# Spectrum scheduling in cognitive radio network between licensed and unlicensed user

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**Abstract**-Cognitive radio systems are emerging as a new paradigm for more efficient use of radio network resources governing bodies in many countries found that most of the radio frequency spectrum was inadequately utilized. One of the big problems in open spectrum usage is the spectrum sharing which refers to spectrum scheduling. This research will improve spectrum development using fuzzy logic in advance software engineering and implement it. We have analyze the different scheduling methods for the secondary user and has evaluate the results of maximum throughput and best resource consumption based on assessment results of different scheduling methods introduced at current time for cognitive radio networks, the number of extra artifacts which produced throughout the project can be reduced. Formulated the scheduling problem such that the average system performance needs to be maximized, with the constraint that the minimum performance requirement of each user must be met.

Index Terms— Cognitive radio, Primary users, Resource utilization, Spectrum sharing, spectrum holes, Secondary users, Spectrum Mobility

## 1 Introduction

Transfer of information between two or more points without any physical medium is called wireless communication. Through wireless communication information can be transferred to very short distances like in between the remote control and television and also to very far distances as millions of kilometers in deep space. It grows very rapidly because of portability and reliability. [1] Wireless communication is possible through electromagnetic radio spectrum on which signals are being transferred from one point to other point. This radio spectrum is rate of oscillation that has range from 3 kHz to 300 GHz which refers to the frequency of radio spectrum and altering currents which carry the radio signals [2], and concluded that spectrum utilization depends strongly on time and place. Moreover, fixed spectrum allocation prevents rarely used frequencies (those assigned to specific services) from being used by unlicensed users, even when their transmissions would not interfere at all with the assigned service. This was the reason for allowing unlicensed users to utilize licensed bands whenever it would not cause any interference (by avoiding them whenever legitimate user presence is sensed). This paradigm for wireless communication is known as cognitive radio. Cognitive radio is an intelligent wireless communication system that relies on opportunistic communication between unlicensed cognitive radio users (CRUs) or secondary users (SUs) over temporarily available spectrum bands that are licensed to primary users (PUs). The FCC suggests that any radio having adaptive spectrum awareness should be referred to as Cognitive Radio

Key Concepts in Cognitive Radio:

**Primary Network:** An existing network architecture which has as access right to certain spectrum band, e.g. Common Cellular systems and TV broadcast networks.

**Primary User (Licensed User):** Has a license to operate in a certain spectrum band.

Secondary Network (Unlicensed Network): Does not have license to operate in a desired band hence, the spectrum access is allowed in an opportunistic manner.

**Secondary User (Unlicensed User):** Has no spectrum license so additional functionalities are required to share the licensed spectrum band.

Main Functions of cognitive radio are [3]

**Spectrum Sensing:** It refers to detect the unused spectrum and sharing it without harmful interference with other users. It is an important requirement of the Cognitive Radio network to sense spectrum holes, detecting primary users is the most efficient way to detect spectrum holes.

**Spectrum Management:** It is the task of capturing the best available spectrum to meet user communication requirements. Cognitive radios should decide on the best spectrum band to meet the Quality of Service requirements over all available spectrum bands, therefore spectrum management functions are required for Cognitive radios, these management functions can be classified as spectrum analysis and spectrum decision

**Spectrum Mobility:** It is defined as the process when a cognitive radio user exchanges its frequency of operation. Cognitive radio networks target to use the spectrum in a dynamic manner by allowing the radio terminals to operate in the best available frequency band, maintaining seamless communication requirements during the transition to better spectrum.

**Spectrum Sharing:** It refers to providing the fair spectrum scheduling method, one of the major challenges in open spectrum usage is the spectrum sharing.

By sensing and adapting to the environment a cognitive radio is able to fill the spectrum holes and serve's its users without causing harmful interference to the licensed users [4].Each primary user has a unique licensed channel so can send their data on these channels but the secondary users don't have such channels so opportunistically tries to send data on to access points by utilizing idle primary channels. Primary users are assumed to be static however the secondary users could be mobile so that the set of channels they can access can change over time. [5]

## Problem conception:

The main objective of this research is to design an efficient scheduling scheme for the secondary users in cognitive radio networks that increase the throughput of the network by ensuring the efficient allocation of the resources of network and removing the interference of the secondary users with primary users. Selection of the channel for secondary users for keeping in consideration the mobility, distance, required spectrum and hold time. And on the base of these parameters chose the channel that is suitable for the successful transmission.

A full cognitive radio should have the ability to tune to any available channel in the target band, Establish network communication and operate in all or part of the channel, implement channel sharing and power control, implement adaptive transmission bandwidth, data rate and error correction schemes to obtain best throughput and implement Adaptive antenna steering to focus transmitter power in the direction required to optimized received signal strength. [6]

Cognitive radio networks have recently emerged as a promising technique to improve the utilization of existing radio spectrum. The key enabler is the cognitive radio [7] that can dynamically adjust its operating points over a wide range depending on spectrum availability.

Consider access point based networks with static licensed and fully mobile unlicensed users. examples of real network that can be module like this include Wi-Fi, cellular and mesh networks with both licensed and unlicensed users .In such networks, the licensed users may not schedule their transmission and thus send at any time they desire. The unlicensed users must make an effort to opportunistically use the spectrum holes without interfering too much with the licensed users, and hence need sophisticated scheduling.

## Related Work:

The main two full concluded that cognitive radio ("Mitola Radio" ) are the observable parameters possible through a wireless node or network is taken into account and spectrum sensing for cognitive radio: radio frequency spectrum which is considered. Independent studies performed in some countries observation confirmed, and the use of the spectrum is strongly dependent on the time and place [2].

In this paper Boland and Massoulie explain the cognitive radio spectrum sensing, spectrum management, spectrum mobility and spectrum of the main functions are briefly described and appropriate spectrum in the spectrum of scheduling noted that scheduling method is provided. The use of open spectrum sharing spectrum is one of the major challenges. [4]

Viswanath and Laroia proposed a scheme for a random fading channel where multiple antennas at the base station are used to transmit the same signal. Indeed, if a scheduler fully exploits the time-differing channel condition, the most extreme cell throughput can be acquired by serving the client with the best channel condition, which however prompts a genuine decency issue. Along these lines, a bundle scheduler ought to accomplish a sensible harmony in the middle of throughput and reasonableness. [7]

Developed a resource allocation scheme with the purpose of maximize the network throughput. This scheme has two stages, in the first stage power and channels are assigned to base stations with the purpose of improving their total coverage while the overall interference caused to each user maintained to already defined threshold level. In the second stage channels are allocated by the base station within the cell ensuring that the number of cognitive users those are utilizing the radio spectrum are maximum.

## PERFORMANCE ANALYSIS:

The underlying challenge is to intelligently determine which and when users can access the allocated spectrum bands or channels to transmit their packets.

In data networks, the packet scheduler is important for resource management. It needs to account for unique characteristics of time-varying and location-dependent channel conditions. Some research results in the literature have shown that the overall system performance, such as the system throughput, fairness, delay, and loss rate, will be significantly affected by the scheduling policy being used [8]. Many scheduling schemes have been proposed to address the resource allocation problem for traditional wireless networks as well as cognitive radio networks.

A scheduling policy has two contradictory goals:

To maximize the overall network throughput, optimal rsource utilization (to guarantee fairness amongst users) [5].

Opportunistic scheduling is used that maximize the throughput of the secondary user subject to maximum collion constraints with primary users, Lyapunov optimization is used to design online flow control ,scheduling and resource allocation to meet the desired objectives. Concept of cognitive radio is getting is still immature and there are a lot of issues that need to be address in future for successful implementation in practical use. Because the main concept behind the cognitive radio is the sharing of licensed spectrum that is in idle state or not being utilized by the licensed user so the privacy and security concerns need to address proper way. In perceptive of scheduling there are many other scenario of practical usage need to investigate and many other factor that need to consider for the selection of suitable channel, firstly need to investigate all possible factor and then later there effect on the selection of channel.

After the selection of channel, assurance of successful transmission of secondary user without interrupting the licensed users is also need to address [10].

on the base of knowledge of channel condition, sensing periods are adaptively scheduled to maximize the spectrum of the CR [9].

Channel status (i.e. occupied by primary) and instantaneous channel quality are assumed to be very fast within a frame which consists of a fixed of slots and on each scheduling epoch , each secondary user will observe channel conditions, channel status and channel quality , and on the base queue size and observed channel conditions , each secondary user will estimate the throughput for each channel over the frame to be scheduled, this algorithm is performed to maximize the expected aggregate throughput of all users.

**Results & Discussion:**

Here we have discussed the spectrum scheduling simulation results and there effects. as in fig1 from plotted average total occupancy (summing allpackets in the queues of the secondary users) versus the input rate ¸ . Each data point represents a simulation over 500; 000 timeslots, and the different curves correspond to values of the flow control parameter V 2 f1; 2; 5; 10; 100g, and the case V = 1 (no flow control) is also shown. In this case, the average total occupancy increases without bound as the input rate approaches network capacity. The vertical asymptote which appears roughly at ¸ = 0:285 packets/slot corresponds to this value.

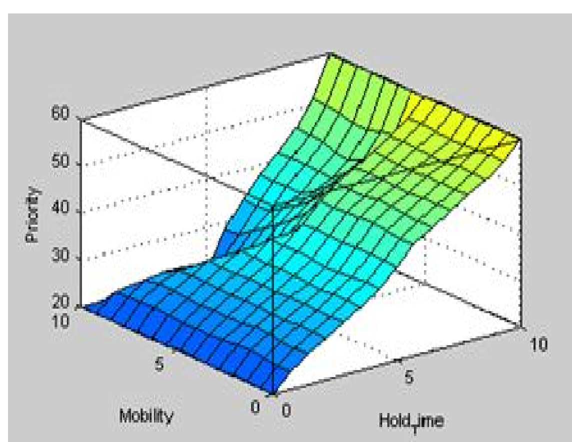



Fig1. Total average congestion vs. Input rate for different values of v

Fig2 illustrates the achieved throughput versus the raw data input rate ¸ for various V parameters. The achieved throughput is almost identical to the input rate ¸for small values of ¸, and the throughput saturates at a value that depends on V, being very close to the 0:285

Capacity level when V is large

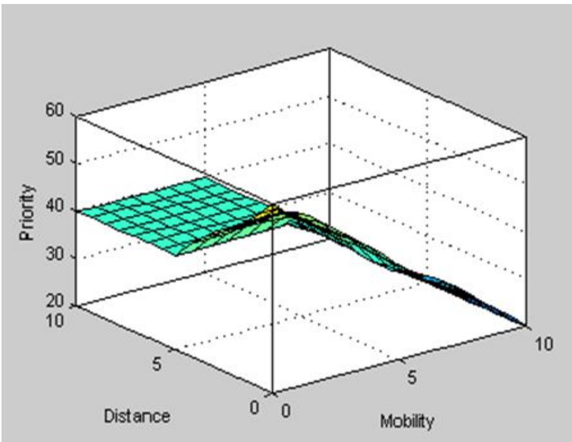



Fig2. achieved throughput vs. input rate for different values of v

In Fig. 3 shows that average throughput increases till the frame size N reaches 4 slots for cases where U = 2 channels and U = 3 channels,also represents that average throughput increases till the frame size N reaches 6 slots for cases where U = 4 channels and U = 5 channels.It can be seen from Fig. 3 that the higher throughput can be achieved using the proposed scheduling compared to the slotbased scheduling (i.e., N = 1)[9].

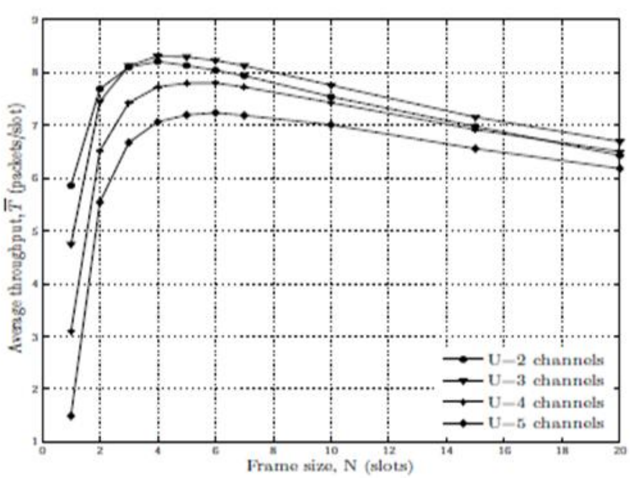
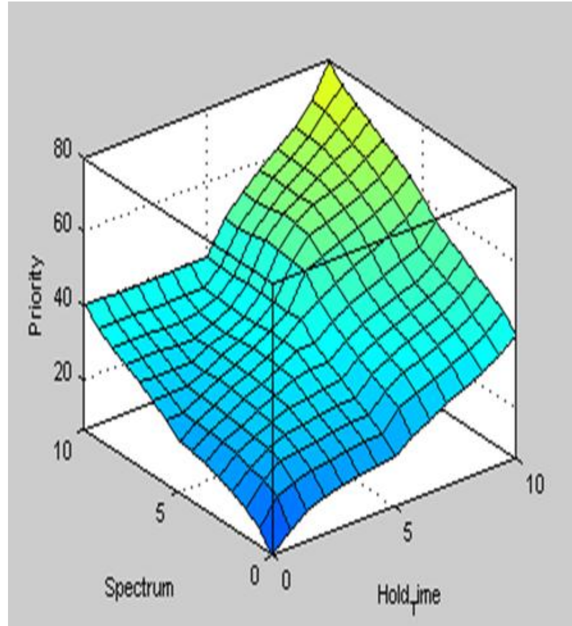



Fig3 Average throughput T under different frame size N for various network settings.




## Future Work

Concept of cognitive radio is getting is still immature and there are a lot of issues that need to be address in future for successful implementation in practical use. Because the main concept behind the cognitive radio is the sharing of licensed spectrum that is in idle state or not being utilized by the licensed user so the privacy and security concerns need to address proper way. In perceptive of scheduling there are many other scenario of practical usage need to investigate and many other factor that need to consider for the selection of suitable channel, firstly need to investigate all possible factor and then later there effect on the selection of channel. After the selection of channel, assurance of successful transmission of secondary user without interrupting the licensed users is also need to address.

## Conclusion:

In this paper a scheduling algorithm is for the secondary users cognitive radio is developed whose purpose was to increase the performance throughput of the overall network and make assure the fairness among the secondary user for the selection of available channel. For this we applied the hybrid approach of combination of underlay spectrum sharing technique and overlay spectrum sharing technique that will be chosen on the base of collision rate. If the collision rate is high then underlay spectrum sharing will be chosen and if collision rate is low then overlay spectrum sharing will be implemented.

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