Energy Conservation In Wireless Sensor Network

Deepika Sharma, Gurpreet Singh

***Abstract*—Wireless Sensor Network is a network of sensor nodes which are battery operated. These sensor nodes are sensitive to energy consumption and may die early. For this purpose we focus on LEACH (low-energy adaptive clustering hierarchy) protocol which is one of the famous hierarchical network routing protocol. This protocol improves the life span of network. Simulation results show that the new Improved LEACH routing protocol consumes less energy and also these results are efficient in terms of the number of sensor nodes that die during the network period.**

***Index Terms*— Base Station (BS), Cluster Head (CH), Cluster Node, LEACH, Wireless Sensor Network.**

I. INTRODUCTION

Wireless sensor network is a large network consisting of hundreds of sensor nodes. These nodes are battery operated. The nodes collect and process the information and send it to base station which is called sink. When base station (sink) receives all the information it sends the queries to sensor nodes. These sensor nodes perform sensing and return the data to base station (BS) as an answer to the queries [9].

Sensor network may consist of different type of sensors such as thermal, radar etc. that are able to monitor a wide variety of ambient conditions. WSN include some applications like Military, Environmental, Health, Home etc.

Routing in WSN can be divided into Flat network routing, location-based network routing and hierarchical based routing. In flat routing, all the nodes work together to perform sensing and routing tasks. In location based routing, nodes location information is used to compute the routing path and the information about nodes location is obtained from the GPS devices attached to the nodes. In hierarchical based routing, every node gets a chance to become cluster head (CH) for the cluster period. LEACH is one of the widely used hierarchical routing protocols for wireless sensor network. To decrease the number of transmitted messages to sink the data aggregation and fusion is performed [4].

II. OVERVIEW OF LEACH (LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY)

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical, self-organizing, adaptive cluster-based routing protocol for wireless sensor networks which partitions the nodes into clusters [10].

***Deepika Sharma**, CSE Department, Yamuna Institute of Engineering and Technology, Kurukshetra University, India.*
***Gurpreet Singh**, Asst. Professor, Yamuna Institute of Engineering and Technology, Kurukshetra University, India.*

LEACH is a hierarchical protocol in which most nodes transmits the data to cluster heads, and the cluster heads (CH) aggregate and compress the data and forward it to the base station. Node first senses its target and then sends the relevant information to its cluster-head. Then the cluster head (CH) aggregates and compresses the information received from all the nodes and sends it to the base station.

Nodes that already have been cluster heads (CH) cannot become cluster heads again for P rounds, where P is the percentage of cluster heads. Each node has a 1/P probability of becoming a cluster head in each round. At the end of each round, each non cluster head node selects the closest cluster head and joins that cluster. For each node the cluster head then creates a schedule to transmit its data [6].

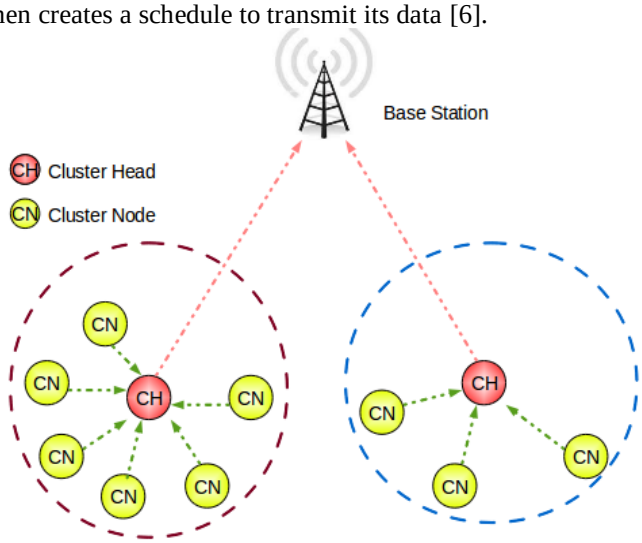

Figure 1: Clustering in LEACH

sensor node n generates a random number such that 0<random < 1 and compares it to a pre-defined threshold T (n).

If random < threshold T (n), the sensor node becomes cluster-head in that round, otherwise it is cluster member.

The threshold is set as:

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

Here P is the percentage of cluster heads (CHs), r is the current round, and G is the set of nodes that have not been cluster head in the last 1/P rounds [8].

After the nodes have elected themselves to be the cluster-heads, it broadcasts an 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. Every 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 then 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 centre to co-ordinate the data transmissions in their clusters. The cluster-head (CH) node sets up the TDMA schedule and transmits this schedule to the nodes in the cluster.
This ensures that there is no collision among the 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.

SET UP PHASE:
In this phase, when clusters are created each node decides whether or not to become a cluster-head for the current round. This decision is taken by node n by choosing a random number between 0 and 1. If the random number is smaller than a threshold value, then that node becomes a cluster-head for the current round. Each node elects itself a cluster-head (CH) for the current round broadcasts an advertisement message (ADV) to the rest of the nodes. For this phase, the cluster-heads use a CSMA MAC protocol, and all cluster-heads transmit their advertisement using the same transmit energy. The non cluster-head (CH) nodes must keep their receivers on during this phase of set-up to hear the advertisements of all the cluster-head nodes. After the completion of this phase, each non cluster-head node decides to which cluster it will belong for this round. That decision is based on the received signal strength of the advertisement.

STEADY STATE PHASE:
The process of transferring aggregated or sensed data from all the sensor nodes to the sink or base station is done under steady state phase. In this phase, nodes in each cluster sends data based on the allocated transmission time to their local cluster heads (CHs). In order to reduce energy dissipation, the receiver of all non-cluster head (CH) nodes would be turned off until the nodes defined allocated time. After receiving the data from the nodes, the cluster head (CH) aggregates all the
data sent from the member nodes into a single signal and transfers it to the base station (sink). The duration of the steady state phase is longer than the duration of the set-up phase in order to minimize overhead [7].

III. RELATED STUDY

Nandakishor Sirdeshpande et. al. [1] Wireless Sensor Networks (WSN) are networks of small and battery powered wireless devices, equipped with on-board processing and sensing capabilities. Wireless sensor network suffers from excessive packet loss, retransmission of the packets due to node mobility and constant energy dissipation. There is several power and energy aware algorithms that claim to compensate for the energy losses. The fundamental of most of the techniques is to route the packets through the highest energy nodes which lead to quick battery drainage of those node. Therefore the lifetime of network decreases. This paper discusses a protocol for Network lifetime improvement by modifying the Leach protocol. The main fundamental of the protocol is to develop a cluster based routing where cluster heads should be selected based on maximum coverage and should have sufficient energy to prolong the communication. Clusters are formed dynamically and changed with transmission. This technique is compared with conventional LEACH protocol. Result shows that the proposed system achieves high data delivery with extended lifetime.

Chunyao Fu et. al. [2] found that due to the limitation of nodes energy, energy efficiency should be considered an important factor when the protocols are designed, this paper proposes a new improved algorithm of LEACH protocol (LEACH-TLCH) in response to the uneven energy distribution that is caused by the randomness of cluster heads forming, this protocol is intended to balance the energy consumption of the entire network and extend the life of the network. The new algorithms results indicate that both energy efficiency and the lifetime of the network are better than that of existing Protocol.

Nabeela Ansari et. al. [3] sensor nodes are sensitive to energy consumption and gets exhausted on working. Various routing protocols are developed to enhance the scalability and stability of network. The cluster based routing is an efficient way of reducing energy dissipation by limiting data transmission from nodes to base station. So a new routing method is proposed which improves the life span of network and its data transmission capability with low energy consumption. This is an improvised version of LEACH protocol which conserves energy by load balancing. Multi hop routing is proposed for the transmission of data. With the help of TDMA scheduling reduction of Energy consumption is achieved. Time division multiple access (TDMA)-based MAC can potentially reduce the delay and provide real-time guarantees as well as save power by eliminating collisions.

Parul Bakaraniya et. al. [4] Wireless Sensor Network is the collection of large number of nodes. The difference between usual wireless networks and WSNs is that sensors are sensitive to energy consumption. Saving energy is the crucial issue in designing the wireless sensor networks so a modified algorithm for Low Energy Adaptive Clustering Hierarchy
(LEACH) protocol is proposed. The modified protocol called "Kmedoids-LEACH protocol (K-LEACH) for clustered WSN" is aimed at prolonging the lifetime of the sensor networks by balancing the energy consumption of the nodes.

Nutan Sindhwani et. al. [5] proposed a protocol called V-LEACH. As one of the major issues in wireless sensor

networks is to develop a routing protocol which has a significant impact on the overall lifetime of the sensor network. This new version of LEACH protocol called VLEACH aim is to reduce energy consumption within the wireless network. Simulation results show that the New Improved V-LEACH routing protocol reduces energy consumption and increases the total lifetime of the WSN.

IV. PROPOSED WORK

In this Dissertation we are going to use clustering in WSN. Every cluster would have a leader, often referred to as the cluster head (CH).In addition to collect data from non cluster nodes the cluster head will aggregate the data which is to be transmitted to base station here we will use multi hop routing technique to transmit data to the base station. In addition to just use shortest path (Energy Conserved) we will also prefer to transmit data through the other nodes which have high energy difference as compared to the nodes which is transmitting data to base station. The cluster membership may be fixed or variable. If we take 100 nodes, then there would be 7-10% CH. We send data to the BS, according to Sensor nodes energy level & we compare the energy level with the given threshold value and energy level of cluster head would be more than their sensor nodes which are in their group. We also check their distance from the Cluster Head, if they have shorter distance but not have sufficient energy than does not take that node. We also take the nodes previous history of their energy level. In short, some time we will prefer longer path to increase the network stable life time.

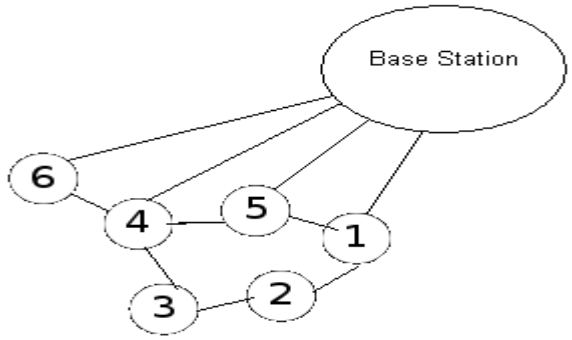

Figure 2: Connection of Different Cluster Heads With Base Stations

Initially a node chosen randomly as a cluster head will communicate with the base station. After some time this node will be replaced by some other node which will act as cluster head for a short period and this procedure will be repeated for the entire network. We will implement this with the concept of Max-Priority queue. The node having the highest energy will be chosen as cluster head. After some time when energy of cluster head is reduced we will call heapify procedure for the rearrangement of nodes such that the node having high energy will be placed as the root of heap. We will call the heapify procedure after a particular interval which can be defined by a particular threshold value.

V. RESULTS AND DISCUSSION

NUMBER OF ROUNDS	ENERGY (EXISTING)	ENERGY (PROPOSED)
100	45.31	39.92
200	81.10	83.88
300	124.82	113.60
400	166.02	149.96
500	268.70	194.24

Table1: Comparison of Energy Consumption between Existing and Proposed

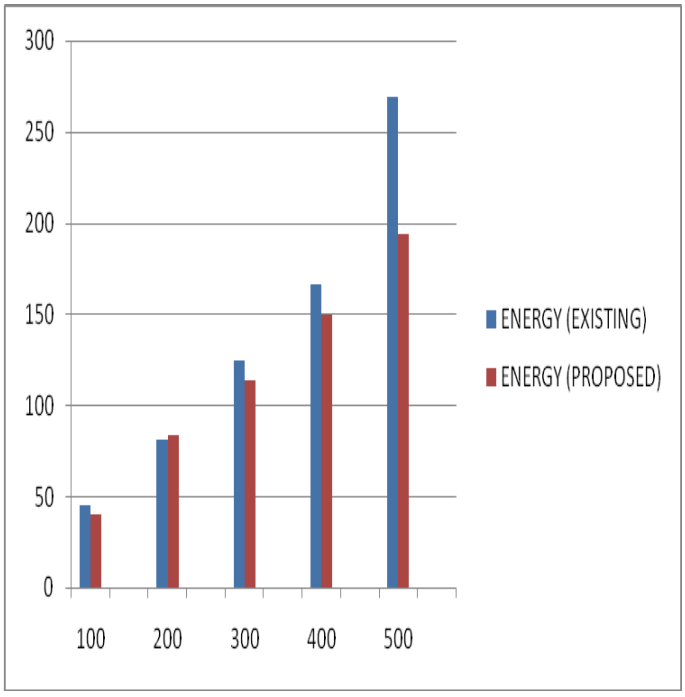

Figure 3: Total Energy Consumed at different rounds

In Figure 3 Comparison of Existing Energy and Proposed Energy is done. Proposed result consumes less energy than that of existing.

NUMBER OF ROUNDS	TOTAL DATA (EXISTING)	TOTAL DATA (PROPOSED)
100	11486	10314
200	20838	21239
300	32133	29247
400	42449	38945
500	52233	50588

Table 2: Comparison of Data between Existing and proposed

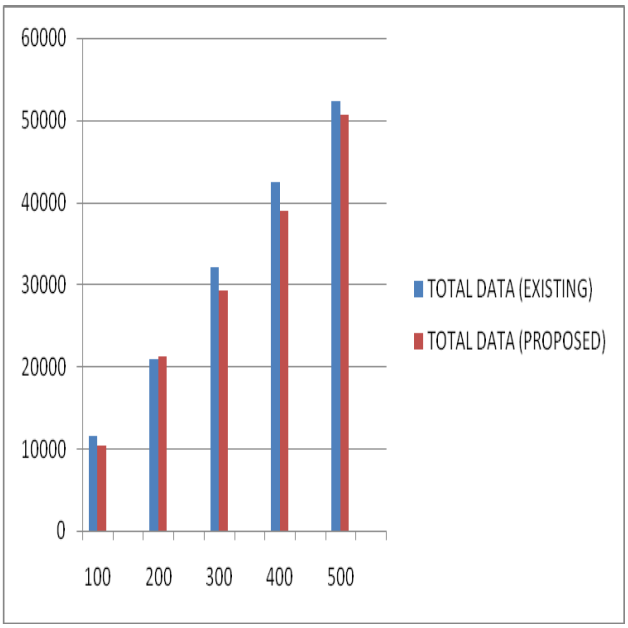

Figure 4: Total Amount of Data Transmitted at each Round

In Figure 4 Comparison of Existing Data and Proposed Data is done. Proposed result consumes less data than that of existing.

NUMBER OF ROUNDS	ALIVE NODES (EXISTING)	ALIVE NODES (PROPOSED)
100	100	100
200	100	100
300	100	100
400	92	100
500	56	100

Table 3: Comparison of alive Nodes between Existing and Proposed

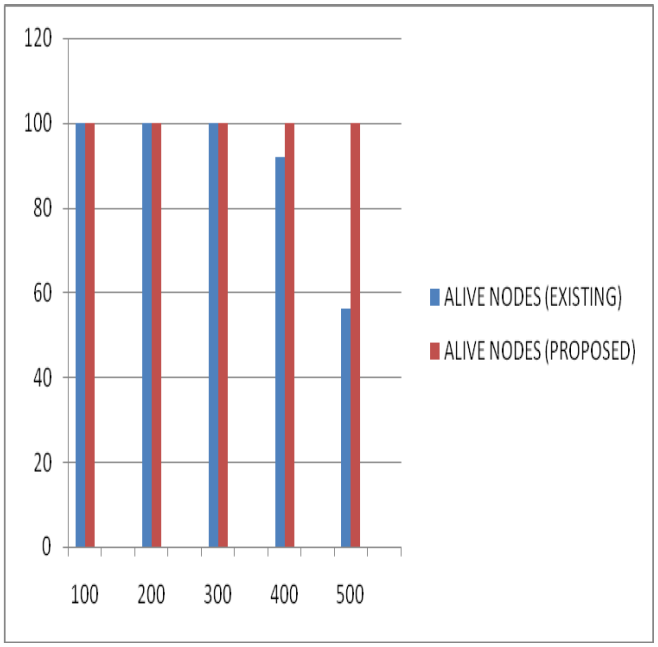

Figure 5: Total number of alive nodes at different rounds

In Figure 5 Comparison of Alive nodes in existing and proposed is done. Proposed result is efficient in terms of the number of nodes that may die early.

VI. CONCLUSION

In this paper, attempt has been made to analyze existing Leach protocol. This paper proposed an improved LEACH Protocol. The main concern of our survey is efficient usage of energy for sensor nodes in network and enhancing their lifetime. We use NS2 for Simulation. Simulation result shows that energy and lifetime of nodes are better than that of existing protocol.

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