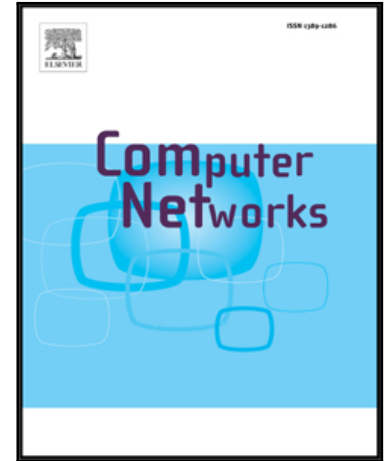


## Accepted Manuscript

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# Optimized Secondary User Selection for Quality of Service Enhancement of Two-tier Multi-User Cognitive Radio Network: A Game Theoretic Approach

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## Abstract

Cognitive Radio Networks (CRN) is the solution for the spectrum scarcity problem, that has surfaced with the exponential increase in number of mobile users. In CRN, the cognitive devices sense the spectrum, and transmits, on detecting an available channel. Thus CRN resourcefully utilize the idle spectrum bands. In CRN, the users are classified into two types - Primary users and Secondary users. Secondary users are further classified into two tiers- Real Time users (RT) and Non-Real Time users (NRT). Users from both the tiers share a single channel for transmission, resulting in efficient spectrum usage. However, with ever growing number of secondary mobile users having diverse QoS requirements, the cognitive interactions among them need to be optimized. This paper uses game theory to study the conflict and cooperation among the two tiers of Secondary Users. An auction game model is proposed that analyzes the complex decision making process and efficiently allocates an idle channel to a pair of RT and NRT secondary users from the pool of several users. The game model is further extensively analyzed mathematically, using Markov chain, showing a reduction in user Blocking Probability, user Dropping Probability, Channel Saturation Probability and increase in user Acceptance Probability, compared to the Basic One-Tier CRN and Non-Optimized Two-Tier CRN. The optimized network model is then simulated using Qualnet 7.1. The simulation result shows improved Bandwidth Utilization Efficiency, Spectral Efficiency and increased number of Secondary Users served, compared with respect to Basic One-Tier CRN and Non-Optimized Two-Tier CRN

**Keyword:** Cognitive Radio Network; Auction Game; Cooperative Sensing; Two-Tier Network; Markov Model; Spectrum Utilization Efficiency

## 1. Introduction

In the entire radio spectrum, the number of voice conversations and data transactions, doubles every 30 months according to Cooper's law [1]. Due to such explosive growth in population of mobile phone users, efficient spectrum utilization has become the biggest challenge in the field of wireless network and communication. Along with it, severe underutilization of spectrum has been observed [2]. Hence, the main aim is to maximize resource utilization by allowing a large number of users, having diverse applications, to coexist. As a result, Federal Communications Commission recommended a more flexible approach in spectrum allocation that allows devices to sense the spectral environment and use it efficiently [2-3]. This introduced the concept of Cognitive Radio Network (CRN). This network allows two sets of users to coexist - a) licensed, Primary Users (PU) and b) unlicensed, Secondary Users (SUs) [4-6]. Spectrum being a scarce resource, maximum utilization of it is desired. With the

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