum percuma untuk pengguna menengah, kami menyiasat kemungkinan penggunaan untuk LTE-OFDM. Kajian kami telah menunjukkan bahawa perkongsian antara DVB-T dan LTE-OFDM, akan mengalami kebarangkalian gangguan yang tinggi dan besar maka pengawal jarak diperlukan. Walau bagaimanapun apabila kita menggunakan teknik CR, ia boleh mengelakkan daripada gangguan yang berbahaya daripada sistem menengah dan meningkatkan kecekapan spektrum. CR teknologi mampu untuk mengesan spektrum lebih jalur frekuensi, dan mengesan kewujudan / ketiadaan pengguna utama, dan asas mengesan spektrum percuma; penggunaan spektrum itu tanpa gangguan yang berbahaya dengan pengguna utama. Jadi, penggunaan spektrum boleh dipertingkatkan dengan membuat akses pengguna sekunder ke dalam lubang-lubang spektrum atau bahagian-bahagian spektrum yang dalam kedudukan dan masa dendam tidak khusus oleh pengguna utama. Hasil kami menunjukkan bahawa kebarangkalian gangguan dengan CR akan dekri dan jarak pengawal akan kurang daripada yang sebelumnya. Juga asas di ambang pengesanan (DT) (apabila kita menggunakan teknik CR), bilangan peranti ruang putih (WSDs) yang aktif atau pengguna menengah berubah apabila kita menggunakan ambang pengesanan yang berubah-ubah. Di samping itu, tingkah laku CR LTE dalam pautan turun rapat dengan ukuran yang telah diperkenalkan untuk uplink. Projek yang dicadangkan menunjukkan peningkatan sistem dengan CR.Oleh kerana bilangan pengguna LTE berkembang dan ia diperlukan spektrum lebih dan ada batasan dalam jumlah spektrum, LTE CR boleh digunakan oleh aplikasi sebagai sistem komunikasi tanpa wayar pada masa depan.

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LIST OF ABBREVIATIONS

ACLR	-	Adjacent Channel Leakage Ratio
ACS	-	Adjacent Channel Selectivity
BS	-	Broadcasting Service
CR	-	Cognitive Radio
DT	-	Detection Threshold
DL	-	Down Link
dRSS	-	Desired Received Signal Strength
DVB-T	-	Digital Video Broadcasting – Terrestrial
FCC	-	Federal Communications Commission
ITU-R	-	Radio communication Sector of the ITU
iRSS	-	Interfering Received Signal Strength
It	-	Interfering transmitter
LTE	-	Long Term Evolution
OFDM	-	Orthogonal Frequency Division Multiplex
PR	-	Protection Ratio
PMSE	-	Program Making and Special Event
QAM	-	Quadrature Amplitude Modulation
RRC-06	-	Regional Radio communication Conference, Geneva
Rx	-	Receiver
SNR	-	Signal-to-Noise Ratio
Tx	-	Transmitter
TVWS	-	TV White Space
3G	-	Third-generation
UE	-	User Equipment
Vr	-	Victim receiver
WSD	-	White Space Device

Wt	-	Wanted transmitter
Wr	-	Wanted receiver

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1. Introduction

Wireless communications has experienced growth remarkably in the past two decades. Today millions of people around the world use cellular mobile phones which has gone through three generations[1].

The radio frequencies signals are categorized for any specific wireless communication system (i.e., LTE, WiFi, WiMAX, etc) that is indicated by government agencies or international organization (i.e. ITU). Today with increasing and developing the wireless systems, this frequency utilizationis limited with the problem ofinsufficiency of spectrum. At the same time the studies show that the licensed spectrum is not use efficiently[2]. Measurements obtained by the Federal Communication Commission (FCC) shows that the spectrum usage range is from 15% to 85%, which might be possibility to use underutilized spectrum opportunistically.In addition,LTE have been deployed in some parts of Asia, Europe, and the United States since 2002 and will be widely deployed in the coming years. Therefore with increasing the implementation of the third generation (3G) integrates cellular phones which provide high speed packet-switching data transmission in addition to circuit-switching voice transmission, we need more portion of spectrum,

so whit limitation of spectrum finding the promising technique to be able to use spectrum more efficient is necessary[3].

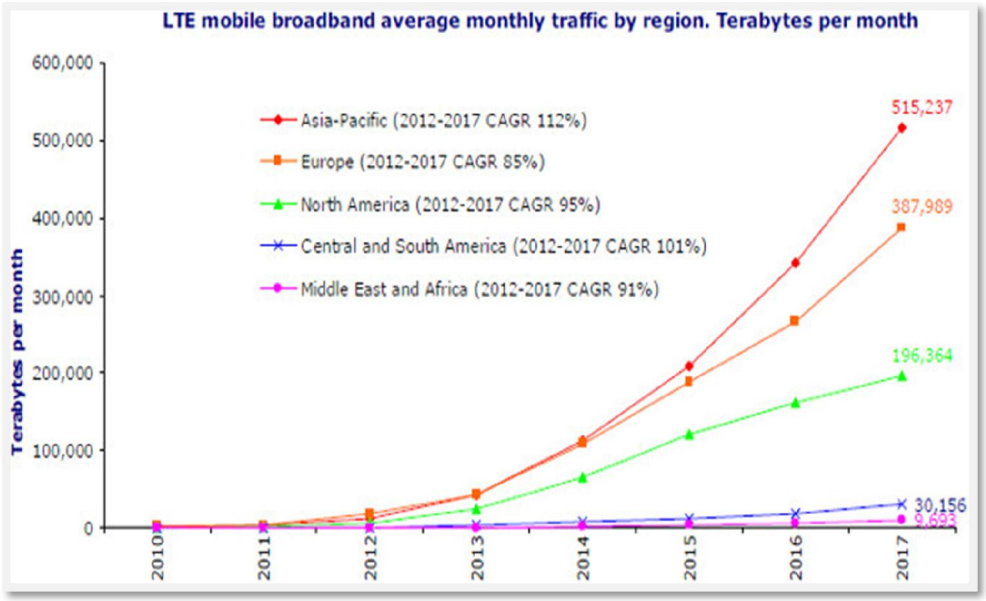

Figure 1.1: Average LTE mobile monthly traffic by different region[1].

In the other side currently the analog TV is moving to digital, so after this switch over there are some parts of frequency which will be free, and may be able to be used for other services.

So in this project we try to use the technology that is able to sense the spectrums over DVB-T frequency band, and detect the existence/absence of primary users, and base on detect the free spectrum, use that spectrum without harmful interference with primary users which is defined cognitive radio (CR). So, the spectrum usage can be enhanced by making a secondary user access into the spectrum holes or spectrum parts, that in an exacting position and time have not dedicated by a primary user[4].

1.2. Our Scenario

This project is defined a new communication model to develop the existing wireless spectrum more efficiency.

We investigated possibility of coexist and sharing between LTE and DVB-T at frequency band 470-790Mhz. (LTE extension over TVWS as a Secondary spectrum market). We study on performance loss when LTE-OFDMA system is deployed in TVWS of DVB-T system. Monte Carlo simulation is used to get the statistic results. Interference model, which is the focus of this project, is modified to prepare the possibility of coexistence of LTE and DVB-T systems.

1.3. Scenario key parameters

- High Market Potential
- High mobility, Coverage extension for rural broadband;
- Traffic peak support for urban scenarios.

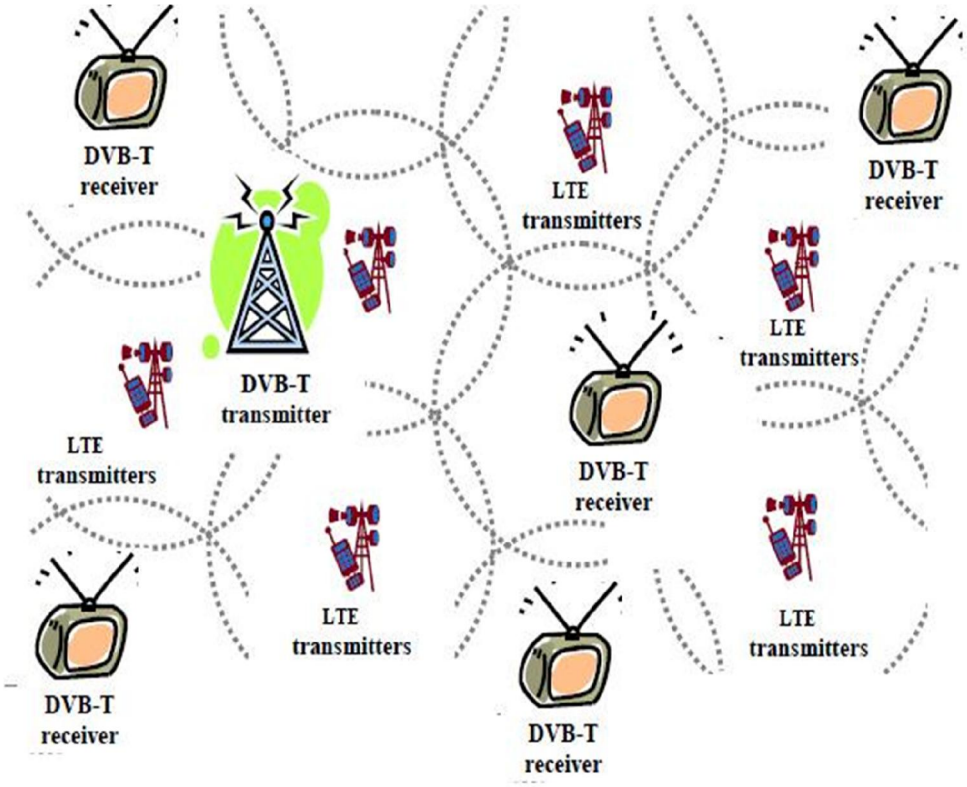

Figure 1.2: Coexistence of DVB-T and LTE

AS it clears in the figure 1.2 the Scenario is the coexistence of DVB-T transmitter as a Wanted Transmitter (WT), DVB-T receiver as a Victim Receiver (VR) and LTE base station as an Interference Transmitter (IT) at the same coverage area.

1.4. Statement of Problem

Despite all the research work, at the present moment, the following are not clear:

- Is there any interference between LTE and DVB-T in DL?
- How much is the interference?
- How to overcome the interference?

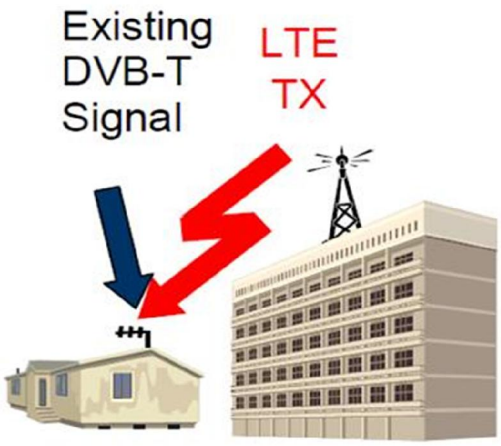

Figure 1.3: A victim and interferer scenario

1.5. Objectives

To shed light on all those uncertainties, it was necessary that the research project pursue the following objectives:

- To find out the probability of interference between LTE and DVB-T.

- To design scheme to avoid the interference produced by coexist and sharing between two systems and finding the protection guard distance.
- To design and simulate the sharing scenario, using cognitive radio technique and show its effectiveness in implementation.

1.6. Research Scope

- Literature review to find what is before done;
- Finding what is the problem: (Interference between DVB-T and LTE in DL);
- Using simulation base on Monte Carlo to find probability of interference;
- Using cognitive radio to decrees the interference;

REFERENCES

[1] Mobile Broadband via Laptop Users to Top 418m Globally in 2017. Available: http://www.ispreview.co.uk

[2] G. A. M.-A. a. J. e. A. Delgado-Pen´ın, "Opportunistic Communication (Cognitive Radio) over Primary Discarded Subchannels by Applying a Double Power Distribution," International Journal of Digital Multimedia Broadcasting, 2010.

[3] A. Al-Habashna, et al., "Joint signal detection and classification of mobile WiMAX and LTE OFDM signals for cognitive radio," in Signals, Systems and Computers (ASILOMAR), 2010 Conference Record of the Forty Fourth Asilomar Conference on, 2010, pp. 160-164.

[4] I. S. Jingyuan Zhang, "Cellular network " book, pp. 654-662, July 18, 2005.

[5] Long Term Evolution. Available: http://www2.nortel.com

[6] http://www.3gpp.org/LTE.

[7] "ECC REPORT 148,,MEASUREMENTS ON THE PERFORMANCE OF DVB-T RECEIVERS IN THE PRESENCE OF INTERFERENCE FROM THE MOBILE SERVICE (ESPECIALLY FROM LTE)," Marseille, June 2010.

[8] "ITUR-RR Vol1-eI " 2001.

[9] "TECHNICAL ANNEX: CRITERIA FOR PLANNING DVB-TECC REPORT 4," January 2002.

[10] P. Newsletter, "DigitalVideoBroadcasting—Terrestrial," FEBRUARY 2011.

[11] E. T. S. Institute, "TR 101 200,Digital Video Broadcasting (DVB); A guideline for the use of DVB specifications and standards," 1997-09.

[12] "FINAL ACTS.470-862 MHz (RRC-06)," 2006.

[13] D. Sirat, et al., "A Basic Framework Analysis on the Needs of Radio Frequency Spectrum Allocation at Ultra High Frequency (UHF) Band for Digital Terrestrial TV Broadcasting in Indonesia," 2010, pp. 73-77.

[14] G. Mastorakis, et al., "TV White Spaces exploitation utilizing a Cognitive Radio system based on DVB-H," 2011, pp. 127-130.

[15] D. L. TC and Á. Gomes, "COGEU D3. 2 Initial Architecture for TVWS Spectrum Sharing Systems," Sep 2010.

[16] P. Marques, "Spectrum in the EU: towards a smarter management of a scarce public resource," S&D Public Hearing on RSPP 1st March 2011.

[17] "CEPT REPORT 24, “Technical considerations regarding harmonisation options for the Digital Dividend”," 2008

[18] "Manual on Cognitive Radio Simulation," July 2010.

[19] "ECC REPORT 159,TECHNICAL AND OPERATIONAL REQUIREMENTS FOR THE POSSIBLE OPERATION OF COGNITIVE RADIO SYSTEMS,IN THE ‘WHITE SPACES’ OF THE FREQUENCY BAND 470-790 MHz," Cardiff, January 2011.

[20] “Technical considerations regarding harmonisation options for the Digital Dividend” 2008

[21] A.HAYAR, "Sensing and Spectrum Pooling Techniques for Cognitive Radio Systems," 2009.
[22] "SEAMCAT Handbook," January 2010.
[23] "Implementation of Cognitive Radio in SEAMCAT (STG10-19) " July 2010.
[24] A. R. Marc Le Dévendec, "THE SPECTRUM ENGINEERING ADVANCED MONTE CARLO ANALYSIS TOOL (SEAMCAT) " 2002.
[25] "ECC REPORT 104,COMPATIBILITY BETWEEN MOBILE RADIO SYSTEMS OPERATING IN THE RANGE 450-470MHz AND DIGITAL IDEO BROADCASTING - TERRESTRIAL (DVB-T) SYSTEM OPERATING IN UHF TV CHANNEL 21 (470-478MHz)," Amstelveen, June 2007.
[26] S. Kawade and M. Nekovee, "Wireless options for high data-rate indoor users: Cognitive access to TV white space," in Cognitive Wireless Systems (UKIWCWS), 2009 First UK-India International Workshop on, 2009, pp. 1-6.
[27] W. Wang, et al., "Analysis of interference from digital Terrestrial Television Broadcast to LTE TDD in Digital Dividend spectrum," in Proceedings of IC-NIDC, 2010, pp. 692-697.
[28] SE43 – Cognitive radio systems - White spaces (470 - 790 MHz). Available: http://www.ero.dk/wgse/se43
[29] I. f. R. (IRT), "SE43(10)32, Protection ratio measurements for cognitive radio systems using LTE technology against DVB-T reception," Munich, Germany, in February 2010.
[30] "SE43(10)102, Initial results of the SEAMCAT simulations using new CRS module," 2010.
[31] TD-LTE in White Space Task Group. Available: http://www.wirelessinnovation.org
[32] European Commission ICT Available: http://cordis.europa.eu/fp7/ict
[33] "SE43(10)22, Availability of spectrum for white space devices in the band 470-790 MHz," 2010.
[34] " STG(11)12rev1, Manual on Cognitive Radio," 2010.
[35] 3GPP, "36104-a00, 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (Release 10)," 2010.
[36] 3GPP, "36942-a10, 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA);Radio Frequency (RF) system scenarios (Release 10)," 2010.
[37] ZAID, "Coexistence and Sharing between IMT-Advanced and DVB-T Services at 790-862 MHz," 2010.
[38] "SE43(10)22,Availability of spectrum for white space devices in the band 470-790 MHz," 01 / 2010.
[39] "COGEU-SMCWS(10)10rev1 - usage for TV white space characterization of DVB-T systems," OCT 2010.
[40] "TECHNICAL REPORT - Annex to ECC REPORT 4, INITIAL IDEAS CONCERNING THE REVISION OF THE STOCKHOLM, AGREEMENT," 1961.
[41] Transmit Spectrum Mask. Available: http://www.home.agilent.com/agilent/

[42] "ECC REPORT 4, INITIAL IDEAS CONCERNING THE REVISION OF THE STOCKHOLM (1961) AGREEMENT," Lisbon, January 2002.

[43] CHARACTERISATION, "SPECTRUM SENSING IN COGNITIVE RADIO NETWORKS FOR DVB-T SYSTEMS AND EXPERIMENTAL CHARACTERIZATION OF WiMAX PROPAGATION," 2010.