# A Theoretical Review on Device-to-Device Communication

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***Abstract* – The Device-to-Device (D2D) communication technique is considered as one of the candidate technologies for the implementation of fifth generation (5G) cellular systems. Basically, this technique allows direct communication between two user terminals that are close to each other, without, thus, using the base radio station (BS, Base Station). The D2D technique has the ability to provide high data rates with lower power consumption due to the shorter link distance between transmitter and receiver. These characteristics are attractive to researchers who are in search of technologies capable of meeting the high data traffic currently circulating in wireless networks, and guaranteeing the quality of service standards expected by users. To understand the basics, this paper presents an overview of the technological operations of D2D communication.**

***Keywords* – 5G, D2D, Energy Efficiency, LAN, Spectral Efficiency, WPAN, etc.**

## I. Introduction

Device-to-device (D2D) communication is a technological concept that enables identification and communication between neighbouring devices without the need for access points or stations to communicate wirelessly between them.

As a direct form of communication, D2D can effectively remove traffic from the core network, resulting in lower power consumption and lower signal latency. In addition, D2D improves spectral efficiency as it can use both licensed bandwidth and free bandwidth; In addition, D2D can improve user experience by extending proximity applications.

In this context, there are wireless technologies based on wireless LAN (Wi-Fi, Wi-Fi Direct, etc.) and WPAN (ZigBee, UWB, Bluetooth, etc.), which allow direct communication between devices of various categories. ... for example, with lower performance under load, providing transfer rates from 25 Mbps to 480 Mbps and operating with low power consumption [1]. However, many of these technologies operate in freely available frequency bands, are subject to strong interference, and can make it difficult to access the frequency band due to traffic congestion.

On the other hand, another type of technology supporting D2D communication is LTE-A, which is standardized by 3GPP, supports new functions to achieve higher transmission rates, has lower power consumption than the previous version of LTE technology, and improves various functions in the field of wireless communications. This type of communication is integrated into 3GPP version 12 under the name Proximity Services (ProSe) or LTE-Direct (LTE-D) and is considered a new technology. This release proposes the use of D2D to position LTE as a competitive technology in critical communications networks that are typically implemented with technologies such as P25 and TETRA, which are classified as bandwidth technologies. Unlike technologies such as Bluetooth, Wi-Fi, Zigbee and UWB, LTE-based D2D provides theoretical transmission rates of up to 1 Gbps, greater range ranges between devices and offers the possibility of making better use of spectral resources.

However, it is still in the development and implementation stage. Therefore, this chapter will address LTE-D technology. Table 1 presents a comparative summary of some technologies that provide D2D functionalities.

Table 1: Comparison of various technologies for D2D [1] [2]

| Characteristic | Techniques | | | | |
|---|---|---|---|---|---|
| | D2D: LTE-D | Bluetooth | Wi-Fi Direct | ZigBee | UWB |
| **Working group in charge of standardization** | 3GPP LTE-A | Bluetooth SIG (Special Interest Group) | IEEE 802.11 | IEEE 802.15.4 | IEEE 802.15.3a |
| **Frequency Band [GHz]** | Spectral bands licensed for LTE-A and / or free use spectral bands | 2.4 | 2.4, 5 | 0.868/0.915, 2.4 | 3.1-10.6 |
| **Maximum reach range [m]** | 1000 | 10-100 | 200 | 10-100 | 10 |
| **Maximum transmission rate [Mbps]** | 1000 | 25 | 250 | 0.250 | 480 |
| **Nominal transmit power [dBm]** | 23 | 0-10 | 15-20 | -25-0 | -41.3 dBm/MHz |
| **Channel bandwidth [MHz]** | 1.4, 3, 5, 10, 15, 20 | 1 | 22 | 0.3/0.6; 2 | 500-7500 |
| **Modulation** | SC-FDMA, OFDM, FDMA | GFSK | QPSK, BPSK, M-QAM, CCK, COFDM | BPSK (+ASK), O-QPSK | BPSK, QPSK |
| **Coexistence mechanism** | Duty cycle, channel detection, power control | AFH (Adaptive Frequency Hopping) | Dynamic Frequency Selection, transmit power control (802.11h) | Dynamic Frequency Selection | AFH |

| | | |
|---|---|---|
| **Infrastructure** | Direct transmission of data autonomously or assisted by a cell phone network | Devices transmit data directly, autonomously in freely usable frequency bands |

## II. Classification of D2D Technology According to Spectrum Use

D2D communication can be categorized depending on the type of spectrum it uses, whether it is concession or free use spectrum [1], as described below.

### A. D2D in Concessioned Spectrum

D2D in concessioned spectrum, also called inband D2D, is the communication that uses concessioned segments of the spectrum destined for data services and cellular telephony. This type of communication can be distributed into two categories: Overlay D2D and Underlay D2D.

#### 1) Underlay D2D (D2D-U)

It is defined as D2D-U when D2D communication and cell phone services share the same spectrum resources. By doing the above, a user cannot establish D2D and cellular communication simultaneously.

The selection between cellular communication and D2D communication is equivalent to an information routing decision made by the system. In this case, the system decides to operate statically or dynamically, in one of the following states:

- D2D Mode: information packets are transmitted only through direct links between devices.
- Cellular Mode: the information packets are transmitted only through cellular links, making use of a mobile telephone network.
- Hybrid Mode: information packets can be transmitted via direct links or cellular links. The decision is made dynamically for each time slot [1].

#### 2) Overlay D2D (D2D-O)

Unlike D2D-U, D2D-O communication allocates a portion of the spectral resources for the operation of the cellular telephone network and another portion for the establishment of D2D communications.

### B. D2D in Free Use Spectrum

D2D in free use spectrum (also called D2D outband), as its name implies, is D2D communication that operates in free use frequency bands. When using these frequency bands, an additional interface is required in the devices, or even, it is necessary to adopt another type of wireless technology (such as Bluetooth, ZigBee, WiFi, UWB, etc.). In this way, the devices carry out direct D2D communications and, separately, establish communications with the mobile telephone network (operating in concessioned spectrum). Additionally, D2D in free use spectrum is divided into two categories:

- Controlled D2D: In this type of communication, the second interface or technology for D2D is coordinated and controlled by a mobile phone network.
- Autonomous D2D: D2D communication is autonomous when the mobile phone network is in charge of coordinating the communication, but leaves the control of direct D2D communication in the hands of the user, that is, in this case the second interface or technology is not found under direct control of the mobile phone network.

Figure 1 shows the classification scheme for D2D communication in the frequency domain.

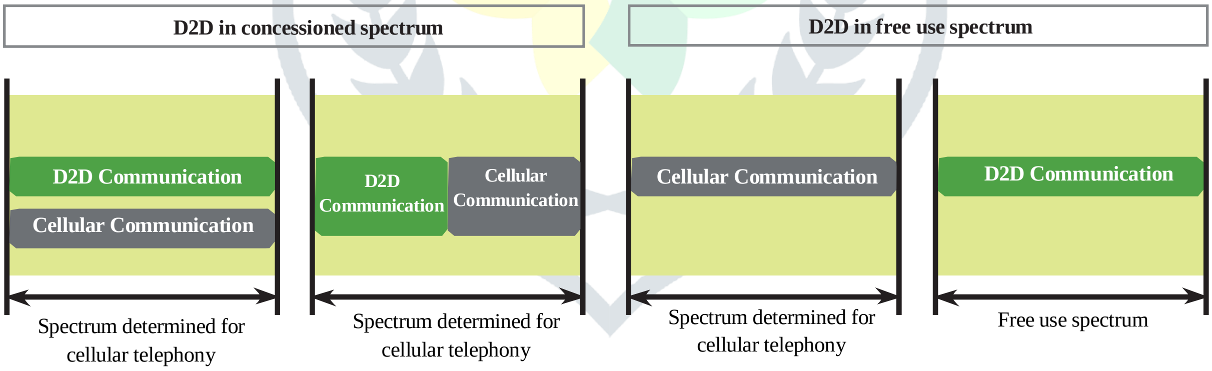


Figure 1: Schematic representation of D2D communication in concessioned spectrum and in free-use spectrum

### C. Spectrum Resource Allocation

In the specifications for D2D communication established by the 3GPP, the devices must be assigned a number of subcarriers in a given time, which are known as Physical Blocks of Resources (PBR). Each PBR occupies a space or slot in the time domain and 180 kHz in the frequency domain, that is, 12 subcarriers with 15 kHz bandwidths as in the specifications for LTE, as represented in the Figures 2 and 3. The bandwidths for transmission are 1.4, 3, 5, 10, 15 and 20 MHz.

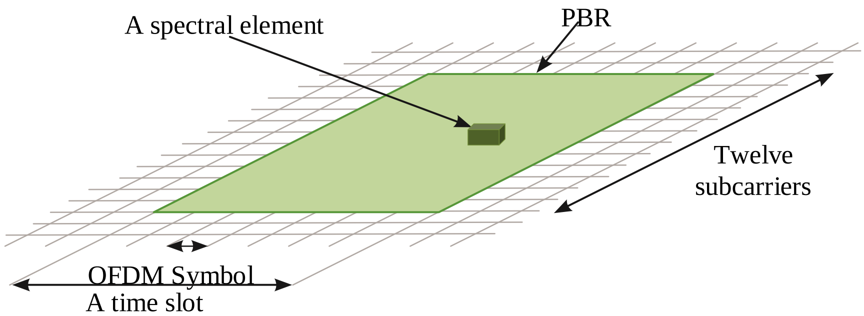


Figure 2: Representation of a spectral physical resource block (PRB) in the time and frequency domain [3]

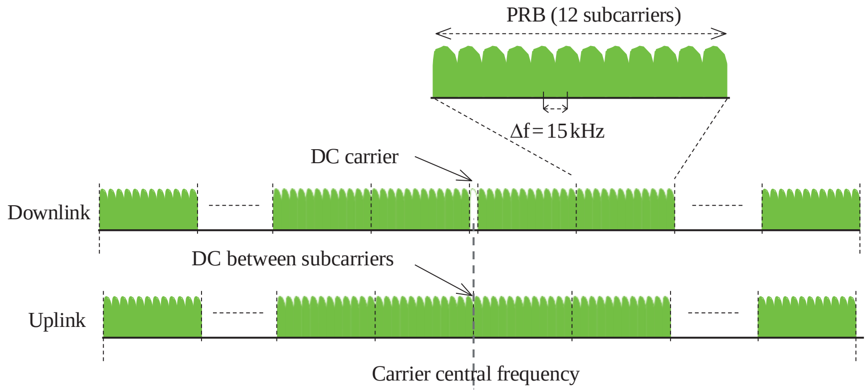


Figure 3: Representation of the LTE structure in the frequency domain [3]

As mentioned above, D2D technology is designed to operate in the frequency bands currently used with LTE technology, since they share the same information uplink and / or downlink. At present, these bands (diversified among the 3 ITU regions) are used in FDD or TDD mode (bands 2, 3, 4, 7, 14, 20, 26, 28, 31, 41 and 68 of 3GPP9). However, it should be mentioned that the use of new frequencies for IMT is currently being investigated, which are within the range of 24.25 to 86 GHz [5], so the frequency bands used by D2D can still continue to diversify globally.

As mentioned above, spectrum sharing in D2D communications is controlled by the cell phone network to which the D2D devices are associated. In this sense, there are different approaches to the methods for accessing the spectrum and many of them promote solutions that involve sharing at a spatial level, such as dividing cells into specific areas to dedicate a fraction of them to D2D communication or modelling the allocation of spectral resources by means of a maximization of spatial reuse. Other alternatives are algorithms for dynamic allocation of resources, static spectral partitions and obtaining optimal distances between devices to dynamically change their modes of operation, among others [4] [5].

In Release 12 of 3GPP, it is contemplated that the allocation of spectral resources can be in two ways: by means of a direct allocation by the network or an automatic allocation carried out by the device itself. In the first case, the network would be in charge of granting the necessary resources for communication and control data in a semi-static way, and in the second case, the device would select its own resources from a group of frequencies designated for D2D communication purposes [6].

## III. Technology Operation

D2D communication can be implemented with different types of devices, including cell phones, tablets, laptops and in general with all those devices that support connectivity through LTE technology with functionalities belonging to Release 12 onwards [7]. The operation of devices using D2D communication can be broadly divided into two parts: device discovery (D2D Discovery) and information transmission (D2D communication). The following describes sequentially the D2D interaction process between the devices, which can be independent or controlled by the network to which they belong. Said process involves the stages of device detection, selection of the operating mode, power control and information transmission.

### A. Device Discovery

An important process for D2D communications is the detection of nearby devices, which can be done by themselves or assisted by the mobile phone network. Subsequently, a direct link is established between the devices (D2D communication) and they are enabled to exchange information, or where appropriate, direct it to the end device. Detection is not necessarily followed by the communication process, so it can be used to enable other services such as locating terminal equipment [8].

#### 1) Direct Detection

In the case of direct detection, the process to locate and identify nearby devices is carried out autonomously (carried out by the devices themselves), through the transmission and reception of periodic signals (transmission of the location signal and identity of the device itself). Device or by requesting information from discoverable nearby devices). Although the above consumes time and energy on the devices, this detection allows the devices to operate in and out of the coverage of a base station and does not exclude assistance from the mobile phone network if it is available.

#### 2) Assisted Detection

In the assisted discovery process, the network determines which devices can communicate with each other, mainly based on their location and priority (previously defined). Likewise, this process can also be started when a Device 1 (D1) sends a request to the base station to communicate with a Device 2 (D2); subsequently, the base station obtains the required information (identity and location of D2) to establish the link. In this mode, the network requires constant registration, tracking and control of the devices and since this process is controlled by the network, it is carried out quickly and efficiently [1].

The detection of devices assisted by the network guarantees a more predictable process, since the network operator is responsible for controlling resources and coordinating the possible interferences that may exist. In addition, since the entire process is executed by the network, the devices are not affected by the consumption of time, physical memory or energy to be able to carry it out.

The assisted detection process can be centralized or semi-centralized depending on how much the network is involved in the detection process, which in turn depends on the design of the network and the needs of the operator.

#### 3) Centralized Detection

This type of detection considers the process in which a D1 wishes to communicate with a D2, which is described below:

1. D1 informs the nearest base station of its intention to communicate with D2.
2. The base station requests D2 to wait for the arrival of a detection message from D1, and requests D1 to send it this message.
3. D1 sends the detection message to D2.
4. If D2 receives the detection message, it requests the identification of D1 from the base station.
5. The base station sends the ID from D1 to D2.

6. After identification, D2 reports to the base station the SINR value of the message transmitted by D1.
7. The base station indicates to both devices that communication can be initiated by means of a direct link if it is favourable [1].

**4) Semi-Centralized Detection**

In the case of semi-centralized communication, the network has a less dominant role since the first part of the procedure does not include the exchange of messages with the base station, but begins with the sending of a detection message between devices without requiring assistance or authorization by the latter.

The procedure to follow, considering that D1 wishes to communicate with D2, is as follows:

1. D1 sends a detection message and its identification to D2.
2. If D2 receives the detection and identification message, D2 sends D1 its identification and the value of the SINR received.
3. D1 sends the SINR value to the base station and informs the intention to communicate with D2.
4. The base station indicates to both devices that communication can be initiated by means of a direct link if it is favourable.

**B. Operation Modes**

After the initial discovery process is complete, devices must select a mode of operation to optimize D2D communication performance, depending on network traffic load, channel conditions, and interference parameters.

Some authors have proposed various modes of operation for devices when they are involved in network controlled D2D communication, which are described below [9].

- ***Silent Mode:*** In this mode, the network cannot guarantee communication because it does not have enough spectral resources to assign to the devices or when it is impossible to implement frequency reuse due to high levels of interference. As a result, D2D devices cannot transmit and remain silent.
- ***Reuse Mode:*** This mode allows devices to communicate by sharing spectral resources of the uplink or downlink of information from the cell phone network. In addition, D2D communication can interfere with cellular communication (lowering the quality level of cellular communications and hindering handover processes), however, energy consumption is minimized since most of the processes are performed solely by the network.
- ***Dedicated Mode:*** In this mode a portion of the spectrum is dedicated to D2D communications so that devices can establish direct communication. During the selection of the operating mode, it is common for the management of spectral resources to be implemented simultaneously to determine the amount of dedicated resources (in D2D-O) or to know which resources can be shared (in D2D- U) to establish communication [10]. This management process includes the allocation of spectral resources and control of the transmission power.

**C. Power Control**

The control of the transmission power is a mechanism to mitigate the interference between users of a network, guaranteeing the minimum requirements of service quality: in general, the allocation of spectral resources and the power control are two inseparable processes. When shares are allocated, there is interference between cellular users and D2D users; in this case, the transmission power of the D2D user is reduced according to the minimum reference value of the cellular communication. Thus, also the network can establish a maximum transmission value for the D2D devices, depending on the impact of the different power levels of the devices on the quality of the cellular links.

When allocating dedicated spectral resources to D2D devices, as opposed to allocating shared resources, the transmission power can usually be higher, since the probability of interference between cell phone users and D2D is low or zero. Thus, the management of spectral resources can be carried out mainly by the network or by the devices themselves. In dedicated sharing, devices must detect the environment and use resources adaptively, trying to cause minimal interference to other users. When resource management is left to the device itself, you get a less predictable process, but with greater flexibility and less complexity.

**D. Transmission of Information**

There are different ways of transmitting information by means of D2D, which are exemplified in the diagrams of Figure 4 and are described below.

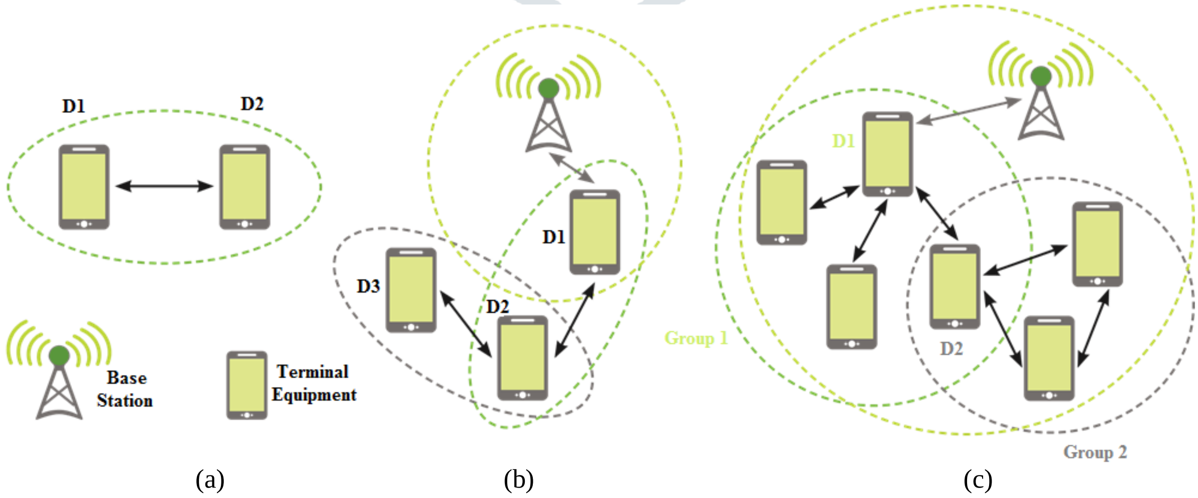


Figure 4: Transmission of information in D2D: a) single broadcast, b) broadcast in repeater mode and c) group broadcast-global broadcast

**1) Single Broadcast**

Also called unicast, direct link or point-to-point, where a D1 initiates the process to communicate with a D2, where both are registered as users of the cell phone network and are subscribed to it, but may or may not be under its coverage (see Figure 4a). There is also a variant of single broadcast, where the D1 can concurrently maintain the processes to communicate with several devices, for example with D2 and D3 (Device 3). The devices under this scheme must meet the same requirements to establish the processes in the establishment of communications and the exchange of information, thus maintaining one-to-one communication through multiple connections.

**2) Broadcast in Repeater Mode**

This broadcast, also called relay, assisted or cooperative transmission, is established when a device acts as a repeater of information for one or more devices. Repeater mode is considered a characteristic of D2D communication, which must be offered by the service operator in order to use it. The devices involved in the process must be registered and subscribed to the network, and may or may not be under its coverage; they must belong to the same communication group and the device that acts as a repeater must have the capacity to receive and retransmit the information directly. This type of broadcast can be exemplified with 3 devices: D1, D2, and D3, where D3 is outside the range of D1, but within the range of D2. If D1 and D2 are in proximity, D2 can act as a repeater, receive the information from D1 and send it to D3; as seen in Figure 4b).

**3) Group Broadcast**

Also known as groupcast or multi-hop; in group broadcasting, a device seeks to send the same information to two or more devices directly and all devices are configured to belong to the same communication group. In group broadcasting the devices are registered and subscribed to the network, and may or may not be under its coverage. In this case, a first device can transmit information to others simultaneously while they are in the same group, even if the detection process has not been carried out by the network or the functionality is disabled. To exemplify the above, Figure 4c) shows that device D1 can transmit in group broadcast mode but only to devices that are in the same communication group.

**4) Global Broadcast**

Also known as broadcast, in this type of communication a device initiates a direct transmission to all devices that are within its transmission range. Global broadcasting is considered a feature within D2D, so it must be offered by the network operator in order to use it. All devices involved in the transmission must register and be subscribed to the mobile phone network, and they can also belong to different communication groups. However, if you want to establish global broadcast communication between different groups, the device that transmits the message must belong to each group to be able to send the information directly to each device. To exemplify this type of communication, in part c) of Figure 4 the device D2 is shown, which belongs to groups 1 and 2, and therefore can perform a global broadcast for the devices of both groups.

Additionally, cases other than those mentioned above can be defined, such as hybrid broadcasting, which allows direct communications and communications through the network to be established simultaneously, that is, D2D and cellular telephony. This same case can be combined with broadcasting in repeater mode to extend the coverage of the devices and thus obtain more robust and personalized D2D communication systems.

**E. Advantages and Disadvantages**

**1) D2D in Concessioned Spectrum**

D2D communication that operates in concessioned spectrum bands makes it possible to increase spectral efficiency, either by reusing spectral resources or by allocating part of the cellular telephone service resources exclusively for D2D users.

Notwithstanding the above, when using D2D-O there may be a waste of these resources by dividing the frequency band between the two services. Likewise, in D2D-U measures must be taken to keep interference between services to a minimum and control the power levels of transmissions, although this entails an increase in the cost and complexity of communications. An important point to consider is that in D2D in concessioned spectrum, simultaneous transmissions, that is, of cellular telephony and D2D, cannot be carried out in the same device.

The D2D communication modality in concessioned spectrum has gained more popularity among the research community and the industry. This is mainly due to the search for better parameters, which can be tentatively achieved with D2D-U, for example: greater spectral efficiency, reduced energy consumption, and service reliability when working in concessioned spectral bands, among others.

On the other hand, the D2D-O modality is being increasingly explored. The main reason for interest in D2D-O resides in the robustness of the communication in the face of interference between mobile telephone networks and D2D communications.

**2) D2D in Free Use Spectrum**

On the other hand, D2D communication in free use spectrum solves interference problems with cellular links (although it preserves the unpredictable interference processes typical of these frequency bands), its implementation is less complex and can provide simultaneous cellular and D2D communications. . Furthermore, given that it is thought that there will be a greater number of devices operating in free use spectrum bands, it can be deduced that there will be a greater number of devices communicating with each other under this modality. Therefore, the free use frequency bands would be prone to presenting a much higher traffic load than the concessioned frequency bands.

**F. Applications**

As seen from an economic aspect, D2D communications can be a key element in the implementation of new business applications. Some of the potential applications are: proximity services (advertising, video games, information services, location, e-commerce, etc.), LAN networks, V2V vehicle networks, ITS intelligent traffic systems, mobile social networks, multicast, M2M communications and critical security services, interactive guides for tourists, advertising of businesses near the user, notifications from social networks, even notifications at airports and parking lots, among others. On the other hand, D2D-enabled devices can function as controllers for so-called M2M and V2V networks, also serving as links between them and cellular networks.

To cite an example, in the case of vehicular communications, known as Vehicle-to-Everything (V2X), they are used mainly for vehicle navigation, road assistance, information for travellers, evasion and control of road congestion, fleet management for transportation of passengers and products, payment transactions on highways and safety on the roads. This type of communication can be carried out between two vehicles (V2V), between the vehicle and an infrastructure (V2I), between the vehicle and pedestrians (V2P), etc., so it is common to use the term V2X to encompass and refer to mobile communication applications in vehicles. The automotive industry considers LTE-based V2X promising, as it enables network coverage in urban and rural areas, high capacities to transmit information, inclusion of applications for entertainment and value-added systems, among others.

Notwithstanding the foregoing, according to the 3GPP, the objective application with which D2D over LTE is being developed is to provide public safety and mission-critical services. The documentation published by the 3GPP about the advances of this technology is oriented to this type of communication, although this does not imply that in the future the standardization criteria for commercial applications cannot be extended.

Currently, most networks for public safety communications are based on technologies such as TETRA or P25, mainly to provide low-speed voice and data communication services, and are designed to use narrow band channels, typically 12.5 kHz or 25 kHz bandwidth per channel. In this sense, "moving" applications for public safety and critical mission to mobile broadband can, among other things, mean the aggregation of more emergency services, multimedia transfers, massive dissemination of critical information, and remote diagnoses of extreme situations and robustness of the system in adverse situations.

## IV. Literature Review of D2D Communication to Achieve Spectral Efficiency and Energy Efficiency

Due to the rapid growth in data transmission, spectral efficiency (SE) plays an important role in the design of future communications systems. In addition, with the advent of smart devices and various applications in recent years, power consumption has become an important issue, so it should not be ignored when designing 5G radio systems, and should be considered for greener wireless communications. ...

D2D communications take advantage of physical proximity, reusability and D2D point-to-point bypass and can significantly improve network operating systems and energy efficiency (EE), two of the most important aspects of future wireless networks.

While D2D communications over cellular networks can provide greater spectrum utilization and efficiency through spectrum allocation schemes, this infrastructure also poses new challenges and challenges as D2D users share the same spectrum as users. Hence, intelligent resource allocation and performance optimization are some of the key issues for D2D communications supporting cellular networks [11].

Previous studies such as [12] have been carried out on the energy efficiency of D2D networks. In [12], resource allocation and power control were optimized to maximize the EE of all D2D channels.

SE and EE are known to be opposing targets in wireless communication systems with limited radio spectrum and limited transmit power. This is because maximizing IF is synonymous with maximizing transmit power and utilizing full frequency on D2D channels and utilizing all resources to improve performance, but in this case EE can be very low due to high power consumption. In terms of OS and latency, we know that maximum OS does not mean that all users can reach the maximum baud rate, so the maximum OS does not always correspond to the minimum average latency, which indicates a possible overlap between IF and timeout [11]. Therefore, it is important to understand the possible intersections between SE, EE and latency. In [11], a new framework is proposed for examining the values between these three components: SE, EE and network latency in order to provide complex services to decision-makers in the system, based on the previous one.

A promising method for improving system performance is the D2D exchange mechanism, which integrates D2D data exchange and data exchange technology. In [13], they focused on studying the benefits of the D2D exchange system for the wireless communication system during UL transmission. For a detailed analysis of system performance, indicators consisting of SE and SE are used as indicators. Like traditional D2D communications polls, SE is considered the classic benchmark. At the same time, with the recent development of green communications, energy efficiency has become another typical milestone. This policy details the impact of custom settings on SE and EE, given that user mapping is an important part of those settings. In addition, the performance of the D2D exchange engine is assessed using three typical matching algorithms based on different assumptions. Based on the same assumptions regarding the use of D2D communications as an exchange system, [14] proposes a two-stage system model that allows an additional D2D exchange channel (RA-D2D) to support traditional cellular connections. EE RA-D2D's connectivity is maximized while maintaining minimum cellular data rates. Optimal transmitter power for D2D transmitters and D2D transmitters is achieved by converting nonlinear fractional programming to nonlinear parametric programming.

Since 5G networks must have both an operating system and EE, increasing network density is considered one of the most effective ways to combine them cost-effectively. However, anti-jamming and environmental design is becoming more and more complex due to their inherent density and flexibility. In contrast, macrophages rely on small, dense cells that exhibit complex abnormalities. It is difficult to define interactive behaviour and strategic decision making among various small cell substances. Flexibility is also an issue in some hot spots. Distributed resource management and interference control will be more effective in a crowded network. However, signal congestion will always be high, which creates problems for the network. The denser the small cells, the more opportunities for cooperation between them [15]. Therefore, in [15] SE performance is maximized with some loss of SE performance. First, the relationship between SE and SE was analyzed, and based on this, we formulated the SE maximization problem. In addition, an optimal SE balance is achieved to maximize SE performance with and without minimal SE constraints.

In [16], we investigate the overlap of D2D communication with spectral energy processes in which a D2D user uses transmit energy to transmit to a mobile phone user for UL transmission in exchange for bandwidth. D2D users temporarily act as a relay, consuming power and keeping the processors away from the operating system. The proposed energy spectrum efficiency aims to exploit individual differences in terms of spectrum and power.

In addition, the D2D millimeter wave communications base in [17] aims to improve the D2D EE millimeter wave communications supported by bi-directional relaying. For this, an iterative non-linear fragmentation algorithm was originally developed based on non-linear interrupt programming to maximize EE. In addition, a bottleneck elimination process (BEEP) has been proposed to further reduce transmit power while maintaining end-to-end throughput. Finally, this technique is combined with a properly designed channel mask to provide the EE algorithm with BEEP iterations.

In order to improve network performance in terms of spectrum efficiency, D2D communication was chosen in the following mode because D2D users use unfair resource blocks with D2D users when mobile users are closer to the operating system than D2D. As a result, the system will be much noisier than a conventional cell phone system. Energy monitoring is an effective way to manage incidents and ensure the quality of user experience. Authors of [18] have proposed an energy efficient power management system for a D2D core network in which multiple D2D pairs reuse the same resource blocks assigned to mobile users. Considering the maximum allowable transmit power and minimum data rate requirements, the issue of maximizing energy efficiency is an invisible issue of outage planning.

Finally, authors of [19] explores resource allocation for energy efficient D2D communication using an overlap model. The D2D transmitter first collects energy from the base station below the power threshold, then connects to the D2D receiver, for example, taking into account the final battery capacity of the D2D communication device, the D2D transmitter extracts energy from the mobile radio BS and uses the stored energy. Submit the tag. The resource allocation algorithm diagram is formulated as an empty optimization problem to maximize the energy efficiency of the system. Authors of [20] explores methods for energy efficient reuse of DL resources for D2D communications on which cellular networks depend. And it maximizes the overall EE of all D2D connections while providing quality service for mobile users and power requirements for BS and D2D connections. Based on superior analysis of shared power management capabilities and D2D-CU connectivity strategy, an iterative EE algorithm is proposed for D2D communications.

## V. CONCLUSION

Recently, the data traffic of mobile users has increased exponentially due to the growing increase in mobile subscribers, the emergence of data-intensive applications such as online games, video sharing, etc. This has prompted both the telecommunications industry and the research community to propose new paradigms that support high data rate requirements within current and future wireless networks in an efficient and effective manner. Wireless devices connected to wireless networks have increased dramatically in recent decades. The present voice and data connection is a key requirement for the 5G wireless technology. Device-to-device communication, widely known as D2D communication, has become one of the new paradigms of cellular communications, and was initially proposed to increase network performance. The new generation mobile system, also known as 5G, is expected to meet the main demands of data services in the telecommunications system. To represent a theoretical scenario of D2D communication, this paper presents a detailed explanation including classification and various technological operations of D2D technique. Finally, the paper provides a short review of recent research work which have been presented to achieve better energy and spectral efficiencies.

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