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An Enhanced Resource Allocation On Multichannel Cognitive Radio Networks Using Co-Operative Resource Allocation Mechanism

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Abstract - **This project's purposed to prove the advantages of collaboration in cognitive radio. To collaborate, cognitive radios are allowed to operate in the same band. As a result, boosting their capability can cut detection time. Two cognitive users (Primary User and Secondary User) are studied, and it is shown how the network's intrinsic asymmetry can be used to improve detection probability. Our research is expanded to include multiple cognitive user networks. We also present a viable approach for allowing random networks to cooperate.**

Keywords: Cognitive radio network, Cooperative resource allocation, MDR, routing and route discovery reliability

1. INTRODUCTION

Future wireless communication systems will face additional hurdles as service demand grows. The shortage of radio resources is one of the most significant obstacles to meeting demand. In the last decade, a number of strategies for optimally utilizing radio resources have been presented in the literature, including cognitive radio [1-7], cooperative communication [8-10], and multi antenna communication [11]. Cognitive radio is a new technology that aims to make better use of the radio frequency spectrum. With the same total power and bandwidth as historical wireless communication systems, cooperative communication and multi antenna systems can boost the data rate of future wireless communication systems. The performance of future wireless systems can be improved further by combining cognitive radio with cooperative communication and/or multiple antennas. The combination of these strategies, on the other hand, presents additional challenges in wireless systems that must be addressed. First, we'll go through the fundamentals of cognitive radio and cooperative communication, including nomenclature.

A cognitive radio is formally described as a radio that adjusts its transmitter parameters in response to its surroundings [3, 12]. The fundamental goal of cognitive radio is to increase spectrum utilization by allowing unlicensed users to access underutilized licensed frequency channels. Wireless devices that are not licensed are already in use [13, 14]. The IEEE 802.22 standard for Wireless Regional Area Network (WRAN) addresses cognitive radio technologies for accessing licensed TV band white spaces. The frequency range for the IEEE 802.22 standard in North America will be 54-862 MHz, while the worldwide standard will use the 41-910 MHz band [1].

The location database is accessible to the secondary users' central controller. The central controller can efficiently manage its resources with information of primary and secondary user locations, ensuring that primary users are not harmed. The following are the key tasks of cognitive radio in supporting intelligent and efficient frequency spectrum utilization:

1.1. Spectrum sensing

Spectrum sensing determines the spectrum's state as well as the principal users' activity. The spectrum hole is detected by an intelligent cognitive radio transceiver without interfering with the principal users. The frequency bands that are currently not in use by the principal users are known as spectrum holes. Spectrum sensing can be done in a centralized or distributed fashion. Because the centralized controller conducts the sensing function, centralized spectrum sensing can reduce the complexity of secondary user terminals. Each mobile device perceives the spectrum individually in distributed spectrum sensing. In distributed spectrum sensing, both centralized and distributed decision-making are feasible. Based on the spectrum sensing data, the central controller allocates resources to ensure efficient use of the available spectrum. One of the main functions of the central controller is to prevent secondary users from sharing spectrum with each other.

1.2. Dynamic Spectrum Access

DSA is defined as real-time spectrum management in response to a changing radio environment, such as a change in location, the addition or removal of some primary users, available channels, and interference limits [1, 2]. In the literature, there are three DSA models: exclusive-use model, common-use model, and shared-use model [2]. Spectrum property rights and dynamic spectrum allocation are two approaches to the exclusive-use concept. Spectrum property rights allow the owner of the spectrum to sell and exchange it, as well as choose the technology of their choice. By utilizing the spatial and temporal traffic statistics of various services, dynamic spectrum allocation enhances spectrum efficiency. The DRiVE (dynamic radio for IP services in vehicular environments) project, funded by the European Union, is a typical example of dynamic spectrum allocation. It enables spectrum-efficient automotive multimedia services by combining cellular and broadcast technologies [6]. The common-use model is an open sharing system in which all users have access to spectrum. Wi-Fi and the ISM band (Industrial, Scientific, and Medical) are examples of the common-use paradigm. The shared-use model employs spectrum underlay and overlay techniques.

2. RELATED WORK

Ghada Hatem et al. [15] devised a resource allocation system in which each secondary user can send and receive a variable amount of packets during each time slot. The scheduling strategy used here boosts throughput while lowering average packet latency for the secondary user. The primary user experiences a slight delay, and the spectrum underlay model is applied. In cognitive radio networks, cross-layer design is accomplished by concurrently optimizing spectrum sensing, access decision, physical layer modulation and coding scheme, and data link layer frame size [16]. In a centralized cognitive radio network, the lower layer design parameters are adjusted together to maximum TCP throughput. In the work [17], the author describes about the cross-layer distributed control algorithm (DCA) that optimizes routing, medium access, and physical layer functions to produce stable and high-capacity wireless communication networks in smart grids. According to the priority of classes, the DCA maintains service assurances in terms of dependability, latency, and data rate for each flow.

3. PROPOSED CO-OPERATIVE RESOURCE ALLOCATION TECHNIQUE

Recently, several papers have focused on cooperation-based spectrum sensing, which takes advantage of the network's intrinsic variety and has been found to enable significantly superior detection of the principal user. Because of the independence of elements such as noise and varying channel gain, which affect the signal received by a secondary user, this diversity emerges. Spatial diversity, temporal diversity, and frequency diversity are all examples of diversity. The measurements of numerous secondary users are pooled and reviewed together in a cooperation-based spectrum sensing system to determine the presence of the major user. When compared to the case where each cognitive user fails individually, the likelihood that all cognitive users fail to recognize the presence of the primary user when present is substantially lower. Several collaboration approaches have been proposed to improve the detection process's resilience. There are two types of cooperative schemes: 1) those that use hard decisions and 2) those that use soft decisions. Individual cognitive radios make judgements on the primary user's existence, and the final decision is produced by fusing these decisions from individual cognitive users. In the case of soft decisions, the decision is decided by comparing the measurements taken by individual users rather than the individual users' decisions. Soft decision making, as opposed to hard decision making, has been found to produce substantially superior results [10].

3.1. Multipath Diversity Routing

To distribute load and relieve congestion in the network, multipath routing is proposed as an alternative to single shortest path routing. Traffic heading for a destination is split across numerous paths to that destination in multipath routing. In other words, instead of using a single "best" path for routing, multipath routing uses numerous "excellent" paths. How many pathways are needed and how to locate these paths are two critical problems in multipath routing. The number and quality of pathways used clearly influence the performance of a multipath routing strategy. There are various reasons why reducing the number of pathways used for routing is desired. For starters, constructing, maintaining, and pulling down routes has a large overhead. As the number of paths increases, the complexity of the strategy that distributes traffic among several paths increases significantly.

4. PERFORMANCE EVALUATION

In this section, we will go through the fundamentals of resource allocation in CRN with cooperative communication and/or multiple-antenna capabilities.

4.1. Relay assignment/selection

Relays in a CRN can be beneficial in two ways. First, it can boost the transmission rate, and second, it can lower the overall transmission power of the systems by using relays. A cognitive radio network's performance can be improved even more by using many relays at the same time. In two ways, a well-designed multiple relay assignment and power allocation method can be useful. It lowers the disturbance caused to primary users in multiuser CRNs and improves wireless network connectivity. If one of the relays in a multiple relay system is dead or in deep fade, the receiver can still receive data from the remaining relays.

4.2. User scheduling

Due to resource constraints and interference constraints in multiuser CRNs, intelligent user scheduling mechanisms can achieve high performance. To maximize total throughput, user scheduling algorithms choose the optimal set of users for each time slot. With the number of users, the complexity of an exhaustive search for user scheduling grows exponentially. For example, if K is the total number of users, then the number of scheduling/selection options for k users is $\binom{K}{k}$. It is computationally inefficient to list all possible combinations in order to discover the one that offers the best results. Because optimal selection is computationally complex (e.g., exhaustive search algorithm), effective user scheduling in cooperative CRN is a hot topic of research.

5. EXPERIMENTAL RESULTS

Binary Linear Programming (BLPNumber)'s of Channels and Network Throughput, as well as the suggested CSA scheme. The suggested cooperative scheme's performance is shown in red, whereas the BLP's performance is shown in blue. The performance of Network Throughput gradually improves as the number of channels grows. When comparing the proposed CSA scheme to the BLP, the comparison graph clearly shows that the proposed CSA scheme outperforms the BLP.

6. CONCLUSION

Because of the many variables in cognitive radio networks, such as node location, energy, and more functioning frequency bands, real-time dynamic control network situations are extremely hard. The majority of current research is based on static modelling optimization calculations, which has limited usefulness. To address these issues, this paper proposes a routing strategy based on the color chart of a cross-layer routing algorithm, a network topology coloring algorithm to distinguish between the number of available frequencies, and update rules to dynamically adjust the network topological structure, ensuring minimal interference of neighbor nodes while increasing network throughput.

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