

# First Node Die (FND) Time Enhancement in LEACH Protocol

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**Abstract:** *In wireless sensor networks, the fixed battery condition is dominating. Generally nodes are equipped with a fixed battery having limited working period. As soon as the battery becomes empty the node no longer contributes in network and becomes a dead node. For improving the lifetime of any wireless sensor network the method is implementation of an efficient protocol that can efficiently use the limited capacity battery. In wireless Ad-hoc networks the LEACH protocol is implemented. In this protocol a clustering based scheme is used. This paper presents the improved LEACH protocol for first node die (FND) time enhancement. The result's reveal that changes made selection process of a cluster head improves the network efficiency. The approach is to vary the cluster head selection probability along with the threshold level. The protocol works to prolong the first node die time (FND). The proposed algorithm is simulated on MATLAB platform and comparison is done between standard LEACH and proposed LEACH protocols.*

**Keywords:** First Node Die (FND), WSN, Cluster Head, Heterogeneous, Lifetime.

## 1. Introduction

LEACH (Low Energy Adaptive Clustered Hierarchy) as the name suggests optimize the limited capacity of battery to prolong network lifetime and improving quality of service. In wireless sensor network (WSN), a large number of low power sensor nodes jointly gather information from their surrounding environments and transmit them towards the Base Station [2].

This is done by adopting different strategies for selecting the cluster heads, their threshold values and monitoring different parameters like the energy level and distance between them. Some strategies involve clustering and incorporation of advanced nodes in the wireless sensor network. Another method adopted is re-election of new cluster heads on basis of the high-energy among the sensor nodes to avoid exhausting of the battery of single sensor in the network. It is always preferred to adopt a protocol in which energy consumption is evenly distributed throughout the network. It is therefore decided to adopt a scheme to keep all nodes alive until the network dies out completely.

For the network, if we use a continuous mode of operation where the nodes always have data to send the base station via cluster head, the LEACH is applicable. But considering to following this protocol the energy utilization cannot remain uniform. Some monitoring is required to operate cluster heads and nodes in the wireless sensor network. The network protocol proposed is an improvement in existing LEACH protocol. Here the propose scheme practices a different approach in cluster head selection process. Protocol selection and Implementation in communication solely depends upon parameters like energy requirement, coverage area and quality of service. In WSN, lifetime and efficiency are the parameters that can be optimized. Lot of research has been done in this field to enhance network parameters by designing different protocols. In wireless sensor network (WSN), a large number of low power sensor nodes jointly gather information from their surrounding

environments and transmit them towards the Base Station [1][2].

In standard protocols with every round the energy of nodes decays until the node dies. In some protocols nodes directly transmit the data to the base station and the energy consumed by nodes is larger because larger transmission power is required to transmit the data to base station. The nodes which are farthest will die earlier because of larger transmission distance. Several Protocols have been designed to make the network efficient. One of the most common protocol used to make the network efficient is based on clustering [3]. In this method sensors are divided into clusters and each sensor node sends data to central clustering head and the clustering head forwards it to a central cluster Head. Cluster Head Forwards the processed data to the Base Station [4]. The nodes closer to the Base Station consumes less Energy since the energy consumption for data transmission is proportional to square of transmission distance.

In WSN Clusters are created and a cluster head (CH) is assigned to each cluster. These Cluster heads are also known as Master Nodes. Cluster Heads are responsible for collecting and processing the data from their respective clusters, and transmitting this data to the BS. In data processing the power consumption is larger than in data transmission. The aggregation of data at CHs greatly reduces the energy consumption in the network by minimizing the total data messages to be transmitted to the BS. Also, the CHs act as local sinks for the data, so that data are transmitted over a shorter transmission distance [5]. The process of cluster formation consists of two phases, cluster-head election and assignment of nodes to cluster-heads. The cluster-head needs to coordinate all transmissions within the cluster, so also it handles the inter-cluster traffic, delivers the packets destined for the cluster, etc. [6-7]. Hence these cluster-heads experience high-energy consumption and thereby exhaust their energy resources more quickly than the ordinary nodes. A protocol

was proposed named LEACH (low energy adaptive clustering hierarchy) based on distributed clustering. Each cluster consists of CH which collects data from it neighboring nodes and transmits toward the base station[9] [11]. New cluster head will be formed on the basis of probability and residual energy of nodes. Here energy dissipated in transmission  $E_{TX}(l)$  to transmit a  $l$  bit message is given by

$$E_{TX}(l, d) = E_{TX-elec}(l) + E_{TX-amp}(l, d) \\ = l * E_{elec} + l * \epsilon_{amp} * d^2 \quad (1)$$

and the receiver energy  $E_{RX}(l)$  to receive a  $l$  bit message is given by

$$E_{RX}(l) = E_{RX-elec}(l) = l * E_{elec} \quad (2)$$

For Cluster head the energy requirement is generally higher as energy is also required to aggregate data received from all nodes in a cluster, this energy is represented by  $E_{CH}$  is given by equation-3

$$E_{CH} = \left[ l * E_{elec} * \left( \frac{N}{K} - 1 \right) \right] \\ + \left[ l * E_{elec} + l * \epsilon_{amp} * (d_{toBS})^2 \right] \quad (3)$$

Here  $\epsilon_{amp}$  and  $E_{elec}$  is the radio amplifier energy and radio electronics energy.

## 2. Methodology

A new approach using LEACH is proposed which focus on lifetime maximization as well as on Quality of Service (Qos). The performance of WSN depends upon many parameters but lifetime maximization is important aspect of any network. In proposed method for improving lifetime anQos, two parameters are chosen i.e. FND (first node die) time and cluster head selection probability. In this protocol the selection process for Cluster head depends not only on maximum energy content of the node in the same cluster after each round but also concerned with probability to become cluster. After every round of transmission the energy level of each node will be different and the cluster head will be changed accordingly. The node which will become cluster head in the beginning will alive for longer duration. The quality of service of the network will also improve as the large number of node will remain alive till end. Cluster head is selected randomly in the beginning. Base station is continuously monitoring the energy level of all the nodes. After completion of a round, the energy level of nodes will vary. The node with highest energy level in that particular cluster will automatically become Cluster Head. Adopting this approach the energy level of nodes will not decay in rapid trend, ultimately increasing the first node die time which will enhance the lifetime as well as Quality of Service. Significance is given to node with highest residual energy after each epoch.

The Flow chart of Priority LEACH is shown in Figure-3. Subsequently first round of transmission, the level of energy of Cluster Head is compared with the energy of remaining nodes in the cluster. Selecting the higher energy node as new CH, if energy of current CH is higher, the same cluster head will carry on the operation otherwise new cluster head will be formed.

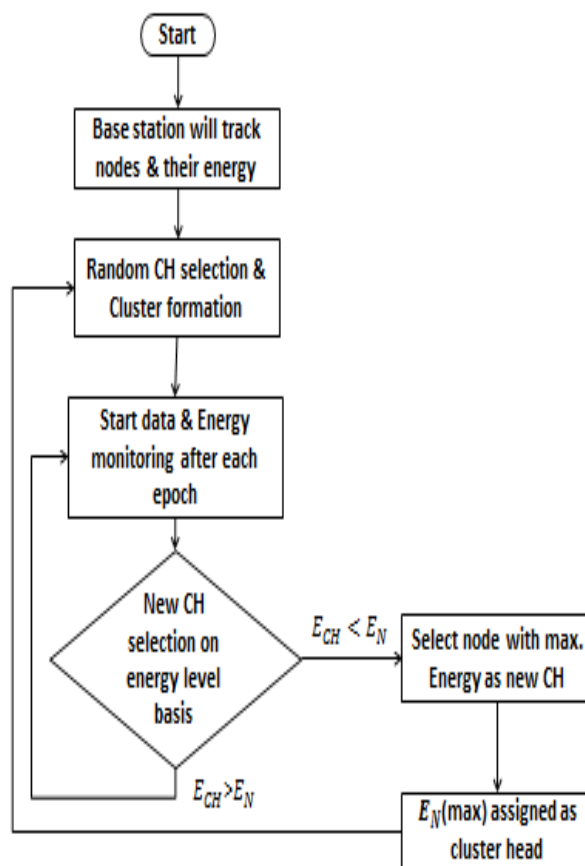


Figure 1: Flow chart of proposed modified LEACH

In simulation a wireless network of 100 nodes was deployed in an area of 100m x 100m dimension. It is assumed that there are  $k$  numbers of clusters in the network. At startup the cluster heads are selected on energy basis only. Table-1 enlists all parameters of the simulation carried out. The other parameters are probability for cluster head selections and threshold for cluster head selection.

Table 1: Simulation parameters

Parameter	Value
Number of nodes N	100
Number of cluster	k
Rounds ( r )	5000
Network size M*M	100 m * 100 m
Node Deploy Region	x(0,100) y(0,100)
Base station location	x=50, y = 175
Length of data message l	2000 bit
Radio electronics energy $E_{elec}$	50 nJ/bit
Radio amplifier energy $\epsilon_{amp}$	100 pJ/bit/m <sup>2</sup>
Data aggregation energy $E_{DA}$	5 nJ/bit/signal
Initial power of node	2 nJ

Random deployment of 100 nodes and position of base station is shown in figure-2. The network was made to

complete 5000 rounds and after the completion of rounds results are analyzed.

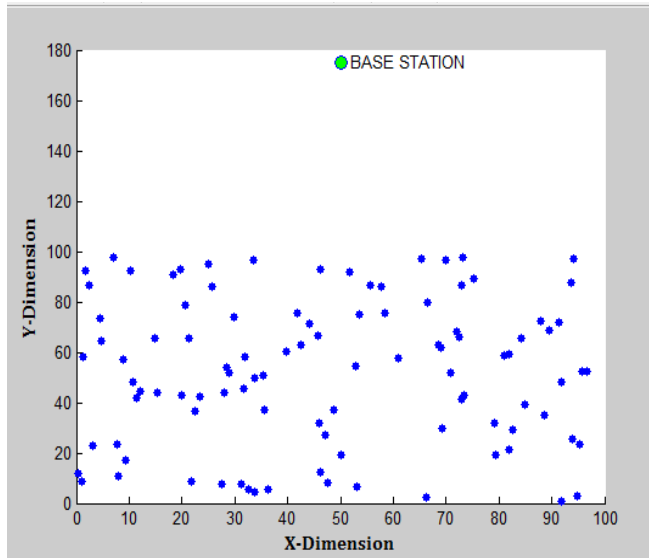


Figure 2: WSN establishment

### 3. Results

Wireless sensor network in real world are of heterogeneous nature. In order to achieve close relation between real networks and simulations random placement of node is done. A comparison is then made between standard LEACH and proposed LEACH protocol. The graph generated from simulation with probability 0.1 and 0.01 of cluster head selection for LEACH and proposed LEACH is shown in figure-3. Here length of the message is taken as 4000 bit. The FND time is increase as shown in graph.

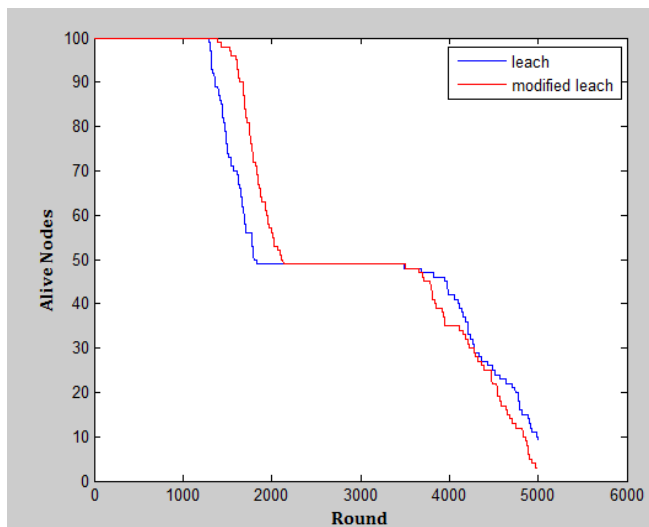


Figure 3: Nodes alive vs rounds

Implementing the network with a message length of 2000bit shows an improvement in overall performance of the network. First node die time (FND) and overall network life is improved in this case. The results are shown in figure-4.

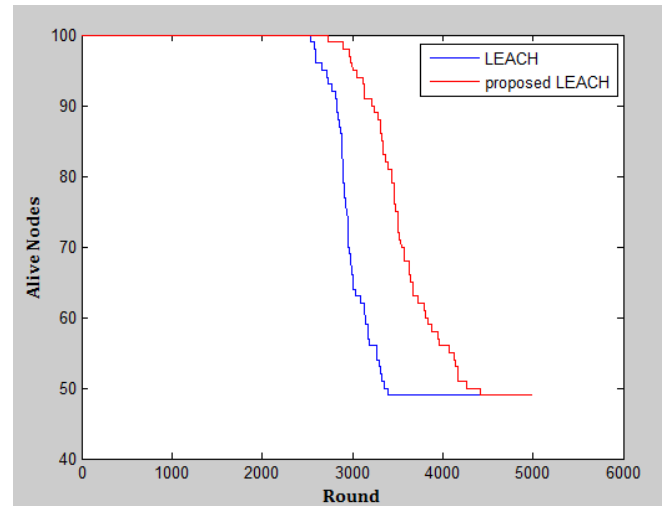


Figure 4: Nodes alive vs round

### 4. Conclusion

Implementing the proposed modified LEACH algorithms shows improvement in network lifetime. It is observed that this algorithm can be optimized for cluster head selection probability function and threshold level for new cluster head selection. Further it is also noticeable that if nature of message is changed the effectiveness of the network can be improved. This protocol proposed is much suitable in cases where the reliability of data is important. As efforts are made to prolong the FND time other nodes also remain alive for considerable longer time. This improves the data integrity.

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