

# Improving Efficiency of Wireless Sensor Network Using LEACH Protocols: Review Paper

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## ABSTRACT

In recent times, Wireless Sensor Networks (WSNs) have given promising directions for a mixed bag of application monitoring along with gathering the required data from the environment. Due to the insufficient transmission range and high density of nodes, routing is considered to be an important field of WSNs. The absolute lifecycle of a wireless sensor network robustly depends upon factors such like how the relaying neighbors are selected by the sensor and the data path taken to get to the objective. Energy used is more for transmission of data from the Cluster Head to the Base Station. Even supplementary if the space between them is more. It is noticeable that by reducing distance energy consumption mechanism will reduce the overall energy consumption of the entire network. Since these sensors are usually deployed in secluded areas where the charging or substitution of batteries is not possible, new methods should be planned to increase the network life span. In this paper we have taken our concern towards it by presenting various protocols to improve the efficiency of the Wireless Sensor Networks, our main focus is to improve the battery life and the life time of the whole network. Furthermore this paper describes various improvements on LEACH protocols. It also enlists some limitations of LEACH and how the extended or modified versions of it have helped to overcome the problem.

**Keywords :** LEACH protocol; Wireless Sensor Network; energy efficiency; remote; lifetime

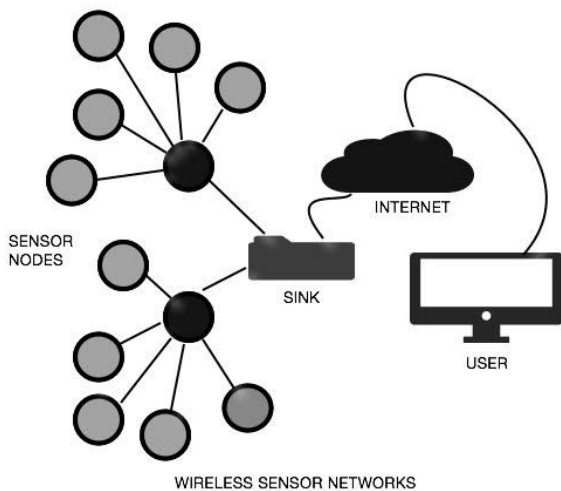
## I. INTRODUCTION

In today's era, Wireless Sensor Networks (WSNs) can be regarded as emerging technology for the internet of things (IoT). Wireless Sensor Networks (WSNs) is a network composed by several sensor nodes, each of which are capable to perform specified tasks. Smart monitoring and management that can be accomplished via network embedded tools. Wireless Sensor Networks (WSNs) are widely used to detect the physical phenomena and to gather information in order to enhance reliability and to consume energy proficiently so as to prolong network life time.

With the advancement in technologies, the overhead of equipments has dropped drastically together with progressive expansion of applications, ranging from environmental monitoring to industrial and temperature sensing. This paper drifts the attention to improve battery life, processing ability, security and robustness of network. Further, data aggregation paved a way so as to save energy and to obtain precise information. LEACH (Low Energy Adaptive Clustering Hierarchy) routing protocol introduced a concept of rounds. Each round has phases associated that are CLUSTER SETUP state and STEADY state. Minimal battery life, computational cost, limited transmission range are some of the constraints associated with Wireless Sensor Networks (WSNs) so

cautious management of resources was mandatory to raise the lifetime to an extent. This paper includes several extensions of LEACH as it does not take into consideration the mobility criteria and power factor and optimal distance between cluster-head and sink. In addition, this paper emphasizes more towards the improvement over LEACH that make it more secure and energy efficient to ensure secure communication. A variety of protocols have been proposed for Wireless Sensor Networks (WSNs) with the elevation of basic energy efficient routing protocol. This paper deals with comparison of Multi-hop LEACH, Mobility -LEACH, Solar aware centralized- LEACH, Modified LEACH, Multi-group leach, Lightweight Secure LEACH (LS-LEACH) and Energy Efficient Heterogeneous LEACH (EEHL). All of them are compared on the basis of their individual performance and their contribution towards the enhancement of network lifetime.

Sensor nodes are susceptible and are prone to collapse so, the only motive is to obtain accurate information from raw data by improvising the life time of Wireless Sensor Networks (WSNs) to a great extent. Moreover, nodes are required to be used efficiently as power of nodes can be increased. In this paper, we proposed and efficiency among varied protocols was compared.



## II. LITERATURE SURVEY

On increasing the size of the LEACH's network beyond a certain limit, the space in between cluster head and base station is increases eminently. In this case normal LEACH protocol is not suitable, in which single-hop protocol is followed. Multi-hop LEACH [1] is another version of LEACH routing protocol for increasing the efficiency of WSN. LEACH makes cluster head directly transmit the signal with the base station no matter what the interspace is between both of them. Wherein Multi-hop LEACH, if the nearby cluster is working and has enough energy, the other cluster heads may send their collective data to the nearby cluster head, and then this nearby cluster heads select near cluster head to retrieve the collective data, through this step by step way the signal is transmitted to sink. Multi-Hop LEACH's are divide into two types of transmission that are intra-cluster (between base station and cluster heads) and inter-cluster (between cluster heads and nodes). In latter communication, when the LEACH sensor network is differentiated into several clusters with cluster heads, then each cluster makes one cluster head. This cluster ensures all communication for all nodes of the cluster. In former type of communication, the distance between base station and cluster head is far, then cluster head uses on way cluster head to send data with base station.

Cluster head choosing procedure is greatly improved by Energy LEACH[2] protocol. Residual energy of the nodes is taken as the primary attribute which decides whether nodes are made cluster head or not. After the initial round of communication the residual energy is different in every node. In the latter rounds of communication n nodes having more residual energy are selected and this process goes until all power gets drained in all nodes. Similar to LEACH protocol this protocol also has the, cluster formation and cluster steady phase which is as in the LEACH.

Mobility of nodes and cluster head is possible in M-LEACH or Mobility LEACH[3] during steady and setup phases.. Through Global Positioning System (GPS), location information of all the nodes are taken into account and base station is considered to be fixed. In order to select the suitable cluster head attenuation model is used i.e. to minimize power consumption in cluster head. In M-LEACH the cluster head is determined on the criteria of minimum mobility and lesser power attenuation. Member nodes decide the selection from multiple cluster heads and choose the cluster head with the most residual energy. In steady state phase condition, if the member nodes drifts away from the cluster head or vice versa ,that results into the inefficient clustering. , M-LEACH provides the solution for it to switch between different cluster heads. When the nodes gets drifted away from the cluster heads then they send a DIS-JOIN message and when they get nearer to a new cluster head they also send a JOIN-REQ message to join the new cluster head and this is how the efficient cluster formation is done.

Some areas where the sensor nodes are not accessible like a battlefield, for such the sLEACH comes in play which is powered by solar energy. The solar power nodes in the lot are generally favourable in the cluster head selection process.

1) Solar-aware Centralized LEACH: In this type of selection process the cluster head are chosen through the base station with the help of efficient cluster algorithm. Base station generally selects those solar nodes with maximum residual energy as the nodes transmit the residual energy and the solar status to the base station. LEACH-C is used to improve the conventional cluster head selection algorithm. Lifetime of the network and depends upon no. of solar nodes and the sun duration upon the network. It provides a CH handover approach as well, i.e. if the node serving as the cluster head is in low battery

condition even in the steady state of the network, the cluster head could be shifted to the solar node with more left over energy, which results in the enhanced life of the system.

2) Solar-aware Distributed LEACH: It is a type of sLEACH network in which the priority is given to the solar driven nodes in comparison to the battery power nodes as it could be more efficient, i.e. the probability of the solar driven nodes are higher. The threshold value for the selection process would be altered by multiplying factor k

$$T(n) = k * [ \text{perc} / (1 - (\text{CH}/\text{NN}) )$$

where, 'k' equals 4, 'perc' represents percentage of optimal CHs. 'CH' denotes cluster head from the start of last meta level and 'NN' is number of nodes.

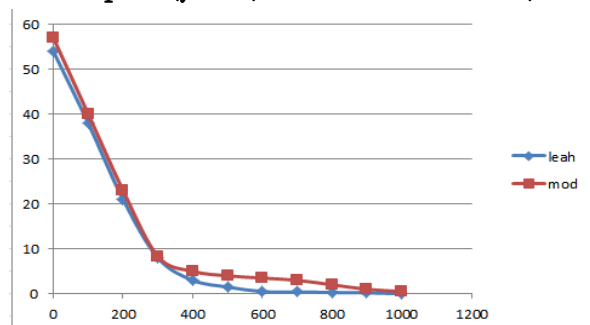
A routing algorithm was proposed called as Multi-Group Leach-framework[4] of leach.LEACH resortto randomize rotation of cluster-heads instead of static selection.Simulation was performed to analyze proposed algorithm MG-LEACH, compared dataset with Leach considering varied parameters. The objective of MG-LEACHwas to exploit redundant nodes so as to perpetuate network life.A table that represented values of FND,HNDandLND,it could be concluded that life span for this algorithm in this situation has performance77% better than leach. Results confirmed that performance and network life time amplified upto 90%.

A limited energy in WSN constituted a challenge and a solution to the problem was instituted called as E-leach, more effective as when FND and HND E-LEACH shows better implementation. More augmented and secure protocol was provided which is LS-LEACH, authenticate algo was consolidated to reassure data authenticity as well as availability. Simulation of LS-LEACH[5] was handled using Network

simulator .NS-2that was build in c++and had OTcl interface. Further,. Simulation results were obtained bycomparing LEACH protocol and LS-LEACHprotocol, performed better taking into account the overall system and theproposed protocol provided an algorithm to validate the newnodes that appeal to unify network.

Effective cluster-head schemeinaugurated routing protocol as MOD LEACH [6].An energy model was proposed and comparedmixed bag of aspects with existing leach protocol.Network Quality was studied based on variousaspects of data transmission due to the modificationon theLeach protocol.Further, Heuristic simulationwere carried outto procure the energy consumptionusing MATLAB and itshowed hat modified leach consumed less energy than leach.Comparisons among LEACH and MOD LEACH protocol demonstrated that efficiency of WSN can be improved if optimum cluster head are taken up by modified leach protocol. Protocolswere implemented in Tiny OS with some accuracy.protocols were substantiated to be more victorious when used for routing packets.

**Comparison of mod LEACH and LEACH , energy consumption(y-axis) vs number of rounds(x-axis)**



Energy Efficient Heterogeneous[7] LEACH(EEHL)which is based on LEACH with escalated stability.This protocol resulted in refined energy efficiency and network lifetime bydeploying advanced nodes in perceptivefashion.The main featuresof proposed protocol are heterogeneity and perspicacious use ofadvanced cluster-head. Simulation was performed using MATLABon Intel

core i3 machinewith 3 GB RAM.Results inMATLABsubstantiated that energy efficiency has increased 10% thanheterogeneous LEACH protocol and 32% than LEACH.

In this protocol LEACH Cell,[8] the sensing field is divided into the form of cells and among them one node is chosen as a cell head . Throughout the network's lifetime the cell structures and the clustering will remain same. The cell heads in the cell receives the data from the various normal nodes which gather information of the environment, and accepts the data in the form of TDM slots. The data collected from the nodes is aggregated in cell head and the after removing the redundant data sent to the cluster head. This data from the cluster head is further aggregated and sent to the sink.

In LEACH, the aggregation, fusion and retransmission of data was done through a single CH, leading to rapid consumption of node energy. When the CH die, the cluster will have no purpose as the data collected will never reach out to base station. Therefore,LEACH-V (Vice low energy adaptive clustering hierarchy) was constituted.

The cluster comprises of

- a. Cluster-Head which transmits received data from the cluster members to the sink.
- b. Vice-Cluster-Head , node that will be a CH of the cluster.
- c. Cluster nodes that gathers data from nearby surrounding area and transmits it to the CH.

As there would be no requirement of electing a new Cluster-Head each time when CH dies and data collected will reach out to sink so, this will automatically prolong network lifetime.

LEACH involves the homogeneity as after certain number of rounds , the cluster node acts as cluster head which does not give assurance of the satisfactory cluster-head distribution, in order to

overcome this demerit LEACH C (Centralized Low Energy Adaptive Clustering Hierarchy) was initiated which includes two states of which steady phase is very much homogeneous to LEACH. but setup phase is as follows:

1. Each node circulate location data mainly using GPS and residual energy to sink.
2. The sink evaluates and the most optimal CH is selected by the sink accordingly.

LEACH-C [8] protocol not only fabricate finer clusters but also determines good clusters. Sink must see to it that the energy load must be distributed appropriately among each and every node. Hence average node energy is computed by the sink based on which nodes having energy below this average are determined. After evaluating the clusters and associated cluster heads, the sink transmits a message comprising of cluster Head ID for each node. If node's ID matches with itself then that node is considered to be CH node else the node need to transmit the data to the concerned node.

**List of LEACH studied:**

LEACH E
LEACH MultiHop
LEACH-S
LEACH-M
MOD LEACH
MG LEACH
LS- LEACH
EEHL LEACH
LEACH Cell
LEACH V
LEACH C

**III. FUTURE WORK**

The LEACH and other protocols to increase the efficiency of the Wireless Sensor Network are highly effective and efficient in increasing the lifetime of the network. But in today's constantly improving

technology we need more efficient and keep updating our protocols. To do so these protocols could be combined together to create a hybrid protocol to improve efficiency.

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