A Review of Device-to Device Communication Based on Different Condition of Interference in Cellular Network

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Abstract

The performance and efficiency of cellular networks depends the minimum intervention of base station. The minimum intervention of base station creates the process of direct communication is called device-to-device communication. The device-to-device communication increase the efficiency of spectrum uses and minimization of energy efficiency. In cellular networks, D2D communication introduces several critical issues, such as interference management and decisions on whether devices should communicate directly or not. In this survey, we provide a thorough overview of the state of the art focusing on D2D communication on the basis of the review of paper, highlight areas not satisfactorily addressed so far and outline major challenges regarding efficient integration of D2D in cellular networks.

Keywords: - Cellular Network, D2D, Interface, Location, Topology

INTRODUCTION

Fifth generation (5G) cellular networks are being developed to satisfy dramatically increasing data traffic among mobile devices with the emergence of various high-speed multi-media applications. A new generation emerges about every 10 years to significantly improve the transmission rate and support more applications. 5G cellular networks are expected to have much higher network capacity and provide multi-gigabits-per-second data rate for each user to support multimedia applications with stringent quality of service (QoS) requirements[1-3]. For example, uncompressed video streaming requires a mandatory data rate of 1.78/3.56 Gb/s. These newly emerging band-width-intensive applications create unprecedented challenges for wireless service providers to overcome a global bandwidth shortage. Device-to-Device (D2D) communication, allowing direct communication between nearby users, is envisioned as an innovative feature of 5G cellular networks. Different from ad-hoc networks, the D2D communication is generally established under the control of the base station (BS). In D2D-enabled cellular networks, the cellular and D2D users can share the spectrum resources in two ways[5, 7, 9]: in-band where D2D communication utilizes the cellular spectrum and out-of-band where D2D communication utilizes the unlicensed spectrum. In-band D2D can be further divided into two categories: overlay where the cellular and D2D communications use orthogonal (i.e., dedicated) spectrum resources and underlay where D2D users share the same spectrum resources occupied by the cellular users. In micromillimeter Wave 5G cellular networks, D2D communications may face two kinds of potential interference within each cell: interference among different local D2D communications (if there are multiple local D2D communications) and interference between local D2D communications and D2B/B2B communications. Most of the existing works on D2D communications focus on the design of optimized resource sharing algorithms by managing the interferences[7]. The performance of frequency reuse among D2D links is analyzed with dynamic data arrival settings to obtain average queue length, mean throughput, average packet delay, and packet dropping probability. The system aims to optimize the throughput over the shared resources while fulfilling prioritized cellular service constraints[14]. The performance of the D2D underlay system is evaluated in both a single-cell scenario and the Manhattan grid environment. It considers resource sharing between one cellular connection and one local D2D connection. For scenarios in which there is limited or no infrastructure support, beyond the use of UAVs, there has been considerable recent works that study the use of direct device-to-device (D2D) communications between wireless users over the licensed spectrum[9-11]. Such D2D communications has been shown improve coverage and capacity of existing wireless networks, such as cellular systems. In hotspot areas or public safety scenarios, D2D will allow users to communicate directly with one another without significant infrastructure. The rest of paper organized as section II discuss the related work. In section III discuss the comparative study and D2D communication models. In section IV discuss the problem formulation and finally discuss conclusion & future Scope in section V.

II. RELATED WORK

In this section describe the related work in the filed of device to device communication based on different models such as frequency reuse, location based, low energy process and many more interference reduction process. The review of work presents in the form of table 1.

Et al.	Author	Title	Approach	Publication
[1]	Jing Guo, Salman Durrani, Xiangyun Zhou and Halim Yanikomeroglu	Device-to-Device Communication Underlaying a Finite Cellular Network Region	They study the outage probability experienced at the BS and a D2D receiver, and spectrum reuse ratio, which quantifies the average fraction of successfully transmitting D2D users. The analysis shows that the outage probability at the D2D receiver varies for different locations.	IEEE, 2017
[2]	Jian Qiao, Xuemin (Sherman) Shen, Jon W. Mark, Qinghua Shen, Yejun He and Lei Lei	Enabling Device-to-Device Communications in Millimeter-Wave 5G Cellular Networks	They introduce an mmWave+4G system architecture with TDMA-based MAC structure as a candidate for 5G cellular networks. They discussed an effective resource sharing scheme by allowing non-interfering D2D links to operate concurrently.	IEEE, 2015
[3]	Minming Ni, Lei Zheng, Fei Tong, Jianping Pan and Lin Cai	A Geometrical-Based Throughput Bound Analysis for Device-to-Device Communications in Cellular Networks	They first introduce the concept of guard distance to explore a proper system model for enabling multiple concurrent D2D pairs in the same cell. Considering the Signal to Interference Ratio (SIR) requirements for both macro-cell and D2D communications, a geometrical method is discussed to obtain the guard distances from a D2D user equipment (DUE) to the base station (BS), to the transmitting cellular user equipment	Springer, 2014

			(CUE), and to other communicating D2D pairs, respectively, when the uplink resource is reused.	
[4]	Yanru Zhang, Erte Pan, Lingyang Song, Walid Saad, Zaher Dawy and Zhu Han	Social Network Aware Device-to-Device Communication in Wireless Networks	an approach, based on the so-called Indian Buffet Process, is discussed to model the distribution of con-tents in the users' online social networks. Given the social relations collected by the base station, a new algorithm for optimizing the traffic offloading process in D2D communications is developed.	IEEE, 2015
[5]	Wei Zhong, Yixin Fang, Shi Jin, Kai-Kit Wong, Sheng Zhong and Zuping Qian	Joint Resource Allocation for Device-to-Device Communications Underlaying Uplink MIMO Cellular Networks	they discussed a non-cooperative resource allocation game for the joint self-optimization of channel allocation, power control, and precoding of the D2D users in a more practical	IEEE, 2015
			setting. The feasibility and existence of the pure strategy Nash equilibrium are then established. An iterative algorithm based on best response dynamic is then discussed to determine the feasible pure strategy Nash equilibrium under specific conditions.	
[6]	Pavel Mach, Zdenek Becvar and Tomas Vanek	In-Band Device-to-Device Communication in OFDMA Cellular Networks: A Survey and Challenges	They provide in-depth classification of papers looking at D2D from several perspectives. Then, papers addressing all major problems and areas related to D2D are presented and approaches discussed in the papers are compared according to selected criteria.	IEEE, 2015
[7]	Mingyue Ji, Giuseppe Caire and Andreas F. Molisch	Wireless Device-to-Device Caching Networks: Basic Principles and System Performance	This paper presents in a tutorial and concise form some recent results on the throughput scaling laws of wireless networks with caching and	Springer, 2014

			asynchronous content reuse, contrasting the D2D approach with a few other competing approaches including conventional unicasting, harmonic broadcasting and a novel coded multicasting approach based on combinatorial cache design and network coded transmission from the cellular base station only.	
[8]	Mohammad Mozaffari, Walid Saad, Mehdi Bennis and M´erouane Debbah	Unmanned Aerial Vehicle with Underlaid Device-to-Device Communications: Performance and Tradeoffs	Two scenarios are considered: a static UAV and a mobile UAV. In the first scenario, the average coverage probability and the system sum-rate for the users in the area are derived as a function of the UAV altitude and the number of D2D users. In the second scenario, using the disk covering problem, the minimum number of stop points that the UAV needs to visit in order to completely cover the area is computed.	Springer, 2016
[9]	Ahmed Hamdi Sakr and Ekram Hossain	Cognitive and Energy Harvesting-Based D2D Communication in Cellular Networks: Stochastic Geometry Modeling and Analysis	They show that energy harvesting can be a reliable alternative to power cognitive D2D transmitters while achieving acceptable performance. Under the same SINR outage requirements as for the non-cognitive case, cognitive channel access improves the outage probability for D2D users for both the spectrum access policies.	IEEE, 2015
[10]	Qiaoyang Ye, Mazin Al-Shalash, Constantine Caramanis and Jeffrey G. Andrews	Distributed Resource Allocation in Device-to-Device Enhanced Cellular Networks	they adopt a distributed approach that is computationally extremely efficient, and requires minimal coordination, communication and cooperation among the	ACM, 2014

			nodes. The key algorithmic idea is a signaling mechanism that can be seen as a fictional pricing mechanism, that the base stations optimize and transmit to the D2D users, who then play a best response to this signal.	
[11]	Monowar Hasan and Ekram Hossain	Distributed Resource Allocation for Relay-Aided Device-to-Device Communication Under Channel Uncertainties: A Stable Matching Approach	They formulate the radio resource allocation problem in a two-hop network to guarantee the data rate of the UEs while protecting other receiving nodes from interference. Utilizing time sharing strategy, they provide a centralized solution under bounded channel uncertainty. With a view to reducing the computational burden at relay nodes, they discussed a distributed solution approach using stable matching to allocate radio resources in an efficient and computationally inexpensive way.	IEEE, 2015
[12]	Ahmed Hamdi Sakr, Hina Tabassum, Ekram Hossain and Dong In Kim	Cognitive Spectrum Access in Device-to-Device (D2D)-Enabled Cellular Networks	They first outline the challenges in resource allocation posed by the coexistence of cellular and D2D users. Next, they provide a qualitative overview of the existing resource allocation and interference management policies for in-band D2D-enabled cellular networks. They then demonstrate how cognition along with limited information exchange between D2D users and the core network can be used to mitigate interference and enhance spectral efficiency of both cellular	IEEE, 2015

			and D2D users.	
[13]	Jun Huang, Ying Yin, Yanxiao Zhao, Qiang Duan, Wei Wang and Shui Yu	A Game-Theoretic Resource Allocation Approach for Intercell Device-to-Device Communications in Cellular Networks	They develop a repeated game model under these scenarios. Distinct from existing works, they characterize the communication infrastructure, namely, base stations, as players competing resource allocation quota from D2D demand, and they define the utility of each player as the payoff from both cellular and D2D communications using radio resources.	IEEE, 2015
[14]	Monowar Hasan and Ekram Hossain	Distributed Resource Allocation in D2D-Enabled Multi-tier Cellular Networks: An Auction Approach	. They provide the bound of achievable data rate and show that the complexity of the discussed scheme is linear with number of transmitter nodes and the available resources. The signaling issues for the discussed distributed solution is also discussed.	IEEE, 2015
[15]	Minming Ni, Jianping Pan and Lin Cai	Geometrical-Based Throughput Analysis of Device-to-Device Communications in a Sector-Partitioned Cell”,	with the help of their recently discussed PED-based interference analysis method, they have derived the guard distances of BS, CUE, and DUE for enabling multiple D2D communications in a sector-partitioned cell by utilizing the identical radio resource designated for the uplink cellular transmission.	IEEE, 2015

III. D2D COMMUNICATION

This section describes high level overview on D2D classification. As indicated in Figure, the classification of D2D can be divided into several main distinctive categories; D2D management, D2D scenarios, and D2D radio resource management (RRM). Individual categories are described in the following subsections[6].

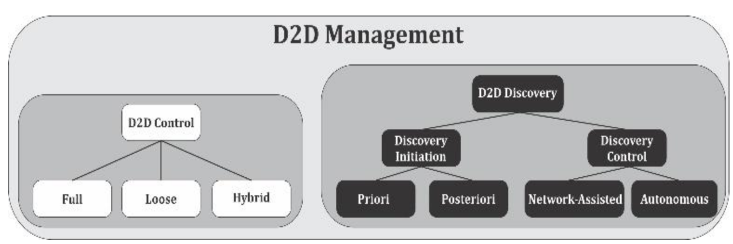

Figure 1: Device to Device Management with its control and discovery.

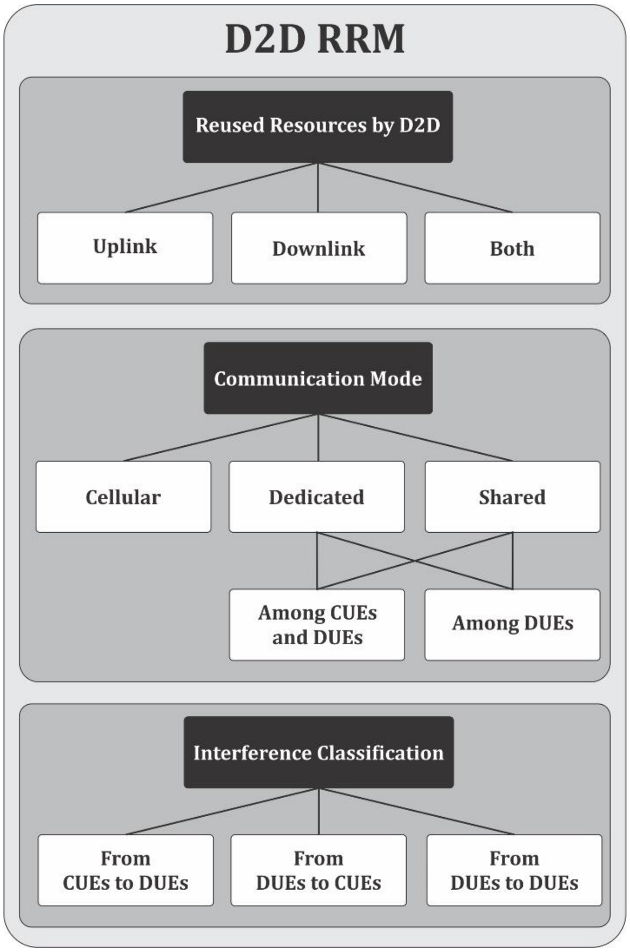

Figure 2: show that the Device to Device radio resource management with its reused resource, communication mode and interference classification.

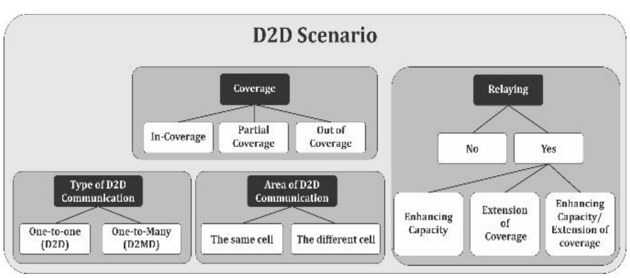

Figure 3: show that the Device to Device scenario with respect to coverage, relaying, communication types and communication area.

IV PROBLEM FORMULATION

Cellular network inherits all the challenges of wireless domain with enhanced complications; thus, device to device communication environment is more sinister than in its infrastructure counterpart. The following factors decrease the performance of networks [3,4].

- DYNAMIC SYSTEM: D2D raised for conventional distributed system, usually, depend upon the network topology; while in cellular, nodes are highly mobile, hence, the topology changes at a very fast rate. Intuitively, node mobility enforces frequent network reconfiguration which makes the network more susceptible to traffic congestion [15].
- VARIATION IN NODE CAPABILITIES: Each node has different battery power, computational power and memory stacks. Moreover, they may have varying software configuration, traffic load distribution, congestion control mechanism, transmission/receiving capabilities and bandwidths. The heterogeneity in node radio capabilities can result in possibly asymmetric links. Thus, designing network protocols for such heterogeneous network can be complex, requiring dynamic adaptation to the changing conditions[8].
- FAILURE OF MOBILE NODES: Mobile nodes are relatively high error prostrate unlike static wired network nodes due to limited resources at nodes.
- NO SECURE MEDIUM: The wireless network is more infringed by a wide range of passive and active attacks. Also, the security mechanisms, like secret keys, trusted authorities, are difficult to implement. Thus, the working of cellular is often obstructed by the attacks, like man-in-middle, denial-of services, which may lead to elect a false coordinator[9].
- LIMITED NETWORK SCALABILITY: At present, most of the static environment protocols have significant network scalability due to relatively small wireless components. However, CELLULAR applications involve large wireless components with thousands of nodes. Hence, scalability is critical to the successful deployment of these networks[11]. Although, these challenges do exist in cellular mobile systems, the coordinator election in CELLULAR is difficult due to absence of some static node like base station (BS) and mobile switching center (MSC) in cellular systems.

V. CONCLUSION & FUTURE WORK

In this paper present the review and problem of device to device communication models for the cellular networks. The process of device to device network increases the uses of spectrum uses and reduces the noise ratio. D2D communication underlying cellular networks is a heavily investigated area, research carried out so far is still in the preliminary stage of studying the performance of D2D in simplified scenarios or under limited conditions. These studies show the potential of D2D in terms of high performance gain in cellular networks and becoming gain integral part of future mobile networks. Nevertheless, recent research also presents many new challenges and issues that must be addressed in order to overcome the expected difficulties and obstacles in the management of D2D communication from a technical perspective.

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