A Power-Aware Routing Scheme for Wireless Sensor Networks

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Abstract: - Since the nodes in Wireless Sensor Networks (WSN) are typically very small in size and are powered by irreplaceable battery, efficient use of energy becomes one of the most challenging tasks while designing any protocol for WSN. In this paper, we propose a routing protocol named Reliable and Energy Efficient Protocol (REEP) for WSN. The performance of REEP has been evaluated with the help of simulations by considering different scenarios. REEP shows better performance compared to a popular data-centric routing protocol for WSN.

Key-Words: - Wireless Sensor Networks, data-centric, energy-efficient.

1 Introduction

During data transmission in WSN, nodes can fail due to lack of power or can be blocked by any obstacle or can get undesirable physical or environmental damage. The ability to sustain such situations by avoiding any interruption of network functionality assures more reliable transmission of information. This is known as the fault tolerance issue. Fault tolerance, or the ability to sustain by avoiding any interruption of network functionality, is an important issue in WSN.

We believe, two important issues should be taken into account while designing a routing protocol for WSN. First, the level of power consumption at each stage of functionalities should be maintained. Second, tolerance of different types of failures should be achieved.

In this paper, we report a new data-centric, energy-efficient, and reliable routing protocol for use in WSN. Data-centric routing refers to the fact that all the information queries in the network result in sampled data and are named by some of their attributes and are routed based on those attribute values. In data-centric routing, interest is disseminated throughout the network to perform sensing tasks. So far there are two popular approaches that have been used for interest dissemination in data-centric routing [6]. The first is the DD protocol, in which sinks broadcast the interest about specific area [3] and the second is the Sensor Protocol for Information via Negotiation (SPIN) protocol, in which sensor nodes broadcast the advertisement for the sensed data and wait for requests from interested nodes [8]. In addition to DD and SPIN, there are some other protocols in this category that have been proposed in the literature. [7] provides a good summary of some of them such as Rumor Routing, MCFA (Minimum Cost Forwarding Algorithm), GBR (Gradient Based Routing), IDSQ (Information Driven Sensor Querying), CADR (Constrained Anisotropic Diffusion Routing), COUGAR, ACQUIRE, Energy Aware Routing and Routing protocol with random walks [13].

SPIN is a family of adaptive protocols, which includes SPIN-1 and SPIN-2 [8]. Without delving into the details of SPIN, it is worth mentioning here that it is the first data-centric routing protocol [9], which uses data negotiation mechanism to eliminate the redundant data transmission. But SPIN does not establish any path for data transmission. Consequently, data delivery is not guaranteed in SPIN. DD [3] has been developed with single path for data transmission. Later, based on this single path routing in DD, a highly resilient and energy-efficient multipath routing scheme has been developed [5]. Many other protocols have been designed and proposed based on or following the similar concept of DD [1, 2, 4, 10, 11, 12, 14].

2 Proposed Scheme

REEP has five important elements. These are: sense event, info event, request event, energy threshold value and Request Priority Queue (RPQ). A sense event is a kind of query, which is generated at the sink node, and is supported by the sensor network for acquiring information. The response of this query is the info event, which is generated at the source node. It specifies the detected object type and the location information of the source node. After receiving this information, request events are generated at the sink node and are used for path setup to retrieve the real data. Real data in any sensor network is the collected or processed information regarding any physical phenomenon.

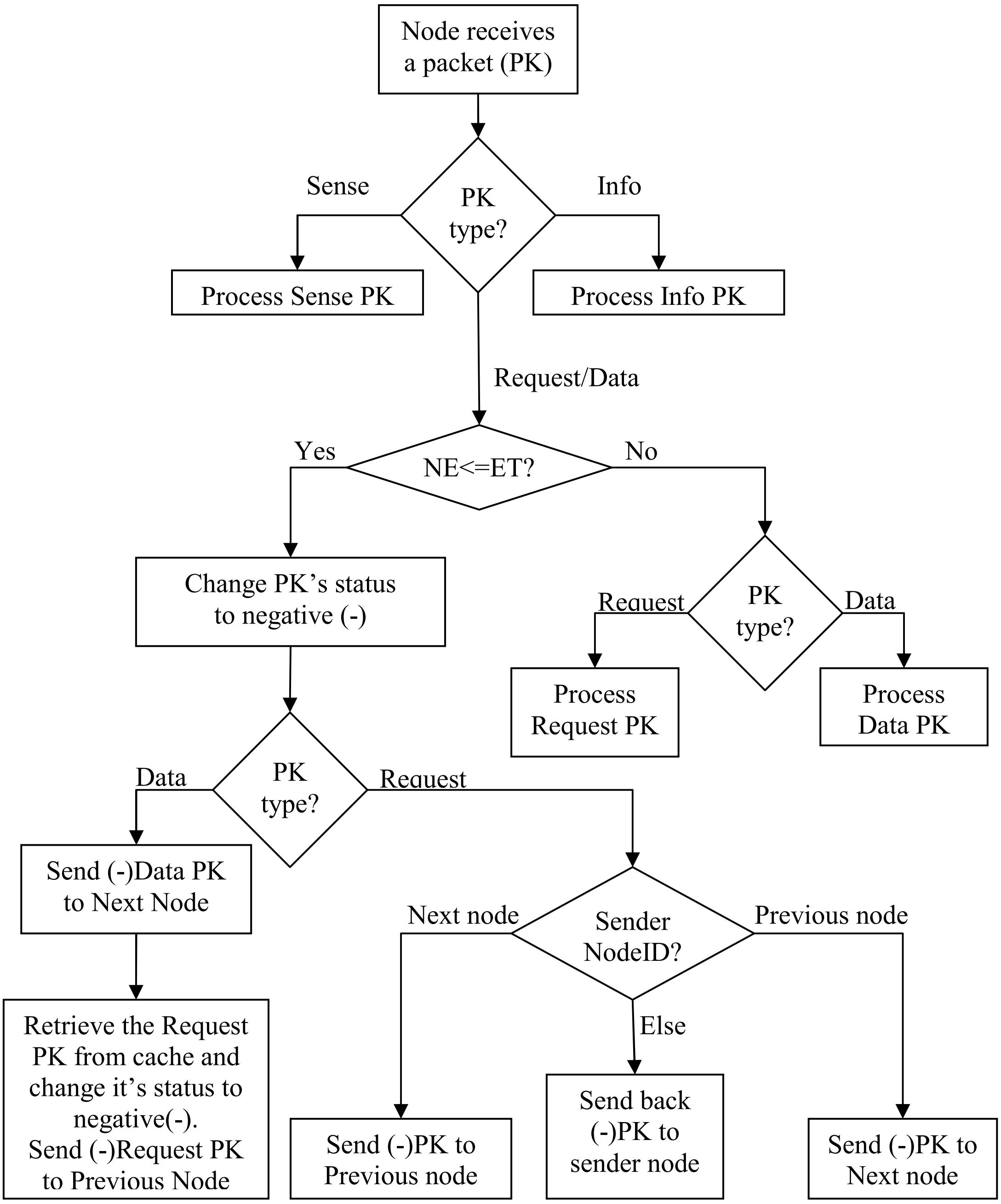


Fig. 1 – Flowchart for REEP

Each node in REEP uses an energy threshold value by checking which node agrees or denies for participating in any further activities. It gives more reliable transmission of any event information or real data. RPQ is a kind of First-In-First-Out (FIFO) queue, which is used in each node to track over the sequence of info event reception from different neighbors and to select a neighbor with highest priority in order to request for path setup. Fig. 1 illustrates the simplified view of how REEP works.

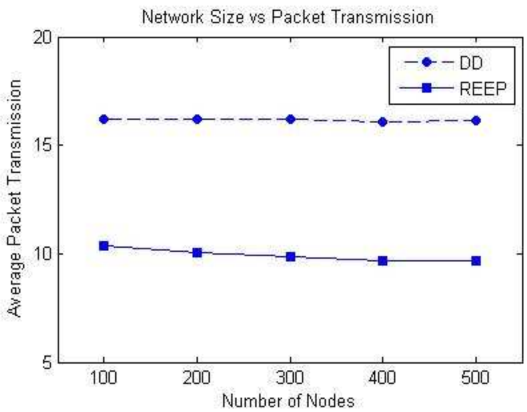
As mentioned earlier, REEP follows the data-centric approach for routing. Therefore, at the outset, a naming scheme is required for this data-centric approach to work properly. We have followed the naming scheme used in DD [3]. In the interest of brevity, it is not mentioned here, but in short, in this scheme each task includes a list of attribute-value pairs.

The flowchart corresponding to the REEP algorithm is given in Fig. 1. In the Flowchart, NE denotes the Node's Energy and ET denotes Energy Threshold. The algorithm is invoked when a node receives a packet.

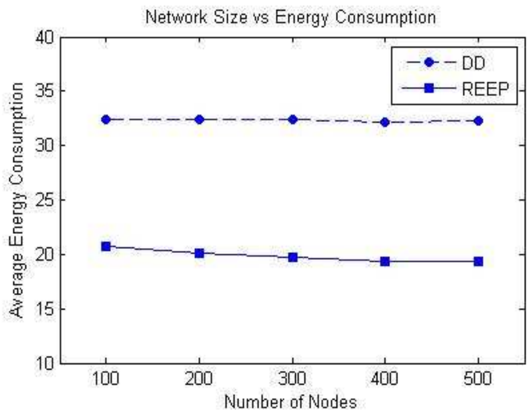
3 Simulation Results

The simulation results are explained in this Section with the associated configuration and graph results. It should be noted that all the value points in all graphs are the average of ten simulation runs.

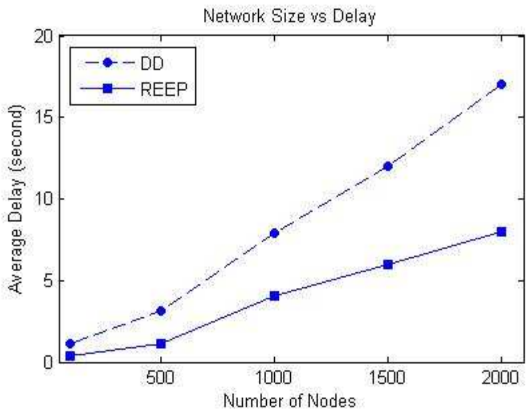
The performance of DD and REEP is compared in most of our experiments in terms of the average packet transmission, average dissipated energy and average delay as a function of the network size and the average data loss ratio is computed as a function of energy. In this experiment, we have simulated five different network sizes, with an increment of 100 nodes each time, ranging from 100 to 500 nodes. The sensor field has been generated by placing all the nodes in a grid fashion within a square area, and by scaling and keeping the communication range constant. Fig. 1 shows that REEP performs comparatively better than DD.



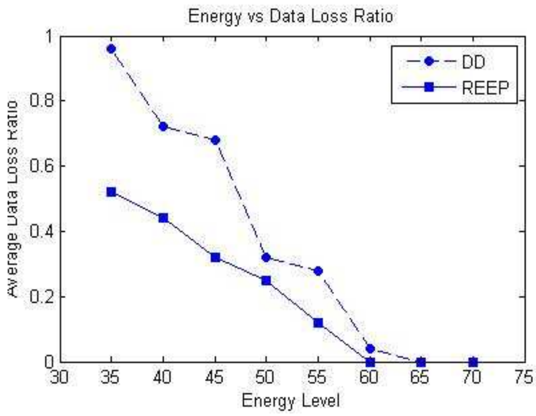
(a) Average Packet Transmission



(b) Average Energy Consumption



(c) Average Delay (seconds)



(d) Average Data Loss Ratio

Fig. 2 – Simulation Results

5 Conclusion

In this paper, we have reported a new protocol named REEP, which is diffusion-based and data-centric. Communication paths established in REEP are inspired by the observation of strictly local communication in physical system [14]. In such systems, path setup functions cannot use global topology metrics.

We believe, REEP is best suited for security maintenance by location tracking applications, where periodical observations of environmental phenomena are not required. Despite this, we believe, REEP can be easily modified for event triggered applications also, in which sensor nodes sense all the time and notify the sink whenever any event has been detected.

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