Implementing Leach Protocol for Network Life Time Enhancement through an Energy Efficient Approach

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Abstract—A key concern in Wireless Sensory Network technology is to increase the network lifetime and to reduce the energy consumption of the sensor network. Wireless sensor nodes are dispersed typically in sensing area to monitor earthquake, battle field, industrial environment, and habitant monitoring agriculture field, physical atmosphere conditions and smart homes. Sensor nodes sense the environment, gather information and transmit to BS through wireless link. The objective of the work, we advise gateway based energy-efficient routing protocol (MGEAR) for Wireless Sensor Networks (WSNs). We divide the sensor nodes into four logical regions on the basis of their location in the sensing field. We install Base Station (BS) out of the sensing area and a gateway node at the center of the sensing area. If the distance of a sensor node from BS or gateway is less than predefined distance threshold, the node uses direct communication. We divide the rest of nodes into two equal regions whose distance is beyond the threshold distance. We select cluster heads (CHs) in each region which are independent of the other region. These CHs are selected on the basis of a probability. We compare performance of our protocol with LEACH (Low Energy Adaptive Clustering Hierarchy). Performance analysis and compared statistic results show that our proposed protocol perform well in terms of energy consumption and network lifetime.

Keywords**:** *Wireless Sensor Networks, LEACH Protocol.*

I. INTRODUCTION

Remote Sensor Networks comprises of little sensors that are described by restricted preparing force and vitality assets. All sensor hubs have restricted power supply, constrained memory and have the abilities of data detecting, information handling and remote correspondence. In a WSN, on the off chance that one hub passes on, it could prompt a detachment of the sensor arrange. In this manner, each sensor hub ought to live as far as might be feasible to expand the lifetime of the remote sensor arrange. Sensor hubs are scattered in a sensor field (figure1) .Each of these scattered hubs has the capacities to total information and course to the base station (sink) and afterward to the end clients. Information is directed to end client by utilizing multihop methods. It involves coordination between sensor hubs to give brilliant data that managed physical condition. Remote sensor system will be broadly conveyed later on the grounds that they extraordinarily extend our capacity to screen and control the physical condition from remote ranges. The range of remote sensor systems is one of the rising and quickly developing fields in the logical world .Current pattern of research around there predominantly concentrates on directing calculation intended for better execution and delay the lifetime of system. One of the fundamental limitations in remote sensor system is constrained battery control which plays an incredible impact on the lifetime and the nature of the system. A few directing conventions have been intended for Wireless Sensor Network to fulfil vitality use and productivity necessity. Consequently, productivity, adaptability and lifetime of remote sensor system can be improved utilizing various levelled steering .The plan of directing convention is subject to the way of use prerequisites. The remote sensor systems are a developing field that plays out a thorough procedure of detecting and estimations, estimation logging, information exchange and administration by means of a remote information arrange. The remote sensor is a modest little gadget that joins all capacities in exceptional estimations and calculation. A mass or set of sensors associated however arrange in work frame perfuming a systems administration convention. The bouncing information of the sensors starting with one sensor then onto the next is a noteworthy convention and strategy, the sensors that jumping information from one to each other is supposed "Hub". The association and participation of expansive number of hubs makes an unbending system with high abilities and particulars. The forthcoming and capacity of any remote sensor systems to convey an availability of huge number of hubs, which speaks to little “modest” gadgets, speaks to the energy of that system. This systems sort is right now sent to be utilized as a part of extensive variety of utilizations with an appropriate cost as for its planned. The remote sensor systems real lead is to gauge particular field and logging its estimations to a host, and this is the most application that known and straightforwardly utilized. In any case, additionally, it can be utilized to control a few applications or actuators in that field. It additionally, diminishes the cost of equipment establishment and cabling, originating from

the way that, it needn't bother with vast equipment establishment.

From the other hand, cancelation of vast equipment establishments and cabling, diminishes altogether the cost of upkeep, neither crisis support nor proactive upkeep. Over that, the open air establishments, particularly links, nearly are subjected to be stableman. This topology of remote sensors diminishes the likelihood of slowing down the gear and equipment, due to no utilization of links. Notwithstanding low establishment cost, shoddy gadgets, littler detecting transducers, longer enduring, it is likewise, versatile and can be reconfigured to work in various regions. For instance, in a major homestead, a similar system that measure temperature, weight, and dampness, likewise, can be arranged to gauge the wind speed, additionally, couple of setups can empower that system to detect presence of particular materials in air. The single gadget of remote sensor systems costs under $1 in many applications. The remote sensor hubs additionally, don't require discussing straightforwardly with the closest control tower which is high power or even don't require specifically conveying to the base station. In any case, it speaks with the hubs neighborhood peers as it were. Subsequently, this association will be a pear-to-pear association making a work arrange. The work design suggests an adaptable systems administration of bouncing branches. What's more, the framework is extremely versatile for hub disappointment substitution and remuneration. Every sensor hub in the remote sensors systems administration can perform correspondence over a scope of 50 meters. Along these lines, to impart amongst sensors and exchange the information, no repeaters are required and no immense number of sensors is required.

Figure 1.1 demonstrates a case of remote sensor systems connected to a homestead. It has a major essential in agribusiness fields, and such fields are dynamic territory for scientists and engineers. Unmistakably, expansive number of hubs are conveyed all through the field and associated together. That is setting up what alleged "Directing Topology" or "System Topology". The mount of sensors can be stretched out from tenth or hundreds to thousands now and again.

A. Motivation for the study

LEACH gives birth many protocols. The procedures of this protocol are compact and well coped with homogeneous sensor environment. If a cluster head has not utilized much of its energy during previous round, than there is probability that some low energy node may replace it as a cluster head in next cluster head election process. There is a need to limit change of cluster heads an every round considering residual energy of existing cluster head. Hence an efficient cluster head replacement algorithm is required to conserve energy. In clustering protocols as LEACH, nodes use same amplification energy to transmit data regardless of distance between transmitter and receiver. For example, transmitting a packet to cluster head with same amplification power level as required by a node located at farthest end of network to base station results in wastage of energy. One solution can be having global knowledge of network and then nodes decide how much they need to amplify signal. Locating and calculating distances with in full network topology needs lot of routing and so, this approach do not work for saving energy. To solve above mentioned problems, we propose two mechanisms. i.e. efficient cluster head replacement and dual transmitting power levels.

B. Wireless sensor network

A Wireless Sensor Network is supposed to be made up of a large number of sensors and at least one base station. The sensors are autonomous small devices with several constrains' like the battery power, computation capacity, communication range and memory. They also are supplied with transceivers to gather information from its environment and pass it on up to a certain base station, where the measured parameters can be stored and available for the end user shown in figure 1.1[8]. In most cases, the sensors forming these networks are deployed randomly and left unattended to and are expected to perform their mission properly and efficiently. As a result of this random deployment, the WSN has usually varying degrees of node density along its area. Sensor networks are also energy constrained since the individual sensors, which the network is formed with, are extremely energy-constrained as well. The communication devices on these sensors are small and have limited power and range. Both the probably difference of node density among some regions of the network and the energy constraint of the sensor nodes cause nodes slowly die making the network less dense. Also it is quite common to deploy WSNs in harsh environment, what makes many sensors inoperable or faulty. For that reason, these networks need to be fault-tolerant so that the need for maintenance is minimized.

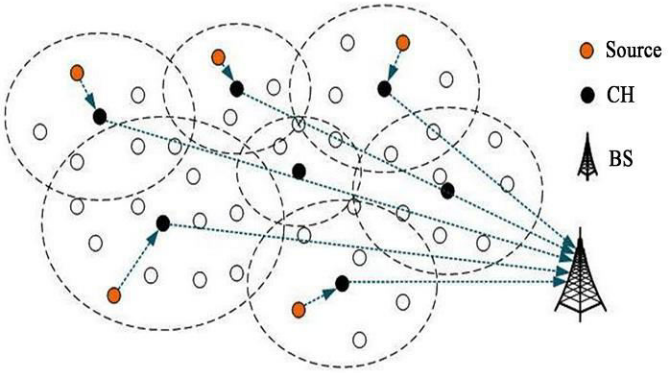

Figure 1.1: Wireless Sensor Network

Typically the network topology is continuously and dynamically changing, and it is actually not a desired solution to replenish it by infusing new sensors instead the depleted ones. A real and appropriate solution for this problem is to implement routing protocols that perform

efficiently and utilizing the less amount of energy as possible for the communication among nodes.

II. RELATED WORKS

A. Sensor Nodes

Sensors nodes are typically built of few sensors and a mote unit as. A Sensor is a device which senses the information and passes it on to mote. Sensors are typically used to measure the changes in physical environmental parameters like temperature, pressure, humidity, sound, vibration and changes in the health parameter of person e.g. blood pressure and heartbeat. MEMS based sensor has found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad hoc network. A mote and sensor together form a Sensor Node. Sensors nodes are typically built of few sensors and a mote unit as. A Sensor is a device which senses the information and passes it on to mote. Sensors are typically used to measure the changes in physical environmental parameters like temperature, pressure, humidity, sound, vibration and changes in the health parameter of person e.g. blood pressure and heartbeat. MEMS based sensor has found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad hoc network. A mote and sensor together form a Sensor Node.

B. Base Station

A base station links the sensor network to another network. It consists of a processor, radio board, antenna and USB interface board. It is preprogrammed with low-power mesh networking software for communication with wireless sensor nodes. Deployment of the base station in a wireless sensor network is very important as all the sensor nodes handover their data to the base station for processing and decision making. Energy conservation, coverage of sensor nodes and reliability issues are taken care of during deployment of base station in sensor network. Generally base stations are assumed static in nature but in some scenarios they are assumed to be mobile to collect the data from sensor nodes.

C. Energy-efficient Routing Algorithms

Energy efficient routing algorithm can be categorized as follows: data centric routing algorithm, location based routing algorithm and hierarchical routing algorithm. Data centric routing algorithm uses Meta data to find the route from source to destination before any actual data transmission to eliminate redundant data transmission Location based routing algorithm requires actual location information for every sensor node. Hierarchical routing algorithm divides the network into clusters. Cluster head (CH) is elected in each cluster. CH collects data from its members, aggregates the data and sends to sink. This approach is energy efficient but relatively complex than other approaches [9].

D. ROUTING PROTOCOLS IN WSNs

The routing protocols are responsible for all aspects of end-to-end packet delivery, including logical message addressing and routing packets between different networks. The main goal of a routing technique is to efficiently deliver data from the source to the destination. Although all routing protocols share this goal, each protocol adopts a different approach to achieve it. Routing paths for transmission of data packets from one node to another can be established in one of three ways, namely proactive, reactive or hybrid. In proactive routing [21], all the routes are computed in advance and maintain consistent up-to date routing information from each node to every other node in the network. Every node in the network maintains one or more routing tables that store the routing information. This is also called table driven routing and is preferably used in the application where the sensor nodes are static. Proactive routing protocols periodically monitor the changes in the topology to ensure the ready availability of any path amongst active nodes. When a topology changes due to the failure of nodes, the change has to be propagated throughout the network as updates so that the network view remains consistent. In reactive routing, routes are discovered only when desired. This means that protocols don't make the nodes initiate a route discovery process until a route to a destination is required. Route discovery can be initiated either by source or destination. Source-initiated routing means that it is the source node that begins the discovery process, while destination-initiated is the opposite. Once a route has been established, the route discovery process ends and a maintenance procedure preserve it until the route breaks down or is no longer desired. The main disadvantage of reactive protocol is that, significant amount of energy is expended in route discovery and setup. Hybrid routing combines characteristics of both reactive and proactive routing protocols to make routing more scalable and efficient. A routing protocol will be considered adaptive if it can adapt to the current network conditions and available energy levels. Depending on the protocol functioning, these can be classified as multi-path based routing, query based, negotiation based, quality of service based or coherent based.

III. PROPOSED WORK

Manufacturing of cheap wireless sensor nodes having sufficient computation and transmit- ting/ receiving powers are available now. Hence hundreds of nodes can be deployed in a network for any required application. These sensor nodes have a limited power which must be utilized in very precise manner to increase nodes life. No doubt efficient circuit is necessary for efficient use of energy, however, routing protocol running on the

network plays a vital role in bandwidth consumption, security and energy conservations as well (considering WSNs). To cope with these constraints, initially direct transmission approach was discussed. In direct transmission, a node sense data from its environment and transmits it straight to base station. This method, no doubt, ensures data security however, on the other hand we have to compromise on nodes life time due to excessive power consumption (if BS is far away). Hence, using direct transmission technique, nodes that are far away from BS die early as they require more power to propagate their signal, making a portion of field vacant for sensing. To solve this problem, minimum transmission energy (MTE) emerged. In this technique, data is transmitted to base stations via multi hop. This gives birth to almost same problem we faced in direct transmission. Difference is only this that in minimum transmission energy algorithm, far away nodes remain alive longer with respect to the nodes nearer to BS. Reason behind early expiry of nearer nodes is routing of all data traffic to base station. According to this mechanism, all participating nodes of network are distributed in 2-hop cluster. Though this protocol is not much energy efficient for wireless sensor nodes however, it gives way to hierarchical clustering algorithms (Liu et al. [2011]). Clustering for energy conservation is proven as efficient mechanism for wireless sensor networks. When a sensor network is deployed, nodes establish clusters and nominate one node from each cluster as a cluster head. These cluster head nodes are responsible for receiving data from other nodes of cluster, do data aggregation/ fusion of received data and transmit it to base station. In this way, bandwidth consumption and lifetime of network is optimized. They prove that regardless of transmitting fused data direct from cluster head to base station, if data is transmitted in multiple hopes i.e. from one cluster head to another and finally to base station, it would further enhance network life time. Considering cluster based algorithms, today numerous protocols are developed, each having different attributes and enhancements mainly in cluster head selection algorithms. Though one thing is common, all protocols focus on energy conservation and data aggregation. In DEEC existing energy in node is election criteria of a node to become a cluster head (Smaragdakis et al. [2004]). LEACH, TEEN, SEP, DEEC and PEGASIS are prominent routing techniques for WSNs. Main procedure of electing a cluster head was given by\ LEACH and that is further enhanced by SEP and DEEC. TEEN introduces the concept of thresholds that gives good results in network life time by showing reactive nature. These thresholds can be implemented in any routing protocol to enhance its performance with respect to utility or application. Considering LEACH, the algorithm is divided into three parts, i.e. advertising phase, Cluster Set up phase and Scheduling phase. Based on LEACH, SEP and DEEC, numerous protocols are proposed which gives a detailed comparison analysis on different variants of LEACH as A-LEACH, SLEACH and M-LEACH in terms of energy efficiency and applications. Our work is based on LEACH protocol that can be extended to improved version of LEACH. Basically, we introduce two techniques to raise network life time and throughput. To understand our proposed scheme, we have to understand mechanism given by LEACH. This protocol changes the cluster head at every round and once a cluster head is formed, it will not get another chance for next 1/p rounds. For every round, cluster heads are replaced and whole cluster formation process is undertaken. We, in this work, modify LEACH by introducing efficient cluster head replacement scheme. It is a threshold in cluster head formation. for very next round. If existing cluster has not spent much energy during its tenure and has more energy than required threshold, it will remain cluster head for the next round as well. This is how, energy wasted in routing packets for new cluster head and cluster formation can be saved. If cluster head has less energy than required threshold, it will be replaced accord- ing to LEACH algorithm. Besides limiting energy utilization in cluster formation, we also introduce two different levels of power to amplify signals according to nature of transmission. Basically there can be three modes of transmission in a cluster based network.

1. Intra Cluster Transmission
2. Inter Cluster Transmission
3. Cluster Head to Base Station Transmission

Intra Cluster Transmission deals with all the communication within a cluster i.e. cluster member's sense data and report sensed data to cluster head. The transmission/ reception between two clusters heads can be termed as inter cluster transmission while a cluster head transmitting its data straight to base station lies under the caption of cluster head to base station transmission. Minimum amplification energy required for inter cluster or cluster head to BS communication and amplification energy required for intra cluster communication cannot be same. In LEACH, amplification energy is set same for all kinds of transmissions. Using low energy level for intra cluster transmissions with respect to cluster head to BS transmission leads in saving much amount of energy. Moreover, multi power levels also reduce the packet drop ratio, collisions and/ or interference for other signals. In this context, we assume that a cluster at maximum may spread into an area of 10 X 10 m2 in a field of 100 X 100 m2. Energy that is enough to transmit at far ends of a field of 100 X 100 m2 must be lowered 10 times for intra-cluster transmission. When a node act as a Cluster head, routing protocol informs it to use high power amplification and in next round, when that node becomes a cluster member, routing protocol switches it to low level power amplification.

IV. RESULTS AND DISCUSSION

As already discussed, energy efficient WSN deployment is not an easy task due to large number of parameters, i.e., energy parameters and cluster head selection then their data transmission procedure. MATLAB programming platform is used for coding of LEACH and proposed work. Finally, the comparative performance of all algorithms is explained. The parameters considered during simulation have their own significance for the better performance of the network. The important definitions in the WSNs related to this project are: Packet delivery ratio: The ratio of number of packets sent from the source to the number of packets received at the destination. The greater the value of PDR means better performance of the protocol. Network Lifetime: The time for the first node or a certain percentage of sensor nodes to run out of power or it is the time interval from the start of operation (of the sensor network) until the death of the first alive node. Throughput: Average rate of successful packet delivery. The throughput is the most important parameter to analyze the performance of the network, to get better through- put the error should be corrected, instead of retransmitting the packet. If the error is corrected there is no need of retransmitting the packet. If the retransmission traffic is reduced the congestion will not occur. If there is no congestion there is no packet loss that is error. If more number of packets in the network the performance of the network degrades which leads to congestion, which leads to packet loss. If there is an error correction technique which corrects the error instead of going for retransmission it improves throughput.

A. Experiments and Graphs

In the experiment it is shown that the proposed protocol perform better than Leach (2002) and L-Leach (2013). The result show that approximates twice improvement in Leach and about 40% improvement shown compare to the L-Leach.in the L-Leach protocol network life time is around 1600 round in my proposed protocol network life time is about 2500 round.

Number of Alive Nodes

In this subsection is shown a comparison of the number of allive nodes in Homogeneous LEACH and proposed scheme for routing protocol. The evaluated results are shown below.

Number of Dead Nodes

In this subsection the following figure 4.1 presents a comparison of the rounds achieved by all the simulated protocols when the all node dies.

Total network energy of proposed protocol

Besides network life time, another metric to judge efficiency of a routing protocol is its energy. A base station receiving more data packets confirms the efficiency of routing protocol. Energy depends on network life time in a sense but not always. Considering the simulated results as shown in below figure, we deduce that, maximum energy is achieved by proposed work.

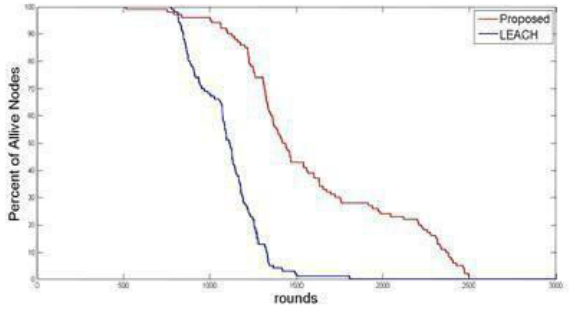

Figure 4.1: Alive nodes Homogeneous LEACH

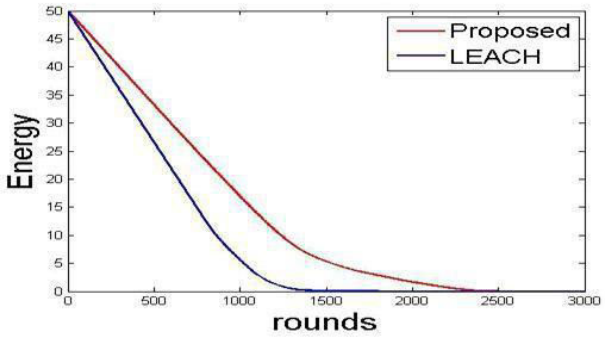

Figure 4.2: Routing Protocol Energy

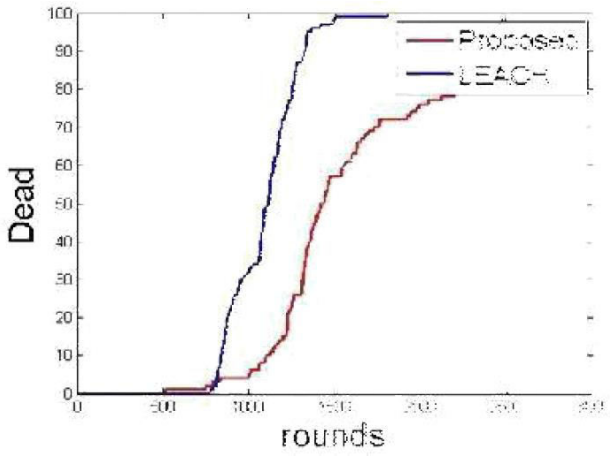

Figure 5.2: Comparison of the rounds

V. CONCLUSION AND FUTURE WORK

In this project work, we give a brief discussion on emergence of cluster based routing in wireless sensor networks. We also propose Protocol, a new variant of LEACH that can further be utilized in other clustering routing protocols for better efficiency. Proposed Scheme tends to minimize network energy consumption by introducing technique to raise network lifetime and throughput. In this scheme, dividing the network into four zones, one zone directly communicated to base station and remaining three zones communicated to base stations via gateway node. In the experiment it is shown that the proposed protocol perform better than Leach(2002) and L-Leach(2013). The result show that approximates twice improvement in Leach and about

40% improvement shown compare to the L-Leach.in the L-Leach protocol network life time is around 1600 round in my proposed protocol network life time is about 2500 round.

Future scope

1. Implementation of MODLEACH protocol on Heterogeneous wireless sensor networks.
2. Next improvement can be possible by considering sink mobility and to ensure successful delivery of data.
3. Design of a better routing protocol in case when CH dies before sending the data to the BS.
4. The future work can include some more level of hierarchy and mobility in the network.

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