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Realization of a Cognitive Radio Networks with an Exclusive In-Band Control Channels

[1]S. Tamilarasan, [2]Dr. P. A. Abdul Saleem

[1]Research Scholar, Centre for Information Technology and Engineering, MS University, Tirunelveli, Tamil Nadu & Assoc. Prof. – CSE, Briandavan College of Engineering, Yelahanka, Bangalore, Karnataka, India

[2]Professor & Principal – Arkay College of Engineering & Technology, Bodhan, Nizamabad District. Telangana, India

Email- [1]stamilarasan74@rediffmail.com, [2]drsaleemprincipal@gmail.com

Abstract — Presently a new technology which is highly preferred is wireless ADHOC networks. The traffic of the wireless ADHOC networks day by day is growing up due to this the scarcity problem arises in the available spectrum. The channel resources are allocated in Cognitive Radio Network (CRN) with a Dynamic Access methods of available sensed radio environment. The Dynamic Spectrum Allocation (DSA) is a suitable technique which solves the issue of spectrum scarcity in the CRNs. This DSA will coordinate with the channel access for schedule sensing , release connection etc. when two networks are active at the same moment. Here this research paper provides an analysis of reliable channels exclusively used for CRNs with respect to distribution of license-exempt bands and also determining the potential and limitations of every methods.

Keywords— CRN, CC, Spectrum Management, Spectrum Allocation

I. INTRODUCTION

Actually the available white Spaces(WSs) are distributed upon the large frequency spectrum due to the anticipated spectrum mobility in CRNs. The Secondary Users (SUs) essential to exchange a great capacity of control messages in order to promise suitable performance levels [9]. Depending on the target application and the operational mode of the CRN, the role of control messaging can differ significantly and thus a choice should be created on wherever and the way to ascertain the Control Channel (CC) [13]. In CRN protocol stack the Control channel provides the services to dissimilar layers. Which includes the physical layer, network layer, and medium access layer. The functionalities strengthened by a Control Channel takes the binding of network organization, network coordination, synchronization, cooperation, spectrum sensing and sharing, and flexible information connections [15].

The algorithms normally utilized, assume the provision of an avid out-of-band CC [20]. But completely different problems arise from such associate assumption. First, this answer will provide the requirement to lease an associate out of-band channel. Second, there will be some delay in data transfer to switch RF front-end from Associate out-of-band Control Channel (CC) to the in-band data channel. The majority of the currently proposed CR Medium Access Control (MAC) protocols consider using dedicated CC solutions in licensed bands. For example, MAC algorithms mentioned in [18], [19], and Opportunistic Spectrum MAC (OS-MAC) [12] use a dedicated CC in a band licensed to the CRN for control message exchange. Moreover, the authors in [14] and [16] assume the availability of a dedicated CC. Also, Ultra Wide-Band (UWB) control channel establishment is the focus of different efforts, e.g. [2], [17], where the authors outline the main design and implementation challenges regarding using UWB where information is spread across large bandwidth in an underlay fashion [3].

In spite of many researchers have addressed about DSA and MAC protocols but little attention has been proposed for the selection and behavior of CCs. However CC Implementation for CRN in License-Exempt (LE) is most critical because of the inability to reserve a special channel for this mission. The need for this research arises from the necessity of practical solutions to have reliable CCs for CRNs. These solutions have to be simple enough, yet sophisticated, to be implemented in real-life networks in order to coordinate channel access, schedule sensing and establish and release connections. Furthermore, most of the works presented in the literature focus on the Data Plane (DP) performance while assuming a perfect exchange of control messages whenever needed, which is not practically the case.

Dedicated in-band CC selection strategies have some advantages that make them a potential solution for the problem in hand. For instance, these schemes are simple to implement and do not require a complex algorithm to be used practically. Also, no switching overhead is required where the CRN chooses one of the Primary Users' (PUs) channels as a dedicated CC. Under this approach, there is no need to look for another CC during communication sessions. In this

paper, we focus our study on the performance of CCs that are based on in-band selection strategies. The contribution of this paper is to provide a comparative study on the effectiveness and performance of in-band dedicated CC selection strategies. In addition, we consider a challenging use case of selecting CCs in the License-Exempt (LE) band of 5 GHz, where there is no licensed spectrum to dedicate to CC, and where Long Term Evolution-Unlicensed (LTE-U) is considered for coexistence with Wi-Fi. The proposed LTE-U technology in North America starts transmitting without sensing the channel; hence, it behaves as a PU. On the other hand, Wi-Fi is a typical SU in this context, which backs off when sensing an activity on the channel. Furthermore, to get a realistic insight on the performance of CCs in practical environments, we consider a real-life scenario of an outdoor stadium, which is acknowledged by industrial and standards bodies as one of the most challenging future deployments. Thorough recommendations on the advantages and disadvantages of the selection techniques for CCs are provided as well.

The subsequent part of this paper is discussed as follows: next section provides details about the network model, environment and scenario. Third section describes the studies selection strategies. Section 4 is dedicated to the performance evaluation and interpretation of the investigated CC selection strategies. Last is the conclusion of the paper.

II. NETWORK MODEL

Here in this CRNs, the Primary Networks (PN) as well as Secondary Networks (SN) are thought to be situated in close locality and the topology of the PN follows a Homogeneous Poisson Point Process (HPPP) with density of the node is θPU [8]. For the (SNs), the SUs quantity is fixed for every studied technique. In this the Access Points (Aps) are assumed to be aware of PUs activity, which is likely by employing specific sensing techniques [1].

We have studied a real-life play script of an outdoor open-air stadium [11]. The simulated area consist of 16 APs and the simulated area is partitioned into blocks where each block has dimensions of 12m X 12m which is served by one AP. SUs' positions are assumed to be fixed and follow the layout of the chairs in stadium design, since the people will be sitting in their seats during the show [11], [4]. APs support 4x4 Multiple-Input Multiple-Output (MIMO) with transmission power of 19 dBm. Also in addition to it the SUs support 2x2 MIMO with transmission power of 15 dBm. The channels are modeled utilizing the WINNER II B1 Line-of-Sight (LOS) outdoor broadcast model [7]. The channel model of WINNER is a geometry-based stochastic model where the parameters of channel are found out based on statistical distributions extracted from channel measurements.

Shadowing impacts the connectivity of the nodes and the standard deviation of the shadowing (s) are in the range of 3 to 12 dB [6]. Furthermore, since the correlation of shadowing is of high importance when studying CRNs due to their coexistence with the Primary Network [10], This is taken into consideration in this research work. In order to reduce the collision rate, the time slots used at SN for packet transmission by SU. The traffic of the communication movements of PUs and SUs are modeled as Bernoulli arrival processes with parameters λPU and λSU, respectively [5]

III. SELECTION STRATEGY

The natural selection approaches of dedicated in-band CC shall be characterized into interweave and underlay.
1. In this interweave approach, when the PU regains the channel, the CRN will refrain from using this channel as CC and consequently the whole communication session will be kept on hold. This process might be repeated as many times as per the requirements.
2. But in underlay setting, the transmission power is set to be 1/3 of the transmission power in interweave setting. Also, the CRN will be using the dedicated CC at all times even if a PU becomes active on this channel.

IV. SIMULATION RESULT

Normally in order to calculate the outcome of studied approaches by the quantity like success percentage (Psuccess) beside with the achieved control messages throughput. Psuccess is well defined as the probability that SUs with control messages succeed in accessing the CC. The achieved output is calculated by averaging the data rate of the control messages flow for taking at least 1000s of simulation runs. The data rate is attained by taking the number of actual bits transmitted over the WINNER II channel model per unit time when a SU succeeds in accessing the CC. Finally, we have assumed a Packet Drop Ratio (PDR) of 5%. The correlation of the shadowing map is set to 1/20 and the number of PUs is set to 50 and their communication activity (λPU) is set to 0.5, unless stated otherwise.

As the range of SUs are keep increasing, the performance of these choice criteria decreases very fast. This is often as a result of the inflated competition in order to access the CC once the SU range of SUs will be increasing. But whatever may be that the success rate is 98%, once the amount of SUs is 50 and λSU is about to 0.1. the rationale behind this is often that SUs creates management messages at a coffee rate and then the CC are ready to accommodate all of the fifty SUs throughout the days of getting the CC vacant from any PUs activity (figure 1). But the system remains ready to succeed the successful rate over 50% of range when the number of SUs is 200 and λSU is 0.1. They came down within the success rate is thanks to the magnified range of mammal genus that conceives to access the CC.

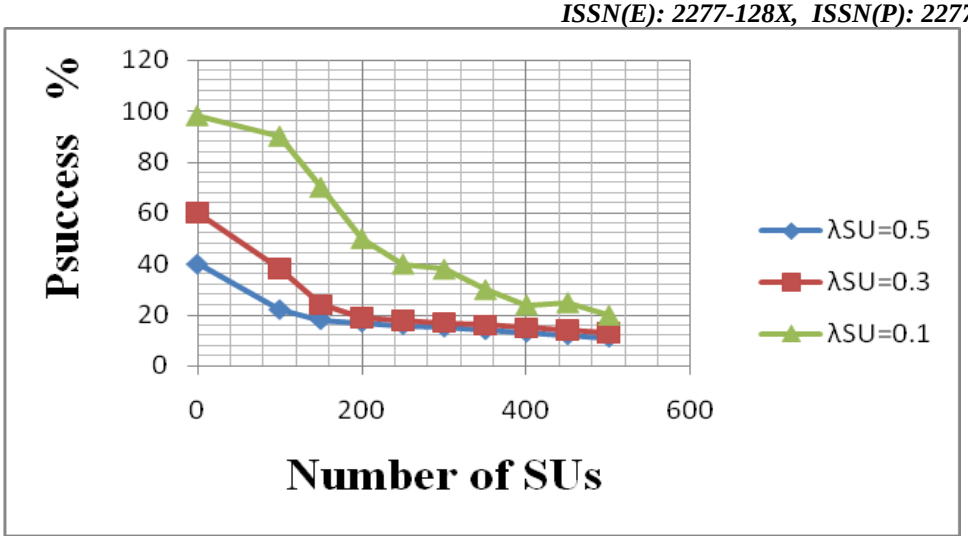

Fig. 1 Probability of success vs. more SUs with distinct λSU values

In figure 2, the attained throughput on the CC is in the range within 4 and 4.5Mbps. Because the variety of SUs will be increasing, the accomplished throughput varies slightly and does not increase respectively. This can be because of the accrued competition between SUs to access the CC and therefore the extent of collision and packet loss will increase, which can keep to the accomplished throughput nearly at constant position.

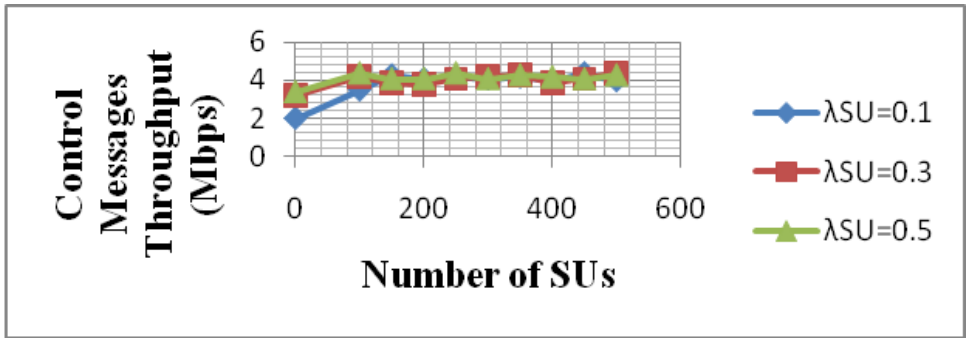

Fig. 2 Throughput vs. SUs

V. CONCLUSION

In this research paper we studied about various possible scopes to pickup an appropriate CC effectively for cognitive radio networks. Also investigated the performance of CC selection approach using simulator tools. It can be concluded that interweave selection strategy is a best way when the movement of the primary network is low. So we proposed hybrid approach that will be subject to the further analysis and validation. Finally, we believe that integrating the CCPU with spectrum allocation algorithms while looking at the whole picture of cognitive radio functionalities will contribute to the success of enabling and deploying CRNs in the near future.

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