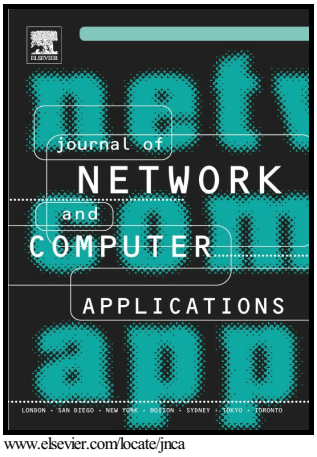
Resource Management in D2D Communication: An Optimization Perspective

M. Ahmad, M. Azam, M. Naeem, M. Iqbal, A. Anpalagan, M. Haneef



www.elsevier.com/locate/jnca

PII: S1084-8045(17)30126-1
DOI: http://dx.doi.org/10.1016/j.jnca.2017.03.017
Reference: YJNCA1889

To appear in: *Journal of Network and Computer Applications*

Received date: 20 December 2016
Revised date: 9 March 2017
Accepted date: 20 March 2017

Cite this article as: M. Ahmad, M. Azam, M. Naeem, M. Iqbal, A. Anpalagan and M. Haneef, Resource Management in D2D Communication: An Optimization Perspective, *Journal of Network and Computer Applications*, http://dx.doi.org/10.1016/j.jnca.2017.03.017

Resource Management in D2D Communication: An Optimization Perspective

M. Ahmad*, M. Azam$, M. Naeem*,‡, M. Iqbal*, A. Anpalagan‡ and M. Haneef $

***Abstract*—Device-to-device (D2D) Communication was primarily introduced to achieve the fundamental goal of high data rates, ubiquitous coverage with low latency, energy efficiency and minimization of cost for per-information transmission. However, with the advent of new applications culminating from the plethora of different market segments, D2D communication is being foreseen as an integral part of the emerging fifth generation (5G) networks. Widespread use of D2D communication can result in numerous challenges namely, security, interference, access control, network mode selection and power allocation. In this paper, firstly, we provide an overview of D2D communication in cellular networks and secondly, an extensive review is presented relating to optimization approaches used for resource allocation in D2D paradigm. We classify the relevant work with respect to different optimization objectives being considered while formulating optimization problems. Some commonly used optimization formulations have been explained which makes this paper a foundation stone for further research in the area. A classification of optimization problem types and the relevant solution algorithms are also presented. We also discuss some candidate technologies for future D2D communication paradigm. Comprehensive coverage of the subject in this paper serves as a first step towards further research relating to the area of resource allocation in D2D paradigm.**

***Index terms*—** Device-to-Device communication, admission control, mode selection.

I. Introduction

Telecom operators are struggling to cope with the existing data rate requirements of the cellular users and to leverage the network performance to accommodate the emerging demands arising from the plethora of different market segments. Although 4G cellular technologies have efficient physical and MAC layer performance, yet these will not be able to catch up the expected thousand-fold increase in total mobile broadband data [1], [2]. Next generation cellular technologies are being developed to cater for huge data needs of the consumers. Different technologies are under development to enable next generation technologies including D2D capabilities. The huge increase in volume of traffic and the number of potential communicating pairs under the control of base station will increase the processing burden over the centralized coordinator. According to the prediction of wireless and mobile communication enablers for 2020 Information Society (METIS) [3], worldwide mobile traffic will increase thousand-fold over the next decade [4]. Prediction by another forecast is to reach 50 billion connected devices by 2020 [5]. The drastic increase in connected devices such as Internet of things (IoT), wireless sensors, actuators and tablet devices will require huge demands of data on the network to support new paradigms. Device-to-device (D2D) communication in cellular networks is being considered by 3rd Generation Partnership Project (3GPP) as potential technology to meet the booming demand of data [6]. In addition to enhancing the throughput of the cellular system, it can offload the processing burden of centralized controller by facilitating two users in the close proximity to communicate directly without requiring the voice and traffic channel between the users and the centralized controller [7]–[9]. Discovery mechanism permits the users to know that some other user is in its vicinity. Proximity based services are becoming attractive source of revenue. Different localization techniques can be deployed such as arriving angle, timing of the arrival and global positioning systems [10]. In [11], authors suggest to use D2D communication for data off-loading of traffic originated due to proximity based services. In [12], authors delineate public safety related proximity services. In case of emergency situation when all other modes of communication are unavailable, D2D mode will be deployed by the users. In the next generation cellular networks, relay nodes are also added along with D2D. However, device-to-device communication paradigm can precipitate new problems relating to the reuse of cellular resources, architecture and intra-cell interference management [13]–[15]. A typical cellular network having D2D communication capability is presented in Fig. 1. The base station controls all the activities related to mode selection and resource allocation for cellular and D2D devices. Usually, base station allows the two users to communicate directly when these are located in close proximity. On the other hand, normal cellular mode is activated when the users are away from each other. In the following subsections we elaborate different modes of D2D communication.

A. Band classification and operating modes in D2D communication

In D2D communication paradigm, the spectrum sharing between cellular users and the D2D users can be implemented in two different ways namely, inband and outband. Further, the control of resources is also managed in two ways, namely, controlled and autonomous. In controlled mode, the control on resources is handled by base stations, whereas, in autonomous mode users themselves configure resources. Fig. 2 illustrates the band classification of device to device communication based on spectrum and control implementation. In [16], authors describe D2D taxonomy based on usage of spectrum only.

* COMSATS Institute of Information Technology, Wah Campus, Wah, Pakistan. ‡. WINCORE Laboratory in the Department of Electrical and Computer Engineering, Ryerson University, Ontario, Canada. $ Foundation University Institute of Engineering and Management Sciences, Islamabad.