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Gateway Based Energy Efficient Routing: GEER

Naziya Anjum
M.Tech Student
AIET, Lucknow
Naziaqidwai27@gmail.com

Masood Ahmad
Assistant Professor
AIET, Lucknow
ermasood@gmail.com

Dr. Shafeeq Ahmad
Director
AIET, Lucknow
ahmad_shafeeq@rediffmail.com

***Abstract**: Wireless Sensor Networks comprise of an extensive number of little and minimal effort sensor nodes energised by little nonrechargeable batteries and furnished with different detecting gadgets. WSN is sent, most likely in a rough and inhospitable landscape, it is relied upon that all of a sudden dynamic to accumulate the required information for a few times when something is identified, and after that outstanding to a great extent idle for drawn out stretches of time. In this way, scientists are constantly persuaded to configuration create effective energy efficient plans and relating calculations with a specific end goal to give sensible optimal utilization of battery power and to enhance the system lifetime for WSNs. The lifetime of wireless sensor network systems is enhanced by cluster location and balancing the network loading among the clusters. In this research work, a gateway based technique has been contemplated. The nodes have been isolated into ordinary, middle of the road and progressed in light of their vitality arrangement and every class has its own particular paradigm for determination likelihood. The calculation performs well as far as a number of alive nodes, network lifetime, average energy and so forth. A comprehensive investigation as far as different graphical parameters are additionally introduced in this work.*

***Keywords**: Wireless Sensor Networks, Routing, Clustering, Network Lifetime, Energy Efficiency*.

INTRODUCTION

The Wireless sensor networks (WSNs) are increasingly used in many applications, such as volcano and fire monitoring, urban sensing, and perimeter surveillance. Wireless sensor networks have many sensor devices that send their data to the sink or base station for further processing. This is called direct delivery. But this leads to heavy traffic in the network and as the nodes are limited with energy, this decreases the lifetime of the network. In a large WSN, in-network data aggregation (i.e., combining partial results at intermediate nodes during message routing) significantly reduces the amount of communication overhead and energy consumption. Efficient designing of wireless sensor networks has become a hot area of research in recent years, due to the vast potential of sensor networks to enable applications that connect the physical world to the virtual world. By networking large numbers of tiny sensor nodes, it is possible to obtain data about physical phenomena that was difficult or impossible to obtain in more conventional ways. In the coming years, as advances in micro-fabrication technology allow the cost of manufacturing sensor nodes to continue to drop, increasing deployments of wireless sensor networks are expected, with the networks eventually growing too large numbers of nodes. Potential applications for such large-scale wireless sensor networks exist in a variety of fields, including medical monitoring, environmental monitoring, surveillance, home security, military operations, and industrial machine monitoring. Sinks are responsible for communicating with the user.

The nodes are randomly deployed either inside the field where a particular phenomenon is to be monitored or very close to it. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities because the large number of nodes in a WSN renders direct manipulation by a user for network organization. A user could not go through thousands of nodes directing the network configuration and clustering. Data aggregation technique can successfully minimize the data traffic and energy consumption only when it is carried out in a secure manner. Data aggregation and gathering technique decreases the data traffic and further saves energy by merging multiple incoming packets into a single packet and then forwarding it to sink. There are different data aggregations techniques based on the network topology.

RELATED WORK

Clustering based systems have been produced to manage energy issues in Wireless Sensor Networks. Low Energy Adaptive Clustering Hierarchy (LEACH) [8] is the primitive work in this regard. Filter, a grouping based convention, utilizes randomized race and pivot of the neighborhood cluster base station (likewise called as 'cluster heads' for exchanging information to the sink (base station) hub to similarly conserve energy among the sensor nodes in organize. This pivot of cluster heads likewise fills in as methods for adaptation to non-critical failure [1]. The sensors arrange themselves into groups utilizing a probabilistic technique to haphazardly choose themselves as heads in each round. In any case, one inadequacy of the LEACH convention is that it is not reasonable for the heterogeneous condition, i.e. at the point when there is a distinction in energy to some limit between nodes in the system, the sensor nodes, cease to exist speedier than in a more uniform node energy setting [12]. In DEEC (Distributed Energy-Efficient Clustering calculation) [10], like LEACH, a likelihood based node clustering algorithm has been proposed. DEEC chooses cluster heads on the premise of the data of the proportion between the lingering residual energy of every node after each round and the normal energy of the system. This learning, however, requires some extra data like energy utilization to be shared among the sensor nodes. Stable Election Protocol (SEP) [12] is a heterogeneity mindful clustering protocol. SEP does not expect nodes to share energy information but rather it takes a shot at the premise of doling out weighted decision probabilities of each node to be chosen cluster head, according to their individual energy. This approach guarantees that the decision of cluster head is haphazardly done and is conveyed on the premise of the division of energy of each node in this manner guaranteeing a uniform utilization of the node energy. H-DEEC and MH-DEEC [17] are directing conventions which have been proposed as energy aware versatile clustering conventions for heterogeneous systems. In H-DEEC convention, the division of system happens on the premise of initial energy and residual energy. Normal nodes choose themselves as cluster heads and beta nodes gather information from cluster heads and send it to Base station utilizing multi-path. H-DEEC and MH-DEEC are found to perform better in a heterogeneous remote sensor organize as thought about SEP and DEEC. Additionally, it likewise considers the issue of finding base station outside the system.

MATHEMATICAL MODEL

For relatively short distances the propagation loss can be modeled as inversely proportional to d2 whereas for longer distances the propagation loss can be modeled as inversely proportional to d4. Power control can be used to nullify this loss by setting the power amplifier to ensure a certain power at the receiver.

According to the radio, energy dissipation model illustrated in the figure and in order to achieve an acceptable Signal-to-Noise Ratio (SNR) in transmitting an L-bit message over a distance d, the energy expended by the radio is given by:

$$Etx(L,d) = \begin{cases} LEelec + LEfsd2 & \text{if } d < do \\ LEelec + LEmpd4 & \text{if } d > do \end{cases} \quad (1)$$

where Eelec is the energy dissipated per bit to run the transmitter(ETX) or the receiver circuit(ERX). The Eelec depends on many factors such as the digital coding, the modulation, the filtering, and the spreading of the signal.

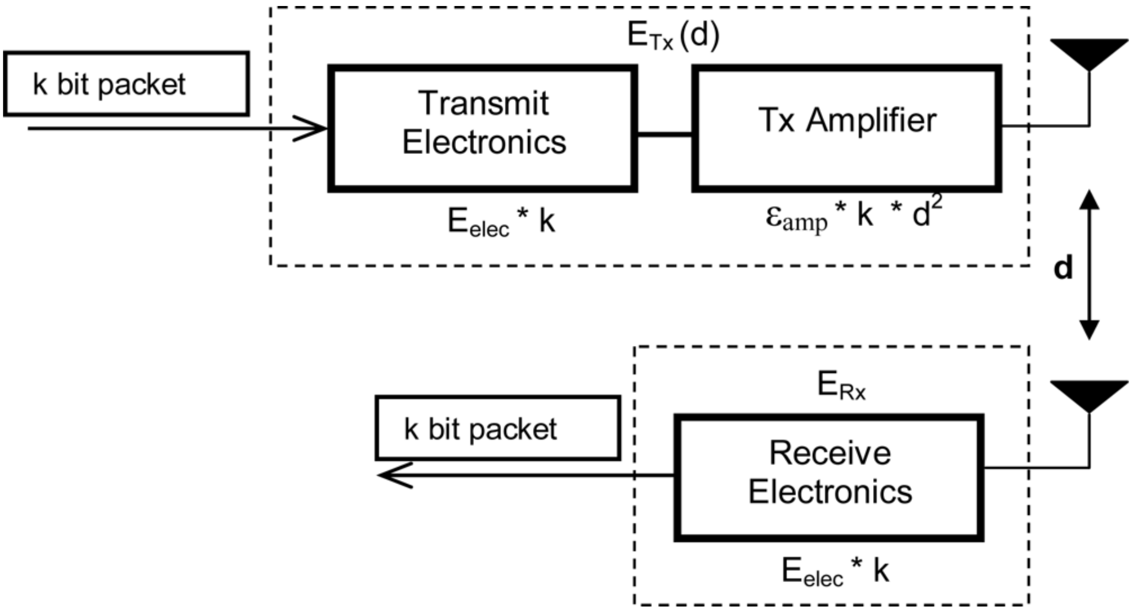

Figure 1: First Order Radio Model

The above diagram is shown in Figure 1,. Shows a pictorial representation of a first order radio model. The transmitter and receiver use the same kind of electronic circuitry and thus their energies are accumulated as Eelec, for each data bit transmitted. The sensor nodes are thus symmetric to each other.

PROPOSED WORK

The setup phase is the primitive phase in deploying the network. As we are simulating the actual network on a virtual software environment, we define the various characteristics which are possible for a network, based on the mathematical and physical modeling of the network. The various properties of the network like the field area, the number of nodes, various kinds of sensor energies are all needed to be defined. As described in the M-GEAR and REECH-ME protocols, in this research work, network field is divided into logical regions on the basis of node's distance from gateway node and BS. The various zones are obtained on the basis of this kind of logical division, which can be described by the following equations:

if NdtoBS < d0	Sector 1	
if NdtoGS < d0	Sector 2	
if NdtoBS >d0 & yn>=yBS	Sector 3	
if NdtoGS >d0 & yN <= yGS	Sector 4	(2)

Based on the above-mentioned conditions, the BS divides the nodes into four different logical regions. The nodes in these distinct regions behave properly and use different techniques to communicate over the network.

Sector 1: Nodes in this region use direct communication and send their data directly to BS as the distance of these nodes from BS is very short.

Sector 2: This sector is comprised of nodes, which are placed near gateway node. Due to their nearness to the gateway node, most of these nodes are in direct communication with the gateway node. These nodes can send their data directly to the gateway. The gateway node, then aggregates this data and forwards this aggregated data and forward it to BS.

Sector 3: The Sector 3 consists of nodes, which are placed according to their distance from base station gateway node as shown in equation 1. The nodes in this region use LEACH based clustering. Sensor nodes in each clustered region organize themselves into small groups known as clusters.

Sector: Sector 4 nodes are decided by their distance from gateway node and the y distance from the gateway. They also form clustering to perform their operation.

SIMULATION RESULTS

The proposed work was implemented using the MATLAB R2010a software tool, using standard network parameters, as shown in Table 1. The various graphs related to network simulation are plotted.

The division of network area into various sectors is as shown in figure 2. The red colour circles show nodes in Sector1, the blue color circles mark the nodes in Sector 2, the black colour circles denote the nodes in sector 3, which can be further said as sector 3a, which lies to the left of gateway node and sector 3b, which lies to the right of the gateway node. Similarly, the green colour circles denote the nodes belonging to the sector 4, and accordingly divided as sector 4a and sector 4b respectively based on the whether they lay to the left of the gateway node or to the right of the gateway node. The base station is shown by the square box in figure 2, while the gateway node is demarcated by an asterisk '*'.

TABLE1: SIMULATION PARAMETERS

Parameters	Values
Network Area	200m
Threshold distance, d0	sqrt(E_{fs}/E_{mp})
Energy consumed in the electronics circuit to transmit in or receive the signal, E_{elec}	50 nJ/bit
Energy consumed by the amplifier to transmit at a short distance, E_{fs}	10 pJ/bit/m_2
Energy consumed by the amplifier to transmit at a longer distance, Emp	0.0013 pJ/bit/m_4
Data Aggregation Energy, EDA	5 nJ/bit/signal
Message Size	4000 bits
Initial Energy, E0	0.5 J

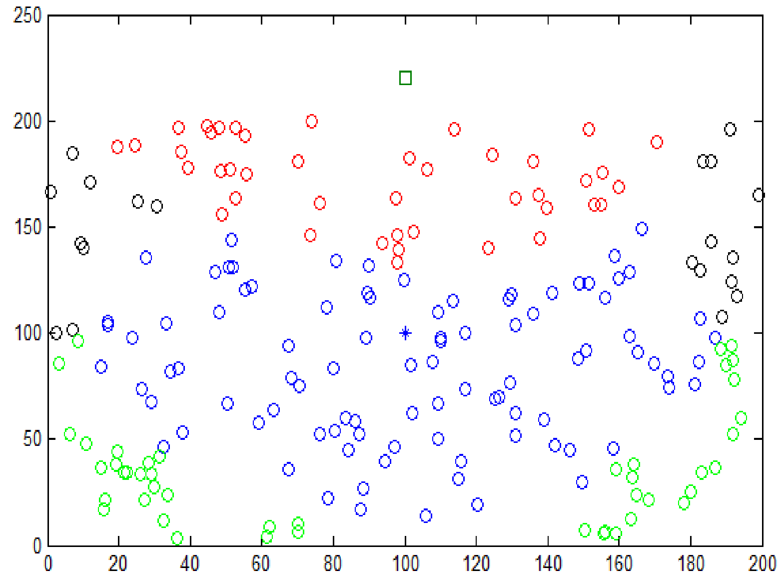

Figure 2: Logical division of Network Area

Figure 2 shows the logical division of the network area as discussed above. Figure 3 shows the dead nodes vs rounds comparison graph between LEACH and GEER protocol.

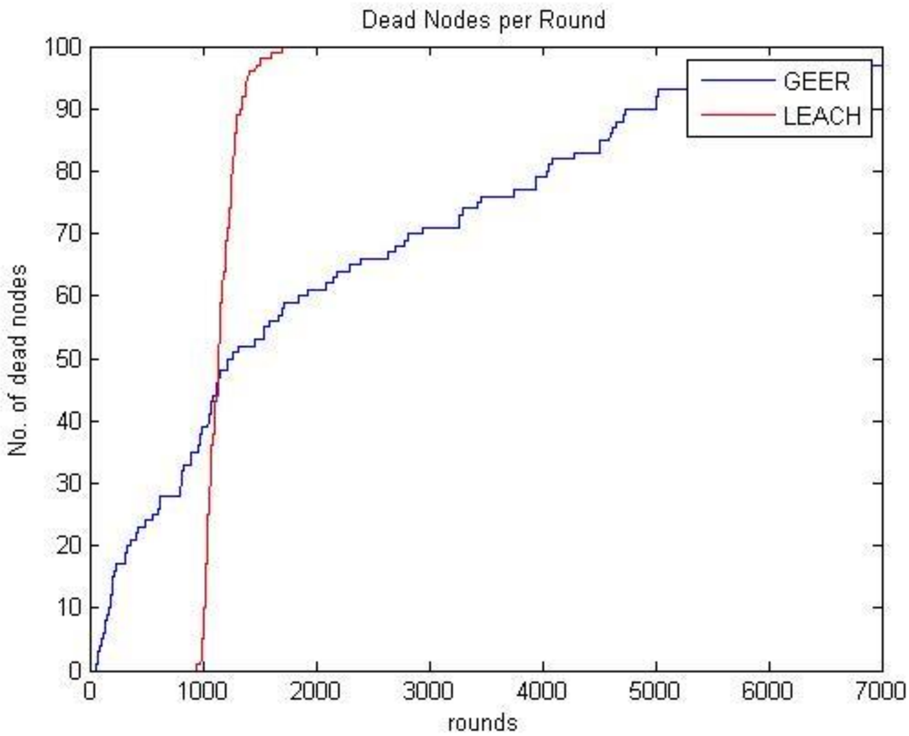

Figure 3: Dead Nodes vs Rounds

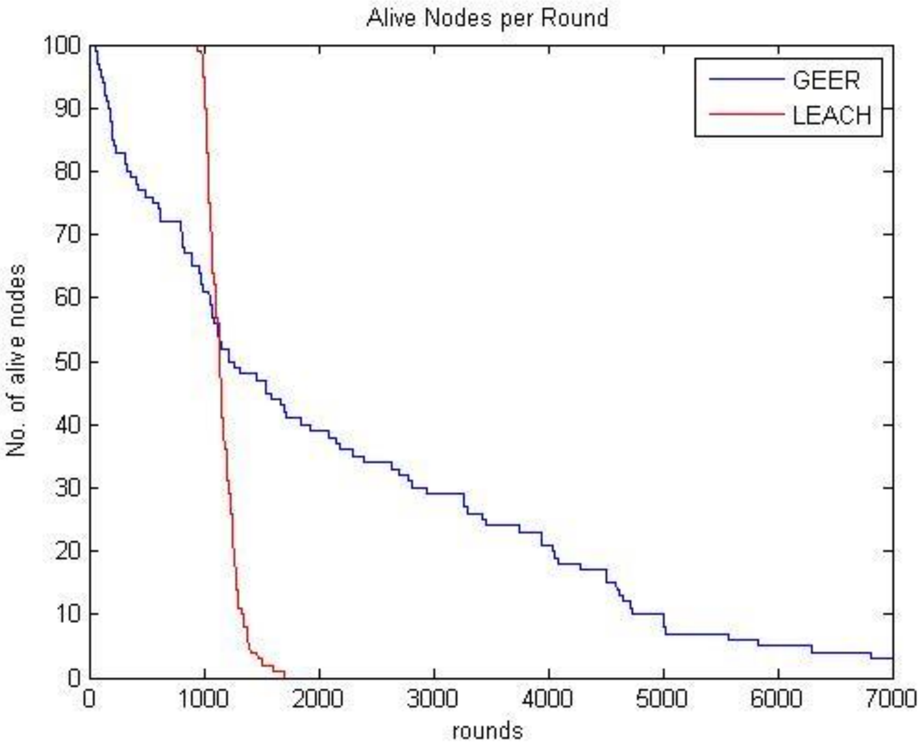

Figure 4: Alive nodes vs Rounds

The number of alive nodes in the proposed protocol also shows considerable improvement over LEACH protocol. The comparison grapg is shown in figure 4. The network lifetime has increased which leads to the network active over a longer period of time and thus increased throughput. The throughput comparison groahn between LEACH and GEER is shown in figure 5.

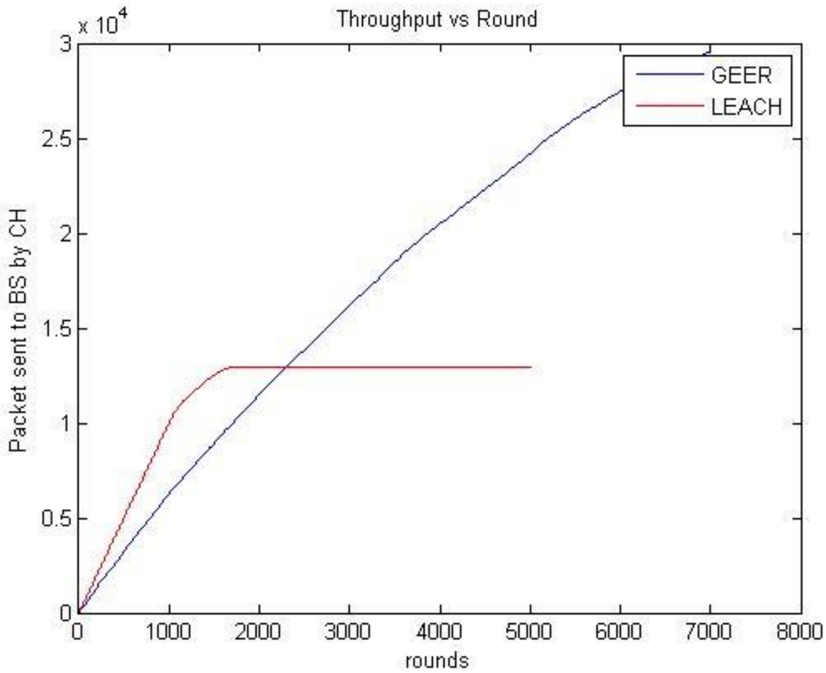

Figure 5: Throughput vs Rounds

CONCLUSION

This research work focusses on implementing a gateway based routing protocol name GEER which shows improved results a compared LEACH (Low Energy Adaptive Cluster Head) protocol. It has demonstrated significant change as far as system lifetime and energy efficiency when contrasted with different strategies and conventions being utilized as a part of Wireless Sensor Networks having settled power sensor hubs. In this examination work, a novel calculation which takes legacy from door based convention has been utilized as a part of which separated from the base station, an extra entryway hub is available. Further, the system range is sensibly partitioned into a few zones, on the premise of their relative situating from the passage hub. The convention has been actualized in MATLAB programming with standard system parameters and reproduction demonstrates enhanced outcomes as far as the number of dead hubs, a number of alive nodes and the packets transferred to the base station.

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