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Device-to-Device Communication in 5G

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ABSTRACT

This super-fast 5G capability is not only to complement the network and as a 4G update, but it can build a new approach where technical capabilities such as data speed, latency, connectivity, and so on will have a different impact than before such as from 3G to 4G. This study uses a literature review method from 5G research and pre-existing device-to-device (D2D) communication. In this study, the advantages of D2D, the working principle of D2D communication, interference in D2D communication, D2D classification, security and privacy, energy consumption, relay to cost will be discussed if this technology is widely applied in the future.

Keywords: *5G, Device-to-Device, Interference, Communication, Spectrum efficiency.*

1. INTRODUCTION

The development of world technology, especially in the cellular sector, is very fast. The 5th generation of cellular technology is in sight. 5G network technology is a fifth- generation cellular technology development that focuses on increasing network capacity and faster data transfer speeds for various application media [1]. In hindsight, Device-to- Device (D2D) technology has been implemented since the fourth generation (4G) Long Term Evolution (LTE)- Advanced. However, in the fifth generation scientists have high hopes because 5G can provide 1,000 times the volume of data, 10-100 times more users, ten times more power- efficient, and five times lower latency than the previous generation [2]. The application of the method of transmitting data from the base point to each device is considered a conventional method. Therefore Device-to-Device Communication was chosen as an option for transmitting data on a 5G network which is considered more modern and more efficient in the data transmission process.

Besides, because D2D communication does not use a base station to deliver data, many advantages are generated by D2D. Such as increasing the spectral efficiency and system capacity, reducing network latency and EU power consumption, dismantling the 5G mobile network, and expanding network coverage [3]. Device to device is a promising technology in 5G, aside from improving connectivity in the next generation of networks, D2D also provides higher data rates and higher bandwidth with better QoS.

5G will not only be an evolution of the current network generation, 5G can be a revolution in the information and communication technology field with innovative network features. D2D communication in 5G refers to a paradigm where devices communicate directly with each other without routing data paths through the network infrastructure.

2. METHODOLOGY

This study uses the literature review method. Our data sources come from the results of research that has been carried out and published in online journals both nationally and internationally.

As researchers, we conducted a journal through the search engines of Google Scholar, Research Gate, Neliti, IEEE Xplore, and Hindawi with the keywords: 5G, Device-to- Device. The online journals that we collect as data sources are published in 2015 – 2020.

3. GENERAL D2D SCENARIOS

3.1. Definition

Device-to-Device (D2D) Communication is a technology that allows communication between devices without communication infrastructure such as access points (APs) and base stations (BSs) [4]. This technology was developed to reduce the workload of an Evolved Node-B (eNB) or base station, where two or more UEs can communicate directly with each other without going through an eNB [5]. In addition, D2D communication increases the coverage of the system by allowing an unenclosed device to pass its data through another closed device [6]. 5G technology believes D2D communication to be the key in the future because it seems like the right technology for proximity-based data sharing services [7].

The implementation of D2D technology for the D2D-5G Environment wireless network uses operator assistance as DataSpotting and Content Aggregator or autonomous modes such as FlashLinQ and Relay by smart-applications [8]. In this paper, we discuss further the prototype for D2D communication and its main experiments and comparisons between them.

3.2. D2D Performance

There are several ways to improve signal/data transfer performance by applying D2D technology to 5G. If a device is outside the range of the base station, then the Signal to Interference plus Noise Ratio (SINR) has a low value which prevents the device from communicating using the base station. However, this can be handled using the working principle of D2D, namely by relaying signals from devices that still receive signals from the *base station* [9].

In [10] the authors propose a spectrum allocation solution to minimize the radio resources required to upload some content to a base station (eNodeB) utilizing the possibility of D2D communication between User Equipment (UEs) adjacent to each other. By combining LTE-A transmission (multicast, D2D, and unicast) can minimize the information diffusion time of the given content with the eNodeB which is responsible for assisting the entire information diffusion process [11].

D2D communication is indeed the most appropriate choice for 5G technology. However, the basic features that exist in 5G technology have an impact on:

- The loss of call data records can disrupt the ICT forensic process
- The D2D communication system will affect the billing system and this needs to be regulated in a regulatory manner
- Privacy issues, especially for personal devices that function as AdHoc
- Regulations that allow the use of other devices as relays, other than that the use of other devices as relays will cause waste of battery/energy [12].

4. INTERFERENCE IN D2D

Interference Management is one of the foremost challenges for D2D communication. This happens because D2D applicators implement sharing mode which aims to increase spectrum efficiency but cause interference to the network[13]. Interference is also caused by the coexistence of the CU and D2D pairs that use the same cellular resources and the D2D users can suffer from intracellular and intercellular interference that depends on the D2D network operation mode, uplink and downlink[14]. Appropriate resource allocation can avoid serious interference, which keeps interference below a reasonable level [15]. Interference management schemes can be classified into interference avoidance, interference coordination, and interference cancellation.

5. CLASSIFICATION OF D2D COMMUNICATIONS

D2D communications are classified into Inband D2D and D2D Outband Communications. In D2D inband communication, the cellular spectrum is used for D2D and cellular links. The goal is to achieve QoS and high control over the cellular spectrum because there is less interference so that efficiency spectrum increases and QoS is preferred [16]. Whereas in outband communication, D2D works under an unlicensed spectrum so there is no interference between D2D and cellular links. Unlicensed spectrum requires an extra interface and usually adopts other wireless technologies, such as Wi-Fi Direct, ZigBee, or Bluetooth [17].

6. SECURITY AND PRIVACY

D2D also presents problems in the area of security and privacy. Security and privacy issues such as data theft, hacking, eavesdropping, data misuse, and privacy violations can occur at any time in the application of D2D technology. What is even more worrying is that due to the working principle of D2D which relays signals between devices, the user's location may be easy to track based on signal transmission data which makes user security vulnerable [18]. However, on the other hand, this can be an advantage for the authorities in the event of an emergency. For example, in the event of an act of terrorism or a natural disaster, information can be disseminated very easily to cellular service users even when there is a malfunction in the cellular infrastructure. Thus, authorities such as police and paramedics can find locations or detect vulnerable areas to speed up the evacuation process [19].

The risk of security threats will be even greater when the 5G network comes. In addition to the large number of devices connected to 5G, D2D communication will also be problematic because of the direct connection between adjacent devices. In paper [20] discusses the eCMS-SD2D protocol that can increase security in multicast services and utilize the resources of the upcoming 5G network. Byungjin Seok et al. [21] proposed a secure D2D communication system based on ECC lightweight cryptography and AEAD cipher. Their proposed system encrypts communications via a lightweight AEAD cipher using tokens as associated data so that data integrity can be performed at every step of data transmission. In addition to energy efficiency, this approach can also protect against crimes such as impersonation, eavesdropping, and location spoofing.

7. LOW ENERGY CONSUMPTION

Another challenge of applying D2D technology to 5G is the issue of energy consumption. Communication-based on D2D offers better energy efficiency for devices than communication-based on the base station. D2D offers a transmission process with the closest device so that it minimizes the amount of energy wasted in contrast to conventional transmission processes. The conventional transmission process requires the device to search for a signal to a specific base station to get a signal. So that the device will work continuously to get the best signal reception which results in a large amount of energy consumption [22][23].

One of the effective ways to increase energy efficiency from the application of D2D technology on 5G networks is to temporarily disable base stations with fewer users. This is related to the fact that the base station is one of the devices that use the most energy in the application of this technology. So by temporarily disabling the base station with fewer users, the device that was originally connected will relay signals from either the base station which has higher traffic or relay signals from other devices that are still within reach of signals from other base stations [24].

8. RELAY

The Scheme relay rights are needed in the application of D2D technology. Relay, which means broadcasting, serves to send signals from both the BS to the device and send signals between devices. Selection of scheme relay the right aims to increase network capacity and/or increase energy efficiency [25].

8.1. Cellular Relay

The cellular relay scheme is explained as a way for devices to receive signals from the base station or other devices connected to the nearest base station.

The schematic below shows that devices that are still inside the circle will receive a direct signal from the transmitter, while devices that are outside the circle will relay signals from devices that are still getting a direct signal from the BS but provided that they are not constrained by the interference spectrum [26].

8.2. IoT Relay Scheme

As another example, the following describes a scheme *relay* D2Din the application of IoT using Massive machine- type communications (mMTC) using the algorithm *K*-Means.

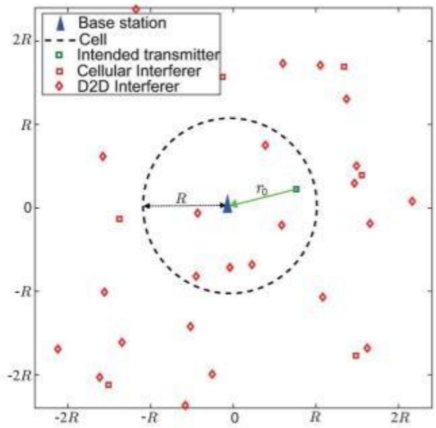

Figure 1 Mobile uplink with D2D. Located in the center is the receiving BS and indicated by a square symbol inside a circle are the devices that receive signals directly from the transmitter; indicated by a square symbol outside the circle is cellular interference; indicated by the diamond symbol is interference D2D[26].

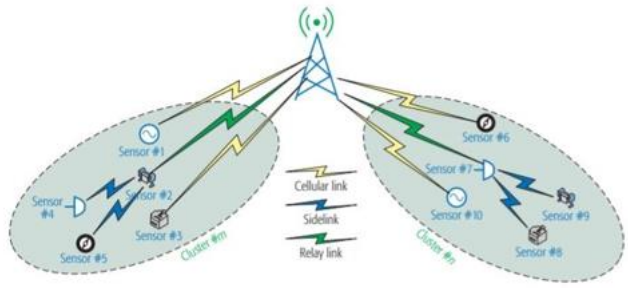

Figure 2 Relay scheme on IoT devices [27].

The basic steps of the algorithm K-means are as follows:

1. Initially, the BS selects K sensors with reference angles that are as far apart from each other as possible; This sensor is considered as the centroid of the K cluster. Because side linking is implemented for the two closest devices and an efficient clustering algorithm can help find sensors at the right distance. The design and implementation of an efficient scheme must consider all possibilities that can help improve system performance.
2. Take another sensor and hook it to the cluster, whose centroid is closest to the selected sensor wrt according to the reference angle.
3. Calculate the mean reference angle of the updated cluster, and select the sensor in this cluster that is closest to the mean value as the new centroid
4. Repeat steps 2 and 3 until each sensor is associated with a cluster [27].

By implementing the scheme relay right, it is hoped that a large network capacity can be achieved with the use of minimal resources to create efficiency and to realize new technologies that are environmentally friendly.

9. COSTS

Costing is one of the unsolved problems if D2D technology is later applied on a wide scale. If in the application of conventional cellular technology the amount of data usage can be known from the amount of data sent to the user through the base station, then the practice applied to D2D is different.

There are several schemes that have been implemented, one of which is with a device that relays signals directly paying incentives to the relayed device but this is only a design that is not yet known how to implement [28]. Then there is a scheme that allows D2D device users to be able to sell access relays to nearby D2D users [29].

10. DISASTER MANAGEMENT USING D2D

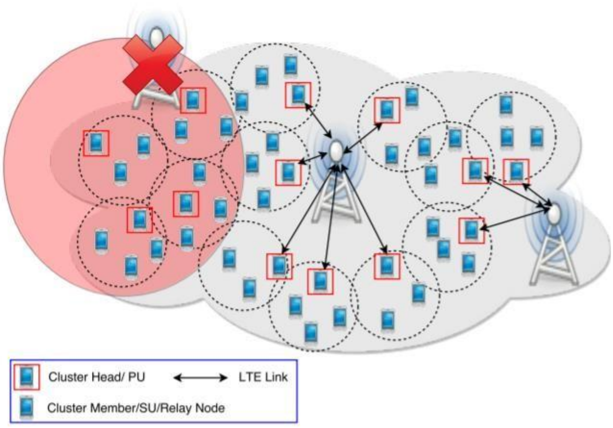

Figure 3 Scenarios of implementing D2D during a disaster [32].

D2D technology in 5G is not just to make it easier for a few people in the field of communication technology. If examined further, D2D technology on 5G can help the mitigation and evacuation process when natural and non-natural disasters occur. As an illustration, Tsunami disasters and large earthquakes often occur without warning. In Nepal, in 2015 there was a major earthquake that killed at least 8,000 people and injured at least 250,000, and caused the collapse of several historic buildings [30].

In a disaster, the effective use of radio resources is essential with the aim of serving the affected people to gather information from different sources in the disaster zone. In this context, D2D communication will be effective as for example, D2D based solutions allow efficient spectrum allocation with low latency rates [31].

Referring to the figure (see Figure 3.) if a disaster occurs that causes damage to several Base Stations, the devices in the red zone will lose signal reception. Therefore, with the application of D2D signals can be easily received by devices that are in the red zone by relaying signals from devices that are still within range of the Base Station which is still online [32].

Then the devices that still get a signal directly from the Base Station will be broken down again into several clusters with certain algorithm methods to be able to send a strong signal, wide range, and efficiently so that it can be received by other devices in the vicinity.

11. CONCLUSION

D2D technology in 5G is the future of communication networks. However, in its implementation, there are still various obstacles such as performance problems, interference, spectrum efficiency, power efficiency, privacy, and security, as well as other obstacles that may occur in the implementation in the future.

With the presence of this technology, it is hoped that it can facilitate all human needs, especially those related to information technology such as in the field of IoT, Big Data, cellular networks, and so on. In addition, this technology is also expected to be able to assist in the mitigation and evacuation stages in the event of a disaster because of its capabilities.

The application of this technology in the real world still requires further study and research to be able to solve the problems described above with the hope of creating D2D technology on 5G with maximum performance, low latency, and privacy and security that makes users feel safe and comfortable in using technology.

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