

## Chapter 7

# A Novel Spectrum Sensing Scheduling Algorithm for Cognitive Radio Networks

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### ABSTRACT

*Cognitive Radios are recognized as a novel approach to improve the utilization of a precious natural resource of wireless communications: the radio frequency spectrum. Historically, telecom regulators assigned fixed spectrum bands to the licensed wireless network operators. This spectrum management approach guarantees an interference free environment, except for some configuration faults or illegal usage. However, with the increasing demand for more bandwidth in the finite radio spectrum, the spectrum becomes underutilized. Hence, the concept of secondary operators have emerged, but with emphasis not to influence licensed operators. Consequently, the Cognitive Radio Network (CRN) architecture enters the market as an intelligent solution to these issues, with concentration on spectrum sensing procedures to achieve the regulatory constraint. The most successful sensing algorithms are those applying cooperation and scheduling to have better scanning information; however, those algorithms are developed based on the primary network activities, which are good in terms of reducing expected interference, albeit with more computational load on the CRN. In this chapter, a novel sensing scheduler algorithm is proposed. The idea is to utilize the CRN by fairly distributing the sensing task among the sensors and afterwards utilizing the radio spectrum shared with the primary networks.*

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## 1. INTRODUCTION

Most telecom regulatory authorities adopt the command-and-control approach when managing the Radio Frequency (RF) spectrum. This methodology has been successful in mitigating the effects of harmful interference in multi-operator environments. However, its usage has resulted in inefficient RF spectrum allocation. The Federal Communications Commission (FCC, 2003) has reported that 15% to 85% of the licensed spectrum is idle in various spatial and temporal accesses depending on the customer distribution and their individual usage.

In the future, such rigid assignments will not be able to accommodate the dramatically increasing demands for more spectrum bandwidth in meeting user requests for broadband access. In fact, even the unlicensed spectrum bands, such as the Industrial, Scientific, and Medical (ISM) band, need an overhaul. Congestion, resulting from the coexistence of heterogeneous devices, operating in these bands, is on the rise. Hence, with an increased saturation of wireless devices, the fixed spectrum usage strategy has been shown to strain the available spectrum.

This necessitates a new license regime approach, known as secondary operators, which is more effective in utilizing the RF spectrum. However, there are concerns about a possible decrease in primary network transmission capacity, due to interference from unlicensed operators. In parallel, when increasing demands for more bandwidth and its scaling growth in applications are addressed, the situation becomes even worse. Hence, a scarcity with the inefficient usage of the spectrum further imposes a new spectrum management model to utilize the wireless spectrum resource opportunistically.

Technically, Cognitive Radio (CR) is recognized as an emerging technology to mitigate the unutilized scarce radio frequency spectrum dilemma. Thus, dynamic spectrum access is proposed to share the available spectrum through

opportunistic usage of the frequency bands by secondary operators without interfering with the primary networks. When the CR Network (CRNs) approach is used, it will enable the secondary networks to perform the following tasks:

1. **Spectrum Sensing:** Determining instantaneous available spectrum portions and detecting the presence of primary users when they appear.
2. **Spectrum Management:** Coordinating the assignment of radio channels to the CRN clients from the available channel list.
3. **Mobility Management:** Vacating the channel when the licensed user is detected and handoff to another available channel.

Due to the CRN being responsible for detecting the existence of the primary user transmission, no additional protocols are needed in the primary networks. Hence, spectrum sensing accuracy is the key challenge in CRN deployment in order to avoid harmful interference to primary networks. This necessitates intelligent algorithms for sensing and scheduling in the access layer of the CRN architecture (Cabric, Mishara, & Brodersen, 2004). Accurate sensing information facilitates the CRN to efficiently optimize the spectrum access, assist in reducing interference probability, and adapt an instant spectrum slots available from the unutilized spectrum pool. This chapter addresses the issue of spectrum sensing in the CRN and proposes a novel scheduling algorithm to utilize the sensing task schedule in CRN and hence utilizing the radio spectrum.

This chapter is organized as follows: in section 2, an overview of spectrum sensing techniques are presented with a derivation of the performance parameters affecting the operation of the CRN. A novel algorithm for spectrum sensing scheduling is proposed, after which its performance is investigated according to the parameters mentioned in section 3 and 4, respectively, whereof conclusions are presented in section 5.

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