The Future of 5G Technology Present & Previous Generations

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ABSTRACT

Due to the exceeding demand to the Cellular subscribers to arrive the billions of connected in the near future as expected in year 2020. So the large number of connections are heterogeneous in nature. There are the reason for the development from first generation to the fifth generation and we are expected for meeting the degrading capacity of the cellular network. In these paper we suggest an architecture to fulfill the demands of the expected exceeding of future exceeding subscribers and their application and to fulfill all the projects of D2D communication. Low latency, the capacity of data rates, and enhancement of throughput. The available spectrum resources are limited and need to be flexibly used to cope with the rising demands. An facilitates for the expected high data next generation networks (NGNs) is device-to-device communication.

Keywords—5G; Internet of Thing (IoT); SDN; massive multiple input and multiple output (Massive-MIMO); Ultra dense networks (UDNs); Millimeter wave (mmWave (N); Device-to-Device (D2D) communication

1 INTRODUCTION

Every day a lot of cellular devices is increasing, with need for higher data rate applications. To meet the needs of the current applications, the current data rates need to improvement. The needs for 5G networks are proposed for fulfill these demands. The technologies of the next generation networks (NGNs) are Device-to-Device (D2D) Communication, which will play the key role in improve the wireless communication. In [1, 2] the author explain that the direct transmission device to device is possible and improve the reliability of the link between the devices and improve the efficiency and capacity of system, and reduce the latency within the networks and allow to communicate between devices, and offloading the Base Station. Device-to-device has become the key issues associated with it like peer discovery, some of its integrant technologies as handover, cognitive D2D and D2D (mmWave)in D2D. In [3] the author is expect (5G) is coming before 2020 and the speed will be more than 1Gbit/s. In this research there has been a great interest of 5G future technology, the concentration some elements as massive-MIMO, millimetre wave, smarter devices, device-centric architectures, and machine-to-machine. In [4] the authors show five challenges for 5G: Heterogeneous Networks, M-MIMO and 3D MIMO, M2M Communications, Software Defined Cellular Networks, and other technologies. In [5] the authors talked about four generic elements which could form the 5G era: Big Data Analytics (Big Data), Cloud Computing (Cloud), Internet of Things (IoT), and SDN. In [3] the authors discussed in detail about many aspects related to the upcoming 5G network:

Engineering Requirements for 5G and the design issues, mmW, M- MIMO, Cloud-Based Networking, SDN, Energy Efficiency, spectrum regulation and standardization for 5G and many more. Result to the small distance between the D2D users, there are power and improvement in energy, throughput, reduce delay and offloading traffic from the network. Some of the challenges can be available as peer discovery, radio resource allocation and security of the communication. In [6, 7, 3] it seems that telecommunication technology advances every decade or so, as 1G started around 1980, 2G by 1992, 3G by 2001, 4G or Long-Term Evolution (LTE) by 2011 and the new 5G network expectantly by 2020. 4G nowadays supports 1 Gbits/s for low mobility and 100 Mbit/s for high mobility. For the new upcoming 5G they estimate 10 Gbits/s for low mobility and 1Gbit/s for high mobility. The latency in 4G is 15 ms while in 5G it is expected to be 1 ms or so. In [8] the research on device- to-device (D2D) communication provide the various issues in D2D communication and show the D2D communication in LTE-Advanced networks. In [9] show D2D communication is presented as Inband D2D and Outband D2D. Architecture for device-to-device (D2D) communication has been proposed, which show the scenario of the next generation networks. It aims to allocating resources optimally to the D2D users and cellular users and using sectored antennas at the base station. So architecture may be efficiently to satisfy the users needs and meet the requirements of the network. There are a number of challenges for device-to-device (D2D) communication. We focus in this survey about different aspects of D2D. The organization of the survey is as follows: The introduction, represent the

D2D communication and some aspects of fifth generation section1. Some of related aspects to the future of 5G networks has been represented in section2. The various features which can be integrated with D2D communication to further enhance their utility and performance in cellular networks are discussed in section3. Types of D2D communications presented in section4. The proposed fifth generation architecture to obtain a good performance and to solve the challenges which had 4G network facing as energy consumption, coverage, and (QoS) has been presented in section5. Some integrant features there are some of features of 5G can be integrated with device-to-device (D2D) communication has been presented in section6. Finally, Section7 presents the conclusion and future of work.

2- Related aspects to the future of 5G networks

New technology of the fifth generation wireless mobile network is the desired future. There are a lot of efforts and research carrying on many aspects fig.(1), e.g. millimetre wave (mmW) radio transmission, massive multiple input and multiple output (Massive-MIMO) new antenna technology, the promising technique of SDN architecture, Internet of Thing (IoT) and many more. In this next section, we brief some aspect about the 5G mobile network.

2.1. INTERNET OF THINGS (IOT)

In [5,10, 11, 12, 13] next big thing in 5G is Internet of Things (IoT) has become key technology in many applications. Many number of devices and billions of sensors are connected to 5G mobile networks as transportation means and smart houses. There are major threats related to the IoT which need to be considered like security and privacy. Internet of Things (IoT) can be processed as cloud-base and will transform gradually to be machine to machine (M2M) whereas D2D and M2M part of the 5G.

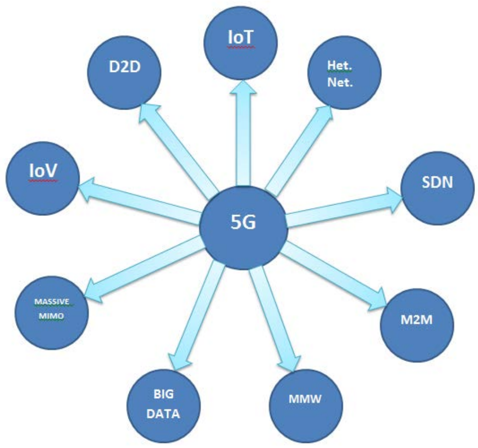


Fig. 1. Some aspects related to the new 5G mobile networks.

2.2. HETEROGENEOUS NETWORK (HETNETS)

In [14, 15, 16] Heterogeneous Network (HET. NETS.) The idea of a large and wide network, has variety of types of base stations. Here the author can improve the power and network coverage. Low transmission power in small base station can improve the capacity and extended coverage. Covering indoor and outdoor that can coverage by optimizing by small cells indoor and offloading the traffic. The architecture of 5G network transmit from base station to small cell and that is heterogeneity. Big data passed from a lot of sources need to be stored and processed and lead to 5G development the traffic in the future in Smart cities, virtual reality, IoT, and many.

2.3. FTWARE-DEFINED NETWORK (SDN)

In [17, 18] Software Defined Cellular Networks (SDN) controller that adjusts bandwidth for each radio access point (RAP), SDN controller of the proposed system providing the management for the system, thus SDN will play a big role in the design of 5G network. In [19] the author proposed an intelligent way to deliver data flow SDN architecture and how to analysis as packet loss rate throughput and how to address the congestion and how to find routing to data flow.

2.4. M2M COMMUNICATION

In [20, 21, 22, 23] the authors explain that the M2M data flow is increasing rapidly in the mobile network in USA only the M2M traffic volume increased by 250% in 2011, and by 2020 it is expected to occupy 45% of the total traffic of the Internet . The main features about the M2M in 5G are self-processing, sharing, and transforming automated data between them with little human effort. M2M communication connects a vast number of devices, smart meters, sensors and smart grid equipments covering a wide geographical area. The main features of M2M communication in 5G mobile network are real time operation, low latency, and high reliability.

2.5. MILLIMETRE WAVE MOBILE COMMUNICATION (mmW)

In [24, 25] the authors did a lot of experiments from 28 GHz and 38 GHz frequencies for loss and gain using different distances. Experiments put her insulators of brick and dry walls, clear and tinted glass for their signal reflection and penetration properties. They found 200 m is the ideal distance with the minimal loss in most conditions. Available bandwidth below 6 GHz is limited and start experiments by using mmW range starting from 3 up to 300 GHz. In [26] the authors proposed an architecture for 5G millimetre wave, which integrates the RF bands (e.g. 2.4 GHz and 5 GHz), and mmWave (30 GHz to 300 GHz).

2.6. BIG DATA

In [27, 28] the author show that big data is among the possible technologies which will lead to the 5G revolution in the nearest future and will aid the traffic for the 5G users, i.e. Smart cities, VR (virtual reality), IoT, HD videos, Games, and many more. The new 5G mobile network is referred to a huge integrated framework of big data passed from multiple sources which needs to be stored and processed.

2.7. MASSIVE-MULTIPLE INPUT MULTIPLE OUTPUT

In [29, 30, 31] the authors a large scale MIMO is a large number of base station serve multiple users in the same time. The conventional massive MIMO is less energy efficient than the hybrid massive MIMO (HMM) system as it is benefited from the newer 5G architecture technologies. The 3D MIMO for example, a large number of antennas in a cylindrical can serve many users scattered in elevation. When the number of the antennas rises in the MIMO array causing a small percentage of fading. However, in large dimensional signal processing, channel hardening may bring some advantages to the system.

2.8. INTERNET OF VEHICLES (IOV)

In [32, 33, 34, 35, 36] Vehicles is Intelligent Transportation System (ITS), many countries have started in, USA, Europe and Japan, to find protocols to control challenging issues as privacy, anonymity, liability, congestion, prioritization of data packets, secure localization, delay constraints, risk analysis and management. may develop to form Heterogeneous Vehicular Networks which connect with the 5G HetNets. A new standard is forming a new protocol by 2020, which integrates with mobile networks cloud. There are limitations to vehicle-to-vehicle (V2V) communication, the manufacturer of the car could access the full CAN (controller area network) bus sensors and all the viewing cams of the vehicle. Google with some auto industry are establishing a new protocol related to the vehicles named Open Auto Alliance (OAA) in which they are planning to add new features to Android

2.9. D2D COMMUNICATION

In [37, 38, 39, 40, 41, 42, 43] the author the data traffic is growing every year and it is expected the number of subscribers exceed 28 billion. The sending and receiving controlling signals and user data in the network of D2D are expose to some of threats including fabrication, manipulation, and eavesdropping, easy to attacker by hacking by broadcast of the wireless communication. A lot of technologies will be used in the D2D communication like Table (1) Bluetooth 5.0, WiFi Direct and LTE Direct, the transmission distance for these wireless standards ranging from less than a meter up to 500 meters. In D2D indoor is small subscribers close to each other can communicate and share information directly between them and and offloading the base station. There are some issues are related to D2D privacy and security. D2D increases the scalability and addressed low latency and energy efficiency by controlling the signaling and end to end network communication.

3- D2D & COMPARISON WITH BLUE TOOTH & WI FI

In [44, 45] the author show that In Bluetooth discovery is only in unlicensed band as WIFI which is subject to interference also it is asynchronous discovery, as more devices transmit receiving devices need to stay longer to discover devices which has also bad impact on energy efficiency. WIFI direct is two devices directly connected to transfer data and can discovery over WIFI direct, two-step process first broadcast request asking for Mac ID of all devices that are closed to it then all devices that hear the request sent to the device a unicast respond, after that the device send a unicast request for each device to discover its services and get a unicast response from each one but it is bad for energy efficiency. In LTE direct is far more efficient broadcasted by D2D users in the Discovery process contains ID, and services of each Device, D2D direct is synchronous discovery where device transmit and receive at the same time also discovery range can up to 500 m range while WIFI up to 200 m maximum while Bluetooth can discover devices up to 300 m. The data rate we can see the high difference of data rate of D2D compared to WIFI direct and Bluetooth as in D2D maximum data rate is 5-10 Gbps, while WIFI direct is 250 Mbps and Bluetooth is 48 Mbps only that's why the future of 5G network will depend on D2D Communications.

Feature Name	D2D	Wi-Fi Direct	Bluetooth5.0
Frequency band	Licensed band and unlicensed band	2.4 GHz, 5GHz	2.4-2.485GHz
Max data rate	5-10 Gbps	250 Mbps	48Mbps

Device discovery	BS coordination	ID broadcast and embed soft access point	Manual pairing
Max transmission distance	500 m	200m	300m
Uniformity of service provision	Yes	No	No
Quality of service	Qos guarantees	No Qos guarantees	No Qos guarantees
Standardization	3GPP	Release12 802.11	Bluetooth SIG
Application	Public safety, Content sharing, Local advertising, Cellular relay	Content sharing, Group gaming, Device connection	Object Exchange, Peripherals Connection

Table (1) Comparison between Bluetooth, WiFi Direct and LTE Direct

4- TYPES OF D2D COMMUNICATIONS

There are four main different types of D2D communications [46]:

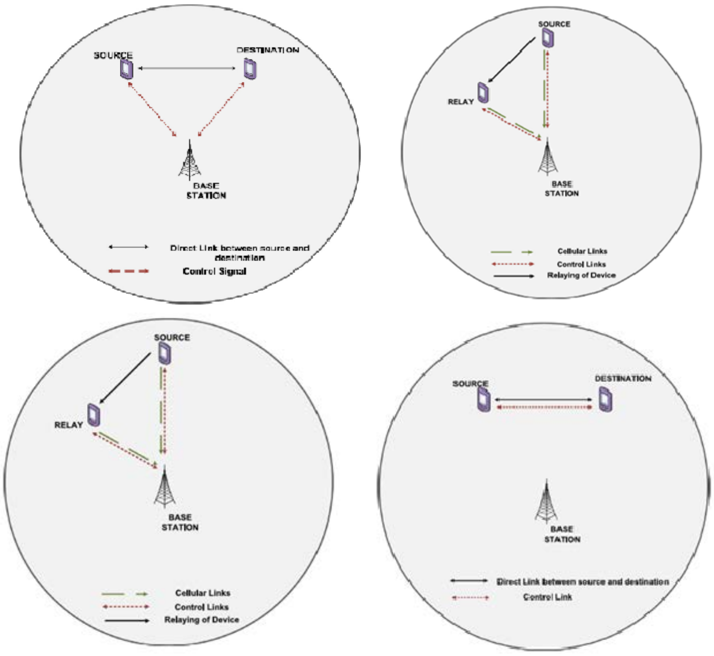
1) Relay device to other device or devices with control link established: Relaying with controlled link connection from the operator, devices at the cell edges or in poor coverage areas are capable of communicating with gNodeB by relaying information through different devices. All tasks of building the communication between the devices are handled by gNodeB.

2) Direct D2D communications under gNodeB controlled links from operator: Two devices communicate directly with each other, with control links provided by gNodeB in this scenario the communication is entirely managed by gNodeB. AS we can

see in figure 2- (2). a centralized Base station take the rule of interference management

3) Relay with device controlled link establishment: Two devices communicate via relays, Resource allocation and interference management all is managed by the devices themselves, no management of base station occur.

4) Uncentralized D2D Communications: Devices communicate directly, where there is no role from base station. Call setup and management are handled by the devices themselves as shown in figure 2-(4)., this 21 two-tier network architecture have a lot of benefits over ordinary cellular architecture like:



4- TYPES OF D2D COMMUNICATIONS

5. 5G NETWORK ARCHITECTURE

In [47] a lot of aspects for architecture of the new network to obtain a good multimedia, high resolution image, and mobile phones and social media apps. Some of challenges is solved with development 5G mobile network. The 5G mobile network can to solve the challenges which had 4G network facing as energy consumption, coverage, and (QoS).

5.1. CONTRIBUTIONS

In [8, 9] the authors, show the growing need for (D2D). Existing studies on device-to-device communication provide an comprehensive studies on the various issues. We proposed architecture for device-to-device communication, which are presenting as scenario for next generation and showing the inband and outband of D2D. Contributions in this survey aim to by sectoring antennas In the best places and allocating resources In the best places to the D2D users in the network and the cellular users, the architecture of the network can offer the best for the users.

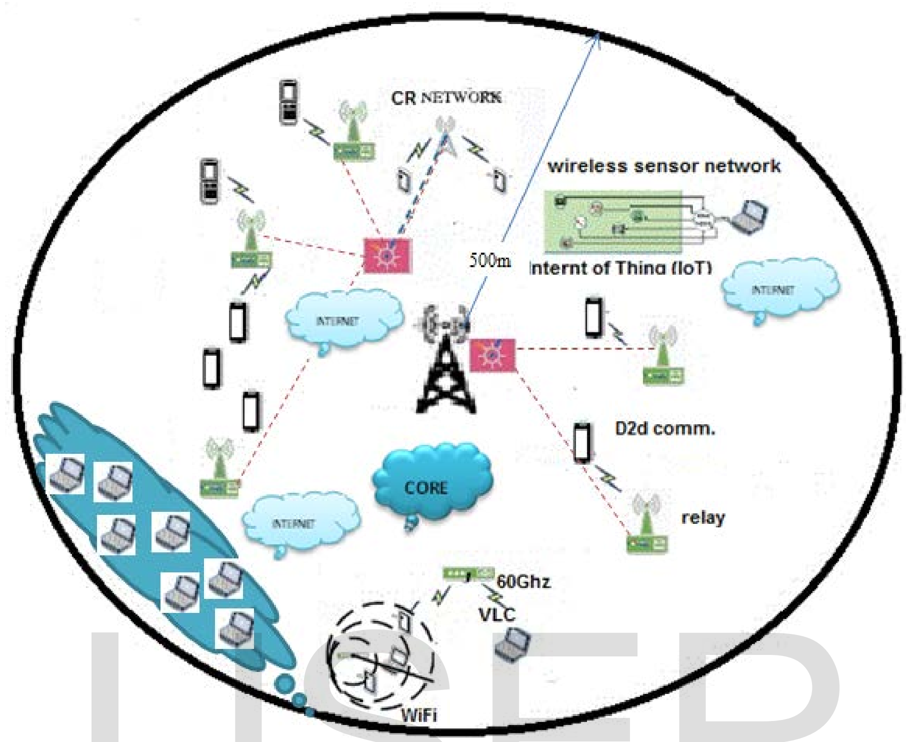


Fig. (3)

6. Integrant features of D2D

The devices communicated in a distributive fashion, in the industrial, scientific, medical (ISM) band, in the absences of any controlling entity. Some of application in device-to-device (D2D) communication as ad hoc networks and sensor networks,. Now a days, D2D communication is gaining popularity for use in the licensed band. Formation of direct links is useful for the improvement in the overall network performance, and also to the devices in terms of energy efficiency and complexity. There are some of features of 5G can be integrated with device-to-device(D2D) communication (Fig. 8some of these briefly listed below.

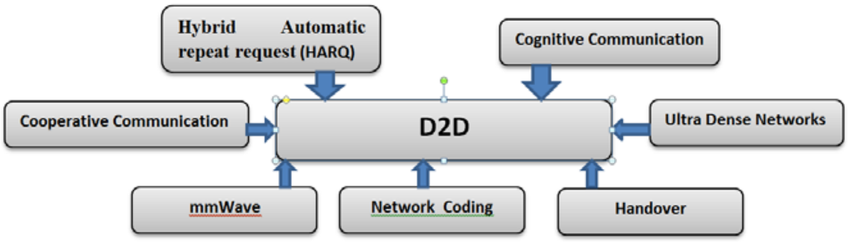


Fig. 4 . D2D integrant features.

6.1. Cognitive D2D

In [48, 49] the authors sensing and reusing of ISM band resources is possible with cognitive D2D. The cognitive spectrum access (CSA) optimized by optimize selection of the network design parameters. Cognitive and energy harvesting-based D2D communication has been modeled in [2]. Shows QoS of the cellular network improves with cognitive D2D communication, when network parameters are tuned carefully, the use of cognitive radio for offloading traffic. The results show reduction in transmission delay and play an essential role in improvement of spectrum efficiency by enabling the use of vacant bands by secondary users without causing any problem to primary users.

6.2. D2D ultra dense networks

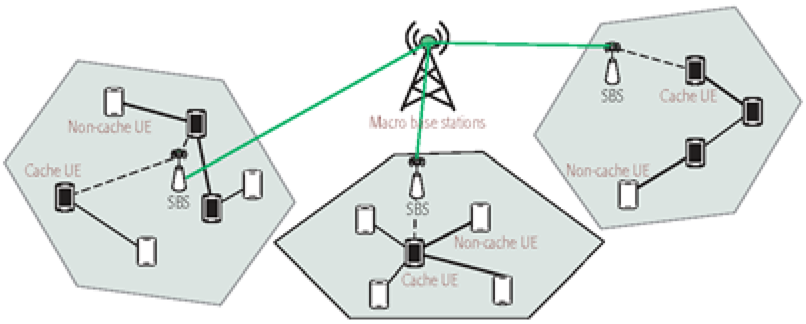


Fig. (5) An illustration of data caching under ultra dense network

The next generation 5G wireless network is expected to connect a large number of User Equipment (UEs), support massive machine to machine (M2M) communication, and enable the 1000-fold data traffic increase [50]. Cell size reduction has significantly improved network capacity. As stated in [51], from

1950 to 2000, wireless network capacity has increased 25 fold due to the implementation of wider spectrum frequency bands, 10 fold due to advances in modulation techniques and coding schemes, and 2700 fold through both the reduction of cell size and corresponding decrease in communication distance. As shown in Figure 1, a simplified UDN includes the components: densely deployed small cells, macro Base Stations (BS), network server/controller, moving nodes, and UEs. The principle features of the UDN are the following: (i) A large number of small cells and access points (greater than or equal to number of UEs). The frequency reuse can be improved by the large number of small cells in the same way that close distance and spectrum sharing works in macro cells. The dense small cells improve the network capacity by offloading macrocell traffic, balancing network loads, and reducing congestion. (ii) Dense and richly interconnected cross-tier deployment. This consists of macro cell, small cell (e.g., Pico, Femto), device to device (D2D) links, relay, etc., which collectively increase the complexity of the network environment. (iii) Fast access and flexible switching (e.g., handovers). In the densedeployment environment, the moving UE may frequently switch the connection among access nodes, for the sake of better service, optimal connections, etc. High Quality handover (HO) performance is needed to provide seamless and smooth connections.

6.3. Handover

When the two uses are near from some of them, they undergo a joint handover. some certain condition, the devices may not be near some of them or one of them may get handed over to some neighboring cell, resulting in a half handover. Very less literature is available on handover of D2D communication. Hand over margin is a constant variable representing a threshold of the difference between the strength of the received signal to the source BS and the strength of the received signal to the target BS. Unnecessary handovers, called “Ping-Pong effect” can be reduced by Hand Over mobility. D2D threshold (D2Dth) is used to check the radio signal strength of D2D quality. In case of joint handover, a collective handover of all the occurs, there is exchange of some unnecessary control overhead as well, between the devices. A general handover scenario has been depicted in Fig. 2, representing handover of UE from one base station to another (BS1 to BS2). Mobility management solutions have been provided in Yilmaz etal.(2014) where two schemes for smart mobility management have been proposed: D2D-aware handover and D2D-triggered handover.

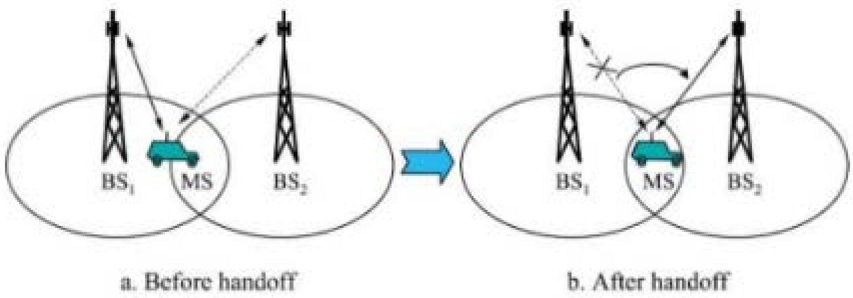


Fig. (6)

6.4. Network coding

In [54, 55] there are two aspects of study on network coding: codes design and system-level design. The design of network codes has the target of improving the efficiency of cooperative transmission, and closer matching with the channel conditions of each link in the entire chain. System design encompasses user pairing, selection of router, and resource scheduling. Network coding is highly coupled with deployment scenario, and detailed solutions should target certain scenarios, for example, cooperative relay or bi-directional transmission. They would have different impacts on the air interface specifications. A potential technique for the overall throughput improvement of a network is network coding. The transmitting nodes, with network coding, tend to combine the packets before transmission. This reduces the amount of routing information. Network coding in D2D communication helps in reducing power consumption, interference.

6.5. Millimeter wave D2D communication

In [56, 57] the author is proposed a wide frequency band of 30GHz to 300GHz. Efficient utilization by device-to-device (D2D) communication in 5G called millimeter wave(mmWave) to the user. Connections are due to the high direction antennas exploiting D2D transmissions has been proposed, resulting in transmission efficiency and improved network capacity. Using of directional antennas is enhanced network capacity but there are problems arise in case of neighbor discovery. The problem related to blockage and directionality in mmWave communication. Two types are local and global D2D communication, in local if the LOS path is blocked, then a path is changed between the two devices by help from the same base station, by help of relays or directly. In global, devices associated with different BSs. But, D2D connections in mmWave networks can suffer interference. There are multiple D2D communications local and global D2D communication in the network results in interference between local D2D communications and (Base station to base station/Device to Base station) communications. The mmWave communication use directional antennas, high data rate B2B communications are supported in the cellular networks.

6.6. Cooperative D2D communication

Cooperative D2D as a Technology Enabler for 5G. D2D communication is also being considered as technologies for the 5G network architecture [58]. This is because D2D-enabled 5G networks such as, cellular network offloading and vehicle-to-vehicle communication, the following potential gain network capacity gain by sharing radio resources efficiently between conventional and D2D-enabled UEs. User data rate gain, high peak rates may be achieved when UEs are close to each other with strong propagation links between them. Latency gain, direct communication between UEs bypassing the network infrastructure reduces the end-to-end latency. Additionally, D2D connectivity makes it possible for mobile devices in the multi-tier 5G network architecture to function as transmission relays for each other. Such improve the network performance without deploying new BSs [59]. By considering the D2D relaying example illustrated in **Fig. 2** System model for cellular wireless systems with cooperative D2D communication. UEs with strong communication links from the BS can send/receive data directly from the BS. However, UEs with bad communications links from the BS (for example, due to network blockage) can benefit from D2D communication with relay UEs to send/receive the data from the BS. The BS has to communicate some information with the destination UE. However, due to network blockage, direct communication with the destination UE cannot be established. The Relay UE, which is closer to the BS and has strong communication links with it, can act as a relay for the destination UE to enable indirect communication between the BS and the destination UE.

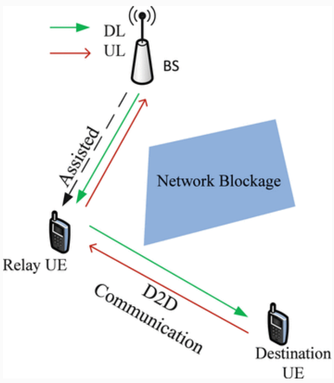


Fig.(7) System model for cellular wireless systems with cooperative D2D communication.

6.7. Hybrid automatic repeat request (HARQ) operation

Data transmissions in wireless channels are subject to errors because of variations in the signal quality received. Link Adaptation can handle such errors to some degrees. However, counteractions cannot be done to receiver noise and interference that are unpredictable. Therefore a Forward Error Correction is used in all wireless systems. The main principle beyond forward error-correction coding is to introduce redundancy in the transmitted signal. In this, the parity bits are added to the information bits prior to transmission. These parity checks are computed from the information bits using a method given by the coding structure used. The other approach to handle transmission errors is to use Automatic Repeat Request. In this approach, the receiver employs an error detection code to detect the received packet contains error or not. A positive Acknowledgement (ACK) is sent by the receiver to the transmitter when no error is detected in the packet. In case of an error occurring, the receiver discards the received error packet and transmits a negative Acknowledgement (NACK) to the transmitter. Thus the transmitter re-transmits the information after receiving the NACK.

Most of the modern wireless systems, including LTE deploy Hybrid ARQ (HARQ), which uses a combination of Forward Error Coding (FEC) and ARQ scheme in which unsuccessful attempts are used in FEC decoding instead of being discarded. The received packets are discarded and the receiver requests retransmissions of corrupted packets. The first proposal of Hybrid ARQ was in

[60] and since then, numerous publications have appeared (see literature [61] and references therein). In principle, any error-detection and error correction code can be used. But most of the practical hybrid ARQ schemes rely on cyclic redundancy check code for error detection and convolution or turbo codes for error correction.

7. Future work & Conclusion

7.1. Future work

I went into deep details about peer discovery and selection of D2D pairs using different discovery algorithms after that, I investigated types of interference that face D2D due to resource reuse, then I started to be more familiar with device discovery algorithms after that I choose different algorithms to apply in emergency scenario for single cell and multicell scenario and getting results. My main target is to find suitable solution for discovery and selecting D2D pairs in disaster scenario using different algorithms by comparing results of the average number of pairs that can be selected using different algorithms with respect to the number of devices and probability of the outage from the simulations.

7.2. Conclusion

In this survey paper, we briefly addressed aspects respect to the 5G network. An comprehensive investigation on device-to-device has been performed. We focused on the main approaches and did not go deeply into the algorithms. The integrant technologies is expected to solve the various challenges of the mobile network operators, efficiently satisfying all the demands of the users. A lot of features had used with D2D communication, to improve the cellular networks. Features of D2D are supported to the expected architecture to cellular networks. There are some challenges are overview in this survey, so D2D communication is an key technology for future networks.

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