Chapter 2
Cognitive Radio Networks:
IEEE 802.22 Standards

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ABSTRACT

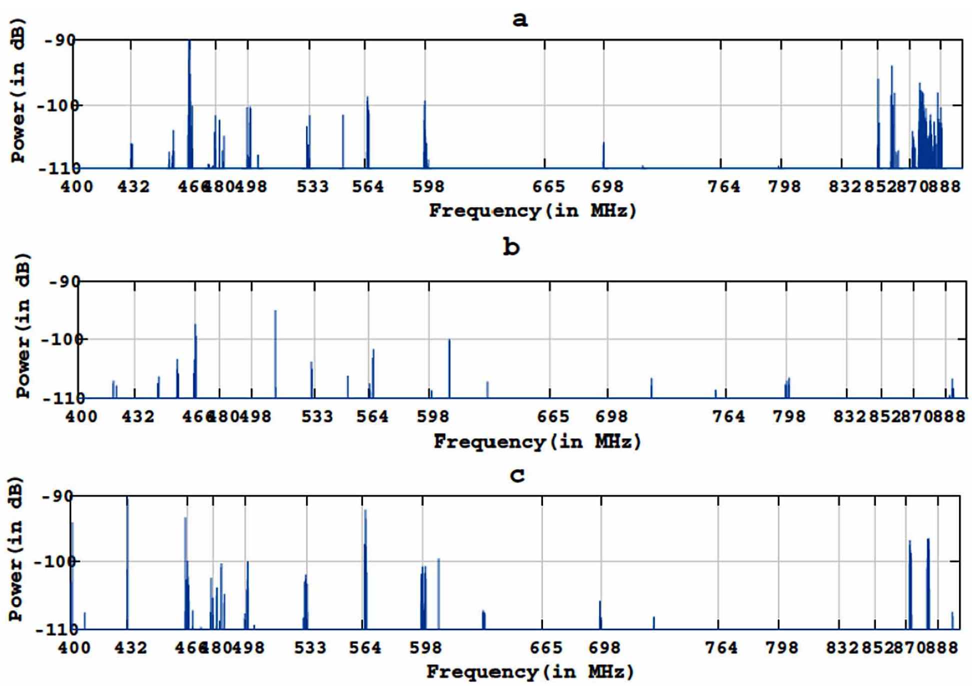
Cognitive radio (CR) offers a novel way for effective usage of wireless spectrum by using dynamic spectrum sensing and allocation. One of the main components of CR is to find a spectrum hole for data transmission. Spectrum hole can be found by using spectrum sensing, a geolocation database, or by using a beacon signal. In this chapter, the authors describe algorithms for spectrum sensing in the presence of both additive white Gaussian and colored Gaussian noise. The algorithms include blind, non-blind, and cooperative sensing-based methods. The authors have compared the performance of various methods for IEEE 802.22 standard (which is the first standard incorporating CR).

INTRODUCTION

Telecommunication regulation authority of each country allocates spectrum to licensed users, also known as primary users (PUs), on a long-term basis and for large topographical regions. However, it has been found that a large amount of the allocated spectrum remains unutilized (Mishra, 2014, Sharswat, Godara, Bishnu, & Bhatia, n.d). The inefficient utilization of the limited spectrum leads to the development of dynamic spectrum access techniques. The users who do not have a license for the spectrum, also known as secondary users (SUs), are allowed to use the unutilized licensed spectrum on a temporary basis. In recent years, the researchers have been considering more comprehensive and flexible uses of the available spectrum through the use of cognitive radio (CR) technology (Wang, 2011). Figure 1 shows the contiguous bandwidth available in three different locations of Indore, India on television (TV) bandwidth. It is observed from Figure 1 that about 85-90% of the band is available which is not used for TV transmission.

DOI: 10.4018/978-1-5225-5354-0.ch002

Figure 1. Contiguous bandwidth available for (a) Mundla Nayta, (b) Harnya Khedi, and (c) Simrol



Cognitive radio offers a novel way for effective usage of spectrum by using dynamic spectrum allocation. It is defined as a radio that can alter its transmitter's parameters according to the interactions with the environment in which it operates. It differs from conventional radio devices as a CR provides *cognitive capability* and *reconfigurability* to users. Cognitive capability refers to the capability to sense and collect information from the nearby environment, such as information about transmission bandwidth, frequency, modulation power, etc. With this capability, secondary users can recognize the best available spectrum (Wang, 2011). Reconfigurability refers to the capability to rapidly adjust the operational parameters according to the sensed information in order to attain the optimal performance (Wang, 2011). By exploiting the spectrum opportunistically, the CR enables secondary users to sense the available spectrum, choose the best available channel, coordinate spectrum access with other users, and vacate the channel when a primary user returns back to access the same channel. In CR based dynamic spectrum access, the secondary users (SUs) can utilize the spectrum opportunistically without interfering with the PUs using three approaches: underlay, overlay, and interweave techniques (Haykin, 2015).

The IEEE 802.22 wireless regional area networks (WRAN) is the first wireless standard to include interweave CR in its specification where primary users are digital television (DTV) and wireless microphone, and secondary users are customer premises equipment (CPE) (Bishnu, 2015). According to federal communication commission (FCC) for in-band spectrum sensing (SS), primary users after their appearance should be detected within 2 s with the probabilities of false detection and misdetection no greater than 0.1 for maximum protection of primary users (Kim, 2010). To meet above mentioned requirements, in-band sensing must be performed once every 2 s and a detection method (e.g., energy or feature detection (Cordeiro, 2006)) that yields the best performance should be selected. Since SS is

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