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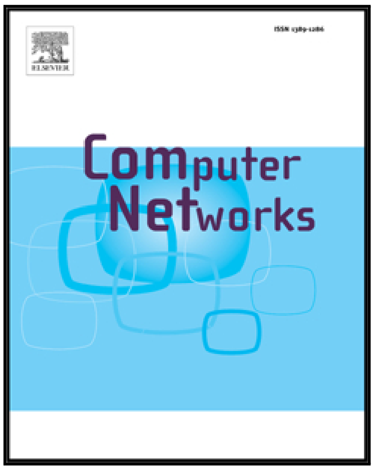

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Efficient Resource Allocation Algorithm for Overlay D2D Communication

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Abstract—**Device-to-device (D2D) communication in cellular systems offers an economically viable means of improving the system capacity by allocating multiple D2D links within the same resource block (RB), under appropriate interference-control techniques. In this paper, we propose an efficient resource allocation algorithm that enables maximum spatial reuse in orthogonal frequency division multiple access (OFDMA) systems. Given a set of D2D requests, the proposed algorithm greedily determines the number of RBs required, following the reliability criteria. Simulation results show that, compared to the greedy algorithm (Lee, Choi, and Jeon, 2013), the proposed algorithm could save up to 18.6% RBs, improve the throughput per RB by up to 23.4%, and reduce the computation time by up to 67.9%.**

Index Terms—**Device-to-device communication, spatial reuse, resource allocation, cellular network, intra-cell interference.**

1. Introduction

DUE to the increasing popularity of hand-held smart devices, the data demands of user equipment (UE) are pushing the limits of the existing cellular networks. Extending the spectrums and increasing the deployment of Evolved Node B (eNB) are some of the remedies for network capacity enhancement, to accommodate the booming data demands. However, spectrum extension and eNB deployment are inherently expensive and time consuming. As a large number of the applications require local area networking, device-to-device (D2D) communication appears to be an important supplement for proximity-based services [1]-[11].

Unlike traditional cellular communication, D2D communication allows direct data transmission between two nearby UE, without the need for an eNB, and has many potential benefits for both users and network operators. From the user's perspective, short-range D2D communication can 1) increase the data rate, 2) improve the power efficiency, 3) extend the battery life for a mobile user, and 4) reduce the end-to-end delay from cellular communications. From the operator's perspective, D2D communication can provide multiple benefits such as: 1) traffic offloading from the eNB to the local area network 2) system-capacity and frequency-efficiency enhancement due to spatial reuse and 3) eNB coverage extension via UE-to-UE relaying.

The implementation of D2D communication in cellular networks involves many fundamental challenges [1],[2]. One such issue is the efficient utilization of the cellular spectrum by both the D2D links and the cellular links. The best solution is to allow multiple links within a resource block (RB) to communicate simultaneously. By allocating an RB to multiple links, the spectrum efficiency might either be improved because of reuse, or degraded because of co-channel interference (CCI) between the links. In practice, a resource scheduler is indispensable to fully exploit the reusing gain, with appropriate CCI management.

Based on the manner of resource reutilization, D2D communication can be classified as underlay D2D or overlay D2D. In underlay D2D, the D2D links reuse the RBs already used by cellular links, while in overlay D2D, the cellular and D2D links use orthogonal RBs. There are cross-tier and D2D-self CCIs in underlay D2D, while there is only D2D-self CCI in overlay D2D, where cross-tier CCI is the CCI between the D2D and cellular links, and D2D-self CCI is the CCI between D2D links.

For overlay D2D, one critical issue is to minimize the number of RBs required for D2D communication with a reliability constraint [12],[13]. In comparison with the existing literature, the main contributions and outcomes of this study are summarized as follows:

D2D: Device-to-device
RB : Resource block
OFDMA: Orthogonal frequency division multiple access
eNB : Evolved Node B
3GPP: Third Generation Partnership Project
LTE: Long Term Evolution
RAN: Radio Access Network
CCI: Co-channel interference
CSI: Channel-state information
QoS: Quality of service
TTI: Transmission time interval
RV: Random variable
MCS: Modulation and coding scheme
SINR: Signal-to-interference-plus-noise ratio
SIR: Signal-to-interference ratio
GA: Greedy algorithm
SRA: Stepwise removal algorithm