MODLEACH- An Energy-Efficient Clustering Formation of LEACH for Wireless Sensor Networks

Varsha Tiwari, Vivek Sharma

Abstract: ***Wireless Sensor Networks (WSNs) consists of a small group of sensor nodes used to gather data from the area which they deployed. The nodes are cannot be charged so there is a need for Energy-Efficient protocol to choose a better cluster. The nodes are grouped into cluster and election of Cluster Head (CH) is a vital task in WSNs. This paper presents a better energy-efficient model for WSNs. The proposed model called MOD-LEACH presents a novel idea in election of CH with the specified parameters such as residual energy, distance, threshold energy, total nodes of cluster and forms a cluster in order to work in an efficient manner. The proposed scheme is suitable for large scale networks where the energy is one of the main constraints. Efficiency is also enhanced by utilizing the power amplification models of the proposed scheme. By the simulation results obtained K-LEACH is comparatively better in energy-efficient model for WSNs.***

Index Terms: Energy Efficient Protocol, Cluster Head Election, Threshold Energy, Power Amplification.

I. INTRODUCTION

WSN is also called as Wireless Sensor and Actuator Network (WSAN) which is mainly designed to acquire the environmental conditions and physical conditions such as temperature, light, sound, etc. WSN is a spatially distributed network which acquire the data and forward it to the Base Station (BS). This kind of networks are mainly used in the geographical area where the humans cannot able to move in and get the required data. Monitoring and controlling the machineries and in battlefield surveillance are also the field where WSNs are in rapid growth [1]. This kind of networks does not require any fixed network structure for communication therefore it supports fast employment and surveillance in the source area where it is deployed.

WSNs consists of several sensor nodes which is used to obtain the high-quality results where this also results in increasing the sensor nodes usage which ends in developing cheap and energy-efficient nodes. To achieve the above-mentioned nodes the network protocols are introduced. As well as the routing protocols are also plays an important role in performing local data fusion which also reduces the bandwidth usage of WSNs.

In past years, gathering and processing of data from a sensor is under research as the node‟s energy consumption and how to reduce the energy consumption of a node. This research results in that the energy is consumed mainly by communication bandwidth and data aggregation. Thus, the need for an innovative technique to identify where the energy loss occurs and how to reduce it without affecting the network performance. The network layer of the WSNs is one of the important layers where the new methods for data relaying and discovery of route to reach the source and destination to be identified and processed.

Routing is not an easy task especially in network such as ad hoc based or cellular network-based networks like WSNs when compared to wired networks [2]. The emerging world is giving new problems and also solutions to the same in day by day. WSN routing is classified into 3 different types according to the network structure. They are, Flat, Hierarchical and Location based Routing [3,16]. Flat Routing performs that all the nodes follows a unique structure in collection of data as well as in forwarding the data to the destination. All nodes are classified into single group. Sensor Protocols for Information via Negotiation (SPIN) [4], Direct Diffusion [5] are some of the best protocols which follows Flat Routing.

According to Hierarchical routing, the nodes are classified into different groups called clusters which improves the network scalability and lifetime by using the node's energy in an efficient manner. Each and every node is monitored to identify the communication routing path to reach the destination. Low-Energy Adaptive Clustering Hierarchy (LEACH) [6] is the best protocol to use in the hierarchical routing. As well as the location-based routing where established based on the location and the purpose of the sensor network. This network is concentrating on the location where it is monitored to identify the basic route path for further communication. Geography Adaptive Routing (GAR) [7] and Geographic and Energy-Aware Routing (GEAR) [8] are the good example for location-based routing protocol. As well as the all other layers of the networking protocol stack are also given equal priority in forming the new protocol [9]. In Extension of network lifetime, the Energy-Efficient Protocols are identified and modified based on the process of clustering formation and aggregation of data also be given an equal importance in identifying the protocol. Data query and message broadcasting are also an efficient technique of the clustering protocol.

This paper is designed as Literature Review and gives a short note on research problem identification and directions. It also Illustrates the parameters of proposed protocol (K-LEACH). discuss about effectiveness of K-LEACH clustering parameters. Section 6 gives K-LEACH Proposed Protocol a detail description. The analysis of K-LEACH Protocol is in Section 7. Further, the proposed methodology is compared with the existing ideas under the experimental results using simulation section in Section 8.

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Section 9 concludes with conclusion and future enhancement.

II. RELATED WORK

This section briefs the work already proposed related to the proposed methodology based on the problem identification of the existing schemes and gives a better model as proposed idea. Data aggregation protocols are in many numbers for WSN as the problem increases day by day. Clustering the sensor nodes is the important task of the designed protocols. Sensing the data from the environment and forwarding it to the BS is to identified in an efficient way and to be implemented in the protocol design to suite it to the WSNs.

The historic protocol Low Energy Adaptive Clustering Hierarchy (LEACH) proposed by Heinzelman et al. [6, 10, 11] place first in the related work. This protocol follows distributed cluster formation and reduces the communication bandwidth and energy of the node by local processing and by choosing the CHs in a rotation basis which improves the lifetime of the network. Clustering and CH election are the vital process in WSNs and the same is carried under the scheme LEACH. Here the random selection of CH for each round was introduced where it improves the lifetime of the node which in terms improves the lifetime of the network.

This protocol is comprised of two phases: 1) Set-up Phase and 2) Steady Phase.

Set-up Phase is used to form the clusters and Steady Phase is used to takes care about the data transmission from node to BS. This protocol consists of rounds where the time to reform the clusters. The set-up phase forms the cluster by using the Threshold function which is mentioned in (1).

$$T(n) = \begin{cases} \dfrac{P}{1 - P * (r \bmod \frac{1}{P})} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \quad T(n) = 0$$

Where, P denotes the needed percentage of CHs, r denotes the number of round (current) and G denotes the fraction of nodes from the $1/p$ round which are all able to become CH for the current round.

The threshold function finds a threshold value for each node and then all the nodes are asked to choose a random number from 0 -1. After the nodes gets their random number the random number will be checked with the threshold function. The nodes which holds the lesser value than the threshold value will be choose as CH for that round. For each round, the same procedure is used. After clusters are formed steady phase deals with the clusters in terms of collecting the sensed data from the nodes and forward it to the CHs. These CHs aggregates the collected information and forward it to the BS. LEACH clears that the CHs takes care about the data forwarding as well as the aggregation of the data.

This tells that the CH needs more energy to do the above specified processes in order to make effective and efficient WSNs but the same denotes that the electing of CH is to be given more priority than the other tasks where the CHs plays a vital role. Waoo et.al [15] proposed TSMEHP i.e. Threshold Sensitive Stable Election Multi-path Energy Aware Hierarchical Protocol for Clustered Heterogeneous Wireless Sensor Networks.

One of the main drawbacks of LEACH protocol is that the election of CH based on choosing a random number. To overcome from this there are many more ideas are discussed and proposed. Some common methodologies are discussed and compared with proposed methodology in results section. Energy-Efficient Cluster Formation Protocol proposed by Chamam & Pierre [12] where the energy efficient clustering protocols are the basic need for the WSNs [13]. This methodology was deployed mainly in flat topology where the CHs collects and sends the data BS directly, when the BS is not in range of the CH then it forwards the data to the nearest CH which is nearer to BS too. EECF follows fully distributed network architecture which also follows a spanning tree connection for all CHs to reach BS.

Here CH election is processed after a three-way communication between each node. First a score value is obtained using Score Advertisement Broadcast (SAB) by (2).

$$Score(i) = \propto . \frac{degree\ (i)}{N-1} + (1-\propto) . \frac{Er(i)}{E_0} \quad (2)$$

Where denotes the weigh the residual energy of the node with respect to the number of neighbors, i denotes the node (i). After obtaining the SAB from the nodes, the values are sub divided into two groups where the higher values than the score value of node i is stored in one group and lower values than the score value of node i is stored in another group. Then the tendency of node i to select which group is calculated and identified and afterwards another formula is calculated to identify the probability of the node i to elect as CH.

The Clustering Problem presume that n nodes are isolated in a field and the beyond assumptions hold. Our purpose is to spot a set of cluster heads which cover up the entire field. every node v_i, where $1 \le i \le n$, must be mapped to exactly one cluster c_j, where $1 \le j \le n_c$, and n_c is the number of clusters ($n_c \le n$). A node should be able to directly communicate with its cluster head (via a single hop). Cluster heads can use a map-reading protocol to compute inter cluster paths for multi hop communication to the observer(s), as discuss in fragment 4. The following requirements must be met:

Clustering is completely distributed. Each node alone makes its decisions based only on local information. Clustering terminates surrounded by a fixed amount of iterations (regardless of network diameter).

At the end of each TCP, each node is either a cluster head, or not a cluster head (which we refer to as a regular node) that belongs to closely one cluster. Clustering should be efficient in terms of processing intricacy and message swap.

Cluster heads are well-distributed over the sensor field and have comparatively high standard residual energy compared to normal nodes.

III. CLUSTERING PARAMETERS

The goal of our approach is to extend network lifetime. For this reason, cluster head selection is mainly based on the enduring energy of each node. Measuring this enduring energy is not necessary from the time when the energy consumed per bit for sensing, processing, and communication is normally known and, thus,

Enduring energy can be projected. To increase energy efficiency and additional pro- long network lifetime, we also consider intra cluster "communication" as a secondary clustering stricture. For example, cost can be a function of neighbor proximity or cluster compactness.

We apply the primary clustering parameter to probabilistically opt for an initial set of cluster heads, and the secondary parameter to "break ties" among them. A strap in this perspective means that a node falls within the range of more than one cluster head. To identify with what range denote in this t e s t , study that a node usually has a number of discrete transmission power levels. Therefore, the cluster range is determined by the transmission power level used for intra cluster announcement and throughout clustering. We pass on to this level as the *cluster power level*. The cluster power level should be place to one of the lesser power levels of a node, to increase spatial reprocess, and reserve superior power levels for inter cluster communication. These higher power levels should envelop at least two or more cluster diameters to agreement that the resulting inter cluster cover will be associated. If this condition cannot be satisfied, then our approach for clustering in combination with power level choice is unsuitable. We analyze inter cluster connectivity conditions in Section. The cluster power level dictates the quantity of clusters in our network. It is nontrivial to determine an optimal cluster power level because network topology change due to node failure and energy depletion. The secondary clustering parameter, intra cluster communication rate, is a function of

1. Cluster property, such as cluster size, and
2. Whether or not variable power levels are permitted for intra cluster communication.

IV. CLUSTERING APPLICATIONS

Our approach should be for construct energy-efficient hierarchies for routing protocol, in which superior tier nodes should have more residual energy. Our advance plane can also be effective for sensor applications require more capable data aggregation and extended network lifetime, such as environmental monitoring applications. We take one such application in this section. Cluster heads in our application do not consume similar amount of energy during every T_{NO} period, as assumed in [8].

In distributed clustering protocol for micro sensor networks (LEACH) was introduced for prolonging the network lifetime. LEACH was projected for applications in which sensor nodes are random distributed on a grid area and are always sensing the environment to send reports to a remote sink (e.g. base station). The application assumes that nodes are uniformly significant and data aggregation possible. In LEACH, a node elects to develop into a cluster head at random according to a target number of cluster heads in the network and its own enduring energy. Clustering starts by computing the most favorable number of clusters in the network. When clustering is trigger, certain nodes broadcast their selection to become cluster heads, and regular nodes link clusters according to cluster head propinquity. Each cluster head then creates a TDMA schedule for this node and broadcast it. Every node sends its data to its cluster head according to the specific TDMA program. Direct Sequence Spread Spectrum codes are used to reduce inter cluster interfering (thus, we overlook collisions in our model). Each cluster head fuse the data it receive from its nodes into one frame and sends it to sink. Clustering is trigger each T_{NO} TDM frames.

It is clear under optimal conditions (no interference or data losses), the most network lifetime occurs at the minimum possible choice of T_{NO} (i.e., for T_{NO} 1) if the clustering overhead is unique to the application load. However, such small values of T_{NO} cause. The system should be always in an unsteady state, which might lead to undesirable property, such as excessive interference, data loss, and response in delay. Thus, T_{NO} can be in the array of seconds for applications where all nodes are constantly sending information, and a cluster head consume a considerable portion of its energy for serving its cluster member. Alternatively, for data-driven applications, and the aggregation and forwarding processes are not very expensive, T_{NO} can be in the range of summary.

Our work is based on MOD LEACH protocol that can be extended to SEP and DEEC. Mainly, we bring two techniques to raise network life span and throughput. To understand our proposed scheme, we have to understand mechanism given by MOD LEACH. This protocol changes the cluster head at every round and once a cluster head is formed, it will not get more chance for next 1/*p* round. For each round, cluster heads are replaced and whole cluster pattern process is undertaken. We, in this work, modify LEACH by through *"Dual Transmission power levels and efficient cluster head replacement scheme"*. It is a threshold of cluster head formation for next round. If presented cluster has not spent much energy during its possession and has more energy than required threshold, it will wait cluster head for the very next round as well. This is how, energy wasted in routing packets for every new cluster head and cluster formation can be saving. If cluster head has less energy than necessary threshold, it will be replaced according to MOD LEACH algorithm. However, limiting energy utilization of cluster formation, we also set up two different levels of power to amplify signals according to nature of transmission. Mainly there should be three modes of transmission in a cluster-based network.

Intra Cluster transmission work with all the communication within the cluster i.e. clusters member's sense data and give information sensed data to cluster head Base. The transmission/reception linking two clusters heads can be termed as inter cluster transmission whereas a cluster head transmitting its data without delay to base station lies under the caption of cluster head to base station transmission. Buck amplification energy required for inter cluster or cluster head to Base Station communication and amplification energy required

For intra cluster communication that cannot be same.
In MOD LEACH, amplification energy is place same for all types of transmissions. By using low energy level for intra cluster transmissions in respect to cluster head to Base Station transmission leads in saving much amount of energy. However, multi power levels also shrink the packet drop ratio, collision and interference for other signals.

We assume that a cluster with maximum may spread into an area of $10X10m^2$ in a area of $100X100m^2$. Energy that is sufficient to transmit at far ends of a field for $100X100m^2$ must be lowered 10 times for intra cluster transmission. When a node act as like a Cluster head, routing protocol informs it to use high power amplification in next round, when that node work same as cluster member, routing protocol switch it to low level power amplification. Finally, soft and hard threshold schemes are also implemented in MOD LEACH that gives enhanced outcome.

V. EXPERIMENT AND RESULT

Simulations are conducted with *MAT LAB* (*R*2018b) to get specific plots. Simulations outcome data are support for that MODLEACH performs better consider metrics for throughput, network life time, and optimized cluster head pattern of network. MOD LEACH performs best for network life time with use minimum amount of energy and performs optimized cluster and its throughput.

TABLE I

Network Parameters	Value
Network Size	$100X100m^2$
Initial Energy of Sensor Nodes	0.5 J
Packet Size	4000 bits
Transceiver idle state energy consumption	50 nJ/bit
Data Aggregation/ Fusion Energy consumption	5 nJ/bit/report
Amplification Energy (Cluster to BS)$d \geq d_o$	Efs $10pJ/bit/m^2$
Amplification Energy (Cluster to BS) $d \leq d_o$	Emp $0.0013pJ/bit/m^2$
Amplification Energy (Intra Cluster Comm.) $d \geq d_1$	$Efs/10 = Efs_1$
Amplification Energy (Intra Cluster Comm.)$d \leq d_1$	$Emp/10 = Emp_1$

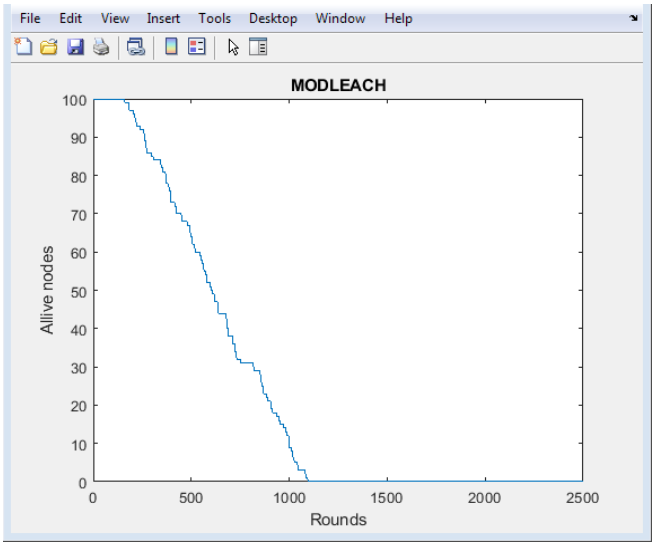

Fig.1. No of Alive Nodes and Its Rounds to Get Power

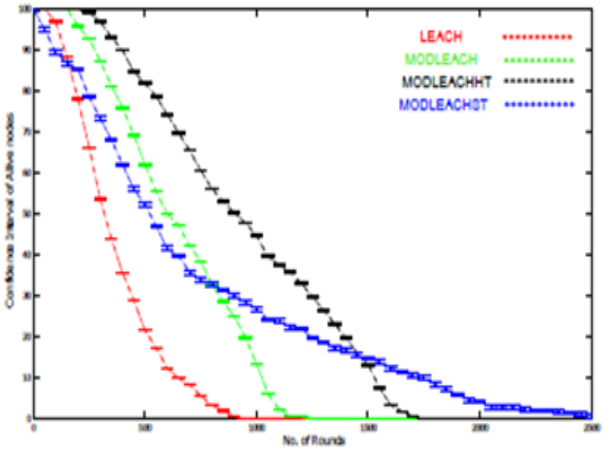

Fig. 2. Alive Nodes of Network

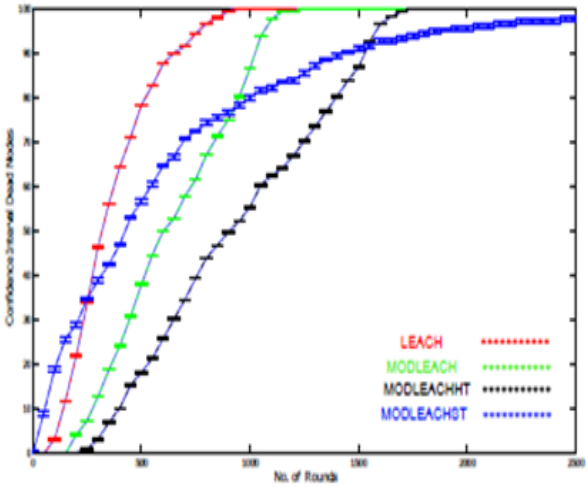

Fig. 3. Dead Nodes of Network

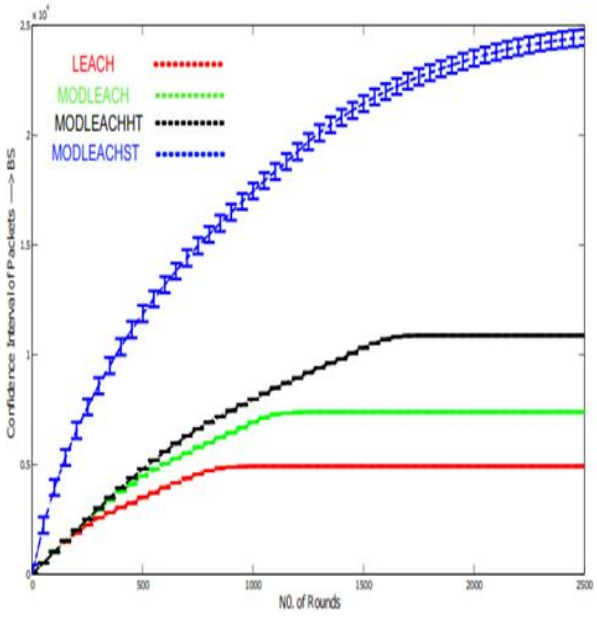

Fig. 4. Packet Transmitted to Base Station

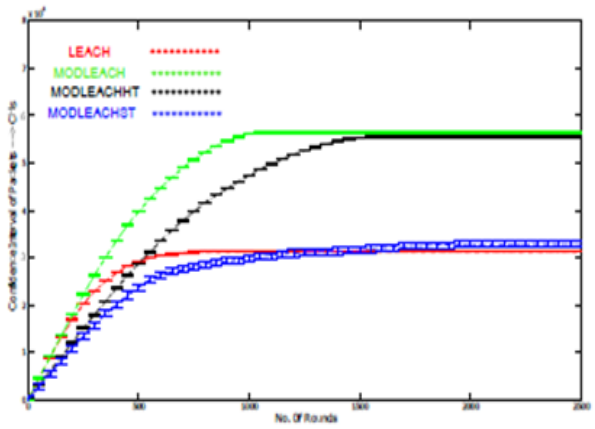

Fig. 5. Packet Transmitted to Cluster Heads

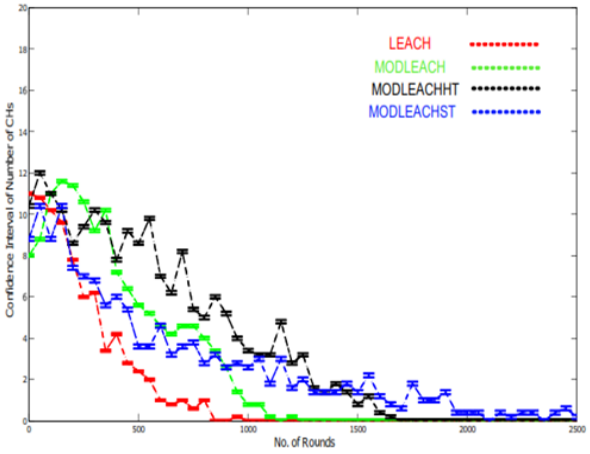

Fig. 6. Number of Clusters Head

VI. CONCLUSION

In this paper, we present a brief discussion on emergence of cluster-based routing in wireless sensor networks. We put forward MOD LEACH, a new alternate of LEACH that can advance be utilized in other clustering routing protocols for enhanced efficiency. MOD LEACH tend to reduce network energy consumption by proficient cluster head substitute after very initial round and dual transmit power levels for intra cluster and cluster head to base station communication. In MOD LEACH, a cluster head will only be replaced when its energy fall lower then certain threshold minimizing routing of protocol. Hence, cluster head replacement method involves enduring energy of cluster head at the start of each round. Further, soft and hard thresholds are implemented on MOD LEACH to propose a comparison on performances of these protocols allowing for throughput and energy consumption.

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