A Brief Review of Cognitive Radio and SEAMCAT Software Tool

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***Abstract*—In today times, the use of wireless communication increases rapidly. For a wireless communication, the radio spectrum remains constant but the user's increases very fast. According to Federal communication commission (FCC) research report, seventy percent of radio spectrum allocated has been already underutilized. So we want to overcome this problem by using some new technique. Cognitive Radio is a one of the method that will solve this problem. The rapid development in wireless services caused spectrum shortage. Cognitive Radio is a technique which uses licensed spectrum in a very efficient way**

***Keywords*—**Cognitive Radio, Spectrum Sensing, Primary Users, Secondary Users, SEAMCAT.

I. INTRODUCTION

The name Cognitive Radio derives from the word 'Cognitive' which means gaining knowledge by thought or perception. It is a latest technique which senses the radio spectrum and finds the white space or spectrum holes. White spaces is an unused licensed spectrum. With the help of this technique, the unlicensed user uses the licensed bands without causing any interference with licensed user.

There are two types of users, one is Primary User and the second is Secondary User. The Primary User is also known as licensed User and the Secondary User is known as unlicensed user. The effect of a cognitive decisions on the network performance depends on the amount of network state information available to it. In order for a cognitive network to make a decision based on end-to-end goals, the cognitive elements must have some knowledge of the network's current state and other cognitive element states.

The licensing approach of radio spectrum has resulted in wastage of the valuable natural resource. The proposed concept of Cognitive radio exploits the unused frequency of the spectrum and thus make a fruit full use of this natural resource. A cognitive radio is an intelligent radio capable of learning the radio environment of the surrounding and modify itself to adjust with available radio spectrum. The Federal Communications Commission (FCC) gave following definition for cognitive radio.

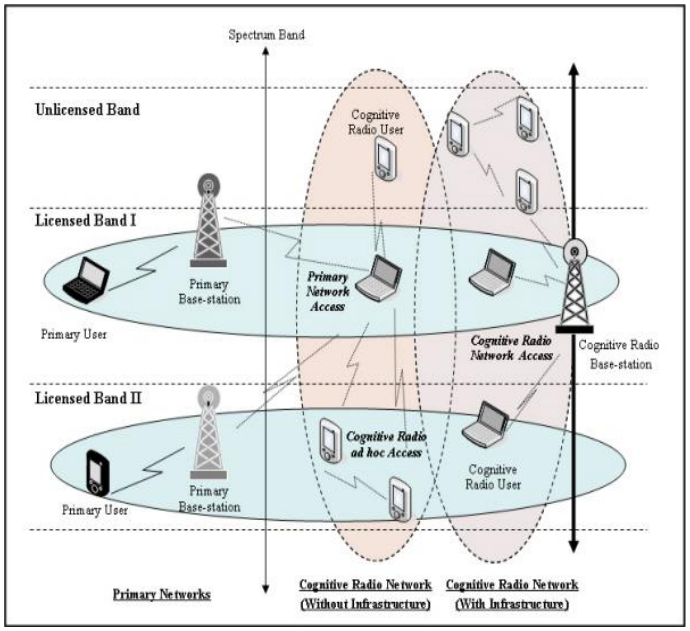

Fig 1: Cognitive Radio Network

Three types of spaces are present in the frequency band spectrum of Primary User that are as following:-

a) Black Spaces: - Completely used slots due to the presence of signal and noise in this spaces.
b) Grey Spaces: - Partially used slots due to the presence of interference and noise in this spaces.
c) White Spaces: - Unused slots except from natural and artificial sources noise.

There are two types of spectrum holes that are as following:-

1) Temporal Spectrum Holes
2) Spatial Spectrum Holes

1) Temporal Spectrum Holes: - Temporal Spectrum Hole is that spectrum band which is assigned to primary user. When the primary user not using this spectrum band for the transmission than it can be used by secondary user.

2) Spatial Spectrum Holes: - Spatial Spectrum Hole is that in which Primary User transmission can be done in a specific area and the outer side area can be used by the secondary user.

II. Roles of Cognitive Radio

The main roles performed by Cognitive Radio (CR) are as following:-

a) Spectrum Sensing
b) Spectrum Management
c) Spectrum Mobility
d) Spectrum Sharing

a) Spectrum Sensing: -The role of SS is to recognize the unused spectrum and shares it to the secondary users (SU's) without creating any harmful interference with other licensed users i.e., primary users (PU's) (e.g. Television (TV), Cellular Networks).

b) Spectrum Management: -The role of spectrum management is to select the available spectrum and allocating it to user for better communication.

c) Spectrum Mobility: -In this process exchange of frequency of operation by CR user takes place.

d) Spectrum Sharing: - Spectrum sharing determines the secondary user (SU) that can utilize theWhite space (i.e., spectrum hole) at some particular time.

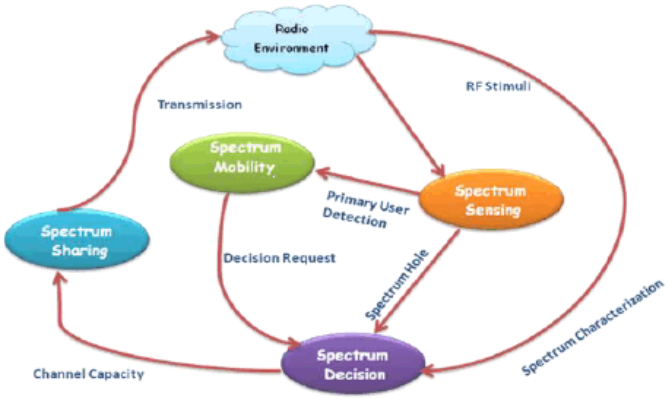

Fig.2: Cognitive Radio Functions

III. APPLICATIONS AND ADVANTAGES OF COGNITIVE RADIO

Applications:

1) Improving reliability in wireless communication system.
2) Less expensive radio.
3) Advanced network topologies.
4) Automatic radio resources management.

Advantages

1) Solve spectrum access issues.
2) Spectrum utilization improves.
3) Improves wireless networks performance through increased user throughput and system reliability.

IV. LITERATURE SURVEY

Amir Ghasemi et. al. (2008), presented the opportunistic unlicensed access to the (temporarily) unused frequency bands across the licensed radio spectrum is currently being investigated as a means to increase the efficiency of spectrum usage. Such opportunistic access calls for implementation of safeguards so that ongoing licensed operations are not compromised.

Ozgur B. Akan et. al. (2009), defined that dynamic spectrum access stands as a promising and spectrum-efficient communication approach for resource-constrained multihop wireless sensor networks due to their event-driven communication nature, which generally yields bursty traffic depending on the event characteristics.

Ying-Chang Liang et. al. (2011), described that cognitive radio (CR) is the enabling technology for supporting dynamic spectrum access: the policy that addresses the spectrum scarcity problem that is encountered in many countries. Thus, CR is widely regarded as one of the most promising technologies for future wireless communications. In this paper, they provided a systematic overview on CR networking and communications by looking at the key functions of the physical (PHY), medium access control (MAC), and network layers involved in a CR design and how these layers were crossly related. In particular, for the PHY layer, they will address signal processing methods for spectrum sensing, cooperative spectrum sensing, and transceiver design for cognitive spectrum access.

Won Mee Jang et. al. (2014), proposed a blind spectrum sensing method using signal cyclostationary. Often, signal characteristics of the primary user (PU), such as carrier frequency, data rate, modulation and coding may not be known to cognitive users. This uncertainty introduced difficulties in searching for spectrum holes in cognitive radios. At a low signal-to-noise ratio, it had been understood that monitoring the presence of the PU's signal was hardly possible without knowing its cycle frequencies.

Kirtibala Shinde1 et.al (2015), analyzed the Spectrum Sensing by using Energy Detection technique in the Cognitive Radio. The energy detection in cognitive radio is proposed to improve the spectrum utilization. Cognitive Radios are the secondary users of the allocated spectrum bands for the primary users. In the cognitive radio system, the signal detection technique is required for spectrum sensing in order to sense the occupied and vacant bands. The challenge of spectrum sensing is the detection of poor signals in the presence of noise and interference. In this paper, have evaluated the performance of energy detection system under the real noise at -10dB, -15dB & -20dB SNR using energy detection. In general Energy detector is the one of the method used in spectrum sensing due to its simplicity; it requires no need of synchronization and knowledge of transmission information through the transmitter.

V. SEAMCAT

Introduction

Abbreviation of SEAMCAT is Spectrum Engineering Advanced Monte Carlo Analysis Tools.

- The SEAMCAT is a software tool which is based on the Monte Carlo simulation method, gives statistical modeling of different radio interference situations.
- In SEAMCAT there are three different received signals in the interference scenario. The following are the received signals given below:
    a) dRSS:- dRSS stands for desired received signal strength. It represents the signal which is transmitted by the wanted transmitter to the victim receiver. Due to interference this signal will experience impairment.
    b) iRSS:- iRSS stands for Interfering Received signal strength. It represents the signal which is transmitted by the interfering transmitter to the victim receiver. This signal impairs the dRSS.
    c) SRSS: - SRSS stands for Sensing Received Signal Strength. It represents the signal transmitted by the wanted transmitter to interfering transmitter.

How to simulate Cognitive Radio devices in SEAMCAT?

In SEAMCAT, the Cognitive Radio devices are assumed to be the interferers. A SEAMCAT workspace will contain one victim system and more than one interferers. It is possible to decide the impact of interferers that can be either CR devices or not. The scenario allows the impact of spectrum sensing to be investigated where a cognitive radio device is activated nearby a victim system. Both the victim and the interfering dialogue interface should be filled to enable spectrum sensing in SEAMCAT.

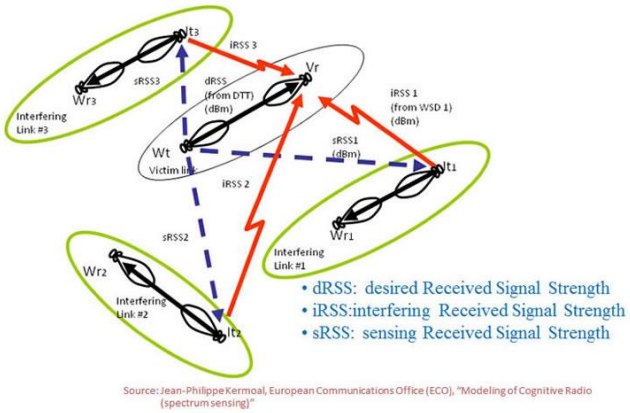

Fig 3: Illustration of 3 cognitive radio systems (WSD) and a victim system.

Victim link

The frequency of the interfering cognitive radio device is dependent on the frequency range defined for the victim. It means that when the CR module is activated, the interfering frequency function dialogue box is de-activated. Depending on how the victim frequency is defined (i.e. constant, discrete or distributed between fmin and fmax). SEAMCAT only allows the use of the following distribution: Constant, User defined, Uniform, User defined (stair). SEAMCAT automatically calculates the number of possible channels the WSD will operate in based on the operating frequency range of the victim system and its victim receiver bandwidth.

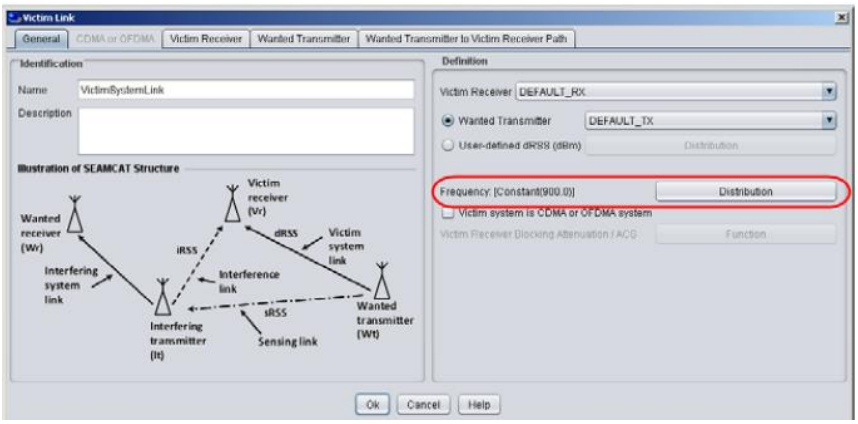

Fig. 4: Setting the victim Frequency

Then the user has to select the transmitting characteristic of the wanted transmitter, i.e. the energy that the cognitive radio spectrum sensing device is to sense, and the **use CR features** button to enable the emission mask and the emission floor.

Interfering link

It is possible to simulate more than one interferer. The Number of cognitive radio device to simulate is user selectable. It can be set by using selecting numerous interfering link.

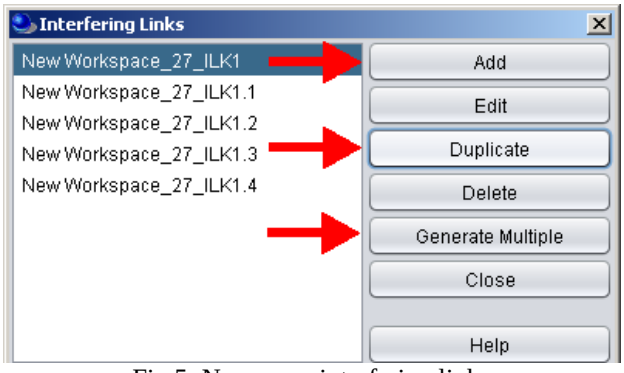

Fig 5: Numerous interfering links

VI. CONCLUSION

Cognitive Radio is the technology that uses the spectrum in a very efficient way and provide fast speed and reliability to users of wireless communication. With the help of spectrum sensing the spectrum is scanned continuous, when any spectrum hole is found then that spectrum hole or white spaces are provided to secondary users without providing any harm to primary user.

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