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**On Uplink Virtual MIMO with Device Relaying Cooperation Enforcement in 5G Networks**

**Abstract:**

In this paper, a novel protocol is proposed in which mobile terminals (MT) form a virtual Multiple-input Multiple-output (MIMO) uplink by means of device relaying on Device to Device (D2D) tier in 5G Cellular Network. The competitive scenario is considered in which each of the selfish MTs tries to transmit its own data and not relay others’ data in the formed virtual MIMO. The main focus is to design an incentive for MTs to form the virtual MIMO and cooperate in relaying others data. A direct revelation on-line mechanism for the BS is designed, in order to assist forming a stable virtual MIMO. A self-punishment mechanism is also proposed in which MTs autonomously punish malicious MTs that do not cooperate in relaying. We prove that our designed direct revelation on-line mechanism and proposed self-punishment mechanism enforce all-cooperation (all-C) profile as a Nash equilibrium (NE), under uncertainty in the presence of MTs in the formed virtual MIMO. Our simulation results confirm that the proposed protocol, even in the competitive scenario, increases the bit rate and decreases power consumption at the same time. The proposed protocol can improve the energy efficiency up to 35% compared to a non-cooperative case, i.e., Single-Input Multiple-Output (SIMO) uplink. Moreover, if the multi-user MIMO transmission is used for the uplink medium access layer, the proposed protocol can improve the energy efficiency up to 42% compared to SIMO uplink with multi-user MIMO transmission. Under the proposed OCVM protocol with Shapley value fairness, the price of anarchy reaches to 0.78 in the competitive scenario. In addition, the energy efficiency improvement of our proposed protocol is almost robust to the preferences of MTs. Simulation results show that if BS employs our on-line mechanism and MTs autonomously punish malicious MTs, the malicious MTs cannot gain by defecting from relaying other MTs’ data.

**Existing System:**

The device relaying makes it possible for devices in a network to function as relays for each other. In uplink, there is one transmitting antenna for each MT and two or more receiving antennas for the BS. Therefore, if we allow single antenna MTs to cooperate with each others on information transmission at the same sub-channel, a virtual MIMO link can be constructed by device relaying.

Consequently, not only MTs increase their data rate, but also the BS can save resources in terms of sub-channels. Designing an efficient virtual MIMO uplink by device relaying faces numerous technical challenges in the D2D tier of 5G cellular network such as: resource allocation and interference management, privacy of user data, and persuading devices to participate in this type of communication.

**Proposed System:**

The main contribution of this paper is to propose a novel Online Collaborative Virtual MIMO (OCVM) protocol, for persuading selfish MTs to form uplink virtual MIMO in D2D tier and enforce cooperation among them to relay others’ data. We model the problem using a gametheoretical framework, where we consider both bit rate and battery consumption of MTs as their preferences. We design a direct revelation on-line mechanism for OCVM protocol, in which MTs should reveal their duration of presence in the virtual MIMO coalition. The goal of on-line mechanism is to increase total uploaded data by MTs, persuade them to participate in virtual MIMO and guarantee fairness among them. After forming virtual MIMO, we design a self-punish mechanism which enforces MTs to reveal their duration of presence in the coalition truthfully and cooperate in the formed virtual MIMO. We will show that our proposed OCVM protocol provides all-cooperation (all-C) profile as a Nash equilibrium (NE) under uncertainty about the MTs’ duration of presence in the coalition.

We use both of coalitional and noncooperative games to design a novel virtual MIMO formation by autonomously device relaying. We apply the coalitional game to find out the formed cooperative virtual MIMO groups and also we use the noncooperative game to design self-punishment mechanism in each coalition.

Without a-priori knowledge of mobility pattern of MTs, we use the uncertainty about the MTs’ duration of presence of MTs in the coalition to motivate the selfish MTs to form stable coalitions and relay others’s data in each coalition. According to the best of our knowledge, it is the first time that the unknown mobility pattern of MTs is applied to enforce cooperation between MTs in wireless applications.