

Cognitive Radio Network – Review

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Abstract: *The cognitive radio network came to solve the spectrum scarcity problem, through arrival of the unauthorized users (secondary user) to the unlicensed spectrum to take advantage of the unused spectrum avoiding interference with authorized users (Primary User), thus all spectrum is used.*

Keywords: Cognitive Radio Network (CRN), Wireless Networks, Adaptation, Primary User (PU), Secondary User (SU), Dynamic Spectrum Access (DSA), Software Defined Radio (SDR)

1. Introduction

CRN a wireless network, consisting of a transceiver, it can detect available channels of communication in an intelligent way and also discover other channels if there channels occupied, thus the interference will be less [1]. CRN has ability to change the transmitter parameters based on the environment in which it operates [2]. The Information gathered from the basic network uses to determine the RF environment thus sensing the spectrum, and detect spectrum users and primary users after that will discover unused spectrum and will be used by secondary users [3]. The CR uses cognitive radio device, and able to configure different parameters, depending on the surrounding environment. Cognitive network does not have a fixed frequency, does not have the priority in the reach of the primary network, but occupies the available spectrum and exploits it. The basic idea of the cognitive network is exploiting the spectrum to be used in an optimal way to take advantage of it, this leads to increased use of the frequency spectrum, but we face many challenges such as interference between users [4].

Sugata Sanyal, Rohit Bhaduria and Chittabrata Ghosh in 2009 Secure Communication in Cognitive Radio Networks, the authors focus on cognitive network applications, also multiple methodologies which give a safe network to get continuous reliability without presence of eavesdropping and leaking information [5] and Victor Balogunhe in Moscow, November 2010, Challenges of Spectrum Handoff in Cognitive Radio Networks, the author studied Challenges of spectrum delivery and that by investigation and verification from the performance of the TCP, in order to solve TCP deterioration problem of secondary user, while trying the secondary user to the delivery channel when reaches the user primary [6] and Yuehong Gao in Trondheim, December 2012, Performance Analysis of a Cognitive Radio Network, the author Using Network Calculus work on performance analysis of a multi-channel cognitive radio secondary network in order to ensure a certain level of service guarantee in the cognitive radio system[7].

2. CRN Components

2.1 Primary Network

2.1.1 Primary users (pu)

Uses a licensed frequency, this user has priority in the use of the spectrum [8].

2.1.2 Primary Base Station

Controls the access of primary users to spectrum [8]

2.2 Secondary Network

2.2.1 Secondary User (SU)

Uses an unlicensed frequency, and then exploits empty spaces of the unused spectrum [8].

2.2.2 Secondary Base-Station

A fixed infrastructure component with cognitive radio capabilities and allows to single hop connection to secondary users [8].

3. Fundamentals of Cognitive Radio Networks

CRNs vary from traditional wireless communication networks, because they have cognitive capabilities to sense, to analyze, and to adapt to the random of the communication environment thus the spectra have been allocated to the PU. So, the SU can monitor activities of different users on specific spectrum, thus exploit the vacant frequency band to obtain a reliable communication.

4. Cognitive Radio Characteristics

4.1 Reconfigure ability

The ability of receive and transmit at different frequency band enables the cognitive radio to reconfigure its parameters and selecting the best frequency band [9].

4.2 Cognitive Capability:

The ability to sense the unused spectrum at specific time and location (spectrum hole) [9].

5. Spectrum Holes

A spectrum hole known as a band of frequencies which are readily assigned to a PU, it may not be always used by the PU at a specific time or geographic area. Depending on the radio environment, the spectrum holes determined frequency and time or space as:

5.1 Frequency Spectrum Hole

Is neighboring frequency band of the SU do not cause any interference to the PUs.

5.2 Temporal Spectrum Hole

SU detect spectrum hole, and access it so frequency band that is not occupied by a PU for a period of time.

5.3 Spatial Spectrum Hole

Is frequency band in a specific area, the PU transmission is being occupied. SU use this band when it is outside this area [10].

6. Functionalities of CRN

6.1 Spectrum Sensing

Sensing the unused spectrum and after that determine the empty holes in the basic network, then allows the secondary users to capture empty holes to avoid interference [11].

6.2 Spectrum Mobility:

The Spectrum operates in a dynamic way to get radio stations, using available frequency band and this needs to sophisticated control mechanisms to detect available spectrum when the primary user access to the secondary user to be able to move quickly to another spectrum, thus guarantee a smooth mobility [11].

6.3 Spectrum Sharing:

Coordinate access to the best channel, then the participation many users in the specified spectrum [11].

6.4 Spectrum Management:

After obtaining the unused spectrum and optimum spectrum will be able to obtain the best channels, and this needs to appropriate mechanisms for decision-making in the selection from these channels, and thus choose the ideal spectrum to satisfy user requirements, and the ideal spectrum is important to obtain good service quality requirements [11].

7. Software Defined Radio (SDR)

Is a device has a processor and uses to implement a lot of wavelengths, and used for general purposes, also able of sensing and run many different frequencies band, and has high quality and good flexible [12].

7.1 Relationship between Cognitive Radio and Software Defined Radio:

SDR Provides the radio functions, this functions are very flexible by cognitive network, CRN works about SDR device or designed around it, so CRN be responsible from improvement and development of SDR based on the input parameters [12].

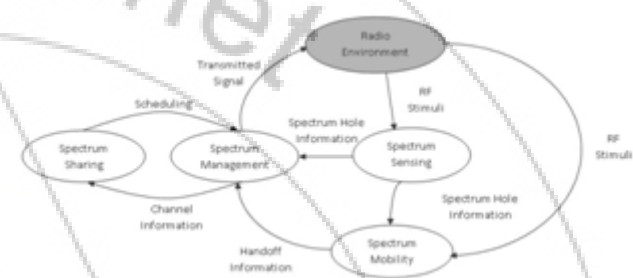


Figure 1: Basic cognition cycle [13]

8. Applications of Cognitive Radio Networks

- Tenant network.
- Cognitive mesh network.
- Emergency network.
- Military network.

9. Access Methods of CR Networks

9.1 Overlay CR Networks

This approach is known as the interference-free approach. The secondary/unlicensed users only access part of the spectrum that is not occupied by the licensed/primary users.

9.2 Underlay CR Networks

In this configuration called, interference-tolerance approach, unlicensed or secondary users operate below the noise level of primary users by publishing their signals over the available spectrum. The unlicensed users could interfere with licensed users to a certain acceptable extent [6].

10. Dynamic spectrum access (DSA)

Means detecting holes in the empty spectrum (access to unused spectrum). Components:

1. Spectrum Access.
2. Spectrum pooling.
3. Spectrum activities.
4. Spectrum management [4].

11. Benefits of Cognitive Radio

The cognitive radio is a smart device able of opportunism the white spaces in licensed bands without interference, that important to solve the spectrum scarcity.

12. Conclusion

In this paper we discussed CRN that came in order to solve the problem of wireless networks which use specific spectrum, and we explained components of CRN and relationship between PU and SU, the SU exploits the empty spectrum to obtain on reliable communication. CRN has the ability to reconfigure parameters and chooses the best frequency also we knew spectrum holes and functionalities of CRN that divide to Spectrum sensing, Spectrum Mobility, Spectrum Sharing and Spectrum Management all this Functions lead to all operations in CRN. We knew Software Defend Radio (SDR), and relationship between CRN and SDR, also we talked about Applications of Cognitive Radio Networks and Dynamic spectrum access (DSA) that reveals holes in the empty spectrum. Finally we explained the benefits of Cognitive Radio network where CRN has the ability to exploitation of the unused spectrum without interference and solve the spectrum scarcity problem.

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