

## **A Review of Enhanced Cluster Based Routing Protocol for Mobile Nodes in Wireless Sensor Network**

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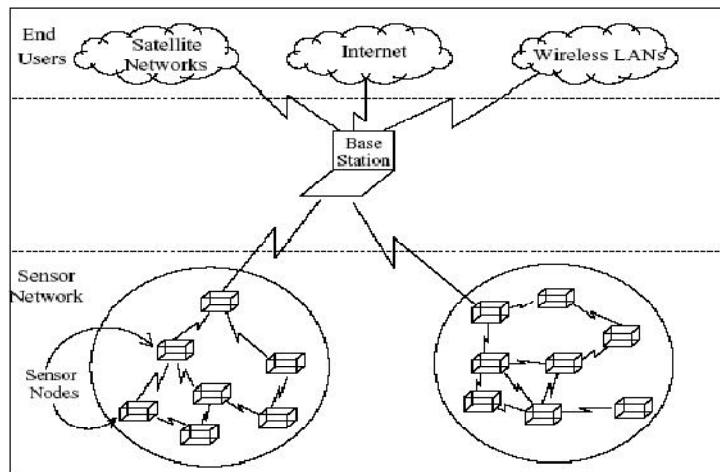
### **Abstract**

The current emerging technology is Mobile Wireless sensor Network (MWSNs) which consist of hundreds of tiny, inexpensive, resource constrained sensor nodes. The major challenging task that the wireless sensor suffer from is Routing and the critical issue while designing the Wireless sensor Network is Energy Saving. There are many routing protocols that have been developed and among them is clustering based. In clustering based routing protocol the network is partitioned into small clusters and each cluster is examined and controlled by a single node called Cluster Head (CH). In this paper, we review an enhanced algorithm for Low Energy Adaptive Clustering Hierarchy-Mobile (LEACH-M) protocol called ECBR-MWSN which is Enhanced Cluster Based Routing Protocol for Mobile Nodes in Wireless Sensor Network. ECBR protocol selects the Cluster Head (CH) using the parameters of highest residual energy, lowest mobility and least distance from Base Station which aimed to prolonging the lifetime of the sensor networks by balancing the energy consumption of the nodes. Then compare the performance of our proposed algorithm with the cluster based protocols using ns2 simulator. The simulation result indicates that the proposed algorithm gives better performance in terms of higher packet delivery ratio, throughput, energy consumption, routing overhead, and delay.

**Keywords:** Wireless Sensor Network, Cluster, Energy Efficient, Mobility, Throughput, Routing.

## 1. Introduction

A Wireless Sensor Network (WSN) is a current emerging technology consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, and so on[1]. WSN is broadly studied in ubiquitous computing environment. Ad-hoc is a Latin word, which means "for this or for this only." A Wireless Sensor Network (WSN) consists of a large number of sensor nodes that co-operatively monitor a specific region of interest. Typically, a sensor node is a small hardware device consisting of a processing unit, a sensing unit, a communication unit and a power unit that is used for sensing, data processing and communication purposes. Each node is equipped with integrated sensors, data processing capabilities. These nodes collectively gather sensed information and forward it to the special node called *base station* which acts as interface between the sensor nodes and users. The uniqueness of a sensor node lies in its small size and light weight. Sensors gather useful information in a timely manner and send it to a centralized node named *sink*. The sink node is also known as base station and is responsible for further processing such as node query. Due to the large number of sensor nodes and the voluminous data that should be reported, data communication should be done in energy efficient manner. However, there are a lot of constraints such as limits on resources in terms of energy, memory, computational speed, band width and so on.[2][3]. In addition, while designing the Wireless Sensor Network, Energy saving is the critical issue. This energy saver often consists of a battery with a limited energy budget. In addition, it could be impossible or inconvenient to recharge the battery, because nodes may be deployed in a hostile or unpractical environment.



**Fig. 1:** Wireless Sensor Network.

In order to enhance the network lifetime there are many routing protocols and one of them is clustering based in which network is partitioned into small clusters and each cluster is examined and controlled by a single node called **Cluster Head (CH)**. Sensor network should have a lifetime long enough to fulfil the application requirements.

Nodes in mobile ad-hoc network are free to move and organize themselves in an arbitrary fashion. Each user is free to roam about while communication with others. The path between each pair of the users may have multiple links and the radio between them can be heterogeneous. This allows an association of various links to be a part of the same network.

The Review Protocol is an Enhanced algorithm of Low Energy Adaptive Clustering Hierarchy–Mobile (LEACH-M) Protocol called ECBR-MWSN which is Enhanced Cluster Based Routing Protocol for Mobile Wireless Sensor Network.

ECBR-MWSN protocol selects the CHs using the highest residual energy, lowest Mobility and least Distance from the BS. The BS periodically runs the proposed algorithm to select new CHs after a certain period of time.

## 2. Related Work

This section presents the existing works relating to Wireless Sensor Networks. Many kinds of cluster based routing protocols have been proposed for Wireless Sensor Networks. These can be categorized into two types of nodes called Static and Mobile Nodes.

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH).LEACH [5] is well known clustering protocol for wireless sensor networks. In LEACH [5], the nodes are organized themselves into local clusters. Each node has the same initial energy because of homogeneous networks. In the set-up phase, the CH is selected from the organized clusters if a random number between 0 and 1 chosen by CH is less than threshold value. In the steady-state phase each non CH node sends data and the time slot allocated to CH .The CH aggregates the data and sends it to the BS. But the cluster formation is initiated in each round is not energy efficient and also it does not support mobility.

Cluster-based Energy-efficient Scheme [6] (CES) for Mobile Wireless Sensor Networks (MWSNs) which relies on weighing k-density, residual energy and mobility parameters for cluster-head election. The CES scheme carries out a periodical cluster-head election process after each round.

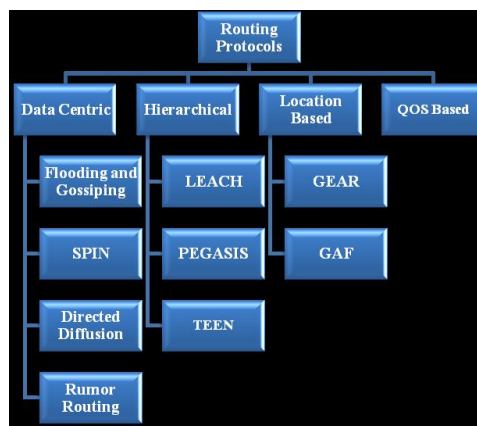
There are different routing protocols already reported for WSN applications but mostly they are for static networks. All major protocols may be categorized into four categories as shown in Table 1

Category	Representative Protocols
<b>Data centric Protocols</b>	Flooding and Gossiping, SPIN, Directed Diffusion, Rumor Routing, Gradient Based Routing, CADR,COUGAR & ACQUIRE
<b>Hierarchical Protocols</b>	LEACH,PEGASIS,H-PEGASIS,TEEN & APTEEN

<b>Location Based Protocols</b>	MECN & SMECN, GAF & GEAR
<b>Network Flow &amp; QoS Aware Protocol</b>	Maximum Lifetime Energy Routing, Maximum Lifetime Data Gathering, Minimum Cost Forwarding, SAR & SPEED

### 3. Protocol Studied

This section gives the overview of the working of the LEACH routing protocol. There are various routing clustering protocols but the discussed among them is LEACH Protocol:



#### 3.1 Leach Protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters. Each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA (Time division multiple access) schedule and sending aggregated data from nodes to the BS where these data is needed using CDMA (Code division multiple access). Remaining nodes are cluster members. The architecture LEACH (Low-Energy Adapted Clustering Hierarchy) introduced by Heinzelman, Chandrak as an, and Balakrishnan, [7][8], is a randomized, distributed clustering protocol that is widely proposed and tested in wireless sensor networks.

LEACH protocol is divided into rounds. Each round consists of two phases:

##### a) Set-up Phase

Each node decides independent of other nodes if it will become a CH or not. Decision takes into account when the node served as a CH for the last time (the node that hasn't been a CH for long time is more likely to elect itself than nodes that have been a CH recently).

In the following advertisement phase, CHs inform their neighborhood with an advertisement packet that they become CHs. The non-CH nodes pick the advertisement packet with the strongest received signal strength.

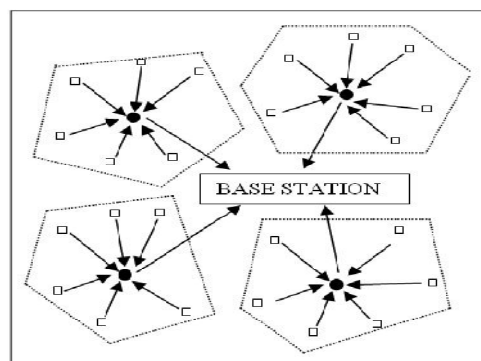
In the next cluster setup phase, member nodes inform the CH that they become a member to that cluster with "join packet" contains their IDs using CSMA. The cluster-setup sub phase, CH knows the number of member nodes and their IDs. When based on all messages received within the cluster, CH creates a TDMA schedule; pick a CSMA code randomly and broadcast the TDMA table to cluster members. And after that steady-state phase begins.

#### b) Steady-state phase

Data transmission begins; Nodes send their data during their allocated TDMA slot to the CH. And this transmission uses a minimal amount of energy (chosen based on the received strength of the CH advertisement). Radio of each non-CH node can be turned off until the nodes allocated TDMA slot, therefore minimizing energy dissipation in these nodes.

### 3.2 Architecture of LEACH Protocol

When all the data has been received, CH aggregate these data and send it to the BS. The LEACH is able to perform local aggregation of data in each cluster to reduce the amount of data that transmitted to the base station.



**Fig. 2:** LEACH Protocol Architecture.

Although LEACH protocol acts in a good manner and it suffers from many drawbacks such like;

- CH selection is randomly, that does not take into account energy consumption.
- It can't cover a large area.

CHs are not uniformly distributed; where CHs can be located at the edges of the cluster. Since LEACH has many drawbacks, there is a requirement to make this protocol performs better.

The LEACH is a clustering-based protocol that includes the following features:

- Randomized, adaptive, self-configuring cluster formation,
- Localized control for data transfers,
- Low-energy media access, and
- The application- specific data processing, like as data aggregation.

In LEACH, the nodes organize themselves into local clusters with one node acting as the cluster-head. Non-cluster-head nodes must transmit their data to the cluster-head so the cluster-head node must receive data from all the cluster members, that perform signal processing functions on the data (e.g., data aggregation) and transmit data to the remote base station. Thus, being a cluster-head node is much more energy-intensive than being a non-cluster-head node. In the scenario where all nodes are energy-limited, if the cluster-heads were chosen a priori and fixed throughout the system lifetime, as in a static clustering algorithm, the cluster-head sensor nodes would quickly use up their limited energy [9]. Once the cluster-head runs out of energy, so it is no longer operational.

Thus, when a cluster-head node dies (e.g., uses up all its battery energy), all the nodes that belong to the cluster lose communication ability. Thus LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes.

#### **4. Performance Metrics**

The evaluation of performance of routing protocols can be considered under the below matrices:

##### **4.1 Delivery Ratio**

Measures the percentage of data packets generated by nodes that are successfully delivered.

##### **4.2 End to End Delay**

This metric measure the average time it takes to route a data packet from the source node to the destination node.

##### **4.3 Energy Consumption**

The energy metric is taken as the average energy consumption per node calculated through simulation time.

##### **4.4 Network Lifetime**

The time of first node failure due to the exhaustion of battery power charge during the simulation with a particular routing protocol.

#### **5. Simulation Result**

Comparison of LEACH Routing Protocol with LEACH-M i.e. Enhanced Cluster based Routing Protocol on the basis of the below parameters.

**Table 2**

<b>Parameters</b>	<b>LEACH</b>	<b>LEACH-M(Enhanced)</b>
Delivery Ratio	Low	High
End to End Delay	Long delay	Less delay
Network Lifetime	Short	Long
Energy Consumption	High	Low

## 6. Conclusion and Future Scope

This paper evaluates the performance of the proposed protocol in terms of four factors like Average Energy Consumption, Packet Delivery Ratio, Throughput, Routing Overhead and Average end to end Delay. The simulation results indicate that the reviewed clustering approach is more energy efficient.

The performance of the proposed protocol is compared with that of LEACH through simulation experiments. It is observed that the proposed protocol outperforms LEACH under all circumstances considered during the simulation. As a future scope of this work, the protocol can be enhanced for dealing with mobility of nodes. Even effort can be made to decide the number of clusters dynamically and this may give better scalability to the protocol for dealing with very large wireless sensor networks.

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