An Efficient Approach for Cluster-head Selection in LEACH Protocol

Mr. Rohit Kumar Gupta, Deepshikha Varshney, Deepika Tayal

***Abstract*— Wireless Sensor Networks (WSNs) have gained worldwide attention in recent years which comprises of several sensor nodes that can sense, measure, and gather information from the environment. Due to its energy constraints, the deployments of WSNs will require advance techniques to maintain the network lifetime. A clustering based routing algorithm called Low-Energy Adaptive Clustering Hierarchy (LEACH) was proposed as a solution for energy saving. In order to save energy consumption, the data must be aggregated and then sent to the base station. But in the case of homogeneous sensor network, the cluster-head will soon die which needs to be re-clustered that cause high energy consumption. This paper proposes a concept of associate cluster head selection that reduces the overhead of clustering process, reduce the load over cluster head, avoiding re-clustering and thus reduce the energy consumption within cluster in large-scale and dense sensor networks. The selection of the associate cluster head is based on the distance between the cluster and the base station and on the residual energy of the sensor node in wireless sensor network. In our proposed algorithm introduce a technique that save the energy that is consumed by the sensor nodes during the re-clustering process, so it saves the energy and enhances the lifetime of the sensor network.**

***Index Terms*— Base Station, Cluster head (CH), Clustering, Re-clustering.**

I. INTRODUCTION

A. Wireless Sensor Networks[1]

Wireless Sensor Network (WSN) comprises of hundreds to thousands of low-power multi functioning sensor nodes, operating in an unattended environment with limited computational or sensing capabilities which is used to cooperatively bypass their data through the network to a main location. The elementary components of a sensor node are sensing unit, a processing unit, a transceiver unit and a power. Usually, sensor nodes are scattered in the sensing field, being the area where we want to monitor some ambient conditions. Sensor nodes have to coordinate among themselves to get information about the physical environment. The information collected by sensor nodes is routed to the Base Station either directly or through other sensor nodes. The Base Station is a fixed node or mobile node, which is capable to connect the sensor network to an infrastructure networks or to the Internet where users can access and process data. The fundamental objectives for WSN are reliability, accuracy, flexibility, cost effectiveness, and ease of deployment. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. Recent developments in this technology have made these sensor nodes available in a wide range of applications in military and national security, environmental monitoring, and many other fields.

Figure 1 show the basic architecture [10] of the wireless sensor network in which sensor node deployed in the sensor fields and they communicate with each other for collect the information from the environment, or directly send to the base station basically base station act as a gateway.

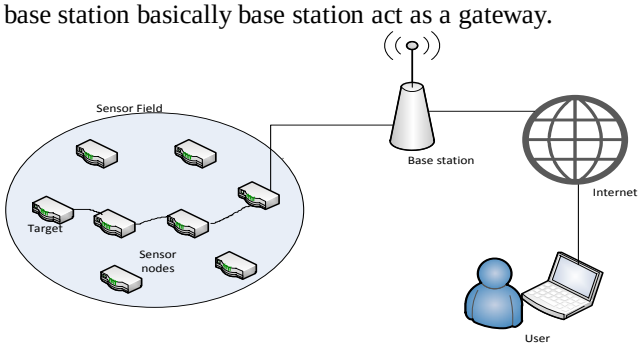

Figure 1: Architecture of Wireless Sensor network

B. Routing Protocols in WSN

Routing in WSNs is very challenging due to the specific characteristics that distinguish WSNs from other wireless networks such as wireless ad hoc networks or cellular networks. Many new algorithms have been proposed, taking into consideration the inherent features of WSNs along with the application and architecture requirements. In general, routing in WSNs can be divided into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure[10]. In flat-based routing, all nodes are typically assigned equal roles or functionality. In hierarchical based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network. A routing protocol is considered adaptive if certain system parameters can be controlled in order to adapt to the current network conditions and available energy levels.

C. Clustering

In WSNs, broadcasting plays an important role during data transmission. In this process, a source node transmits a message to all other nodes in the network. Clustering is one of the techniques that come under Broadcasting. Because, our main concern is only about LEACH[2,3] which is a cluster based protocol.

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Clustering is the way by which the sensor nodes in a network organize themselves into hierarchical structures. Sensor nodes[10] can use the scarce network resources such as radio resource, battery power more efficiently. Such type of grouping of sensor nodes creates self disjoint sets called a cluster. This provides network scalability, resource sharing and efficient use of constrained resources that gives network topology stability and energy saving attributes. Cluster schemes will decrease the overall energy consumption and reducing the interferences among sensor nodes or reduce the communication overheads.

In clustering schemes, each cluster having two types of nodes, one cluster head (CH) and several other cluster members (CMs). Cluster members gather data from the environment periodically and send the data to cluster heads. As shown in Figure 2, Cluster heads aggregate the data from their cluster members, and send the aggregated data to the base station (BS).

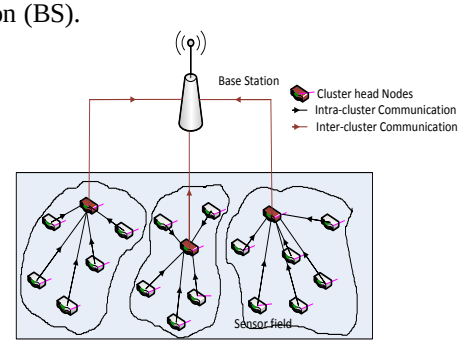

Figure 2: Clustering In WSN

II. RELATED WORK

A. LEACH

LEACH (LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY) is a cluster-based energy efficient routing protocol, which reduce the number of transmissions towards to the BS. In other words, it reduces network traffic and the contention for the channel. LEACH has motivated the design of several other protocols which try to improve upon the CH selection process. There are number of clustering based routing protocols proposed in literature for WSNs. These protocols show better energy consumption and performance when compared to flat large-scale WSNs, but it also increase the overhead to configure and maintain. LEACH is one of the first hierarchical routing approaches for WSNs.

LEACH based on two basic assumptions:

- ✓ Base station is fixed and located far away from the sensors, and
- ✓ All nodes in the network are homogeneous and energy constrained.

The idea behind LEACH is to form clusters of the sensor nodes depending on the received signal strength and use local cluster heads as routers to route data to the base station.

B. Brief Introduction to LEACH Protocol

LEACH Protocol is a typical representative of hierarchical routing protocols. It is self adaptive and self-organized. The working of LEACH is broken up into rounds.

Each round consists of two phases: set-up phase and steady-state phase. Set-up Phase [4] divided into Advertisement Phase and Cluster Set-up Phase or Steady Phase [4] included Schedule Creation and Data Transmission. The operation of LEACH is separated into fixed-length rounds, where each round starts with a set-up phase followed by a steady-state phase. The duration of the steady state phase is longer than the duration of the setup phase in order to minimize the overhead.

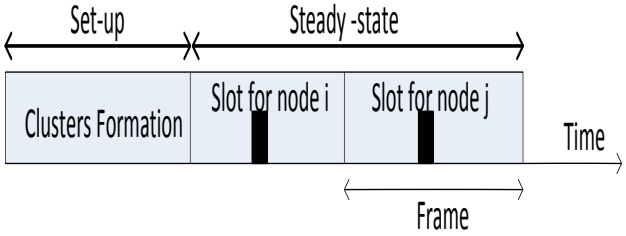

Figure 3: Phases of LEACH

1. Set-up Phase: By using a distributed algorithm, clusters are formed where nodes make autonomous decisions without any centralized control. In addition, no global communication is needed to set up the clusters. In homogenous sensor network, assuming that all sensor nodes having same amount of energy and having equal resources and each nodes are cluster-heads approximately the same number of time. A sensor node chooses a random number, r, between 0 and 1.

Consider threshold value[7] be T (n):

$$T(n) = \begin{cases} \frac{P}{1-P(r \bmod (1/p))}, & \text{if } n \in G, \\ 0, & \text{otherwise.} \end{cases}$$

Where,

G-It is the set of nodes that are involved in the CH election.

T (n) - a threshold value

p- Predetermined fraction of nodes

r- Current round

The threshold value is calculated by using above given equation. If this random number is less than a threshold value, T (n), the node becomes a cluster-head [5,6,9] for the current round. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV) to the all cluster member's. This message containing the node's ID and a header that distinguishes this message as an announcement message. Based on the received signal strength of the cluster head, each non-cluster-head node determines to which cluster it belongs. After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits a join-request message (Join-REQ) back to the chosen cluster-head. The cluster-heads in LEACH plays an important role during data transmissions in their cluster.

Before data transmission, each cluster-head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non cluster-head node to be turned off at all times except

during their transmit time, thus minimizing the energy dissipated by sensor nodes in the network.

2. Steady-state Phase: This phase is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot. The radio of each non-cluster-head node is turned off until its allocated transmission time. Since all the nodes have data for sending to the cluster-head and the total bandwidth is fixed, the cluster-head must keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster-head receives all the data, it can operate on the data and then the resultant data are sent from the cluster-head to the base station.

III. PROBLEM DEFINITION

In wireless sensor network, Clustering is efficient scheme for performing data aggregation or fusion over the data gathered from the nodes in the network. In each cluster, sensor node sends data to the cluster head (CH) and then cluster head perform aggregation process on the received data and then send it to the base station (BS). Performing aggregation function[8] over cluster-head in the cluster still causes significant energy wastage.

In case of homogeneous sensor network[1] (where all the sensor nodes are assigned with equal energy, computation, and communication resources and CHs are designated according to a random way or other criteria, then it will call as homogeneous schemes), cluster-head will soon die out and again re-clustering (for cluster-head selection) has to be done which again cause energy consumption, also a time consuming procedure.

A. In order to avoid the re-clustering[6]or to reduce the overhead of clustering process and reduce the load over cluster head, reduce the energy consumption *Improved Approach*

This is an efficient approach for avoiding the re-clustering process in the sensor network, which introduce the concept of the Associate CH .ACH is the node that will become a CH of the cluster in case of CH energy below from average energy, cluster nodes gathering data from environment and send it to the CH. In case of LEACH the CH will die earlier than the other nodes in the cluster because of its operation of receiving, sending and overhearing. When the CH die, the cluster will become useless because the data gathered by cluster nodes will never reach to the base station. Therefore, the role of the CH is important in data transfer among the nodes in the cluster. CH selection is same as the LEACH protocol. While processing of Cluster head node the energy become reduce, so if the energy of CH is becomes below to the non cluster head nodes energies means next round should be processed. In the next round, the Associate cluster-head should be made as a lead while selection of cluster head for the first round, so no need to select the cluster-head for next round. This approach in wireless sensor network works in two phases namely: Cluster set-up phase and cluster steady phases same as a LEACH protocol. This proposes approach work into rounds. Each round begins with a set-up (clustering) phase when clusters are structured, followed by a cluster steady phase, the CH is always on receiving data from cluster members, aggregate these data and then send it to the BS that might be located far away from it.

B. Steps of Proposed algorithm

1. Firstly, we have a network of nodes.
2. Selection of cluster heads according to the random no generator.
3. Divide into clusters.
4. TDMA schedule creation by cluster heads.
5. Local data aggregation by cluster heads.
6. Data transmission by cluster heads to BS.
7. Check the residual energy of all the nodes in the cluster
   If the energy of the CH is less than the energy of non-CH
   Then the associate cluster head is chooses among the nodes in the cluster Else Go to step 2 Stop.

IV. CONCLUSION

In this, we studied various cluster head selection algorithm for data aggregation in LEACH protocol. But all have survived due to periodically select cluster head, for this lot of energy is consumed. That's why we take an assumption that this approach for the cluster head selection in which no need to select cluster head periodically when the cluster head died in the cluster. So this approach is used to avoid the concept of re-clustering then it saved the lots of energy, reduced the cost and save the time .

REFERENCES

[1] Jennifer Yick, Biswanath Mukherjee, Dipak Ghosal," Wireless sensor network survey", Computer Networks 52 (2008) 2292–2330

[2] Kajal V. Shukla," Research On Energy Efficient Routing Protocol LEACH For Wireless Sensor Networks", International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 3, March – 2013 ISSN: 2278-0181

[3] Kiran Maraiya, Kamal Kant, Nitin Gupta," Efficient Cluster Head Selection Scheme for Data
Aggregation in Wireless Sensor Network", *International Journal of Computer Applications (0975 – 8887) Volume 23– No.9, June 2011*

[4] Meena Malik, Dr. Yudhvir Singh , Anshu Arora," International Journal of Advanced Research in Computer Science and Software Engineering ",Volume 3, Issue 2, February 2013 ISSN: 2277 128X

[5] K.Ramesh and Dr. K.Somasundaram," A COMPARATIVE STUDY OF CLUSTERHEAD
SELECTION ALGORITHMS IN WIRELESS SENSOR NETWORKS", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.2, No.4, November 2011

[6] Srie Vidhya Janani. E, Ganeshkumar.P, Vasantha Suganthi.G, Sultan.M, Kaleeswaran. D," A Survey on Algorithms for Cluster Head Selection in WSN ", *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, No 5, May 2013 ISSN: 2278 – 1323*

[7] Lan Tien Nguyen †1, Xavier Defago †2, Razvan Beuran *†3, Yoichi Shinoda," An Energy Efficient Routing Scheme for Mobile Wireless Sensor Networks"

[8] Jamal N. Al-Karaki Ahmed E. Kamal," Routing Techniques in Wireless Sensor Networks: A Survey".

[9] D. SURESH, Dr. K. SELVAKUMAR," ENERGY EFFICIENT DOUBLE CLUSTER HEAD SELECTION ALGORITHM FOR WSN", Journal of Theoretical and Applied Information Technology 20th December 2013. Vol. 58 No.2 ISSN: 1992-8645

[10] Yazeed Al-Obaisat, Robin Braun," On Wireless Sensor Networks: Architectures, Protocols, Applications, and Management".

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