INTERFERENCE STUDIES BETWEEN IMT-ADVANCED AND FIXED SATELLITE SERVICE

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This project report is dedicated to my beloved grandmother, my father Professor Dr. Kays Shareef, my mother, my brother and my sisters. There is no doubt in my mind that without their continued support and counsel I could not have completed this process.

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ABSTRACT

The International Telecommunication Union (ITU) in world Radiocommunication conference (WRC-07) meeting recommended the IMT-Advanced to operate in the range of 3.4-3.6 GHz to achieve high bit rate and large bandwidth. However, this band is used for fixed satellite service (FSS). Accordingly, different types of interference like Co-Channel Interference and Adjacent Channel Interference is faced by FSS. In this project, testing the compatibility between the International Mobile Telecommunication (IMT-Advanced) and Fixed Satellite Service (FSS) networks in range 3.4-3.6 GHz (C-band) has been studied and discussed in details. Possibility of coexistence and sharing analysis were obtained by taking into account the detailed calculations of most useful formulas for path loss effect and clutter loss by using the existing parameters of FSS and IMT-Advanced. In-band interference has been concluded, analyzed and simulated by using MATLAB for several environments in response to different clutter altitude. MATLAB also used to find out the required interference threshold for FSS and required separation distance based on in and out of band and saturation interference. Moreover, different techniques are investigated in order to study the Co-Channel Interference as well as Adjacent Channel Interference. Furthermore, the results indicated that the proposed mitigation scheme is highly efficient in terms of reducing the separation distances.

ABSTRAK

International Telecommunication Union (ITU) dalam salah satu persidangannya, Radiocommunication Conference (WRC-07), mencadangkan agar IMT-Advanced beroperasi menggunakan yang berada di dalam julat jalur 3.4 GHz hingga 3.6 GHz bagi meningkatkan kadar bit dan memperoleh lebar jalur yang lebih besar. Walau bagaimanapun, julat jalur ini telah digunakan bagi aplikasi Perkhidmatan Tetap Satelit (FSS). Oleh yang deikian, terdapat beberapa gangguan seperti Co-Channel Interference dan Gangguan Saluran Bersebelahan akan dikesan oleh penerima FSS. Di dalam projek ini, keserasian diuji antara akses Telekomunikasi Mobil Antarabangsa (IMT-Advanced) dan jaringan Servis Satelit Tetap (FSS) dalam julat 3.4-3.6 GHz (jalur-C) telah pun belajar dan dibincang secara teliti. Kemungkina wujud sama dan analisis berkongsi diperolehi dengan mengambil kira kiraan rumus bagi kesan kehilangan laluan dan kehilangan sepah dengan menggunakan parameter FSS yang sedia ada dan parameter IMT-Advanced. Gangguan In-band telah disimpul, dianalisis dan disimulasi dengan menggunakan MATLAB bagi pelbagi persekitaran berdasarkan kepada altitus sepah yang berlainan. MATLAB juga digunakan untuk diperlukan mengetahui yang gangguan ambang untuk FSS dan diperlukan jarak pemisahan berdasarkan di dan keluar dari jalur,dan gangguan kejenuhan .Lagi pula, teknik yang berbeza telah diselidiki untuk mempelajari Co-Channel Interference serta Gangguan Saluran Bersebelahan. Selanjutnya, Keputusan menunjukkan cadangan skim susutan adalah sangat berkesan dari segi mengurangkan jarak berasingan.

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LIST OF ABBREVIATIONS

3GPP	-	3rd Generation Partnership Project
ACLR	-	Adjacent Channel Leakage power Ratio
ACS	-	Adjacent Channel Selectivity
ATPC	-	Automatic Transmit Power Control
BER	-	Bit Error Rate
C/N	-	Carrier-to-Noise power ratio
CDMA	-	Code Division Multiple Access
DOE	-	Direction of Earth station
EIRP	-	Effective Isotropic Radiated Power
FEC	-	Forward Error Correction
FSS	-	Fixed-Satellite Service
GSO	-	Geostationary Satellite Orbit
IMT	-	International Mobile Telecommunications
ITU	-	International Telecommunication Union
LNA	-	Low Noise Amplifier
LNB	-	Low Noise Block downconverter
LOS	-	Line-Of-Sight
MIMO	-	Multiple Input Multiple Output

NLOS	-	Non Line Of Sight
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDM	-	Orthogonal Frequency Division Multiple Access
OOB	-	Out Of Band
PSK	-	Phase Shift Keying
SDMA	-	Space Division Multiple Access
TDMA	-	Time Division Multiple Access
TVRO	-	TeleVision Receive Only
VSAT	-	Very Small Aperture Terminal

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CHAPTER 1

INTRODUCTION

C-Band is a prime band for satellite communication. There are more than 160 geostationary satellite are operating in C-Band today and are using the ITU FSS location in these bands [1]. Many more satellites today operate communication channels in other frequency bands but depend on telemetry operations (Telemetry, Tracking and Ranging) in C-band Mainly the C-Band downlink is divided into two parts the Extended C-Band and Standard C-Band. When, the extended C-band is the frequencies between 3400-3700 MHz and the standard C-band are the frequencies between 3700-4200 MHz. Several administrations have allotted the Extended C-Band for this new terrestrial service "IMT 2000" so it become a cause of in band and out of band interference and service interruption for satellite ground station and their related services. The increasing demand for wireless services has induced recent radio spectrum shortages. Given that spectrum is limited and is a scare natural resource, it should be used to its fullest. Emerging wireless

communication standards will demand spectrum sharing with existing systems as well as high throughput. In order to update frequency allocation decisions and other conditions of use of the radio spectrum at the global level, the World Radiocommunication Conference (WRC) is held every two to four years. WRC-07 agenda item 1.4 considers frequency-related matters for the future development of international mobile telecommunication 2000 (IMT-2000) and systems beyond IMT-2000, taking into account the results of International Telecommunication Union for Radiocommunication (ITU-R) studies in accordance with Resolution 228 (Rev.WRC-03). Thus, ITU-R has become involved with the spectrum allocation for next generation mobile communication services in preparation for WRC-07. During preparatory work performed within ITU-R working party (WP) 8F, the frequency bands of 3400-4200 MHz and 4400-4990 MHz have been identified as candidate bands for the future development of IMT-Advanced systems [2]. These bands are already being used for fixed-satellite services (FSS) in many countries around the world. Therefore, the spectrum allocation should be preceded by sharing studies between FSS and IMT-Advanced systems.

In wireless communication, Interference between two systems occurs when these systems operate at overlapping frequencies, sharing the same physical environment, at the same time with overlapping antenna patterns. ITU-R recommends expressing the level of interference in terms of the probability that reception capability of the receiver under consideration is impaired by the presence of an interferer. Concerning the different systems of International Mobile Telecommunication (IMT-Advanced) and Fixed

Wireless Access (FWA) systems, it is natural to conclude that those technologies will work in the same environment that leads to occurrence of performance degradation. Main mechanisms of coexistence are: co-sited (co-located) and non co-sited (non co-located). IMT-Advanced and Fixed Satellite Service (FSS) downlink part use 3400- 4200 MHz band. Meanwhile, the 3400-3600 MHz frequency band is identified at WRC-07 for IMT-Advanced in several countries in Asia with regulatory and technical constraints [3], which mean that frequency sharing between these systems is bound to happen and this sharing will lead to an interference because of different reasons.

When a system IMT-Advanced of other is considered, main type of interference is intrasystem interference, including interference coming from given cell, adjacent cell, and thermal noise. Whereas two systems coexist in the same geographic area, the interference includes not only intrasystem interference, but also intersystem interference.

The fact that the band 3400-4200 MHz is currently shared between FSS receives earth stations and radio relay systems in the FS does not mean that sharing between FSS and IMT-Advanced is feasible. The density of IMT-Advanced transmit stations will be much higher than that of radio-relay transmit stations. Moreover, transmit antenna patterns are much more directional for radio-relay stations than for IMT-Advanced stations.

1.1 Problem Statement

The satellite systems that operate in the 3400-4200 MHz band (C band) are suffering substantial interference, to the point of system failure, in places where national administrations are allowing IMT-Advanced system to share the same spectrum bands already being used to provide satellite services. We can describe the problem of this project that causes degradation in user connectivity in term of throughput, connection quality and in range by these points below:

• In-band, co-channel interference where IMT-Advanced and FSS operate at the same frequency.

• Adjust channel Interference from unwanted emissions of IMT-Advanced stations (out-of-band and spurious emissions) operating in one portion of the 3400-4200 MHz band into FSS receivers operating in another portion of this band.

• Overdrive and non-linear operation of FSS receive LNB's due to the power levels of IMT-Advanced emissions within the receive band of these, driving them outside their dynamic range.

1.2 Objectives

We will consider the interference between IMT-Advanced and Fixed Satellite Service (FSS), the aims of the project is to avoid interference between FSS earth station and IMT-Advanced by using minimum separation distance, also will:

I. Calculate the exact value of the mutual power interference between the FSS and IMT-Advanced.

II. Consider LOS and N-LOS path loss methods to measure the separation distance.

III. The mitigation technique used to provide coexistence between IMT-Advanced and FSS.

1.3 Scope

The scope of this project is to solve the co-channel and Adjacent channel interference in the frequency (3400 – 3600) MHz by making the exact calculation and analysis in term of some equation and calculation methods to find the minimum distance. All that will be done by using (MATLAB) software for finding the minimum distance and let the both IMT-Advanced and FSS operate at the same area.

1.4 Thesis outline

The thesis body contains five chapters, first chapter include the introduction that has the problem statements and the objectives. Second chapter will discuss about the literature review, the previous researches related to the effect of the co-channel interference and the separation distance as the mitigation technique all have been presented in this chapter. Analysis and the specification to find the separation distance between IMT-Advanced and FSS ES, also the methodology and the calculation methods all in chapter three. At chapter four, the calculations and the measurements of the separation distance by using MATLAB will be present. The conclusion and future works will be show in chapter five.

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