IoT 환경에서 모바일 엣지 컴퓨팅을 통한 디바이스간 타스크 관리 프레임워크

고광만*, Ramtin Ranji**, Ali Mansoor**, 김순곤***
*상지대학교 컴퓨터공학과, **University of Malaya,
***중부대학교 컴퓨터게임공학과
e-mail:kkman@sangji.ac.kr

Green Device to Device Task Management Framework by Mobile Edge Computing in IoT Environment

Kwang-Man Ko*, Ramtin Ranji**, Ali Mansoor**, Soon-Gohn Kim***
*상지대학교 컴퓨터공학과, **University of Malaya,
***중부대학교 컴퓨터게임공학과

Abstract

Motivating by two promising technique of 5G, namely D2D and Edge computing, and the above mentioned problem of the current joint studies, We believe that more study is needed on the benefits of joining these two techniques in a single framework by more precisely taking into account the energy needed to computation, sending data, receiving data and as a result achieving more realistic energy efficiency in 5G cellular networks.

1. Introduction

By 2020, more than 50 billion devices will be connected to the Internet. This huge amount of devices bring about energy efficiency and computation challenges. Device-to-Device communication is considered as a promising technique in 5G cellular network. In D2D communication two devices can interact without the need to send data to eNodeB and since there are much close to each other, they can conserve their energy. For computation problem currently devices send their complex computation tasks to the cloud. However, current cloud services can not handle those amount of service requests in time. Edge computing is proposed to tackle the problem of the delay sensitive services by bringing the cloud in proximity of the user. Moreover, it can help to conserve the battery of the devices by computation offloading.

Device to device communication needs device discovery and handle malicious nodes to achieve high energy efficiency. With the dense deployment of devices, these tasks become complicated and energy consuming. On the other hand, in Edge computing, considering only the eNodeB as a helper node to perform the computation of the devices will overlook the vast amount of potential devices in the proximity of the requester node. In heterogeneous network, devices have different computation capabilities and also different levels of energy. So, they can help each other to achieve more energy efficiency of the whole network.

Studying the joint solutions based on D2D communication and Edge computing currently attracting researchers to tackle the shortcoming of each solution. The problem in current literatures is that they don't consider the sending and receiving data as separate transmission tasks in their scheduling algorithms, while sending data needs much more energy than receiving data.

Motivating by two promising technique of 5G, namely D2D and Edge computing, and the above mentioned problem of the current joint studies, We believe that more study is needed on the benefits of joining these two techniques in a single framework by more precisely taking into account the energy needed to 1) Computation 2) Sending Data 3) Receiving data and as a result achieving more realistic energy efficiency in 5G cellular networks.

2. Literature Review

The first ever published work in the context of fog/edge computing in 5G radio access network has been done by authors in [1]. They define

architecture of the system and principles behind the design of such combination. They discussed that D2D connection is most appropriate for user centric services and fog can bring large amount of storage, management, configuration, and computation and measurement capabilities next to the user. Putting two functions of signal processing and resource management for collaborative communications on Fog-APs(Access Points) cause decreasing the load on the fronthaul. In their architecture, Fog-UEs defined as D2D enabled UEs that have access to Fog-Aps. In a small area, Fog-APs and High Power nodes (HPNs) can become active and D2D relay fog nodes can leverage the need of increasing the capacity when there is a huge load. If distance of two D2D enabled device is further than their supported range, a third Fog-UE can become relay in between. Fog-APs and HPNs can sleep when the load is below threshold. Although they discuss that this new framework will lead to energy efficiency but they don't provide any energy consumption model.

In [2] the authors proposed the first integration of D2D connection and fog/edge computing as a hybrid task offloading framework and named it HyFog. In HyFog, every device have the ability to choose between three types of task execution. 1) Local execution. 2) D2D offloading the task to the more powerful proximate device. 3) Offload the task to the resource rich edge cloud. They first build a three layer graph and then transform it to a minimum weight matching problem and finally they impose a revised version of the Edmonds's Blossom algorithm to find which option is optimal for task execution. They enhance their work and introduce D2D crowd system in [3]. They consider task offloading by collaboration of heterogeneous devices in term of connection quality and processing power. The base station help to identify the most efficient task offloading assignment again by solving a graph-matching based algorithm. They claim 50 percent of energy efficiency in task offloading in comparison with the case all tasks performed locally. However, in their formulation there is a lack of differentiating between transmitting data and receiving data. As a matter of fact, transmitting data consumes much more energy. As a result, it must be considered separately to formulate the energy consumption more realistic. Also, for the numerical analysis they use a simple mobility simulation and general assumptions about signal quality and Ue load. In this research, we are going to propose an energy-efficient D2D task offloading in MEC framework to cover the mentioned gaps in [3].

3. Research Motivation and Problems

Energy efficiency is a crucial part in every technology. By the massive increase in the number of connected devices to the Internet, energy efficiency of connected devices becomes a constant challenge. In the latest cellular standard, 5G, two promising technologies will be contributing to the energy efficiency namely device to device communication and edge computing. Currently, integration of these two technologies attract the attention of the academics to design energy efficient Framework [1][3]. Since, it's a new approach and there are some gaps in each work, it motivates me to study in this field to mitigate the mentioned problems and contribute to the energy efficiency of mobile cellular networks.

More and more devices are going to connect to the Internet. There are two separate solutions for energy saving of devices which each of them has their own drawbacks. Using device to device connection can help to shorten the distance of the communication to provide energy efficiency. Mobile edge computing can help to offload energy hungry task to the more powerful and also non-battery limited power. The former solution has the problem of identifying the proximate nodes which consume energy and also malicious nodes can degrade the performance of the network in term of energy management. The later solution overlooked the capabilities of other devices in the network in the proximity of requester device. The current problem is that how we can join these two solutions to gain more energy saving and also overcome the problems of each solution as depicted in the Fig. 1. Since these two technique are going to be included in 5G, more research needed to develop a fine framework for cooperating devices in 5G network.

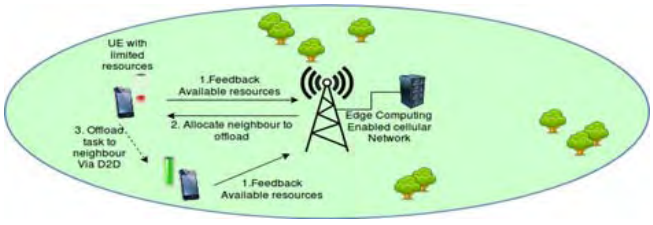

Fig. 1. Model of D2D Communication in 5G Environment

There is a gap in the current literature for joint solution of D2D communication in edge computing environment. They don't differentiate the higher energy consumption of transmitting the data in comparison with receiving data. So there is a need to develop a realistic energy efficient task Scheduling algorithm, which consider the following factors: 1)Power needed for computation. 2)Power needed to send data and 3)power needed to receive data. 4)Fair task allocation to prolong the life-time of the network. 5)Take into account resources constraints of UEs and delay constraints of tasks.

4. Conclusion

Energy efficiency is a NP-Hard problem and needs a constant research form academic. Moreover, 5G cellular network is the solution of the ever increasing wireless communication needs of billion devices. As a result, 5G will be deployed globally and energy efficient deployment of 5G will help to alleviate global warming, decreasing the cost of mobile users for buying more powerful devices to perform their computation hungry tasks and also it helps mobile service providers to increase. The coverage of their network and increase the quality of experience of users. All in all, my research can give insight to researches to investigate energy efficiency benefits of joining D2D and edge computing more realistically. And also encourage engineers who works on 5G networks to consider D2D and Mobile edge computing features more seriously in their design.

Acknowledgement. This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education (2017030223).

References

[1] Alippi, C., Fantacci, R., Marabissi, D., & Roveri, M. ,"A cloud to the ground: Thenew frontier of intelligent and autonomous networks of things." IEEE Communications Magazine, 54(12), 14 - 20, 2016.

[2] Pu, L., Chen, X., Xu, J., & Fu, X. ,"D2D Fogging: An energy-efficient and incentive-aware task offloading framework via network-assisted d2d collaboration" IEEE Journal on Selected Areas in Communications, 34(12), 3887 - 39014, 2016.

[3] Chen, X., Pu, L., Gao, L., Wu, W., & Wu, D. (2017). Exploiting Massive D2D Collaboration for Energy-Efficient Mobile Edge Computing. IEEE Wireless Communications, 24(4), 64 - 71. https://doi.org/10.1109/MWC.2017.1600321.