

Review Paper on Cognitive Radio Networks

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Abstract

Now a days the telecommunication systems have been concerned as a required for a life, the number of users are improved therefore the usage of spectrum are increased. From many different studies and researches very bad utilizations of spectrum were found.

To solve it cognitive radio network is introduced in order to dynamic the spectrum therefore to increase the spectrum efficiency, decreasing costs and increasing number of wireless users, cognitive radio network solved bad utilizations and in advance it improved more characteristics for the spectrum. The goal of this paper is to identify along with clearly describe the concept of cognitive radio networks.

Keywords: Cognitive radio; PU; SU; Whitespace; DSA; Re-configurability

Introduction

The Federal Communications Commission FCC has costumed the spectrum frequencies to use it for one use, so when this frequency specified for one user that means we are in danger of running out of spectrum and bad utilizations of it [1]. According to that the FCC defines a cognitive radio networks CRN to solve that problem.

The definition of cognitive radio states that it's a radio that able to alter its transmitter parameters based on interaction with its operation environment [2]. CRN enables to dynamically using of spectrum, a CRN was called Next Generation (xG) network [3].

Cognitive radio CR is an enhanced to Software-Defined Radio (SDR) that its automatically detects the surrounding RF, catalysts and smartly accommodates its operating parameters to the infrastructure of network according to meet user demand [4], if this band is further used by a licensed user, the cognitive radio stirs to other spectrum band or remains in the same band with altering its level of the transmission power or modulation scheme all of that avert interference, calibrations the congestion due to spectrum participating [4].

The main functions for cognitive radios in xG networks can be summarized as follows:

- **Spectrum sensing:** Spotting unutilized spectrum and sharing the spectrum without disadvantaged interjecting with other users.
- **Spectrum management:** Captivating the best available spectrum to meet user communication demands [5].
- **Spectrum mobility:** Preserving tractable communication exigencies during moving to better spectrum [6].
- **Spectrum sharing:** Providing an equitably spectrum scheduling method between cohabitation xG users [7].

Characteristics of Cognitive Radio

Characteristics of cognitive radio are the capability and reconfigurability which are described in detail as follow:

Cognitive capability

The cognitive capability of a cognitive radio enables interaction with

its environment in real time to determine the suitable communication parameters and adapt the radio environment dynamically. The required mission for adaptive operation in open spectrum is shown in Figure 1 which is called as the cognitive cycle [8]. And the main steps of the cognitive cycle as following:

- **Spectrum sensing:** A CR monitors the available bands on the spectrum and detects the spectrum holes by capturing their information [4].
- **Spectrum analysis:** A CR estimates the properties of these bands which were detected in spectrum sensing.
- **Spectrum decision:** A CR calibration the data rate, the bandwidth, and the mode of transmission, then the fitted spectrum bands are chosen according to the user demands and spectrum properties [8].

The communication can be officiated over the spectrum hole. When an operating spectrum hole is determined however since the radio environment mutates over space and time the CR have to retain this mutation track of the changes of the radio environment [4]. Any environmental change during the transmission such as user movement, appearance of PU or any variation on the traffic can trigger this adjustment [2].

Procedure: This procedure explained by the concepts of:

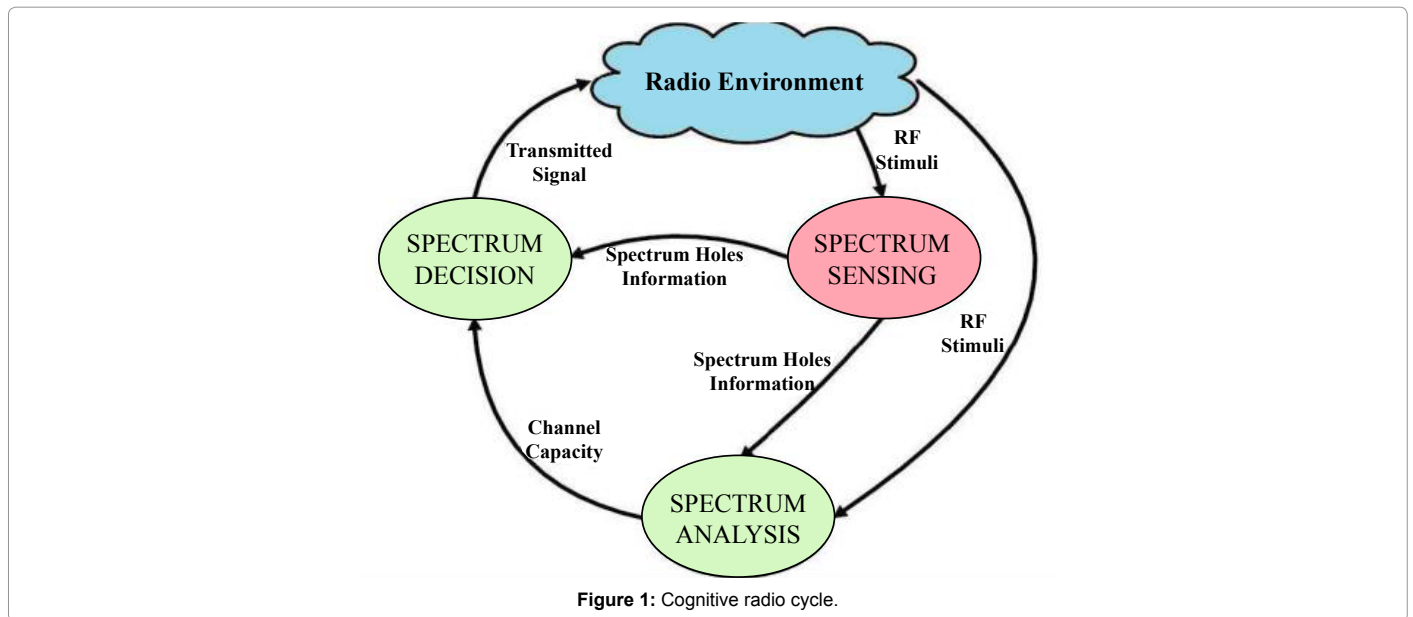
Self-organized capability: Spectrum/radio resource management to ably administer and structuring spectrum bands information among secondary users, good spectrum management scheme is needful. Connection and mobility management due to disparate of XG networks, routing and topology information is more complicated but its help to discover the neighborhood, available Internet access

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can be detected and the vertical handoffs can be supported which aid secondary users to choose route and networks [9].

Trust/security management: Since CRNs are disparate networks in complex, various heterogeneities (e.g., system/network operators, wireless access technologies) offers amount of security tasks. Trust is thus a pre-requisite for securing processes in CRNs [9].

Cognitive re-configurability

Reconfigurability is the caliber of adjusting the parameters of operating for the transmission on the fly without changing on the hardware components. This ability enables the CR to dynamically adapt with the radio environment [10]. There are several reconfigurable parameters that can be included into the cognitive radio as explained below:

- **Operating frequency:** According to ability of CR to change its operating frequency. Based on the radio environment information, the most suitable operating frequency can be determined and the communication can be dynamically officiated on this suitable operating frequency.
- **Modulation:** According to channel conditions and user requirements the modulation scheme of CR should be adaptive [10].
- **Transmission power:** Power constraints are control the transmission power reconfiguration by enabling dynamic configuration for transmission power within the permissible power limit. If higher power operation is not necessary, the CR reduces the transmitter power to a lower level to decrease the interference and allow more users to share the spectrum [9].
- **Communication technology:** Among different communication systems. Cognitive radio used to enable interoperability. The transmission parameters of a cognitive radio can be reconfigured during the transmission [7].

According to the spectrum characteristics these parameters can be reconfigured such that the cognitive radio is switched to a different spectrum band, the parameters of the transmitter and receiver are

reconfigured and the suitable modulation schemes and communication protocol parameters are used.

Software-Defined Radios (SDR)

The FCC define a SDR as a radio that consists a transmitter in which the operating parameters of frequency range, modulation type and maximum output power or the transmitter circumstances which it is operates on in accordance with commission rules, can be changed by making a mutation in software without making any changes to hardware components that affect the emissions of the radio frequency [11].

Briefly, capability of user of changing its transmissions on the fly rather than being bound by hardware constraints is its main idea of SDR [3].

Applications of Cognitive Radio Network

There are four applications for cognitive radio networks:

- **Leased network:** A leased network can be provided by primary network, with the agreement with a third party by allowing opportunistic access to its licensed spectrum within immolation the service finesse of the license user [12].
- **Emergency network:** Emergency networks and public safety is another tract of implementation of CRNs. In normal debacles which possibly provisionally disable or destroy the infrastructure of the existing communication, establishing emergency networks are needed by emergency personnel working in the debacles areas. Since emergency networks treat with the critical info, unimpeachable communication should be indemnified made with minimum latency [13].
- **Military network:** A military radio environment is one of the most interesting possibility applications of a CR network [14].
- **Cognitive mesh network:** Wireless mesh networks are appearing as a cost-effective technology for introducing the connectivity of broadband However, as the applications need a supreme throughput and the network density augments, mesh

networks require higher capacity to meet these applications requirements [15].

Previous Studies

The related works must be considered. Assila and Penttinen [16] state that the important incentive for CRNs is the deeply underutilized frequency spectrum. The development is being pushed forward by the quick progresses in SDR technology which enable a spectrum agile and highly configurable radio transmitter/receiver. And the fundamental problems in detecting the white spaces are naturally mostly involved to signal processing at the physical layer. While Ibrahim and Babiker [17] states that the simulation of CR system to must detect the existence of primary user to avoid interference which they should spot the spectrum holes and the idle state of the primary users in order to exploit the free bands and also immediately vacate the spectrum as soon as the primary user becomes active. Also Kaur and Aulakh [18] concluded that Cognitive radio is the technology in which a framework can sense its surroundings and adjust to the new working parameters to improve the quality of transmission. While Omer et al. [19] recommends about CRN as its can capture the best available spectrum to meet user communication requirements by sharing unused spectrum depending on parameters like signal strength, dimension, node speed and availability of unutilized spectrum. Another description of CRN is given by Tabaković [8] who states that the cognitive radio has the potential for making a significant difference in the way how the radio spectrum can be accessed and used by wireless systems. And Preet and Kaur [20] summarized it as “Cognitive radio is the enabling technology for supporting spectrum access in dynamic manner. The cognitive radio networking is transforming the static spectrum allocation based communication systems in to dynamic spectrum allocation”.

Conclusion

Now a day's the telecommunication systems have been concerned as a requirement for a life, the number of users are improved therefore the usage of spectrum are increased, so very bad utilizations of spectrum were found. Cognitive radio network is introduced in order to dynamic the spectrum therefore to increase the spectrum efficiency, increasing number of wireless users and decreasing costs, it's also improved more characteristics for the spectrum. This paper identifies cognitive radio networks along with a clear description of it.

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