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STUDY OF LEACH PROTOCOL FOR WIRELESS SENSOR NETWORKS

Surbhi Sharma [1], Sarvesh Singh [2]

Department of Computer Science

Jyoti Vidyapeeth Womens' University, jaipur, Rajasthan, India.

Surbhi039sharma@gmail.com [1], Sarvi899@gmail.com[2]

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Corresponding Author:

Surbhi Sharma

Computer Science & Engineering Department, JVWU, Jaipur, India

Email: rashi.saxena@yahoo.co.in

ABSTRACT

Wireless sensor networks are presenting as an essential need for mankind. It composed from a large number of sensor node with the ability to sense and process data in the physical world in a appropriate manner. In this work, cluster based routing in wireless sensor networks is studied specifically. The most prominent wireless sensor network's routing protocol "LEACH" as modified LEACH (MODLEACH) by introducing *efficient cluster head replacement scheme* and *dual transmitting power levels*. The modified LEACH, in respect with the LEACH out performs it using metrics of cluster head formation, through put and network life. Afterwards, hard and soft thresholds are implemented on modified LEACH (MODLEACH) that boasts the performance. A clustering based routing algorithm known as Low-Energy Adaptive Clustering Hierarchy (LEACH). It was proposed as a solution for low power consumption. In this work, cluster based routing in wireless sensor networks is studied precisely. LEACH algorithm shows some drawbacks that want an improvement to overcome it as to improve the performance. Then, the modified LEACH algorithm was proposed where the improvement was done in cluster head selection based on LEACH. In cluster head selection, modified LEACH taking into account the residual energy of each node for calculation of the threshold value for next round. Meanwhile in LEACH, the cluster head selection was based on distributed algorithm. Both of these protocols was implemented in network simulator to compare the performance. This study shows that there were a better performance achieved by modified LEACH depends on the results obtained.

Index Terms: LEACH, Wireless, Sensor, Networks, Routing, Protocol, MODLEACH, WSN's, Cluster, Head and Threshold.

INTRODUCTION

Wireless sensor network consists of large number of small, low power, low cost sensor nodes with limited memory. It also contains computational, and communication resources and a Base Station. These nodes continuously monitor environmental conditions and collect whole information about the physical environment in which they are installed. It transmits the collected data to the BS. BS is a gateway from sensor networks to the outside world. The BS has a very large storage and large data processing capabilities. It passes the data that collects from sensor nodes to the server from where end-user can access them. The sensors nodes are usually deployed around the area of the Base Station and make groups as per the need of the BS.WSN contains an advantage of being operated unattended in the environment where continuous human monitoring is either risky. Sensor nodes run on batteries and once nodes are used their batteries cannot be recharged. There are many uses of Wireless Sensor Network; they are mainly deployed in military and health applications. They are also applied in robot control, automatic manufacturing, and home automation. WSN is useful in detecting forest res based on temperature information it collects from large number of distributed sensor nodes. After literature survey of WSNs we obtain the following properties. Wireless Sensor Networks (WSNs) are widely used to

create a smart environment that relies on sensory data from real world. The application of wireless sensor networks provides huge wirelessly connected infrastructure facilitating the function of monitoring a physical and environmental conditions, such as temperature, sound, vibration, pressure, humidity, acidity, motion and pollutants. The main features of WSN are defined such as:-

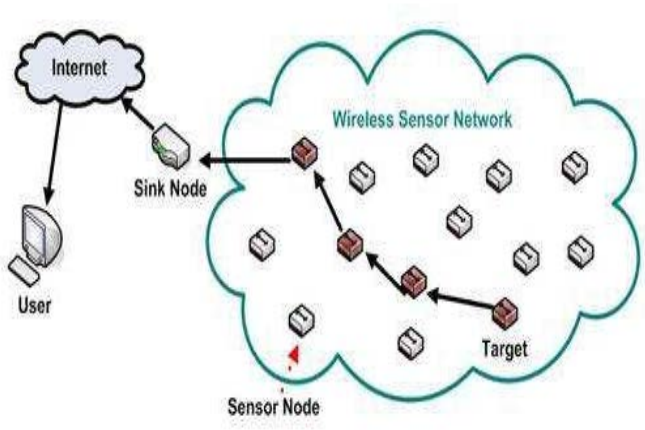

Figure 1: Wireless sensor network architecture

- All sensor nodes are battery operated which has very less power, and after deployment recharging those batteries is impossible.
- Links among the sensor nodes are symmetric, i.e., two nodes can communicate using the same transmission power.
- All the sensor nodes which are deployed have initially same amount of communication and battery power.
- There are various transmission power levels for all sensor nodes, and dynamically each node can change their power level.
- Mobility of sensor node varies from application to application, so in general they are quasi-stationary.
- Location of sensor nodes once deployed cannot be tracked down as they are not equipped with GPS antennae.

I. RELATED WORK

Today's, manufacturing of cheap wireless sensor nodes having sufficient computation and transmitting/ receiving powers are available easily in market. Hence hundreds of nodes can be deployed in a network for any required application in networking field.

These types of nodes known as sensor nodes which have a limited power which must be utilized in very precise manner to increase node's life.

We have no doubt that 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 WSN's). In direct transmission, we have a node to sense data from its environment and transmit it straight to base station. This method ensures data security without having any doubt. However, on the other hand we have to compromise on node's life time due to excessive power consumption (if BS is far away). Hence we used direct transmission technique in which 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. After the implementation of that technique we again faced same problem which are already occur in direct transmission. The minuet difference is only that, it is used 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. Moreover, transmitting bulk of sensed data from each node use much energy in comparison to others.

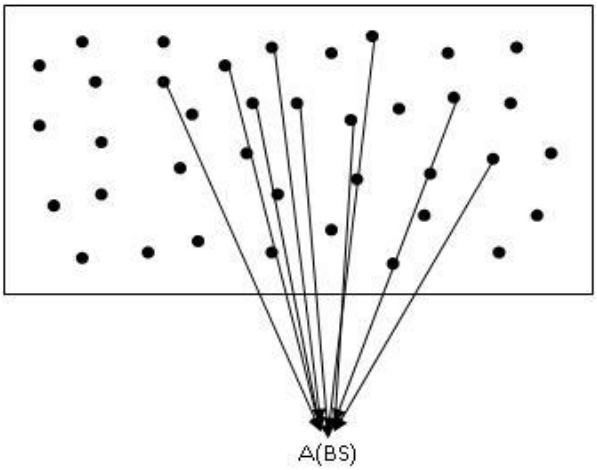

Figure 2: Sensor information forwarding without clustering and aggregation

To overcome this problem, concept of Directed Diffusion was introduced that discuss data processing and dissemination. Then we have needed to work on a hierarchical clustering mechanism dealing with asymmetric communication for power saving in sensor nodes. In which presented a cluster based routing protocol (CBRP). According to this mechanism, all participating nodes of network are distributed in 2-hop cluster. After applying this protocol is not much energy efficient for wireless sensor nodes however, it gives way to hierarchical clustering algorithms. WSN consists various sensor nodes, moreover these sensor nodes run on non rechargeable batteries. So to give the objective of fault-tolerance, load balancing and network connectivity, grouping of nodes is required. It is a method of dividing sensor nodes into groups on the behalf of a huge number of parameters. It selects a

group leader from each group. They are called clusters and group leaders are called Cluster Heads (CHs) of the clusters. Parameters for making the clusters include distance between cluster head and its member, intra-cluster communication cost, residual energy of sensor nodes, location of node with respect to BS etc.

Clustering for energy conservation is proven as efficient mechanism for wireless sensor networks which shows the network scenario when there is clustering in the network. It divides the sensor nodes into clusters and selects a Cluster Head (CH) for each cluster, so the member from each cluster communicates through their CH in order to communicate to the BS. The clustering increases network lifetime as after clustering less number of nodes will access the channel for communication with the BS. All the information's and updates of whole cluster are merged together at CH and forwarded to the next CH in the BS. CH can also look into other functions like data aggregation, group key management, distributed computation. When a sensor network is deployed, nodes establish clusters and nominate one node from each cluster as a cluster head (CH). 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 life time of network is optimized. when 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.

II. MOTIVATION

When Wireless Sensor Networks are deployed mainly for military and health applications. There is a good need of secure communication among sensor nodes. There are various methods to secure network data transmissions. It is mostly preferred due to power constraints of WSN, group key based mechanism. Hence to implement scalable energy to secure group communication. The best source would be hierarchical based like Clustering Most of the WSN designs depend on clustering. Base Station is the midpoint of contact to the outside world. It may lead to total disconnection in the communication in the case of failure. So in order to give better fault tolerant immediate action, a new BS at some other physical location will have to take the charge. This may lead to a complete change in the hierarchical network topology. Which leads to re-clustering the whole network and in turn formation of new security keys? Hence in such situations, we need a clustering algorithm which will perform the minimum re-clustering with low energy consumption and less execution time. LEACH gives birth to many protocols in which we have some milute difference. According to this protocol, for every round, new cluster head is elected and hence new cluster formation is required in wireless sensor node. This leads to unnecessary routing overhead resulting in excessive use of limited energy which are already specify. 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 at every round considering residual energy of existing cluster head during the working time. 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 depends on the need. To preserve energy, there should also be a transmission mechanism that specifies required amplification energy for communicating with cluster head or base station. 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.

III. **PROPOSED SCHEME**

Our work is based on LEACH protocol. Basically, we introduce two techniques to define the network life time and throughput. To understand our proposed scheme, it is too necessary to understand mechanism given by LEACH. In 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 single round, cluster heads are replaced and whole cluster formation process is undertaken. In this work, we introduce the modify LEACH by introducing "efficient cluster head replacement scheme".

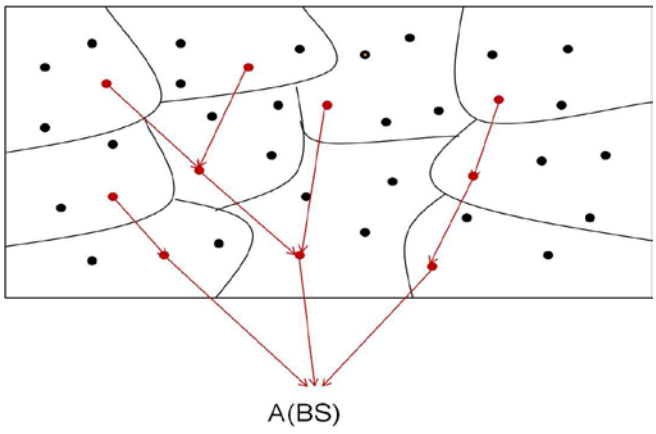

Figure 2: Clustering hierarchy before failure of Base Station

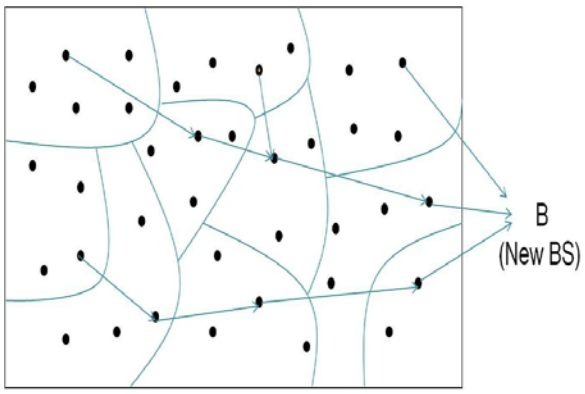

Figure 4: New clustering hierarchy after failure of Base Station

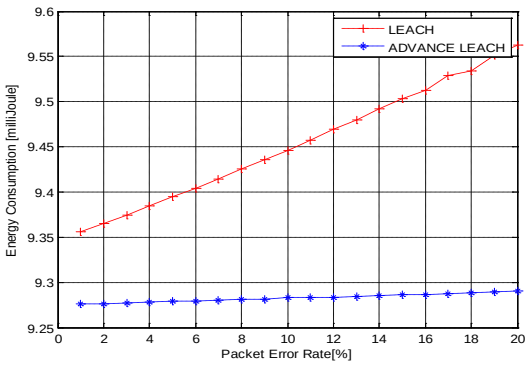

Figure 5:

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 according 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 which 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 in the process of intra cluster 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 the process. In LEACH, amplification energy is set same for all kinds of transmissions in the WSN. Using low energy level for intra cluster transmissions with respect to cluster head to BS transmission leads in saving much amount of energy which is useful. Moreover, multi power levels also reduce the packet drop ratio, collisions and/ or interference for other signals. Finally, soft and hard threshold schemes are also implemented in MODLEACH that gives better results.

IV. CONCLUTION

In this work, we give a brief discussion about the cluster based routing in wireless sensor networks. We also propose MODLEACH, a new variant of LEACH that can further be utilized in other clustering routing protocols for better efficiency in which we can save the power. MODLEACH tends to minimize network energy consumption by efficient cluster head replacement after very first round and dual transmitting power levels for intra cluster and cluster head to base station communication. In MODLEACH, a cluster head will only be replaced when its energy falls below certain threshold minimizing routing load of protocol during the time of transmitting /interchanging data. In the cluster head replacement procedure, we study about the residual energy of cluster head at the start of each round. Then, soft and hard thresholds are implemented on MODLEACH to give a comparison on performances of these protocols considering throughput and energy utilization. In future, we will carry our work to calculate routing load of MODLEACH, MODLEACHST and MODLEACHHT analytically and apply efficient cluster head replacement mechanism along with dual transmission power levels in other clustering routing protocols of wireless sensor networks to study their impact in a broader sense or try to getting the better result towards our work.

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