COEXISTENCE BETWEEN THE MOBILE SERVICE AND TERRESTRIAL-DIGITAL VIDEO BROADCASTING IN THE 790-862 MHz FREQUENCY BAND

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This work is dedicated to my beloved parents,
my family, my friends and all my
teachers who helped me to become who I'm.

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ABSTRACT

The International Telecommunication Union for Radiocommunication (ITU-R) became involved with the spectrum allocation for next generation mobile communication services in World Radio Communication conference 2007 (WRC-07). The reason is to minimize the adjacent channel interference between Mobile service and DVB-T system within the same geographical area. Therefore the objective of this research is to study the compatibility between Mobile services as a case study for the International Mobile Telecommunication (IMT-Advanced) and Digital Video Broadcasting – Terrestrial (DVB-T) in the 790 to 862 MHz frequency band. This research also involves the studies and propagation characteristics within this band which can provide better coverage. Possibility of coexistence and sharing analysis were obtained by taking into account the detailed calculations of the path loss effect by using the practical parameters of DVB-T and Mobile service. The interference has been analyzed and simulated for several environments (rural and suburban) in different channel bandwidths for Mobile service at 5MHz and 20MHz, and in different transmitted power for Digital Video Broadcasting – Terrestrial. From simulation on ICS telecom (Information Communication Solutions) software the best separation distance are 21.73 Km and 15.88 Km for bandwidth of 5MHz and 20 MHz respectively. In the simulation two scenarios in two different places; Johor Bahru and Terual state in France were applied. The project involves identification of the spectrum suitability for systems to operate in the band 790 to 862 MHz. This is done by taking into account that the operation of broadcasting stations in the same geographical area may create incompatibility issues and intersystem interference between two wireless communication systems.

ABSTRAK

Kesatuan Telekomunikasi Antarabangsa bagi radiokomunikasi (ITU-R) terlibat dalam agihan frekuensi spektrum untuk generasi radio bergerak masa hadapan dalam seminar komunikasi radio sedunia 2007 (WRC-07). Alasannya adalah untuk meminimumkan gangguan saluran yang berdekatan antara perkhidmatan sistem radio bergerak dan Digital Video Broadcasting - Terrestrial DVB-T sistem dalam kawasan geografi yang sama. Oleh kerana itu objektif kajian adalah untuk mengkaji keserasian antara perkhidmatan sistem radio bergerak sebagai kajian kes untuk International Mobile Telecommunication (IMT-Advanced) dan (DVB-T) pada julat frekuensi 790-862 MHz. Penyelidikan ini juga melibatkan kajian dan ciri perambatan dalam jalur ini bagi menyediakan liputam yang lebih baik. Analisis kemungkinan perdampingan dan perkongsian diperolehi dengan mempertimbangkan pengiraan terperinci kehilangan dengan menggunakan parameter praktikal yang digunakan dalam DVB-T dan perkhidmatan bergerak. Gangguan ini telah dianalisia dan disimulasikan untuk beberapa kawasan (luar bandar dan pinggiran bandar) pada berbagai lebarjalur saluran untuk perkhidmatan Mobile 5MHz dan 20MHz, dan pada pelbagai kuasa terpancar dari DVB-T. Dengan menggunakan perisian simulasi ICS telecom, jarak tebaik adalah 21.73 Km dan 15.88 Km dan untuk lebarjalur 5MHz dan 20MHz. Dalam simulasi ini dua senario di dua tempat yang berbeza; Johor Bahru dan kawasan Terual di Perancis telah digunakan. Projek ini adalah untuk mengenalpasti kesesuaian sistem spektrum yang beroperasi pada jalur 790-862 MHz. Ini dilakukan dengan mengambil kira bahawa pengoperasian stesen penyiaran di kawasan geografi yang sama mungkin menimbulkan masalah ketidakserasian dan gangguan antara dua sistem komunikasi wayarles.

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LIST OF ABBREVIATIONS

ITU-R	-	International Telecommunication Union for Radiocommunication
WRC	-	World Radiocommunication Conference
IMT	-	International Mobile Telecommunications
UHF	-	Ultra high frequency
DVB-T	-	Digital Video Broadcasting – Terrestrial
DVB-H	-	Digital Video Broadcasting – Handheld
GE06	-	Geneva agreement 2006
WARC	-	World Administrative Radio Conference
FPLMTS	-	Future Public Land Mobile Telecommunication Systems
GSM	-	Global System for Mobile communications
CIS	-	Commonwealth of Independent States
PPDR	-	Public Protection and Disaster Relief
WiMAX	-	Worldwide Interoperability for Microwave Access
EU	-	European Union
DTT	-	Digital Terrestrial Television
MPEG	-	Moving Picture Experts Group
COFDM	-	Coded Orthogonal frequency-division multiplexing
OFDM	-	Orthogonal frequency-division multiplexing
ETSI	-	European Telecommunications Standards Institute
SFN	-	Single-Frequency Network
GPS	-	Global Positioning System
ISI	-	Inter Symbol Interference
OFCOM	-	Office of Communications
FCC	-	Federal Communications Commission

EC	-	European Commission
CEPT	-	European Conference of Postal and Telecommunications Administrations
DSO	-	Digital Switchover
ACLR	-	Adjacent Channel Leakage Ratio
ACS	-	Adjacent Channel Selectivity
ACI	-	Adjacent Channel Interference
BER	-	Bit Error Rate
ACIR	-	Adjacent Channel Interference Ratio
RSPG	-	Radio Spectrum Policy Group
BEM	-	Block Edge Mask
BS	-	Base Station
LOS	-	Line-of-sight

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CHAPTER 1

INTRODUCTION

The radio spectrum is a limited resource, and as a result of the drastic growth demand for wireless communication applications, radio spectrum regulation and management have become increasingly significant. On the other hand, it is commonly believed that the usage of spectrum is vastly underutilized all over the world [1].

In recent years, this inefficient utilization of spectrum motivates many communication engineers to pay attention to spectrum management such as resource allocation, coexistence, and spectrum sharing in order to promote more flexibility in spectrum usage.

Due to scarcity of the frequency spectrum, many bands are allocated for more than one radio service and thus the sharing is necessity. Consequently, the increased sharing of spectrum translates into a higher likelihood of users interfering with one another [2].

Interference between two wireless communication systems (intersystem interference) occurs when these systems operate at overlapping frequencies, sharing the same physical environment, at the same time with overlapping antenna patterns which leads to capacity loss and coverage limitation [3].

International Telecommunication Union for Radiocommunication (ITU-R) has become involved with the spectrum allocation for next generation mobile communication services in WRC-07. During work performed within ITU-R working party (WP) 8F (the last WRC-07), the frequency band of 790-862 MHz (the 800 MHz band) has been allocated to the mobile service and identified for the future development of International Mobile Telecommunications IMT which includes (IMT-2000 and IMT-Advanced) systems in Europe and others countries from the year 2015, meanwhile, this frequency band is currently used by broadcasting services in most of the world countries including Malaysia [4,5].

This means that interference probability due to frequency sharing between these two systems is bound to happen if the two systems operate in adjacent areas with same carrier frequency (co-channel frequency) or in the same area with an adjacent carrier frequency.

This amount of spectrum is in fact limited when compared to the frequency bands identified for mobile in other regions. Nevertheless, it will allow a valuable positive evolution of spectrum usage in Europe and some countries have decided to start using this capacity earlier than 2015.

The band plan for mobile services in the UHF band will play a crucial role in enabling mobile operators to make the most efficient use of this spectrum, and hence to provide the greatest economic and social benefit [5].

Meanwhile, the said band is currently allocated for broadcasting services which means that interference may be occurred between the mobile service and broadcasting services and thus systems performance will be degraded, therefore interference and coexistence studies between these systems should be done to investigate the probability of the harmful interference effects on the possibility of coexistence and spectrum sharing between these systems.

1.1 Problem Statement

Communication technologies in the 800 MHz band are used for broadcasting television signals, radio navigation, internet delivery, data communication and voice telephony. The systems that operate in this band (800 MHz) are suffering substantial interference, to the point of system failure.

Several national administrations have designated portions of the frequency band 790-862 MHz for terrestrial wireless applications such as mobile services and (IMT advanced, beyond 3G, 4G). This band was already allocated to the broadcasting and radio navigation services.

The problem is the adjacent channel interference that causes degradation in user connectivity in term of throughput, connection quality and in range. The Adjacent channel interference from the name is caused by the neighbouring channels. Adjacent channel interference, when is not minimized, decreases the ratio of carrier to interference. This ratio of carrier to interference will then be used in measuring the adjacent channel interference.

1.2 Objectives

In this dissertation the interference between Mobile Service and TV-broadcasting (DVB-T) is considered and the aim of the dissertation is to avoid adjacent interference between Mobile Service and DVB-T by using minimum separation distance. The other objectives to achieve the aim aforementioned are outlined as below:

- To calculate the exact value of the mutual power interference between two systems.
- To verify the feasibility of coexistence between the mobile service and broadcasting services in the specified band depending on the input specification.
- To determine the separation distance to coexist each two systems, decrease the interference.

1.3 Scope of Work

The scope of this dissertation is to carry out the spectrum sharing and coexistence studies, Spectrum occupation and Systems Specifications for mobile service and broadcasting will be covered. All necessary formulas that should be applied for sharing studies have to be analyzed and the required parameters are going to be determined. The required coexistence and interference criterion values for each

service should be adjusted and assessed. Specifications, suitable radio propagation models and its parameters and coefficients should be estimated.

1.4 Thesis Organization

The thesis comprises of five chapters beginning with a brief introduction. Literature review shall be discussed in the next chapter. Previous researches related to the effect of the adjacent channel interference and the separation distance as the mitigation technique have been presented in the Chapter 2. The methodology and the calculation methods, analysis and the specification to find the separation distance between Mobile Service and DVB-T have been existing in Chapter 3. Chapter 4 demonstrated the two simulations MATLAB and ATDI to calculate and measure the separation distance between Mobile Service and DVB-T. Finally, conclusion and future works are showed in Chapter 5.

1.5 Summary

This chapter defines the importance of this research, the aim and objectives, scope of work as well as the problem statement observed. The outline has been also described.