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Resource Sharing of Device to Device Communication in Cellular Network

Saptarshi Sarkar
Computer Science
Symbiosis Institute of Technology,
Pune, India

Prof. Manisha Tijare
Computer Science
Symbiosis Institute of Technology,
Pune, India

***Abstract*—Device-To-Device (D2D) communication was primarily proposed in cellular networks as a new archetype to upgrade network performance. The emergence of new application includes, among others, proximity and subsequently triggers different devices (location-aware advertisements, smart communication between vehicles, local exchange of information and so on) introduced new use cases and scenarios for device-to-device communication in cellular networks. The primary studies exhibit that device-to-device communication has support increased spectral efficiency and communication performance. Despite, this device-to-device communication mode acquaints new complication in terms of interference control and protocols. In this article, ontology based on the device-to-device communicating spectrum and reviews the possible literature broadly under the proposed ontology. Furthermore, we provide intuition into the explored areas which guide us to identify research problems and related issues of D2D communication in cellular networks**.

Index Terms—LTE-A, Device-To-Device (D2D) communication, Cellular network.

I. INTRODUCTION

With the increase in high data rated mobile users and applications, operators struggle to satisfy the demands of cellular network and mobile communications. Furthermore, the existing technology (WiMAX[1] and LTE-A[2]) which have high efficiency and physical layer performance, are procrastinate cellular users prospering demand of data. Despite, two cellular users can able to communicate directly with each other under a better channel state between them. These sorts of communication between cellular users in the network are known as Device-To-Device communication. Therefore, D2D become one of the standards in next generation cellular technology[3]. However, D2D has considerable gain over traditional indirect communication via Base Station (BS)[4]. First, to achieve higher performance and throughput or/and reducing transmission power level, D2D exploit a better channel state. Second, D2D communication utilize less resource of radio network than traditional communication via BS as D2D communication requires only one channeling from sender user to receiver user whereas traditional communication requires two channeling i.e. one from sender user to BS and other from BS to receiver user. Third, D2D communication can reduce traffic at the BS. Hence, by exploiting D2D communication, not only the performance of the D2D users increased but also that of the other users.

D2D could provide a decentralized approach to proximity discovery and device-to-device communication, which is efficient and secure, to enable proximity-based services to flourish[5]. D2D communication in cellular network is defined as the capability of utilizing the direct link between two cellular users instead of traversing the BS[6, 7]. In other words, the BS does not require relay packets between two proximity mobile users which are communicating with each other. D2D communication in cellular network is illustrated in Fig: 1.

Mostly, literature on D2D communication proposed to utilize

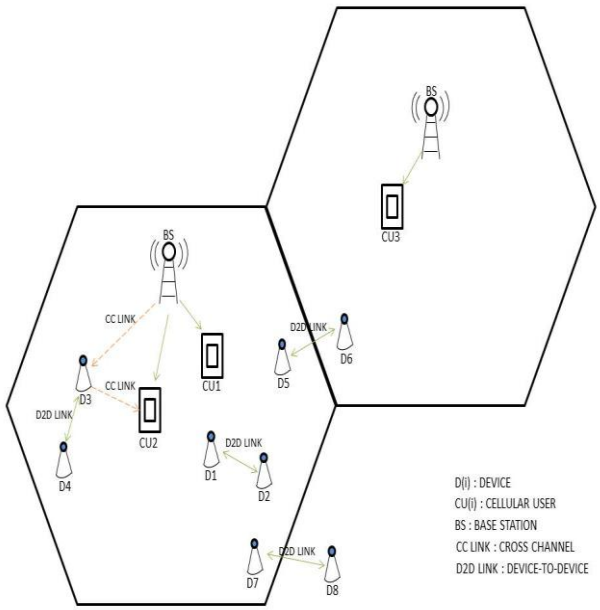


fig. 1. Device-To-Device Communication

the cellular spectrum for inband and outband D2D. These works basically study the problem of D2D communication interference[8, 9, 10, 11, 12, 13, 14, 15, 16]. In this paper, we provide a pervasive review of literature on D2D communication.

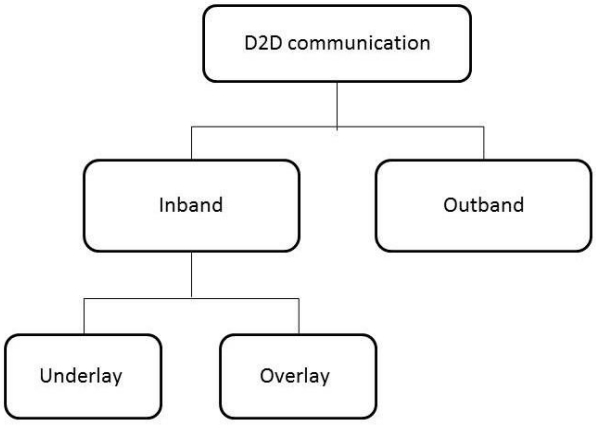


Fig. 2. Classification of Device-To-Device Communication

. Besides, we give new intuition to the current works on D2D communication which advanced us to the unanalyzed open issues. In section II we classify the available literature according to our proposed classification. Later, we analyses the works employing inband D2D. In section III, we provide a review on the common hypothesis of the available literature. Further, in section IV, we take a glimpse on open issues and give possible research oversight for D2D communication in cellular network. In section V, we conclude the paper.

II. CLASSIFICATION

Although standalone D2D communication have been studied in the literature for more than a decade, the concept of the D2D communication in the cellular network is relatively new. Moreover, recent studies confirm the use of D2D communication in cellular networks is commercially justified because of the resulting spectrum and power efficiency gain over the conventional cellular networks[17]. In this section, according to the spectrum whereabouts D2D communication work, we classify the literature on D2D communication. In the following subsections, we examine the explicit definition of the subcategories of the D2D communication. Classification of D2D communication into Inband and Outband is given in Fig: 2.

Inband and Outband: Under this category, majority of the available literature proposed to the spectrum utilization for cellular and D2D link. High regulations on the licensed cellular spectrum encourage the inband communication whereas unlicensed spectrum lay down QoS constraint due to interference in the channel. In addition, D2D inband communication is classified into overlay and underlay. In outband D2D, D2D pair communicate over industrial, scientific and medical (ISM) band (unlicensed spectrum) which is commonly used by ad hoc technologies such as WiFi[18], ZigBee[19] and Bluetooth[20]. In contrast, inband D2Dcommunication requires the D2D pairs to transceiver over the cellular network licensed spectrum[21, 22].

Underlay and Overlay inband D2D: Inband D2D can be further classified as overlay and underlay. Recently, most of available literature focused on reusing and improving of the resources of the spectrum used in D2D communication and also to inband (i.e. underlaying and overlaying inband D2D) communication. Although the concept of underlay D2D communication may resemble cognitive radio (CR) network[23, 24], there are significant difference between these two. The main difference is that D2D communications in cellular network are controlled by the network (i.e. the scheduler in the BS) but the secondary users in CR is not controlled by the primary network or a centralized entity in the network of the primary users[9, 25, 17]. Furthermore, the primary network in CR has no obligation to serve secondary users, whereas the cellular network treats the D2D users with the same priority as the cellular users. Moreover, Interference management in underlaying D2D communication can be less complex than the white space detection in CR system[26, 27]. In overlay D2D communication, a portion of the cellular resource is solely dedicated for D2D communication[17, 22, 28, 29, 30, 31]. Underlay D2D communication allows each D2D pair to reuse the same cellular resource which are simultaneously being used by another cellular user. Overlay D2D increase both spectral and power efficiency because the communication is completed via a single transmission instead of one uplink and one downlink transmission. In addition, it does not generate any extra interference to the system. Whereas underlay D2D proved to be improved efficiency of spectrum than overlay D2D due to reusing resources of cellular networks. Therefore, underlay D2D has higher gain than overlay given that a proper interference management algorithm controls the interference caused by underlaying communication. In addition, underlay D2D[?] increases energy efficiency and spectrum efficiency of cellular network[4, 32]. So, if proper interference management strategies exist the underlay system exploit would be better than that of the overlay.

III. STATE-OF-THE-ART APPROACHES OF D2D COMMUNICATION

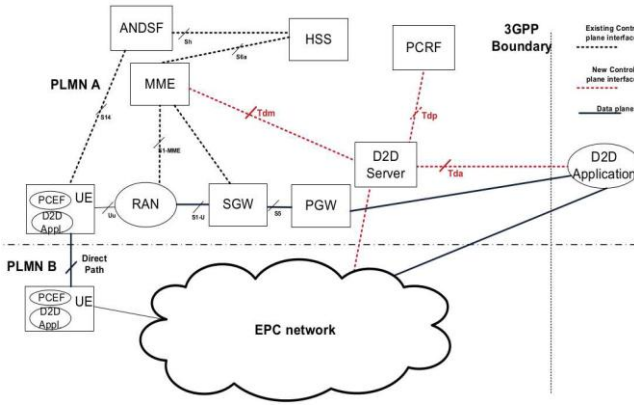
In this section, we provide an overview of D2D communication underlaying cellular network. The majority of authors of the available literature concentrated on the issues related to resource allocation and reusing of resource block, energy efficiency, power consumption, infeasibility,

TABLE I: COMPARING RESOURCE ALLOCATION OF D2D

	Channel reuse	Mode selection	Opportunistic scheduling	Optimal algorithm	Power control	QoS requirements	Subchannel allocation
[14, 36]	Yes	-	-	-	-	Yes	Yes
[25]	Yes	Yes	-	-	-	Yes	Yes
[27]	Yes	Yes	-	-	Yes	Yes	Yes
[21]	Yes	Yes	-	-	Yes	Yes	-
[32]	Yes	Yes	-	Yes	Yes	-	-
[33]	Yes	Yes	-	-	Yes	-	-
[37]	-	Yes	Yes	Yes	-	Yes	Yes

interference and so forth. In the literature of [25, 4, 33, 14, 7, 34, 11, 35, 15, 36] focus on the techniques of resource allocation and reusing of resource blocks [14, 36], interference controlling and management [7, 34, 11, 35, 15], and mode selection [25, 4, 33] to improve spectral efficiency. These techniques are mainly used for downlink and uplink resource of D2D communication.

Another factor of D2D communication is energy efficiency. Power consumption and allocation, specific scheduling algorithm and mode selection are the solutions to achieve



maximum energy efficiency. Some author provide hybrid system i.e. combination of aforesaid techniques. In [21], an exhaustive search algorithm is proposed and in [25], a distributed heuristic algorithm is proposed. Both i.e. [21, 25] considered the uplink resource block sharing and emphasize on power consumption optimization and mode selection to improve the energy efficiency. In [32], both downlink and uplink resource block sharing is considered and to solve the optimization issue, a heuristic centralized algorithm is proposed.

In [39], to achieve expanded cellular coverage and for higher throughput, author propose an algorithm based on call admission control taking into account mobility within and between cellular user. In [40], author introduced a resource allocation scheme based on column generation method to improve performance and spectral utilization.

IV. POTENTIAL FUTURE WORK

Here we detailed about the open issues and research directionof D2D communication. The queue stability analysis, spectral utilization, power trade-off issues can be handled by Lyapunov optimization technique. As increase in cellular users, issues such as interference, discovery and connection set-up of D2D and security must be tackling. Moreover, aforesaid the resource sharing (reusing) and optimization of D2D communication is the major factor to handle. As D2D proposed new use cases in cellular network such as M2M, multicasting and so on, D2D will come up with more interesting application.

V. CONCLUSION

In this paper, we determine an extensive overview on the possible literature on the D2D communication in cellular net-work. Based on utilization of spectrum, we classify the D2D communication into inband[3] and outband; where inband is further categorized into underlay and overlay D2D communication. We figure out major factors of the D2D communication and give insight to the issues related to D2D communication such as resource allocation and resource block reuse (sharing), interference controlling and management, mode selection and so forth. We provide a potential future work and research direction of D2D communication. Our study point that still many vital issue need to resolve to improve the D2D communication for the application in the real world.

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