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Sara Kassan, Jaafar Gaber, Pascal Lorenz

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Game Theory based distributed clustering approach to maximize Wireless Sensors Network lifetime

[1]Sara Kassan, [2]Jaafar Gaber, [1]Pascal Lorenz
[1]Univ. Haute-Alsace UHA, 34 rue Grillenbreit, 68000 Colmar Cedex France, email: {sara.kassan, pascal.lorenz}@uha.fr
[2]FEMTO-ST Institute, Univ. Bourgogne Franche-Comté UBFC, Univ. Technology Belfort- Montbéliard UTBM, 13 rue E.T.Mieg, 90010 Belfort Cedex France, email: jaafar.gaber@utbm.fr

***Abstract*— One of the most significant difficulty in Wireless Sensors Network (WSN) is the development of an effective topology control method that can support the quality of the network, respect the limited memory and at the same time increase the lifetime of the network. This paper introduces a new approach by mixing a non-cooperative Game Theory technique with a decentralized clustering algorithm to address the problem of maximizing the network lifetime. More precisely, this approach uses Game Theory techniques to control the activities of a sensor node and its neighbors to limit the number of the forwarding messages and to maximize the lifetime of the sensor's battery. In other words, the approach will decrease the energy consumed by the WSN by decreasing the number of forwarded packets and improve the network lifetime by harvesting energy from the environment. The simulations results show that the performances in terms of energy saving and increasing the number of data packets received by base station outperforms those with distributed based clustering algorithms without GT, such as low energy and location based clustering LELC and LEACH algorithms.**

Keywords—WSN; sensor lifetime; energy harvesting; clustering protocols; game theory; equilibrium

1. INTRODUCTION

The WSN has required an important attentiveness in these years. It is implicated widely in different domains, such as health care, ecosystem monitoring, environmental assessing, target tracking, maintaining control, and urban areas applications [1] [2] [3]. The major activities of a sensor node are capturing the data information in its urban environment, aggregate it and forward it to reach the sink using routing protocols. Moreover, the finite batteries capacity implies a limited lifetime of the sensor nodes and their applications. For this problem, several solution techniques have been proposed to prolong the network lifetime. Some of these solutions are based on topology control, routing protocols, data aggregation, forecasting approaches and others [4] [5] [6] [7] [8]. The main tasks of our study is to extend the network lifetime by decreasing the wasted energy during the sensor node activities, and compensate the loss of energy by harvesting environmental energy in the sleeping mode. Our proposed method is based on a non-cooperative MGET in a clustering hierarchical structure. This approach is divided in two phases. The first one consists to select dynamically the clusters and their clusters heads based on sensors energy and location [9]. In the second phase, the sensor node aggregates the sensing messages by a compression method to save sensor's energy and memory and decided to stay out of the communication to charge its battery in the sleeping mode or to enter the market game and send the message to its neighbors. The suitable decision of the sensor node depends on the probability obtained by maximizing its utility.

In this paper, the rest main contributions are structured as follows:

Section □ presents the categories of clustering protocols. In addition, it shows the different types of the GTs, their applications in WSN and the GT principle. In section □, we explain the energy consumed by the different activities of an arbitrary sensor node and the model of sensor's rechargeable battery. In section □, we adapt a non-cooperative game theory in a decentralized clustering protocol to prolong the WSN lifetime, decrease the wasted energy in the network and increase the number of data information arrived to the BS. The simulation results are presented and investigated in □. Finally, we conclude the paper in section □.

2. Related work

2.1. Clustering

Clustering protocols are one of the effective techniques of broadcasting for organizing the network and improving its lifetime and . Election of cluster heads (CHs) play a significant role in energy consumption management [10]. Clustering protocols can be categorized in two classes: Centralized [11] and distributed clustering algorithms [12].

2.1.1. Centralized clustering

In centralized clustering, the BS is the organizer to form clusters. At the start of each round, sensors nodes have to transmit their location information and energy status to the BS. The BS will collect all information from all the sensors nodes in the network, select Cluster Heads (CH), and form clusters. This type of clustering is not a very suitable way to