BASE STATION DRIVEN ROUTING PROTOCOL EVALUATION USING TOSSIM

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Abstract: ***Routing protocols play an important role in wireless sensor networks. There are primarily two types of protocols viz. data collection and data dissemination protocols. This paper compares two collection protocols: Base Station (BS) driven routing protocol [1] and a modified version of Low energy adaptive clustering hierarchy (LEACH) protocol [2]. The simulation results show that utilizing BS driven routing protocol, less time is spent compared to LEACH protocol.***

Keywords: WSN,TinyOS 1.x, TOSSIM

1. INTRODUCTION

Wireless sensor networks are comprised of a large number of small sensor devices which are commonly known as motes. Collectively these motes are able to form themselves into autonomous ad-hoc networks using a variety of communication mediums. They are capable of sharing data with each other and of transmitting data through the network back to the base station.

The routing protocols in sensor networks can be broadly divided into two categories viz. data collection and data dissemination protocols. Data collection protocols are the ones where the sensor nodes collect data and send it to the base station for further analysis. Data dissemination involves with protocols where the base station sends some important information to the rest of the nodes in the sensor network.

To fully understand the routing issues, a good comprehension of the sensor network is required. Seen from Figure.1, a sensor network is composed of sensor nodes and a base station (often called BS), every sensor node is equipped with one or several sensors which can sense the temperature, moisture, the position of targets and so on. So sensor nodes are in charge of collecting information the user are interested in and send them to the BS. To get the data information quickly and efficiently, there should be an efficient route for the node to send data collected, so there are many issues about routing to be concerned such as node deployment, data reporting method, scalability, network dynamics, transmission media, data aggregation, quality of service and so on[1],[7].

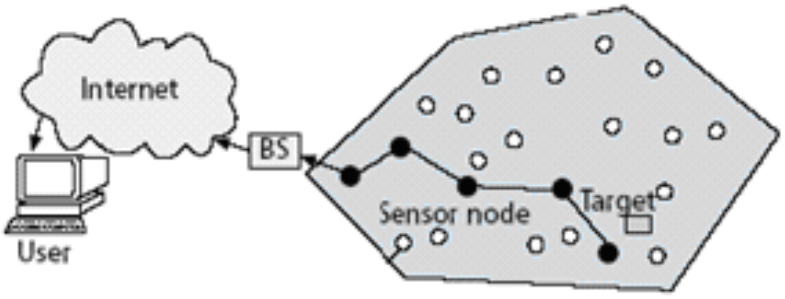

Fig1: The Sensor Network

Problem definition

The objective of this paper is to simulate and evaluate BS driven routing protocol and LEACH protocol. Both these protocols are data collection protocols. The platform to be used for simulation is TOSSIM. TOSSIM is a discrete event simulator which has been designed to simulate sensor networks that use the TinyOS [4], [5] operating system.

Contribution

LEACH and BS driven routing protocols are collection protocols. Both these protocols are implemented, simulated and evaluated using TOSSIM. The benchmarking is done for a five by two grid topology with twenty feet spacing. The result is presented in graphical form.

Outline

Section 2 describes the two routing protocols i.e. BS driven routing protocol and LEACH for WSNs. In Section 3, a brief description of the implementation of the protocols in TOSSIM is discussed. The simulation parameters are presented in Section 4 followed by the simulation results in Section 5. Finally, Section 6 presents the conclusions and future work.

2. ROUTING PROTOCOLS

There are two dominant traditional strategies in the data collection protocols in sensor network routing: proactive routing [8] and on-demand routing [9].LEACH is a proactive routing collection protocol. We compare it with BS driven routing protocol.

A. BS driven routing protocol

In BS driven routing protocol [1], the sponsor of the routing activities is the destination node instead of the source node. In this protocol, the BS start the routing by broadcasting a route request packet to the network, the nodes within its range receive this packet and record the BS-node as their next hop node, then they continue to transmit this request to their neighbors, and the neighborhood nodes do the same things as the anterior nodes do. This method of finding the next hop node ensures that a node always has the one hop destination node that is nearest to the BS, and at the same time, there are much less useless broadcast packets transmitted during the routing activities.

B. LEACH

The LEACH protocol [2] is a dynamic cluster based protocol. LEACH reduces the number of nodes that communicate directly with the base station by forming clusters. Leaf nodes connect to the cluster head which requires the least amount of power to communicate with. The cluster head nodes connect directly to the base station. Cluster head nodes allocate each leaf node that connects to it a time slot to communicate in. This allows the leaf nodes to sleep between its allocated communication slots. Once the cycle of slots has completed the data from that cycle is aggregated by the cluster head to save power and then it is sent back to the base station.

3. IMPLEMENTATION

The two protocols are implemented by simulating them using TOSSIM [3], [6]. TOSSIM is a discrete event simulator which has been designed to simulate sensor networks that use the TinyOS [4], [5] operating system. The main aim of TOSSIM is to provide a high fidelity simulation of TinyOS applications. TinyOS, its libraries and applications are all written in the nesC language. TinyOS is an operating system that is designed to manage the operation of a variety of mote devices as well as the sensors attached to them. TinyOS also provides a networking stack to allow the motes to form an ad-hoc network. Since TinyOS has been built using nesC it is built using components and interfaces. This results in a lot of flexibility to select alternative components such as different networking modules that implement different protocols. In order to customize motes for different purposes a single application can be integrated with the TinyOS structure. When TinyOS is compiled all selected components, custom components and the application is integrated into a single multi-threaded program. The TinyOS executable consists of two threads. One thread is used to execute tasks and the other thread is used to execute the hardware event handlers.

The topology used for simulation is a five by two grid topology. It is not a complete graph. The input to the application is specified through a ".nss" topology file [6]. This file is created by specifying the probabilities for packets being transmitted between any two nodes in the network.

4. SIMULATION PARAMETERS

In order to evaluate the protocols it is necessary to record some values to describe the operation of the protocols [2]. Each node has three variables to allow it to keep track of the number of packets sent, received and forwarded by that node.

It is also necessary to track the number of packets received from each node by the base station as well as the time taken for packets to reach the base station from those nodes. In order to do that, a data structure is defined to record the following:

- Number of packets received.
- Total time taken for packets to travel from origin to base station.
- Total time taken per hop by the packets.
- Worst time taken to travel from the origin node to the base station.
- Worst time taken for a single hop.
- Best time taken to travel from the origin node to the base station.
- Best time taken for a single hop.

An array of the data structure is kept, one for each node in the network. Every time a packet is received at the base station the table is updated. Using these values the average time taken by source node to send packets to the base station is calculated.

5. SIMULATION RESULTS

The simulation for both the protocols viz. modified Leach and BS protocol is run for 10 motes and the results are as shown in Table 1. It specifies the results for both the protocols for the average time taken to send packets from source node to the base station

Node	Average time for Leach	Average time for BS
1	0	0
2	0	0
3	0	0
4	433	712
5	722	713
6	1005	887
7	1378	1224
8	1739	1382
9	1477	1701

TABLE 1: RESULTS FOR LEACH AND BS DRIVEN ROUTING PROTOCOL

Graphs are plotted based on the values of time taken and the node id. Time computed is in milliseconds. Figure 2 shows the graph for average time for packets to travel from origin source node to the base station

It is observed that less time is required propagation in BS driven protocol than in LEACH. The improvement in speed is more evident for the farthest nodes in the topology.

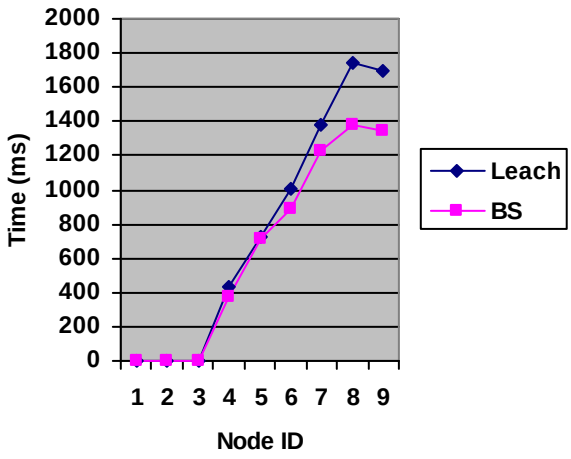

Fig 2: Graph for Average time

From the graphs we can see the advantages of BS driven routing protocol over LEACH. Some nodes that are not activated during the simulation run time do not receive or send packets. Hence their time taken is zero (for e.g. node id 2). The improvement in time is more evident for nodes 8 and 9 which are farther from the base station. Overall the average time taken for packets to travel from origin node to base station is improved in BS driven protocol as compared to LEACH.

6. CONCLUSION

During the simulation of BS driven routing protocol and LEACH protocol, it is observed that the sensor network could complete the routing activities faster in the former protocol as compared to LEACH protocol. Both these protocols are implemented, simulated and evaluated using TOSSIM which has not been done earlier to the best of our knowledge.

Future work involves simulation and evaluation of results for a non stationary base station. That means the base station position would change as often as needed [1]. The BS driven routing protocol, under the situation of the movement of the BS-node could sponsor another circle of routing for the whole network in a short period of time. This will not bring much cost of time and energy for the network to rebuild routing, and it assures the validity and the real time of the routing.

Future work also involves simulating various topologies for the sensor network based on parameters like number of nodes and subsequent evaluation of the base station driven routing protocol.

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