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Power Control in Cognitive Radio: Review

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Abstract: With the increasing number of wireless services and potential users of wireless multimedia, competence in utilization of allocated spectrum became a focal point in the spectrum battle, not only in highly populated areas. Cognitive radio is recently introduced as one of the principles for more efficient spectrum utilization, relying on spectrum sharing and utilization of white spaces and recently available spectrum for mobile services.Cognitive Radio is evolving technology that manages spectrum more efficiently by allowing non-licensed users to with dynamism access to the same. In this paper, we consider the problem of spectrum sharing with primary user and secondary users.

Keywords: Cognitive Radio, Cognitive Radio Networks (CRNs), Dynamic Spectrum Access (DSA)

I. INTRODUCTION

The radio spectrum, which is needed for wireless communication systems, is a naturally limited resource. To support different wireless applications and in a non interfering basis, the FCC's policy has been adopted by spectrum regulators, which assign each piece of spectrum with certain bandwidth to one or many dedicated users Fig.1.1. According to FCC, 15% to 85% as signed spectrum is used with large temporal and geographical variations traditional communications, where frequencies are determined by regulatory policies. This is especially valid for the developed markets, but the rest are gradually more keeping the paste. According to that, more and more users are expecting to be provided with the immediate access to multimedia content from almost every place, thus keeping broadband and mobility as the most important feature of future communication habits. This development puts a special attention to content delivery
technologies and brings spectrum policy in focus once again, cooping with the request for new services to provide large bandwidth, good quality of service and short delay. Many technologies have been considered in order to fulfil those requirements, but the general impression is that spectrum availability for new technology implementations is very low or practically non-existent.

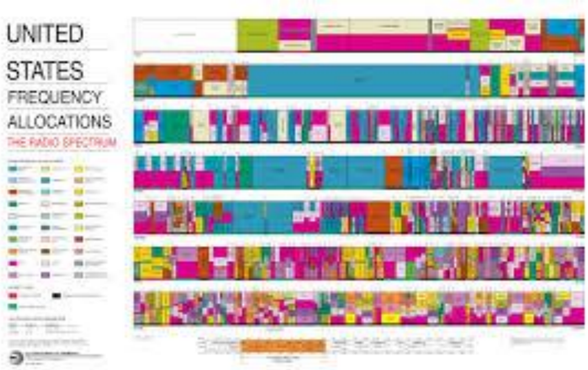

Figure.1.Spectrum occupancy measurements (FCC).

Cognitive Radio allocates and access frequency spectrum dynamically. A Cognitive Radio is a radio can change its transmitter parameters based on interaction with the environment. It is a type of radio that can sense and automatically reason about its surroundings and adapt consequently. Cognitive radios can dynamically adjust its operating parameters.
After simple introduction to Cognitive Radio development in recent years, I focus on issue of how to implement interference alleviation by power control techniques amongst multiple cognitive radios. An overview of simultaneous power control schemes.

II. LITERATURE REVIEW

Pan Zhou, Yusun Chang, John A. Copeland [1] discussed a robust distributed robust power control algorithm is designed with low implementation complexity for CR network through reinforcement learning which does not require the interference channel and power strategy information among CR users (and from CR users to PUs).

Zhengqiang Wang, Lingge Jiang [2] investigated price-based power control problem in the spectrum sharing cognitive radio networks. The base station (BS) of primary users (PUs) can admit secondary users (SUs) to access if their interference power is under the interference power constraint (IPC). In organize to access the spectrum; the SUs need to pay for their interference power. The BS first decides the price for each SU to maximize its revenue. Then, each SU controls its transmit power to maximize its revenue based on non-cooperative game. They planned novel price-based power control algorithm to maximize the revenue of the BS.

Fabio E. Lapiccirella, Xin Liu, and Zhi Ding [3]

investigate distributed control of multiple secondary users attempting to access the channel of a high priority primary user. They maximize the sum cognitive user throughput under the constraint of under primary user's queue stability. They consider the effect of primary user link adaptation that allows the primary transmitter to become accustomed its transmission rate in response to the secondary interference-level at the primary receiver. To control the sum secondary interference to primary receiver beyond the traditional collision-avoidance paradigm, they proposed a novel power control algorithm for secondary nodes to function. To develop such a distributed algorithm and to improve secondary user adaptableness, they allow secondary nodes to monitor primary's radio link control in sequence on the feedback channel.

Liang Zheng and Chee Wei Tan [4], studied a utility maximization structure for spectrum sharing among cognitive secondary users and licensed primary users in cognitive radio networks. All the users maximize the network utility by adapting their signal-to-interference-plus noise ratio (SINR) task and transmit power subject to power budget constraints and supplementary interference temperature constraint for the secondary users. The utility maximization difficulty is challenging to solve optimally in a distributed method due to the non convexity and the tight coupling between the power budget and interference temperature constraint sets. We first study a special case where egalitarian SINR fairness is the effectiveness, and a tuning-free distributed algorithm with a geometric convergence rate is developed to solve it optimally.. This leads to a utility maximization algorithm that leverages the egalitarian fairness power control as a sub module to preserve a attractive separability in the SINR assignment between the secondary and primary users.

Lu Lu, Geoffrey Ye Li [5] discussed power allocation

schemes for CR networks with both direct and relay-aided transmissions. They formulated an overall rate optimization problem with interference constraints to the PU and peak power constraints at each node and obtain solutions by hypothetical analysis. To take the fairness among CR users into consideration, they further examine the overall rate optimization problem with an additional sum power constraint and achieve justice between two CR users by adjusting the sum power threshold.

Hui Yu, Lin Gao, Zheng Li, Xinbing Wang and Ekram Hossain [6],investigated the pricing issue in a competitive cognitive radio network in which the secondary users deliberately adjust their uplink transmission power levels to maximize their utilities and the primary restore provider charges the secondary users on their transmitted power levels to develop its own revenue. We model the competitive behaviour of the secondary users as a non-cooperative game and address the existence and individuality of Nash equilibrium Based on the unique equilibrium; they formulate the pricing problem for the primary service provider as a non-convex optimization problem. They proposed a sub-optimal pricing scheme in conditions of income maximization of the primary service provider, and we claim that this scheme is not only fair in terms of power allocation among secondary users but that it is also efficient.

Chen Sun, Gabriel Porto Villardi, Zhou Lan, Yohannes D. Alemseged, Ha Nguyen Tran and Hiroshi Harada [7], discussed two types of coexistence between wireless networks coexistence amongst secondary user networks and coexistence between primary user and SU networks. The former type addresses the sharing of a common spectrum occasion among SU networks to achieve an efficient spectrum usage, whereas the latter type addresses the interference from SUs to PUs. The trend of spectrum regulations and industrial consistency, they hypothesize a potential use scenario and describe the management procedure of SU networks under the interference constraints to the PU receivers.

Hua Xiao, Kai Yang, and Xiaodong Wang [8], developed robust power control strategies for cognitive radios in the presence of sensing delay and model parameter ambiguity. They used a discrete-time Markov chain (DTMC) to typify the primary users dynamics as well as the fading channel. The power control problem is formulated as a Markov decision process problem, which can be optimally solved by dynamic programming. However, due to the time-varying nature of the wireless channel and the spectrum sensing transparency, typically only the delayed sensing results are available at any time. The delay in spectrum sensing, if not correctly accounted for, could significantly deteriorate the power control performance. Furthermore, the false sensing data and limited feedback cause estimate of the transition probability matrix, leading to further performance deprivation of the power control and channel outage.

Edward C.Y.Peh, Ying-Chang Liang, Yong Liang Guan and Yonghong Zeng [9], discussed a secondary user is authorized to access the licensed spectrum of the primary user when it is inactive. Conventional power allocation strategies, which do not consider spectrum sensing information (SSI), may not be optimal in dynamic Spectrum Access based cognitive radio system because when the SU mis-detects the PU's being there, the interference from the PU will cause a lower data rate or a higher outage probability to the SU. They discussed power allocation strategies for each frame are designed based on the SSI gathered by the SU throughout the sensing period of the frame.

Chen Sun, Yohannes D. Alemseged, Ha Nguyen Tran and Hiroshi Harada[10], proposed an adaptive-power-control format for a cognitive radio system (CRS) in a Rayleigh fading channel. By allowing transmit power adaptation at the secondary user (SU) transmitter to preserve a constant output SNR to the SU receiver, this scheme maximizes the output SNR and limits the interference to a primary user (PU) within an interference constraint. To compute this maximum constant output SNR at the SU receiver subject to the interference constraint of the PUs, They developed an investigative replica for the distribution of the interference to the PU while allowing for the detection presentation at the SU.

III. CONCLUSION

This paper provided an impression of the development of power control in cognitive radio networks and momentarily discussed the advantages from the taking on of power control techniques and explained the basic mechanisms for an efficient power control scheme. By reviewing some fundamental papers in the area, as well as their major assistance to the field. In this way ,the contributed a vision of the large picture for the subareas discussed, including some important aspects of power control algorithms that could accelerate the deep familiarization with the area.

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