Energy Efficient Channel Sharing Tradeoff in Cognitive Network Using ALOHA Protocol

Author

Ms.R.Janani

Department of Electronics and Communication Engineering

Author

Mr.s.Mohamed Nizar

Department of Electronics and Communication Engineering

Abstract:**In cognitive radio networks (CRNs), the design of an optimal spectrum sharing scheme is an important problem that has recently been drawing consideration attention. Various sharing-related performance trade-offs have been studied as an efficient means to maximize the secondary network performance. The coexistence and resource sharing between a primary network utilizing cognitive relays and a secondary network are investigated. Two multiple access protocols are proposed to coordinate idle time slots sharing between the networks in a TDMA setting. While relays in the primary user slot are using these free time slots to help users in the secondary user by forward their unsuccessfully transmitted packets, also users of the secondary network use these time slots to transmit their own packets. The diversity-multiplexing sort of trade-off imposed by this resource sharing problem and optimum resource allocation strategy are studied through the characterization of the maximum stable throughput region of single network.**

Index Term**: Cognitive Radio Networks, Diversity-Multiplexing Sort, Secondary User(SU), TDMA (Time Division Multiple Access.**

I. INTRODUCTION

Although the slotted-ALOHA (S-ALOHA) multiple access protocol was developed about a half-century ago, it and its family are still widely utilized in wireless communication fields, mainly due to its simplicity and low-cost in implementation. For example, in mobile communication systems such as the Long Term Evolution (LTE) and LTE-Advanced (LTE-A), some variants of S-ALOHA are adopted as the channel access technique for the random access channel (RACH).The S-ALOHA is also used for small ad-hoc networks such as the vehicular ad-hoc network (VANET).Since the maximum channel utilization of the S-ALOHA is not high, it has been used for the applications that generate a small amount of traffic randomly. However, some emerging S-ALOHA applications need more bandwidth. For example, the machine-to-machine (M2M) communication via RACH of cellular systems can cause severe congestion on the channel because there may exist a large number of M2M users (for example. The most important Requirement of CR system is to protect PU from the potential interference caused by the SUs. When the PU is activated on its channel, the SUs operating on the channel should move to another vacant channel. As soon as possible. To determine channel availability, CR systems carry out channel sensing and/or utilize geo-location information and database of PU activity at the location. The channel sensing is mandatory when the CR system consists of sensing-only SUs (e.g., CR ad hoc network having a small service area) or when the PU activity cannot be announced a priori (e.g., in the case that PU is not TV station). In this paper, we consider the CR systems relying on channel sensing, where the SUs sense the channel for detecting PU activation, periodically or when it is suspicious. Since the SUs cannot transmit their data during the channel sensing, the efficient sensing scheduling, which accomplishes a high throughput of CR system with minimum PU disturbance, is of essential importance [4].Recently, the S-ALOHA networks using CR technology (CR S-ALOHA networks) have been proposed actively [3],[5]–[7]. In these proposals, the SUs control their respective transmission according to S-ALOHA as well as schedule the channel sensing for detecting PU. In [5], a two-level opportunistic spectrum access strategy has been proposed. With this strategy, the slots form a frame with fixed length. At the beginning of each frame, a spectrum sensing duration is arranged. If SUs cannot detect the PU

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activity at the beginning of a frame, they can access the slots in the frame, according to S-ALOHA. That is, the strategy in [5] is based on the periodic channel sensing. The authors of [6] considered multi-channel environment where an SU chooses a channel randomly, senses the channel, and, if PU is inactive, contends for the channel with a certain probability. They developed adaptive algorithms to find the optimal contention probability of SUs. The authors of [7] focused on pricing-based spectrum control with random access in CR networks. In their proposal, each SU first senses the channel to detect the PU activity. If PU is not detected, SUs contend for the channel by random access. Most of the existing CR S-ALOHA proposals, including the above-mentioned ones, carry out channel sensing explicitly and anticipatively (i.e., before a transmission attempt).However, it may not be a necessity. In the CR S-ALOHA networks, an SU can fail to transmit a packet by the collision not only with the other SUs but also with PU. Thus, a sequence of transmission failures implicate the possibility of PU appearance. If it is the case, the SUs should sense the channel explicitly to confirm the PU appearance. Our study starts from this intuition. The problem is how to schedule this explicit sensing to guarantee a given level of PU protection, based on the observation of the previous packet transmission results. In this paper, we propose a combined channel access and sensing scheme for packet transmission and channel sensing in the CR.

II COGNITIVE RADIO:

Due to the increased usage of wireless communications in personal, commercial, and governmental capacities, efficient spectrum utilization has become a prime research topic. The Federal Communications Commission governs spectrum usage and allocates specific ranges to licensed users. However, some spectrum ranges are overcrowded, while some are under-utilized. The overcrowded spectrum reduces overall quality of service for users in that allotment. A potential solution to this problem is cognitive radios, which performs two major tasks. First, it searches the spectrum and determines which parts are unoccupied, a technique known as spectrum sensing. Second, it determines a method of assigning secondary users to the unoccupied spectrum without interfering with the primary users. Cognitive radio networks could drastically change the way wireless communications operate in the future by dynamically allocating spectrum usage and ultimately, provide a better quality of service to users. The paper review is examine and aggregate the current research on cognitive radio technology.

Cognitive radios can be largely classified by their method of spectrum management. Spectrum management includes four main tasks: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. First two aspects of spectrum management, spectrum sensing and decision. The author delivers a high level overview of each component in spectrum management, as well as current challenges and limitations of cognitive radios. Spectrum sensing allows cognitive radios to be aware of the surroundings by determining which frequencies are in use. Algorithms such as energy detector, waveform-based, cyclostationarity-based, radio identification, and matched filtering will be analysed and compared. Cognitive radio determines available frequency holes, it decides which is the optimal frequency hole to meet the secondary users requirements. Spectrum decision must also not interfere with the primary users frequency allocation and transmission. The main considerations for spectrum decision is performed, which covers channel identification, channel capacity estimation, channel interference estimation, and spectrum selection.

Nowadays, the development of wireless communication techniques cannot meet the fast increasing of communication requirements. One of the most essential bottlenecks is the scarce spectrum resource, which is suitable for wireless transmissions. The fixed spectrum allocation policy makes the problem even severer. In most countries, the use of spectrum bands is regulated by governments through a spectrum management process known as spectrum allocation. A number of forums and standards bodies are also involved in the spectrum management process, such as International Telecommunication Union (ITU) and European Telecommunications Standards Institute (ETSI). Spectrum bands are assigned in three types . No one may transmit: frequencies reserved for radio astronomy to avoid interference at radio telescopes Anyone may transmit, as long as they respect certain transmission power and other limits: open spectrum bands such as the unlicensed Industrial, Scientific and Medical (ISM) bands. The “listen before talk” contention based protocol is mostly used in this case Only the licensed user of that band may transmit: the licensing body may give the same frequency to several users as a form of frequency reuse if they do not interfere because their coverage map areas never overlap. For those high-demand sections of the electromagnetic spectrum, auctions may be used to decide who can use them. Generally, the aforementioned spectrum allocation is static or fixed for a certain time length. It has been found that some bands are not efficiently utilized in space domain or in time domain. According to the utilization of the fixed spectrum assignment is approximately 15-85%

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based on temporal and geographical variations. On the contrary of under-utilization, the requirements for spectrum resource increase urgently. In other words, dynamic spectrum allocation mechanism is required in order to make better use of the spectrum.The proposal of cognitive radio provides a novel solution to improve spectrum utilization efficiency. The concept of cognitive radio was firstly proposed by Joseph Mitola III in a seminar in 1998, and then published in an article by Mitola and Maguire in 1999 [9]. After that, cognitive radio has gained a lot of attention. A cognitive radio is the key enabling technology for dynamic spectrum access, and it has various definitions given by different regulatory bodies, such as Federal Communications Commission (FCC) and International Telecommunication Union. (Definition by FCC) A Cognitive Radio is a radio that can change its transmitter parameters based on interaction with the environment in which it operates. (Definition by ITU) A radio or system that senses and is aware of its operational environment and can dynamically and autonomously adjust its radio operating parameters accordingly. No matter how the specific definitions are made, the essential concept is the ability to know the environment and the ability to adjust to use vacant resources. In a cognitive radio network, there are two coexistent networks, i.e. primary network and secondary network. The users belonging to the primary network, called primary users, are licensed users and have a license to access a certain spectrum band. Primary users do not need any modification or additional functions for co-existence with the secondary network. However, the users belonging to the secondary network, called secondary users, are non-licensed users. Therefore, additional functionalities are required to share the spectrum band with primary users. The required tasks form a cognitive cycle as summarized.The cycle starts from the spectrum sensing process. In this part, the secondary users sense the available spectrum bands (named spectrum holes), capture their information, and then detect the vacant spectrum resources. Based on the sensing results, secondary users can decide which resource they want to utilize. Then, spectrum sharing is conducted to prevent collisions between multiple secondary users trying to access the same spectrum. In addition, secondary users should switch to other vacant bands when the primary users need the specific portion of spectrum, because secondary users are visitors to the spectrum. This operation is the so-called spectrum mobility.

III PROPOSED SYSTEM:

To design optimal spectrum sharing scheme by using the Cognitive Radio networks in an efficient way. This is the main objective of the proposed system .In this scheme the packet transmission and the channel sensing can be controlled together using ALOHA protocol.Delay can be completely reduced by time slot division multiplexing and Congestion will be reduced.Hidden Markov Model is used to find the state of channel and HMM is mainly used to find whether the primary user and secondary user is using the 2G or 3G spectrum in order to share the unused spectrum of the primary user to the secondary user. Sharing of unused spectrum can be mainly classified into five modules in this proposed systembased on that efficient sharing of channel can be calculated.

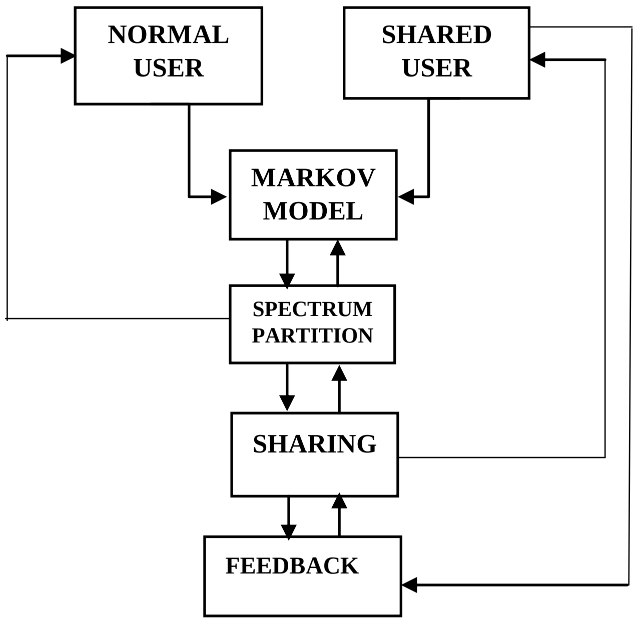

Fig 1. Block Diagram of Proposed System

IV MODULE DESCRIPTION:

STEP 1-Creating the users such as Primary user (Normal user) and Secondary user (Shared user).

STEP 2-Using the Hidden Markov Model the state of the user is identified whether the user is using the 2G or 3G Spectrum and then unused spectrum are collected.

STEP 3-Then the collected unused spectrum are partitioned based on the number of users and their requirement.

STEP 4- Then those Partitioned Spectrum are shared to the requested secondary user from the Primary user based the number of Secondary user available.

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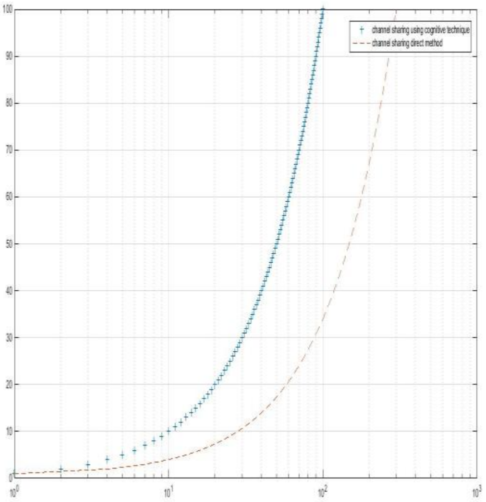
STEP 5-Feedback which mainly used to find whether the spectrum shared to the secondary user is correct or not.

V RESULTS:



VI ALGORITHM AND EXPLANATION:

[1]Start on the signal range. How far is the signal from the range? Zero steps, mark the first iteration with the number 0.

[2]Find all number of primary and secondary user in the network that are exactly one step away from the request. Mark them with the number 1. (In this network, if the goal is the exit hexagonal, then there is only one range that is exactly one step away.)

[3]Now find all secondary user in the network that are exactly from the range of request. These requests
are from those marked 1 and have not yet been measured the response and access time.

[4]Find the state of primary user using markovin model.

[5]Keep ideal requests in the network in order of increasing distance from the spectrum. After marking spectrum with the number *k*, mark with the number *k*+1 all new coming secondary user that are one step away from those marked *k* and have not yet been marked.

VII RELATED WORKS:

Modelling of the considered cognitive radio network is made, where several key aspects are taken into account, including system model, channel model, sensing error model, and re-transmission schemes. The research results mainly focus on probabilistic backlog distribution, probabilistic delay distribution and delay-constrained capacity. In a cognitive radio network, secondary users try to make use of the spectrum when the primary users are away from the spectrum. Secondary users should vacant the spectrum when primary users need to use the spectrum resource. Due to this, a cognitive radio network is naturally modelled as a priority system with two classes of inputs. The spectrum access decision of secondary users is made based on spectrum sensing results. However, spectrum detection is not always reliable, errors may happen sometimes. Spectrum sensing errors can be classified into two types, i.e. mis-detection and false alarm, which have different impacts on users. A mis-detection happens when a primary user is actually occupying the spectrum but the sensing result tells a secondary user that the spectrum is vacant. Then collision between a primary user and a secondary user will occur, which leads to both transmission failures. In a false alarm, the spectrum is available for a secondary user while the sensing result indicates the spectrum is occupied. Therefore, secondary users will miss the transmission opportunity. The impacts of mis-detection and false alarm should be properly modelled, so that the system performance can be better evaluated. In this work, sensing error processes are modelled by the concept of wasted service. Re-transmission is a normally employed scheme to compensate for transmission failures, and its strategy has particular impacts on delay and loss probability. Generally, more re-transmission attempts will lead to more reliable transmission and longer delay. In this work, three typical schemes are considered and discussed: without re-transmission (WO-RT), re-transmission until success (RT-S) and maximum-N-time re-transmission (Max-N-RT). For WO-RT scheme, a packet will be cleared from the queue when it is transmitted out, no matter it is received by the receiver or not. For the RT-S scheme, a packet will be re-transmitted until the receiver sends back the acknowledge (ACK) signal. In the Max-N-RT scheme, a packet can be re-transmitted for N times at most, and then it will be removed from the queue. Based on the working principle, WO-RT scheme has better delay guarantee, RT-S provides more reliable transmission, where the Max-N-RT scheme is a trade-off between delay and loss probability. For the spectrum sharing policy, it is assumed that there exists a virtual central control point to coordinate the transmissions from all primary users in a First-In-First-Out (FIFO) manner, and another point to coordinate all secondary users by FIFO. Therefore, no collision

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will happen between two primary users (or between two secondary users). This assumption may be too ideal in practical networks, however, it helps to obtain tractable performance bounds. In wireless networks, channel fading is also an important aspect to be modelled. In this work, a constant rate channel without fading is considered at the beginning. Then, the two-state Gilbert-Elliott channel is employed to study the impacts of fading, which can also be considered as a constant channel with an impairment process. A GE channel has two states, i.e. state ON and state OFF, and the channel transfers between these two states according to a Markov chain In state ON (state 1), data can be received correctly, while in state OFF (state 0), the channel is in deep fading and no data can be successfully received at the receiver. The transition rate from state i(i∈ {0, 1}) to state j(j ∈ {0, 1}) is represented by qij .summarizes the considered cognitive radio network. Two types of users are organized into two independent FIFO buffers. Misdetection and false alarm have their impacts on two flows. Packets are transmitted through the wireless channel, and then receivers send back their ACK4 signals, which are used by re-transmission how to schedule the next packet waiting in the queue.In this work, network calculus is applied to conduct performance analysis for a cognitive radio network. Although several key aspects are considered and the corresponding results are obtained, there are still some interesting issues left for future study.

• In the later part of this work, which consists of Publication D and Publication E, the fading channel is modelled by a two-state Gilbert-Elliott channel. This model is simple to be applied since it has only two states, ON with constant rate R1 (R1 > 0) or OFF with constant rate R0 = 0. However, it is too rough to catch the characteristics of a real fading channel, where the channel supports more that two rate levels. Therefore, advanced channel model, such as Finite State Markov Channel (FSMC) can be studied in the future, and the possible difficulty may be how to obtain the stochastic service curve for such a multiple-rate fading channel. The authors of present an approach to map a Rayleigh channel to a GE channel. The work in studies statistical properties of the capacity of mobile fading channels in various wireless communication systems, and the results therein may be useful.

• In this work, it is assumed that there exists a virtual central control point to coordinate transmissions from the same type of users, and all packets will be served in a FIFO manner without considering any fairness or QoS requirement. Hence, more scheduling mechanisms can be studied in the future. In addition, this issue may be connected with channel model, since scheduling algorithm in a wireless network is usually linked with channel fading properties. In some results have recently been obtained along this direction.

• In the theoretical analysis using network calculus, no restrict is assumed for input traffic models as far as their stochastic arrival curves can be found. However, Poisson traffic and Periodic traffic are mainly used in this work in order to simplify the numerical calculation. Other types of traffic can be evaluated in future work. Some typical models have been summarized.

• Further study on independent case analysis is needed, especially when the convolution operation involves several bounding functions. In addition, more scenarios can be considered to further validate possible improvements led by applying independent case analysis.

• Multiple parallel channels are considered in this work under the assumption of periodical and exclusive reservation for primary users along each channel. This assumption is made in order to obtain the guaranteed service provided to secondary users, and it greatly restricts the generality of the analysis. The biggest challenge on the way to remove this assumption is how to derive the stochastic service guarantee of parallel servers, and this blank area is waiting to be filled.

CONCLUSION:

In this paper, we have designed an adaptive sensing scheduling scheme for CR S-ALOHA networks, while exploitingthe inherent property of adaptive S-ALOHA that the SUsare always monitoring the channel in order to control thetransmission trial probability p. Despite of the adaptive controlof p for avoiding collision, when transmission failures occurconsecutively L times, the proposed scheme recognizes it asa sign of PU activation and performs channel sensing. Thissensing triggering is well matched with adaptive transmission Control of S-ALOHA and can be very simply implemented.

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