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# Gateway Based WSN algorithm for environmental monitoring for Energy Conservation

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***Abstract*—**In this paper, we provide a new geographical routing protocol for wireless sensor network in term of energy conservation and also comparing two protocol i.e. LEACH routing protocol and proposed protocol. Proposed protocol is geographical based, so a lot of no. sensors are spread in given region and these sensors sensing data from environment and provide to base station. These sensor nodes use GPS (global Positioning system) which provide location of nodes to base station. Base station is away from sensing environment i.e. far from sensor node. In proposed protocol, gateway node is used in middle of sensing environment and it provide sensing data to base station. In proposed protocol, if distance of nodes from gateway node and sink node is less than predefined threshold distance then sensor nodes uses direct communication for transmission. Rest of nodes is dived in equal two regions, whose distance is more than threshold distance. In each region cluster head are formed and cluster head formation is based on probability, residual energy of nodes. Cluster head receive data from node and send to gateway node. Gateway node transmits received data to base station. For simulation we use MATLAB implementation and also taking homogeneous sensor nodes.

***Keywords*** **–** *Clustering, Routing Protocol, Low-Energy Adaptive Clustering Hierarchy (LEACH)*

## 1. INTRODUCTION

WSNs (Wireless sensor networks) are most and important technology in 21th century as used many areas for monitoring purpose. WSNs (Wireless Sensor Networks) are mainly utilized in automation, medicinal, industrial, research applications. In WSNs, many tiny sensor nodes are deployed in the environmental field and these sensors nodes have limited battery backup. These sensor nodes have many units such as sensing unit, processing unit, transmission unit, power unit, etc which are used for sensing data, collecting data, aggregating data and transmit data.

These sensor node sense data from physical environment and transmit it to Base station. User can access data from base station through internet/satellite. An important thing is, the sensor nodes which are used for sensing purpose are not rechargeable. For these sensed data transmission many type of routing protocol are used in WSN. Before understanding of routing protocol, it is necessary to understand clustering in WSN (wireless sensor network)

## 2. CLUSTERING

In WSNs, clustering mean collection of nodes and form a region which are used for gathering information. Sensor nodes are deployed in field, randomly and these sensor nodes use clustering and form small-small region. Each region selects one of them nodes as a Cluster Head. This CH is selected on the basis of probability. sensor node sense data from physical environment and transmit to cluster head and cluster head received data, aggregate it and again send to base station, which are used for monitoring purpose.

## 3. ROUTING PROTOCOL

Many type of routing protocol are used for sensed data transition from sensor node to base station. But there are mainly three type of routing protocol are used i.e. Flat routing, Hierarchical routing and Location base routing.

In flat routing, each node play same role and collaborate together for sensing. Here a large no of nodes so global identification is not possible. Example of Flat routing is SPIN, Direct Diffusion, Energy aware routing.

In hierarchical routing, some sensor nodes are used for special task such as collection of data, aggregation of data and these are known as Cluster Head. All nodes sense data from physical environment and transmit to cluster head. Cluster Head perform special task on that data and then send it to base station. Example of hierarchical routing is LEACH [1], PEGASIS [2], SOP.

In Location based routing, each sensor nodes have GPS (global positioning system). Base station known about location of nodes through GPS. These routing protocol are mainly used for geographical purpose. Example of Location based routing is GAL, GEAR, and SPAN.

## 4. LEACH PROTOCOL

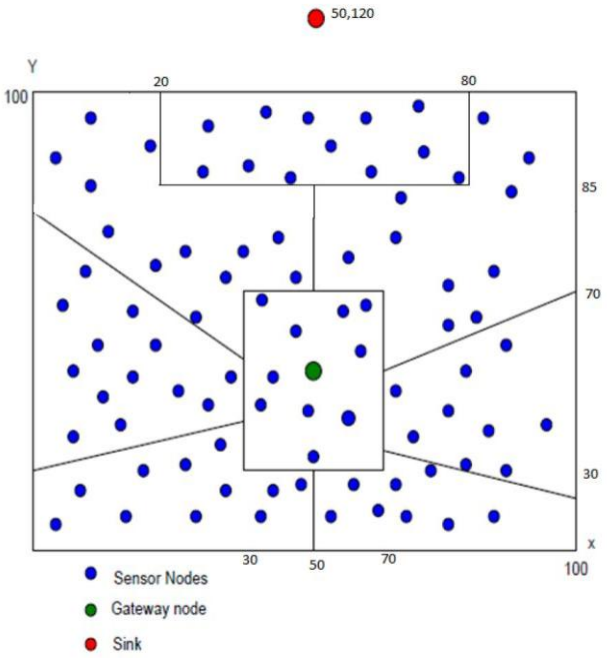
LEACH is the first hierarchical routing protocol and stand as Low-Energy Adaptive Clustering Hierarchy. LEACH is a cluster based protocol. In LEACH, sensor nodes are deployed randomly in field and nodes formed cluster region in field. There are many cluster regions in field and each cluster region select one of them node as Cluster Head. Cluster Head have many responsibilities such as data collection, Aggregation and transmission to base station. Cluster Head provide a TDMA schedule to each node. Each sensor node sense information from environment and then sends it to cluster head based on TDMA. After receiving data, CH Process it and transmit to Base Station.

## 5. PROPOSED PROTOCOL

Our aim is design a geographical gateway based routing protocol which provides energy conservation.

Whole network is divided in four regions and gateway node putted in the middle of sensing field, which reduces transmission distance of nodes. Hence it reduces consumption energy and gives a better network lifetime. Cluster-Head is elected in each region, so defiantly each region has a cluster head.

In network model we consider N sensor nodes and these nodes are randomly deployed for monitor environment. We represent $i^{th}$ node as $n_i$ and all node set as N= $n_1$, $n_2$, ……., $n_n$. The network model is shown in figure.




We placed sink node or base station far from sensing field and after placement sink node and sensor nodes both become stationary. A gateway node is also deployed at the middle of sensing field. After deployment gateway node is stationary and rechargeable. In proposed protocol we use homogeneous nodes, which have same computational & sensing capability. An ID (distinctive identifier) is assigned to each sensor node.

For our proposed protocol, we use first order radio wireless communication model. This model provides sensor nodes energy dissipation for aggregating, transmitting and receiving data. The required energy to transmit L bits data packets to distance d is given as:

$E_{tx(L,d)} = L.E_{elec} + L.\varepsilon_{fs}.d^2$ $d<=d_0$(for short distance)

$E_{tx(L,d)} = L.E_{elec} + L.\varepsilon_{mp}.d^4$ $d<=d_0$(for long distance)

The required energy to receive L bits data packets is given as:

$E_{rx}= L.E_{elec}$ (for both cases)

Where L represents bit amount of sensing information, d represents distance between transmitter and receiver and $E_{elec}$ represents energy consumed to transmit or receive L bit message.

We use sensor nodes, which are homogeneous and deployed randomly in sensing field. At first sink broadcast a HELLO message. Then sensor nodes give response such as distinctive identification (ID), their location, residual energy. Then sink node calculate distance of each sensor node and save it in node data table and this data tables contain location, ID, distance from gateway node and base station and residual energy. Sensing field divided into 4 logical regions on the basis of nodes location, in first sensing region, nodes which have very short distance from base station, is use direct transmission for data sending with BS. Similarly in second nodes which are near the gateway node, transmits their data directly to gateway which aggregates it and sends to base station. First and second region is known as non-clustered region and all other rest nodes divided in to 2 equal half regions and it is referred as clustered regions. Cluster Head are selected in every clustered region. Here $r_i$ represents no. of rounds to become CH for node $N_i$. Each sensor node select itself as CH once, every $r_i$=1/p rounds. At start of first round all sensor nodes have same energy, so each node has equal chance to become a CH. After then CH is elected on the basis of node energy (remaining energy), probability of nodes. The election of CH based on decision taken through sensor node by randomly generating no between 1 and 0. If generated no is less than T(n) (threshold), Then sensor node becomes a cluster head of that round. The value of T(n) is given as:

$$T(n)=\begin{cases}\left[\frac{p}{1-p\times \mathrm{mod}(r \mathrm{mod}(1/p))}\times\frac{E_{remain}}{E_0}\right] if(n\in G)\\ 0\end{cases}$$

Where $E_{remain}$= remaining energy, $E_0$= initial energy, r= current round, p= percentage of CH, , G= set of node not selected as CH.

Once cluster head has been elected in each region, cluster head broadcast advertisement packet to all sensor nodes. Then after receiving advertisement message (packet) each sensor node send an acknowledgement packet to nearest cluster head and join as member of that CH. Each CH provides a time slots of their member nodes based on TDMA schedule. All member nodes send their sensed data to the respective CH in own time slots. Otherwise go in sleep mode, hence energy dissipation of node get decreases. All sensor nodes send their sensed information (data) to CH. CH collects these data by member nodes and forward on gateway node, gateway node aggregated these data by gateway nodes and transmit it to BS.

## 6. SIMULATION RESULT AND ANALYSIS

Here we consider 100 sensor nodes, which randomly distributed in network and consider 100m ×100m field. Gateway node is putted in middle of the field i.e. (50m, 50m). Base station is putted/deployed away from field at (50m, 120m) and after deployment of gateway node and sink node, both are stationary. We consider the packet size of 4000bits. We compare proposed protocol with exiting protocol i.e. LEACH The parameters are shown in table 1.

| ***parameter*** | ***Value*** |
|---|---|
| ***Message size*** | 4000 bits |
| $E_{mp}$ | 0.0013pj/bit/m$^4$ |
| $E_{fs}$ | 10pj/bit/m$^2$ |
| $E_0$ | 0.5j |
| $E_{elect}$ | 5nj/bit |

**Table 1:** Radio parameter

In this paper we evaluate mainly three performance parameter, which are given below-

### 6.2 Network Lifetime

It is the time amount of network until sensor nodes destroy their energy. Every sensor node in network is assumed dead after consuming 0.5jule energy. Our proposed protocol provides the longest lifetime network because division of network region into logical region and selection of cluster head, While LEACH sensor node die quickly. We note that proposed protocol is different and provide better performance.

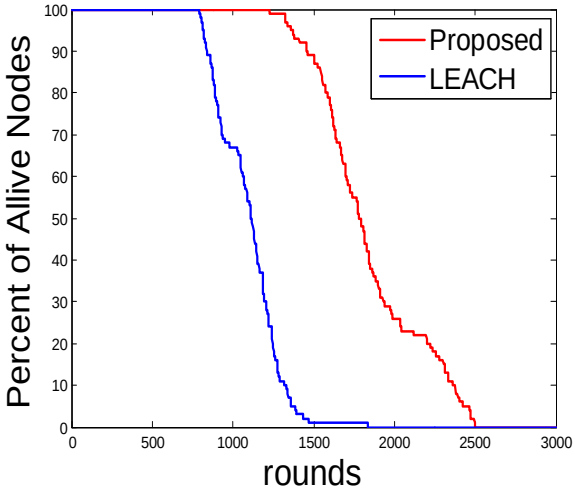



**Fig 1:** Network life time analysis

### 6.2 Throughput

It is no of packets transmitted in each round by nodes in each round and compare with no of received packet by base station. It shows how much of the no of data packet transmitted to base station.

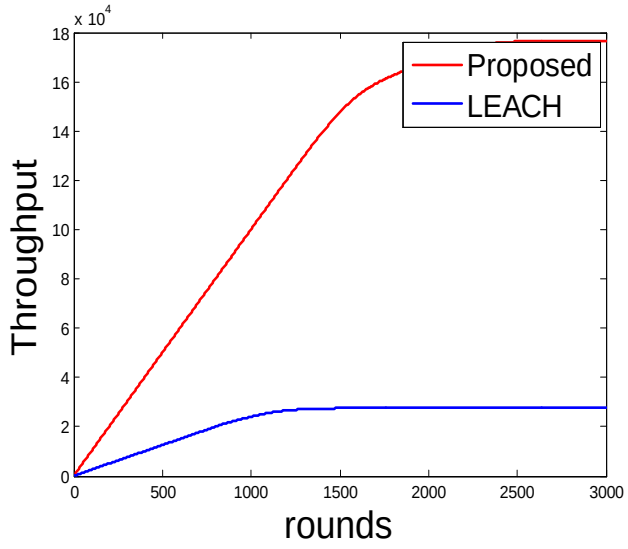



**Fig 2:** Throughput Analysis

### 6.3 Residual Energy

It is the energy of battery in the network to analyze consumption of energy in each round. Fig gives information

of residual energy of each round for network. We consider each node has 0.5jule energy and total no of nodes are 100, so the total energy is 50jule in the network. Proposed protocol gives better performance for energy consumption also.

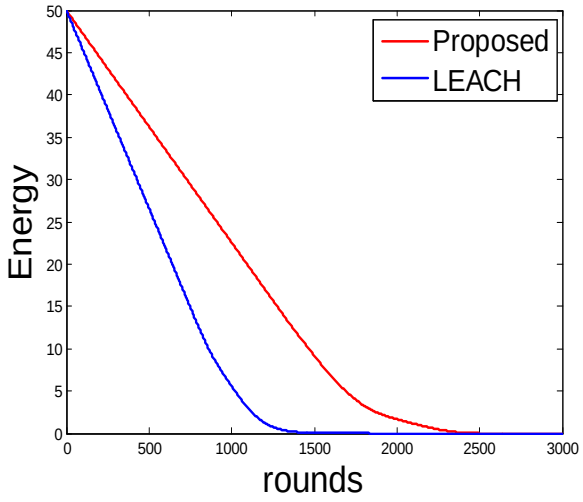



**Fig 3:** Analysis of Residual energy

## 7. COMPARISION IN LEACH PROTOCOL, M-GARE PROTOCOL AND PROPOSED PROTOCOL BASED ON MATHEMATICAL ANALYSIS

We analyze both protocol for different-different round and calculate alive node, dead node, residual energy, packet to BS. We see at 1500 round LEACH is approximately over and our proposed protocol going to 2500 round. Table-2, 3, 4 gives a view of mathematical results.

| Protocol | Dead node | Alive node | Packet to BS | Residual energy |
|---|---|---|---|---|
| LEACH | 33 | 67 | 23990 | 5.5929 |
| M-GARE | 4 | 96 | 49362 | 16.9182 |
| Proposed | 0 | 100 | 100100 | 22.5606 |

**Table 2**: analysis after 1000 rounds

| Protocol | Dead node | Alive node | Packet to BS | Residual energy |
|---|---|---|---|---|
| LEACH | 100 | 0 | 27846 | 0 |
| M-GARE | 76 | 24 | 87550 | 1.6642 |
| Proposed | 74 | 26 | 168365 | 1.6792 |

**Table 3**: analysis after 2000 rounds

| Protocol | Dead node | Alive node | Packet to BS | Residual energy |
|---|---|---|---|---|
| LEACH | 100 | 0 | 27846 | 0 |
| M-GARE | 100 | 0 | 95409 | 0 |
| Proposed | 100 | 0 | 176257 | 0 |

**Table 4**: analysis after 3000 rounds

## 8. CONCLUTION AND FURURE

We can see from above calculation our proposed geographical routing protocol is energy efficient protocol, which means minimum energy consumed by nodes and provide a lot of packets to base station through cluster head & gateway node. In this protocol two key factors are used i.e. selection of cluster head, which is based on probability, and rechargeable of gateway node. The result shows much better performance in comparison of LEACH and M-GARE routing protocol. In future work, we will study ETX link metrics and implement this metric in our scheme.

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