1 Introduction

This document describes a course project proposal regarding energy-efficient query schemes in wireless sensor networks. Our goal is to combine the comb-needle model [1] for discovery and the ripple-zone-based scheme [2] for energy-efficient data query and data aggregation [2] into a unified model with the advantages of the two. Moreover, this combined approach aims to improve the shortcomings of one model with the advantages of the other.

2 The Comb-Needle Model

This model [1] is a simple and efficient data discovery scheme for supporting queries in large-scale sensor networks. It combines the advantages of push and pull strategies for data dissemination and builds an efficient query-support mechanism that adapts itself to the frequency of queries and events.

In a push-based data dissemination strategy, the nodes in the network always broadcast information throughout the network whether or not the information was previously required. As a result, when the demand for information is low, considerable broadcast bandwidth and node energy is wasted. In a pull-based data dissemination strategy, a node broadcasts a query for certain information on demand. Thus, when the frequency of queries is low compared to the frequency of events, the pull-based strategy performs better, because the communication occurs only when it is required.

The comb-needle model requires the nodes to push their data only to a certain neighborhood and to query for information only in a subset of the network. The model also addresses other important issues, such as query coverage in unreliable networks and adaptive strategies when the frequencies of queries and events are unknown \textit{a priori}. 

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3 The Ripple-Zone-Based Data Query Mechanism

In [2], in the context of a mobile telemedicine application, the authors propose a ripple-zone-based energy-efficient data query mechanism to enable a medical specialist to collect physiological data from their patients. In order to limit wireless communication, the mechanism requires sensors to organize themselves into different zones. In each zone, the nodes form a Minimum Spanning Tree and use intra-zone multi-hop communication to find the shortest paths among each other.

The zones are combined into domains which have as their center a Medical Phone, which performs data aggregation (duplicate elimination, sums, min, max, etc...). In their inter-zone architecture, a medical specialist’s query is broadcasted to all medical phones, which broadcast the message to their zones. Their simulation results showed that this scheme has very low energy consumption.

4 Integrating the Two Approaches

The comb-needle model is energy-efficient for data discovery because queries and events are not broadcasted to all nodes in the network. The queries are broadcasted only vertically and then fan out horizontally from only certain nodes of the network grid. The events, on the other hand, are broadcasted vertically and only to a certain number of nodes. In spite of that, this model does not employ any data aggregation scheme and, therefore, the replies to queries pass through many hops until they reach the query node, thus, wasting energy.

The ripple-zone-based scheme has the advantage of employing data aggregation, dividing nodes into clusters, consequently, limiting wireless communication to a short distance. Nonetheless, their inter-zone architecture makes use of flooding twice: first, when a medical specialist’s query is broadcasted to all medical phones, and second, when the medical phones broadcast the received question to the nodes inside their zones.

The goal of this project is to investigate the use of the comb-needle model for inter-zone discovery in the ripple-zone-based data query mechanism. The advantages are twofold. First, we will be able to evaluate the comb-needle model performance integrated with a data aggregation scheme. Second, we will be able to analyze how the comb-needle model associated with the ripple-zone-based scheme improves the performance of the latter.

References
