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Cognitive Radio Network Review

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Abstract

Cognitive radio network (CRN) is a technology that works on the rationalization of the radio spectrum by exploiting the spectrum of the secondary user (SU) if the primary user (PU) is idle taking into account the non-interference, which affects the quality of networks. Leadership exploited the entire frequency spectrum, which allows increasing the capacity of networks and improved. The objective of this paper is to investigate this technology buy introducing descriptive analysis of the hardware and software requirement in addition to previous study.

Keywords: *CRN, SU, PU, RS, Idle.CR-MS.*

1. Introduction

The Radio spectrum is one of the most scarce and valuable resources. Cognitive radio is an exciting emerging technology that has the potential of dealing with the stringent requirement and scarcity of the radio spectrum. Such revolutionary and transforming technology represents a paradigm shift in the design of wireless systems [1].

Cognitive (or smart) radio networks are an innovative approach to wireless engineering in which radios are designed with an unprecedented level of intelligence and agility [2]. This advanced technology enables radio devices to use spectrum (i.e., radio frequencies) in entirely new and sophisticated ways. Cognitive radios have the ability to monitor, sense, and detect the conditions of their operating environment, and dynamically reconfigure their own characteristics to best match those conditions [2]. Cognitive radios working on identify potential impairments to communications quality, like interference, path loss, shadowing and multipath fading. They can then adjust their transmitting parameters, such as power output, frequency, and modulation to ensure an optimized communications experience for users [2].

Conventional, or "dumb" radios, have been designed with the assumption that they were operating in a spectrum band that was free of interference. As a result, there was no requirement to endow these radios with the ability to dynamically change parameters, channels or spectrum bands in response to interference. Not surprisingly, these radios required pristine, dedicated (i.e., licensed) spectrum to operate [2].

By contrast, xMax cognitive radios have been engineered from the ground up to function in challenging conditions. Unlike their traditional counterparts, they can view their environment in great detail to identify spectrum that is not being used, and quickly tune to that frequency to transmit and/or receive signals. They also have the ability to instantly find other spectrum if interference is detected on the frequencies being used. In the case of Amax, it samples, detects and determines if interference has reached unacceptable levels up to 33 times a second. Here lies the importance of cognitive radio [2].

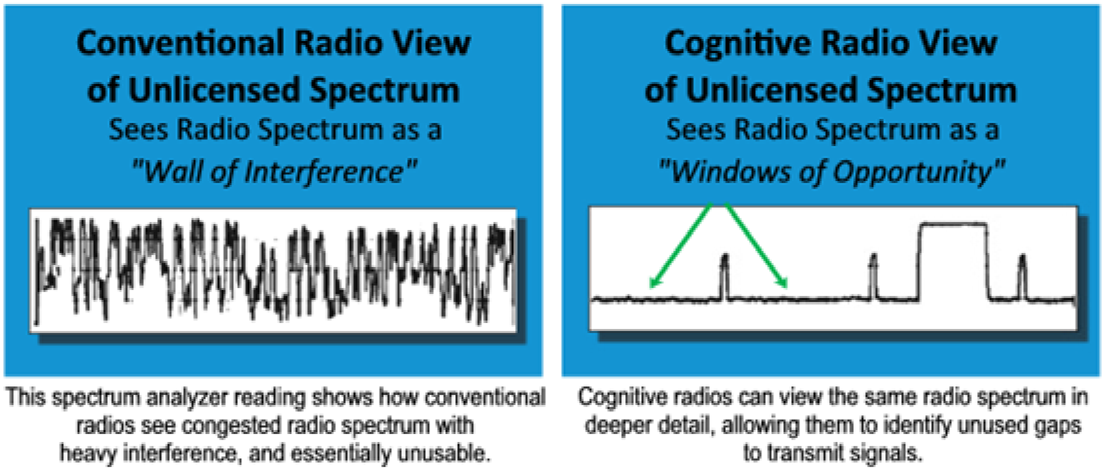

Fig [1]: cognitive Radio VS. Conventional Radios

The objective of this paper to introduce the concept and hardware &software requirement for cognitive radio network and analyzed previous study on this new technology.

2. Hardware Requirement: Cognitive Radio Network Architectures

A typical CRN environment consists of a number of Primary Radio Networks (PRNs) that coexist within the same geographical area of a single CRN (also referred to as the secondary network)[3]. A primary network is an existing network that is licensed to operate in a certain spectrum band. Hence, a primary network is also referred to as a licensed network. Primary networks can either be based on a centralized infrastructure or distributed ad-hoc in nature. The users of a primary network can only access the spectrum licensed to this particular network [3]. Primary users have priority with respect to spectrum access and operate as they are the sole users of their licensed spectrum. Hence, primary users do not provide any type of cooperation with the secondary network. PRNs are non-intrusive and the transmissions of the primary users should not be affected by the secondary users. Therefore, the primary networks define upper bounds on the CRN activities in their licensed bands, typically in terms of maximum power levels, to guarantee the promised performance level to their legitimate users [3].

On the other hand, the CRN is not licensed to operate in a predefined band. Spectrum access for the CRN is achieved in an opportunistic manner that allows the secondary users to opportunistically access the entire spectrum available to all of the geographically-collocated PRNs. Recall that the cognitive users can also exploit the unlicensed spectrum. This is referred to as spectrum heterogeneity of CRNs [3]. When operating in a licensed band, the CRN transmissions must adhere to the constraints imposed by its primary owner. A CRN can either be centralized infrastructure-based network or a distributed ad-hoc network as shown in Fig.2,

Centralized Cognitive Radio Networks

Centralized CRNs are infrastructure-based networks in which cognitive radio base stations control and coordinate the transmission activities of the secondary cognitive radio users as shown in Fig [2.1]. The cognitive radio base stations control the secondary transmissions over both the licensed and unlicensed bands by collecting all the spectrum-related information from the cognitive radio users. Based on the collected information, the base stations take global spectrum access decisions for all nodes [3]. An example centralized infrastructure-based CRN is the IEEE 802.22 network model. The IEEE 802.22 is the first world-wide standard for CRNs. The IEEE 802.22 standard defines the specifications of a point-to-multipoint communication scheme over the unused television (TV) bands in which a base station manages cognitive radio users within 33 km radius using a centralized spectrum database [3].

Fig [2]: centralized infrastructure based-CRN

Ad-hoc Architecture

There is no infrastructure support (or defined) in ad-hoc architecture. If an MS recognizes that there are some other MS nearby and are connectable through certain communication standards/protocols, they can set up a link and thus form an ad hoc network. Note that links between nodes may be set up by different communication technology. Two cognitive radio terminals can either communicate with each other by using existing communication protocols (e.g. Wi-Fi, Bluetooth) or dynamically using spectrum holes [4].

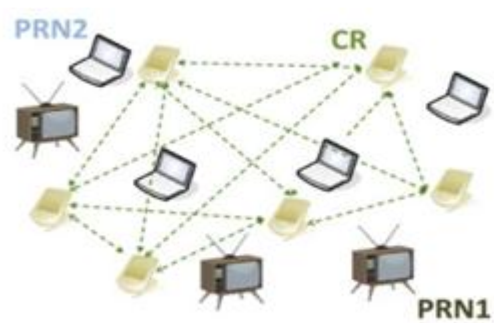

Fig [2]: distribution ad-hoc CRN

Cognitive Mesh Networks

Multi-hop wireless mesh networks have recently gained significant popularity as a cost-effective solution for last-mile Internet access. Traditional wireless mesh network are challenged by the scarcity of the wireless bandwidth needed to meet the high-speed requirements of existing wireless applications. Opportunistic Spectrum Access can be used to alleviate the bandwidth scarcity problem of mesh networks by allowing the mesh nodes to dynamically explore any available spectral opportunities. Such cognitive mesh networks are meant be used to provide broadband access to rural, tribal, and other under-resourced regions [3].

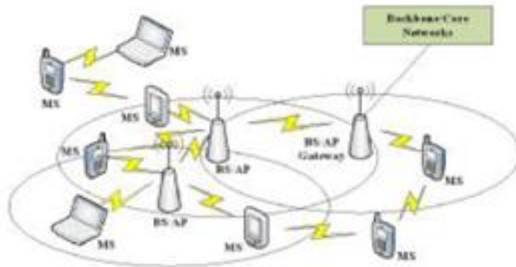

Fig [3]: Mesh Architecture Networks

Cognitive Radio Base Station (CR-BS)

A CR-BS is a fixed component in the cognitive radio system and has cognitive radio capabilities. It represents the infrastructure side of the CR system and provides supports (e.g. spectrum holes management, mobility management, security management) to CR-MSs [4]. It provides a gateway for CR-MSs to access the backbone networks (e.g. Internet). CR-BSs can also form a mesh wireless backbone network by enabling wireless communications between them, and some of them act as gateway routers if they are connected with wired backbone networks. If a CR-BS can run PR system protocols, it can provide access network services to PR-MSs [4].

Cognitive Radio Mobile Station (CR-MS)

A CR-MS is a portable device with cognitive radio capabilities. It can reconfigure itself in order to connect to different Communication systems. It can sense spectrum holes and dynamically use them to communicate with CR-MS or CR-BS [4].

Links in CRNs

Since the Cognitive Radio System can provide interoperability among different communication systems, some inter-system connections should be enabled [4].

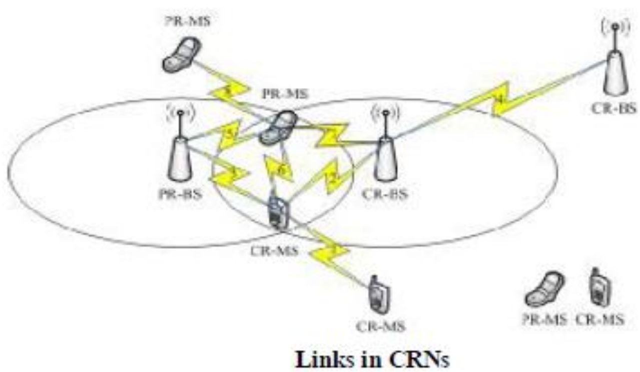

Fig [4]: Links in CRN

3. Software Requirement

Two decades ago most radios had no software at all, and those that had it didn't do much with it. In a remarkably visionary article published in 1993 [5], Joseph Mitola III envisioned a very different kind of radio: A mostly digital radio that could be reconfigured in fundamental ways just by changing the software code running on it. He dubbed this software-defined radio[5]. A few years later Mitola's vision started to become reality. In the mid-1990s military radio systems were invented in which software controlled most of the signal processing digitally, enabling one set of hardware to work on many different frequencies and communication protocols. The first (known) example of this type of radio was the U.S. military's Speakeasy I and Speakeasy II radios, which allowed units from different branches of armed forces to communicate for the first time [5]. However, the technology was costly and the first design took up racks that had to be carried around in a large vehicle. Speakeasy II was a much more compact radio, and was the first SDR with sufficient DSP resources to handle many different kinds of waveforms. Speakeasy II subsequently made its way into the U.S. Navy's digital modulator radio (DMR) with many waveforms and modes, able to be remotely controlled with an Ethernet interface. These Speakeasy II and DMR products evolved not only to define these radio waveform features in software, but also to develop an appropriate software architecture to enable porting the software to an arbitrary hardware platform, thus achieving independence of the waveform software specification and design from the underlying hardware [5] . Software-defined radio allows flexibility to handle several standards since the radio functions can be changed by software. In application where access to multiple bands with multiple radio access modes is needed, the software-defined radio can reduce hardware size, weight and power through fewer radio units[12]. It has been designed cognitive radio software architecture as follows:

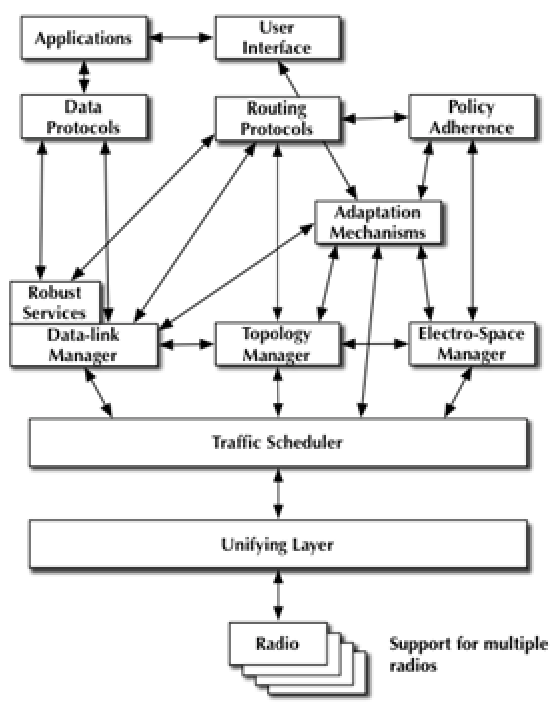

Fig [5]: Cognitive Radio Software Architecture [6]

- For adaptation…
- Sense RF, network, and communications environment performance.
- Adjust radio components to current operating conditions for best performance.
- Based on trade-offs between alternative adjustments.

Topology Manager

- Determine which radios should communicate
- Based on…
- Available electro space resources
- Application load(network queues)
- Adaptation (determining when to adjust)
- A connection involves…
- Allocation of electro space
- Scheduling reception and transmission

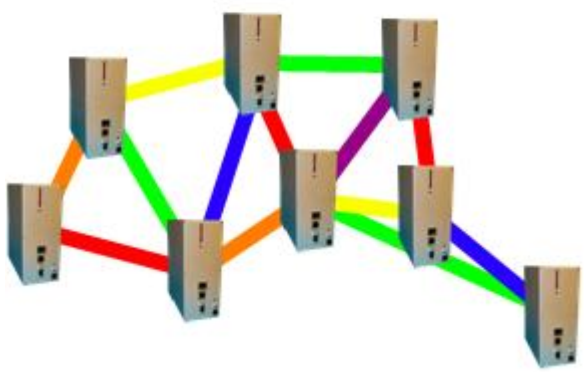

Fig [6]: Adding Network router[6]

Adaptation Mechanisms

- **Cognitive parameters**

➢ **General Radio Model**

- Every processing stage is programmable and controllable.

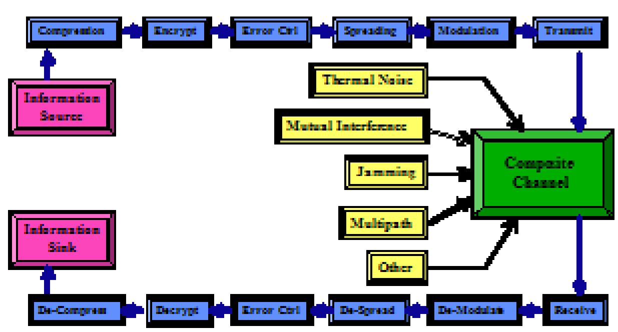

Fig [7]: General Radio Model [6]

- Transmission parameter(knobs)
- Transmit power
- Modulation
- Code rate
- Symbol rate
- Frame length

- Environmental parameters(dials)
- SNR
- Path loss
- Battery life
- Delay spread

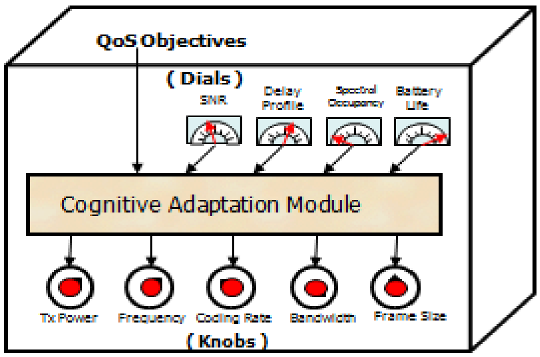

Fig [8]: Cognitive Adaptation Module[6]

4. Previous studies

In this paper, we are providing a simple yet efficient overview on cognitive radio and the existing research challenges, which will help the researchers around the globe to grab the concept of cognitive radio fast enough and work on it [7].

In this paper, a simple overview of the various spectrum sensing techniques in cognitive radio along with their advantages and Full defects and some spectrum He also mentioned the challenges sensor. Cooperative sensing the spectrum better than the classic Spectrum remote sensing because it overcomes the primary user hidden Problem and it reduces the false alarm and gives more Accurate detection signal. However, in order to ensure Spectrum efficient communication [8].

In this paper, we suggest a method to optimal pairing of sensing duration and energy detectors threshold to increase average throughput of the system by the use of energy harvesting system. Sensing duration must be kept smaller. Proposed algorithm use in this paper is Matched filter detection. The matched filter also referred to as coherent detector, is a sensing technique. It is very accurate since it maximizes the received signal-to-noise ratio (SNR). Matched filter correlates the signal with time shifted version and compares between the final output of matched filter and predetermined threshold will determine the PU presence [9].

This paper presents a comprehensive survey on the state-of-the-art channel assignment algorithms in cognitive radio networks. We also classify the algorithms by presenting a thematic taxonomy of the current channel assignment algorithms in cognitive radio networks. Moreover, the critical aspects of the current channel assignment algorithms in cognitive radio networks are analyzed to determine the strengths and weaknesses of such algorithms. The similarities and differences of the algorithms based on the important parameters, also investigated. We also discuss open research issues and challenges of channel assignment in the cognitive radio networks [10].

In this work, a fuzzy logic based system for spectrum management is proposed where the radio can share unused spectrum depending on parameters like distance, signal strength, node velocity and availability of unused spectrum. The system is simulated and is found to give satisfactory results. Researchers throughout the World are trying to find out the best methods to develop a radio communications system that would be able to fulfill the requirements for a Cognitive radio [11].

5. Conclusion

Previous studies dealt with a general idea of cognitive radio networks, also dealt with surrounding sensing techniques and their advantages and disadvantages of the similarities and differences between them and the challenges they face. As well as the study has an external management. As it has been studet spectrum, which is managed through the use of available spectrum, depending on the distance and signal strength and speed management. It is clear from our previous studies, which we must examine and clarify sensing algorithms to reduce output misinformation spectral attenuation and noise, which clearly affect the performance of cognitive networks.

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