SPECTRUM SENSING PROTOTYPE USING SOFTWARE DEFINED RADIO USRP

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Specially dedicated to *Mohamad Feetrie, Jamaliah Nordin, and Othman Mahluddin.*

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ABSTRACT

Cellular networks recently faced an increasing amount of mobile data traffic which causes network congestion. The concept of mobile data offloading has been introduced. Existing literature on offloading mainly focusses on numerical simulation, without actual measurement to verify the findings. The report therefore proposes the development of a USRP and LabVIEW software to implement the spectrum sensing prototype that is capable to evaluate the channel occupancy of a wide range of frequencies to investigate the feasibility of offloading between bands. The experiment focusses on the 2.4GHz ISM band (Wi-Fi band) and LTE 1800 MHz bands, to study the feasibility of Wi-Fi band to offload the LTE traffic. Different scenarios are investigated to find out the occupied or unoccupied channels in the selected range of frequencies. The raw data collected from the LabVIEW is analysed. The results shows that mostly all channels in LTE 1800 MHz band is fully occupied compared to the 2.4GHz ISM band which is 30% and 60% occupied for indoor and semi-outdoor enviroments respectively . The results justifies that that Wi-Fi band is feasible to be used to offload LTE traffics for indoor and semi-outdoor environment.

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ABSTRAK

Rangkaian telekomunikasi kini menghadapi peningkatan jumlah trafik data mudah alih yang menyebabkan kesesakan rangkaian. Konsep punggahan data mudah alih telah diperkenalkan. Kajian yang sedia ada kebanyakannya focus pada pemunggahan yang memberi tumpuan kepada simulasi berangka, tanpa ukuran sebenar untuk mengesahkan penemuan tersebut. Oleh itu, laporan ini mencadangkan pembangunan USRP dan perisian LabVIEW untuk melaksanakan spektrum prototaip sensing yang mampu untuk menilai penghunian saluran pelbagai frekuensi untuk menyiasat kemungkinan pemunggahan antara kumpulan-kumpulan. Eksperimen ini memberi tumpuan kepada jalur 2.4GHz ISM (Wi-Fi band) dan LTE 1800 MHz band, untuk mengkaji kemungkinan Wi-Fi band melepaskan trafik LTE. Senario yang berbeza disiasat untuk mengetahui saluran yang telah diguna pakai atau diduduki dalam julat frekuensi yang dipilih. Data mentah yang dikumpul daripada LabVIEW dianalisis. Keputusan menunjukkan bahawa kebanyakannya semua saluran dalam LTE 1800 MHz jalur diduduki sepenuhnya berbanding dengan band ISM 2.4GHz iaitu 30% dan 60% masing-masing diduduki oleh persekitaran tertutup dan separa luar. Keputusan membuktikan bahawa Wi-Fi band adalah sesuai digunakan untuk offload LTE trafik untuk persekitaran dalaman dan separa luar.

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LIST OF ABBREVIATIONS

Wi-Fi	-	Wireless Fidelity
ISM	-	Industrial, Scientific and Medical radio bands
LTE	-	Long Term Evolution
LTE-A	-	Long Term Evolution-Advanced
MCMC	-	Malaysian Communications and Multimedia Commission
SDR	-	Software Defined Radio
USRP	-	Universal Software Radio Peripheral
IEEE	-	Institute of Electrical and Electronics Engineers
GSM	-	Global System for Mobile Communications

CHAPTER 1

INTRODUCTION

1.1 Project Background

Cellular networks recently faced an increasing amount of mobile data traffic which can cause network congestion. The network congestion is due to the rapid growth of user subscription and the popularity of the used of android applications. For this reason, most of the mobile operators have introduced and started to implement a mobile data offloading strategy [18]. Mobile data offloading strategy can be used to increase the network capacity and network coverage. In order to carry large volumes of traffic over radio waves, recently application of small radio cells like femto-cells has been proposed. However, costs, environmental aspects and especially radio interference issues makes this option less attractive. As an alternative, data offloading is a more cost effective solution. This paper is introducing spectrum sensing technique which a part of offloading strategy. This paper just introduces the spectrum sensing process without actual offloading implementation. The proposed technique is able to perform the frequency scanning to define the used or unused channels in the frequency range of interest. The technique does not include the selection to proceed with the transmission process, it can be done as a future work.

The spectrum scanning focusses on Wireless Fidelity (Wi-Fi) frequency spectrum where it starts from 2.401MHz until 2.483MHz. This paper will also look into Long Term Evolution (LTE) 1800 MHz frequency spectrum which is from 1800MHz until 1855MHz. The frequencies are chosen for a proof of concept only. Moreover, the prototype developed can work with a wide range of frequencies. In future, it can be used for other frequency band too. The Wi-Fi band is chosen because Wi-Fi is an unlicensed spectrum and it can be freely used without the need to apply for the permit from regulators like the Malaysian Communications and Multimedia Commission (MCMC) in Malaysia. Same goes with the selection of frequency band of LTE 1800 MHz that already been used by operators such as Celcom Axiata Bhd and Maxis, the major network operators in Malaysia telecommunication industries.

This report defines the prototype of spectrum sensing that provides benefit to the other researchers to continue with the offloading mechanism.

1.2 Problem Statement

According to Cisco, for the period from 2010-2015, the global mobile data network will experience a growth of more than 26 times in only five years which could results in severe problems in handling with the mobile data traffic [6]. The increases in mobile users will lead to even higher data consumption in a cellular network. Many network providers have plans to avoid their network to be congested. One of the methods is the traffic offloading from busy channels to vacant channels, which requires frequency scanning to achieve such objective.

In previous paper [25], the authors presented a survey of spectrum sensing methodologies for cognitive radio which is solvely based on simulation without any performance measurement based on the real environment. In contrast, this report will implement the spectrum sensing based on real environment. In [26], the authors proposed spectrum sensing evaluation just in the television (TV) white space, not for newer technologies such as LTE. In this report, the evaluation covers the newer technologies such as the ISM band and LTE 1800 band. There is recent papers that perform the experiment measurement in real environment but just for an indoor environment [27]. Wheares in this project, the measurement is conducted in both indoor and semi-outdoor environment. In addition, from paper [28], the researchers do the spectrum sensing by using many devices and that can be reduced to one device by the new implementation proposed in this report.

1.3 Research Objectives

The objectives of this project are:

1. to develop a spectrum sensing prototype using USRP software defined radio for vacant channel detection.

2. to study the feasibility of Wi-Fi offloading from LTE 1800MHz band for indoor and semi-outdoor environments.

1.4 Scope of Work

The scope of this project is to develop a prototype of a Wi-Fi spectrum sensing prototype using universal software radio peripheral (USRP) hardware and Labview software. The project mainly focuses on understanding the concept of spectrum sensing, Wi-Fi and LTE 1800 frequency band, software defined radio (SDR), LabVIEW, and received power.

In order to achieve the objectives of this project, several scopes have been outlined, as shown in the following:

1) Use off-the-shelf NI USRP-2922 to implement the spectrum measurement prototype.
2) The programming of the USRP is by using NI LabVIEW software.
3) The measurement is done by using Wi-Fi frequency band (2.401-2.483MHz) and LTE 1800MHz frequency band (1.805-1.855MHz).

4) The measurement parameter of interest is received power obtained from measurement.
5) The measurement is performed indoor and semi outdoor (pedestrian area).

1.5 Report Outline

This report is organized in five chapters. Chapter 1 gives an overview and the introduction of the project.

Chapter 2 discusses the literature review and the introduction of all scopes for this project. The introduction of SDR platform used in this project is elaborated. The Wi-Fi and LTE 1800 MHz band characteristics are studied. Other than that, the used of LabVIEW is explored. The most important part is the description of the spectrum sensing technique is stated.

Chapter 3 covers the design methodology of the project. In this chapter, the overview of the design project is discussed which includes the front panel interface, block diagram and LabVIEW codes developed in this project.

Chapter 4 shows the results from measurements conducted together with the discussion of the analysis.

Lastly, Chapter 5 gives a summary of the overall project together with the suggestion for future work.

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