INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN ENGINEERING (IJITE) ISSN: 2395-2946
ISSUE: 94, VOLUME 70, NUMBER 01, OCTOBER 2020

A Review on Energy-Efficient Spectrum Access in Cognitive Radio

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Abstract: In cognitive radio sensor networks (CRSNs), the sensor devices which are enabled to perform dynamic spectrum access have to frequently sense the licensed channel to find idle channels. The behavior of spectrum sensing will consume a lot of battery power of sensor devices and reduce the network lifetime In the next-generation cognitive radio networks, numerous secondary users will share the spectrum resource with the primary users. As it may not be possible to support all the communication rate requirements, there are many supporting sets for the secondary users as long as the communication rates of the primary users are guaranteed? In this paper, we study the maximum feasible set problem to access as many secondary users as possible, under the constraints of power budgets and communication rates in cognitive radio networks. In this interesting issue, the existing literature generally removes a subset of the secondary users so that the remaining users achieve the thresholds with communication rates and power budgets. However, the removal algorithms cause more interference when there are plenty of unsupported secondary users. In this work leverage the spectral radius of the network characteristic matrix as the admission price to access the new secondary user. Then, will design a hybrid access control algorithm to reduce the interference time and approximate the maximum network capacity. Moreover, different supported sets produce the different energy efficiency, even having the same network capacity, while all users require the high communication rates. Numerical results demonstrate that our algorithmswill provide the decent energy efficiency under the communication rate constraint the simulation will be perform on MATLAB simulation

Key Words –DPC algorithm,Enery Efficiency Cognitive Radio, Wireless Communication,

I INTRODUCTION

Cognitive radio is a type of wireless communication where a transceiver can intelligently distinguish the channels for communication which are being used and which are not being used, and move into unused channels while maintaining a strategic distance from occupied ones. This enhances the utilization of available radio-frequency spectra while interference is minimized to other users. This is an ideal model for wireless communication where transmission or reception parameters of system or node are changed for communication dodging interference with licensed or unlicensed clients. [3]The radio frequency spectrum is a limited characteristic asset that is divided into spectrum bands. In the course of the most recent century, spectrum bands have been apportioned to diverse services, for example, mobile, fixed, broadcast, fixed satellite, and mobile satellite services.

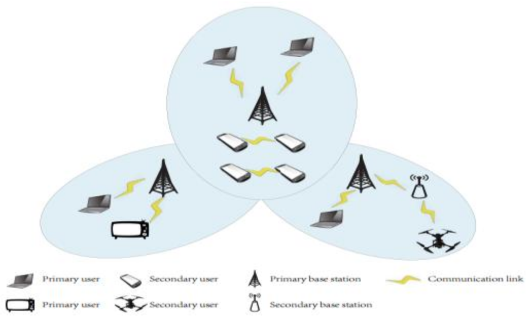

Fig 1 cognitive network

As the entire spectrum bands are as of now dispensed to diverse services, most often requiring licenses for operation, a crucial issue confronting future wireless systems is to discover suitable carrier frequencies and bandwidths to take care of the anticipated demand for future services. Traditional wireless sensor networks (WSNs) have been an attractive area of research since last decade and usually operate on the license-free industrial, scientific, and medical (ISM) band. However, as the number of wireless devices and applications has seen explosive growth over the past few decades, there has been increasing pressure on the limited spectrum resources [1, 2]. Moreover, the improvement in throughput of wireless networks largely depends on the utilization of channels [3]. In this situation, the concept of cognitive radio (CR) has emerged to alleviate the scarcity of limited radio spectrum resources by improving the utilization of spectrum resources [4]. The CR is a dynamically programmable and configurable radio that opportunistically uses an idle licensed channel in its vicinity to address the problem of unlicensed spectrum resources shortage and the underutilization of the licensed spectrum resources [5, 6]. Such a radio can be applied in the existing network technologies, like wireless sensor networks, machine to machine networks, wireless body area networks, etc., enabling the PHY (PHYsic) and MAC (Media Access) layers of the devices to automatically and dynamically detect available channels and then accordingly change their transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band. As a specific application of the CR technology, cognitive radio sensor network (CRSN) is recently regarded as one of the most attractive topics in IoT paradigms [7].

Not the same as the traditional WSNs [8–12], CRSNs operate on licensed bands, periodically sense the spectrums, and determine vacant channels. In order to achieve this, CRSDs (cognitive radio-enabled sensor devices) in CRSNs have to frequently sense the licensed channels to identify an idle one and detect the active state of primary users (PUs) signal with strictly limited interference to PUs [13]. On the other hand, different from CR networks [14, 15], CRSNs inherit the basic limitations of traditional WSNs of which the lifetime is strictly constraint due to energy limitations. In addition, spectrum sensing (SS) [16, 17] is a crucial element in the implementation of a CRSN, and energy consumption is also a major consideration in spectrum sensing. The more SUs that participate in spectrum sensing will result in higher energy consumption of the network and shorter network lifetime. For this reason, our goal is to improve the network energy efficiency by optimizing the number of spectrum sensing nodes (SSNs) that participate in spectrum sensing while still guaranteeing the spectrum sensing accuracy.

Moreover, it has been shown that cooperative spectrum sensing (CSS) can not only deal with multipath fading and shadow effects but also improve the accuracy of spectrum sensing [18–21]. The idea of CSS scheme is to use multiple SUs and combine their sensing results at a fusion center (FC). There are two possible CSS strategies: the first one is that all nodes perform CSS, and the second one is that some nodes sense spectrums. But if their performance is similar, the second one is obviously more suitable. To this end, there are some existing node selection methods in various works [3, 22–27]. Specifically, an optimal hard fusion strategy was proposed to maximize the energy efficiency in [22]. In [23], an optimal number of multihop-based SUs was derived. To minimize the total energy consumption, a closed-form equation and optimal conditions due to *KKT* were proposed in [24] to determine the SUs which sense the spectrum. An energy-efficient CSS was also proposed in [25] to solve the problem of sensing node selection. Taking into consideration the scenario when only partial information of SUs and PUs is available in [26], an energy-efficient SUs selection algorithm has been proposed to save energy and improve the detection performance. In [3], a correlation-aware node selection scheme was proposed to adaptively select uncorrelated nodes for CSS, because of the openness, dynamics, and uncertainty of wireless environment. Moreover, in [27], general criteria for decision-approach selection were analyzed and derived when there are actual channel propagation effects.

However, when the environment of network changes dynamically, fewer nodes cannot guarantee the accuracy of spectrum sensing, and more nodes involving spectrum sensing will increase the energy consumption of the network. Therefore, all of the above existing work cannot ensure the accuracy of spectrum sensing and less energy consumption at the same time. In addition, there is no efficient mathematical model which quantitatively describes the relationship between the number of SSNs and spectrum sensing performance.

[1]With Cognitive Radio being utilized as a part of various applications, the territory of spectrum sensing has become progressively vital. As Cognitive Radio technology is being utilized to provide a method for utilizing the spectrum all the more productively, spectrum sensing is key to this application.The ability of Cognitive Radio frameworks to get to spare sections of the radio spectrum and to continue observing the spectrum to guarantee that the Cognitive Radio framework does not create any undue interference depends totally on the spectrum sensing components of the framework. For the overall framework to work viable and to provide the required change in spectrum efficiency, the Cognitive Radio spectrum sensing framework must have the capacity to adequately recognize some other transmissions, distinguish what they are and inform the central preparing unit inside the Cognitive Radio so that the required actions can be taken. After Mitola coined the word “Cognitive radio” its definition is also growing as research interest in CR is increasing. Regulatory bodies, prominent researchers and forums define it in different ways. According to Mitola [3], CR is defined as the point in which wireless personal digital assistants (PDAs) and the related networks are sufficiently computationally intelligent about radio resources and related computer-to-computer communications to: (a) detect user communications needs as a function of use context, and (b) to provide radio resources and wireless services most appropriate to those needs. However the concept of CR is not limited strictly to wireless devices such as PDAs.

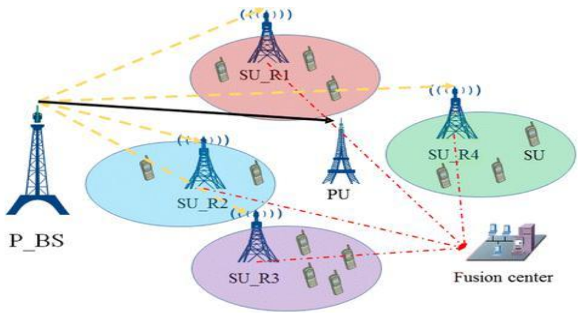

Figure 2 Centralized Cooperative spectrum sensing

According to Mitola, CR is an intelligent radio and it is proposed to detect the available channels to improve the spectrum utilization by changing its transmission parameters. From the radio frequency environment CR can observe, learn and can adapt to the environmental conditions for taking effective spectrum detection.

The fusion center provides decision about the utilization of the spectrum is based on the received observations. The decision is taken either soft or hard combining with AND or OR logic rules. From Figure 2 the Non- Cooperative detection methods are classified in to Matched Filter Detection (MFD), Energy Detection (ED) and Cyclostationary Feature Detection (CFD). In Non-Cooperative detection methods no fusion center is available for decision making and each channel or node is independent to take decisions.In cooperative detection methods all the channels or nodes information is given to fusion center and there by the user availability is identified .So compared to Cooperative detection method, Non cooperative detection method decision takes fast. The various types of Non Cooperative detection methods are explained as follows.

II RELATED WORK

The electromagnetic radio- frequency spectrum is a highly valuable natural resource, but its use is regulated by governments through licensing agreements. Careful studies on the current usage of the radio spectrum by several agencies reveal that some frequency bands are heavily used; other frequency bands are only partially occupied, while most frequency bands in the spectrum remain largely unoccupied [1]

Spectrum utilization can be improved significantly by making it possible for a secondary user to access a spectrum hole unoccupied by the primary (licensed) user at the right location and time. Cognitive radio, inclusive of Software-Defined Radio (SDR), has been proposed as the means to promote the efficient use of the spectrum by exploiting the existence of spectrum holes.

Cognitive radio, including SDR as the enabling technology, is suggested for the first time in [2] to realize a flexible and efficient usage of spectrum. The term cognitive radio is derived from “cognition” and provides a three-point computational view as defined in the Encyclopedia of Computer

B. Venkataramana et al. (2020) Wireless technology is rapidly spreading. Thanks to the use of wireless technology, devices such as laptops, PDAs and cell phones have become very important. Nowadays, there is also a huge demand for spectrum distribution, and the highest standards should be used effectively. Cognitive radio (CR) network is such a smart network, which aims to use the highest licensed channels for unauthorized users Cognitive radio can understand the spectrum without used in a specific place at a time. This application helps to ease interference with licensed users and improve network performance. The choice of navigation protocol is one of the major strategies in designing a wireless or cable network. In a cognitive communication network, the selected navigation protocol should be the best at setting up effective leads, addressing network topology challenges, and should be able to reduce bandwidth consumption. Analyzing the performance of our protocol helps in selecting the best of the network. The purpose of this research is to evaluate the effectiveness of various communication networks, such as the on-demand demand protocol (SORP) with or without black hole attacks, the mesh traffic (SAMER) and network dynamics. Source routing (DSR) uses a variety of different parameters through the NS2 simulator, such as throughput, delay, and packet transmission rate.

Avirup Das et.al (2019) With the advent of smarter technologies in mobile networks, the bands most commonly used in low-cost versions are often overlooked. To take advantage of this, in this work, we are proposing a new radio paradigm where self-regulatory networks (S) take advantage of the use of white space on existing mobile networks. Each SU can move freely, and can collaborate with other adjacent SUs in a self-organizing manner to collect channel data of large networks for cognitive use of licensed spectrum. The integrated technology for channel distribution in SU eliminates the need for central control and improves channel utilization and output. In order to improve the durability of the spectrum, we have further applied reinforcement learning technology to achieve better channel estimates. Simulation research shows that, compared to other existing methods, the methods we have proposed can improve the rate of call / block reduction, and can also provide better QoS, but at a lower cost additional messages not visible.

Murtaza Cicioğlu et al. (2018) Software Defined Networking (SDN) has introduced a new network structure as a solution to the resource management problem. Cognitive Radio Network (CRN) technology is a new dynamic access technology that can be used to a minimum. CR technology allows unlicensed secondary users to take advantage of mining in an exploitative manner without disturbing authorized first-time users. This article presents a new SDN-based network framework for CRN technology. The system uses dynamic spectrum entry (DSA) mechanisms to meet QoS requirements. In addition, the responsibility for managing resources is managed by the software, which manages the entire network from the center. In this way, the workload of network users and base camps is greatly reduced. This architecture reduces dependence on base camps and provides an independent distribution of infrastructure resources for BR users.

V. Noel Jeygar Robert et.al (2018) The ISM (Industrial Science and Medicine) wireless network (WSN) often suffers from infinite problems due to multiple channels, and consumes a lot of energy to transmit data. To use the spectrum more effectively, cognitive radio technology has been integrated into wireless communication networks. Networks called cognitive radio and wireless networks create new words, that is, cognitive radio networks, which can use the spectrum more effectively by accessing licensed channels. . However, to support cognitive radio (CR) such as channel detection, transmission and signal access to wireless network sensors, the task is more difficult because CRSN consumes more energy. To address existing problems, this work has developed a new system that can effectively access CRSN channels to improve energy utilization. Based on the functionality and capabilities of cognitive radios, this work explores further how nodes can transmit channels from groups that often have ISM communication channels depending on the rate of non-existing channels license to improve energy. This function provides efficient channel access and exchange systems for internal and external data transfer within the CRSN. The results of the proposed algorithm show that the rate of energy consumption of CRSNs decreases.

K.S. Preetha et.al (2019) In today's world of communication, uninterrupted communication is essential and sought after. Cognitive radio technology plays an important role in this. Cognitive radio technology finds ways to make better use of these channels and improve the quality of service by examining first-time and cognitive / low-user users, and sharing existing networks. We reviewed the results of the limited transfer delay and compared it to reviewing the remaining hours. The results of the duration of the craft and the allocation of time remaining to the presentation of the show are also discussed. The answer is given to accept the same answer.

I. Ngomane et.al (2018) Cognitive radio technology poses the challenge of solving the lack of diffusion by allowing unauthorized cognitive devices to take advantage of the spectrum allocated to licensed devices. . However, the advent of this technology has created a variety of attacks on cognitive radio devices, one of which is the general perception of data manipulation attacks. In the midst of the disruptive abuse of energy attacks, destructive devices share inappropriate signals on other radios. This paper examines data attacks that interfere with network attacks. We use modified Z tests to isolate network outliers. Applying the Q-out-of-m rule plan can mitigate data prevention attacks, in which the m number is not selected from the sensory response, and Q is the final decision of m. The plan does not require Fusion Center services to make decisions. This article has led to theoretical analysis of the proposed proposals.

IoannaKakalou et al. (2019) introduced the Radio Environment Map (REM) as a radio communication network as a powerful tool for managing interference between transmitters. With the development of the heterogeneous 5G environment, Rem has been forced to evolve into a more powerful device to meet the diverse needs of large networks. This article validates REM and offers improved Rem horizontal for integration into 5G networks.

GrigoriosKakkavas et.al (2020) Network communication systems that support software-defined radios (SDRs) are expected to play an important role in future 5G networks. Despite the growing interest in research, the current application is small and provides limited use. In this article, we have contributed to mitigating the limitations of SDR distribution by promoting and evaluating the way resources are distributed through the waveforms applied through SDR technology to ' the two ORCA test platforms. The resource allocation is based on the Markov Random Field (MRF) system, which implements cross-layer computing for auxiliary nodes in a network. The implementation of the proposed plan includes a separate model developed on GNU Radio, which applies the functions, such as the sense of exploitation, the perception of conflict, etc. We demonstrated the feasibility of sharing MRF-based resources and provided extensive feedback and performance analysis, highlighting key factors to consider. The latter provides a useful insight into the strength of our project, and at the same time points to the technical barriers that are currently causing concern.

Rupali Sawant ; et.al (2020) With the growing demand for wireless communication services, cognitive radio and collaborative technologies have been used to effectively use radio resources. The efficient allocation of resources (electricity and distribution) to a co-operative cognitive radio network (CCRN) includes a reduction in average transmit power, reduced internet access and retention of quality of service (QoS). Evaluate the performance indicators of the communication networks by calculating the potential for disconnection. This paper presents a model of analysis in calculating the potential for CCRN outages. Considering Rayleigh's top-rated resource distribution away from Hybrid Cooperative Cognitive Radio Network (HCCRN). The network is hybrid because it uses a licensed source of information to access licensing and information in a mixed manner. We calculate the signal-to-noise rate and interference rate (SINR) of the authoritative link and the cognitive link by examining the control of the cognitive user power. The way licenses are assigned to cognitive users does not detract from the performance of licensed users.

Mohammad Soleymani et.al (2019) Improper Gaussian signaling (IGS) has been used as an effective interference management tool in interference limited systems. Improper Gaussian signals are correlated with their complex conjugates. In this paper, we investigate the optimality of IGS from an energy efficiency (EE) perspective. First, we obtain closed form optimality conditions for IGS. We then leverage these conditions to devise a bisection method that finds the optimal transmission parameters. Our results show that IGS can improve the EE of an underlay cognitive radio system.[7]

Mahdi Zareei et.al (2019) the rapid expansion of wireless sensor technology triggers several interesting applications. Given the small power capacity of a sensor, energy harvesting is an inevitable approach to extend the lifetime of the sensor nodes. In this paper, a distributed transmission power control mechanism for the energy harvesting cognitive radio sensor network (EH-CRSN) is proposed. The main concept is to adjust the transmission power of the nodes dynamically based on the network condition to maintain network connectivity. Each node decides to increase or decrease its transmission power dynamically based on several parameters such as its available power and neighboring nodes available power. This dynamic transmission power adjustment transforms the network logical topology to adjust with the power condition of network better. The transmission power control is tested in two scenarios; flat network and clustered network. Extensive simulation results show that by using of the proposed transmission power control method we can improve network end-to-end performance.[8]

Boyang Liu et.al (2019) Traditional mobile edge computing (MEC) methods always assume that the wireless devices (WDs) can offload their data to the base stations (BSs) or the access points (APs) at any time, which are not practical due to the tension between a large number of the WDs and the limited spectrum resources. In this paper, a framework for MEC-enabled cognitive radio (CR) networks is proposed, which integrates three technologies: MEC, CR, and wireless power transfer (WPT). To obtain the spectrum for offloading, cooperative relaying is considered. Optimization problems are formulated to study the upper bound of the energy efficiency (EE) of the WD and to maximize the practical EE in both partial offloading and local computing scenarios, which are non-convex and intractable. In order to tackle these problems, a two-phase method is proposed. The transmit power, the time for energy harvesting (EH) and MEC, and the central processing unit (CPU) frequency of the WD are jointly optimized. Semi-closed-form solutions are obtained in partial offloading scenario by using fractional programming theory, Lagrangian dual decomposition, and successive pseudo-convex[9]

III PROPOSED SYSTEM

Cognitive radio (CR) is regarded as one of the most promising technologies in the future wireless communications. In cognitive radio networks, cognitive users could access to the idle licensed spectrum of primary users to improve the spectrum efficiency. Moreover, the cognitive users could adapt their transmission parameters by spectrum sensing to mitigate the interference. Recently, the cell networks that integrate with cognitive radios have drawn much attention. First, for the cell network, it works on the licensed cellular spectrum to seamlessly integrate with the cellular network.

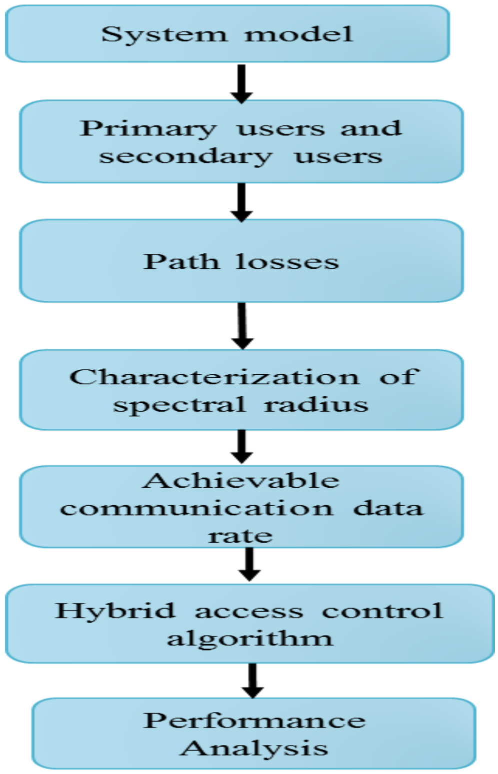

Fig 3Proposed System Model

Thus, the spectrum insufficiency problem is becoming more serious due to the busy traffic and limited spectrum of cellular networks. In this proposed system centralized two-tier network architecture with a macro BS and a number of FAPs, where the FAPs are deployed by the indoor users and connected to the macro BS by the wired backhaul, such as cable and fiber. Compared with Wi-Fi, the FAPs work on the licensed cellular spectrum and use the cellular standard to seamlessly integrate with the cellular network. Moreover, the same spectrum overlay model and is employed in this system. In spectrum-overlay-based cognitive .the FAPs that are equipped with CR technology could dynamically sense the utilized channels by the macro cell and surrounding cells and occupy the spectrum holes of the licensed cellular spectrum to avoid cross-tier and intra-tier interference to the macro cell and surrounding cell.

V CONCLUSION

In this work the network capacity for the next-generation cognitive radio networks with numerous secondary users under the constraints of power budgets and communication rate requirements. We showed that we should iteratively access the secondary user who has the short transmitting distance and small communication rate requirement based on the characterization of spectral radius. Then, we propose a decentralized power control algorithm to check the feasible state, and design a hybrid access control algorithm to reduce time of suffering interference. Numerical evaluations verified that our algorithm is well combined with existing removal algorithm and fast enough to converge to a near-optimal solution in terms of maximum supporting set of secondary users and high energy efficiency. It approves that the hybrid access strategy is better than the arbitrary access strategy. As future work, we will extend these price-driven algorithms to the joint spectrum access of both the primary and the secondary users and we will consider the influence of different weights on the performance of our algorithm.

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