Performance of the Energy Aware Routing Protocol in Wireless Sensor Networks with mobile nodes

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Abstract— *Wireless Sensor Networks (WSNs) are increasing in popularity. This is due to several applications (like car tracking, acute patient monitoring and forest fire detection). Energy in WSNs is a scarce resource and therefore has to be optimized. Several studies on energy aware routing schemes have been made. However, most of them cater for fixed nodes yet in some cases, some WSN nodes are mobile. In this paper, we extend the Energy Aware Routing Protocol (EARP) [1] to cater for WSNs with some mobile nodes. We propose EARP with Mobility Support (EARP-MS) and evaluate its performance. We show that (i) the energy consumed increases as the distance between the source and recipient nodes increase, (ii) providing for node mobility prolongs the WSN lifespan, (iii) mobile nodes have higher residual energy than the static nodes and (iv) the average transmission time is lower when some nodes are mobile..*

Keywords: WSN, mobile nodes, routing, EARP, EARP-NS

1. Introduction

WSNs are used in a variety of applications. These include forest fire detection, acute patient monitoring and target tracking. In general, when a node senses a change in environment, it conveys the message through the network to the base station. Along the way, some processing may take place on the nodes. Nodes, therefore, incur energy as they route the data through the WSN. It is rare that after some time of operation, the energy in all nodes in a WSN is the same. This is because the amount of the energy consumed differs among the nodes. This is dictated by the role and how active a node is. Energy consumed by a node gathering data differ from that consumed by a node transmitting data. Likewise, energy consumed by the cluster head differs from the rest. Even among nodes of similar roles, energy consumption is bound to be different. For example transmitting nodes far away from the cluster heads tend to lose more energy. Further more, redeployment of nodes for prolonging network lifetime also causes residual energy not to be equal among sensor nodes. Overall, Routing of the data from the source to the cluster head comes at a cost. It is the main determinant of the energy levels in a WSN. It is of paramount importance that all nodes have sufficient energy as total draining of some nodes' energy my mean that it is impossible for data to take a certain route. A lot of research on improving WSN lifespan has been carried out [1], [2], [3], [4].

Ming et al [1] analyzed three algorithms, LEACH [2], HEED [3] and EECS [1]. They proposed the EARP that addresses most of the weaknesses of LEACH, HEED and EECS. They showed that indeed EARP is superior compared to the three. Much as EARP is effective, it assumes (i) all nodes are static and (ii) each node captures data from environment. This is not always true. There are cases where some nodes are mobile and data comes from mobile nodes (e.g. car surveillance) which cannot be addressed by EARP.

In this paper, we extend the EARP to cater for mobile nodes as well as cases where not all the nodes can collect data. We improve the algorithm to cater for the above scenario and also test the effectiveness of the improved algorithm.

The rest of the paper is organized as follows, In Section 2 we discuss earlier research related to this work which also form a basis for it. In Section 3, we discuss the improved EARP that caters for mobile nodes. We then present and discuss our experimental results in Section 4 and conclude the paper and propose future research in Section 5.

2. Related work

Substantial work has been done on energy aware protocols in WSNs. The most recent and popular work include LEACH [2], HEED [3], EECS [1], PEGASIS [4], M-LEACH [5] and EARP [1].

2.1 LEACH

The Low-Energy Adaptive Clustering Hierarchy (LEACH) was proposed by Heinzelman et al [2]. It assumes a unique base station outside the sensor network and that all the sensor nodes are able to directly communicate with the base station. In order to save energy, LEACH chooses a fraction p of the sensor nodes to serve as cluster heads.