

# Improved Energy Efficient Protocol using Clustering in Wireless Sensor Networks (IEEP)

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**Abstract** --- Wireless sensor networks are made up of large number of inexpensive devices that are networked via low power wireless communications. Sensors depend entirely on the battery life which cannot be generated or substituted. The design of energy efficient protocol to prolong the lifetime of the network is necessary. In this paper, we present a mechanism for improving the efficiency of a Wireless Sensor Network by considering levels of clustering and chain mechanism for routing data packets to base stations. The design of energy efficient protocol to prolong the lifetime of network is necessary. The proposed protocol, Improved Energy Efficient Protocol (IEEP) using clustering balances the energy, saves the node energy and prolongs the network lifetime. The performance of the protocol is analysed with the comparison of various network parameters which includes cluster formation, cluster head selection, chain formation, data aggregation and communication. The experimental results are simulated using NS2 simulation tool by considering set of parameters.

**Index Terms** — Energy Efficient, Wireless Sensor Networks, Clustering, Network lifetime, Data Aggregation, Communication, Mobility.

## 1 INTRODUCTION

Wireless Sensor Networks [WSN] consists of individual nodes that are able to interact with their environment by sensing or controlling physical parameters [1]. These nodes have to collaborate to fulfil their tasks, as a single node is incapable of doing so. They use wireless communication to enable this collaboration. WSNs are powerful in that they are amenable to support a lot of very different real world applications. There is no single set of requirements that clearly classifies all WSNs, and there is also not a single technical solution that encompasses the entire design space. For example, in many WSN applications, individual nodes in the network cannot easily be connected to a wired power supply but rather have to rely on on-board batteries. In such an application, the energy efficiency [2] of any proposed solution is very important. In many scenarios, nodes will have to rely on a limited supply of energy using batteries. Replacing these energy sources in the field is usually not practicable. Simultaneously a WSN must operate at least for a given mission time or as long as possible. Hence the lifetime of a WSN becomes a very important figure of merit. Thus an energy efficient way of operation of the WSN is necessary.

The precise definition of lifetime depends on the application at hand. A simple option is to use the time until the first node fails or runs out of energy. Other options include the time until the network is disconnected in two or more partitions, the time until 50% of nodes have failed, or the time when for the first time a point in the observed region is no longer covered by at least a single sensor node. To support long lifetimes, energy efficient operation is a key technique. It includes energy-efficient data transport between two nodes measured in J/bit. Clustering has been traditionally used to enhance the network manageability, channel efficiency and to provide routing or multicasting scalability. It can also be extended to multi-hop network by creating clusters that access can be controlled and bandwidth can be allocated in each clusters.

We propose wireless sensor networks in our work where, the

transmission range of the node can be varied to communicate with the nodes in the network and the nodes in the network are homogeneous and energy constrained.

## 2 RELATED WORKS

Hierarchical routing is the routing method of framing routers in a hierarchical way [3]. In hierarchical routing sensor nodes are organised into cluster, based on the signal strength received which use cluster head as router to base station. Data fusion and aggregation are performed at cluster head to reduce energy consumption. Cluster heads are elected with a certain probability. Here the base station is fixed and located at a far distance away from the sensors.

LEACH [4], the hierarchical routing approach for sensor network. An energy efficient technique designed for sensor nodes with continuous data delivery mechanism and no mobility. Cluster heads are elected among the sensor nodes and the non-cluster heads of the closest set to the cluster head to join a cluster. The cluster head's role is rotated periodically to balance energy consumption.

Load balancing in clusters is an important factor to be considered by researchers [5]. This aimed to produce clusters of bounded size which requires node to have uniform traffic load. This sufficiently balances the load among all clusters. The balancing helps in node energy level consumption without being depleted at the earliest.

In [6], proposes an energy efficient clustering in WSN based on a metric for characterizing the significance of a node w.r.t relaying messages. The protocol achieves communication complexity and improves network longevity.

In [7], the authors describe a high degree of localization where the duplicate message retransmissions are reduced and the messages are forwarded to the destination nodes.

EEMC [8] proposes an energy efficient multilevel clustering

algorithm to achieve minimum energy consumption in sensor networks. Here the sink node is remotely located and sensor nodes are stationary. The algorithm is effective in prolonging the network lifetime of a large scale network. It lacks stochastic distribution and the issue of channel collision which happens frequently in wireless networks.

[9] Proposes an algorithm for reducing the energy consumption and prolonging the network life time. Analytical clustering modelling is considered. The optimum one hop distance and clustering angle are formulated by minimizing the energy consumption between inter cluster and intra cluster. The frequency of updating cluster head and the energy consumption for establishing new cluster head can be reduced.

### 3 IMPROVED ENERGY EFFICIENT PROTOCOL

The protocol [10] is an approach of multilevel clustering technique using cluster formation and balancing to increase the energy efficiency. The multilevel clustering approach involves two layers of cluster formation. The first layer of cluster heads (CH) is formed where the normal nodes transmit their own data to their respective first layer cluster head. The CH's aggregate the received data. In the second layer the second level cluster heads are formed. The CH's reach the nearest second layer cluster head by calculating the distance between them and transmit their data to the respective second layer cluster head. Second layer cluster head receives data from the nearest cluster head aggregates all received data and forward them to the base station as shown in the fig 1.

At the second level cluster head, chain construction is done using the greedy approach as shown in fig 2. The second level cluster head which has the highest energy level is chosen as the leader at the current round of communication. Here at the second level cluster head, the cluster head C0 passes its data to cluster head C1. The cluster head C2 passes its data to cluster head C1. C1 waits to receive data from both cluster heads and then aggregates its data with its neighbour's data. Finally cluster head C1 transmits one message to the base station.

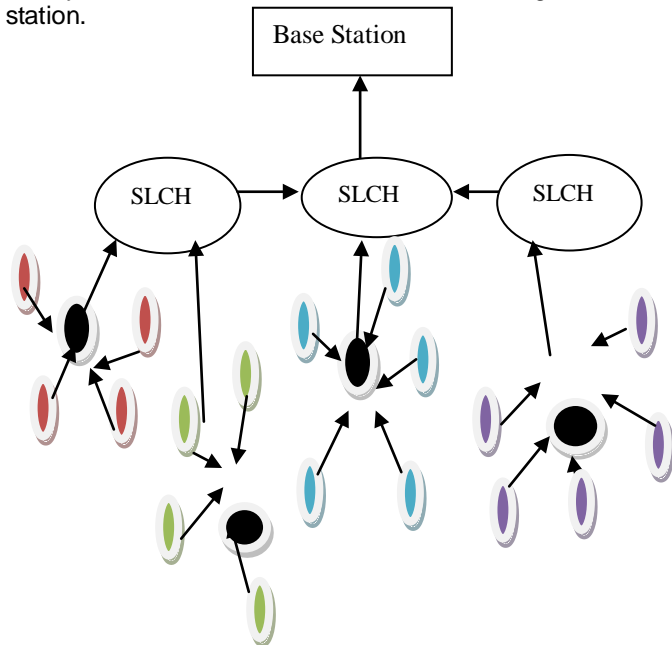


Fig 1 : Cluster Formation

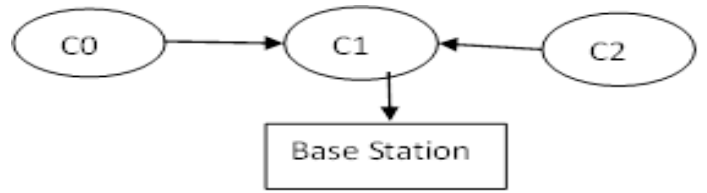


Fig 2: Chain formation of the cluster heads

The sensor nodes process data from the environment and transmit them to the base station. The base station receives the data from the sensor nodes. The transmission and receiving operation is carried out by transmitter circuit and receiving circuits which are attached with the sensor nodes and base station [11]. The transmitter circuit uses more amount of energy as compared to the receiver circuit. The power dissipated is calculated using the equation (1), (2) & (3) [12].

$$E_{Tx}(k,d) = E_{Tx} - \{ (E_{elec} * k) + (E_{amp} * k * d^n) \} \quad \dots(1)$$

$$E_{Tx}(k,d) = E_{Tx} - \{ (E_{elec} * k) + (E_{fs} * k * d^n) \} \quad \dots(2)$$

$$E_{Rx}(k) = E_{Rx} - (E_{elec} + E_{DA}) * k \quad \dots(3)$$

Where,

$E_{elec}$ , Energy consumption per bit in the transmitter or receiver circuitry

$E_{amp}$ , Amount of energy consumption for multipath fading.

$E_{fs}$ , Amount of energy consumption for free space.

$E_{DA}$ , Data aggregation energy.

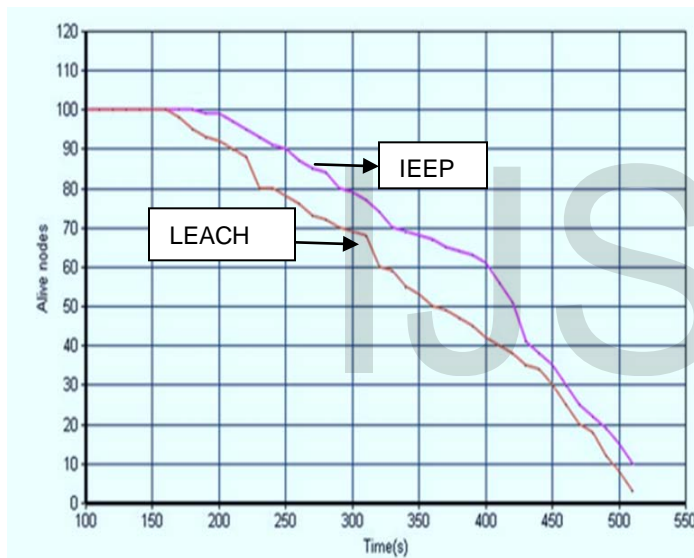
### 4. Performance Evaluation

The routing protocol has been simulated on NS2 environment for better analysis. In the WSN, the energy of the nodes that are hierarchically clustered is analysed. Sensor nodes are assumed to be randomly distributed and are not mobile. The coordinates and the dimensions of the sensor field are known [13][14]. The graph in figure 4 shows that the number of nodes which are active within the network decreases as the time elapses. The number of alive nodes for a specified period of time shows that the proposed protocol has a longer life time. The longer life time of a node in the network specifies the energy of the node for further transactions. This prolongs the network life time.

The Table 1 compares the LEACH and the proposed IEEP against different parameters. In the LEACH, the cluster formation happens considering the hierarchical approach [15]. In IEEP, clusters formed as multilevel approach. The chain formation is not seen in standard LEACH protocol where it is an added advantage in IEEP. In both the approaches cluster heads are elected by considering the energy levels of the cluster nodes. Data aggregation is done at the cluster heads to transmit the data to the base station whether the communication is single hop or multi hop. With respect to all these parameters the network life time is improved in IEEP by considering the total alive nodes after a certain period of time.

**Table 1**  
**Comparison between LEACH and IEEP**

Parameters	LEACH Protocol	IEEP protocol
Cluster Formation	Clusters are formed	Clusters are formed
Chain formation	No chain formation	Chain formation is done
Cluster Head	Cluster heads are elected	Cluster heads are elected
Data Aggregation	Data aggregation is necessary	Data Aggregation is done
Base station Mobility	Fixed Base station	Fixed base station
Network Life Time	Good	Very good
Communication	Single hop	Multi hop



**Fig 3: Time Vs Alive nodes**

**5. CONCLUSION**

We have presented an improved energy efficient technique. The proposed IEEP experimental results clearly show that the energy efficiency is attained for the sensor nodes of random topology. These results are compared with LEACH protocol by considering different set of parameters. The NS2 simulation tool is used to demonstrate and analyse the behaviour of the sensor network. Further the proposed protocol can be used with multicasting mechanism so that if there is a broken link due to node mobility, the link can be recovered.

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