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Enhanced Leach Protocol

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Abstract:
Technological advances in wireless sensor networks have made impact on everyday life. In wireless sensor networks energy is main concern & it is considered while designing sensor networks. We use hierarchical routing protocols based on clustering because of balanced energy consumption and scalability. The efficient usage of energy in a sensor node is most important parameter to increase the life time of wireless sensor network. In this paper we analyze the design issues constructing the cluster in the wireless sensor networks and detail working of LEACH (Low Energy Adaptive Clustering Hierarchy) protocol and its SIMULATION .The results reveal the measure for performance of sensor networks.

Keywords: *Cluster head, Data aggregation, Energy efficient, Hierarchical routing, LEACH, Life time, Wireless sensor network*

I. Introduction

A Wireless Sensor Networks (WSN) is a set of thousands of micro sensor nodes that are capable of sensing, communicating between each other and performing computational and processing operations. Wireless Sensor Networks can provide great advantages with respect to low-power, low-cost and fast deployment for many applications without human supervision[1]. Energy efficiency is one of the most important issues while designing protocols which are lifetime critical. Sensor nodes are equipped with tiny batteries with limited power. They can be randomly dropped or deployed manually. Organizing the wireless network in efficient and scalable manner is by using the clusters. Cluster head (CH) is responsible for information gathering by the nodes of its cluster and may aggregate and compress the data before transmission to sink. However, this results in a higher rate of energy utilization by cluster heads. The most popular clustering method is LEACH, which addresses clustering energy problem by probabilistically changing the role of cluster head among all nodes. The probability of becoming a cluster head should be selected wisely to increase the performance of the network. The main focus of this paper is to address energy problem and developing a method for selection of cluster head with the optimal probability from the point of minimizing the energy consumption [2].

II. Literature review

Firstly sensor networks were mainly used by military applications but later have been considered for the applications such as environmental monitoring, health monitoring etc. A sensor network design is motivated by many factors, which include Fault Tolerant Communication, Scalability, Power Consumption, Data Delivery Models, Data Aggregation/Data Fusion, Node Deployment. LEACH is the network protocol used to increase the lifetime of the network by using hierarchical routing for wireless sensor. All the nodes in a network formulate themselves into local clusters, with one node performing as the cluster-head. All non-cluster-head nodes transmit their data to the cluster-head. While the cluster-head node performs data processing like data aggregation and then transmits data to the remote base station. Therefore, cluster-head node is much more energy-intensive than other nodes of cluster. Thus, when a cluster-head node dies all the nodes that cluster lose communication ability with base station. LEACH incorporates probabilistic rotation of the high-energy cluster-head in order to avoid exhausting the battery of any one sensor in the cluster. In this way, the energy load of a cluster-head is evenly distributed among the nodes of the cluster. Since the cluster-head knows all the member nodes, it will create a TDMA schedule for each node, which tells the nodes exactly when to transmit its data. Using a TDMA for data transfer avoids intra-cluster collisions. The cluster head is responsible for the transfer of the data to the base station.

III. Leach protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol for sensor networks is proposed by W. R. Heinzelman which tries to minimize energy dissipation in wireless sensor networks. The arrangement of clusters is done depending on the of the received signal strength. The main purpose of LEACH protocol is to provide data aggregation for sensor networks. In LEACH protocol the total nodes are divided into many small groups called clusters for proportional distribution of power consumption inside the network. The cluster formation will be done as shown in the figure1 [3]

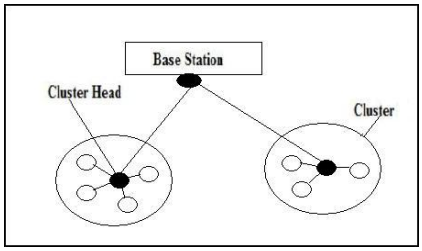

Figure 1 Cluster formation

The cluster head can be selected randomly and then rotate this role probabilistically to evenly distribute the energy load among the sensors in the cluster. The node n chooses a random number between 0 and 1 and the nodes becomes a cluster head for the current round if the number is less than the threshold T (n).

$$T(n) = \frac{p}{1 - p * \left(r \bmod \frac{1}{p} \right)} \quad : \text{if n E G}$$

$$T(n) = 0 \quad : \text{Otherwise}$$

Where, *p*- the desired percentage of cluster heads (e.g. 0.05),
r - the current round
G- the set of nodes that have not been cluster heads in last 1/p rounds.
There is only 5% of the nodes need to act as cluster head which act as a router to the base station.

The cluster head (CH) nodes receives the data and compress all the data coming from nodes that belong to the respective cluster, and sends an aggregate data to the base station. Data aggregation is performed to minimize the amount of information that must be transmitted to the base station. Data aggregation is performed local to the cluster[4]. This protocol is divided into rounds and each round consists of two phases:

A. Setup phase

1. Advertisement phase
2. Cluster Set-up phase

B. Steady phase

1. Schedule creation
2. Data transmission

The setup consists of three steps. In Step 1 (advertisement step), nodes independently and probabilistically decide whether or not to become a CH for the current round .The nodes sends a broadcast message as indication of becoming CH, the message can heard by everyone in the network. To avoid collision, a carrier sense multiple access protocol is used. In Step 2 (cluster joining step), the remaining nodes join a cluster based on the largest received signal strength of an advertisement message, and inform their intention to join cluster by sending a join request message. Once the CHs receive all the join requests, Step 3 (confirmation step) the CHs broadcasts a message informing time slot schedule to be used by their cluster member nodes for communication. Once the clusters are set up, the network goes to steady-state phase, where actual communication between sensor nodes and the BS takes place. Each node knows its time slot, to transmit information. The CHs combines the messages from all their cluster members, aggregates the information and sends the result to the BS. The steady-state phase comprises of multiple reporting cycles, and will be of much longer time compared to the setup phase [5].

When n k-bit of messages has gathered by cluster head in its cluster then it compresses the data to a μ (n * k) – bit message and sends this message to base station, where $\mu \leq 1$ is the compression coefficient [6].

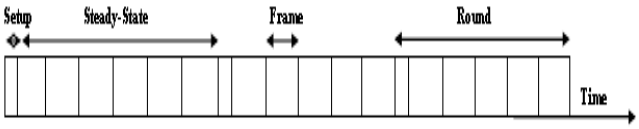

Figure 2 Time line of leach protocol

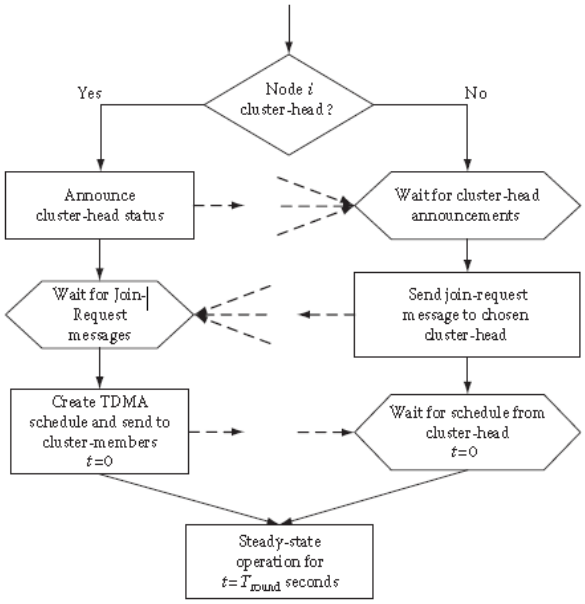

Figure 3 Cluster formation process

IV. Analysis of simulation and results

The simulation shows performance evaluation of LEACH protocol in terms of number of dead nodes. With this simulation results the life time of LEACH protocol can be studied. The graph in the fig.5 shows the number of alive nodes in the network. Initially there were zero dead nodes in the network. But when transmission starts the number of dead nodes increases immediately. The energy consumption by the nodes increases and finally attains zero.

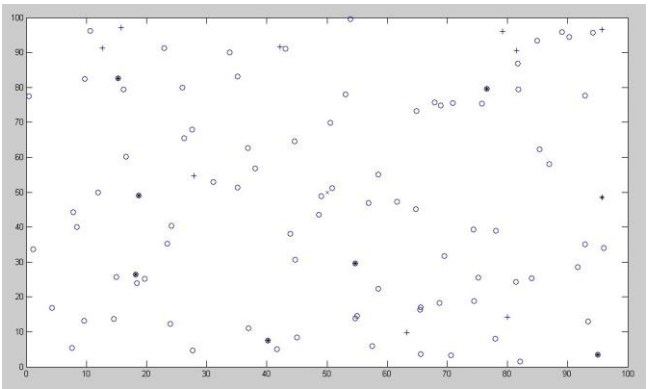

Figure 4 Field distribution

Figure 5 shows the initial field distribution of the network implementation. A 100m*100m field has been considered and nodes are randomly placed in the field. The base station, which is denoted by a ×, is placed at the center of the field. Here, the cluster head are shown by a plus symbol (+) and other nodes by a circle. All the nodes are alive in the network.

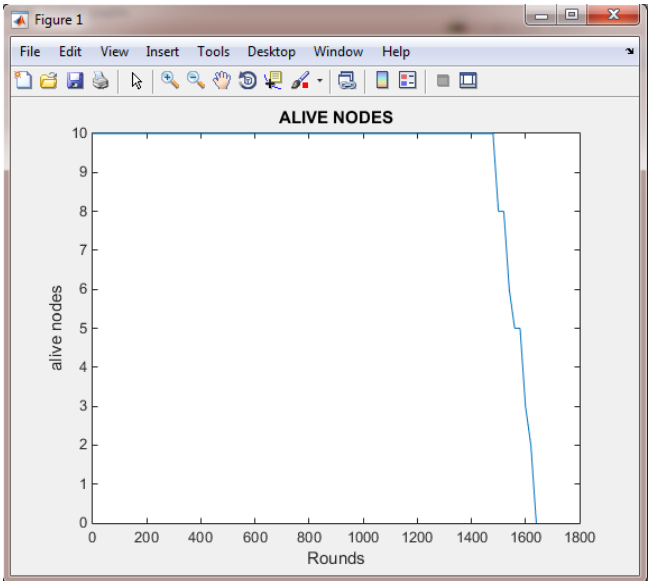

Figure 5 Simulation result – alive nodes

V. Conclusion

In this paper we analyze the LEACH protocol, an existing protocol architecture for wireless sensor networks that incorporates the concepts of energy efficient cluster based routing together with data aggregation to achieve required performance. We can implement LEACH protocol on both ns2 and MATLAB platform to evaluate the performance of LEACH protocol.

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