

Chapter 8

Enabling Device-to-Device Technology in 5G Heterogeneous Networks

Hanan H. Hussein

Electronics Research Institute, Egypt

Hussein A. Elsayed

Faculty of Engineering, Ain Shams University, Egypt

Sherine M. Abd El-kader

 <https://orcid.org/0000-0001-5561-2424>

Electronics Research Institute, Egypt

ABSTRACT

5G is the next step in the evolution of mobile communication. The evolving 5G cellular wireless networks are envisioned to provide higher data rates, enhanced end-user quality-of-experience (QoE), reduced end-to-end latency, and lower energy consumption. Device to device (D2D) is one of the key technologies provided to enhance 5G performance. Direct communication between two devices without involvement of any central point (i.e., base station) is defined as device to device (D2D) communication. It is a recommended technique to enhance the network performance of 5G in terms of energy efficiency, throughput, latency, and spectrum utilization. In this chapter, the authors provide a detailed survey on the integration of D2D communication into cellular network especially 5G network. The survey highlights the potential advantages; classifications and application for D2D technology have been indicated. Main D2D standards have been presented. Finally, the chapter addresses main topics that could be related to D2D and indicates all major possible challenges that face most researchers.

INTRODUCTION

No doubt telecommunication systems developments enhance lifestyle in unexpected ways. 5G wireless cellular network deployment is the main key technology of the next wireless cellular network evolution. 5G cellular networks commercial service is estimated to be launch in 2020 (Shafi et al., 2017). The main target of 5G is to provide ubiquitous connectivity for any kind of device and any kind of application. 5G network should satisfy some needs (Agiwal et al., 2016). in order to enhance the performance. It should support data rate from 1 to 10 Gb/s for reality applications (i.e. telemedicine and vehicle-to-vehicle applications). Also it is needed to have a latency less than one millisecond to support reality application. Tens of millions of devices and hundreds of billions of sensors (El-Basioni et al., 2016) are vital to be served. Hence, network has been extended especially in airplanes and remote areas.

Such requirements need special technologies to be deployed. The detailed 5G standards are still work in progress and uncertain yet. Carrier Aggregation, massive Multiple Input – Multiple Output (MIMO), beam forming, cloud computing, millimeter Waves (mmW), Cognitive Radio (CR) (Salem et al., 2017), Full Duplex (FD), Non-Orthogonal Multiple Access (NOMA), green communication, energy harvesting, and D2D are potential technologies under research to meet 5G needs and be applied on it. All these previous technologies are out of our scope except D2D.

D2D Communication is one of the competent technologies for 5G, which is predictable to have an essential part in enhancing the era of wireless cellular communication. In previous mobile generations (i.e. 1G-4G), applying D2D technology did not take much attention; however, it is predicted that such a technology will play a vital role in next generation. D2D communication in cellular networks is known as a direct communication between two or more terminal devices without evolving the Base Station (BS) or any core network (Jameel et al., 2016). In contrast to traditional a wireless cellular network, D2D technology can provide more power saving due to close distance among connected devices. Besides, this technology enhances energy efficiency, throughput, and delay. D2D has the availability to offload traffic from the cellular network with high efficiency.

Main organizations have been co-operated in order to examine the validation of D2D in cellular networks such as 3GPP (Third Generation Partnership Project) (Lin et al., 2014). Release 12 of 3GPP states that such a technology can be applied as a public safety network feature, cellular offloading, vehicle-to-vehicle (V2V) communication, and content distribution. Although, D2D technology introduces a lot of benefits; it faces a lot of challenges that should be taken into consideration (Zhang et al., 2017). Applying D2D technology leads to highly interference among Cellular Users (CUs) and D2D Users (DUs) due to sharing the same resources in the same area. Other concerns that face D2D technology such as peer discovery, handover, radio resource allocation management and optimization, and security issue.

In this chapter, the above-mentioned topics will be illustrated in more details. Also, other topics will be provided focusing on D2D communication. Chapter is organized as follows: Section 2 provides the potential advantages of D2D technology. Section 3 introduces the D2D classification with its three main categories, while D2D scenarios and applications are provided in section 4. 3GPP and IEEE are the main standards applied for D2D that stated in section 5. Section 6 discusses the prototypes and experiments (i.e. FlashLinQ, Data Spotting and Relay by smartphone). D2D integrated features are laid out in section 7; as Hyprid Automatic Repeat ReQuest (HARQ), IoT, and Vehicle to Vehicle (V2V). Section 8 details D2D's challenges such as peer discovery, handover, and resource allocation. Finally, the chapter has been concluded in section 9.

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