Energy Efficient Routing Protocol for Wireless Sensor Network

Amit Kumar Tiwari[1] Jigyasha Maru[2]
[1]M.Tech Student [2]Assistant Professor
[1,2]Department of Electronics & Communication Engineering
[1,2]Dr. C.V. Raman University, Bilaspur, Chhattisgarh-India

Abstract— *Wireless sensor networks (WSNs) have attracted tremendous attention in both academia and industry in recent years. A WSN consists of one or more sinks and perhaps tens or thousands of sensor nodes scattered in an area. The upstream traffic from sensor nodes to the sink is many-to-one multi-hop convergent. A WSN consists of one or more sinks and perhaps tens or thousands of sensor nodes scattered in an area. The upstream traffic can be classified into four delivery models: event-based, continuous, query-based, and hybrid delivery. A Wireless Sensor Network or WSN is supposed to be made up of a large number of sensors and at least one base station. The sensors are autonomous small devices with several constraints like the battery power, computation capacity, communication range and memory. They also are supplied with transceivers to gather information from its environment and pass it on up to a certain base station, where the measured parameters can be stored and available for the end user.*

Keywords— Wireless Sensor Network

I. INTRODUCTION

In most cases, the sensors forming these networks are deployed randomly and left unattended to and are expected to perform their mission properly and silently. As a result of this random deployment, the WSN has usually varying degrees of node density along its area. Sensor networks are also energy constrained since the individual sensors, which the network is formed with, are extremely energy-constrained as well. The communication devices on these sensors are small and have limited power and range.

The WSN consist of two main components:

1) Sensor Nodes, and
2) Base Station (Central Gateway).

A. Sensor nodes

Sensors nodes are typically built of few sensors and a mote unit as shown in Fig.1.2. A Sensor is a device which senses the information and pass it on to mote. Sensors are typically used to measure the changes in physical environmental parameters like temperature, pressure, humidity, sound, vibration and changes in the health parameter of person e.g. blood pressure and heartbeat. MEMS based sensor have found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad hoc network. A mote and sensor together form a Sensor Node. A sensor network is a wireless ad-hoc network of sensor nodes. Each sensor node can support multi-hop routing algorithm and function as forwarder for relaying data packets to a base station.

B. Base Station

A base station links the sensor network to another network. It consists of a processor, radio board, antenna and USB interface board. It is preprogrammed with low-power mesh networking software for communication with wireless sensor nodes. Deployment of the base station in a wireless sensor network is very important as all the sensor nodes handover their data to the base station for processing and decision making. Energy conservation, coverage of sensor nodes and reliability issues are taken care of during deployment of base station in sensor network. Generally base stations are assumed static in nature but in some scenarios they are assumed to be mobile to collect the data from sensor nodes.

C. Radio Model

We have assumed the same radio model which has been used in earlier works. For the radio hardware, the transmitter dissipates energy to run the transmitter radio electronics and power amplifier, and the receiver dissipates energy to run the receive radio electronics as shown in Fig.1.4. For the scenarios described in this project work, both the free space (d2 power loss) and the multi path fading (d4 power loss) channel models were used depending on the distance between the transmitter and the receiver. If the distance is less than a threshold, the free space (fs) model is used; otherwise, the multi path (mp) model is used

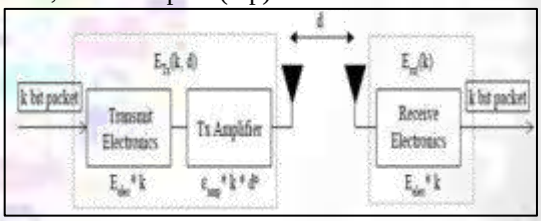

Fig. 1.4: Radio Model

D. Energy-efficient Routing Algorithms

Energy efficient routing algorithm can be categorized as follows: data centric routing algorithm, location based routing algorithm and hierarchical routing algorithm . Data centric routing algorithm uses meta data to and the route from source to destination before any actual data transmission to eliminate redundant data transmission Location based routing algorithm requires actual location information for every sensor node. Hierarchical routing algorithm divides the network into clusters. Cluster head (CH) is elected in each cluster. CH collects data from its members, aggregates the data and sends to sink. This approach is energy efficient but relatively complex than other approaches (Akkaya and Younis [2005]).

E. Data centric

Data centric protocols are query based and they depend on the naming of the desired data, thus it eliminates much redundant transmissions. The BS sends queries to a certain area for information and waits for reply from the nodes of that particular region. Since data is requested through queries, attribute based naming is required to specify the

properties of the data. Depending on the query, sensors collect a particular data from the area of interest

There is a need to limit change of cluster heads at every round considering residual energy of existing cluster head. Hence an efficient cluster head replacement algorithm is required to conserve energy. In clustering protocols as LEACH, nodes use same amplification energy to transmit data regardless of distance between transmitter and receiver. To preserve energy, there should also be a transmission mechanism that specify required amplification energy for communicating with cluster head or base station. For example, transmitting a packet to cluster head with same amplification power level as required by a node located at farthest end of network to base station results in wastage of energy. One solution can be having global knowledge of network and than nodes decide how much they need to amplify signal. Locating and calculating distances with in full network topology needs lot of routing and so, this approach do not work for saving energy. To solve above mentioned problems, we propose two mechanisms. i.e.efficient cluster head replacement and dual transmitting power levels. II

II. LITERATURE REVIEW

The literature review refers to the fact that the main advantage of hierarchal approach is to control the data duplication and is best suited for data aggregation. With this format, nodes are not allowed to communicate with the sink directly that they must go through a cluster head for communication purposes, while the cluster head collects the data from different nodes within a specific cluster area, and then it sends the collected data either to another cluster head or directly to the sink. This approach is more balanced and energy efficient comparable to flat and location based routing protocols.

According to this mechanism, all participating nodes of network are distributed in 2-hop cluster. Though this protocol is not much energy efficient for wireless sensor nodes however, it gives way to hierarchical clustering algorithms (Liu et al. [2011]).

When a sensor network is deployed, nodes establish clusters and nominate one node from each cluster as a cluster head. These cluster head nodes are responsible for receiving data from other nodes of cluster, do data aggregation/ fusion of received data and transmit it to base station. In this way, bandwidth consumption and lifetime of network is optimized. They prove that regardless of transmitting fused data direct from cluster head to base station, if data is transmitted in multiple hopes i.e. from one cluster head to another and nally to base station, it would further enhance network life time. Considering cluster based algorithms, today numerous protocols are developed, each having different attributes and enhancements mainly in cluster head selection algorithms. Though one thing is common, all protocols focus on energy conservation and data aggregation (Mahmood et al. [2013]).

In the year February ,2014, Aniruddha Singh et.al published a paper on ijarcsse;

The arrival of wireless technology has reduced the human efforts for accessing data at various locations by replacing wired infrastructure with wireless infrastructure and also providing access to devices having mobility.Since wireless devices need to be small and bandwidth constrained, some of the key challenges in wireless networks are Signal fading, mobility, data rate enhancements, minimizing size and cost, user security and Quality of service (QoS).This paper is provide an overview of the Research Issues and Challenges in wireless networks.

III. PROBLEM IDENTIFICATION

Hierarchal routing protocols are considered more energy efficient when compared with flat and location based routing protocols.

However, the disadvantage of this approach is that it results in quick energy drain of the cluster head nodes as most of the time they are involved in sending and receiving the data packets. Rotation of cluster heads is possible but it also brings along an issue related to the loss of the energy resource.

Manufacturing of cheap wireless sensor nodes having sufficient computation and transmit-ting/ receiving powers are available now. Hence hundreds of nodes can be deployed in a network for any required application. These sensor nodes have a limited power which must be utilized in very precise manner to increase nodes life. No doubt efficient circuit is necessary for efficient use of energy, however, routing protocol running on the network plays a vital role in bandwidth consumption, security and energy conservations as well (considering WSNs).

To cop with these constraints, initially direct transmission approach was discussed. In direct transmission, a node sense data from its environment and transmits it straight to base station. This method, no doubt, ensures data security however, on the other hand we have to compromise on nodes life time due to excessive power consumption (if BS is far away). Hence, using direct transmission technique, nodes that are far away from BS die early as they require more power to propagate their signal, making a portion of eld vacant for sensing.

To solve this problem, minimum transmission energy (MTE) emerged. In this technique, data is transmitted to base stations via multi hop. This gives birth to almost same problem we faced in direct transmission. Difference is only this that in minimum transmission energy algorithm, far away nodes remain alive longer with respect to the nodes nearer to BS. Reason behind early expiry of nearer nodes is routing of all data traffic to base station. More over, transmitting bulk of sensed data from each node use much energy. To overcome this problem, concept of Directed Diffusion was introduced that discuss data processing and dissemination

IV. METHODOLOGY

To achieve aforesaid objectives, the following phases has been adopted:

A. Initial Phase

A detailed literature survey is done from eminent journals like IEEE, Elsevier and Springer, etc. This will provide the basic and conceptual knowledge of the domain.

The needed detailed literature survey, to get preliminary knowledge and search scope of investigation, to

implement Low energy adaptive clustering hierarchy, is explained in this chap-ter. This Report presents investigational studies in several energy efficient routing algorithms and its general purpose. This Chapter contains the overview of Leach and its variants.

B. Leach Algorithm

W.Heinzelman, introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH). LEACH arranges the nodes in the network into small clusters and chooses one of them as the cluster-head. Node first senses its target and then sends the relevant information to its cluster-head. Then the cluster head aggregates and compresses the information received from all the nodes and sends it to the base station. The nodes chosen as the cluster head drain out more energy as compared to the other nodes as it is required to send data to the base station which may be far located. Hence LEACH uses random rotation of the nodes required to be the cluster-heads to evenly distribute energy consumption in the network. After a number of simulations by the author, it was found that only 5 percent of the total number of nodes needs to act as the cluster-heads. TDMA/CDMA MAC is used to reduce inter-cluster and intra-cluster collisions. This protocol is used were a constant monitoring by the sensor nodes are required as data collection is centralized (at the base station) and is performed periodically

1) Implementation Phase

A MATLAB programming environment is used for development of algorithms for energy efficient routing in WSN. LEACH is supposed to be one of the most significant algorithm proposed in WSN routing. The same will be again implemented here in both homogeneous WSNs and heterogeneous WSNs. LEACH protocol is re-investigated in this project. To explore LEACH and MODLEACH routing protocols in WSN.

2) Testing Phase

A comparative analysis for various network parameters are then conducted.

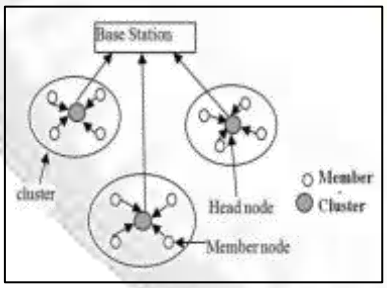

Fig. 4.1: Clustering in LEACH Protocol

C. Simulation

In this chapter, firstly, MATLAB software used for deploying WSN is presented. Secondly, simulation of Homogeneous-Leach, Heterogeneous-Leach and Modified-Leach (MODLEACH) routing protocol for WSNs are discussed in detail.

1) Introduction

Today, most of the research is done to develop ultra-low powered WSN which is only possible only if the overall network lifetime increases, energy consumption decreases and the network run with high stability and reliability. To achieve this, many algorithms have been imple-mented. They are called energy-e cient algorithms. These algorithms in their basic form have already been implemented on various network protocols including LEACH, AODV, TEEN etc. However, these algorithms need further research for increase in network lifetime, energy efficiency etc.

2) MATLAB Environment

The simulation is carried out using Custom Built Iterative Based Simulator in MATLAB 8.2.0.701 (R2013b) which simulates the sending, receiving, dropping and data forwarding etc. MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation.

V. RESULTS AND DISCUSSION

The parameters considered during simulation have their own signi cance for the better per-formance of the network. The important de nitions in the WSNs related to this project are:

Packet delivery ratio: The ratio of number of packets sent from the source to the number of packets received at the destination. The greater the value of PDR means better performance of the protocol.

Network Lifetime: The time for the rst node or a certain percentage of sensor nodes to run out of power or it is the time interval from the start of operation (of the sensor network) until the death of the rst alive node.

Throughput: Average rate of successful packet delivery. The throughput is the most important parameter to analyze the performance of the network, to get better through-put the error should be corrected, instead of retransmitting the packet. If the error is corrected there is no need of retransmitting the packet. If the retransmission traffic is reduced the congestion will not occur. If there is no congestion there is no packet loss that is error. If more number of packets in the network the performance of the network degrades which leads to congestion, which leads to packet loss. If there is an error correction technique which corrects the error instead of going for retransmission it improves throughput.

Number of Packets Transmitted to Base Station;- Besides network life time, another metric to judge effieciency of a routing protocol is its throughput. A base station receiving more data packets con rms the effieciency of routing protocol. Throughput depends on network life time in a sense but not always. Considering the simulated results as shown in below gure, we deduce that, maximum throughput is achieved by MODLEACH.

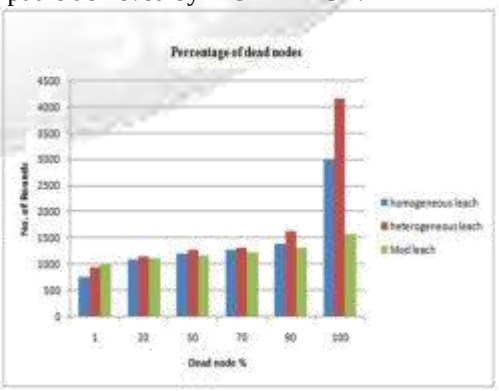

Fig. 5.1: Comparison, Percentage of Dead Nodes of Network with number of rounds

Fig 5.1 percentage of deadnode vs number of round

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusions

In this project work, we give a brief discussion on emergence of cluster based routing in wireless sensor networks. We also propose MODLEACH, a new variant of LEACH that can further be utilized in other clustering routing protocols for better e ciency. MODLEACH tends to minimize network energy consumption byefficient cluster head replacement after very rst round and dual transmitting power levels for intra cluster and cluster head to base station communication. In MODLEACH, a cluster head will only be replaced when its energy falls below certain threshold minimizing routing load of protocol. Hence, cluster head replacement procedure involves residual energy of cluster head at the start of each round.

B. Future Work

1) Implementation of MODLEACH protocol on Heterogeneous wireless sensor networks.
2) Next improvement can be possible by considering sink mobility and to ensure successful delivery of data.

REFERENCES

[1] Akkaya, K. and Younis, M. (2005). A survey on routing protocols for wireless sensor networks. Ad hoc networks, 3(3):325{349.
[2] Beiranvand, Z., Patooghy, A., and Fazeli, M. (2013). I-leach: Anefficient routing algorithm to improve performance & to reduce energy consumption in wireless sensor networks. In Information and Knowledge Technology (IKT), 2013 5th Conference on, pages 13{18. IEEE.
[3] Chaurasiya, S. K., Pal, T., and Bit, S. D. (2011). An enhanced energy-e cient protocol with static clustering for wsn. In Information Networking (ICOIN), 2011 International Conference on, pages 58{63. IEEE.
[4] Deng, S., Li, J., and Shen, L. (2011). Mobility-based clustering protocol for wireless sensor networks with mobile nodes. IET wireless sensor systems, 1(1):39{47.
[5] Jindal, P. and Gupta, V. (2013). Study of energyefficient routing protocols of wireless sensor networks and their further researches: a survey. Energy, 2(2).
[6] Liu, Z., Liu, Z., and Wen, L. (2011). A modi ed leach protocol for wireless sensor networks. In Advanced Computational Intelligence (IWACI), 2011 Fourth International Workshop on, pages 766{769. IEEE.
[7] Loscri, V., Morabito, G., and Marano, S. (2005). A two-levels hierarchy for low-energy adap-tive clustering hierarchy (tl-leach). In IEEE Vehicular Technology Conference, volume 62, page 1809. IEEE; 1999.
[8] Mahmood, D., Javaid, N., Mahmood, S., Qureshi, S., Memon, A., and Zaman, T. (2013). Modleach: A variant of leach for wsns. In Broadband and Wireless Computing, Com-munication and Applications (BWCCA), 2013 Eighth International Conference on, pages 158{163. IEEE.
[9] Muruganathan, S. D., Ma, D. C., Bhasin, R. I., and Fapojuwo, A. (2005). A centralized energy-e cient routing protocol for wireless sensor networks. Communications Magazine, IEEE, 43(3):S8{13.
[10] Pantazis, N. A., Nikolidakis, S. A., and Vergados, D. D. (2013). Energy-e cient routing protocols in wireless sensor networks: A survey. Communications Surveys & Tutorials, IEEE, 15(2):551{591.