International Journal of Engineering & Technology, 7 (3.20) (2018) 435-440

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Review on Device-to-Device Communication in Cellular based Network Systems

Mustafa Hasan Al-Bowarab, Nurul Azma Zakaria[2], Zaheera Zainal Abidin[3], Ziadoon Kamil Maseer[4]

Center for Advanced Computing Technology, Faculty of Information Communication Technology, Universiti Teknikal Malaysia Melaka (UTeM), Hang Tuah Jaya, 76100, Durian Tunggal, Melaka Malaysia

Abstract

In a traditional cellular-network based system, the devices are not allowed to be interconnected directly in the certified mobile bandwidth, and all communications are carried out via the base station (BS). At present, device terminal broadcasting allows devices in the distributed network to act as transmitting relays to each other and reach a massive ad hoc network of networks that is different from the previous cellular architecture that faces technical challenges. Therefore, this article explores the application of a cellular-based two-layer network system that includes a base station (BS) cellular layer, such as cellular-to-device communication and communication between devices. In the proposed two-tier cellular-based network system, user data is transmitted through other users' devices to implement the privacy protection that is lacking in prior communication between devices in cellular systems. To ensure a negligible impact on the performance of current communication between devices, a two-layer network is assimilated to autonomous interference management schemes and associated resource allocation schemes. The findings from this review provide an overview of the major challenges in two-tier networks and propose a two-tier cellular-based system in which user data is routed through other users' devices to implement privacy protection.

Keywords: *data-to-data communication; cellular-to-device communications; network communications; celluar bases system; two-tier network.*

1. Introduction

With the launch of several smart handheld devices, mobile broadband user needs are experiencing unrivaled growth. The sharp rise in bandwidth systems, such as sharing media files and streaming videos, is already pushing the limits of current cellular-based systems. The ever-increasing demand for advanced data rates and capabilities requires unconventional thinking for a new generation of cellular network systems [1]. Mobile network-based networking means a new class of wireless communication techniques in which network nodes help each other to transfer data to realize spatial benefits.

This new communication paradigm promises a significant increase in performance in terms of transmission range, communication reliability, efficiency, spectral and system capabilities [2]. Cooperative comm unication has been extensively explored in literature and static broadcasting of terminals, which primarilzy involve the deployment of low-power base stations to support data communication between destination and source. Device-to-Device (D2D) network Communication in cellular network systems brings improvements in cellular systems, but full collaboration capability can only be achieved by application transfer devices. The term network communication between devices therefore refers to a portable wireless device or any other mobile phone with mobile connectivity, such as a laptop, tablet, etc. which is owned by an end user. Device communication allows devices in the network to function as relay relays and to implement a massive ad hoc network [3].

This is, of course, probable with the capabilities of cellular based network systems on device-to-devices, which allows two nearby devices to interconnect each other in the licensed cellular bandwidth without a connected base station or a limited base station (BS) association. It is clearly a dramatic departure from orthodox cellular architecture. In the first four versions of cellular-based network systems, the D2D communication options have not been decided. This is mainly because it is primarily int ended as a tool to reduce the costs of providing local services which were negligible in the past on the basis of market data on cellular transactions [4].

For this reason, operators' access to D2D features has recently changed due to numerous developments in the wireless market. The number of awareness-raising applications and services is growing rapidly. These applications need to communicate with neighboring devices as well as possessing location discovery features. Therefore, the availability of such features would reduce the communication fee between the devices. D2D features can also play a lively role in mobile cloud computing, enabling operational sharing of application resources, computational social content, energy spectrum, and so on. For users who are close to each other. In addition, service providers can use the D2D capabilities to use some off-network capabilities in a remote area such as campuses by enabling direct communication between mobile phones and other related devices [5].

In addition, D2D capabilities can be effectively used in communicating natural disasters. In the case of a hurricane or an earthquake, an emergency network based on data communication can be deployed using D2D functions in a short space of time and replace the broken communications network and Internet infrastructure. In the current trend, previous technologies and systems like Bluetooth or WiFi bring some D2D communication capabilities. However, it operates in an unlicensed band and the

disruption is uncontrollable. In addition, they cannot provide security and quality of service (QoS) as well as mobile networks. The reluctant to lose the evolving D2D market, cell manufacturers and operators have discovered the potential of introducing D2D communication capability into cellular network systems that have several options [5-7].

The structure of this review document is as follows. Section 2 is the materials and methods; Section 3 is the result of a review, section 4 is a discussion, and finally section 5 is conclusion and future work.

2. Materials and Methods

This study adopts a review of the literature by extracting and synthesizing secondary data to provide a theoretical understanding of communication between device-to-devices in cellular based network systems. Hence this Section comprises the research questions, categories of D2D communication, and advantages of D2D communication and issues of D2D communication in cellular based network systems.

2.1. Research Questions

This sub Section presents the research question this review papers aims to answer. Hence the following research questions are to be answered to guide this research study;

- What are the categories of D2D communication in cellular based network systems?
- What are the advantages of D2D communication in cellular based network systems?
- What are the issues of D2D communication in cellular based network systems?
- How to achieve device-to-device communication in cellular based network systems?

2.2. Categories of D2D Communication

This section provides a response to the first research question; what are the categories of D2D communication in cellular based network systems? Where D2D communication in a cellular based network system can be characterized as Outband D2D and Inband D2D based on the area in which D2D communication takes place. Therefore, D2D communication is divided into two categories or modes called Inband underlying mode when D2D communication uses cellular spectrum and resources. Inband overlay mode occurs when cell data is allocated to two D2D end devices that are directly connected [4-9].

On the other hand, Outbound D2D communication is based on the ability to eliminate communication interference between D2D communications. In addition, in the outband, D2D communication is challenged during the coordination phase by many problems between different communication bands [2].

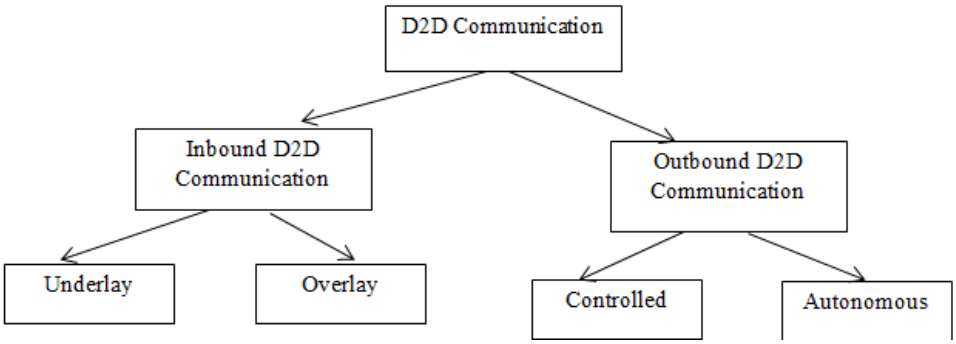

Fig.1: Categories of D2D Communication [1, 8]

Figure 3 shows the categories of D2D Communication which are described below as follows;

Inband Communication

This type of D2D communications called inband communication utilized mainly for high regulation over licensed spectrum. Results from previously studies conducted by XU et al. [10] show that the Quality of Service in inband communication is faced with lot of data communication requirements which is triggered by concern of the uncontrollability of intrusion in the unlicensed spectrum [1,8].

Although the practicalities of D2D communication and its impacts in the licensed spectrum have been studied by simulation-based analysis and examples, various scenarios and findings from authors such as Gandotra and Jha [8] show that tolerance of the spread of interference in the licensed spectrum may affect D2D communication [6].

Undelay Inband D2D mode

In underlay inband mode, D2D communication and cellular-based communications have the same broadcasting means. To date, most literature research has focused on D2D communication, which is the basis for underlying cellular based networks based on inband mode[1, 8].

Where the underlay inband can increase and improve the performance of various objectives such as cellular coverage, energy efficiency and spectrum efficiency by deploying different methods including resource allocation via network devices, reducing interference and encoding multiple devices [1, 8],

Overlay Inband D2D mode

In this approach, D2D communications and cellular based network systems are assigned dedicated cellular resources and are taken from cellular-based users to rule out interference from cellular-based systems transmission and D2D communication [1, 8].

Outband D2D communication

At the moment, Outband D2D communication is fascinating the responsiveness of many network based researchers .Hence this category of D2D communication is executed in the unlicensed spectrum which includes ISM 2.4G which communications the device communication interference between cellular network based systems and D2D communications which is usually impossible. In contrast to Outband D2D which may result to the uninhibited nature of unlicensed spectrum during device communication. But to exploit the unlicensed spectrum it is indispensable to have another second interface that can be deployed with Bluetooth or WIFI-Direct [1, 8].

Controlled mode

In this D2D communications classification, all literature recommends the use of cellular based network system advanced controlling features to increase the reliability and efficiency of D2D communication and also to improve the performance of cellular systems based on Multicast, power efficiency and throughput [1, 8].

Autonomous mode
Currently, there are very few research centered on this classification. Autonomous D2D communication is mainly aims to decrease the overhead of cellular network based systems. This classification does not entail any changes at the BS and can be easily deployed. It is presumed that the BS does not constantly have traffic to send to all end users at any time. They represent a scenario with two end users, u1 and u2 that being attended by single BS [1].

2.3. Advantages of D2D Communication

This Section provides answer to the second research question; what are the advantages of D2D communication in cellular based network systems? In which D2D communications was originally proposed in cellular network based communication systems in relation to a new standard towards enhancing network based performance routine. The impetus for D2D came mainly from the end user requirements and D2D based communications that can serve detailed future requirements. These needs which include new categories of data intensive short range services and applications [1, 8, 12]
But due to the eminent development of technologies and systems applications such as multimedia programs there has been a need to establish the deployment of D2D technology. Although D2D communications does allow new types of application services mainly peer-to-peer (P2P) file sharing, video streaming, multimedia and online gaming downloading services to users [1, 8, 13].
But this D2D communication uses technologies that empower pertinent communication between numerous D2D devices or users without requiring base station or intermediary devices on a distributed network. This enables D2D communication technology to address a few cellular network based systems problems such as interference management and poor network coverage. D2D communication thus increases spectrum utilization and network load capacity by improving network throughput and performance. Differing from the Bluetooth and WiFi-direct, D2D communication is thus utilized in D2D communication based on the spectrum in which D2D communications transpires.
Thus, D2D communication can be deployed on D2D communication and in this case it is mostly referred to as Inband D2D or can surface in unlicensed spectrum and is called Outband D2D. This is the main motivation for network vendors to towards choosing inband communications due to its high control above licensed spectrum [1, 8, 14-17].
Lastly in D2D communications the D2D communication can handle internet data traffic and several phone calls without extra networks load from the persuasive material. However, there are many complications of setting up cellular based network system and deploying D2D communications in advanced networks. These complexities and challenges include issues such as D2D devices causes intrusion to the
cellular users which distress the performance of the network devices and D2D communications outline new QoS request that must be addressed [1, 8, 18-20].

2.4. Issues of D2D Communication

This section provides a response to the first research question; what are the issues of D2D communication in cellular based network systems? In which D2D communication can be performed by direct communication between sender and receiver or D2D end users who act as relays on networks. The most unusual use of communication between the devices (D2D) is cellular unloading, resulting in improved network capacity. To carry out D2D communications in cellular networks, a number of significant issues need to be addressed. Some concerns about D2D communication include;

Peer Discovery
Since D2D communication is becoming popular, it is essential to include qualified resources to identify close users. The peer detection process should be effective to quickly emerge and detect D2D communication. It is also important to ensure the best performance, resource allocation and efficiency within the system. Set up direct communication requires that devices first determine each other. Once discovered, direct communications will be established and then communicated through these communications. Researchers are working on various methods of detecting devices [1, 8, 21].
Spatial association of wireless channels is considered for low energy peer detection. The simulation results show that peers can be revealed with much reduced energy consumption. It delivers a very precise method of peer detection. Peer discovery procedures can be restricted discovery and open discovery. In case of limited discovery, the devises cannot be perceived without their exact explicit permission [1, 8, 21].
This thus upholds user privacy. In case of open detection, devices can be detected during the period for which they lie in nearness of other Devices. From the perception of the network, device finding can be controlled by the BS either lightly or tightly.
Resource Allocation
Once the device is detected, the availability of resources to facilitate communication via direct connections is essential. The allocation of radio resources is therefore necessary to improve the spectral proficiency of D2D communication, undelaying cellular network based system communication [1].
Resource allocation approaches in D2D communication can be distributed or centralized. The centralized method devices cause complication in case of big networks while distributed technique devices tend to lessens the device complexity. The distributed technique devices follow the scalability of the D2D communications. A number of different methods for cellular network based system are available in existing literature [1, 21].
Power Control
Setting up primary power management for frequency re-use is an important area for researchers. This is particularly important in the case of higher communication signals due to near-far influence and co-channel interfering. Upon sharing a high level of performance with D2D users, the quality of service (QoS) of end-users of the cellular network system is maintained throughout the network. The controlling force effectively mitigates penetration into cellular networks. For cellular network based D2D, interest in performance management methods has been of great interest. The limit is set at the energy level of the D2D transmitter and its reused cellular network to achieve the best of the overall performance of the cellular system [1, 21].
Interference Management
Facilitating D2D communications within a cellular-based system creates a huge threat of interruption of the communications network. D2D communication can cause interference between D2D users and cellular users, causing increased cellular interference. Where communication between cells is also possible for D2D communication under a cellular network system [1, 21].
Interference can be moderated power control, over mode selection and optimal allocation of resources. Setting the D2D's extreme transmit power limits is an effective way to control interference between devices. A very dangerous term related to the prevention of interference is the mode selection. In general, the distance between cellular users and D2D users is considered when choosing a network mode, thereby avoiding interference [1, 21].
Security
Prior to implementing and accepting D2D technology in the cellular network, security needs to be ensured. Channels are prone to several security attacks, such as node impersonation, message modification and wiretapping. To prevent this, cryptographic clarification can be used to encrypt data before transmission. Safety contours provided by cellular operators can be used by D2D users if they are in coverage [1, 13].

But, users in separate coverage of the operators cannot be secured. In this case, safety signals may be delivered on through relays. But since relays are highly susceptible to malicious attacks, like spying attack, denial of service attack and free riding attack. Thus, deploying security schemes for D2D communication is an imperative challenge to be resolved [1, 12].

3. Results of the Two-Tier Cellular based Network System

This section provides a response to the fourth question of research; how to achieve device-to-device communication in cellular based network systems? This report proposes a cellular-based two-tier network system by reviewing and theorizing a two-tier cellular based network system with BS macro cell tier and device tiers. The structure of the BS macro cells tiers includes communication between base stations (BS) and devices as in the orthodox cellullar system as proposed by Tehrani et al. [3] and Gandotra and Jha [8].

The device tiers comprise D2D communication. If the device refers to a cellular-based communication system via BS, this device is considered to be functional in the macro cell tier BS. If the device is transferring through other devices or directly to another device, these devices are considered to be part of the device. In such a cellular-based communication system, BS will continue to serve the devices as normal. However, at the edges of cells or overloaded areas, devices will be certified to interconnect and form an ad hoc network. When communicating with the device level, the seller may have different levels of control. Based on the business model, either fully or partially controls the allocation of data between data sending devices and targets, the source, or prefers to have no regulation [3, 8].

Therefore, we can describe the following two main categories of device-tier communications, device relaying with operator controlled communication creation: A device at the edge of a cell or in a reduced coverage area can converse with the BS over relaying its information via additional devices. This permits for the device to attain more battery life or a higher QoS. The operator interconnects with the relaying devices for full or partial control communication establishment [3, 8].

Direct D2D communication with a communication created by an operator called “Device Relaying Operator Controlled Communication Formation” (DROCF), which creates communication between target and source devices, speaks and exchanges data without the need of BS, but with the help of the the operator for communication formation [3, 8].

In device relaying with device organized communication formation (DROCF), the operator is not intricate in the process of communication formation. Therefore, destination and source devices are answerable for organizing communication using relays between each other. Direct D2D communication with device controlled communication establishment (DROCF) The destination and source devices have direct communication with each other deprived of any operator control. Therefore, destination and source devices should use the available data in such a way as to guarantee less interference with other devices in the same similar tier alongside the BS macro cell tier [3, 8].

A two-tier cellular based network system brings significant improvements compared to standard cellular system architecture. Before reviewing the D2D features, a number of technical issues should be overcome, notably in terms of interference management and security. Due to the fact that user data is routed through other users' devices, data protection has to be secured. One possible security clarification is secure access for devices that want to work at the device level [3, 8].

In a closed or secure access, the device has a list of only trusted devices, and devices that are not in the trusted user list must use BS macro cell tier to connect to them. For example, workplace or neighboring users who are mutually recognized or users who have been verified and verified through a trusted party, such as associations, can communicate directly to each other and meet the level of protection of personal data. Devices in a group can set appropriate security measures among themselves to prevent their data from being detected to other devices on the same cellular network based communication system.

In open access, each device can function as a relay for other devices without any limitations. Since there is no type of regulation, or security measures in this case are the tasks of open research. A security issue in D2D communication involves investigating probable attacks, threats, and system exposure.

Previous work on Machine-To-Machine (M2M) safety issues may be adopted to address D2D security issues with open access. For example, work that recommended trusted settings to create trust relationships between M2M tools while a security-based approach controller is deliberated in. Detection of potential attacks, software-based symmetric key cryptography and secure routing can be further explored in another important concern in a two-tier system for D2D security implementation.

In (DROCF), the data allocation and call setup are performed by the BS. This suggests that BS can mitigate the problem of interference control by means of consolidated methods that are the core of wireless communication research. Conversely, there is no single entity in DROCF to manage the allocation of data between devices. Functions in the same license zone will be that devices in a cellular-based communications system inevitably affect mobile users [3, 8].

In order to ensure a negligible impact on the performance of existing cellular BS, a two-tier network with separate interference management approaches and appropriate resource allocation outlines should be proposed. In addition, there is interference between end-users in the device layer in interference between device and BS levels. Various methods such as bargaining game, relay selection, non-cooperative game, resource pooling power allocation, cluster partitioning and admission control can be initiated to solve resource allocation for this type of cellular communication communications [3, 8].

In (DROCF), as shown in Fig. 1, because BS is one of the communication components, some of the above problems can be solved by BS using existing methods. BS can verify transmission devices and use appropriate encryption to maintain adequate confidentiality of device information. BS can also manage the allocation of frequencies between transmitting devices to prevent them from being mixed with other devices.

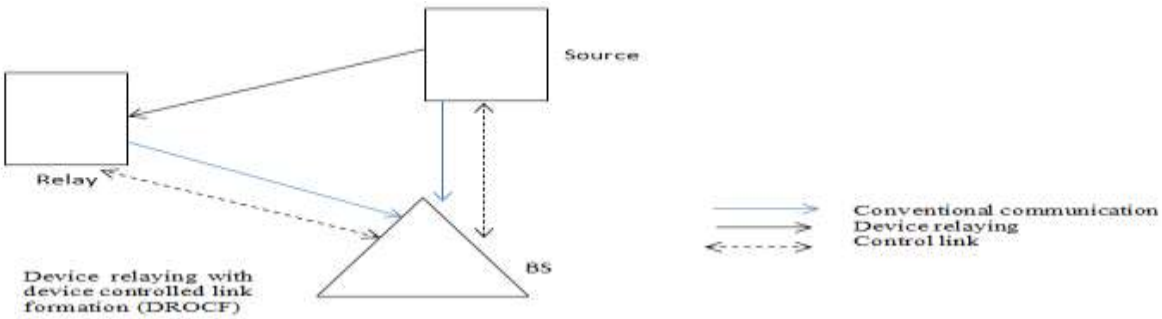

Fig.2: Device relaying with device controlled communication formation (DROCF) adopted from [3, 8].

Fig. 1 shows the device relaying communication with operator controlled communication formation (DROCF) structure. The device connects to BS by transferring its data over other devices.
While Fig. 2 shows a D2D direct communication image with operator controlled communication formation (DROCF). Source and target devices can exchange data and communicate with each other without having to have BS, and therefore help BS through control communications.
In (DROCF), shown in Figure 2, devices interconnect each other directly with well-organized operator communications. It's the operator that deals with connection management, monetary interaction, resource allocation, and access authentication across multiple devices. Therefore, it has full control over D2D connections, which includes control plane tasks such as maintenance and connection setup. Others include data plane functions, such as data allocation.
D2D communication shares a cellular licensed band with regular cell-based BS cellular connections. The network can either dynamically assign resources to each D2D connection in the same way as a systematic cellular connection, or semi-statically allocate the committed resource pool to all D2D connections.
In (DROCF), there is no server or BS to regulate the data transfers between devices. Hence numerous devices communicate with each other based on cooperative or non-cooperative association, and one or many devices can interacts and perform the role of relays for each other devices.

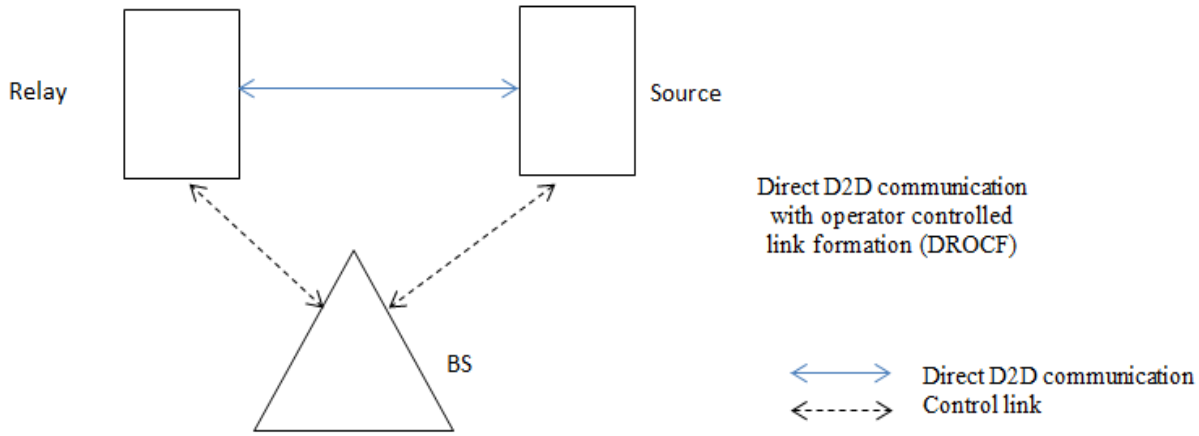

Fig.3: Direct D2D communication with operator controlled communication formation (DROCF) adopted from [3, 8].

Although this type of communication is more confusing than the previous, because there is no integrated surveillance over the broadcast. Connection operations, interference management, and resource distribution should therefore be addressed by scattered methods. Prior to the data communication phase, two devices must be exposed to one
another on the basis of adjacent relays. Devices may intermittently transmit the data so that other devices can respond to their presence and decide whether or not they can initiate D2D uninterrupted communications or transmission of device communications.

4. Discussion

Device-to-device (D2D) communications is being researched as a significant domain in cellular network based communication system. D2D can progress resource utilization in two ways which includes reuse of resources and unloading cellular traffic to D2D used by older cellular transmissions for D2D communication. To fulfill the cumulative service need and also deliver improved user experience, and for limited traffic load and device-to-device (D2D) infrastructures have been suggested for advanced cellular network based communication system [1, 8]. With D2D communications, nearness users in a cellular network can interconnect nonstop with each other devoid of going over the base station (BS).
Device-to-device (D2D) communications also increases the overall cellular network based communication system spectral efficacy and thus allowing network to acknowledge more end users devices. Nevertheless, D2D communications may produce interference into the present cellular network if not deliberate properly. Thus, intrusion management is one of the most perilous concerns for D2D underlying cellular networks where D2D where cellular communications co-occur in the network. To limit related interference in prevailing cellular users (CUs), limiting the transmit power of D2D infrastructures and the distance between the users of a D2D communication has been recommended by Feng et al. [2].
In this review paper, the Device-to-Device (D2D) communication allowed within is considered two-tier networks. The two tiers in these networks are denoted to as the macro cell tier and the device tier. Traditional cellular communication is maintained by the BS macro cell tier, while D2D communication is maintained by the device tier. These cellular network based communication system thus are similar to the existing networks [1, 8]. The difference is that some services can be achieved by devices in the locked areas of the devices. Since Device Level Devices allow direct D2D communication, BS may have limited management or full management over communication between or between devices.

5. Conclusion and Future Work

Device-to-device (D2D) communications is seen as innovative architype that will be applied in the succeeding generations of mobile networks towards providing extraordinary performance in cellular network based communication system [8].
Thereby enhancing coverage, providing spectral competence, deploying high data rates and offering better peer-to-peer services with QoS highly guaranteed [8]. Hence this paper, proposed a two-tier cellular based network system integrated with a BS and device tiers towards achieving a device-tier communications, by which the operator may possess different levels of regulation for cellular network based communication system.
This study provided a classification of D2D communication in relation to the degree of connection various cellular operator. Then this review also discussed some issues to be addressed for D2D communication for cellular network based communication system, which ranges from, resource allocation, security and

interference controlling issues. Finding from this review paper demonstrated the two-tier cellular based network system for device-to-device communication can bring about substantial benefits for both the operator and users in comparison to traditional single-tier counterpart.

Future work, will involves usage of diverse statistical models and simulation software to study and analyze the different necessities to attain better speed download, increased capacity, and QoS guarantees for D2D communication. Furthermore, we plan to enhance the two-tier cellular based network system for device-to-device communication by adding two more relaying steps to achieve 4 steps instead of two steps as presented in this review paper.

References

[1] M. Hicham, N. Abghour and M. Ouzzif, "DEVICE-TO-DEVICE (D2D) COMMUNICATION UNDER LTE-ADVANCED NETWORKS," International Journal of Wireless & Mobile Networks (IJWMN), vol. 8, 2016, pp. 11-22.

[2] D. Feng, L. Lu, Y. Yuan-Wu, G.Y. Li, G. Feng and S. Li, "Device-to-device communications underlaying cellular networks," IEEE Transactions on Communications,vol. 61, 2013, pp.3541-3551.

[3] M. N. Tehrani, M. Uysal and H. Yanikomeroglu, "Device-to-device communication in 5G cellular networks: challenges, solutions, and future directions," IEEE Communications Magazine, vol. 52, 2014, pp.86-92.

[4] T. Bansal, K. Sundaresan, S Rangarajan and P. Sinha, "R2D2: Embracing device-to-device communication in next generation cellular networks," 2014 Proceedings INFOCOM IEEE, pp. 1563-1571, 2014.

[5] G. George, R.K. Mungara, A. Lozano, "An analytical framework for device-to-device communication in cellular networks," IEEE Transactions on Wireless Communications, vol. 14, 2015, pp.6297-6310.

[6] J. Liu, Y. Kawamoto, H. Nishiyama, N. Kato and N. Kadowaki, "Device-to-device communications achieve efficient load balancing in LTE-advanced networks", IEEE Wireless Communications, vol. 21, 2014, pp.57-65.

[7] G. Fodor, A. Pradin and A. Gattami, "Device-to-device communications and network coding: friends or foes," IEEE Comsoc MMTC E-Letter, vol. 9, 2014, pp.33-35.

[8] P. Gandotra and R. K. Jha, "Device-to-device communication in cellular networks: A survey," Journal of Network and Computer Applications, vol. 71, 2016, pp.99-117.

[9] Y. Chen, S. He, F. Hou, Z. Shi and J. Chen, "Promoting device-to-device communication in cellular networks by contract-based incentive mechanisms," IEEE Network, 2017.

[10] K. D. Saifuldun Mostafa, Hayder Saad, Mustafa Musa Jaber, Mohammed Hasan Ali, "The Design Trends of Keystream Generator for Stream Cipher for High Immunity Attacks," in Advanced Computer and Communication Engineering Technology, Springer International Publishing, 2016, pp. 877–889.

[11] M. H. Ali, M. F. Zolkipli, M. M. Jaber, and M. A. Mohammed, "Intrusion detection system based on machine learning in cloud computing," J. Eng. Appl. Sci., vol. 12, no. 16, 2017.

[12] M. H. Ali, M. F. Zolkipli, M. A. Mohammed, and M. M. Jaber, "Enhance of extreme learning machine-genetic algorithm hybrid based on intrusion detection system," J. Eng. Appl. Sci., vol. 12, no. 16, 2017.

[13] S. K. Abd, R. T. Salih, S. A. R. Al-Haddad, F. Hashim, A. B. H. Abdullah, and S. Yussof, "Cloud computing security risks with authorization access for secure Multi-Tenancy based on AAAS protocol," in IEEE Region 10 Annual International Conference, Proceedings/TENCON, 2016.

[14] S. K. Abd, S. A. R. Al-Haddad, F. Hashim, A. B. H. J. Abdullah, and S. Yussof, "Energy-Aware Fault Tolerant Task offloading of Mobile Cloud Computing," in Proceedings - 5th IEEE International Conference on Mobile Cloud Computing, Services, and Engineering, MobileCloud 2017, 2017.

[15] S.Y. Lien, C.C. Chien, F.M. Tseng and T.C. Ho, "3GPP device-to-device communications for beyond 4G cellular networks," IEEE Communications Magazine, vol. 54, 2016, pp.29-35.

[16] Z. Uykan and R. Jäntti, "Transmission-order optimization for bidirectional Device-To-Device (D2D) communications underlaying cellular TDD networks—A graph theoretic approach," IEEE Journal on Selected Areas in Communications, vol. 34, 2016, pp.1-14.

[17] H. Chen, L. Liu, T. Novlan, J.D. Matyjas, B.L. Ng and J. Zhang, "Spatial Spectrum Sensing-Based Device-to-Device Cellular Networks," IEEE Transactions on Wireless Communications, vol. 15, 2016, pp.7299-7313.

[18] K.W. Choi, D.T. Wiriaatmadja and E. Hossain, "Discovering mobile applications in cellular device-to-device communications: Hash function and bloom filter-based approach," IEEE Transactions on Mobile Computing,vol. 15, 2016, pp.336-349.

[19] T. Zhang, H. Wang, X. Chu and J. He, "A Signaling-based Incentive Mechanism for Device-to-Device Content Sharing in Cellular Networks," IEEE Communications Letters, 2017.

[20] J. Yao, T. Wang, X. Wu, L. Wang and B. Zheng, "Blind spot coverage strategy based on D2D communications for electric LTE network," 8th International Conference on Wireless Communications & Signal Processing (WCSP), pp. 1-4, 2016.

[21] A. Hematian, W. Yu, C. Lu, D. Griffith and N. Golmie, "A Clustering-Based Device-to-Device Communication to Support Diverse Applications," Proceedings of the International Conference on Research in Adaptive and Convergent Systems. pp. 97-102, 2016.