



## Review of Energy Conservation in Wireless Sensor Network

<sup>1</sup>Deepika Sharma \*, <sup>2</sup>Gurpreet Singh<sup>1</sup>Student, CSE Department, <sup>2</sup>Associate Professor<sup>1,2</sup> Yamuna Institute of Engineering and Technology, Kurukshetra University, India

**Abstract**— Hierarchical network routing divides the network into clusters to achieve energy-efficiency and scalability. One of the famous hierarchical network routing protocol is low-energy adaptive clustering hierarchy (LEACH). Cluster heads consumes more energy in aggregating and routing the data, so it is important to have an energy-efficient mechanism for cluster heads election and rotation. The protocols developed for wireless sensor networks must be energy efficient so that the network lifetime can be prolonged.

**Keywords**— LEACH, Hierarchical, Clustering, Protocol, Cluster Head.

### I. INTRODUCTION

Wireless sensor networks popularly known as WSN is combination of three words. Sensors are tiny devices that sense physical quantities and convert them into electrical signals. The word network signifies that these sensors can communicate among themselves. Wireless denotes that the communication takes place through a wireless medium [6]. Thus wireless sensor network consists of hundreds of sensor nodes that can sense their vicinity and communicate among themselves or to the external base station. Wireless Sensor network (WSN) is a large network consisting of huge number of sensor nodes and these nodes are directly interacting with their environment by sensing the physical parameters such as temperature, humidity, etc [1].

The nodes in WSNs are battery operated sensing devices with limited energy resources and replacing or replenishing the batteries is usually not an option. Sensor nodes have to coordinate among themselves to get information about the physical environment.

In WSN, all the sensor nodes collect local information and process that information and send it to a remote base station (called sink). After receiving the information from all the nodes, Base station sends the queries to the sensor nodes that perform the sensing task and return the data to the base station as answer to the query. In wireless sensor networks more energy is consumed during communication than the other tasks like sensing and processing.

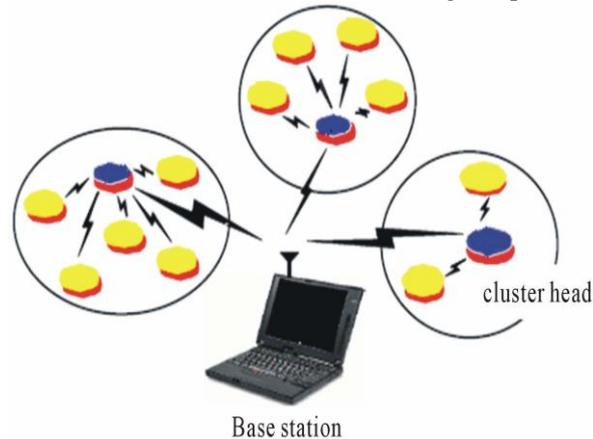


Figure1: A sensor network with clustering

The communication between sink and sensor nodes can takes place in two ways:

- flat
- hierarchical

In flat architectures the sensor nodes send the sensed data directly to the base station whereas in hierarchical architecture the nodes are organized into clusters and for each cluster there is a cluster head, and sensed data is send by sensor nodes to the cluster head which relays the data to the base station. In flat networks more energy is consumed by node because it has to deliver the data to a long distance.

In conventional clustering, the network is divided into small group of nodes known as cluster. From each cluster one node is selected as a Cluster Head. The remaining nodes in the cluster send their data to their respective cluster head. The task of cluster Head is to collect the data and send that data to the base station. This scheme works better than direct

transmission but network depends on lifetime of Cluster Head and energy consumed by Cluster Head is more than the other nodes and may die early [5]. WSNs are used for variety of purposes like habitat monitoring, forest-fire detections, transport monitoring etc.

There are some cases that the nearby node senses the same data and transmit that data to Base Station, which makes network inefficient. So to maintain the information at the Base Station, the nodes must be responsible for data fusion and aggregation. A reliable network is the network in which the redundant information is negligible. So many clustering algorithms were proposed to avoid redundancy.

## II. ROUTING PROTOCOLS CLASSIFICATION FOR WIRELESS SENSOR NETWORK

For WSN routing protocols are classified as:

- a) In Flat network routing, all nodes have the same functionality and all nodes work together to perform sensing and routing tasks.
- b) In location-based network routing, nodes location information is used to compute the routing path. This location information can be obtained from global positioning system (GPS) devices attached to each sensor node.

## III. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

LEACH is the first proposed wireless hierarchical routing protocol and also known as cluster-based routing protocol which includes cluster formation. It is a two layer architecture where one layer is engaged in cluster head (CH) selection and other is responsible for routing [10]. In Leach, the nodes form themselves into local clusters, where one node acts as the local cluster-head (CH). Leach includes randomize rotation of the high-energy cluster head position such that it rotates among the several sensors nodes in order to not deplete the battery of a single sensor. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes. The cluster-head (CH) node knows all the cluster members, it creates a TDMA schedule that tells each node exactly when to transmit its data. Using a TDMA schedule for data transfer prevents intra-cluster collisions.

In addition, cluster heads performs data fusion to compress the amount of data arriving from the nodes that belong to the respective cluster and transmit aggregate data to the base station, and reducing energy dissipation and enhancing system lifetime.

The operation of cluster forming and data transmission in LEACH is done in two phases.

- a. Set-up phase
- b. Steady phase

### Set-up phase

In LEACH, nodes take autonomous decisions to form clusters by using a distributed algorithm without any centralized control. In this, no long-distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network and also no global communication is needed to set up the clusters. The algorithm for cluster formation should be designed such that nodes are cluster-heads approximately the same number of time, assuming that all the nodes start with the same amount of energy. Finally, the cluster-head (CH) nodes should be spread throughout the network, as this will minimize the distance and non cluster-head nodes need to send their data. The sensor node chooses a random number,  $r$ , between 0 and 1. Let the threshold value be  $T(n)$  :

$$T(n) = p / (1 - p \times (r \bmod p^{-1}))$$

If this random number is less than the threshold value  $T(n)$ , then that node becomes a cluster-head (CH) for the current round. This threshold value is calculated based on the above given equation that incorporates the desired percentage to become a cluster-head, the current round, and set of nodes that have not been selected as a cluster-head in the last  $(1/P)$  rounds, here  $p$  is cluster head(CH) probability. After the nodes have elected themselves to be the cluster-heads, it broadcasts the advertisement message (ADV). This advertisement message is a small message containing the node's ID and a header that distinguishes this message as an announcement message. Each non cluster-head (CH) node determines to which cluster it belongs by choosing the cluster-head that requires the minimum communication energy, on the basis of received signal strength of the advertisement from each cluster-head (CH). After each node has decided to which cluster it belongs, the node must inform the cluster-head node that it will be a member of the cluster. Every node transmits a join-request message (Join-REQ) back to the chosen cluster-head (CH). The cluster-heads in LEACH act as local control centres to co-ordinate the data transmissions in their cluster. The cluster-head node sets up the TDMA schedule and transmits this schedule to the nodes in the cluster.

Thus it ensures that there is no collision among data messages and also allows the radio components of each non cluster-head node to be turned off at all times except during their transmit time, thus minimizing the energy dissipation by the individual [9].

### Steady phase

In the Steady phase, every member node in cluster send its data to the cluster head only in its time slot and for energy conservation at the rest of time pieces goes to sleep mode.

The cluster-head must keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster-head (CH) receives all the data, then it can operate on the data and the resultant data are sent from the cluster-head to the base station [8].

In this method, more energy is consumed by cluster head (CH) for receiving the data, processing and directly sending that data to the BS node. So in order to increase the life time of the network it is necessary to replace role of cluster head between network nodes.

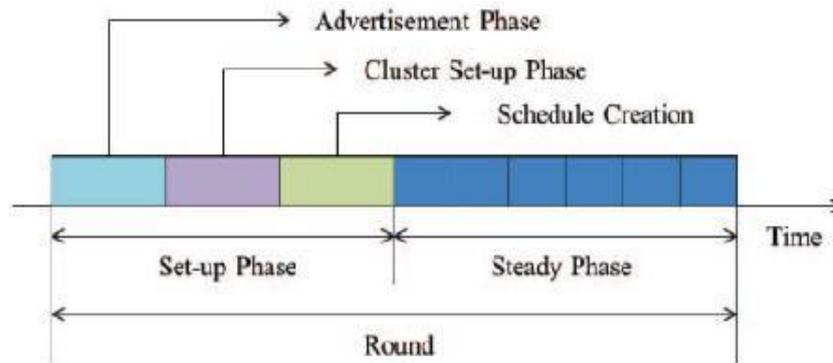


Figure2: Phase structure of LEACH

#### IV. LITERATURE SURVEY

There are various techniques for Wireless Sensor Networks that are described below:

##### A) *Position Based Clustering*

An distributed energy efficient clustering algorithm for heterogeneous WSNs, is evaluated by Abderrahim Beni Hssane in 2010 [1] called Position-Based Clustering (PBC). This protocol is an improvement of LEACH-E. LEACH-E protocol is proposed to elect the cluster-heads according to the energy left in each node. In PBC, the cluster-heads are elected by using probabilities based on the ratio between residual energy of each node and the remaining energy of the network. It uses a 2-level hierarchy by selecting an intermediate cluster head for data transmission. Moreover, it uses a new technique for cluster formation based not only on the received signal strength of the cluster head's advertisement but also on its position. The result of Simulation show that the proposed algorithm increases the lifetime of the whole network and performs better than LEACH.

##### B) *Energy-Efficient Level Based Clustering Routing Protocol*

This energy-efficient routing protocol is provided by Meenakshi Diwakar in April 2012 [2], to improve the lifetime of the networks. The author proposed EELBCRP (Energy-Efficient Level Based Clustering Routing Protocol), the protocol for wireless sensor networks. Network is partitioned into rings by using various power levels at base station and each ring having various sensor nodes and also consider the residual energy of each node and distance from the BS of nodes as the principle of cluster-head election. The results are obtained in terms of three metrics- lifetime of the network, in the number of clusters and energy consumption of cluster heads.

##### C) *Cluster-based routing protocols*

Various routing protocols were founded by Vikas Nandal in September 2012 [3], like flat routing protocols, location-based protocols, QOS based, hierarchical routing etc. With which the optimal routing can be achieved.

Hierarchical routing (cluster-based routing protocols) have shown to be more scalable and energy-aware. The author developed a mechanism to increase the lifetime of sensor nodes controlling long distance communication, efficient delivery of information and balancing of nodes. LEACH (low-energy adaptive clustering hierarchy) is well-known & divides the whole network into several clusters, the run time of network is broken into many rounds. In each round, the nodes in the cluster contend to be cluster head according to a predefined criterion. Cluster heads consumes more energy in aggregating and routing the data, so it is important to have an energy-efficient mechanism for cluster heads election and rotation. The author proposed an algorithm for cluster head selection based on the residual energy, distance & the reliability.

##### D) *Fuzzy Based Master Cluster Head Election Leach Protocol*

The author Tripti Sharma in 2012 [4], proposed F-MCHEL (Fuzzy Based Master Cluster Head Election Leach Protocol). In LEACH protocol the clusters are formed randomly on the basis of threshold values; whereas, in this protocol a fuzzy logic approach is used to elect the cluster-head on the basis of two descriptors - energy and the proximity distance. Out of these elected cluster heads (CH's) one Master cluster head has been elected. The cluster head which has the maximum residual energy is elected as Master cluster head (CH). In conventional Leach approach all the cluster heads (CH's) are used to send the aggregated information to the base station, however in this proposed protocol only Master cluster head sends the aggregated information to the base station. Results obtained shows that an appropriate Master cluster-head election can drastically reduce the energy consumption and enhance the lifetime of the network.

##### E) *Energy Efficient Load Balanced Clustering Technique*

The author A.Babu Karuppiyah in 2013 [5] proposed an Energy Efficient Load Balanced Clustering Technique which is used to find energy efficiency as well as the load balancing. This Energy Efficient Load Balanced Clustering Technique

is a min heap based Clustering algorithm. The efficiency of WSNs is measured by the total distance between nodes to the base station and data amount that has been transferred. Cluster-head(CH) responsible for the creating cluster and cluster nodes may affect the performance of the cluster. The result shows that the proposed algorithm is efficient in terms of balancing the load, energy efficiency, and the number of sensor nodes that die during the network period.

**F) Modified Stable Election Protocol**

The author Jin Wang in 2013 proposed [7] found that the Sensor nodes usually have limited energy supply and they are impractical to recharge. To balance traffic load in sensors in order to increase network lifetime is a very challenging research issue. Many clustering algorithms have been developed for wireless sensor networks (WSNs). However, sensor networks with one fixed sink node often suffer from a hot spots problem since nodes near sinks have more traffic burden to forward during a multi-hop transmission process. The use of mobile sinks has shown to be an effective technique to enhance network performance features such as the latency, energy efficiency, network lifetime, etc. So, the author proposed a modified Stable Election Protocol (SEP), which employs a mobile sink, for WSNs with non-uniform node distribution. The selection of cluster heads (CH's) by the sink is based on the minimization of the associated additional energy and residual energy at each node. Besides, the cluster head (CH) selects the shortest path to reach the sink between the direct approach and the indirect approach with the use of the nearest cluster head.

**G) Energy Efficient Routing Protocols To Increase Network Lifetime**

An energy efficient routing protocols is developed by Anand Nayyar in 2014 [8] for wireless sensor network so that the network lifetime can be prolonged. Because Wireless sensor networks (WSNs) consists of large number of multi-functional sensor nodes. Routing protocols developed for other ad hoc networks cannot be applied directly in WSN because of the energy constraint of the sensor nodes. These sensor nodes are battery powered and deployed in harsh environments so it is not always possible to recharge or replace its batteries. This routing protocols developed for wireless sensor networks must be energy efficient so that the network lifetime can be prolonged.

ALGORITHMS & TECHNIQUES USED	AUTHOR & YEAR	FINDINGS
PBC (Position-Based Clustering Algorithm)	Abderrahim Beni Hssane in 2010	uses a 2-level hierarchy in order to increase the lifetime of the whole network.
EELBCRP (Energy-Efficient Level Based Clustering Routing Protocol)	Meenakshi Diwakar in 2012	This protocol gives results in terms of three metrics- lifetime of the network, number of clusters and energy consumption of clusters heads.
Cluster-based routing protocols	Vikas Nandal in 2012	This protocol is used to increase the lifetime of sensor nodes.
F-MCHEL (Fuzzy Based Master Cluster Head Election Leach Protocol)	Tripti Sharma in 2012	reduce the energy consumption and gives enhancement in the lifetime of the network.
Energy Efficient Load Balanced Clustering Technique	A.Babu Karuppiah in 2013	uses min heap based Clustering algorithm for balancing the load, energy efficiency, and the number of sensor nodes that die during the network period.
SEP (Modified Stable Election Protocol)	Jin Wang in 2013	for balancing traffic load in sensors.

**V. CONCLUSION**

Hierarchical routing (cluster-based routing protocols) have shown to be more scalable and energy-aware. Number of Leach enhancements have been reviewed to increase the lifetime of sensor nodes controlling long distance communication, efficient delivery of information and balancing of nodes. LEACH (low-energy adaptive clustering hierarchy) is well-known & divides the whole network into several clusters, the run time of network is broken into many rounds.

## REFERENCES

- [1] Abderrahim Beni Hssane, Moulay Lahcen Hasnaoui, “*An Energy-Efficient Clustering Hierarchy for Heterogeneous Wireless Sensor Networks*”, Abderrahim Beni Hssane et. al. / (IJCSSE) International Journal on Computer Science and Engineering, Volume02, ISSN:2831-2835, No. 09, 2010.
- [2] Meenakshi Diwakarand Sushil Kumar, “*An Energy-Efficient Level Based Clustering Routing Protocol for Wireless Sensor Networks*”, International Journal Of Advanced Smart Sensor Network Systems (IJASSN), Vol 2, No.2, April 2012.
- [3] Vikas Nandal and Deepak Nandal, “*Maximizing Lifetime of Cluster-based WSN through Energy-Efficient Clustering Method*”, IJCSMS International Journal of Computer Science & Management Studies, Volume 12, ISSN: 2231 –5268, Issue 03, September 2012.
- [4] Tripti Sharma and Brijesh Kumar, Department of Information Technology, “*Fuzzy Based Master Cluster Head Election Leach Protocol in Wireless Sensor Network*”, International Journal of Computer Science and Telecommunications ,Volume 3, ISSN 2047-3338, Issue 10, October 2012.
- [5] A.Babu Karuppiyah and P.Suresh, “*Min-Heap based Energy Efficient Load Balanced Clustering Technique for WSN*”, International Journal Of Engineering And Computer Science, Volume 2, ISSN:2319- 7242, Issue 2, Feb 2013.
- [6] Gurpreet Singh, Amanpreet Kaur, “*Using Random Way Point Mobility Model To Compare The Performance Of Reactive And Proactive Routing Protocols Of MANETs in Ns-2*”, In the proceedings of National Conference on Futuristic Trends in Computing, Communication & Information System – FTTCCIS and Yamuna Journal of Technology & Business Research - Volume 3. Issue (1-2), pages 5.1-5.7, July 12-13, 2013.
- [7] Jin Wang and Weiwei Yuan “*An Energy Efficient Stable Election-based Routing Algorithm for WSN*”, Suwon 449-701, Korea, 14301-14320, doi:10.3390/s131114301, October 2013.
- [8] Agam Gupta and Anand Nayyar, “*A Comprehensive Review of Cluster-based Energy-Efficient Routing Protocols in WSN*”, International Journal of Research in Computer and Communication Technology, Vol 3, Issue 1, January 2014.
- [9] Meena Malik, Dr. Yudhvir Singh, “*Analysis of Leach Protocol in WSNs*”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, ISSN: 2277 128X, Issue 2, February 2013.
- [10] Priyank Garg, Reena Rani, Gurpreet Singh, “*Achieving Energy Efficiency in WSN using GSA*”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 4, April 2014.