

# Throughput-Optimal Queue Length Based CSMA/CA Algorithm for Cognitive Radio Networks

K. R. Lavanya<sup>1</sup>, S. Senthil Kumar<sup>2</sup>PG Scholar, Sri Venkateswara College of Engineering and Technology, Thiruvallur, India<sup>1</sup>Assistant Professor, Dept of CSE, Sri Venkateswara College of Engineering and Technology, Thiruvallur, India<sup>2</sup>

**ABSTRACT:** Cognitive radio networks allow unlicensed users to access licensed spectrum opportunistically without disrupting primary user (PU) communication. Developing a distributed implementation that can fully utilize the spectrum opportunities for secondary users(SUs) has so far remained elusive. Although throughput optimal algorithms based on the well-known maximal weight scheduling(MWS) algorithm exist for cognitive radio networks, they require central processing of network-wide SU information. In this paper, a new distributed algorithm is introduced that asymptotically achieves the capacity region of the cognitive radio systems. The proposed algorithm achieves the full SU capacity region while adapting to the channel availability dynamics caused by unknown primary user activity. Extensive simulation results are provided to illustrate the efficacy of the algorithm.

## I. INTRODUCTION

Cognitive radio networks (CRNs) allow unlicensed or secondary users to opportunistically access licensed spectra to improve the overall utilization of wireless resources and address the problem of spectrum shortage. The design of CRNs poses new challenges that are not present in traditional wireless networks [6]. SUs are allowed spectrum access only when they do not cause unacceptable levels of interference to licensed or primary users (PUs). DARPA's 'Next Generation' (XG) program [15] mandates that cognitive radios sense signals to prevent interference to existing military and civilian radio systems.

On the other hand, IEEE regulates unlicensed access to the TV spectrum without interference, as described in the IEEE 802.22 standard [7]. These and other interference avoidance mechanisms profoundly impact the design of algorithms and protocols for cognitive radio networks. The complete utilization of the so-called spectrum opportunities while avoiding interference on PUs is the goal of algorithm and protocol design for cognitive radio networks. In traditional wireless networks, maximum weight scheduling (MWS) algorithm [16] and its variants achieve the full capacity region of the network, where a scheduling policy is said to achieve the full capacity region (or be throughput optimal) [9] if it stabilizes the system for any arrival rate vector the system can be stabilized for by some scheduling policy. However, these algorithms require the knowledge of the entire network state and centralized processing to compute conflict free schedules. Similar algorithms have also been proposed for cognitive radio networks: In [17], opportunistic scheduling policies are developed for multichannel single-hop CRNs subject to maximum collision rate constraints with PUs. In [18], scheduling algorithms are investigated in multi-channel multi-hop CRN overlaid with a PU network. The optimal throughput can be provably and asymptotically achieved in adaptive-routing scenarios. Both networks require solving an NP-hard problem centrally.

These centralized throughput optimal algorithms suffer from two main shortcomings. The first is the high computational complexity, and the second one is the cost associated with the collection of network state information at a central location. The first problem has been countered in the literature through lower complexity suboptimal algorithms. Maximal scheduling is such an algorithm that reduces the time complexity of MWS at the expense of achieving a small fraction of the capacity region [1]. Another algorithm, greedy maximal scheduling (GMS), always selects a line with the longest queue that does not cause interference to links already chosen. GMS is shown to be

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throughput optimal if the network topology satisfies the local-pooling condition [2]. Nevertheless, only a fraction of the capacity region can be achieved for general topologies [9]. Further more, the distributed implementation of GMS entails signaling overhead which is not scalable [11].

Recently, a new class of distributed algorithms has been proposed to achieve throughput optimality while circumventing these problems. These new algorithms are random access algorithms based on the notion of channel sensing. These algorithms use queue lengths to determine channel access probabilities, achieving the full capacity region in adhoc wireless networks in a distributed manner.

In [8], an adaptive throughput optimal CSMA scheduling algorithm

## II. EXISTING SYSTEM

Cognitive radio networks (CRNs) allow unlicensed or secondary users to opportunistically access licensed spectra to improve the overall utilization of wireless resources and address the problem of spectrum shortage.

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- ▶ Destination-Sequenced Distance-Vector
- ▶ Adds two things to distance-vector routing
  - Sequence number; avoid loops
  - Damping; hold advertisements for changes of short duration.

### DISADVANTAGE OF EXISTING SYSTEM:

- ▶ Poor choice for representing the state in CRN(Cognitive Radio Network), and leads to a non-reversible DTMC(Discrete Time Markov Chain )
- ▶ SU links, where 1 interferes with 2, 2 interferes with 3 and 1 does not interfere with 3.
- ▶ All SU links are within the interference range of the PU.

## III. PROPOSED SYSTEM

Channel allocation algorithms use queue length to determine channel access probabilities, achieving the full capacity region in wireless networks .

Introducing a system state representation that includes channel state information, and design our algorithms to achieve throughput optimality without causing interference with PUs.

A new class of channel allocation algorithm has been proposed to achieve throughput optimality.

- Water filling strategy
- Divide the spectrum strategy

### ADVANTAGE:

- ▶ The channel state changes, one chain stops evolving while the other starts evolving.
- ▶ Secondary user cannot access the Primary user information.

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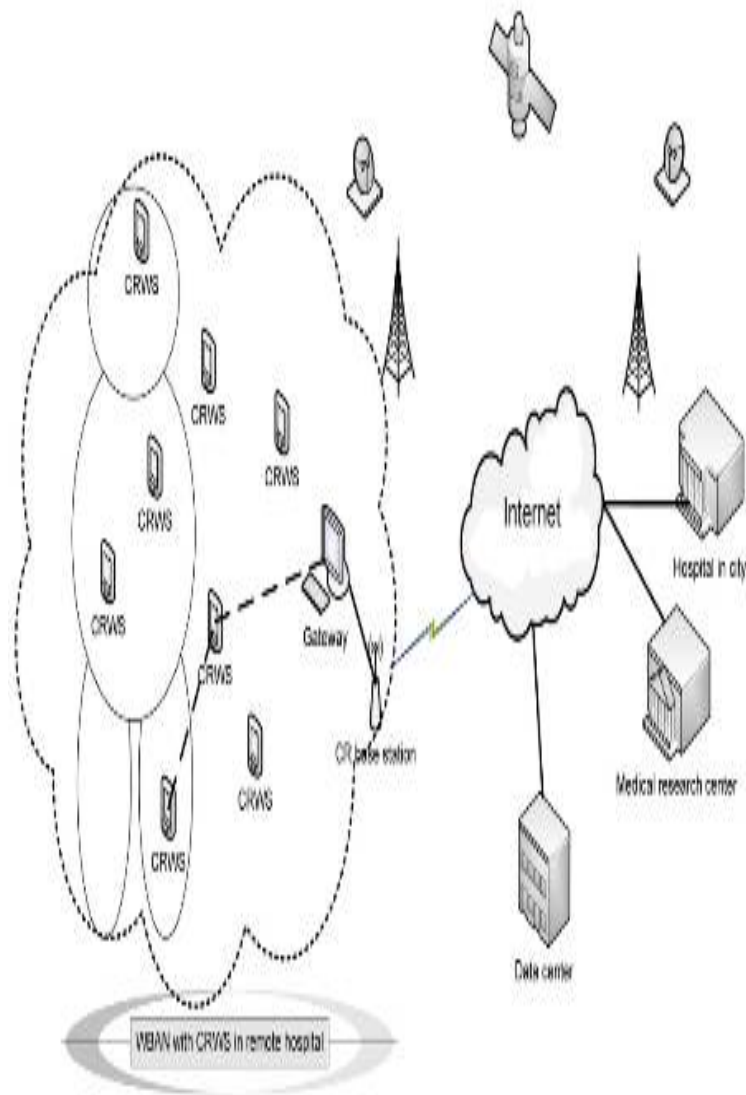
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- The channel state is available, all SUs treat the most recently available slot as their previous slot ignoring the unavailable period, and schedule packets in a way similar to Q-CSMA

## IV. SYSTEM ARCHITECTURE

Fig.1 System Architecture



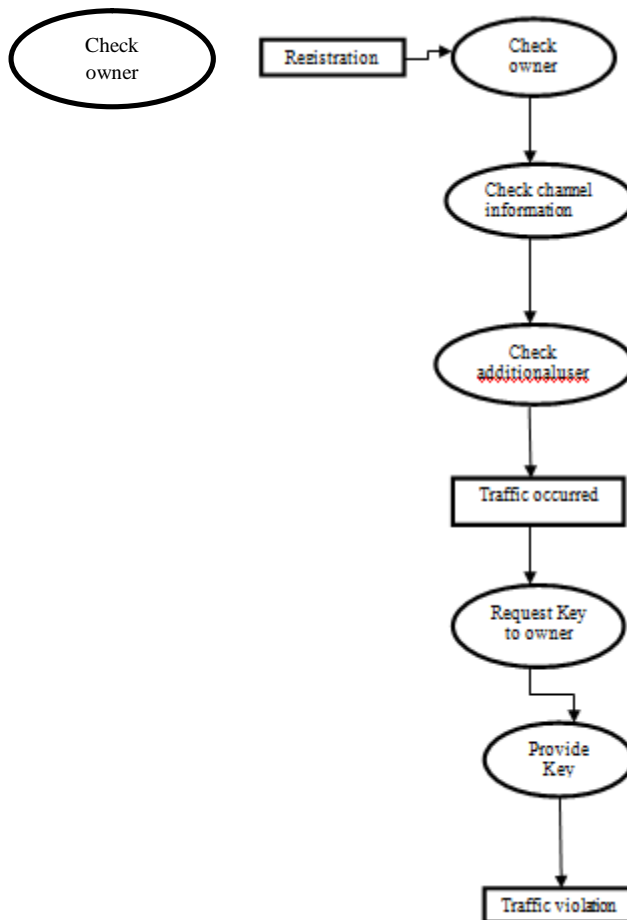
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## Data Flow diagram:



## MODULES:

- ▶ Primary user creation
- ▶ Secondary user creation
- ▶ Channel creation
- ▶ Check Channel information
- ▶ Channel allocation

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## Module 1: Primary user creation.

Primary user is a the users who receives the signals from the satellite and it will distribute the signal to the secondary users. The primary user are created as primary nodes Using this nodes we use to distribute the signal to the secondary users

## Module 2: Secondary user creation

Secondary user is a the users who receives the signals from the primary users. The secondary user are created as secondary node .Using this nodes we use to distribute the signals to the secondary users

## Module 3: Channel creation

A **channel check** is third-party research on a company's business based on collecting information from the distribution channels of the company. It may be conducted in order to value the company, to perform due diligence in various contexts, and the like. Industries where channel checks are more often conducted include retail, technology, commodities, etc.

## Module 4: Check Channel information

When the third party user uses our site for the first time he needs to register on to our site with his information. The registration module is very similar to other registration in other site. The user needs to enter the first name and other stuffs like DOB phone number and so on.

## Module 5 : Channel allocation

A **channel allocation** is third-party research on a company's business based on collecting information from the distribution channels of the company.

It may be conducted in order to value the company, to perform due diligence in various contexts, and the like. Industries where channel checks are more often conducted include retail, technology, commodities, etc.

## Scheduling Algorithm for Single Channel CRNs

Channel allocation schemes can be divided in general into:

Fixed Channel Allocation schemes (FCA schemes);

Dynamic Channel Allocation schemes (DCA schemes);

Hybrid Channel Allocation schemes (HCA schemes: combining both FCA and DCA techniques);

FCA: In FCA schemes, a set of channels is permanently allocated to each cell in the network.

DCA: All channels are kept in a central pool and are assigned dynamically to new calls as they arrive in the system.

HCA: HCA schemes are the combination of both FCA and DCA techniques. In HCA schemes, the total number of channels available for service is divided into fixed and dynamic sets by arrivals, departures and channel state in the current time slot.

## V. CONCLUSION

In this paper, we develop CA-CSMA: a throughput optimal distributed queue length based CSMA/CA scheduling algorithm for cognitive radio networks. The algorithm needs to signal a group of SUs during channel state change, different from existing distributed queue-length based CSMA/CA algorithms. Our algorithm is designed to adapt to the channel availability dynamics caused by unknown PU activity.

In the future, we plan to relax the time-scale separation assumption, and extend our work to multi-hop and multi-PU cognitive radio networks.

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