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Design Approach of Distributed Uplink Power Control Algorithm for Multicell Cognitive Radio Network.

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Abstract—The paper presents the power control algorithm to reduce the uplink interference management problem in cognitive radio network. In this power control algorithm the underlying secondary user (SUs) share the same licenced spectrum with the primary users (PUs). The primary users will have higher priority than the secondary users, all primary users are supported to the target signal to interference noise ratio (SINRs). By supporting the primary users with the target signal plus interference noise ratio the minimal number of secondary users are removed.In our proposed methodology every primary user will be tracked by target signal plus interference noise ratio with tracking power control algorithm (TPC). The secondary users will employ the TPC up to when the received power of PU is below threshold otherwise it reduce the transmit power proportional to the received power and threshold. Our aim is to improve the number of secondary users and all primary users will support with target signal plus interference noise ratio. Finally we propose that because of distributed power update function the outage ratio for primary users become zero and better outage ratio for secondary users.

Keywords: *Primary users(PUs), Secondary users (SUs)Signal to interference plus noise ratio(SINRs),tracking power control (TPC)*

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I. INTRODUCTION

Cognitive radio is an intelligent radio which will change its transreceiver parameters dynamically depending upon the environment conditions (I. F. Akyildiz et al., 2006). In cognitive radio networks, each secondary user can dynamically access the spectrum without interfering with primary users in the network. A user node can join in a cognitive radio network, if it has wireless communication, networking and cognitive radio capability. There are two types of users using the network; Primary Users (PUs) and Secondary Users (SUs). Primary Users are also called licensed users who will utilize the already allocated spectrum. Secondary Users are also called Cognitive Users or unlicensed users because, for communication, no fixed spectrum is allocated for SUs. SUs can utilize the spectrum of PUs without giving interference to the PUs. In cognitive radio network there are two types of communication strategies. In cognitive radio network primary users coexist with secondary users using spectrum underlay and spectrum overlay strategies. In the overlay strategy when primary users are active then secondary units does not transmit means the interference temperature limit is assume to be zero. Underlay strategy uses fixed interference temperature limit and the transmission opportunities of secondary users are wasted in ideal period. But instead of assuming interference temperature limit fixed we can assume it can vary in an optical manner. This strategy is called as a mixed strategy. Generally as the number of primary users are increased then the value of interference temperature decreases at each primary receivers. The mixed strategy can be obtained by dynamically setting the value of interference temperature limit. Because of this strategy the spectrum access opportunities and interference tolerability those are missed in underlay and overlay strategies, can be used to increase the performance of the secondary users. The mixed strategy can be implemented by efficient power control method.

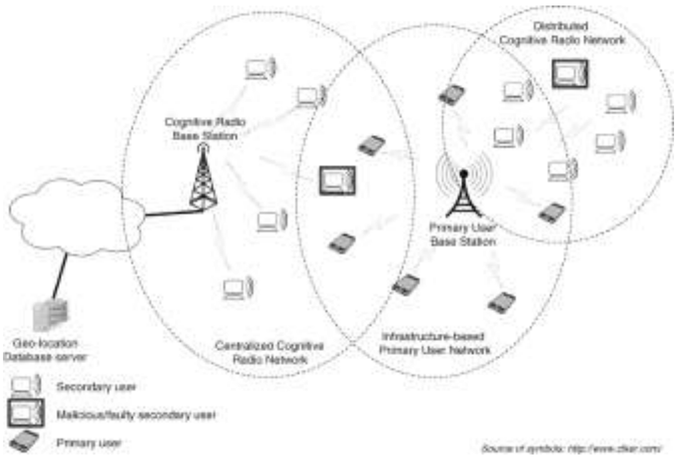

Fig. 1. Cognitive radio network

A. *Two main approaches of CR*

- Full Cognitive Radio ("Mitola Radio") where every possible parameter is taken into account.
- Spectrum Sensing Cognitive Radio where only radio frequency spectrum is considered.

B. *Four main functions of CR*

- Spectrum sensing: It determines which portions of the spectrum are available and detect the presence of licensed users.

- Spectrum management: It is to select the best available channel. Capturing the best available spectrum to meet user communication requirements, while not creating undue interference to other (primary) users. Cognitive radios should decide on the best spectrum band (of all bands available) to meet quality of service requirements; therefore, spectrum-management functions are required for cognitive radios.

- Spectrum sharing: It coordinates access to this channel with other users. Spectrum sharing cognitive radio networks allow cognitive radio users to share the spectrum bands of the licensed-band users. However, the cognitive radio users have to restrict their transmit power so that the interference caused to the licensed-band users is kept below a certain threshold.

- Spectrum mobility: It vacates the channel when a licensed user is detected. Process by which a cognitive-radio user changes its frequency of operation. Cognitive-radio networks aim to use the spectrum in a dynamic manner by allowing radio terminals to operate in the best available frequency band, maintaining seamless communication requirements during transitions to better spectrum.

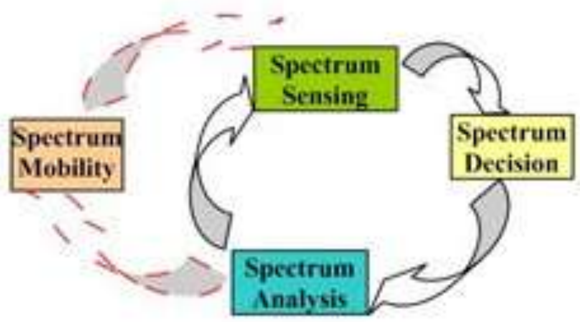

Fig. 2. Spectrum management functionality

C. *Power Control in Cognitive Radio Networks*

In Cognitive Radio (CR) networks, power control deals with the selection of proper transmit power for CR users' transmissions that achieves high spectrum efficiency by enabling CR users to reuse the PUs' spectrum bands under the interference constraints imposed by PUs. In the next generation wireless communications, CR users are expected to be uncoordinated opportunistic users, whereas there are conflicting interests among the CR users. This motivates the use of non-cooperative game theory to do research on CR networks. Compared to traditional centralized solutions, the game-theoretical approach has the advantage of distributed implementation for CR networks: each CR user only takes care of their own utility maximization, and it does not need to know other users' payoff (or utility function).

In cellular systems, a base station tells mobile units to adjust their transmit powers by measuring the power received from them. Cellular systems are used for applications such as telephony where the pre-installation of a fixed base station infrastructure is feasible. Cellular systems have star topologies and every mobile unit communicates exclusively with an associated base station. An ad-hoc network on the other hand does not have a centralized arbiter which can tell each node the transmit power to use to communicate with a particular receiver. Furthermore, well defined cells or domains do not exist. Thus power control in an ad-hoc network is not trivial and needs to be administered in a distributed manner. However, the benefits of power control remain. Instead of every node using the same transmit power, if a node uses only the power level that is required to communicate with a desired receiver, it might extend its battery life. Furthermore, it will reduce interference seen by other simultaneous transmissions in the network.

II. LITERATURE REVIEW

We propose a distributed power control algorithm to address the uplink interference management problem in cognitive radio network where the underlying secondary users (SU) share the same licensed spectrum with the primary users (PU)in multi cell environment. Normally two strategies are used for transmitting the signal.

The first strategy is overlay strategy, and the secondstrategy is underlay strategy. But in this concept we will use a mixed strategy sometimes underlay and sometimes overlay strategy depending on the requirement. Precisely, both strategies are simulated using NS2 simulator. Simulation results show the improvements obtained in the efficiency in transmission of primary and secondary users. [1]

We address the problem of distributed uplink power control in cellular CRNs. Having obtained the interference temperature limit of each primary receiver, we aim to devise a distributed power control scheme for the PUs and SUs to set their transmit power levels so that a maximal number of SUs reach their target-SINRs, while all the PUs are supported with their target-SINRs (i.e., the interference caused by the SUs to each primary receiver remains below its interference temperature limit). [2]

This proposed algorithm suggests that PU have higher priority of channel access compared to secondary users. All primary users are supported with their target signal-to interference-plus-noise ratios (SINRs), which is assumed feasible. In our proposed algorithm, each primary user rigidly tracks its target-SINR by employing the conventional target-SINR tracking power control algorithm (TPC). Each transmitting SU employs the TPC as long as the total received power at the primary receiver is below a given threshold; otherwise, it decreases its transmit power in proportion to the ratio between the given threshold and the total received power at the primary receiver, which is referred to as the total

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received-power-temperature. We show that our proposed distributed power-update function has at least one fixed-point. We also show that our proposed algorithm not only improves the number of supported SUs but also guarantees that all primary users are supported with their (feasible) target-SINRs [3]

We have been focused on the problem of uplink power control in CRNs in multi cellular environments to minimize the outage ratio for the SUs subject to the zero-outage constraint for the PUs. We present a distributed power control scheme to achieve this design goal. Specifically, in our proposed algorithm, each PU rigidly tracks its target-SINR by employing the traditional TPC algorithm proposed in Each transmitting SU employs the TPC algorithm as long as the total received power at each of the primary receivers is below a given threshold; otherwise, it decreases its transmit power in proportion to the ratio of the given threshold to the total received power at a primary receiver. [4]

III. Power Control Methods

A. Fixed-Step Power Control

The power level is increased/decreased depending whether the measured SIR is below or above target SIR This is the default choice both in the uplink and the downlink closed-loop power control. The uplink situation is slightly modified when the mobile is in soft handover. Then, the mobile receives power control commands from every connected cell. To ensure that the power is adapted to the best cell, the mobile only increases the power if all commands are equal to +1, otherwise the power is decreased. This algorithm is equal to the single-bit error representation.

B. Uplink Alternatives

It makes it possible to emulate slower update rates, or to turn off uplink power control by transmitting an alternating series of TPC commands.

C. Downlink Alternatives

There are two downlink alternatives, both aiming at reducing the risk of using excessive powers. In the first one, the control commands are repeated over three consecutive slots. The second one, reduces the controller's ability to follow deep fades by limiting the power raise.

D. Soft Handover

One corecentral feature in DS-CDMA systems is soft handover, where the mobile can connect to several base stations simultaneously. For best performance, the mobiles controls its power with respect to the signal from the base station with the most favourable propagation conditions. Intuitively, the mobile only increases the power if the TPC commands from all the base stations require it to do so. When command errors occur,this might lead to unwanted eff ects. The mobile algorithm of the TPC command combination is not standardized, and the problem is addressed in Grandell and Salonaho (2001).

For downlink power control, the base stations adjusts its powers according to the received TPC command from the mobile. Due to feedback errors, these powers might drift from the ideal power levels. To compensate for this drift, a centralized power balancing is proposed in the standards, see 3GPP.

IV RESULT

The result has been calculated in the form of delay, amount of energy remaining,throughput and jitter.

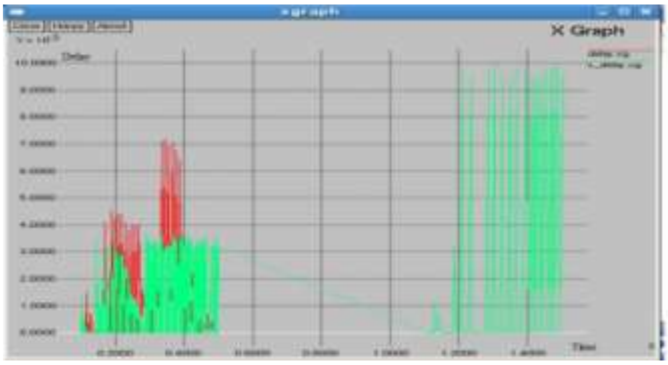

Fig.3 Delay with and without power control

The delay of communication between two nodes should be as low as possible. The controlled delay in the above graph is 3.5ms whereas without power control is 7.2ms.

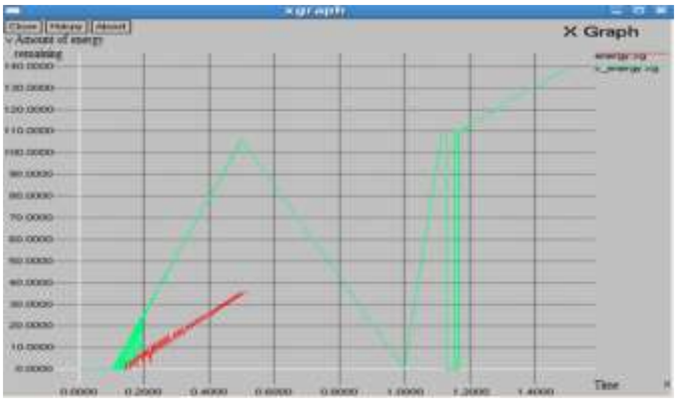

Fig.4 Energy with and without power control

The energy remaining in the node should be maximum. The above graph shows that the energy remaining in the node with power control is approximately 105 mJ whereas without power control is 35 mJ.

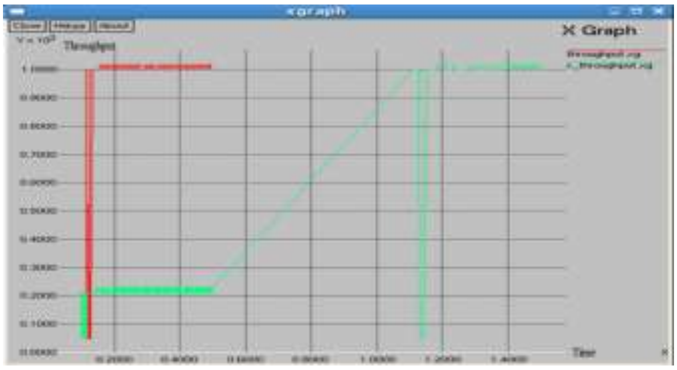

Fig.5. Throughput with and without power control

The throughput of both controlled power and without power control is 1000 Mbps. Throughput of control power increase steadily so it consumes less power.

Fig.6.Jitter with and without power control

Jitter means delay minus mean delay. The jitter should be as low as possible.The above graph shows that the controlled jitter is about 3 ms whereas without power control is6 ms.

VCONCLUSION

Author have presented an efficient power control algorithm for multicell cognitive radio network. The result shows that the controlled delay is 3.5 ms , energy remaining is 105 mJ ,throughput is 1000 Mbps,and jitter is 3 ms which is far better than without power control method so it shows that distributed uplink power controlled algorithm increases the efficiency of communication than without power control method.

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