



## Better Cluster Head Management in WSN using Min Heap algorithm

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**Abstract**— *The aim of this Paper is to reduce the consumption of network resource, to propose a Clustering algorithm for Load balancing. This enhanced clustering algorithm will improve network lifetime and as well as the scalability of wireless Sensor network. In this paper, an efficient Load balancing clustering Technique is proposed which is used to find energy efficiency and as well as better cluster head management. Energy Efficient Load balancing Clustering technique is a Clustering algorithm which is based on Min Heap algorithm and used to measure Performance analysis of Average no of cluster formation in each round, Network life time, load balancing and Data transmitted. Cluster head creates the cluster and so these cluster nodes may affect the performance of cluster. The result show that proposed algorithm is efficient in terms of energy efficiency, amount of data to be transmitted, Number of alive nodes in each round.*

**Keywords**— *Wireless sensor network (WSN), Leach protocol; Min-Heap; clustering algorithm; Energy Efficiency ; Load Blancing*

### I. INTRODUCTION

The sensor nodes consist of sensing, data processing, and communicating components along with a power unit. In WSN, all the sensor nodes collect local information, process them and send it to a remote base station (called sink). The sink is connected to the Internet for the public notice of the phenomena. One of the most important constraints on sensor nodes is the requirement of low power consumption. Sensor nodes are energy constrained because they carry a limited energy. Because nodes are deployed randomly in a harsh environment so replacement or recharging of battery is not quite possible. Energy consumption in transmission is directly proportional to the square of the distance between transmitter and receiver. So, reducing energy consumption for maximizing network lifetime is thus considered as the most critical challenge in WSN Clustering of nodes is a scalable and energy efficient process for Wireless Sensor Networks. In conventional clustering, network is divided into small group of nodes called cluster. One node from each cluster is selected as a Cluster Head. All the remaining nodes in the cluster send their data to their respective cluster head. Cluster Head aggregate the data and sends to the base station. This scheme works far better than direct transmission but network depends on lifetime of Cluster Head and Cluster Head consumes more energy than other nodes and may die early. Every node has the possibility of being a cluster head. Because Cluster Heads election is done randomly, energy load balancing is achieved among the sensor nodes in the network. In a few WSN scenarios, some high-energy nodes called "Gateways" are deployed in the network. These gateways group sensors to form distinct clusters in the system and act as a CH. The CHs manage the network in the cluster, perform data fusion and send the processed data to the sink through other CHs or sensor nodes. Each sensor node only belongs to one and only one cluster and communicates with its CH. The functionality of a cluster constructed in WSN with single-hop communication is shown in fig. 1. The advantages of a cluster based WSN are as follows. It reduces energy consumption significantly; conserves communication bandwidth and improves the overall scalability of the network[1].

A large number of sensor nodes are deployed in the monitored area, Forming a network through the way of self organization. The data monitored by sensor nodes is transmitted along other nodes one by one, that will arrive the sink node after a multi-hop routing and finally reach the management node through the wired or wireless Internet.

The energy, the storage capacity and communication capability of sensor nodes are very limited. Random distribution of the nodes in the sensing field makes battery recharge or exchange and impossible fact. A primary design goal for wireless sensor networks is to use the energy efficiently. Due to their energy constraints, wireless sensors usually have a limited transmission range, making multi hop data routing toward the PN more energy efficient than direct transmission (one hop). Cluster-based routing algorithm has a better energy utilization rate compared with noncluster routing algorithm. The basic idea of clustering routing is to use the information aggregation mechanism in the cluster head to reduce the amount of data transmission, thereby, reduce the energy dissipation in communication. In order to design good protocols for wireless microsensor networks, it is important to understand the parameters that are relevant to the sensor applications. While there are many ways in which the properties of a sensor network protocol can be evaluated. WIRELESS SENSOR NETWORK (WSN) has attracted considerable attentions during the last few years due to characteristics such as feasibility of rapid deployment, self-organization (different from ad hoc networks though) and fault tolerance, as well as rapid development of wireless communications and integrated electronics. Such networks are

constructed by randomly but densely scattered tiny sensor nodes. As sensor nodes are prone to failures and the network topology changes very frequently, different protocols have been proposed to save the overall energy dissipation in WSNs. Among them, Low-Energy-Adaptive-Clustering-Hierarchy (LEACH), first proposed by researchers from Massachusetts Institute of Technology is considered to be one of the most effective protocols in terms of energy efficiency [3]. Wireless sensor networks are a class of wireless ad-hoc networks. In these networks, sensor nodes collect data from physical environment and after processing sent to the base station (BS1). Thus allow monitoring and control many types of physical parameters. Each sensor node has limited energy and in most applications, replacing energy sources are not possible. So lifetime of sensor nodes is highly dependent on energy stored in their battery. Clustering is a designing method that used for management of wireless sensor networks. In this method, the network is divided into several independent collections that these collections called cluster. So each cluster contains a number of sensor nodes and a cluster head node. Member nodes in a cluster send their data to relative cluster head node. Cluster head node aggregates these data and send to the base station. Therefore, clustering in sensor networks has advantages such as data aggregation support, data gathering facilitation, organizing a suitable structure for scalable routing and efficient propagation of data in the network. Data gathering in wireless sensor networks is an important operation in these networks and for this purpose many methods have been proposed. The LEACH2 protocol has been considered as a hierarchical basic method. This method is suitable for monitoring applications. Each node periodically senses the information and sends them. In this algorithm, the clustering method has used for data gathering and aggregation. The cluster and cluster head selected randomly, therefore there is no assurance to select the exact improved number and uniform distribution of cluster head throughout the network. The cluster-head selection mechanism directly affects the energy consumption and network lifetime in WSN based water-environment monitoring systems. Thus, the cluster-head selection mechanism and the energy saving strategy would be considered as the important aspects in the design of network routing protocols. However, the present routing protocols usually have problems such as previously selected cluster-head, unbalancing energy loads and short lifetime. It can not be applied to the real-time WMN with large area. While there are many ways in which the properties of a sensor network protocol can be evaluated, we use the following metrics:

#### Ease of Deployment

Sensor networks may contain hundreds or thousands of nodes, and they may need to be deployed in remote or dangerous environments, allowing users to extract information in ways that would not have been possible otherwise. This needs that nodes be able to communicate with each other even in the absence of an established network infrastructure and the predefined node locations.

#### Lifetime

These networks should function for as long as possible. It may be inconvenient or impossible to recharge the node batteries. Therefore, all aspects of the node, from the hardware to the protocols, must be designed to be highly energy efficient.

#### Latency

Data from sensor networks are typically very time sensitive, so it is important to receive the data in a timely manner.

#### Quality

The notion of "quality" in a microsensor network is very different than in traditional wireless data networks. For sensor networks, the end user does not need all the data in the network because 1) the data from neighboring nodes are highly correlated, making the data redundant and 2) the end user cares about a higher-level description of events occurring in the environment being monitored. The quality of the network is, hence, based on the quality of the aggregate data set, so protocols should be designed to optimize for the unique, application-specific quality of a sensor network[2].

## II. RELATED STUDY

A.Babu Karuppiah et. al. [1] Clustering is one of the key mechanisms for load balancing. Clustering Algorithm is an efficient technique to improve life time and scalability of a Wireless Sensor Network. In this paper, an Energy Efficient Load Balanced Clustering Technique is proposed which is used to find energy efficiency as well as load balancing. Energy Efficient Load Balanced Clustering Technique is a min heap based Clustering algorithm. Efficiency of WSNs is measured by the total distance between nodes to the base station and data amount that has been transferred. Cluster-Head which is totally responsible for the creating cluster and cluster nodes may affect the performance of the cluster. The result show that the proposed algorithm is efficient in terms of load balancing, energy efficiency, and the number of sensor nodes that die during the network period.

Wendi B. Heinzelman et. al. [2] In this paper it is proposed that to develop and analyze low-energy adaptive clustering hierarchy (LEACH), a protocol architecture for microsensor networks that combines the ideas of energy-efficient cluster-based routing and media access together with application-specific data aggregation to achieve good performance in terms of system lifetime, latency, and application-perceived quality.

Vikas Nandall et. al. [3] proposed a progressive algorithm for the cluster head selection. The proposed algorithm for cluster head selection is based on residual energy, distance & reliability. LEACH (low-energy adaptive clustering hierarchy) is well-known & divides the whole network into several clusters, and the run time of network is broken into many rounds. In each round, the nodes in a cluster contend to be cluster head according to a predefined criterion. Since CHs consume more energy in aggregating and routing data, it is important to have an energy-efficient mechanism for CHs' election and rotation. The cluster head generation algorithm with the original LEACH clustering protocol can cause unbalanced distribution of cluster heads, which often leads to redundant cluster heads in a small region and thus cause the significant loss of energy.

Lianshan Yan et. al. [4] investigated an improved energy-efficient communication protocol for wireless sensor networks (WSNs) in the presence of distributed optical fiber sensor (DFS) links located at the center of WSN fields based on the protocol—low-energy adaptive clustering hierarchy (LEACH). They investigated a modified energy-efficient communication protocol, called O-LEACH, for wireless sensor networks that consist of DFS links and randomly scattered wireless sensor nodes. Survival round numbers of WSN nodes are simulated for various cases using different parameters. Network performances in terms of lifetime of nodes are simulated for the cases that two WSNs can or cannot communicate with each other. The lifetime of such sensor network with rectangular topology is further investigated. The lifetime of the situation that two WSNs are isolated is more than 20% better than that of the case where nodes inside two WSN fields are reachable to any live nodes within the whole sensor field. This can be a deployment guideline for such hybrid sensor networks.

Jafar Amiri1 et. al.[5] Data gathering in wireless sensor networks is one of the important operations in these networks. These operations require energy consumption. Due to the limited energy of nodes, the energy productivity should be considered as a key objective in design of sensor networks. Therefore the clustering is a suitable method that used in energy consumption management. For this purpose many methods have been proposed. Between these methods the LEACH algorithm has been attend as a basic method. This algorithm uses distributed clustering method for data gathering and aggregation.

Nazia Majdi et. al. [6] build a wireless sensor network in which each sensor node remains inside the transmission range of CHs and therefore, the lifetime of the network is prolonged. A wireless sensor network is composed of a large number of sensor nodes that are densely deployed in a phenomenon or very close to it. The lifetime of sensor nodes shows a strong dependence on battery lifetime. Clustering provides an effective way for prolonging the lifetime of a wireless sensor network. Therefore, clustering techniques are used to distribute the energy consumption among nodes in each cluster and extend the network lifetime. LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of Cluster-Heads (CHs) to evenly distribute the energy among the sensors in the network. But LEACH cannot select CHs uniformly throughout the network. Therefore there is the possibility that the elected CHs will be concentrated in certain area of the network. Hence, some nodes will not have any CHs in their vicinity.

Xiaohua (Edward) Li et. al. [7] The efficiency of space-time block code-encoded (STBC) cooperative transmission is studied within low-energy adaptive clustering hierarchy (LEACH), which is a typical networking/ communication protocol for wireless sensor networks. Cooperation protocol with low overhead is proposed, and synchronization requirements among cooperating sensors are discussed. Energy efficiency is analyzed as a tradeoff between the reduced transmission energy consumption and the increased electronic and overhead energy consumption.

A.S.Poornima and B.B.Amberker et. al. [8] proposed a secure data aggregation scheme which provides end-to-end data privacy. Wireless Sensor Network (WSN) consists of a large number of nodes with limited resources. In such network consisting of resource constrained nodes, data transmission is an energy-consuming operation. Hence to extend the lifetime of the network it is necessary to reduce the number of bits transmitted. One widely used method for reducing the data bits is data aggregation. The security issues such as data integrity, confidentiality and freshness in data aggregation become crucial when the WSN is deployed in a remote or hostile environment where sensors are prone to node failures.

Chenmin Li et. al. [9] proposed that Water-environment monitoring network (WMN) is a wireless sensor network based real-time system, which collects, transmits, analyzes and processes water-environment parameters in large area. Both cluster selection mechanisms and energy saving strategies play an important role on designing network routing protocols for the WMN. Since those existing routing algorithms can not be used directly in the WMN, thus this paper has proposed an improved version of LEACH, a LEACH-Head Expected Frequency Appraisal (LEACH-HEFA) algorithm, for the WMN in this paper. Simulation results show that the LEACH-HEFA can balance the energy consumption of nodes, rationalize the clustering process and prolong the network lifetime significantly in the WMN. It indicates that the LEACH-HEFA is suitable to the WMN.

Yi Liu et. al.[10] A low energy uneven cluster protocol design method is proposed. Aiming at the random choosing for cluster head of traditional Leach protocol, and the defect of the single hop from all the cluster heads to the sink node, an improved method for Leave protocol is advanced. Firstly, the election model of cluster head is improved, and the node residual energy is considered in the process of threshold and the cluster head election to improve the whole network life circle. In the multi-hop route, choosing the maximum energy and the nearest node as the next hop and a route transferring data among many clusters is formed.

Meenakshi Diwakar and Sushil Kumar et. al. [11] proposed EELBCRP (Energy-Efficient Level Based Clustering Routing Protocol), a protocol for wireless sensor networks. Nowadays, advanced technology of wireless sensor networks used in many applications like health, environment, battle field etc. The sensor nodes are equipped with limited power sources. Therefore, efficiently utilizing sensor nodes energy can maintain a prolonged network lifetime.

Baiping Li and Xiaoqin Zhang et. al. [12] proposed LEACH-CC in which a chain routing between clusters is established to reduce the amount of nodes which communicate with the base station. It not only extended the lifetime of the network, but also improved the energy efficiency. Using a central control algorithm, better clusters were produced by dispersing the cluster-head nodes throughout the network. Then a chain routing between cluster-heads was established to reduce the amount of nodes which communicate with the base station.

Yi Liu, Shan Zhong and Licai You et al. [13] proposed a low energy uneven cluster protocol design method. This paper improved the method of randomly choosing cluster head of LEACH protocol, and removed the defect of the single hop from all the CHs to the sink node.

### III. PROPOSED WORK

The proposed work is about to reduce Energy Consumption , to increase the amount of data to be transmitted and as well as to increase the alive nodes in each round. This paper proposed a way to fulfill all the above described things. Previously the work done on WSNs mainly focused on reducing energy consumption in LEACH protocol but little focus has been made for the in WSN on load balancing so in the proposed work a Min heap algorithm is used which focus on Load balancing. As cluster head will be of highest energy among those nodes. A cluster having more nodes have to consume more energy as compare to cluster with less nodes .so with the help of Load balancing used in Min heap algorithm ,cluster has to consume less energy and due to this there will be increased amount of data to be transmitted and as well as the number of alive nodes. There is a need to address for such algorithm that helps to reduce energy consumption so due to this there will be increased amount of data transmitted and as well as the number of alive nodes. This paper performs following task to implement LEACH protocol with Min-Heap algorithm (LEACH\_MH):

- Study of LEACH protocol
- Implementation of Min-Heap algorithm with LEACH and simulate LEACH and LEACH\_MH.
- Compare the results in NS2 using LEACH protocols with and without Min-Heap algorithm

In this Paper a protocol LEACH\_MH based on LEACH protocol is used to balance the load. The LEACH\_MH is based on the same round concept as the original LEACH. Hence in this paper Min-Heap based algorithm in LEACH protocol is implemented to reduce energy consumption.

### IV. RESULTS AND DISCUSSION

In this section the results obtained are presented from the simulations This Section focuses on result and its analysis based on the simulation performed in NS-2.34 simulator. To compare the performance of LEACH and LEACH\_MH(LEACH with Min Heap algorithm) consider the performance metrics of energy consumed, data transmitted and number of alive nodes. In table 1, Performance comparison of LEACH\_MH and LEACH is done when simulated for 600 seconds.

Table 1: Performance comparison of LEACH\_MH and LEACH when simulated for 600 seconds.

Performance metrics	LEACH_MH	LEACH
Total Energy Consumed(Joules)	180.67	273.27
Total Data Transmitted (bits)	45147	44977
No. of Alive nodes	99	16
Simulation time(seconds)	600	600

#### 4.1 Energy Consumed

Figure 1 compares the energy consumption of LEACH\_MH and LEACH during the simulation period of 600 seconds. This result was carried out and the graph is compared with the normal working protocol LEACH so as to observe the energy consumed during Simulation.

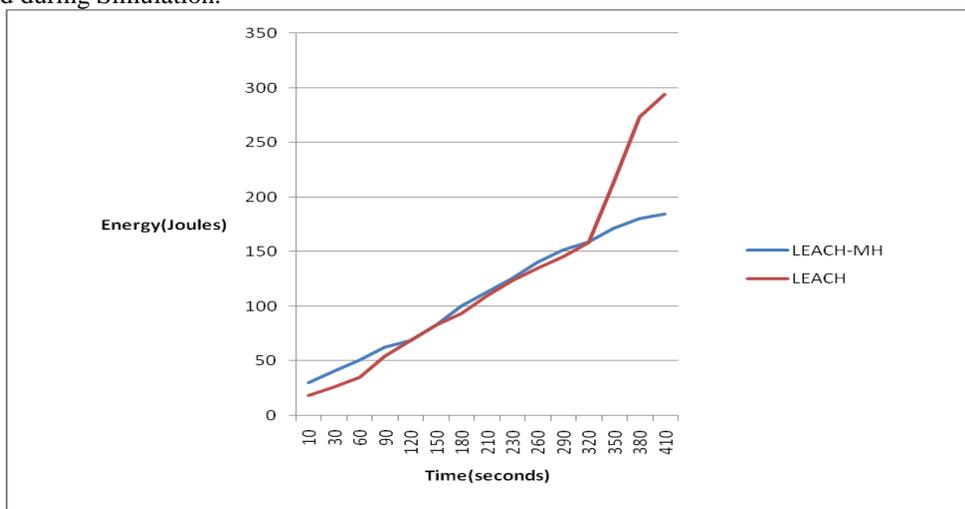


Figure 1 Energy Consumed vs. Time

The Figure shows that LEACH\_MH consumes Less energy as compared to LEACH. Since Min Heap Algorithm balance the load in each cluster hence no extra energy consumption and hence LEACH\_MH Less energy as consumed by LEACH.

#### 4.2 Data Transmitted

Figure 2 compares the number of bits transmitted by LEACH and LEACH\_MH for each time period during the simulation period of 600 seconds. This result was carried out and the figure is compared with the normal working protocol LEACH so as to observe number of bits transmitted during simulation. The Figure shows that LEACH\_MH transmits More bits in each round as compared to LEACH.

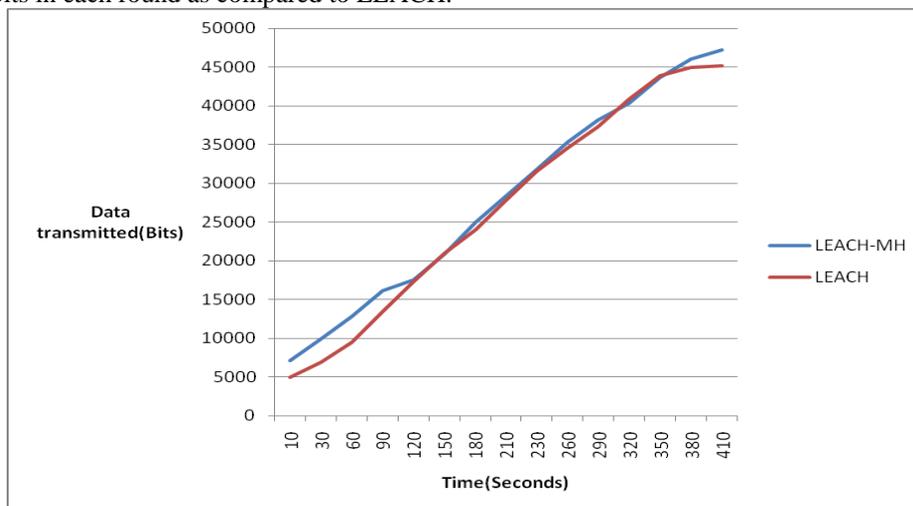


Figure 2 Data Transmitted (bits) vs. Time

#### 4.3 Number of Alive Nodes

Figure 3 shows the comparison between LEACH and LEACH\_MH in terms of number of nodes alive during simulation time of 600 seconds. More the number of nodes alive, more will be the network lifetime and more data can be transmitted/received. This figure shows that numbers of nodes alive in LEACH\_MH are more as compared to LEACH. Hence it shows that LEACH\_MH performance better to LEACH.

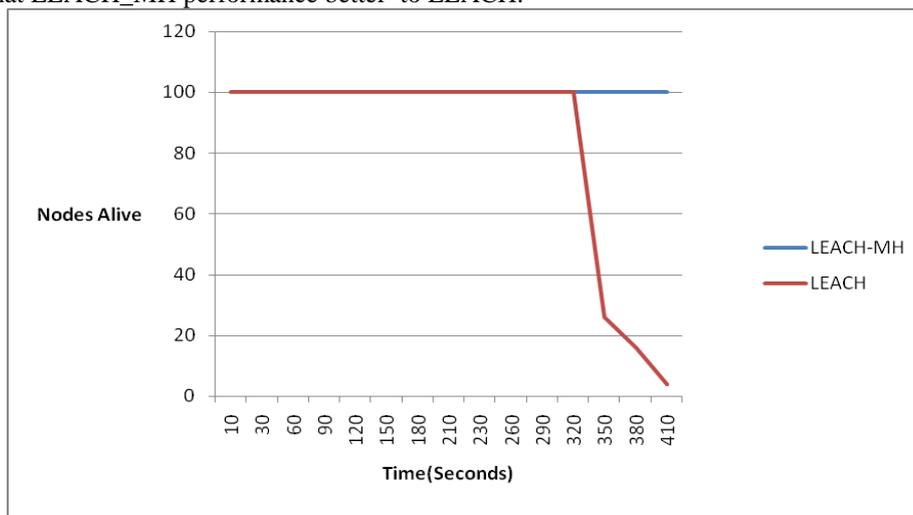


Figure 3 Nodes Alive vs. Time

### V. CONCLUSION

In this paper it is analyzed that the behavior and different performance matrices like energy consumed, data transmitted and number of alive nodes for LEACH\_MH is better than LEACH. Having simulated the Min-Heap based clustering algorithm in Leach (LEACH\_MH), results shows that the performance of LEACH\_MH doesn't degrades Infact It performs better as compared to LEACH. Adding Min-Heap based clustering algorithm to LEACH neither reduces the network lifetime nor does it consume extra energy. Graphs of performance comparison in figure 1-3 shows that LEACH\_MH consumes less energy as consumed by LEACH. LEACH\_MH transmits more number of bits as compared to LEACH. Moreover lifetime of LEACH\_MH is better than LEACH. Hence these performance parameters depicts that adding Min-Heap based clustering algorithm to LEACH doesn't degrades the performance. It works better to simple Leach protocol. Our future research will be towards the enlargement of load balancing and highly energy efficient clustering, for the sensor networks .An effort to devise a scheme for the Cluster Head selection is also made. Research in the area of LEACH Protocol in WSN is still actively done. Due to the time constraint and code limitations the current work i.e. simulation of LEACH protocol with Min-Heap based Clustering algorithm was only focused on evaluating some selected performance metrics. The evaluation of LEACH\_MH discussed in this Paper work with some more performance metrics like throughput, average energy consumed, more stability etc will be considered as future research work.

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