Performance of Energy-Efficient Spectrum Access in Cognitive Radios Network

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Abstract: In the next generation of cognitive radio networks, many secondary users will share spectrum resources with primary users. Since it is impossible to meet all communication speed requirements as long as the communication speed of the primary user can be guaranteed, are there many support sets for the secondary user? In this article, we study the maximum possible set of as many secondary users as possible under the constraints of power budget and communication speed in cognitive radio networks. In this interesting issue, the existing literature usually deletes some secondary users so that the remaining users reach the threshold below communication speed and power budget. However, when there are a large number of unsupported help users, the deletion algorithm will cause more interference. We use the spectrum radius of the network function matrix as the entry price to access new secondary users. We then designed a hybrid access control algorithm to reduce the interference time and approximate the maximum network capacity. In addition, although all users need higher communication speeds, different support sets and even the same network capacity will produce different energy efficiencies. Numerical results show that our algorithm provides good energy efficiency while limiting the communication speed.

Key Words –Cognitive Radio, Wireless Communication, DPCAlgorithm, Enery Efficiency.

I INTRODUCTION

Cognitive radio is a type of wireless communication in which the transceiver can intelligently distinguish between the used and unused communication channels and move into the unused channel while maintaining a strategic distance from the occupied channel. This can improve the use of the available radio frequency spectrum, while minimizing interference to other users. This is an ideal model for wireless communication, where the transmission or reception parameters of the system or node are changed to avoid communication interference with licensed or unlicensed clients. [3] RF spectrum is a limited characteristic asset, divided into spectrum bands. Over the last century, spectrum has been allocated to various services such as mobile, fixed, broadcast, fixed satellite and mobile satellite services.

As the entire frequency band is currently allocated to different services and in most cases operating licenses are required, the key problem for future wireless systems is finding appropriate transport frequencies and bandwidths to meet the expected demand for future services. [1] As cognitive radio is used as part of various applications, the spectrum sensing area becomes more and more important.

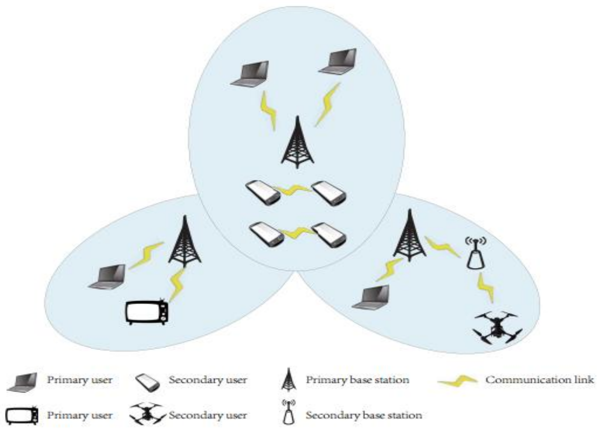

Fig 1 cognitive network

As cognitive radio technology is used to provide a more efficient way to use spectrum, spectrum detection is the key to this application. The ability of the cognitive radio frame to acquire spare parts of the radio spectrum and to continue observing the spectrum to ensure that the cognitive radio frame does not generate any unnecessary interference depends entirely on the spectrum recording component of the frame. To enable the whole framework and provide the required changes in spectrum efficiency, the cognitive radio spectrum sensing framework must have sufficient capabilities to fully identify some other transmissions, distinguish between what they are and inform the Central Preparatory Department of the Cognitive Radio for Necessary Measures to be taken . After Mitola termed the term "cognitive radio", its definition also grew with increasing interest in CR research. Regulators, famous researchers and forums define it in different ways. According to Mitola [3], CR is defined as the point at which wireless personal digital assistants (PDAs) and related networks have sufficient computational intelligence in radio resources and related computer-to-computer communications to: (b) provide the most suitable for these need Radio resources and wireless services. However, the term CR is not strictly limited to wireless devices such as PDAs.

According to Mitola, CR is a smart radio and it recommends detecting available channels to improve spectrum utilization by changing its transmission parameters. CR can observe from the radio frequency environment, learn and adapt to environmental conditions for efficient spectrum detection.

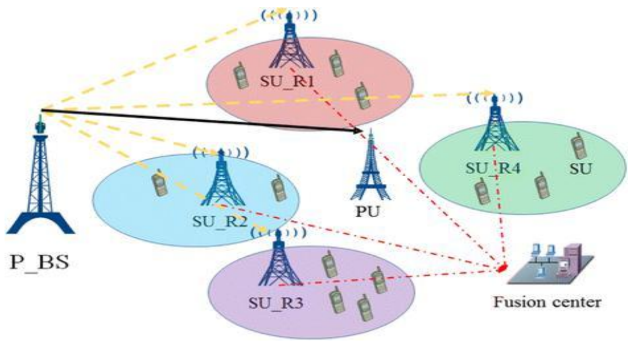

Figure 2 Centralized Cooperative spectrum sensing

The Fusion Center makes spectrum utilization decisions based on the observations received. The decision is made through a soft or hard combination of and-or-logical rules. According to Figure 2, non-cooperative detection methods are divided into matched filter detection (MFD), energy detection (ED) and cyclostationary function detection (CFD). In the non-cooperative detection method, no fusion center can be used for decision making, and each channel or node makes independent decisions. In the collaboration detection method, all channel or node information is provided to the fusion center and identified according to user availability. Therefore, compared to the cooperative detection method, the decision speed of the non-cooperative detection method is faster. The different types of non-cooperating detection methods are described below.

II RELATED WORK

The electromagnetic spectrum is a very valuable natural resource, but its use is regulated by the government through licensing agreements. Some institutions have conducted serious studies on the current use of the radio frequency spectrum, and the results show that certain frequency bands have become widespread. Other frequency bands are only partially recorded, while most of the frequency bands in the spectrum are still available [1]

By giving secondary users access to spectrum holes that are not occupied by the primary (licensed) user at the correct location and time, the frequency utilization rate can be significantly improved. Cognitive radio, including software-defined radio (SDR), has been proposed as a means of promoting efficient use of spectrum by exploiting the existence of spectrum gaps.

Literature [2] first suggested the use of cognitive radio, including SDR as a possible technology, to achieve flexible and efficient spectrum use. The term cognitive radio is derived from "cognition" and provides a three-point computer view defined in the "Computer Encyclopedia"

Mohammad Soleymani et.al (2019) False Gaussian Signaling (IGS) has been used as an effective interference management tool in interference-limiting systems. The Gaussian signal is incorrectly related to its complex conjugate. In this article, we study the optimality of IGS from an energy efficiency perspective (EE). First, we obtain the closed shape optimization condition for IGS. We then use these conditions to design a dichotomy that can find the best transmission parameters. Our results show that IGS can improve EE in the underlying cognitive radio system. [7]

Mahdi Zareei et al. (2019) The rapid development of wireless sensor technology has led to some interesting applications. Given the small power capacity of the sensors, energy harvesting is an inevitable way of extending the life of the sensor nodes. This paper proposes a distributed transmission control mechanism for energy harvesting of cognitive radio sensor network (EH-CRSN). The main concept is to dynamically adjust the transmission power of nodes according to the network conditions to maintain network connection. Each node decides to dynamically increase or decrease its transmission power based on several parameters (such as its available power and the available power of neighboring nodes). This dynamic transmission power adjustment can change network logic topology to better adapt to the power conditions of the network. Transmission power management was tested in two cases; flat network and cluster network. A large number of simulation results show that we can improve the end-to-end performance of networks using the proposed transmission power control method. [8]

Liu Boyang et al. (2019) The traditional MEC (mobile edge computing) method always assumes that the wireless device (WD) can read its data to the base station (BS) or the access point (AP) at any time, and this is not due to the large number of WD ' is and the limited There are tensions between the spectrum resources, so it is very convenient. This paper proposes a framework for a Cognitive Radio Network (CR) that supports MEC, which integrates three technologies: MEC, CR, and Wireless Power Transmission (WPT). To obtain the spectrum for reading, cooperative forwarding is considered. An optimization problem is proposed to examine the upper limit of WD energy efficiency (EE) and maximize the actual EE in the local unloading and local calculation schemes, which are non-convex and difficult to handle. To solve these problems, a two-step method is proposed. The transmission power of WD, energy harvest time (EH) and MEC and frequency of central processing unit (CPU) are optimized together.

Using fractional programming theory, Lagrangian double decomposition and continuous pseudo-convex [9], a semi-closed solution is obtained during partial dissolution.

III PROPOSED SYSTEM

Cognitive radio (CR) is considered to be one of the most promising technologies in future wireless communication. In a cognitive radio network, cognitive users can access free licensed spectrum for the main user to improve spectrum efficiency. In addition, cognitive users can adjust their transmission parameters through spectrum recording to reduce interference.

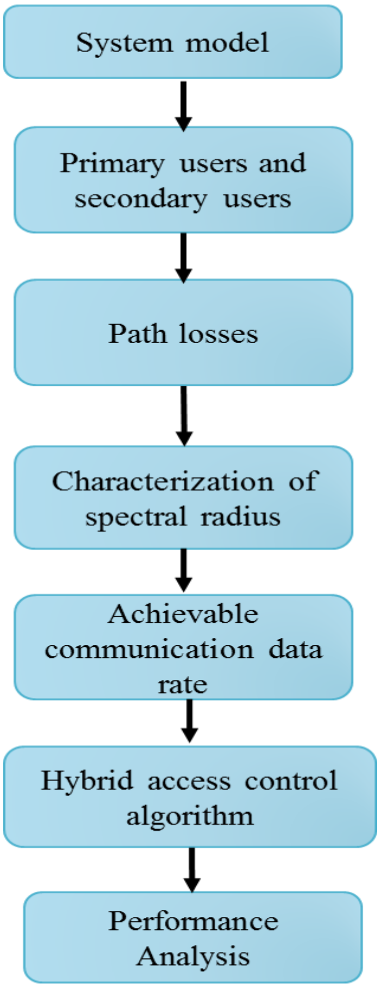

Fig 3 Proposed System Model

Recently, mobile networks integrated with cognitive radio have attracted much attention. First, for mobile networks, it can work on the licensed cellular spectrum to integrate seamlessly with mobile networks. Therefore, the problem of insufficient spectrum has become more serious due to busy business and a limited spectrum of mobile networks. In the proposed system, a centralized two-tier network architecture with a macro BS and multiple FAPs, where FAPs are rolled out by indoor users and connected to the macro BS through the cable backhaul (such as cables and optical fibers). Compared to Wi-Fi, FAP operates on the licensed cellular spectrum and uses mobile standards to seamlessly integrate with mobile networks. In addition, the same spectrum coverage model is used in this system. In the spectrum-based recognition, FAP equipped with CR technology can dynamically detect the channels used by the macrocell and the surrounding cells, and record the spectrum gaps in the licensed cellular spectrum, thus avoiding interlayers across and interference between the layers. Macrocell and surrounding cells.

IV RESULT DISCUSSION

We initialize the same network parameters as in the scene. In a single cell channel, a user is indexed by 1 and four secondary users, and the distance vector d = [310, 540, 640, 880, 950]> m. The communication speed vector vector for these five users is r = [0.3364, 0.2623, 0.3001, 0.2231, 0.2231] >. Algorithm 2 uses the distributed deletion algorithm that eliminates user 3 to achieve the same supported secondary users so that the remaining users meet their communication speed requirements. In another case, for a general network with heterogeneous loss of path, we compare our algorithm with the centralized deletion algorithm. There are four main users who communicate in a viable cognitive radio network. Their transmission threshold and communication speed requirements are set to the same. At the same time, six secondary users tried to access the channel. When the cognitive radio network gives A = {5, 6, ..., 10} for all ten users, the maximum spectrum radius $\rho = 0.4956 < 1$. We use algorithm 1 to find out that the network is not possible, that is, it can not satisfy all ten users at the same time. On the contrary, according to the centralized deletion algorithm, the network becomes possible after the elimination of three secondary users $B * = \{8, 10, 5\}$. Listing the corresponding spectrum radii for these three secondary users is necessary in Algorithm 2. Interestingly, the descending order of spectral radius is the same as the elimination order of the elimination algorithm. Our hybrid algorithm achieves the same set of unsupported help users $B * =\{5, 8, 10\}$.

In general, power management is used to meet communication speed requirements and provide appropriate energy efficiency for cognitive radio networks. Traditional power control algorithms work well in sustainable wireless networks. However, due to the exponential growth of wireless terminals, it is impossible to meet the communication requirements of all users at the same time. In this case, the cognitive radio network is not possible, which means that some secondary users transmit with their maximum possible power, but they still can not meet their communication speed requirements due to excessive interference. When the cognitive radio network is not possible, the existing power control algorithm may be unstable or divergent. In particular to ensure the communication quality of the largest users,

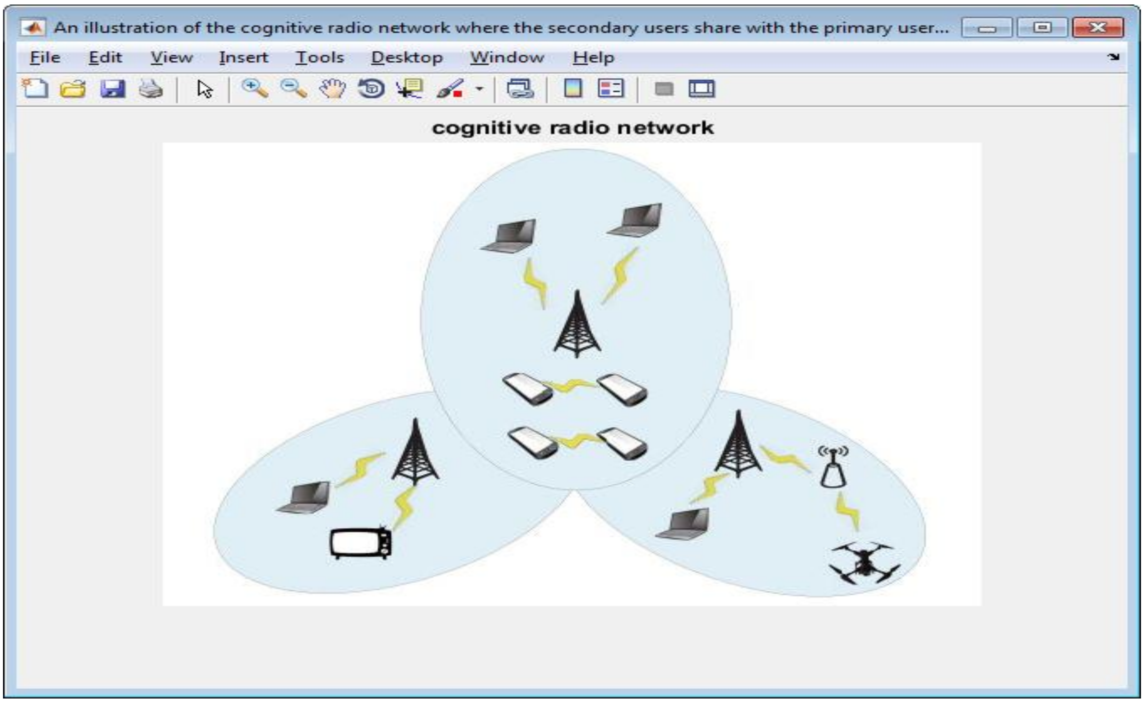

Figure 4: An illustration of the cognitive radio network where the secondary users share with the primary users in the underlay manner.

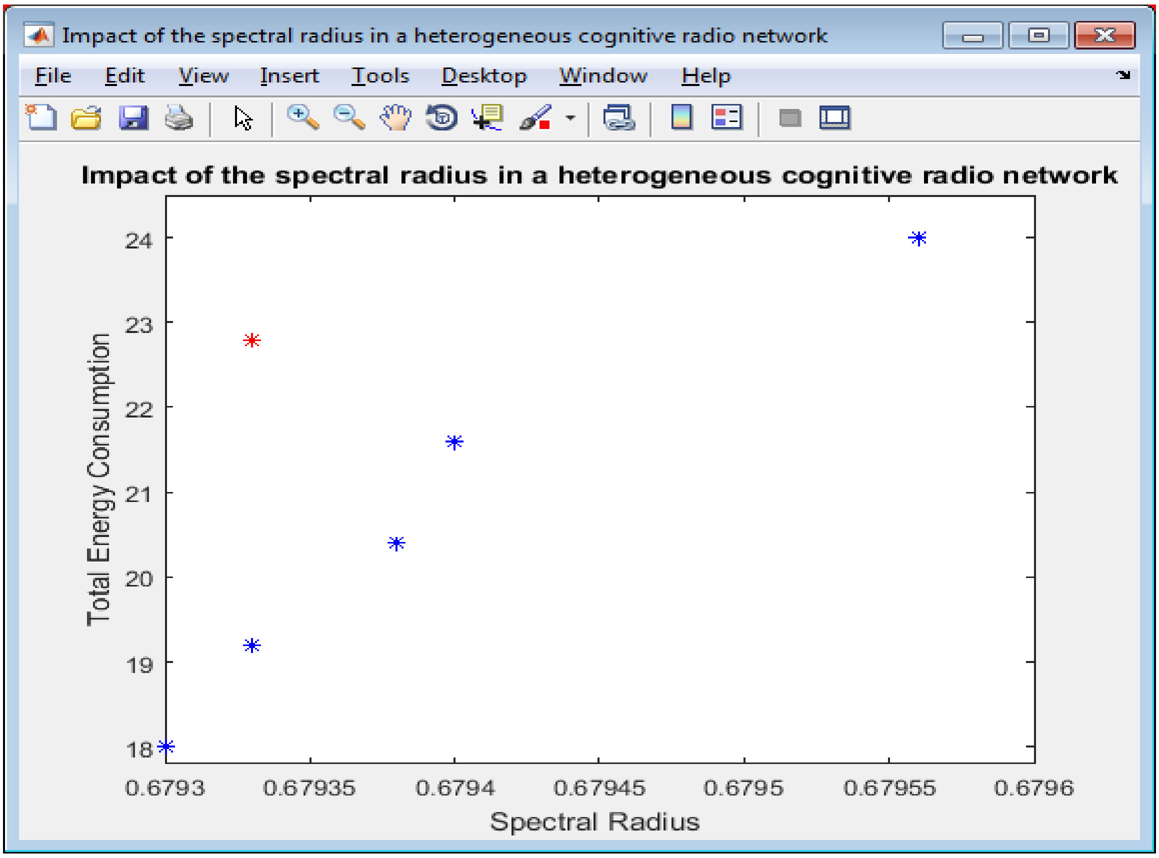

Figure 5:An illustration of the disorder impact of the spectral radius in a heterogeneous cognitive radio network. The red point denotes the disorder impact of the secondary user

Figure 4 shows that the selected user with lower energy consumption may not be the secondary user leading to the smallest spectral radius, such as the red case. However, the trend between energy consumption and spectrum radius for heterogeneous cognitive radio networks is the same as for similar networks.

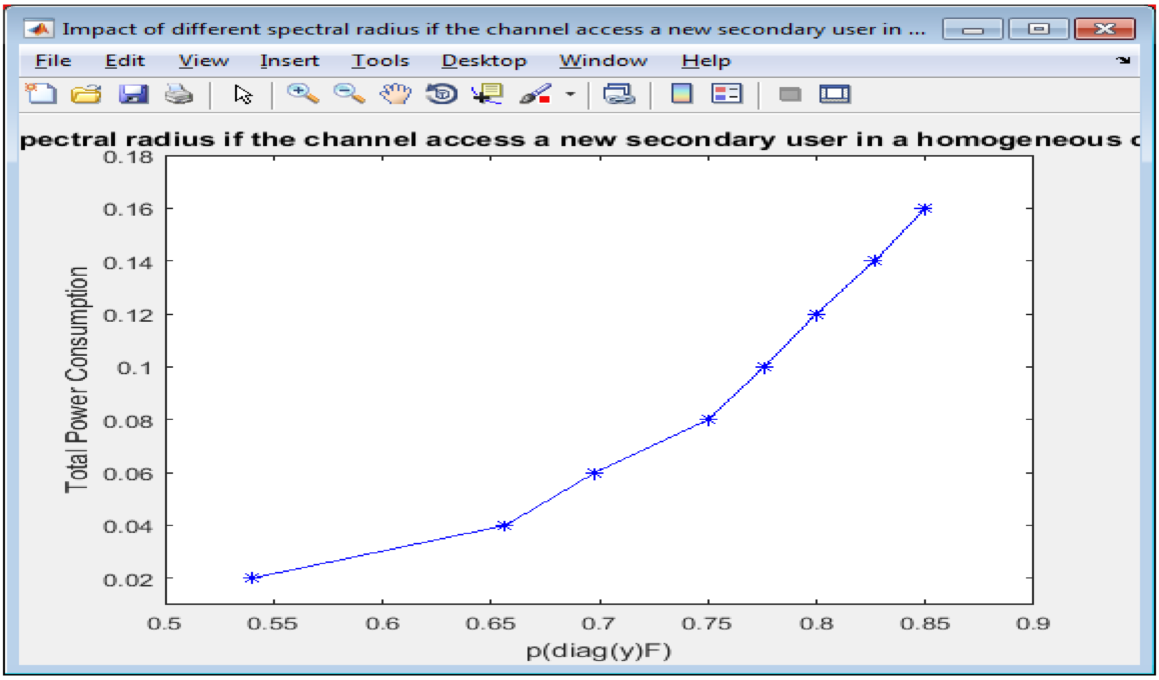

Figure 6:An illustration of the impact of different spectral radius if the channel access a new secondary user in a homogeneous cognitive radio network.

In this section, we analyzed the relationship between spectrum radius and power consumption. Depending on the price of the spectrum radius, different from secondary users are deleted. On the contrary, due to the large number of waiting auxiliary users, we are adding new auxiliary users to the already feasible cognitive radio network based on spectrum radius. Intuitively, we allow the other user to cause the smallest spectral radius after adding the j-th user, namely ρ (diag (ērj-1) F). Note that ρ (A) ≤ρ (B) ≤ of non-negative matrix A B is based on non-negative matrix theory. Therefore, the selected auxiliary user depends on the corresponding transmission distance and communication speed requirements. First, we prove the spectral radius characteristics of the homogeneous network, that is, the price loss is the same, that is, Gij = Gjj. In a cognitive radio network with a distance of d = [300, 530, 740, 860, 910]> m, there are a total of five users sharing the same channel. Each record represents the distance between the recipient and the corresponding sender. The communication speed requirement vector is r = [0.2, 0.1, 0.2, 0.1, 0.1]>. It is assumed that the noise σ from all receivers is the same, which is 1 × 10-15W

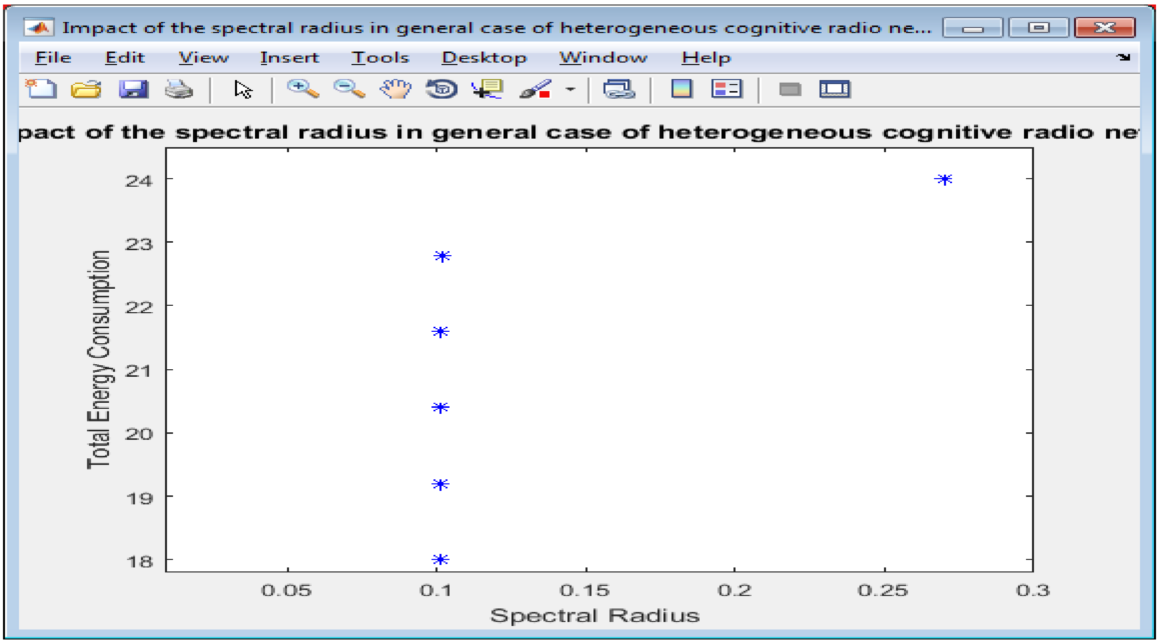

Figure 7 : An illustration of the normal impact of the spectral radius in general case of heterogeneous cognitive radio network

We then calculate the spectrum radius by successively trying to add an auxiliary user. The figure shows that when the spectral radius ρ increases, the total energy consumption is almost exponential.

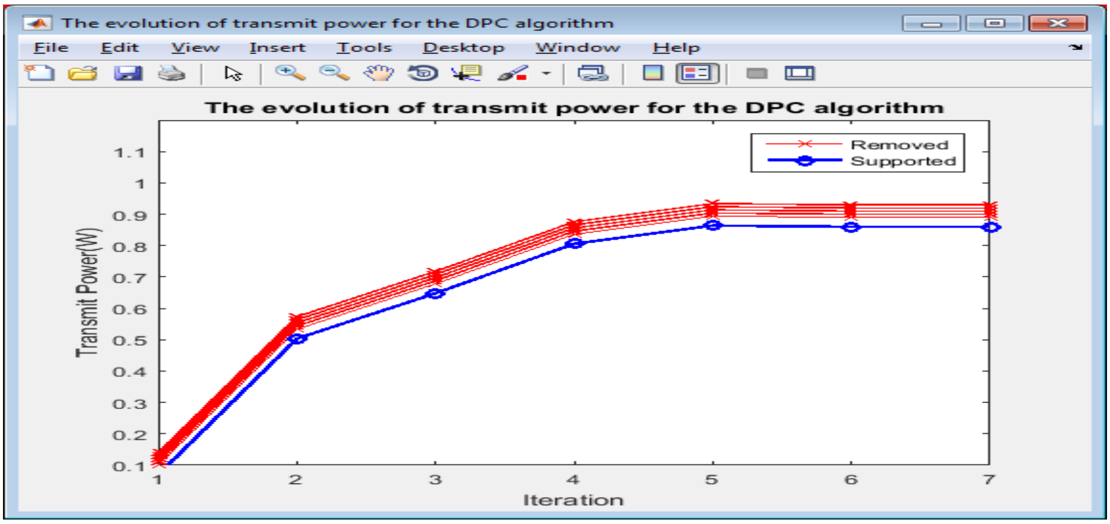

Figure 8: The evolution of transmit power and individual energy efficiency for our algorithm. The blue lines are the seven supported users

We compare the hybrid algorithm with the limited DPC algorithm, so the network has a more general channel gain Glj 6 = Gjj when all l 6 = j. We are considering a network with 2 primary users (which cannot be deleted) and 8 secondary users. Channel gain is generated randomly

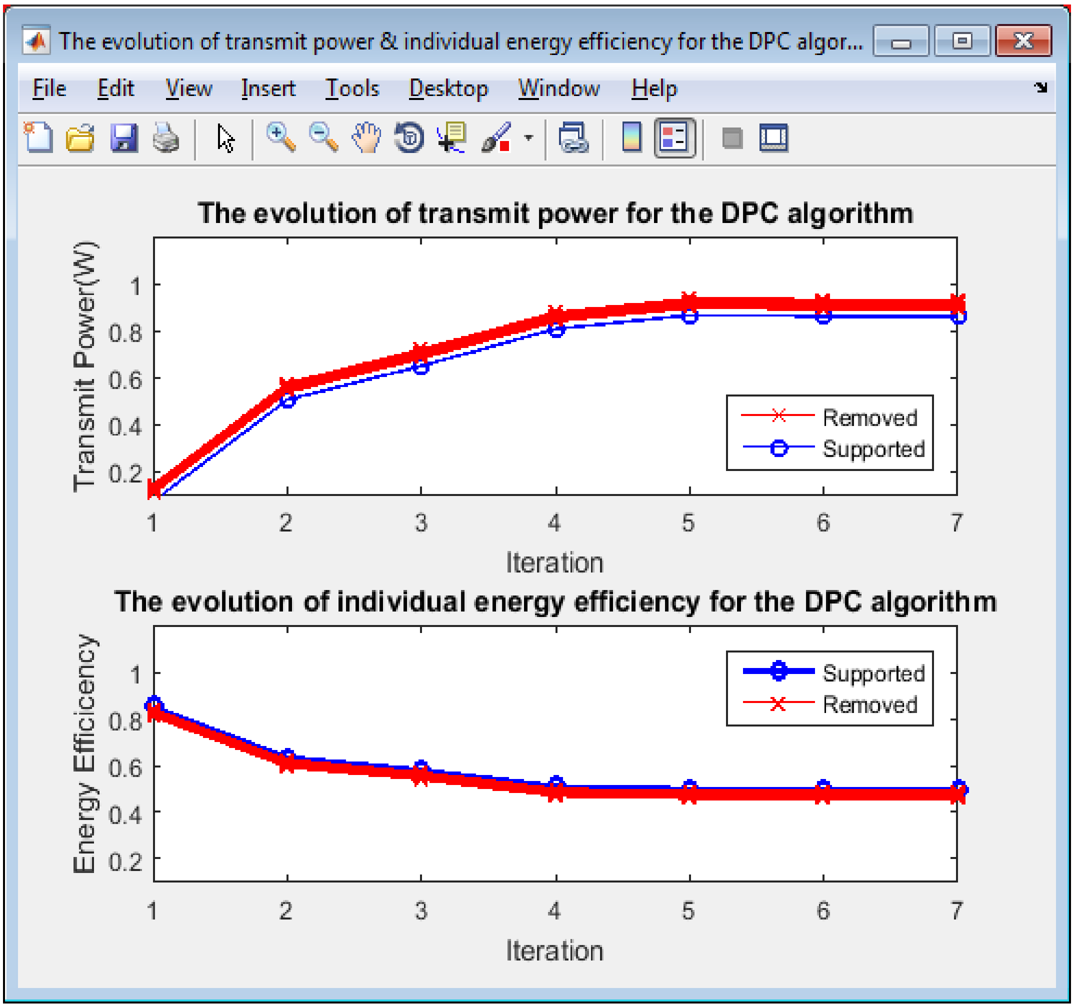

Figure 8: The evolution of transmit power and individual energy efficiency for the DPC algorithm. The blue lines are the two supported users. The red lines are the eliminated secondary user

Figure 8 shows the development process of the DPC algorithm, where eight secondary users transmit at their maximum power but have not yet reached the speed threshold. Once these secondary users are deleted, the remaining two primary users can reach their speed thresholds. Figure 7 shows the development of our hybrid algorithm. After iterative deletion of the {3,5,10} user (ie the secondary user) a total of seven users can reach their speed threshold. Compared to the DPC algorithm, our algorithm increases system capacity from 20% to 70%. At the same time, using the following criteria, the average energy efficiency of the DPC algorithm is 0.4176, and one of our algorithms is 0.4668

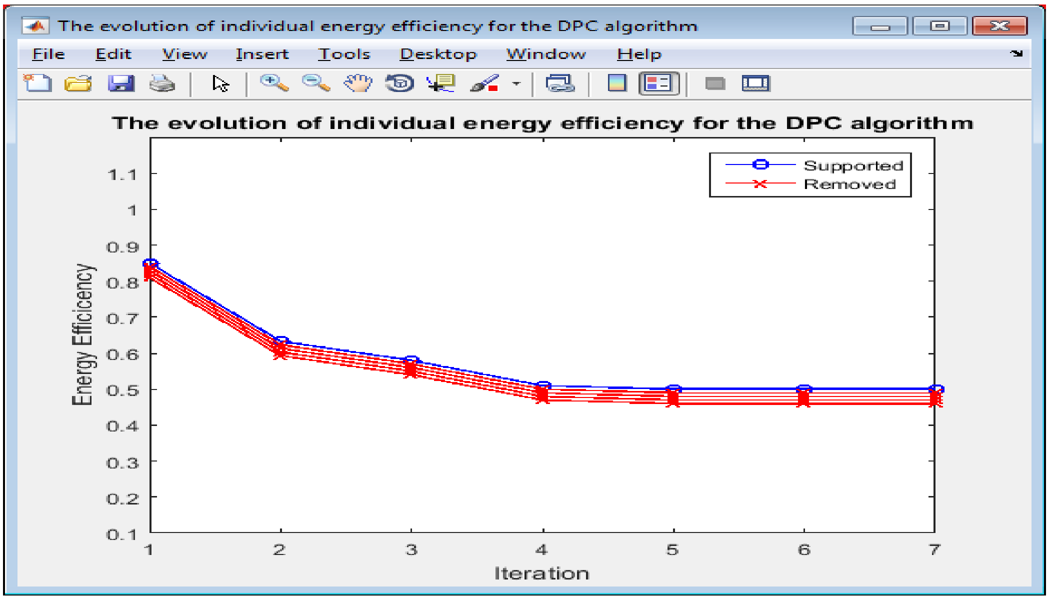

Figure 9: The evolution of transmit power and individual energy efficiency for our algorithm. The blue lines are the seven supported users. The red lines are the eliminated secondary user.

In another case, for a general network with heterogeneous loss of path, we compare our algorithm with the centralized deletion algorithm. There are four main users who communicate in a viable cognitive radio network. Their transmission threshold and communication speed requirements are set to the same. At the same time, six secondary users tried to access the channel. When the cognitive radio network provides services to all ten users, the data transmission rate for algorithm 2 is higher than for the DPC algorithm under the same energy situation. In other words, if the algorithm 2 and the DPC algorithm have the same data transmission speed constraints, the algorithm 2 can save more energy than the DPC algorithm. The main reason is that the DPC algorithm excessively eliminated secondary users based on the transmission power, but Algorithm 2 uses the access price to determine which secondary user is the worst. We also compared our solution with the solution obtained through algorithm 1, which eliminates users and thus minimizes theminimum possible data transfer rate, and both achieve the same solution.

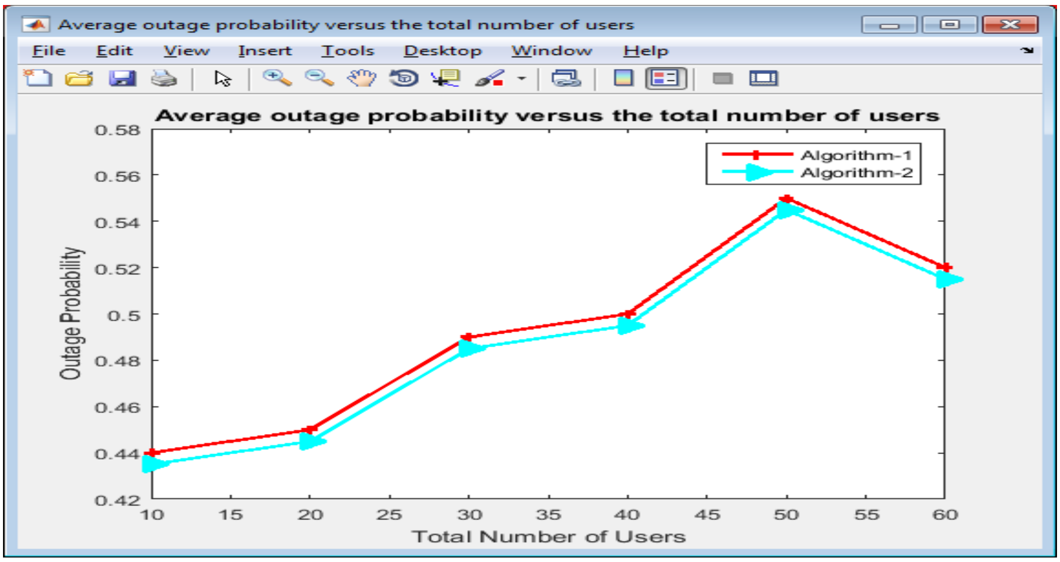

Figure 10: Average outage probability versus the total number of users. The lower bounds of all the communication rate requirements are set to be the same

The primary users are randomly chosen 10% from all the users. The rest of users are regarded as the secondary users. All the power budgets are set the same

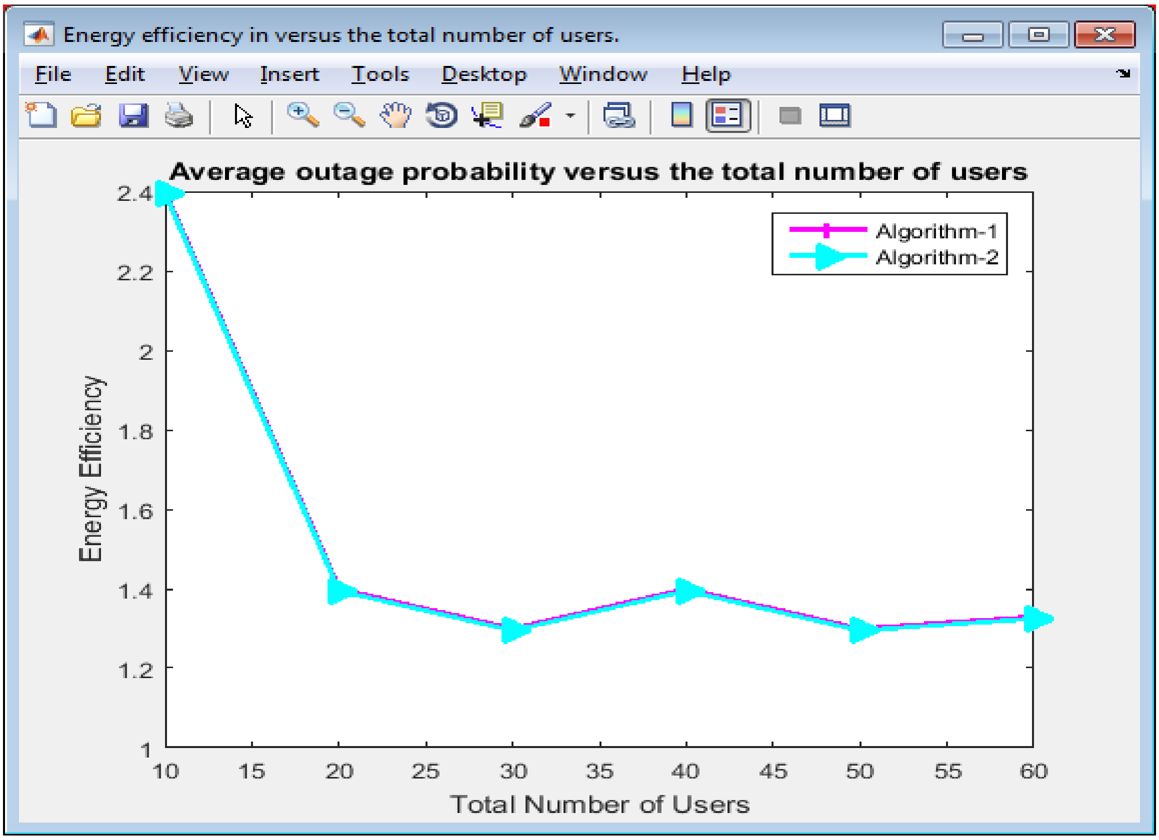

Figure 11: Energy efficiency in (14) versus the total number of users

Example 3: Be aware that different algorithms may have different sets of supported help users because the maximum possible set is probably not unique. Based on the Monte Carlo (MC) method of at least 200 MC runs, we have now compared different algorithms based on the probability of failure and energy efficiency.

V CONCLUSION

Under the constraints of power budget and communication speed requirements, we studied the network capacity of the next generation of cognitive radio networks with a large number of auxiliary users. We show that iterative visits to auxiliary users with short transmission distances and requirements for low communication speeds should be based on the characteristics of the spectrum radius. We then propose a decentralized power management algorithm to check the possible status and design a hybrid access control algorithm to reduce the interference time. Numerical evaluation shows that our algorithm is well integrated with the existing removal algorithm and it has converged to an almost optimal solution in terms of maximizing support of secondary users and high energy efficiency. It approved the hybrid access strategy rather than the random access strategy. In future work, we will expand these cost-driven algorithms to include common spectrum access for primary and secondary users, and we will consider the impact of different weights on the algorithm's performance.

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