Volume 4, Issue 10, October 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Analysis of Energy Efficient Wireless Sensor Network

Inna
Post graduation Student
Department of ECE
Rbiebt Kharar, Mohali, India

Ritu Gupta
Assistant Professor
Department of ECE
Rbiebt Kharar, Mohali, India

Abstract- This paper reveals the design and energy efficient techniques. The main requirement of WSN is to improve the lifetime and energy efficiency of network. It is necessary to implement energy efficient routing in sensor nodes such that network lifetime is enhanced. This paper concerns the comparison of network clustering and optimization techniques in WSN. In this paper, we had discussed various existing energy efficient routing scheme. The energy constraint of WSN makes energy saving and prolonging the network lifetime becomes the most important goals of various energy efficient techniques. We focus on the residual energy of sensor nodes to elect the cluster head of any cluster formation. This paper shows different energy efficient protocol for WSN and compares these protocols on various points like, no. of alive nodes and dead nodes, packet delivery, and power consumption by using the MATLAB aiming to find the best method for energy consumption and lifetime of network.

Keywords— Wireless sensor network (WSN), LEACH protocol, network lifetime, energy efficient, HEED, PEGASIS, cluster head selection ACO.

I. INTRODUCTION

WSNs have greatly prolonged playing a key role for the data efficient selection and delivery. The energy efficiency is a very most important issue for the networks particularly for WSNs which are described by "limited battery capabilities". Due to complexity in WSNs operations, what is required is the use of energy-efficient routing techniques and protocols, which will assure the network connectivity and routing of information with less required energy.WSN are composed of a large no. of low cost and tiny sensors. WSN has many advantages, such as wide coverage, high precision monitoring, self-organization, fault tolerance, and so on. At present, it shows a great charm in military defence, medical transportation; environmental monitoring and other areas.WSN consist of the individual nodes that are able to interact with their environment by sensing or controlling the physical world [1].

The application of the sensor node can be used in many areas such as military monitoring, industry, medical. Sensor node has a battery with limited bandwidth and the capacity. Many of the clustering and the optimization techniques like LEACH,HEED,PEGASIS and ACO are one of these algorithms in WSN, which are used to enhance the lifetime and the energy consumption of sensor network. LEACH has many improvement protocols which consider the residual energy of node to select the cluster head (CH).HEED protocol consider the residual energy and communication cost to select CH [2]. Clustering based routing protocol which are design for the energy efficiency of network are capable of data aggregation. Delay can be easily reduced with in a cluster [3]. The time delay to reach the cluster head was minimized and thereby increasing the energy efficiency of the network.

II. OVERVIEW OF CLUSTERING AND OPTIMIZATION TECHNIQUES

1. LEACH (Low Energy Adaptive Clustering Hierarchy). This protocol mainly works on the homogeneous networks. In LEACH protocol the node in a sensor network are arranged in small cluster and choose one of the nodes as cluster head (CH) [4]. It uses the random rotation of the nodes, the CH to evenly distribute energy consumption in the network. There are two phases in the LEACH protocol "Set up phase" and the "Steady State Phase". Cluster-heads can be chosen *stochastically* (randomly based) on this algorithm:

$$T(n)=\begin{cases}\dfrac{P}{1-P(r \bmod \frac{1}{P})} & :n \in G \\ 0 & :otherwise\end{cases}$$

- If n < T(n), then that node becomes a cluster-head.
- The algorithm is designed so that each node becomes a cluster-head at least once.

Increasing the lifetime of a Leach can be achieved by reducing the threshold (Tn).

2. PEGASIS (power efficient gathering in sensor information system). It is a near optimal chain-based protocol that is an improvement over LEACH. The key idea in PEGASIS is to form a chain among the sensor nodes so that each node will receive from and transmit to a close neighbour [5]. Chain can be constructed by the greedy algorithms. The aggregated data are sent to the BS using leader. This algorithm eliminates the overhead of the dynamic cluster information and it reduces the number of transmissions. LEACH and PEGASIS use the same constants for calculating energy cost; PEGASIS achieve its energy saving by minimizing distance and the number of transmission and receives for each node.

Etx(k,d)=Eelec k + εamp kd^ λ

Erx = Eelec k

3. HEED (Hybrid energy efficient distributed)protocol for heterogeneous WSN.HEED protocol is the clustering protocol. It uses residual energy as a primary parameter and network topology feature. In this all nodes are assumed to be homogeneous. i.e. all sensor nodes are equipped with same initial energy. Four primary goals are in this clustering algorithm: extending network lifetime, eliminating the clustering process within a number of iterations, minimizing control overhead, producing well-distributed cluster heads and compact clusters [6]. These algorithms are used to form the nodes into clusters then choose Cluster head by considering the communication distance and the remaining energy of the node and the second parameter is considering the cost of communication within the intra cluster. The first parameter depends upon the residual energy. It does not require special node capabilities such as location awareness. The advantages of HEED are it does not make assumptions about node distribution, and operates correctly even when nodes are not synchronized.

4. ACO (Ant Colony Optimization) The TSP is a very important problem in the context of Ant Colony Optimization because it is the problem to which the original AS was first applied, and it has later often been used as a benchmark to test a new idea and algorithmic variants. In the ACO based approach, each ant tries to find a path in the network, providing minimum cost. Ants are launched from a source node *s* and move through neighbour repeater nodes *ri*, and reach a final destination node (sink) *d*. The key idea of our E&D ANTS scheme is taking advantages of the conjunction of energy and delay in wireless networks in order to update nodes' pheromones.

III. SIMULATION AND ANALYSIS

The sensor nodes are randomly distributed in a square region. After the normal nodes are deployed the base station and nodes are fixed and the CH rotates randomly. Nodes can communicate not only with each other in the network, but also with the base station directly. Nodes can adjust the wireless transmission power according to the distance. To evaluate the algorithms performance, we simulate the clustering and optimization techniques by MATLAB using several random 100 node networks. These nodes are randomly distributed in 100m x100m square area. We ran the simulations to determine the number of rounds of communication when First node dead (FND), Half node dead (HND) and Last node dead (LND) of the nodes die using direct transmission.

In this paper protocols are simulated and compared with each other. A random sensor network of 100 nodes is created. The initial energy of the node can be taken as 0.5J and the no of rounds are 5000. Sensor network consist of 100 nodes in a 100x100 sensor field.

IV. RESULTS

The first node dead show in figure1, half node dead show in figure2 and the all node dead show in figure 3. All these figures are shown below.

The result can be summarized as below:

Table 1.Comparison result of FND, HND and LND

PROTOCOL	FND	HND	LND
LEACH	**110**	**190**	**290**
PEGASIS	**2100**	**2400**	**2400**
HEED	**1600**	**3200**	**3600**
ACO	**20**	**750**	**3700**

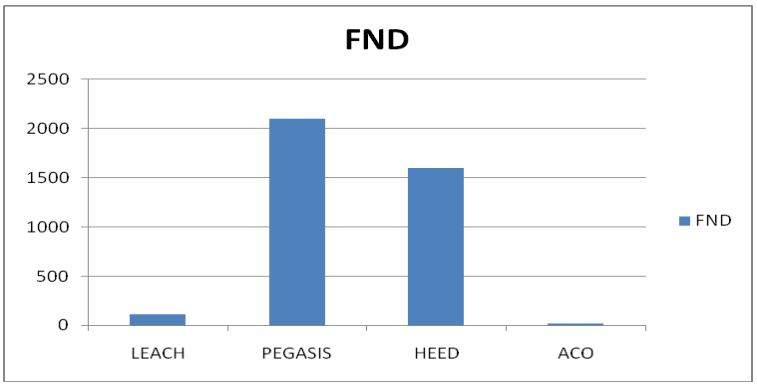

Fig1.comaprison result of all protocol when FND

In figure.1 the no of rounds are consider 5000 and 100 nodes are randomly chosen and the initial energy of each node taken as 0.5J. The first node death in the HEED protocol occurs at 1600 round, PEGASIS at 2100 rounds, LEACH at 110 rounds where as in ACO it occurs at 20 rounds. Also the HND and the LND occurs later in HEED as compare to the other protocols.

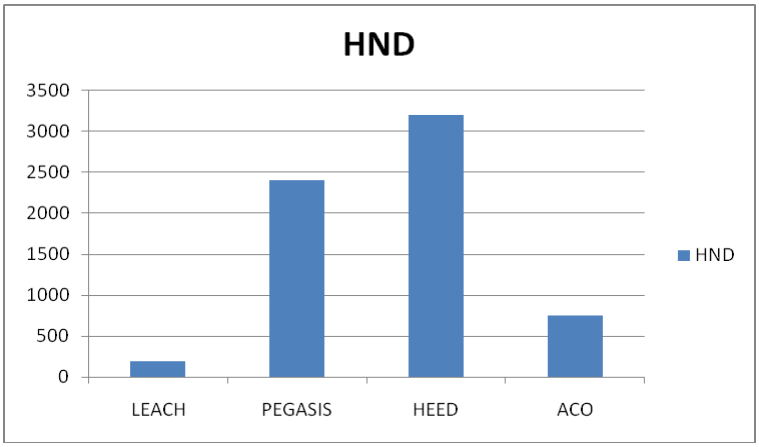

Fig 2.comparison results of all protocol when HND

In figure2 the initial energy of nodes considered as 0.5J and 100 nodes are randomly distributed in 100x100 sensor network area. In the figure.2 the HND occurs in the HEED protocol at 3200 rounds, PEGASIS at 2400 rounds, LEACH at190 rounds and the ACO at 750 rounds. In HEED half node death occurs later as compare to the other protocol.

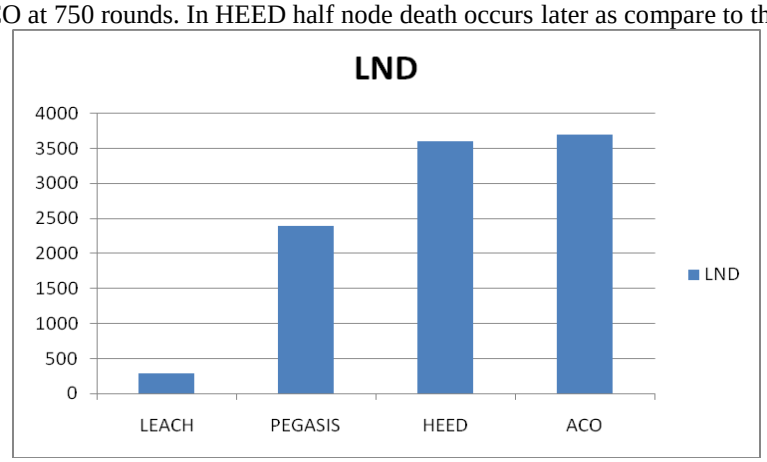

Fig3.compaison result of all protocol when LND

In figure.3 all nodes are dead at 3700 rounds in ACO, at 3600 rounds in HEED, at 2400 rounds and at 290 rounds in LEACH. The initial energy is considered as 0.5J/node and 100 sensor nodes are selected.

V. CONCLUSION

In this paper we describe PEGASIS and ACO as a chain based protocol. PEGASIS, a greedy chain protocol that is near optimal for a data gathering problem in sensor networks. We also describe the LEACH and HEED as a cluster and hierarchy based protocol. Distributing the energy load among the nodes increases the lifetime and quality of the network. Our simulations show that performance of the HEED protocol is better than LEACH, PEGASIS AND ACO when FND,HND and LND of nodes die for different network size and topology. We observed that the HEED protocol is more energy efficient and lifetime as compare to other protocols. While justifying our protocols through simulation results, we have increased the lifetime and energy in the wireless sensor network. The energy efficiency is a very most important issue for the networks. We used the energy efficient routing techniques and protocols to increase the network lifetime and for less energy consumption. The application of the appropriate routing protocol will enhance the lifetime of the network and at the same time it will guarantee the network connectivity and effective and efficient data delivery.

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