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# Optimized Spectrum Selection through Instantaneous Channels Characteristics Evaluation in Cognitive Radio

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**Abstract**

The key idea to spectrum decision in Cognitive Radio Networks (CRN) is the selection of the best available spectrum band to satisfy Secondary Users (SUs) Quality of Service (QoS) requirements, without interfering with transmission of the licensed or Primary Users (PU). This challenging task requires a very good cooperation between users with different demands for the best use of spectrum channels of different characteristics in a heterogeneous network. In this paper we propose a linear optimization spectrum selection algorithm based on the evaluation of different channels characteristics and a linear optimization solution to ensure the selection of the best available spectrum satisfying the demands of the Secondary Users. The simulation results show that this approach ensures both the best transmission throughput and the transmission quality of service.


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Keywords: Cognitive Radio Networks, Primary User, Secondary User, Quality of Service, Linear Optimization, Spectrum Selection,

## 1. Introduction

The improvement of wireless communication over the past decade has increased the demand of the electromagnetic radio spectrum as societies become increasingly mobile and information technology dependent. In November 2002, the Federal Communications Commission (FCC) published a report prepared by the Spectrum-Policy Task Force, aimed at improving the way in which the radio spectrum is managed in the United States [1]. In traditional wireless network, the radio spectrum is allocated to licensed users by the regulatory agencies and a scan portions of the radio spectrum allocated to licensed users,

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reveals that some frequency bands in the spectrum are largely unoccupied most of the time or partially occupied while the remaining part are heavily used [2, 3]. Consequently, Dynamic Spectrum Access (DSA) techniques are proposed to solve the current spectrum inefficiency problems. In May 2004, the FCC followed up on its previous report and released its proposals dealing with the possible use of cognitive radio technology for low-power unlicensed devices to share spectrum in the very high frequency (VHF) and ultra high frequency (UHF) television bands [4].

In his dissertation published in 1999 [5], J. Mitola defined "Cognitive Radio" as a class of radio terminals that uses a real-time interaction with its environment to determine transmitter parameters such as power, frequency and modulation. From this definition, Cognitive radio contain two main functions [3,6,7]: The cognitive capability that refers to the ability of the radio technology to capture or sense variations in the radio environment using both autonomous learning and action decision and the Reconfigurability that enables the radio to be dynamically programmed according to the received information. For a good performance of the above functions, The Cognitive Radio Networks require the spectrum-aware operations, which form the cognitive cycle consisting of four spectrum management functions namely: Spectrum sensing, spectrum sharing, spectrum mobility and spectrum decision [3,8]. The latter spectrum management function is very important although it has received little attention compared to other functions of cognitive radio network [9]. Different decision algorithm can be used to select the best available spectrum such as neural networks [10], Fuzzy logic[11], and game theory[12]. The main goal remains the selection of the optimized transmission channels responding to the dynamic changes of the wireless resources and ensuring a good quality of service.

N. Jain and Al. proposed a spectrum selection based on Signal-to-noise ratio[13] and R. Prasad an Al. used probed packet delay as channel quality metrics to provide an estimation for channels quality[14]. Unfortunately those metrics do not accurately characterize channel contentions leading to high hit between primary users and secondary users. M. Kaplan and F. Buzluca[15] developed a dynamic decision scheme utility function based on the parameters of the traffic class examining the effect of the user types in the decision making with different user categories while L. Marin and L. Giupponi[16] developed a spectrum decision scheme for a cognitive ad-Hod Network based on the activity of the PUs and the maximum allowed interference. Although those methods provides an advantage on the estimation of the PUs activity of the spectrum, more instant transmission parameters need to be taken into consideration to ensure effective quality of service.

In our work, we present a linear optimization spectrum selection based on the instant spectrum characteristics including SNR, transmission power, and spectrum interference as registered in each targeting the maximum channel capacity with a better quality of service. This method allows the selection of the optimum spectrum by ensuring the inclusion of the above parameters as a set of variable and the evaluation of their effect in the quality of Service. The remainder of this paper is arranged as follows. Section II provides the functions of a spectrum decision scheme in CR network. Section III gives the details and the mathematics equations of the proposed spectrum selection scheme. Section IV give the simulation and the performance result. Section V concludes the paper.

## 2. Spectrum decision in Cognitive Radio

Cognitive radio networks require the capabilities to select the best spectrum band among the available bands according to the quality of service requirements. This notion called "Spectrum Decision" is very important in cognitive radio as it ensures better transmission performances.
Spectrum decision is closely related to the channel characteristics and the operations of the Primary users and usually consists of three main functionalities [6]: