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An overview of game theory for resource allocation in device to device communication

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ABSTRACT

Device to Device communication which allows the mobile device such as smartphone and tablet to use licensed as well as the unlicensed band for communication. In this paper, we study the detail concept of D2D communication and also the game theory concept of resource allocation so as to improve the spectrum efficiency problem. Game theory is an important tool for various allocation with the different strategy.

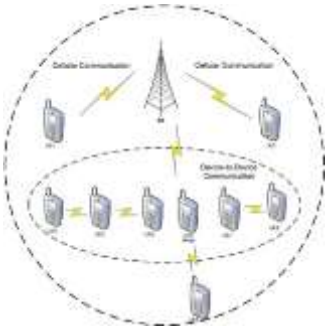
Keywords: *Device to device communication, Game theory, Resource Allocation*

1. INTRODUCTION

In the recent year, there is phenomenal growth of mobile data demand due to higher data rate application which results in the bandwidth scarcity in the available radio spectrum. So our current 4G technology does not fulfil the requirement. As the number of mobile users increases it result in shrinking the inter-distance between a nearby device which gives rises to invent new communication technique. So we have developed a 5G technology which has a various feature like device to devise communication, massive multiple inputs multiple outputs, network function virtualization (NFV), prioritized spectrum access, and base station (BS) densification. It will all so provide us high data rate to overcome this issues.

D2D communication which enables direct communication between nearby device without involvement of the base station and evolved nodeB (eNB). It offers wireless peer-to-peer services and improves spectrum utilization in the LTE-advanced network. They include new types of short-range services and data-intensive short range applications. D2D communications will allow new types of services such as multimedia downloading, video streaming, online gaming and peer-to-peer (P2P) file sharing. D2D connectivity will make operators more flexible in terms of offloading traffic from the core network, increase spectral efficiency and reduce the energy and the cost per bit. Fig.1 show thee conceptofD2Dcommunication.

In D2D communication, we can use both the licensed as well as the unlicensed band. A large amount of data can be transferred fast between mobile devices with .in short distance. In D2D communication there is an effective technique. It can support local data service which can be used for unicast, group and broadcast application. There are two important things in local data service. There are two important things in local data service i.e. information sharing and data offloading. In information sharing the UEs can leverage D2D links to transfer files, audios and videos with higher data rates and lower energy than those in conventional cellular channels while in data and computing offloading a device with a good Internet connectivity can act as a hotspot to which data is offloaded/cached from the BS and from which other devices may download data using D2D links. UEs having the poor processing power or low energy budgets may also offload computation-heavy tasks to nearby more capable UEs using D2D links.



2. CLASSIFICATION OF D2D COMMUNICATION

D2D communication in a cellular network can be categorized into both in-band D2D and out band D2D based on the spectrum used i.e. licensed or unlicensed band for direct link formation. The key motivating factor for choosing the in-band D2D Communication is high control over licensed spectrum. On another hand, the main motivation of using out band D2D communications is the capacity to eliminate the interference between D2D links.

2.1 In-band D2D Communication

In-band communications can be divided into underlay and overlay categories. It can be used to improved spectrum efficiency by reusing the time and frequency resources by d2D users (i.e. Underlay) or allocating time and frequency resources occupied by D2D users (i.e. overlay). The disadvantage of in-band D2D is the interference caused by D2D users to Cellular Communications.

In underlay in-band mode, cellular and D2D communications share the same radio resources. Underlay in the band can improve and enhance the performance of different targets such as spectrum efficiency, energy efficiency, and cellular coverage by the use of different techniques including diversity techniques, interference reduction, and resource allocation and by using network coding.

In overlay mode, a cellular and D2D are given dedicated cellular and those cellular resources are subtracted from cellular users in order to eliminate interference for D2D on cellular transmissions.

2.2 Out band D2D communication

Out-band D2D Communication exploits the unlicensed spectrum for the formation of direct links. It is classified into two modes depending on the occurrence of the second interface.

Out-band controlled and autonomous communication, in controlled mode, the radio interfaces in D2D are managed by the evolved node B, While Autonomous D2D communication these are controlled by the user equipment themselves. Interference between D2D uses and cellular is no issue in out band D2D, but Coordination of the communication in the unlicensed band requires a second radio interface.

3. LITERATURE SURVEY

Hongliang Zhang [1] has described the resource allocation methods consider for the interference between two user equipment (UEs), but they cannot demonstrate the interference from multiple UEs to completely characterize the interference. The case study was carried out on channel allocation using hyper graph theory to arrange the interference between D2D pairs and cellular UEs, where an arbitrary number of D2D pairs are allowed to share the uplink channels with the cellular UEs so that we have to increase the cell capacity.
After studying this paper we can conclude proper allocation of D2D pairs can actually increase the cell capacity by 33%. The throughput of D2D pairs increase.

Rui Liu[2] has discuss the to minimize the overall interference of cellular and Wi-Fi users because interference generate from the D2D communications by using joint mode selection and resource allocation algorithm while guaranteeing the signal-to-noise-and-interference ratio requirements of all users, including those of cellular, D2D, and Wi-Fi. In the case study, he said that in many of the case the duty cycle-based unlicensed spectrum access method achieves better system throughput than the listen-before-talk-based access method.
After studying the paper, two heuristic algorithms are developed for the LBT based and the duty- cycle based accessing mechanisms. It can achieve a performance very close to the corresponding optimal solutions by the branch-and-bound algorithm. From this, we conclude the duty-cycle method achieves better performance than the LBT method.

Klaus Doppler [3] has present a paper which described the mechanisms for D2D communication session setup and management involving procedures in the LTE System Architecture Evolution. The case study shows that D2D communication can increase the total throughput observed in the cell area.
After completing the study of this paper we can analyse that D2D communication in a local area cellular network. The cellular network may be interference limited already by the cellular communication alone, the D2D peers are still able to use the D2D communication opportunity if they are close and located in the same room. By allowingD2D communication to underlay the cellular network, the overall throughput in the network may increase up to 65 percent compared to a case where all D2D traffic is relayed by the cellular network.

4. GAME THEORY

Game theory is a branch of mathematics that is concerned with the actions of individuals who are aware that their actions will affect each other. Game theory deals with interactive optimization problems.

4.1. Types of game theory

In game theory, there is two main type i.e. noncooperative and cooperative game.In non-cooperative games, each participant player acts in his own interest and the unit of analysis is always the individual player instead of a group of players. In these games, the players are always selfish they always try to increase their own individual payoffs without taking care of other player's payoffs in the game. From this, we understand that the individual players have competitive nature with other where players aim to increase their own benefits from the strategic situation [5].
In cooperative games, the groups of players are the unit of analysis and the players tend to increase their group payoffs as well as their own. It can be considered as a competition among the groups in a game rather than individual players. The applications of

cooperative game theoretical models are in the situations where players form groups, called coalitions, and the individual or group of player's contribution towards the game depends on the actions of other agents in the game [6].

5. GAME THEORY BASED RESOURCE ALLOCATION

There are different game theory model to solve the resource allocation in D2D communication which can be given as power control, local radio resource allocation as well as global radio resource allocation [7].

5.1 Non-cooperative power allocation

In the traditional cellular networks, direct communication between users is not allowed. The centralized operation mode is used for the management and control of resources and interference, but the efficiency of resource utilization is low. So, in order to improve the efficiency of spectrum utilization.D2D communication has played a wide role. D2D communication is a new technology that allows the end users to communicate directly through the shared cell resources under the control of the cellular system. D2D communication, which can reduce the burden of the base station and also reduce the communication delay. As we compare with the cellular communication, D2D communication only occupies half of the spectrum resources. The users which are closer can use D2D communication to reduce the transmission power and save energy. But the interference between the cellular network communication system and D2D communication is the main problem, as well as the interference between the D2D users. In order take a benefit of direct communication, a series of power control and interference suppression methods can be to meet the demands of users [4].

5.2 Local and global radio resource allocation

Local radio resource allocation is based on Stackelberg game work, which has hierarchical, and has a leader and a follower. The leader acts first, and then the follower observes the leader's behavior and decides his strategy. The Stackelberg game has been employed in cooperative networks and cognitive radio networks. In Stackelberg game, the cellular UEs are assumed as leaders and the D2D UEs are followers. We group cellular and D2D UEs into leader-follower pairs. The leader charges some fees for the follower using the channel. We analyze the optimal price for the leader and the optimal power for the follower. The strategies lead to a Stackelberg equilibrium. Then, we propose a joint scheduling and resource allocation algorithm. The leader-follower pairs form a priority queue based on their utilities, and the system schedules the D2D UEs according to their orders in the queue [8].

For global resource allocation, a combinatorial auction (CAs) game theory is used. The CA-based resource allocation mechanism allows an agent (bidder) to place an offer on combinations of resources, called "packages", rather than a just individual resource. The CAs motivate bidders to fully express their preferences, which is an advantage in improving system efficiency and auction revenue. To apply the CA game is solving arbitrary D2D links reusing the same cellular frequency bands.

6. CONCLUSION

In this paper, we overview type of D2D communication used in licensed as well as unlicensed and the concept of D2D to improve the limitation of current 4G technology. We study various game theory technique to improve the performance of D2D communication based on resource allocation scheme.

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