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4G Spectrum Activity Analysis inNagapattinam-India

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***Abstract*—In this paper, The spectrum activity status of various frequency bands of 4G Long Term Evolution-Advanced (LTE-A) cellular systems are obtained by Deep Radio in Nagapattinam district, India. The measurements are taken from E.G.S.Pillay Engineering College within a1000 square-meter area are analyzed at a day of continuous 1 hour duration. The data capturing and spectrum monitoring processes are presented in detail. Numerical analysis of the captured data has been explained in detail. The results are presented the average percentage count of the LTE-A frequencies in a day of continuous 1 hour duration. This motivates for secondary user spectrum allocation in Cognitive Radio (CR). The python code is used in this Kaggle platform to convert captured data samples to graphical representation. The spectrum is collected for each 10s and then calculating occupancy percentage.**

I.INTRODUCTION

The increasing use of communication systems(like.,4G,5G,6G,Etc..,) makes it more and more difficult to accommodate all users in the limited spectrum available. Some frequency bands are already overcrowded at times and spectrum managers more often need to know the actual occupancy percentage in certain frequency bands. [1]Spectrum resource describes the availability of spectrum in terms of space (e.g. location), time and number of channels (in a channelized band) that all users on a certain territory may access.In this, we use a Deep Radio that is a transceiver device, which means it both transmission and reception. It can transmit and receive signal from 50MHz to 6GHz. It is basically open source platform, so it can be programmed and managed as a Standalone system.[2] It contains telescopic antenna which is suitable for 75 MHz to 1GHz. Since the signal processing was performed in the system the same of the hardware can be used to generate many kind of Radio waveforms. Thus, it is also called Software Define Radio(SDR). [3]Deep Radio is a platform for developing Deep Learning based wireless applications. In wireless communication scenarios, the traffic model has been played a vital role in the design and performance evaluation. The spectrum activity E.G.S Pillay Engineering College have been measured using Deep Radio . [4]The spectrum occupancies have been calculated by energy detection technique (EDT), and average spectrum occupancy technique (ASOT) for 800 MHz to 2400 MHz of cellular frequency bands, GSM900, GSM1800, UMTS2100,LTE800, LTE900, LTE1800, and LTE2300.In this method we found that most of the 2G bands are vacant and availablefor 4G/5G transmissions and deployment of Cognitive Radio (CR). In this work, we study the activity of 4G frequency bands in time-domain at E.G.S Pillay Engineering College locations within a small geographical region in Nagapattinam district, Tamilnadu - India .

II SYSTEM MODEL

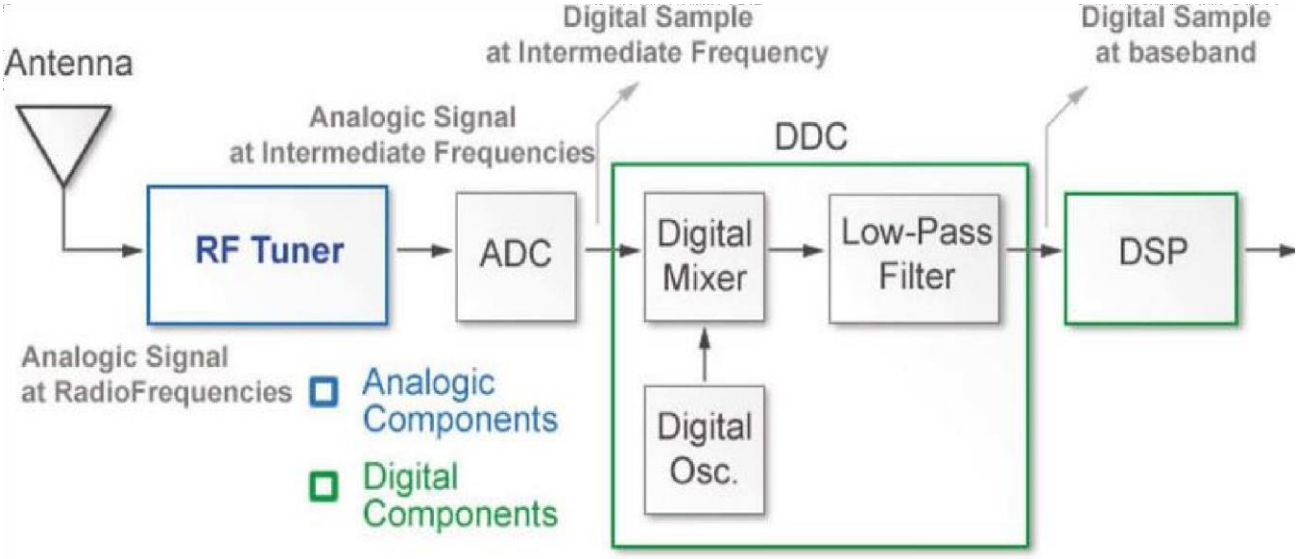


Fig 1 Deep Radio Block Diagram

Deep Radio is a transceiver is a combination transmitter/receiver in a single package. While the term typically applies to wireless communications devices, it can also be used for transmitter/receiver devices .In this, A transmitting antenna is one, which converts electrical signals into electromagnetic waves and radiates them. A receiving antenna is one, which converts electromagnetic waves from the received beam into electrical signals. In two-way communication, the same antenna can be used for both transmission and reception. [5]Tuners are a primary part of receiver circuit, and they receive RF signals from the antenna and convert the selected carrier frequency and its associated bandwidth into a fixed frequency[6]. In Deep Radio, an analog-to-digital converter (ADC, A/D, or A-to-D) is a one block that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal.

Mixer is also one block of Deep Radio widely used to shift signals from one frequency range to another, a process known as heterodyning, for convenience in transmission or further signal processing.[7] For example, a key component of a superheterodyne receiver is a mixer used to move received signals to a common intermediate frequency. It is a nonlinear electrical circuit that can produce new frequencies from two applied signals. Also, a frequency mixer in its purest form takes two applied signals and creates new signals equal to the difference and sum of the originating frequencies.[8] A low-pass filter (LPF) it is used in DDC block of DR , it is a circuit that only passes signals below its cutoff frequency while attenuating all signals above it. [8]It is the complement of a high-pass filter, which only passes signals above its cutoff frequency and attenuates all signals below it.

[9]A digital oscilloscope is ideal for displaying intricate signal waveforms where calculations and measurements on specific portions of the waveforms must be made to provide numerical and waveform output displays which reflects the chosen parameters of the waveforms.

[10]In digital signal processing for communications systems, essential DSP design methodologies and applications for the development of modern (DSP-intensive) communication systems.Course topics include: digital pulse shaping filters with efficient polyphase structure, digital modulation schemes (QAM, FSK, PSK), digital transceivers with sampling and automatic gain control, carrier recovery, timing recovery, equalization, and error correction coding.Additional topics that may be presented are iterative receiver design, OFDM (applicable to LTE ,WiFi and more) and multiple antenna processing (MIMO), and wireless and mobile fading channels characterizations.

III. RESULTS

Table 1 4G Frequency Bands Used By The Mobile Operatorss In Nagapattinam District ,Tamil Nadu-India

AIRTEL	RELIANCE JIO	VODAFONE IDEA	BSNL
BAND 3,40,8,1	BAND 3,5,40	BAND 3,8,1	BAND 3,8

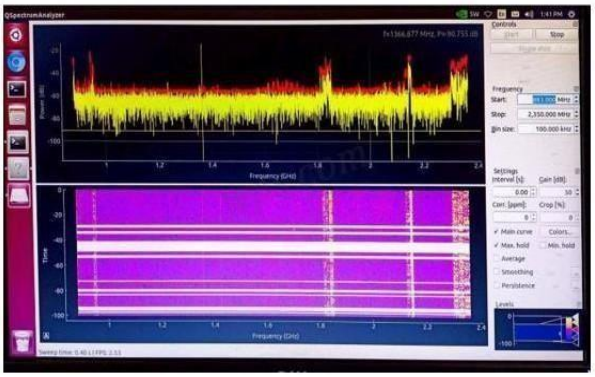


Fig 2 4G Frequency bands used in Nagapattinam district, Tamilnadu -India

Table I shows 4G (LTE) frequency bands used by the telecom operators Airtel, Reliance Jio, and Vodafone Idea in Nagapattinam district, Tamilnadu, India.

A. Measurement setup

In order to observe the spectrum occupancy, real-time signals of nine different LTE-A frequencies (881, 949.5, 1820,1847, 2310, 2330, 2350, 2365, and 2375 MHz) have been captured from the nearest cell towers. This experiment has been carried out at E.G.S. Pillay Engineering College locations in Nagapattinam district, Tamilnadu, India as shown in Figure .

B. Data Processing

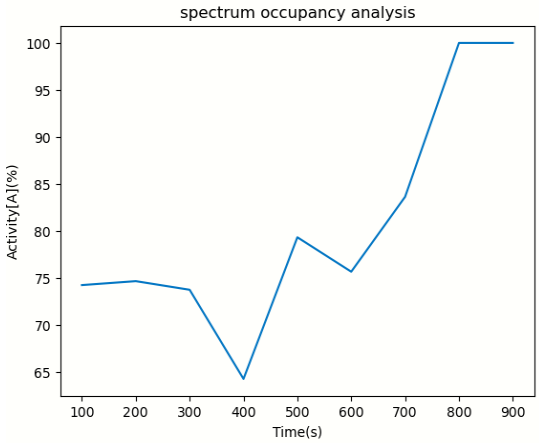
We have collected the samples of each frequency band for fixed one hour duration (i.e. T_{cap} = 900 seconds) with sampling frequency fs = 20 Msps using Deep Radio. The entire dataset preparation of nine different frequencies have been performed in a day.[11]The dataset have been processed on a computer. The 'dat' files for different LTE-A frequencies are stored and are processed with the help of Python packages Figure 5 describes the activity percentage of(881, 949.5, 1820, 1847, 2310, 2330, 2350, 2365, and 2375MHz LTE-A bands over a time period of an hour.

C. Discussions

Table III shows the activity for E.G.S. Pillay Engineering College observed at the same time in the continuos 1 hour durations

Fig 3 Data Collection Location at E.G.S Pillay Engineering College, Nagapattinam district, Tamilnadu, ,India.

Fig 4 Spectrum Activity Graph



[12]The above graph shows the activity percentage in terms of percentage and time in seconds.The spectrum are monitored some selected frequencies like (881, 949.5, 1820,1847, 2310, 2330, 2350, 2365, and 2375

MHz).the starting frequency 73.6% in this percentage the graph decreases and increases simultaneously.[13]above this percentage there is no activity in some frequency bands.so this bands are used by another user.

Frequency (MHz)	E.G.S. Pillay Engineering College(Nagapattinam) Location
881(MHz)	84.77
949.5(MHz)	75.41
1820(MHz)	67.86
1847(MHz)	70.25
2310(MHz)	78.85
2330(MHz)	73.73
2350(MHz)	71.76
2365(MHz)	84.4
2375(MHz)	100

Table 2 Spectrum Activity

The above table shows the some selected spectrum frequency that are taken from E.G.S. Pillay Engineering College,Nagapattinam,India..

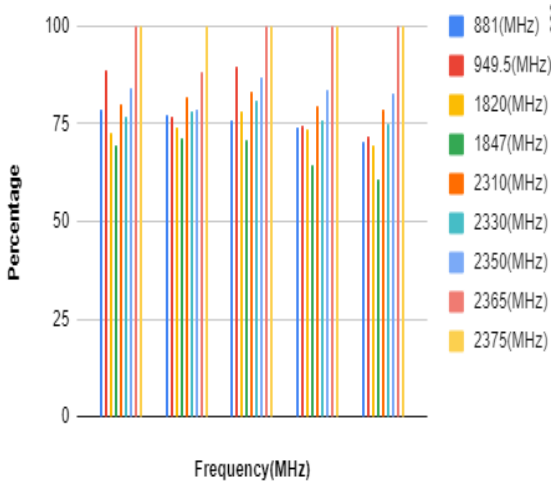


Fig 5 Frequency Vs Activity Percentage

The above figure shows the spectrum occupancy percentage of our real time data's that are generated by Deep Radio. That the real time data of spectrums are collected by a format of dat files and csv zip files are uploaded in Kaggle software and then the percentages are provided.from this all the frequencies are noted by a Excel sheet.we are selected by a particular frequency in our excel sheet that is plotted by a bar chart

form.from this bar chart we know the percentages in xaxis,know the frequencies in y axis.

IV. CONCLUSION

In this work, we studied and presented the results of spectrum activity for various 4G cellular frequency bands at a day of continuous 1 hour duration in Nagapattinam region. We discussed the system model, measurement setup, and algorithms for data capturing and pre-processing. The activity status of different LTE-A frequencies have been monitored for various sessions of the day at E.G.S.Pillay Engineering College locations. It has been observed that the average activity range shows similar performance for all sessions, whereas high and low activity range vary according to the user traffic for the respective sessions. This work finds that the under- utilized frequency bands can be shared (both in time and space) in- between 4G cellular systems.

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