

# Cluster Head Selection for in Wireless Sensor Networks

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**Abstract:** Wireless sensor network consists of several distributed sensor nodes. It is used for several environmental applications, military applications and health related applications. To prolong the lifetime of the sensor nodes, designing efficient routing protocols is critical. Most of the research in energy efficient data gathering in data centric applications of wireless sensor networks is motivated by LEACH (Low Energy Adaptive Clustering Hierarchy) scheme. It allows the rotation of cluster head role among the sensor nodes and tries to distribute the energy consumption over the network. Selection of sensor node for such role rotations greatly affects the energy efficiency of the network. Some of the routing protocol has a drawback that the cluster is not evenly distributed due to its randomized rotation of local cluster head. We have surveyed several existing methods for selecting energy efficient cluster head in wireless sensor networks. We have proposed an energy efficient cluster head selection method in which the cluster head selection and replacement cost is reduced and ultimately the network lifetime is increased. Using our proposed method, network life time is increased compared to existing methods.

**Keywords:** WSN, CH, BS, LEACH, LEACH-B, LEACH-F

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## I. INTRODUCTION

Wireless Sensor Network is an emerging field with lot of applications. Due to its wide applications in the field of defense security, civilian applications and medical research, there is lot of research going on. One of the advantages of wireless sensors networks (WSNs) is their ability to operate unattended in harsh environments in which contemporary human-in-the-loop monitoring schemes are risky, inefficient and sometimes infeasible. Therefore, sensors are expected to be deployed randomly in the area of interest by a relatively uncontrolled means, e.g. dropped by a helicopter, and to collectively form a network in an ad-hoc manner [1, 2].

Since WSNs consist of battery-powered devices, the energy efficient network protocols must be designed. Due to large network size, limited power supply, and inaccessible remote deployment environment, the WSN-based protocols are different from the traditional wireless protocols. Due to the short range communication and the fact that consumption of energy is proportional to the square of the distance making communication multi hop instead of direct node tries to perform computation of data locally so data to be forwarded is reduced, because computation is less expensive than data transmission in WSNs. This network protocol operation varies from application to application. One routing algorithm might be good for periodic monitoring while it may not perform well where it will have continuous data sensing. [3]

Data aggregation in WSN is a data transfer technique where multiple data packets from sensor nodes are gathered to a certain sensor node and combined into a less number of packets. This technique is essential in the wireless sensor environment because the reduction of data packets enables less usage of wireless transmission modules, reducing energy consumption, increase network lifetime, and decrease end-to-end delay. Efficient data aggregation techniques can provide these advantages by ensuring quick and high data aggregation rates, while avoiding excessive use of control packets. The rest of the paper is organized as follow: Section II describes various existing methods for energy efficient cluster head selection in wireless sensor networks. Section III describes our proposed method. Section IV describes results and analysis. Finally conclusion is presented in section V. [4]

## II. RELATED WORK

In this section we have focused on the related work that has been done previously by several researchers. Energy Efficiency for prolonging the WSN has received much focused attention. The various existing methods are described as follows:

**A. *Low Energy Adaptive Clustering Hierarchy [5]***

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol has attracted intensive attention because of its energy efficient, simplicity and load balancing properties. LEACH is a cluster based protocol. The numbers of cluster heads and cluster members generated by LEACH are important parameters for achieving better performance. LEACH organizes nodes into clusters with one node from each cluster serving as a cluster-head (CH). It randomly selects some predetermined number of nodes as cluster heads. CHs then advertise themselves and other nodes join one of those cluster heads whose signal they found strongest (i.e. the CH which is nearest to them). In this way a cluster is formed. The CH then makes a Time Division Multiple Access (TDMA) schedule for the nodes under its cluster. The communication between different clusters is done through CHs in a Code Division Multiple Access (CDMA) manner. The CHs collect the data from their clusters and aggregate it before sending it to the other CHs or base station (BS). After a predetermined time lapse, the cluster formation step is repeated so that different nodes are given a chance to become CHs and energy consumption is thus uniformly distributed.

**B. *V – Leach [6]***

New version of LEACH protocol, the cluster contains; CH, vice-CH, cluster nodes. In the original LEACH, the CH is always on receiving data from cluster members, aggregate these data and then send it to the BS that might be located far away from it. The CH will die earlier than the other nodes in the cluster because of its operation of receiving, sending and overhearing. When the CH dies, the cluster will become useless because the data gathered by cluster nodes will never reach the base station. In V-LEACH protocol, besides having a CH in the cluster, there is a vice-CH that takes the role of the CH when the CH dies because the reasons we mentioned above by doing this, cluster nodes data will always reach the BS; no need to elect a new CH each time the CH dies. This will extend the overall network life time. The main problem with LEACH protocol lies in the random selection of cluster heads. This problem is resolved by using the concept of V-Leach uses the concept of alternate Cluster Head called Vice Cluster Head. As a Cluster Head dies it is replaced by the Vice Cluster Head. But in case of Vice Cluster Head Dies, it does not provide solution for that and the network start reducing the energy very fast and finally the network dies completely.

**C. *LEACH-F (LEACH with Fixed Clusters) [7]***

The advantage of fixed cluster is that once the clusters are formed, there is no set up overhead at the beginning of each round. Clusters are created using centralized cluster formation algorithm. An approach where the clusters are formed once and fixed and the cluster head position rotates among the nodes in the cluster may be more energy efficient than LEACH. The drawback is new nodes cannot be added.

**D. *PEGASIS: Power-Efficient Gathering in Sensor Information System [8]***

By this author proposed algorithm PEGASIS that is a chain based protocol provide improvement over LEACH algorithms. In PEGASIS, each node communicates only with a close neighbor and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Using greedy algorithm, the nodes will be organized to form a chain, after that BS can compute this chain and broadcast it to all the sensor nodes. Energy saving in PEGASIS over LEACH takes place by many stages: First, in the local data gathering, the distances that most of the sensor nodes transmit are much less compared to transmitting to a cluster-head in LEACH. Second, only one node transmits to the BS in each round of communication. PEGASIS outperforms LEACH by limiting the number of transmissions, eliminating the overhead of dynamic.

**E. *Multi hop LEACH [9]***

When the network diameter is increased beyond a certain level, LEACH (in which the BS is at single-hop to the CH) becomes inefficient. In this case energy dissipation of cluster-head is not affordable. To address this problem, authors introduced the Multi-Hop LEACH which aims to increase energy efficiency of a WSN. Like LEACH, in Multi-Hop LEACH some nodes elect themselves as CHs and some associate themselves with the elected CHs to complete the cluster formation in the setup phase. In steady state phase, a CH collects data from all nodes in its cluster and transmits data directly or through other CH to the BS after aggregation. Multi-Hop LEACH allows two types of communication

operations. These are the inter-cluster communication and the intra-cluster communication. In Multi-Hop intra-cluster communication, when the whole network is divided into multiple clusters, each cluster has one CH. This CH is responsible for communication between all nodes in the cluster; it receives data from all nodes at a single-hop distance and aggregates and transmits the data directly to the BS, or through intermediate CH(s). In Multi-hop inter-cluster communication, when the distance between the CH and the BS is large, the CH uses intermediate CH(s) to communicate to the BS.

#### **F. Random competition based clustering (RCC) [10]**

The RCC algorithm applies the First Declaration Wins rule, in which any node can “govern” the rest of the nodes in its radio coverage if it is the first to claim being a CH. After hearing the claim which is broadcasted by the first node, neighboring nodes join its cluster as member and give up their right to be a CH. To maintain clusters, every CH in the network broadcast a CH claim packet periodically. Since there is a time delay between broadcasting a claim packet and receiving it, concurrent broadcast can possibly create a conflict. Since random timer is not a complete solution, RCC resolve further the concurrent broadcast problems by using the node ID. If the conflict persists, node having lower ID will become the CH. Although frequent node mobility still has direct effect, RCC is shown to be more stable than conventional clustering schemes.

#### **G. Balanced LEACH [11]**

LEACH-B protocol adds a second selection of cluster heads to modify the number cluster-head in the set-up phase considering the node’s residual energy per round. In order to save the energy consumption and to prolong the life span of the network, the protocol needs to ensure that the partition of cluster is balance and uniform. To achieve this goal, the number of CHs needs to be dominated, and the network needs an optimal CHs amount.

#### **H. Energy Efficient Chain Based Routing [12]**

The proposed protocol organizes sensor nodes as a set of horizontal chains and a vertical chain. In each chain, a node is selected as chain head. For selecting the chain heads in horizontal chains, EECRP considers residual energy of nodes and distance of nodes from the header of upper level that does not need to reselect leader of the vertical chain. This causes time and energy saving. In each horizontal chain, sensor nodes transmit their data to their own chain head based on chain routing mechanism. EECRP also adopts a chain based data transmission mechanism for sending data packets from the chain heads to the base station.

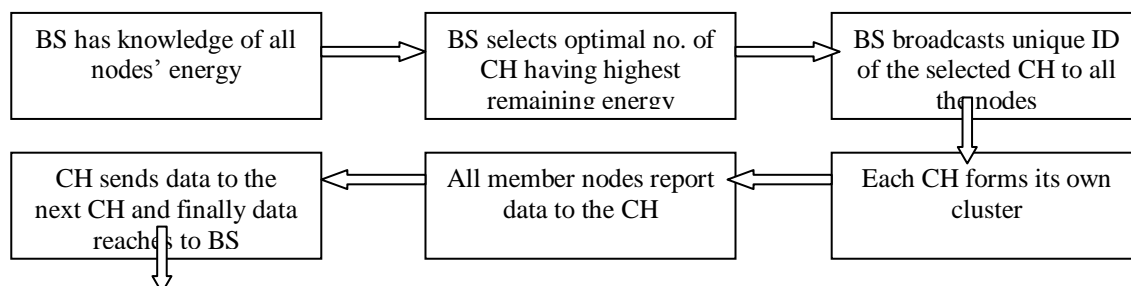
#### **I. GROUP [13]**

GROUP clustering algorithms based on clustering algorithm that provides scalable and efficient packet routing for large-scale WSNs. Only some parts of total number of sensor nodes participate in formation of cluster heads (CHs). In this, cluster heads are arranged in a grid manner and primary sink (One of the sink), dynamically and randomly builds the cluster grid. Greed Seed (GS) is a node within a given radius from the primary sink. Any queries from sink to nodes are propagated from greed seed to its cluster heads and so on.

### **III. PROPOSED METHODOLOGY**

In most of the energy efficient routing protocols, nodes selected as cluster heads must broadcast to member nodes of the clusters to which they belong that they have become cluster heads. As the frequency of rounding and of cluster head replacement increases, energy consumption increases due to message transmission for broadcasting.

Our goal is to reducing the amount of cluster head selection and replacement cost and ultimately to extend the lifetime of the entire networks compared with the existing clustering protocols.



If the energy of the CH becomes less than the threshold, then CH is replaced by the BS

Our proposed method is efficient because of the three factors:

- (1) Uniform distribution of cluster head.
- (2) Multi hops communication.
- (3) Cluster head is not replaced during each round.

#### IV. RESULT AND ANALYSIS

We have implemented our algorithm in MATLAB. Every node in the network belongs to some cluster. The various parameters we have considered for simulation are as follow:

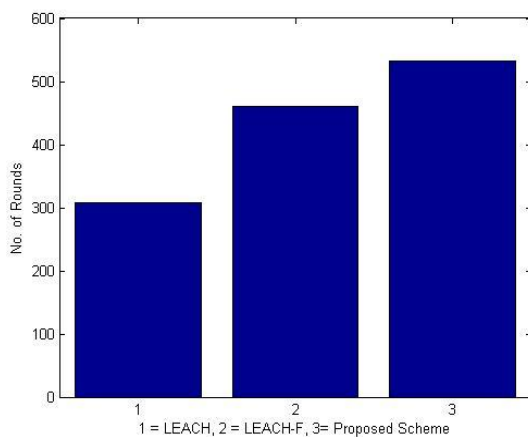
- Network size = 100\*100
- No. of Nodes = 100
- Node deployment: Nodes are randomly deployed in a given area.

We have measured no. of rounds for the proposed method.

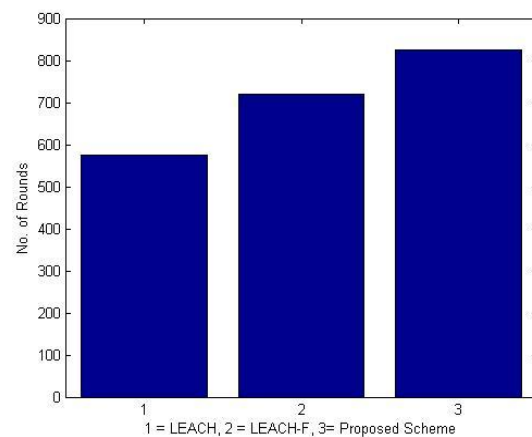
J/Node	LEACH	LEACH-F	Proposed Method
0.25	308	461	532
0.5	576	721	825
0.75	987	1192	1304
1.0	1077	1262	1487

#### ❖ NO. Of Rounds Graph

1) Energy 0.25 J/node

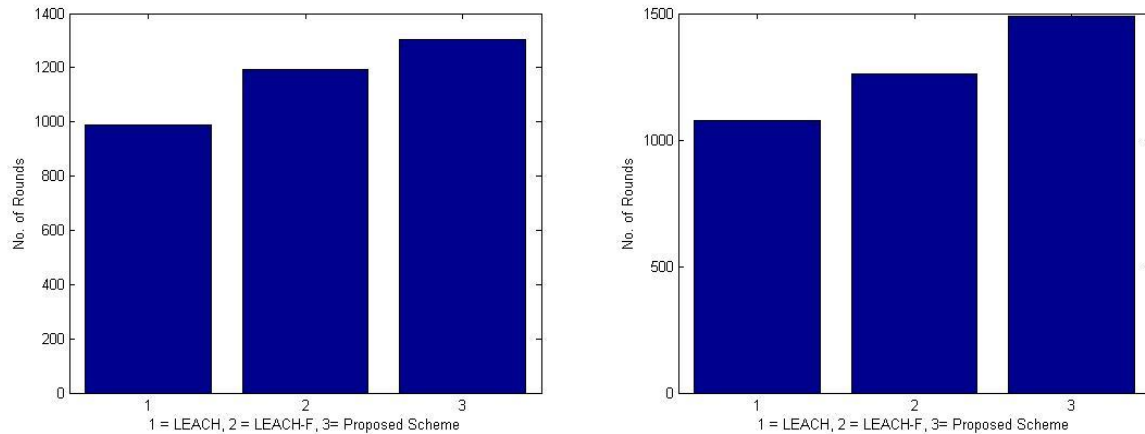


2) Energy 0.5 J/node



3) Energy 0.75 J/node

4) Energy 1.0 J/node



## V. CONCLUSION

Energy Efficiency for prolonging the WSN has received much focused attention. Our proposed method has good performance due to uniform distribution of cluster head, multi hop communication and not periodically replacement of cluster head. Our proposed method can be further improved by taking mobility into consideration. Security is an important and vital requirement. It can be made secure by bringing in some security features.

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