An overview about cellular D2D communications and its Challenges on Multiple phases

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ABSTRACT--- Wireless Cellular communications and its application evolutions has increased the challenges behind its implementation. Wireless Cellular network is a distributed network consists of cells. These cells provide services across large geographical areas. It provides solutions to the existing challenges such as capacity, battery usage and interference. This paper, gives an overview of device to device communications (D2D communications), challenges faced in communication and solutions to the existing challenges.

Keywords: Device-to-device communications, cellular networks, Node discovery

I. INTRODUCTION

Cellular networks are wireless networks and it is used for the communication. Each cellular network distributed over different locations, these are called cells. Each cell will be having a constant location. This constant location is called as a base station or base transceiver station. For the transmission of voice, audio, video and other types of data base stations provides the network. Cellular networks use different frequencies to avoid the interference from the other cells and provide the high quality of service within a cell [1]. When cells are joined together provide wide range of area network, it covers the maximum number of nodes (e.g. Laptops, tablets, mobiles and etc.). Currently using GSM, CDMA and LTE networks all are called as cellular networks [2].

The main advantages of cellular networks are

- Even in roaming cellular networks provide high quality voice and audio services.
- Cellular networks connect both wired and wireless mobile users.
- These are easy to maintain.
- Cellular networks provide faster data transfer rates.
- It provides larger coverage area of network.
- If Cell towers are closer mobile devices consume less power to communicate with other devices.

1.1 Evolution of cellular networks:

From the last few years, mobile devices in wireless networks experienced a significant change. Generally, each mobile generation refers a change in accuracy, frequencies, system, latency and technology etc. Every mobile generation different from the other mobile generation that means each generation have different technologies, different frequencies and also includes new features in every new generation. Mobile communications from last few decades has become more popular due to the cellular networks from 1G to 5G [3].

1.1.1 First Generation (1G):

First generation mobile phones are introduced in 1982 and completed in 1990 and these are the first mobile phones in cellular networks. This generation mobile phones are used for voice calls and it uses AMPS (Advanced mobile phone system) technology. AMPS uses FDMA (Frequency division multiple access) with frequency band of 824-894MHz. 1G mobile devices allow voice calls in one country and it uses analog signals. 1G mobile device have poor battery life and poor voice quality.

1.1.2 Second generation (2G):

2G mobiles introduced in late 1980's and it mainly based on the GSM. For voice transmissions it uses digital signals. 2G devices used for transmission of text and picture messages. 2G provides better quality and capacity. 2G devices unable to handle complex data like videos and other types of complex data.

1.1.3 Third generation (3G):

3G devices introduced in 2000. 3G based on the GSM and the main aim of the 3G is, provide high data rate services. The speed limit of 3G systems is 2Mbps. It provides faster communication and it also provides video conferencing, 3D gaming. 3G requires high bandwidth and expensive to effort.

1.1.4 Fourth generation (4G):

LTE is also considered as a 4G technology. 4G provides high data rate services like downloading large videos and multimedia services. LTE is developed to increase the QOS (quality of service). The speed limit of 4G is upto 10Mbps to 1Gbps. It provides high quality of video streaming and also provides more security. It is hard to implement and consumes more battery life.

1.1.5 Fifth generation (5G):

5G devices introduced in late 2010's. It covers the maximum number of area and cover maximum number of nodes. It mainly focuses on WWWW (World-wireless World Wide Web). It provides high speed, high capacity and

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also provides faster data transmission. 5G devices are more effective and attractive. On other side dynamic spectrum access (DSA) becoming most prominent solution for providing high bandwidth by using unused spectrum. In this, instead of creating new bandwidth reusing existing spectrum in an effective direction. Though it is challenging task for research, increasing in bandwidth expected more [12].

1.2 D2D Communications:

Device-to-Device communications provides direct communication between nearby devices with or without using eNB (Evolved Node B) [4]. 5G networks provide high data rates, low power consumption and higher storage capacity. In 5G networks, D2D communications is considered as a key technology for higher data rates and also for quality of service. D2D communications are one of the promising solutions for enhancing spectrum utilization in traditional networks. Compared to the base station communication, direct communication provides higher throughput and less power consumption. D2D communication also improves the network coverage area, by that it covers the maximum number of nodes in a network.

1.2.1 Advantages of D2D communications are:

Energy efficiency: D2D communications communicate with only nearby devices. Because of that less distance, power consumption and time is less [5].

D2D communication networks consists of 2 main structures (1) stand-Alone D2D (without infrastructure) (2) network-Assisted D2D (with infrastructure). Main difference in between these structures is the existence of infrastructure. In stand-Alone D2D, systems organize the communications without infrastructure. In network-Assisted D2D, communications are organized with the help of infrastructure. There are many benefits of using D2D communications, but there are many limitations to overcome for improving technology. Particularly, D2D communications need well organized node discovery technologies, accurate mode selection (Dedicated, cellular, reuse mode) algorithms, complex resource management methodologies, mobility management approaches and strong security protocols.
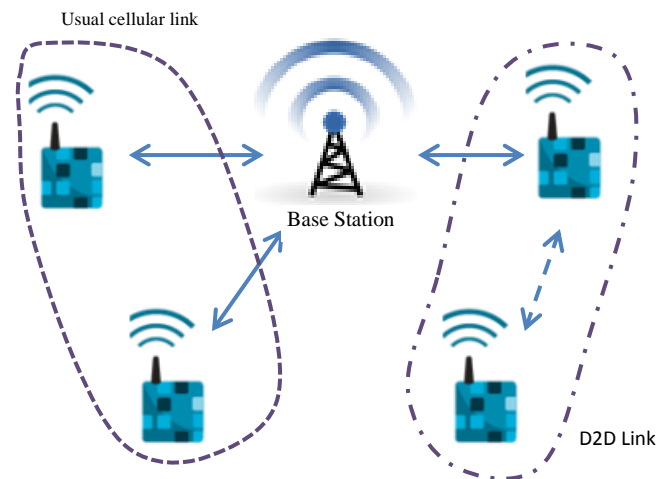

Figure 1 Cellular network with D2D link and usual cellular link

II. MULTIPLE PHASES INVOLVED IN D2D COMMUNICATIONS

2.1 Node Discovery:

First, users must be able to discover each other. User equipment's only can detect the nearby eNB's in the existing wireless cellular networks. By using random access procedures and synchronization, user equipment discover the nearby eNB's. Initially user equipment's has no information about nearby devices. To enable the D2D communication in cellular networks a new methodology is used for node discovery. In D2D communications after discovering the node, resources are allocated. Resources are allocated for D2D communications either in uplink or uplink. Next, direct link quality is estimated by the users, determines the proper modulation techniques and it also explains about the coding schemes. Finally, once the transmission starts, there is a need for feedback control to apply the hybrid automatic repeat request for the transmission [6] [13].

By checking the IP address of the packet or by checking the tokens of the two user equipment's, an eNB determines the user equipment's belongs to the same cell or not. However an eNB is needed, to process the IP headers and also needed two users for prior connection.

2.2 Mode selection:

Mainly mode selection is based on less distance in between the sender and receiver, quality of the direct link and D2D link is atleast as good as the cellular link or not. Then only mode selection procedures are proposed. InD2D, if D2D users are close to one another and resources are accessible. Then it prioritizes dedicated mode. If the coverage area is high and interference is low it prioritizes reuse mode. If the signal quality is high it prioritizes the cellular mode [7].

2.3 Resource allocation:

An efficient resource allocation method plays a critical role in upcoming cellular networks. Efficient resource allocation methods can increase the network throughput and reduces the traffic load in the base station or eNB. To increase the sum data rate ofD2Dand cellular user equipment's share the same resources with the consideration of co-channel interference. Intercell interference can be achieved by controlling the proper power control. An auction game is proposed based on the resource allocation algorithm. By applying auction game we can adequately reuse the resource of cellular users with D2D users [8]-[9] [14].

2.4 Security:

There are many benefits of D2D communications, but it exposes many security threats because of new application services. Compared to ordinary connections in between the mobile devices connected with eNB, direct transmissions are unprotected due to (1) the restricted estimation capacity of mobile devices for security related evaluations;) (2) semi- or fully- autonomous security management, such as mutual authentication, key arrangement and so on [10].

III. MAJOR CHALLENGES AND ITS TENTATIVE SOLUTIONS

3.1 Challenges in node discovery:

In LTE-A networks a new distributed, random access-based approach is proposed for peer discovery. To aware of their locations, a new node discovery protocol is proposed for D2D communications. D2D communication provides direct communication in between two users, but all data transmissions and signalling under the control of the base station or eNB in order to suitably into the existing cellular networks i.e. LTE-A network. In what follows, we first briefly introduce the LTE-A frame structure [11]. There are two main key features in traditional cellular networks. They are data transmission scheduling and frequency hoping. In D2D communications these two key components (frequency hopping and scheduling) are adopted to enhance the node discovery.

Two key features in the existing LTE-A standard, including data transmission scheduling, and frequency hopping are introduced. These two key components (frequency hopping and scheduling) are adopted by the proposed protocol to enhance the node discovery in D2D communication.

3.2 Challenges in mode selection:

Mode selection in a network decides two nodes in close proximity should communicate directly or not and whether to use dedicated mode, reuse mode or cellular mode. D2D users mainly operated in three communication modes. A multi-objective decision model for considering multiple performance factors for making mode selection. MCDM models are used for making decisions with consideration of multiple factors about alternatives.

3.3 Challenges in resource allocation:

D2D communications helps to improve the spectral efficiency and also increases the network coverage. But D2D communication introduces the interference to the normal cellular users. But it needs to develop the efficient interference and also cellular devices needs to realize the importance of D2D communications. Heterogeneous nature is a key challenge in cellular networks. In D2D communications, densification of Cellular base stations by using the small base stations and relays make resource allocation into a complex thing. To solve the resource allocation problem researchers found distributed methods with less difficulty. By using these distributed methods we can achieve the power allocation problems. To solve the resource allocation problems, stable matching, Stackelberg game and other methods are used.

3.4 Challenges in security:

To protect the private information, data access control needs to be applied for data transmission. By this process, authorized users can only access the data. To protect the confidentiality of the distributed data a session key is distributed in between the D2D users. Diffe-Hellman Key Exchange (DHKE) is used for the encryption of data.

IV. CONCLUSION

In this paper, we provide major survey on D2D communications in cellular networks. D2D communications had many advantages compared to traditional cellular networks. For future generations, D2D communications are optimistic and correct solutions.

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