ABSTRACT

Energy efficiency is still a challenging issue in wireless sensor networks (WSNs). Balancing nodes’ activities and duty cycling are efficient ways that could enhance WSN’s performances. In this paper the authors introduce a new asynchronous power saving mechanism that provides an adaptive duty cycle and a minimum overhead to achieve load balancing and energy saving. This mechanism relies on two basic functions: an asynchronous duty cycling for activity balancing and a lightweight geographic routing. Extensive simulations showed the effectiveness of the proposed approach in terms of residual energy, energy consumption balancing and packet delivery ratio.

Keywords: Energy Saving, Forwarding, Geographic Routing, MAC Protocols, Routing, Wireless Sensor Networks

1. INTRODUCTION

Because of their wide range of potential applications including military, medical systems, and robotic exploration, wireless sensor networks have become a promising technology. Those networks consist of small, resource constrained nodes that organize themselves in a multi hop wireless network. A node in the WSN has one or more sensors, embedded processor, moderate amount of memory and transmitter/receiver circuitry.

As demonstrated by Ye et al. (2002), since sensor nodes are usually battery powered, conserving their energy and prolonging the network life time are primary goals while designing protocols for those networks. While traditional protocols are designed to maximize packet throughput, minimize latency and provide fairness, protocol design for wireless sensor networks has to focus on minimizing energy consumption.

Most of the proposed mechanisms in the literature rely on switching off sensors’ radio when unneeded. The major challenge of such solution is to maintain coordination between neighbor nodes to ensure both devices remain active and participate in communication.

Many classifications of such mechanisms has been proposed, the most common classifica-
tion distinguishes between two main categories: the first one includes the synchronous protocols which establish a schedule that specifies when nodes are awake and asleep while the second introduces the asynchronous/contention based protocols, relying generally on polling and control packets to ensure coordination. Some of those protocols will be described later in this paper.

Moreover, balancing nodes activity is important to maximize the network lifetime. When no balance is applied, some nodes can be constantly used, by routing protocol for instance, so they die very early while others may remain unused. Although synchronous mechanisms are more likely to offer balance, they suffer from the complexity of setting up the network synchronization and, in most of those mechanisms, the node level of energy is not considered when deciding to include it in a communication.

In this paper we give a review of the synchronous and asynchronous MAC protocols for WSNs. We introduce after a new asynchronous approach that considers the residual energy of a node as the main factor when organizing the node activity. Our approach is based on two protocols. Lightweight Balanced Power Saving MAC Protocol (LBPS) is a MAC mechanism that combines the simplicity of the asynchronous protocols and the balance provided by synchronous ones. Simple Greedy Routing Protocol (SGRP) is a geographic routing protocol based on minimum local computation and no overhead.

The rest of this paper is organized as follows: the following section presents a review of MAC protocols for sensor networks, afterwards we define our proposal: the SGRP/LBPS mechanism. We then illustrate the results of simulations that show the performance of our approach and we conclude the paper afterwards.

2. RELATED WORK

WSN MAC protocols must utilize the hardware resources on a sensor node thoughtfully to save energy and prolong the network lifetime. Many researches have been carried out at this end. As mentioned earlier and illustrated in Figure 1, two general classes for sensor network MAC protocols exist: synchronous protocols and asynchronous or random protocols.

Scheduled MAC protocols attempt to organize sensor nodes so their communications occur in a predefined order (Akyildiz et al., 2002), while unscheduled protocols attempt to conserve energy by allowing sensor nodes to operate independently with a minimum of complexity.

*Figure 1. Taxonomy of WSN MAC protocols*
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