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CASE STUDY AND REPORT

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Remote Monitoring System for Rainfall Measurement Based On WSN

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Abstract: In the last few years, Wireless Sensor Networks have gained a lot of interest in the research field. WSNs consist of small nodes with sensing, computation, and wireless communications capabilities. Wireless Sensor Networks have inherent and unique characteristics rather than traditional networks. They have many different constraints, such as computational power, storage capacity, energy supply and etc. Many routing protocols have been proposed for WSNs out of energy aware routing protocol is very important in WSN. Most of the hierarchical algorithms proposed for WSNs concentrate mainly on maximizing the lifetime of the network by trying to minimize the energy consumption, but routing protocol which only considers energy has not efficient performance. Therefore considering other parameters beside energy efficiency is crucial for protocols efficiency. Depending on sensor network application, different parameters can be considered for its protocols. Delay and congestion management can affect routing protocol performance. In this paper, we propose Pairs Energy Efficient Routing protocol (PEER), a new routing protocol for WSNs that uses dual power management and focuses on congestion management and the delay cost. A proposed PEER is a new approach to exploit efficiently the network energy, by reducing the energy consumed for cluster forming in LEACH protocol and reducing the congestion to provide the better efficiency for the high priority data. In terms of energy consumption, network lifetime, and average delay, our protocol has performed better than LEACH (a well-known hierarchical sensor network protocol).

Keyword: wireless sensor network, energy aware routing, network lifetime, average delay.

I. INTRODUCTION

In the last few years, Wireless Sensor Networks (WSNs) have gained a lot of interest in both research and industrial fields. WSNs consist of small nodes with sensing, computation, and wireless communications capabilities [1]. Recent advances in wireless communications and electronics have enabled the development of low power, low cost, multifunctional sensor nodes that are small and able to communicate in short distances. A sensor node is composed of four major blocks: sensing unit, processing unit, power unit and communication unit. Wireless Sensor Networks can offer unique benefits and versatility with respect to low-power and low-cost rapid deployment for many applications, which do not need human supervision.

WSNs have inherent and unique characteristics compared with traditional networks [2, 3]. These networks have many limitations such as computing power, storage space, communication range, energy supply and etc. Nodes have limited primary energy sources and in most of applications they are not rechargeable, therefore energy consumption is the most important factor in routing process for wireless sensor networks. Node's energy is consumed due to using sensors, processing information and communicating with other nodes. Communications are the main element in energy consumption. Routing protocol directly affects communications volume; therefore energy aware routing protocols are very effective in decreasing energy consumption [4].

According to the large number of applications, many routing protocols have been proposed for WSNs [5]. Most of the hierarchical algorithms proposed for WSNs concentrate mainly on maximizing the lifetime of the network by trying to minimize the energy consumption, but delay is also an important metric that should be considered. In addition, the previous protocols assume that all sensor nodes have the same energy level at startup, which is not always the case.

In this paper, we propose Pairs Energy Efficient Routing protocol (PEER), a new routing protocol for WSNs. The protocol is based on grouping the sensor nodes into pairs, each two nodes forming a pair should be chosen to be close to each other to ensure minimum energy consumption required for transmission between both nodes. Using dual power assignment one node of the pair transmits data using high power level to deliver data to the BS, and the other node transmits data using low power level to deliver data to its partner. The roles of the node pair should be changed periodically to fairly distribute the far-transmission load between both of them.

In our simulation, we have concentrated on three important metrics, namely, power consumption, network lifetime, and average delay. In addition, two models have been simulated. In the first model, all the sensor nodes have been given the same amount of energy at startup; while in the second model, sensors start the simulation with different energy levels. We have compared our results with a recognized hierarchical protocol, namely, LEACH [6].

II. REALTED WORK

Many routing protocols have been proposed for WSNs. These routing mechanisms have considered the characteristics of sensor nodes along with the application and architecture requirements. Most of the routing protocols can be classified as data-centric or hierarchical protocols. Data-centric protocols are query-based and depend on the naming of desired data. Hierarchical protocols aim at clustering the nodes so that cluster heads can do some aggregation and reduction of data in order to save energy.

The Low-Energy Adaptive Clustering Hierarchy protocol (LEACH) [6] is a well-known hierarchical routing protocol and is one of the pioneering clustering approaches in the literature for WSNs. LEACH randomly selects a few sensor nodes as cluster heads and rotates this role to distribute the energy load among the sensors in the network. Cluster heads perform local data aggregation to reduce the amount of data being sent from the clusters to the BS, which further reduces energy dissipation and enhances the network lifetime.

LEACH assigns the same amount of energy to all nodes at the beginning of the simulation, which is not always the case. Sensor nodes may be different and may have dissimilar energy levels at startup.

III. PEER: PAIRS ENERGY EFFICIENT ROUTING PROTOCOL

In this section, we introduce a routing protocol. We have assumed that every node can determine its position information based on signal strength measurement. The area in which sensor nodes are deployed is divided into regions. Each node can determine to which region it belongs according to its location. We have assumed that all nodes in a certain region have the same reading. In other applications, where adjacent nodes do not have the same reading, a data collection algorithm should be used to gather data from all nodes.

In [7] it has been proved that the network connectivity of a WSN remains strong using dual power management. By using dual power, each node has the availability to transmit using two power levels, high and low. The high (respectively, low) power level is equivalent to long (respectively, short) distance transmission.

Each of nodes will form a pair; one node of the pair transmits data using high power to deliver data to the BS. The other node transmits data using low power to deliver data to its partner. The roles of the node pair will be changed periodically to fairly distribute the far-transmission load between both of them. The protocol is divided into two phases:

A. Joining Pair Phase:

The joining pair phase starts by nodes sending a HELLO message using low power level to introduce themselves to their neighbors. In order to avoid broadcast collisions, a randomly chosen delay is imposed before sending the HELLO message; this will be also done on all MAC broadcasts. Any node that receives one or more HELLO messages chooses the nearest neighbor and reply to it with a JOIN message. The nearest neighbor is chosen by measuring the received signal strength (RSS); the highest RSS is corresponding to the nearest neighbor. A node, that receives a JOIN message and agrees that the neighbor is the nearest one, should reply with an ACK message. Nodes that do not get ACK message have to try to join other nodes using JOIN message.

After forming a pair, *firsts* will send data using high power level, and *seconds* will send data at low power level. After the cycle of the HELLO-JOIN-ACK messages, most of the nodes have formed pairs and only few numbers still have no pairs. The task of individual nodes is explained in the next phase.

B. Transmission Phase:

After the establishment of pairs, nodes are now able to send data to the BS.

a. Low Node Tasks:

a) Turn off its receiver until it becomes a high node.
b) Sense the environment periodically i.e. measures the rainfall and record the reading.
c) Send the reading to its partner, if the reading is changed from the previous one.

b. High Node Tasks:

a) Turn on its receiver.
b) Sense the environment periodically i.e. measures the rainfall and record the reading.
c) If it receives a data message from its partner, it will aggregate its reading with the reading of the low node, process a data message, and then send the message to the BS after waiting a delay. This delay ensures that one high node will send its data message before the others and ensures that far transmissions are distributed on all high nodes.

c. Changing Roles of a Pair:

Nodes start the transmission phase with approximately 100% of their energy as the joining pair phase only consumes a little amount of energy.

At startup *first* (respectively, *second*) will be a high (respectively, low) node. They change their roles when the energy status of the *first* drops to 0.6 from its initial value.

d. Changing Pairs:

When the *second* is dead, the *first* should look for a node to form a pair. This is done by sending a HELLO message to the neighbors and waiting for a JOIN message from an individual node or another *first* that has also lost his *second*. The individual nodes play an important role in this stage, as they can work as higher nodes for those *firsts* that reach low level of energy. We have partially saved the energy of individual nodes to allow them to serve poor-energy nodes at this stage.

IV. PERFORMANCE EVALUATION

To evaluate the performance of our new proposed protocol, we have simulated both LEACH, and the proposed protocol using several random 100–node networks. In our simulation, we have been interesting in comparing the performance of both protocols based on three metrics:

The first metric is the average energy dissipated by the nodes over the time. The second one is the lifetime of the network and is measured through the number of nodes alive over the time. The third metric is the average delay of messages sent through the network. An efficient routing protocol should have low energy consumption, high number of nodes alive, and lower average delay.

In Figure 1, we compare the average energy dissipated per node in both LEACH and PEER; all nodes have the same energy level (0.25 Joule) at the beginning of the simulation. PEER outperforms LEACH by a factor of more than 2. It is clear that short distance transmissions in PEER are much less that in LEACH. Moreover, short distances in LEACH from nodes to their cluster heads are on the average much longer than short distances between pairs in PEER. In

LEACH, at any time 5% of the nodes are cluster heads, which means that 95% of the nodes are going to send short distance transmissions to the cluster heads.

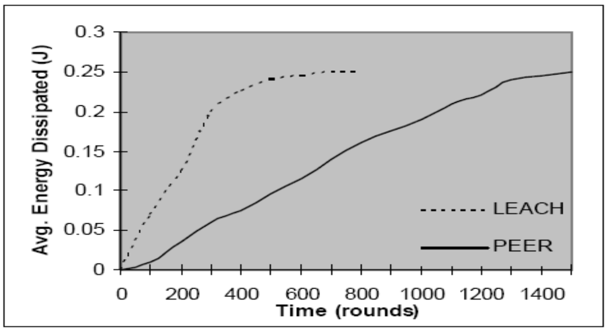

Figure 1 Average Energy Dissipated

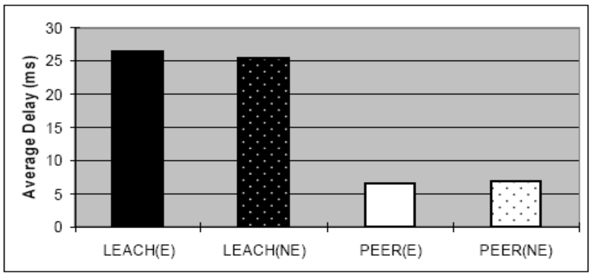

Figure 2 Average Delay

The lifetime of the PEER protocol is twice that of LEACH as the energy dissipated by nodes in PEER is much less than that by LEACH.

Figure 2 shows the transmitted packet average delay for the four cases we have discussed. PEER is better than LEACH by a factor of more than 4. In LEACH, 5% of the nodes are cluster heads, for 100 nodes as in our simulation there would be 5 cluster heads. On the average, there are 20 nodes in each cluster. To allow all nodes in a cluster to send to their cluster head there is a delay of 19 units. The 5 cluster heads need 5 delay units to send to the BS, so the total delay is 24 units. The simulation results are more than 24 units due to the overhead delay for cluster formation.

For PEER the delay units are one delay unit for low node to send to its corresponding high node, and 4 delay units to allow 4 high nodes to send from the four different regions. Other high nodes do not need to send the same data to the BS as stated before. The total delay units are 5 units, and once more due to the additional overhead delays for forming pairs and changing the role of pairs, the total average delay is more than 5 units.

V. RESULT

The remote monitoring system was developed which measures the precipitation or rainfall that has fallen. The real time sense data is recorded in database.

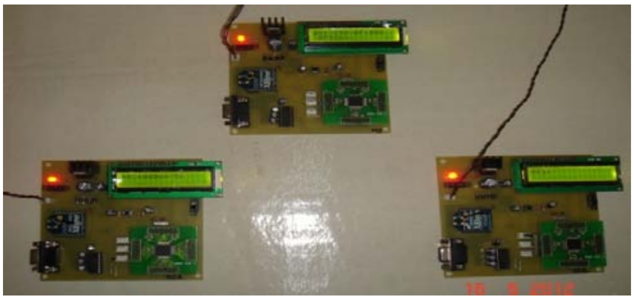

Figure 3 Actual photo of Remote Monitoring System

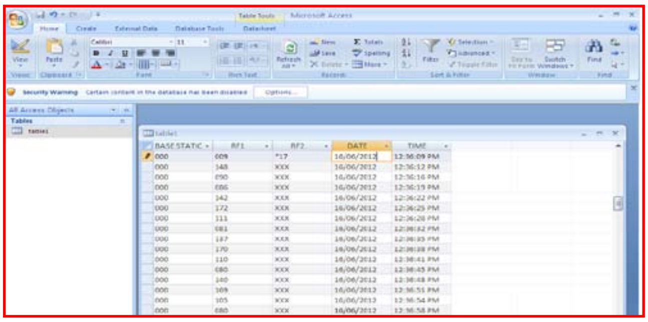

Figure 4 Screenshot of Database

VI. CONCLUSION

In this paper, a design system accurately measures the rainfall which uses a proposed PEER routing protocol for WSNs uses dual power assignment to distribute the load between nodes; each two nodes form a pair and work together in order to reduce the energy consumption. One of the nodes sends at low power level and the other uses high power level. This Protocol outperforms in terms of average energy consumption, network lifetime, and average delay than well-known hierarchical routing protocol LEACH.

VII. REFERENCES

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