Interference Aware Underlay D2D Multicasting through Effective Use of Under-utilized RBs

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ABSTRACT

Conducting simultaneous transmissions of Device to Device (D2D) multicasting alongside cellular network communications in underlay mode has the potential to enhance spectral efficiency. Such multicasting in underlay mode requires appropriate interference mitigation techniques to maintain the quality of network access services. This is due to the mutual interference between the formulated clusters and the ongoing cellular transmissions. Therefore, appropriate resource allocation is an important research concern. This paper addresses an effective strategy of opportunistic spectrum reuse to admit D2D multicasting in underlay cellular networks. The proposed interference-aware D2D multicasting deals with appropriate resource allocation together with cluster formation through efficient cluster-head (CH) selection. The joint problem is mathematically formulated through integer linear programming (ILP). Considering the hardness of the problem an elegant greedy solution has been proposed. The merit of the proposed solution is established through simulations conducted in NS2 showing acceptable service coverage and network throughput.

KEYWORDS

D2D multicasting, Underlay mode, RB allocation, Interference management.

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1 INTRODUCTION

D2D multicasting has been considered a promising approach for delivering common content to a group of intended recipients of nearby locations. This strategy significantly reduces the traffic load on the deployed base station (BS) by facilitating direct content delivery, bypassing the involvement of the BS. Avoiding the involvement of BS or direct individual communications results in higher spectral efficiency and energy efficiency [13]. D2D multicasting has a wide range of applications including public safety, social network, and vehicular communications [4, 6]. In underlay communications, multicasting transmission takes place with coexisting cellular communications in the same spectrum which greatly enhances the spectrum efficiency. However, admitting D2D multicasting with the existing cellular network in the same spectrum creates many challenges such as interference management between the cellular users (CUs) and D2D multicast users (MUs). Furthermore, dealing with inter-cluster interference is also a primary concern that requires judicious resource allocation in such network scenarios.

Opportunistic spectrum reuse represents a flexible and adaptive approach to spectrum management, enabling more dynamic and efficient use of the radio frequency spectrum. In this strategy, some selected channels from the cellular spectrum are used to admit the desired D2D MUs instead of allocating a dedicated spectrum resource for them. This can lead to efficient spectrum usage. However, in a heterogeneous environment, interference management becomes a crucial concern when CUs and D2D MUs transmit simultaneously in the same spectrum. The network performance may be reduced to a significant extent due to increased interference in such cases. Therefore, the resource allocation for the D2D MUs must take care of the existing channel conditions to maintain appropriate QoS. In this context, an interference-aware resource allocation is an important requirement to implement the opportunistic spectrum reuse efficiently.

This manuscript uses an efficient resource allocation strategy to investigate an interference aware D2D multicasting in underlay mode. The underlay mode is demonstrated through the coexisting CUs and D2D MUs involved in simultaneous transmissions in the same spectrum. In such context, we have modelled the interference between the CUs and D2D MUs as well as the inter-cluster interference. To address this interference, we have advocated for a careful selection of the existing cellular spectrum resources which are opportunistically reused for admitting the D2D MUs. In our approach, opportunistic reuse is based on identifying suitable under-utilized cellular spectrum resources that are judiciously allocated to the D2D MUs. Our multicasting strategy also ensures a suitable cluster formation technique that selects the appropriate cluster head (CH) confirming conflict-free transmissions with other CUs and admitted D2D MUs.

We organize the rest of the manuscript as follows. Some relevant research in the same direction has been described in Section 2. Section 3 describes the network environment and interference model. We have mathematically formulated the problem and presented the same in Section 4. The proposed greedy is described in section 5. Section 6 evaluates the performance of the proposed approach. Finally, Section 7 concludes the paper.

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