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Spectrum Sensing Techniques in Cognitive Radio Network

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Abstract*– Cognitive radio is a radio system that leverages the services of other radio systems by using various algorithms and interoperability inform of gateway which has the capabilities of observed, learned and senses a frequency from its present's environment to adjust and be re-configurable to makes decisions. The cognitive radio idea was proposed by one single researcher at royal institute of technology known as Joseph Mitola as novel approached in wireless communications at the same time the first phone call over cognitive radio network was made in center of wireless communications at university of Oulu Finland. Cognitive radio was designed to supported Ad Hoc Mobile Networks which has been a technological advanced exclusively by researchers in Centre of Wireless Communications (CWC`s), and. In this paper, the researcher highlighted the significant rules and policies of standardizations and regulations of IEEE and ITU amendment policies for internet wireless communication methodologies in dynamic frequency selections and subsequences to adaption's of cognitive radio cycle sensing through Media Access Control (MAC) sub layer approached. Furthermore discussed and examining a waveform spire sensing and radio identification techniques for better utilization of spectrum management with the three basic spectrums sensing levels matche filter, energy detector and cyclostationary feature detector associated with others two keys strategies of radio spectrums access a cross layer performance optimized and geolocation database functionality with sensor open systems interconnectivity and the holistic approached of cognitive radio cycle functionality within its environments with supports of proper techniques of physical layer architectures implementations of open systems Interconnections Model globally.

***Index Terms*– Cognitive Radio Network, Sofware Define Radio, Spectrum Sensing, TCP Cross Layer, Regulations and Standadirzaions**

I. INTRODUCTION

MITOLA Cognitive Radio is a promising technology to improve better utilization of spectrum of wireless communication systems. Present research in CR has been paying attention on the functionality of physical layer. The cognitive radio is built on a software-defined radio, it assumes an underlying system hardware and software infrastructure below, and that is capable of supporting the agility and flexibility needed by the cognitive algorithms. As already foretold by Mitola. A cognitive Radio is the final state of evolution of Software Defined Radio (SDR) platform: a fully re-configurable radio system that changes its communication capability and functionality, depending on network conditions and user demands. Mitola's definition on reconfigurability of the system is very generic the paper only focuses here on the reconfigurability of the hardware platform for Cognitive Radio. Software defined radio basically refers to a set of techniques that allow the dynamic re-configuration of a communication system with the help of software alone and without the need to change any hardware element. As shown in Fig. 1.

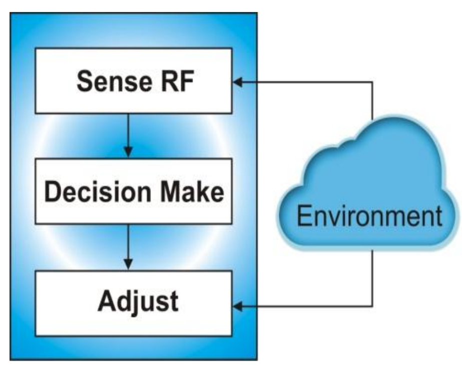

Fig. 1. Simplified view of the cycle

This relies on a cognitive circle. Fig. 1 is from Mitola and is a simplified view of the cycle summarized in three main steps:

- Observe: gathers all the sensing means of a CR,
- Decide: represents all that implies some intelligence including learning, planning decision taking.
- Adjust: reconfigures the radio, designed with SDR principles, in order to be as flexible as Possible.

Fig. 1 also shows the general method that can help the radio to better adapt its functionality for a given service in a given environment without restriction on the nature of sensors. Sensors are grouped into functions of the OSI layers that they correspond to, with an approximate division in three layers. All the sensing information related to the physical layer corresponds to the lower layers of the OSI model: propagation, power consumption, coding scheme (Partha, et al. 2011).

II. SENSING SPECTRUM PROCEDURES

Cognitive radio spectrum sensing techniques describes the accuracy on spectrum occupancy decision, sensing time, and malicious adversary, taking into account the fundamental limits of spectrum sensing algorithms due to noise uncertainty multipath fading and shadowing, in order to solve hidden PU problem and mitigate the impact of these issues, cooperative spectrum sensing has been shown to be an effective method to improve the detection performance by exploiting spatial diversity in the observations of spatially located CRs. Challenges of cooperative sensing include reducing cooperation overhead, developing efficient information sharing algorithms. The coordination algorithm for cooperation should be robust to changes and failures in the network, and introduce a minimum amount of delay. The most prominent hardware trial for spectrum sensing thus far has been the FCC field trial conducted in 2008 by the office of engineering and technology. Although the spectrum sensing approach exhibited good sensitivities satisfying stringent regulation requirements, the future spectrum sensing hardware should improve the receiver selectivity and receiver desensitization, especially when the adjacent channels have high powers. Fig. 2 shows how the radio sense a frequency and readjust it parameters before make decision in its present's environment. The geolocation database-based approach is able to identify occupied channels with 100% accuracy. However, for identification of unoccupied channels, it did not exhibit the best performance, presumably due to incomplete information in the database. This shows that the spectrum sensing alone works to some degree, but the performance could be further enhanced especially in the identification of occupied channels. Combining a geolocation database with spectrum sensing may be a better option provided that the CR device cost and power dissipation are decreased (Amir, et al. 2008).

A) Waveform Spired Sensing

The method of waveform is normally adapted to assist in the utilizations of wireless systems for synchronization, these procedures are preamble and midambles which frequently transmitte pilot patterns and spreading sequences. Having known the two procedures a preamble transmitted in sequences before each filters and midamble transmitted in the middle of trickle. Sensing can be performing as results of relationship of signals received with known copy of itself. The performance of sensing algorithms is increased as the length of the know signal patters increased and the method it is only applicable to systems with known signal patterns and it is termed as waveform base sensing (Yucek, et al. 2009).

B) Radio Recognition Based Sensing

The knowledge of spectrum features will be completely known by the primary users by identified the transmissions radio technology and also such identifications give a cognitive radio users opportunity with higher frequencies dimensional and accuracy. However cognitive radios have capabilities of extracting more useful information from a primary user such as the bluethood devices wireless with range of 10metres and communicate with identified systems applications within a dimension signals. Cognitive devices have the capabilities of search for any available transmission network as long as the devices power is on. The mean goals of cognitive radio to achieved communications through technologies by identified of known transmission which involved two major responsibilities in achieving this goals are initial mode identification and alternative mode monitoring (Chen, et al. 2008).

C) Matche Filter

The best method of any signal detection is matched filter due to less time to provide result and processing at higher level times to maximized received signal to noise ration and detecting any various signals requirements of any matche filters and provide more knowledge on the behaviours of the received signals (Subhider, et al. 2011).

D) Energy Detector

The energy detectors does not requires the knowledge of signal channels but a small mistake occurs may lead to loss of signals or unreliable detection of primary users. Indeed energy detector is totally low of sense noise ration environments and can't not be able distinguished between two measured of signals and noise (Sivarajan, et al. 2011).

E) Cyclostationary Feature Detector

The cyclostationary categories the modulated signals from noise, imposed two dimensional spectral relationship function rather one dimensional power spectral density of energy detector of reliably more the spectral relationship as a results of periodicity feature of modulated signal from the noise that is a wide-sense stationary and no relationship the basic objectives for features detectors is the increased complexity (Claudio, et al. 2009).

III. TCP CROSS LAYER

While the aspect of inter-protocol interaction is included in the concept of cognitive network as means to support user and applications requirement, no relevant and comprehensive analysis is available to address the performance and, in general, the behaviour of applications and networks based on CRS technology. The design of cognitive or self-organized network is itself a challenging task, in particular, the outer and inner loops coordination, the networking middleware for knowledge exchange, and intersystem networking for sharing and cooperation. Challenge is also in the design of high layers including MAC sub-layer and network layer, spectrum management functions integrated at the different layers of the network protocol stack (Fig. 2), cognitive radio resource management and coordination, various protocols and routings.

Many technologies will be using multiple frequency bands. As a result, challenges in interoperability, including coexistence, cooperation and collaboration for devices, and networks signalling with cross-layer interfaces and interlayer signalling are to be solved (Luo, et al. 2010).

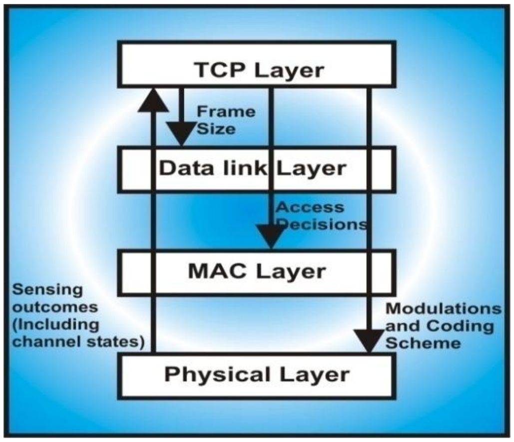

Fig. 2. TCP Cross Layer Overview

IV. COOPERATIVE SPECTRUM SENSING

The mean ideas of cooperative spectrum sensing techniques is to decreased interference of hidden nodes, a primary users communicate directly with white space on based station while a secondary receivers senses theirs channels and identified white space by exploit the medium (Fig. 3). The basic logic by hidden cooperative sensing each secondary receivers have a capability of measured the channels and communicate on their finding to know whether the medium is available with different purposed for other secondary users; the basic goals of cooperative spectrum sensing techniques is to centralized all the information request by receivers and make decision in respect to medium and reply back to receivers. A distribution were the receivers share their information with the aim of taking decision by them self (Cabric, et al.2011).

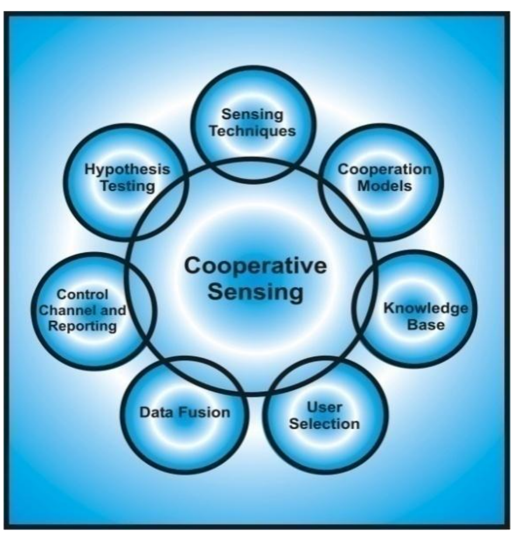

Fig. 3. Cooperative Spectrum Sensing

V. DYNAMIC FREQUENCY SELECTION REGULATIONS AND STANDARDIZATION IEEE

A) Regulations

The European and USA telecom and communications regulatory agencies are developing rules for the unlicensed use of TV White Spaces. In the US the work is being done by the FCC and in UK by Ofcom and the Electronic Communications Committee (ECC) of CEPT in Europe. The FCC in 2010 provided the rules for TV White Spaces which are nothing but unused areas in the TV broadcast spectrum. The use of the 2.36GHz to 2.4GHz band for medical area networks is being worked out. To better utilize the radio spectrum other opportunistic spectrum access beyond TVWS is being contemplated. A great deal of work has been done by Ofcom and they came out with the first consultation in 2009 for developing regulations for the TVWS. In 2011 they released a statement for white space devices and implementation of location based databases. The ECC studied the requirements for operation of CRS in the white space in the Ultra High Frequency broadcasting band of 470 to 790 MHz and that work is being used as the stepping stone for regulatory activities in the ECC.

B) Standardizations

At present international standardization of CRS is done at different levels (IEEE, ETSI, ITU and ECMA). Multiple deployment and business directions are being experimented. ITU has worked on the definition of SDR and CRS and their relationship to summarize the technical and operational studies, as well as relevant recommendations. Radio services and regulation implications in different SDR and CRS usage scenarios has been considered. A working group is currently looking at the description, definition and application of CRS in the mobile service which are land based. The 802 Working Groups (LAN/MAN) of IEEE is very active in CRS, the definition activity for CRSs is currently being done in the 802.11 and 802.22, while the specification activity for components of a CRS is being done in 802.19, 21, and 22. 802.11y is an update for 3650–3700 MHz frequency band for operations in USA, these define new regulatory classes, dynamic frequency selection for 802.11 to share frequency bands with other users and transmit power control. In order to meet the legislative requirements for coexistence and channel access in the TVWS the existing standards namely 802.11 physical (PHY) layers and medium access control (MAC) layers have been modified in a draft standard know as the P802.11af which is an update for TVWS operations standard. In order to optimize the handover between heterogeneous IEEE 802 networks and for facilitating the handoff between IEEE 802 networks and cellular systems the IEEE 802.21 Standards the media independent handover was developed. The P802.19.1 draft was developed for TVWS methods for coexistence (Nguyen, et al. 2012).

VI. DISCUSSION AND CONCLUSION

This paper presented an overview of cognitive radio spectrum sensing techniques and reviewed spectrums utilizations and managements on next generations wireless communications technology for feature expectation on radio frequencies range for wireless access devices without interference, the researcher looked at major procedures on cognitive radio networks sensing methods and standards and regulations for various telecommunications professionals internationally on amendments of cognitive radio policies to avoid interference between white space for TV and wireless communications devices for qualities of services and update on the IEEE technical committees on cognitive radio networks reports.

The cognitive radio forum have set a various committees on the developments of cognitive radio wireless access technologies in different professions by reviewed several literature review done by researcher in respect to cognitive radio dynamic spectrums access methodologies. These committees were forms according to their professions and capabilities of sharing innovations and observations for the existing structures and applications for the purposed of upgrading the radio systems to improve functionality. However the considerations from different areas which consists of commercial, technical, Benefits, public safety, security and radio policies which was held on 8th January 2013 in Washington DC unites State of America.

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