

A Review and Challenges: Spectrum Allocation of Secondary Users over Cognitive Radio

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ABSTRACT: With the rapid growth in the wireless communication during last decade. The demand of spectrum resources increase day by day. Cognitive Radio can successfully deal with the growing demand. CR systems are radios with ability to exploit their environment to increase spectral efficiency and capacity. To exploit the limited spectrum efficiency, CR system allows unlicensed users (secondary users) to access licensed spectrum band of primary user when they are not occupied. To do this the secondary users need to continuously monitor the licensed user's activity to find the unused band. Spectrum sensing is the basic and essential method to find the unused spectrum. It is one of the most challenging issues of CR process to prevent interference between primary users and secondary users. This paper present the overview of the available spectrum sensing techniques such as matched filtering, energy detection, cyclo stationary feature detection, and cooperative spectrum sensing techniques.

KEYWORDS: Cognitive radio, spectrum, primary, secondary, cooperative, power.

I. INTRODUCTION

Radio spectrum usage is undergoing a paradigm shift from the traditional command and control allocation to the open spectrum access[1]. Cognitive radio (CR), which was first coined by Mitola in 1999 [2], is a promising approach to achieve open spectrum sharing flexibly and efficiently [3] [4]. CR is an intelligent wireless communication system that is aware of its radio environment and is capable of adapting its operation to the statistical variations of incoming radio frequency (RF) stimuli [3]. The research on cognitive radio has already penetrated into different kinds of wireless networks, and covered a variety of fields, including spectrum sensing, channel estimation, dynamic spectrum sharing, medium access control (MAC), and routing [4].

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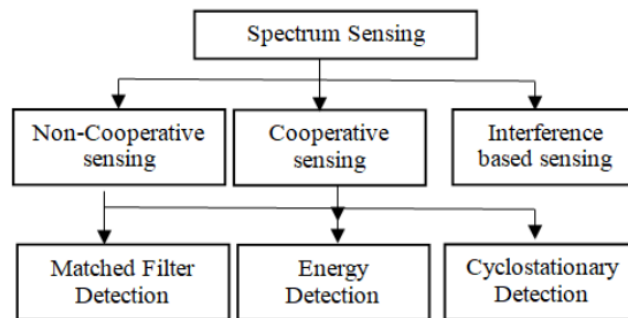


Figure 1: Spectrum Sensing Techniques

In this paper, we focus our study on the spectrum sensing issue of a cognitive radio network, in which a number of primary users and secondary users form a mesh type network using the detected unoccupied frequency band (i.e. spectrum holes) dynamically and independently. We name this kind of network as CogMesh. Basically, a CogMesh network can be regarded as a multichannel multi-access network, in which the available channels of a node undergoes dynamic changes during the node's life time. It is different from the traditional mesh or ad hoc networks in the sense that it can opportunistically utilize various spectral holes for smooth peer-to-peer communications by virtue of the unique CR functionalities. Correspondingly, the topology management of a CogMesh network is affected by two main facts: first, a common control channel may not always exist in the whole network; and second, the network topology changes over time according to the presence of primary users and secondary users.

II. RELATED WORK

Y. Huang et al., [1] Device-to-device (D2D) communications technology can be used to allow unauthorized users to borrow the frequency bands of original authorized cellular users (CeUEs), and to improve the bandwidth shortage problems. In this study, it is propose a heuristic subcarrier allocation method to set the UE throughput threshold which serves as a requirement to D2D multicasting (D2DM) subcarrier allocation. Simulation results show that with the higher threshold of 10 Mbps, the sum of D2DM throughput may increase as the number of D2DUE increases. Moreover, it is set the signal-to-noise-to-interference ratio (SINR) threshold of CeUEs to explore the QoS performance of the D2D communication systems. Simulation results show that with the proposed heuristic subcarrier allocation method, when the threshold increases from 3 dB to 15 dB, and the number of D2DM groups increases from 2 to 5, the system throughput can be maintained at 22.44Mbps.

A. Bhardwaj et al., [2] Underlay in-band device-to-device (D2D) multicast communication, where same content is disseminated via direct links in a group, has potential to improve the spectral and energy efficiencies of cellular networks. However, existing resource allocation techniques may not work well for multicast in next generation wireless networks with many simultaneously connected devices. To address this problem, it is focus on channel allocation algorithms where multiple D2D multicast groups (MGs) share the channel with a cellular user (CU). The objective is to maximize the sum throughput of CUs and D2D multicast groups, while ensuring a certain level of quality of service (QoS) to CUs and D2D MGs. Our main contributions are the exact calculation of outage probability experienced by a D2D receiver in the multicast group and a scheme to share channels among D2D MGs and CUs by minimizing these probabilities. Numerical results demonstrate the impact on the sum throughput of the number of MGs sharing the channel with a CU, geographical spread of MGs, and the maximum transmit power of cellular users.

T. Hou et al., [3] Device-to-device (D2D) communication has been proposed to improve the throughput of multicast from the base station to user equipment (UE) in LTE-based access networks. Such a multicast is divided into two stages where the first stage is from the base station to one or more relay UEs, while the second stage is from the relay UE(s) to the rest of UEs via D2D communication, where D2D-capable UEs form clusters to maintain their short-range

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transmission characteristic. Previous works did not consider taking advantage of D2D's capability of reusing uplink resource blocks that have been allocated to ordinary UEs (or CUE, cellular-network UE). Previous works also mainly focused on maximizing the throughput sum of firststage and second-stage transmissions. it is note that the multicast delay is a more meaningful performance metric for time-sensitive streaming data multicast and high throughput sum does not directly translate to low delay. In this paper, it is study the D2D-assisted two-stage multicast that allows D2D communication to reuse CUEs' uplink resource blocks. it is choose the multicast delay as the main performance objective and evaluate two relay UE selection schemes in their effectiveness in minimizing the multicast delay in comparison to one-stage multicast. Our results show that two-stage multicast performs better than one-stage multicast in both minimizing delay and maximizing resource efficiency when the cluster is far away from the base station and the cluster size is small.

P. Zhao et al., [4] With the ever-increasing demands for popular content sharing among humans, device-to-device (D2D) multicast communication, as a promising technology to support wireless services within a local area, is introduced in a 5G cellular network. However, the existing resource allocation approaches for D2D multicast communication usually consider only physical domain constraints but neglect social domain factors, which would result in ineffective D2D links between users unwilling to share interests. Different from existing works, the D2D multicast scheme proposed in this work will produce effective D2D multicast links by sufficiently utilizing both the physical and social properties of mobile users, with the goal to maximize the throughput of the overall social-aware network and guarantee fairly allocation of the channel between different D2D multicast clusters. The scheme mainly consists of two parts, the formation of D2D multicast clusters and joint optimization of power and channel allocation. In the formation of D2D multicast clusters, members and head in each cluster are selected by taking into account both social attributes and physical factors, such as community, ties, and geographical closeness. In the joint optimization, a two-step scheme is designed to first calculate the optimal power allocation by geometric proximity and then select suitable cellular channels for each D2D multicast cluster utilizing an extended one-to-many bipartite graphs matching algorithm. Simulation results demonstrate that, compared with heuristic algorithm and stochastic algorithm, the proposed scheme can increase the throughput of the overall social-aware network by about 5% and 50%, respectively

A. Bhardwaj et al., [5] Device-to-Device (D2D) multicast communication is emerging as a practical solution to alleviate severe capacity crunch in data-centric wireless networks and to encourage backhaul-free communication directly among devices with similar content requirement. Resource allocation in multicast networks is a critical issue that impacts both, the network throughput and spectrum efficiency. it is devise an uplink resource reuse strategy for multiple multicast D2D groups and multiple cellular users (CUs), with the objective of maximizing the sum throughput, while guaranteeing a certain level of quality of service (QoS) to CUs and D2D users. it is establish the efficacy of the proposed scheme for variable group sizes and geographical spread.

A. Bhardwaj et al., [6] The potential of device-to-device (D2D) technology to support multicast services in LTE-Advanced networks has been recently realized. D2D communication brings great benefits to cellular networks in terms of enhanced spectral efficiency and larger coverage by enabling the devices to communicate directly with each other. D2D communication may lead to improved network capacity by sharing resources with cellular users (CUs). However, the resulting mutual interference may decrease or even outweigh the gain of D2D communication. In this paper, it is propose a scheme to minimize the interference among D2D and CUs through a resource allocation scheme. it is formulate the uplink resource allocation problem where a D2D multicast group can reuse resources of CUs under the constraint that the signal to interference plus noise ratio (SINR) requirements of CUs and D2D users are satisfied. it is analyze a joint power and channel allocation scheme to maximize the total throughput of CUs and D2D users. The performance of D2D communication depends on maximum power constraint for the D2D users. Simulation results establish the efficacy of the proposed scheme.

W. Gong et al., [7] In this paper, the resource sharing problem of device-to-device (D2D) communications underlying evolved multimedia broadcast multicast service (EMBMS) system is investigated, and a novel round- robin resource

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sharing algorithm (RRSA) is proposed. To avoid the interference between D2D user equipments (DUEs) and cellular user equipments (CUEs) without consuming more frequency resources, in this study, it is assume that DUEs do not share frequency with CUEs in the same single frequency network (SFN), but reuse frequency with CUEs in other SFNs. The contribution is threefold: 1) D2D communication is introduced to the SFN in EMBMS system for the first time, 2) the system performance is significantly improved without additional frequency resource costing, and 3) the QoS requirement of high level user is ensured. Simulation results show that the proposed resource sharing algorithm can significantly reduce the outage probability of D2D receivers and enhance the throughput of system.

H. Wang et al., [8] A wireless resources allocation method for Device-to-Multi-Device (D2MD) communication under the control of base station is proposed. In the premise of ensuring quality of services (QoS) of all D2MD groups, the method can allocate wireless resources for D2MD groups through three steps: mode selection, spectrum allocation and power control. Simulation results show that the method can select the high-spectrum-efficiency mode which reuses the spectrum of cellular users for most D2MD communications, and does not affect cellular communications, the interference to cellular uplink of proposed suboptimal LCH algorithm which allocates cellular spectrums for D2MD groups to reuse can achieve the same level as the optimal algorithm, in addition, the calculating complexity is lower therefore shortening the response time of the base station.

Table 1: Summary of literature survey

Sr No.	Author Name & Year	Proposed Work	Outcome
1	Y. Huang, IEEE 2018	It is propose a heuristic subcarrier allocation method	Higher threshold of 10 Mbps.
2	A. Bhardwaj, IEEE 2018	It is focus on channel allocation algorithms	Impact on the sum throughput of the number of MGs.
3	T. Hou, IEEE 2017	Two-stage multicast that allows D2D communication.	Two-stage multicast performs better than one-stage multicast in both minimizing delay
4	P. Zhao, IEEE 2017	Sufficiently utilizing both the physical and social properties of mobile users	The throughput of the overall social-aware network by about 5% and 50%, respectively
5	A. Bhardwaj, IEEE 2016	The network throughput and spectrum efficiency. it is devise an uplink resource reuse strategy.	It is establish the efficacy of the proposed scheme.
6	A. Bhardwaj, IEEE 2015	Proposed resource allocation scheme	Simulation results establish the efficacy of the proposed scheme
7	W. Gong, IEEE 2014	The resource sharing problem of device-to-device communications.	Reduce the outage probability of D2D receivers and enhance the throughput of system.
8	H. Wang, IEEE 2008	Proposed mode selection, spectrum allocation and power control	High-spectrum-efficiency mode which reuses the spectrum.

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III. CHALLENGES AND APPLICATIONS

A. Challenges

Spectrum sensing in cognitive radio networks is challenged by several sources of uncertainty ranging from channel randomness to device level and network-level uncertainties such as channel uncertainty, noise uncertainty. Since spectrum sensing should perform robustly even under worst case conditions, such uncertainties limit the performance of sensing. Cognitive radios have a great potential to improve spectrum utilization by enabling users to access the spectrum dynamically without disturbing licensed primary radios. A key challenge in operating these radios as a network is how to implement an efficient medium access control mechanism that can adaptively and efficiently allocate transmission powers and spectrum among Cognitive radios according to the surrounding environment. Most existing works address this issue via suboptimal heuristic approaches or centralized solutions.

B. Applications

The under-utilization problem of the allocated radio spectrum, cognitive radio (CR) communications have recently emerged as a reliable and effective solution. Among various network models, this survey paper focuses on the enabling techniques for interweave CR networks which have received great attention from standards perspective due to its reliability to achieve the required quality-of-service. Spectrum sensing provides the essential information to enable this interweave communications in which primary and secondary users are not allowed to access the medium concurrently. Several researchers have already considered various aspects to realize efficient techniques for spectrum sensing. In this direction, this survey paper provides a detailed review of the state-of-the-art related to the application of spectrum sensing in CR communications. Starting with the basic principles and the main features of interweave communications, this paper provides a classification of the main approaches based on the radio parameters. Subsequently, we review the existing spectrum sensing works applied to different categories such as narrowband sensing, narrowband spectrum monitoring, wideband sensing, cooperative sensing, practical implementation considerations for various techniques, and the recent standards that rely on the interweave network model. Furthermore, we present the latest advances related to the implementation of the legacy spectrum sensing approaches. Finally, we conclude this survey paper with some suggested open research challenges and future directions for the CR networks in next generation Internet-of-Things applications.

IV. CONCLUSION

A Cognitive radio sensor network (CRSN) is characterized as a circulated system of remote intellectual radio sensor hubs, which sense an occasion flag and cooperatively impart their readings powerfully over accessible range groups. This paper survey of the spectrum sensing problem utilizes the spectra resources for communication, and thus provides unique features different from traditional wireless mesh networks. Spectrum sensing is a technique used by the secondary users to detect whether the primary users are busy or idle, the main problem in spectrum sensing is it causes degradation in primary user throughput.

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