ISSN:0975-9646

Relevance Precise Protocol Structural Design for Wireless Sensor Networks

Gurpreet Singh[#1], Ruby Gupta[*2]

[#1]*Assistant Professor, Department of ECE, GTBKIET*
Chappianwali, Malot, Punjab, India

[*2]*Assistant Professor, Department of ECE, Ferozepur College of Engineering and Technology*
Ferozeshah, Ferozepur, Punjab, India

Abstract— **Wireless Sensor Networks are networks composed of large number of tiny, batter dependent sensor nodes comprising of restricted on-board storage, processing and radio potentials. Nodes sense the information from the surroundings around them and forward it to the central node which is labelled as Base Station. In view of the fact that the nodes consume lots of energy for this processing of data, the architectural protocols and algorithms has to be attentive to provide an efficient routing. Because of efficient routing, the network lifetime can be raised. In general, the real life purposes depend upon the concept of heterogeneity despite homogeneity. In his paper, a protocol is proposed which works upon the implementation of heterogeneous sensors which are differ in the energies of each other. The first simulation is done by using LEACH (Low Energy Adaptive Clustering Hierarchy) which is entirely a homogeneous energy protocol. Subsequently, the second simulation comes out to be more effective which uses H-LEACH (Heterogeneous LEACH). This proposed H-LEACH uses the heterogeneous sensors which considerably reduces the energy consumption and prolong the lifetime of network.**

Keywords— **Wireless Sensor Networks (WSN), Base Station (BS), Cluster Heat (CH), Low Energy Adaptive Clustering Hierarchy (LEACH), Heterogeneous LEACH (H-LEACH).**

I. INTRODUCTION

A WSN typically composed of great quantity of sensor nodes which are deployed thickly over a certain noticeable area. These sensors require little power for their operation and also less expensive. These nodes or devices are furnished with embedded microprocessors, radio receivers and power mechanism for the process of sensing and processing of data. These nodes sense the data, collect it and then transmit this received data to the main or central node described as BS. This main node then makes contact with the client or user or also called end user. The user then access or receive the data from the BS. This processing and sensing of data is done with the technique of routing which makes a path available to the nodes. On the basis of routing technique, a secure and efficient data can be sent [1].

In order to design good protocols for wireless sensor networks, it is important to understand the parameters that are relevant to the sensor applications. While there are many ways in which the properties of a sensor network protocol can be evaluated, we use the following metrics.

A. Simplicity of Deployment

Sensor networks consist of hundreds or thousands of nodes, and they require to be deployed in remote or unsafe environments, allowing users to take out information in ways that would not have been achievable otherwise. This necessitates that nodes should be capable to communicate with each other even in the when the network is not recognized by infrastructure or by predetermined node positions [2].

B. Structure Lifetime

WSNs should do functionality for as long as possible. It may be difficult or unfeasible to recharge node batteries. Therefore, all characteristics of the node, from the design to the protocols, must be intended to be enormously energy efficient.

C. Latency

Data from sensor networks are usually time responsive, so it is significant to receive the data in an appropriate mode [3].

D. Superiority

The concept of "superiority" in WSMs is very special than in conventional wireless networks. In sensor networks, the end user does not need all the data in the network because

1) The data from neighbouring nodes are extremely connected, making the data superfluous and,
2) The end user worries concerning a higher-level explanation of actions occurring in the surroundings being checked. The superiority of the network is, therefore, depends upon the excellence of the collective data, so that the protocols should be intended to optimize for the exceptional and application-specific quality of a sensor network [4].

There are many routing techniques available for the processing of data which includes flat, hierarchical, location based and chain routing. There are dedicated protocols which have been implemented for routing. These protocols transmit the messages, information or data from one node to BS or to user in a proper manner, so that the routing should be efficient [3], [4]. In flat routing, each and every node plays the identical responsibility and sensor nodes work together to carry out sensing task. This concern led to the data centric routing, where the BS transmits inquiries to certain areas and wait for the information from the sensors situated in the preferred areas.

On the other hand, hierarchical routing is one of an efficient technique to perform energy-efficient routing. The higher nodes in hierarchical routing are used to process and

pass the information whereas the lower nodes are implemented to check out the closeness of the target. This concept of routing is entirely depends upon the two-layer routing process where one layer is used for the selection of CHs and other layer is implemented for routing. An important example of protocol used for this routing is LEACH which based upon the formation of CHs within a cluster and transmission of information or data to other CHs. These CHs will make a contact with the central node or BS.

LEACH is considered to be one of the most efficient protocols which depend upon the concept of hierarchical routing. The hierarchical routing concept is that part of routing which facilitated the nodes in a cluster to assign their cluster head for the sending of data to major node or BS. LEACH also allocates the energy to all the sensors homogeneously [5], [6]. Homogeneous nature of nodes consists of indistinguishable parameters in terms of energy, processing abilities and their range to sense the data. In this paper, we proposed an efficient H-LEACH protocol which works upon the idea of heterogeneity. Being heterogeneous in nature, the protocol will have the different energies, sensing capabilities and other important parameters. Apart from this, the heterogeneous nature also assigns the larger percentage of energy to cluster head as compare to other nodes so as to enhance the awake period of CH. This theory of assigning large percentage of energy is deficient in homogeneous environment [7], [8].

The simulation results reveal that the nodes in H-LEACH covers more rounds till their alive time as compare to LEACH. The network performance and lifetime also got better with the implantation of heterogeneous sensors in LEACH.

II. LEACH PROTOOCOL AND HIERARCHICAL ROUTING

In the concept of hierarchical routing, the nodes get separate into small number of grouping named as clusters. Each and every cluster is assigned a CH which communicates with the CH of the other cluster in order to transmit or pass the data. The process goes on till the last CH reaches the BS. This CH is a node which consists of large percentage of energy within the cluster as compare to other nodes [9].

Hierarchical routing is a talented way to lower the consumption of energy and to lengthen the lifetime of network [10].

Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm was introduced by Heinzelman in the year 2000. LEACH is a hierarchical protocol which works on the principal of the formation of cluster and CH. LEACH arbitrary selects a few sensor nodes a CH and revolves this role of formation of CH evenly. With this idea, the cluster formation takes place which results in the creation of CH and hence the transmission and receiving of information and data takes place. The task of CH is to receive the data from the sensor nodes, compress the data and then transmit this compressed data to the BS in the aggregated form. For this compression, LEACH brings into play the concept of TDMA and CDMA which works on Medium Access Protocol (MAC) [11][12].

The functionality of LEACH is done in two phases called setup phase and steady state phase. Each cluster is in contact with another by the use of different CDMA codes. This reduces the disturbance from nodes belonging to another cluster.

In setup phase, the clusters get organised and the selection of CHs takes place. In steady state phase, the transmission of data to the BS takes place. To shrink down the effect of overhead, the duration of steady state phase put to be longer than setup phase [13].

III. SINGLE HOP NETWORKS

LEACH uses single hop networks for the process of communication. In single hop networks, the sensor nodes correspond directly with the CH. This single hop communication has significant features in homogeneous as well as heterogeneous sensors.

A. Single Hop Network for LEACH Homogeneous protocol

The main focus of single hop communication in homogeneous networks is to enhance the network lifetime and hence the efficiency of network model. Following are several prominent features of single hop communication in homogeneous LEACH.

- As all the nodes in homogeneous LEACH are of same design and have same features and hence the main goal of all nodes is to assure the enhancement in lifetime of network. This also promises that all the nodes get died at the same time because of the same energy assignment. All nodes die at the same time because the modest residual energy. Therefore, LEACH applies the unsystematic and intermittent rotation of CH to provide steadiness within the network [14].
- While all the nodes have the same energy for the network's energy, the failure of some nodes do not have an effect on whole of network. Because, all nodes are proficient to act as CH.

B. Single Hop Network for H-LEACH protocol

Hetero means different i.e. the networks consisting of two or more than two types of nodes having diverse abilities to route the information. There can be two types of nodes named as type 0 and type 1 which act as pure sensor nodes and CH. Some of the important features are:

- The CH in this type of network is prearranged and sensor nodes use single hop communication to arrive at the CH, the sensor nodes in close to proximity of cluster have the use of higher energy among all sensor nodes. As a result of this, the battery discharging occurs and hence wastage of energy takes place in the sensor nodes which are placed near the CH.
- The hardware complexity can be low in heterogeneous type. Because only the CH has the responsibility to transmit the data to BS, other nodes can be designed with the simple hardware that facilitates short range

communication. Hence, the hardware complexity can be set inferior in some nodes and superior in little number of nodes. Therefore, the design of CH should be engineered properly for standardized clustering [14], [15].

IV. RADIO NETWORK MODEL FOR CALCULATION

In this proposed work, we use the first order radio model. The main hypotheses of this system are:

1. All the sensors are placed inside the wireless communication range while their communication with each other or with BS.
2. The sensors are of homogeneous in nature when they are modelled with LEACH and heterogeneous in nature when using with H-LEACH [12], [13].
3. The BS is called central node because of the deployment in centre of all nodes. The energy of BS is not constraint. All the nodes are deployed in random behaviour with same level of initial energy.
4. All nodes have power control abilities and each node can alter its power level and communicates directly with the BS.

V. PROPOSED METHODOLOGY

In this work, we have proposed a protocol named as H-LEACH protocol which can be used with the heterogeneous nature of sensors. This heterogeneity is in the field of energy assignment, i.e. the node with the highest energy will become the CH and then it transmits the data or information to another CH. Hence, in H-LEACH the 10-15% of nodes will have the initial energy higher than that of other nodes so as to serve as CH. The selection of CH is also done on the basis of residual energy of the individual node in every round. This will permit all data from nodes contained by cluster to be processed locally and will reduce the data set needs to be sent to the end user.

VI. SIMULATION RESULTS AND DISCUSSION

In this section, the results have been carried out by the use of H-LEACH and LEACH, so as to find out the more energy efficient protocol in between these two. The simulator used is MATLAB 7.11. All simulations have been carried out on a system having Intel Core i5 CPU at 2.20GHz and 4GB of RAM. The simulation focuses on the number of nodes alive as the number of rounds increases and the residual energy of nodes. The parameters are listed as below which are used for the simulation.

TABLE I
PARAMETERS AND VALUES

Parameter	Value
Network Size	100*100
Nodes	100
Initial Energy	1j
Rounds	2500

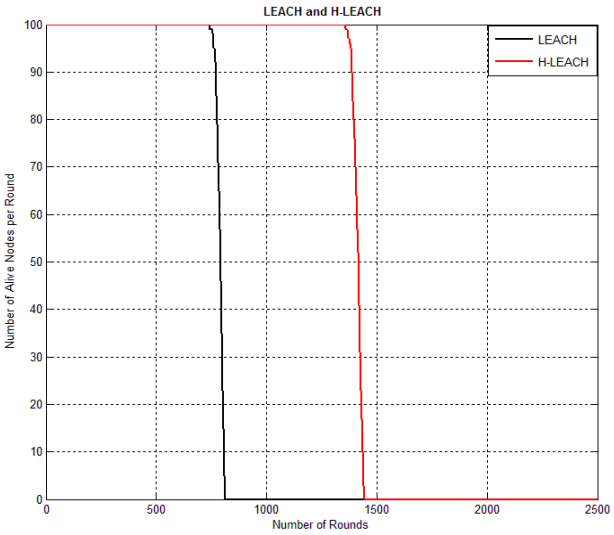

Fig. 1 Number of nodes alive with time

Fig. 1 shows the number of nodes alive as the rounds increases with time. It can be clearly shown that the nodes in H-LEACH covered the larger area or rounds as compare to LEACH. This shows that the heterogeneous sensors are taking more iteration and consume lesser energy than homogeneous which results to prolong the lifetime of network.

TABLE II
AVERAGE NETWORK LIFETIME

Node Mortality	Rounds	
	LEACH	H-LEACH
1%	700	1415
25%	740	1450
50%	760	1465
75%	786	1479
100%	792	1496

Table II clearly shows rounds of both protocols when the node mortality is 1%, 25%, 50%, 75% and 100% which shows that, the average network lifetime and alive time of nodes in H-LEACH is more than that of LEACH.

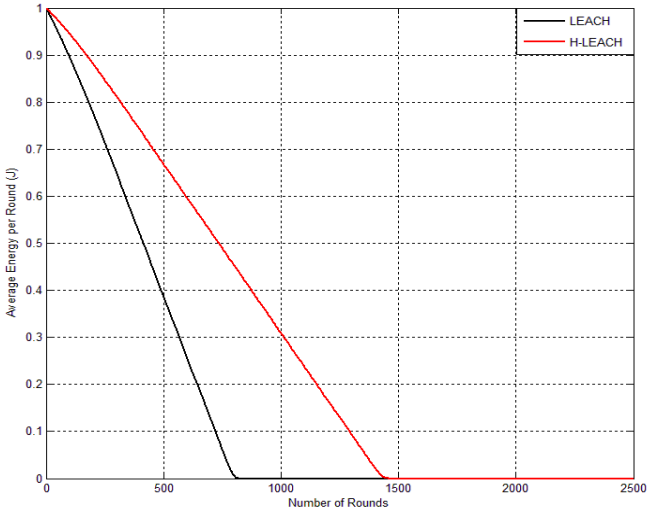

Fig. 2 Average Remaining Energy

As shown in Fig.2, the average residual energy of all nodes in H-LEACH is higher than LEACH and increases as the number of rounds increase. This reveals that the energy efficiency of H-LEACH is higher in contrast to LEACH.

TABLE III

RESIDUAL ENERGY

Protocol	No. of Rounds
LEACH	810
H-LEACH	1457

Table II clearly shows about the average remaining energy of H-LEACH and LEACH protocols where H-LEACH covered 1457 rounds and has higher residual energy as compare to LEACH which covered only 810 rounds.

VIII. CONCLUSION AND FUTURE SCOPE

The implementation of H-LEACH protocol in this paper ensures that the LEACH which is purely a homogeneous protocol can show better results when modelled with heterogeneous sensors. This can also increase the lifetime and residual energy of a network by reducing the consumption of battery.

The simulation results show that H-LEACH is continuously increasing the lifetime of a network as the number of rounds increases. This is because of the fact that in H-LEACH the energy of main node or central node i.e. BS is higher than that of other nodes. Hence, for the transference of information from one to another CH, the residual energy increases.

The future works will also include to analyse the performance of network considering loss of signal and to minimize the overhead formation in the existing model.

REFERENCES

[1] Poonam Tyagi, R.P. Gupta, R.K. Gill, ``Comparative Analysis of Cluster Based Routing Protocols used in Heterogeneous Wireless Sensor Network", *International Journal of Soft Computing and Engineering (IJSCE)*, vol. 1, no. 5, pp. 35-39, 2011.

[2] Luis Javier Garcia Villalba, Ana Lucila Sandoval Orozco, Alicia Trivio Cabrera and Cludia Jacy Barenco Abbas, ``Routing Protocols in Wireless Sensor Networks ", *Sensors*, vol. 9, pp. 8399-8421, 2009.

[3] R. Vidhyapriya and P.T. Vanathi, ``Energy aware routing for wireless sensor networks", in *Proceedings of International Conference on Signal Processing, Communications and Networking*, 2007, pp. 545-550.

[4] Debnath Bhattacharyya, Tai-hoon Kim and Subhajit Pal, ``A Comparative Study of Wireless Sensor Networks and their Routing Protocols", *Sensors*, vol. 10, pp. 10506-10523, 2010.

[5] Ossama Younis, Marwan Krunz, and Srinivasan Ramasubramanian, ``Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges", *IEEE Network*, 2011, pp. 20-25.

[6] Jain1, Praveen Kaushik1, Jyoti Singhai, ``Energy Efficient Maximum Lifetime Routing For Wireless Sensor Network", *International Journal Of Advanced Smart Sensor Network Systems (IJASSN)*, vol. 2, no. 1, 2012.

[7] B.P. Singh, Anish Arora and Ashish Kumar, ``Security in Wireless Sensor Networks", *Journal of Advances in Physics*, vol. 1, no. 3, pp. 1-4, 2010.

[8] Se-Jung Lim and Myong-Soon Park, "Energy-Efficient Chain Formation Algorithm for Data Gathering in Wireless Sensor Networks", *International Journal of Distributed Sensor Networks, Hindawi Publishing Corporation*, pp. 1-9, 2012.

[9] Cong Wang and Cuirong Wang, "A Concentric Data Aggregation Model in Wireless Sensor Network", in *PIERS Proceedings, Beijing, China*, pp. 436-440, March 23-27, 2009.

[10] V. Geetha,P.V. kallapur, and S. Tellajeera, ``Clustering in Wireless Sensor Networks: Performance Comparison of LEACH & LEACH-C Protocols Using NS2", in the *2nd International Conference on Computer, Communication, Control and Information Technology (C3IT-2012) ELSEVIER*, vol. 4, pp. 163-170, 2012.

[11] Mimansa Trivedi and J.K. Singh, ``Performance Analysis with Lifetime Optimization of LEACH Routing Protocol for Wireless Sensor Network", *International Journal of Engineering Trends and Technology (IJETT)*, vol. 8, no. 5, pp. 223--226, 2014.

[12] Vibha Nehra, A.K. Sharma, "PEGASIS-E: Power Efficient Gathering in Sensor Information System Extended", *Global Journal of Computer Science and Technology Network, Web and Security"*, Vol. 13, no. 15, 2013.

[13] Jamal N. Al-Karaki and A.E. Kamal, ``Routing Techniques in Wireless Sensor Networks: A Surevey", *Wireless Communications, IEEE*, vol. 11, no. 6, pp. 6-28, 2004.

[14] O. Younis and S. Fahmy, "HEED: A hybrid, energy-efficient, distributed clustering approach for Ad-Hoc sensor networks," *IEEE Trans. Mobile Comput*ing, vol. 3, no. 4, pp. 366–379, Oct. 2004.

[15] S. Michell, K. Srinivasan, "State Based Key Hop Protocol: A Lightweight Security Protocol for Wireless Networks", *1st ACM International Workshop on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks, Venice, Italy*, October 4, 2004, pp 112-118.