COEXISTENCE & SHARING BETWEEN LTE-ADVANCED & 3.5GHZ FSS FREQUENCY SPECTRUM

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بسم الله الرحمن الرحيم

to my

Norajon Mohd Kasim & Ahmad Zahir Mokhtar

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ABSTRAK

Dunia hari ini menyaksikan pembangunan teknologi komunikasi tanpa wayar yang pesat. Ini selaras dengan peningkatan permintaan perkhidmatan yang lebih pantas dan pelbagai guna seperti aplikasi ‘real-time’ dan multimedia. Pada tahun 2007, Sidang Radio Sedunia (WRC 2007) telah berbincang tentang satu piawaian terbaru dalam industri telekomunikasi yang digelar LTE Advanced. Sistem yang turut digelar sebagai 4G ini merupakan yang pertama seumpamanya, mengatasi system IMT-2000 sedia ada. Dalam perbincangan WRC2007, suatu cadangan tentang nilai pita frekuensi yang sesuai untuk 4G telah dibuat. Hasilnya, frekuensi antara 3400MHz ke 3600MHz telah dikenalpasti untuk kegunaan negara-negara Asia, termasuk Malaysia. Pada masa yang sama, sistem perkhidmatan satelit tetap (FSS) juga mempunyai frekuensi laluan turun antara 3400MHz ke 4200MHz. Oleh kerana itu, adalah dijangkakan bahawa perkongsian frekuensi yang berlaku di antara 3400MHz ke 3600MHz oleh kedua-dua sistem ini akan menyebabkan gangguan perkhidmatan keduanya. Ini memotivasikan keperluan untuk mengadakan suatu kajian yang mendalam untuk memastikan bagaimana kedua-dua sistem masih dapat beroperasi dengan baik di sesuatu kawasan, walaupun menggunakan pita frekuensi yang sama. Kajian ini telah dimulakan dengan membuat semakan semula secara menyeluruh terhadap kajian-kajian yang pernah dijalankan di atas tajuk perkongsian frekuensi dan langkah-langkah mengelakkan gangguan perkhidmatan antara sistem. Kemudian, satu senario dilakar khusus dan semua parameter yang diperlukan dikenalpasti. Senario ini akan dijadikan model yang seterusnya dipindahkan ke dalam perisisan simulasi untuk kerja-kerja simulasi. Dengan menggunakan perisian Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT), kebarangkalian gangguan antara kedua sistem dapat ditentukan. Ini memudahkan penentuan jarak fizikal dan jarak frekuensi yang sesuai antara kedua sistem supaya keduanya dapat beroperasi dengan baik. Hasil kajian dan simulasi menunjukkan bahawa jika kedua-dua sistem beroperasi pada frekuensi yang sama iaitu 3500MHz, jarak fizikal antara keduanya adalah sangat besar dan tidak praktikal sama sekali. Oleh kerana itu, cadangan telah dibuat untuk menentukan jarak frekuensi yang membenarkan keduanya beroperasi tanpa gangguan. Minimum jarak frekuensi antara kedua system ialah 25MHz jika FSS beroperasi dengan ‘bandwidth’ 4KHz, manakala jarak frekuensi 8MHz diperlukan apabila FSS beroperasi dengan ‘bandwidth’ 36MHz.

ABSTRACT

World have seen vast development in wireless communication standards to accomplish the emerging demands of higher speed real-time and multimedia functional communication needs. World Radio Conference 2007 (WRC 2007) has discussed the details of the breakthrough standard called LTE Advanced, a system which is beyond IMT-2000 or also known as 4G. While International Telecommunication Union (ITU) is working on evaluating suitable specification design to be deployed for LTE Advanced, WRC 2007 has concurrently work to identify suitable frequency bands for the LTE-Advanced to operate. It is obvious from the recommendations that frequency band of 3400MHz until 3600MHz is proposed for Asian countries, including Malaysia. Another frequency band from 3400MHz and 4200MHz is actively used by fixed satellite services (FSS) downlink operations as well. This co-existence and frequency band sharing especially involving the frequency band of 3400MHz to 3600MHz requires stringent interference studies, to determine if both systems could operates side-by-side without interfering each other. The interference of LTE Advanced towards Fixed Satellite Services (FSS) system when they co-exist and share the same operating frequency band is expected to cause severe downtime, economical losses, and potential safety threat to the users. This is because of the wide usage of FSS applications in critical applications such as business transaction data communication, healthcare remote multimedia communication, and even the military services. This justify the criticality of performing coexistence and sharing study between these two systems, and appropriate mitigation steps to ensure both systems could work side-by-side without killing one another out. This research is started with extensive literature review works. It is then followed by identifying the scope of simulation scenario to be performed in this case. Next is to identify the accurate simulation parameters for the given simulation scenario. These values represent systems characteristics to be simulated and must be accurately feed in, ensuring accurate results. It is then being brought up to perform the simulation work itself. Simulation work is started with initial system parameter values, which are then being varied to check variations of results. Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) software is used to simulate and calculate possibilities of interference and system's compatibility between the two infrastructures. Results obtained from these variations provide clearer understanding and able to suggest appropriate mitigation plan; the physical distance and operating frequency distance values in this case. A firm conclusion is made following the above findings, and appropriate future works could be suggested then. Based on the simulation works done in SEAMCAT, the co-existence and sharing between LTE Advanced and FSS system operating at the 3500MHz, the physical separation distance needed between these systems are impractically huge. Oppose to that, the minimum frequency distance of **25 MHz** is needed between the operating frequency of both systems to operate without interference from each other when FSS bandwidth used is **4KHz**. In addition, the minimum frequency distance of **8MHz** is needed between the operating frequency of both systems is required to operate without interference from each other when FSS bandwidth used is **36MHz**.

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CHAPTER 1

INTRODUCTION

1.1 Background

World have seen vast development in wireless communication standards to accomplish the emerging demands of higher speed real-time and multimedia functional communication needs. Without exceptions are the interference issues which have became vital in ensuring these vogue technologies are able to work side-by-side, meeting the market's demand. World Radio Conference 2007 (WRC 2007) has discussed the details of the breakthrough standard called LTE Advanced, a system which is beyond IMT-2000 or also known as 4G. While International Telecommunication Union (ITU) is working on evaluating suitable specification design to be deployed for LTE Advanced, WRC 2007 has concurrently work to identify suitable frequency bands for the LTE-Advanced to operate.

It is obvious from the recommendations that frequency band of 3400MHz until 3600MHz is proposed for Asian countries, including Malaysia. Another frequency band from 3400MHz and 4200MHz is actively used by fixed satellite services (FSS) downlink operations as well. This co-existence and frequency band sharing especially involving the frequency band of 3400MHz to 3600MHz requires stringent interference studies, to determine if both systems could operates side-by-side without interfering each other. The interference studies are motivated by multi-billion worth of FSS applications around the globe be it for television broadcasting, credit card transactions data communications, and even the military services.

1.2 Objectives

In this research, a scenario of LTE Advanced deployment versus current C-band FSS application in PETRONAS fuel retails in Kuala Lumpur, Malaysia environment is studied. The C-band FSS system includes also C-band transponders from MEASAT3 at 91.5^{o}E as the transmitters. The scope is limited to Kuala Lumpur coverage area which makes up to approximately 240 kilometres square.

At the end of the study, this research is able to identify;

1) Minimum **distance separation** needed between an LTE Advanced and FSS system in order for both systems to work without being interfered. This involves studies of interference possibilities numbers as separation distance is gradually increase to a point where no interference occurred between them. In other words, we could also refer this to co-channel interference check, as both systems will be operating in same frequency, which is 3500MHz in this study.
2) Minimum **operating frequency separation** needed between an LTE Advanced and FSS system in order for both systems to work without being interfered. This needs an adjacent channel interference study, where both systems will be co-located at the same place. As operating frequency made increased to allow changes of frequency distance, a check will be made to each increment of frequency gap until no interference could occur between both systems detected.

For the interest of this research, the operating frequency of 3500MHz is used as the reference operating frequency of interest. This is because; frequency overlapping between LTE Advanced and FSS occurs from 3400MHz and 3600MHz.

1.3 Problem Statement

The interference of LTE Advanced towards Fixed Satellite Services (FSS) system when they co-exist and share the same operating frequency band is expected to cause severe downtime, economical losses, and potential safety threat to the users. This is because of the wide usage of FSS applications in critical applications such as business transaction data communication, healthcare remote multimedia communication, and even the military services. In addition to that, companies who operate via satellites services such as television broadcasting may have to absorb losses worth billions of dollars for the service interruption if the FSS system is interfered.

This justify the criticality of performing coexistence and sharing study between these two systems, and appropriate mitigation steps to ensure both systems could work side-by-side without killing one another out.

1.4 Methodology

This research is started with extensive literature review works. This includes readings and gaining understanding of both LTE Advanced and Fixed Satellite Services (FSS) operating concepts, their applications, as well as the advantages and disadvantages present. This is vital to ensure the scenario is simulated within full understanding of how the systems actually work and interfere each other.

It is then followed by identifying the scope of simulation scenario to be performed in this case. It is very vague to perform any interference study within narrowing down to a specific scenario where variables are likely easily to be manipulated. Next is to identify the accurate simulation parameters for the given simulation scenario. These values represent systems characteristics to be simulated and must be accurately feed in, ensuring accurate results.

After above steps are properly done, it is then being brought up to perform the simulation work itself. Simulation work is started with initial system parameter values, which are then being varied to check variations of results. Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) software is used to simulate and calculate possibilities of interference and system's compatibility between the two infrastructures.

Results obtained from these variations provide clearer understanding and able to suggest appropriate mitigation plan; the physical distance and operating frequency distance values in this case. A firm conclusion is made following the above findings, and appropriate future works could be suggested then.

1.5 Thesis Contents

The author have arranged this thesis writings to be started with brief introduction on the topic of co-existence and sharing of frequency band between LTE Advanced and Fixed Satellite Services (FSS) specifically at 3500MHz operating frequency. It is then followed by a literature review section which explains deeper the LTE Advanced, FSS, and the Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) software. To equip full understanding on the interference studies, related papers published is then discussed. Based on the facts and figures gained from the paper discussion, a hypothesis is drawn specifically for this study.

Consequently the author continued with the research methodology. This includes all simulation steps taken in details, simulation scenario, as well as the system parameters used in this research. Each and every functions utilized from SEAMCAT is explained explicitly. Then, the results obtained from the simulations carried out are presented. The values obtained are then analyzed and discussed to form a finding.

It is then followed by the last section of concluding the research objective, the findings; including some suggestions for future works could be conducted.

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