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COGNITIVE RADIO NETWORKS USING JUMP STAY ALGORITHM

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Abstract

Most common works for rendezvous in cognitive radio networks deal only with two user scenarios involving two secondary users and variable primary users and aim at reducing the time-to-rendezvous. It is crucial for users in CRNs to search for neighbours via rendezvous process and thereby establish the communication links to exchange the information necessary for spectrum management and channel contention etc. The common type of rendezvous algorithm is jump stay algorithms where in the radios are either in jump mode or in stay mode which enables the Secondary User (SU) in jump mode to achieve rendezvous with the SU in stay mode. This paper focuses on the design of algorithms for blind rendezvous that is the rendezvous without using any central controller and common control channel (CCC). We propose a jump-stay based channel-hopping (CH) algorithm for blind rendezvous. Compared with the existing CH algorithms, our algorithm reaches the succeeding advances: i) guaranteed rendezvous without the need of time synchronization; ii) applicability to rendezvous of multi-user and multi-hop scenarios and iii) Does not have any storage. In this paper, we propose a CRN for single user, multi user and more than two users without using any data storage.

Keywords*:* Blind Rendezvous, channel hopping, Cognitive radio, cognitive radio networks

1. Introduction

The Cognitive Radios need to avoid/minimize interferences to the other users. Cognitive Radio is a wireless communication system which is aware of the environment and its changes and can adapt its transmission parameters accordingly. Cognitive Capability: The ability to sense the unused spectrum at a specific time and location (spectrum hole). Re-configurability: The ability to receive and transmit at different frequency band enables the cognitive radio to reconfigure its parameters and select the best band.

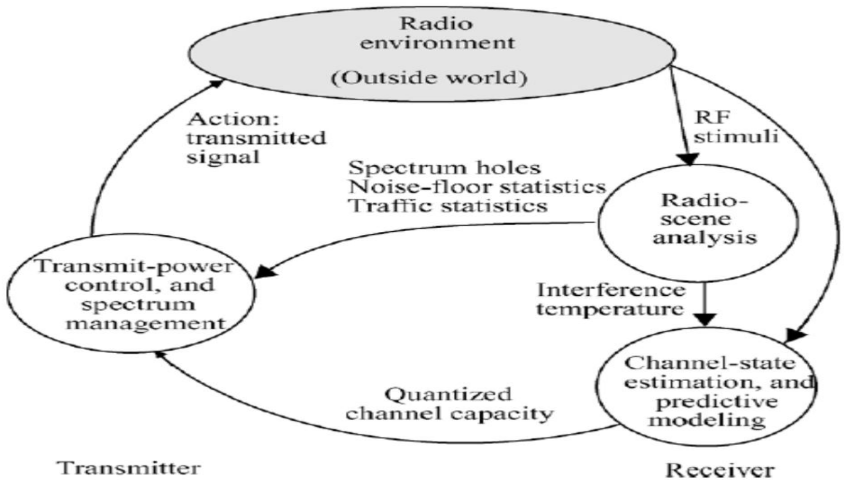

Figure 1: CR Functionalities

Cognitive radio includes five main functional blocks: spectrum sensing, spectrum management, spectrum sharing, spectrum mobility and transmitter-receiver handshake. Spectrum sensing aims to determine spectrum availability and the presence of the licensed users (Primary users), a secondary user can only allocate to a portion of the spectrum if that portion is not used by a secondary user. Spectrum management predicts how long the spectrum holes are available for use to the unlicensed user (secondary user).

Spectrum sharing is to distribute the spectrum among the secondary users according to the usage cost. Spectrum mobility is used to maintain seamless communication during the transition to better spectrum. If the portion of spectrum which is in use is required by the primary user the communication needs to be done in another portion, so spectrum mobility is required for the cognitive radio. Once a portion of the spectrum is allocated for the communication, the receiver of the communication must also know about the indicated spectrum. Hence a protocol known as transmitter-receiver handshake protocol is required for the communication between the cognitive radio nodes.

1.1 Cognitive Radio Networks

In communication networks, cognitive network is a new type of data network that makes use of cutting edge technology from several research areas to solve some problems are faced with current networks. Cognitive network is changed from cognitive radio as it covers all the layers of the OSI model. The unique security problems of CRNs are not faced by conventional wireless networks. The present edge of the CR/Software-Defined Radio (SDR) community is on preventive security measures that secure the radio software download process and on schemes that thwart the tampering of radio software once it is installed. However, preventive security is not sufficient. CRNs are also more open to attacks such as jamming and selfish node misbehaviour. The unauthorized users can be prevented by authentication. An issue of cognitive radio networks is focus on: (i) sensing the spectrum, (ii) link adaption, (iii) advanced transceiver design, and (iv) Admission control.

The CRNs Components can be classified into two ways. Such as (i) Primary network-Primary users: It's have the license to operate in certain spectrum bands. Primary base station: Controls the access of primary users to spectrum and (ii) Secondary network - Secondary users: It's have no licensed bands assigned to them. Secondary base-station: A fixed infrastructure component with cognitive radio capabilities and provides single hop connection to secondary users. Spectrum broker: Scheduling server shares the spectrum resources between different cognitive radio networks.

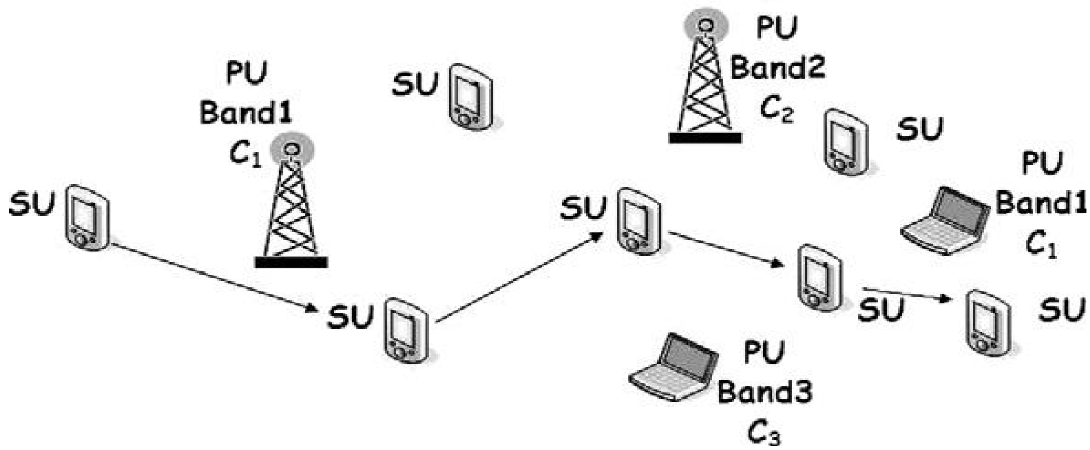

Figure 1: Information routing in multi-hop CRNs

1.2 Advantages of CRN

The use of a cognitive radio network provides a number of advantages when compared to cognitive radios operating purely autonomously: i) Improved spectrum sensing: By using cognitive radio networks, it is likely to improve the significant advantages in terms of spectrum sensing. ii) Improved coverage: By setting up cognitive radio network, it is likely to relay data from one node to the next. In this way control levels can be reduced and performance maintained.

2. Channel-Hopping

Channel-Hopping (CH) is one of the most typical techniques for blind rendezvous. By CH technique, all user of a CRN selects a set of accessible channels and hops among these channels for rendezvous with its potential neighbor. If all users have the same accessible channels called as symmetric model. The different users might have different accessible channels are called as asymmetric model. Several CH algorithms have been proposed in the recent literature. However, these works have one or more of the following limitations: i) without guaranteed rendezvous; ii) Demand on time-synchronization for rendezvous; iii) Not applicable to asymmetric model; iv) Not applicable to rendezvous of multiple users.

In this study, we focus on the design of CH algorithm for guaranteed rendezvous of two or multiple users in time slotted CRNs. Contributions of this work are summarized as follows.

i) New algorithm with guaranteed rendezvous: a novel CH algorithm called jump-stay (JS) is proposed to achieve guaranteed rendezvous without the need of time synchronization under both symmetric and asymmetric models.

ii) Generalized rendezvous for multi-user and multi-hop scenarios: JS is applicable to rendezvous of multiple users within 1-hop and even multi-hop neighbourhood.

iii) We derive this paper was presented as part of the main technical program at maximum time-to-rendezvous (TTR) and the upper-bound of expected TTR of JS for both 2-user and multi-user multi-hop scenarios, where TTR is defined as the number of time slots that it takes for users to rendezvous.

iv) Guaranteed rendezvous without the need of storage under both symmetric and asymmetric models.

DSAP (Dynamic Spectrum Access Protocol) is a centralized protocol that provides dynamic allocation of wireless spectrum to network nodes. Briefly, the goal of DSAP is to increase performance of wireless networks by Intelligently distributing segments of available radio frequency spectrum to wireless nodes to avoid congestion, minimize interference, and to adjust the clients’ wireless medium usage to fit the network administrator’s needs.

A cognitive radio is an intelligent radio that can be programmed and configured dynamically. Its transceiver is designed to use the best wireless channels in its vicinity. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management.

The rendezvous problem in a CRN is generally framed in two scenarios in terms of channel availability per user. In symmetric scenarios, the same sets of channels are accessible for all the users. In asymmetric scenarios, different set of channels are accessible to different users.

The major challenge in blind rendezvous is to provide the guaranteed rendezvous in asymmetric scenarios, as in symmetric scenarios, all users can just linger on the lowest channel to reach rendezvous. To date, most of the rendezvous algorithms use either a central controller or a dedicated channel to aid the users achieve rendezvous. The dedicated channels are referred as Common Control Channels (CCC).
Though these approaches are simple to implement, they suffer from several drawbacks: (1) Establishing CCC is not always feasible because any preselected CCC may be in use by the PUs; (2) The central control and the CCC do not scale well as the number of users increases; (3) The central controller presents a central point of failure. To overcome the above drawbacks, distributed blind rendezvous algorithms which do not require a central controller or a CCC have been proposed.

A major class of these algorithms use the channel hopping (CH) technique, where the users hop the idle channels using a particular hopping sequence so that all of them arrive at the same channel in the same time-slot. Jump-Stay (JS) is the state-of-the-art distributed algorithm that provides guaranteed blind rendezvous in asymmetric scenarios. JS achieves the guarantee via a novel technique that combines channel hopping with a stay stage during which each user stays on a particular channel for a number of time-slots.

In the multi-user case, each user performs jump-stay as before, except at each pair wise encounter one user copies the jump stay parameters from the other (following an implicit ordering of the users). After enough pair wise encounters, all users will have the same jump-stay parameters and hence hop along the same channel sequence, reaching rendezvous. We thus refer to algorithms like JS as Uncoordinated Channel Hopping (UCH) algorithms as the sequence of channels being hopped though propagated is never shortened or split among the users.

In this paper, we introduce a new class of distributed algorithms for multi-user blind rendezvous, called Coordinated Channel Hopping (CCH), sequence of channels where users adjust, or coordinate and hopped as they rendezvous pair wise. We propose two CCH algorithms, Iterative Intersection Hopping (IIH) and Divide and Conquer Hopping (DCH).The two CCH algorithms explore two directions to accelerate the rendezvous between a new user and existing users which typically have already achieved rendezvous. IIH focuses on having the new user quickly meeting the first one of the existing users, while DCH focuses on quickly spreading the information about the new user among the existing users.

3. Conclusion

In this paper, we observe that the state of the art algorithm is optimized for the multi-user scenarios. In particular, when two users encounter, one user inherits the other users hopping sequence but the sequence is never shortened or split among the encountering users. Guaranteed rendezvous without the need of storage under both symmetric and asymmetric models. We introduce a new class of distributed algorithms for multi-user blind rendezvous, called Coordinated Channel Hopping (CCH), where users adjust or coordinate their sequence of channels being hopped upon pair wise rendezvous. Compared to existing rendezvous algorithms, our algorithms achieve 85% lower Time to Rendezvous (TTR) in case of multiple users

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