ENERGY EFFICIENT PROTOCOL IN WIRELESS SENSOR NETWORK

M.V. Jitendra[1], B.T. Krishna[2]

[1]Student, Dept. of ECE, ucek, JNTU Kakinada, AP, India
[2]Professor, Dept. of ECE, ucek, JNTU Kakinada, AP, India

Abstract - *A wireless sensor network is a group of tiny, generally battery powered devices and wireless infrastructure that monitor and record conditions in any environment. The Wireless sensor networks consists of number of sensor nodes connected each other and sense the data and transmits the data to the sink node. The sensor nodes in wireless sensor networks has limited energy, In LEACH (Low energy adaptive clustering hierarchy) every node has chance to become a CHs after 1/p rounds. All the nodes may not have same energy in cluster. So, the energy is not well distributed in the cluster and the low energy nodes will finish earlier than the high energy nodes. To improve the network life time DEEC (Distributive energy efficient clustering) is used.*

Key Words: wireless sensor networks, energy efficient, node, LEACH, DEEC.

1. INTRODUCTION

Now in recent scenario the growth of wireless communication is vast. Because the wireless technology can be applied in any kind of situation it has a capability of reaching in any part of the earth surface. There are so many wireless network are there, some are infrastructure based and some are infrastructure less. Ad-hoc and wireless sensor network, cellular network are some example of wireless network.

The term "wireless" has become a generic and all-encompassing word used to describe communications in which electromagnetic waves to carry a signal over part or the entire communication path. Wireless technology can able to reach virtually every location on the surface of the earth [1].Ad- hoc and Sensor Networks are one of the parts of the wireless communication. In ad-hoc network each and every nodes are allow to communicate with each other without any fixed infrastructure. This is actually one of the features that differentiate between ad-hoc and other wireless technology like cellular networks and wireless LAN which actually required infrastructure based communication like through some base station. [2].

Wireless sensor network are one of the category belongs to ad-hoc networks. Sensor network are also composed of nodes. Here actually the node has a specific name that is “Sensor” because these nodes are equipped with smart sensors [2]. A sensor node is a device that converts a sensed characteristic like temperature, vibrations, pressure into a form recognize by the users. Wireless sensor networks nodes are less mobile than ad-hoc networks. So mobility in case of ad-hoc is more. In wireless sensor network data are requested depending upon certain physical quantity. So wireless sensor network is data centric. A sensor consists of a transducer, an embedded processor, small memory unit and a wireless transceiver and all these devices run on the power supplied by an attached battery.

Advances in wireless communication made it possible to develop wireless sensor networks (WSN) consisting of small devices, which collect information by cooperating with each other. These small sensing devices are called nodes and consist of CPU (for data processing), memory (for data storage), battery (for energy) and transceiver (for receiving and sending signals or data from one node to another). The size of each sensor node varies with applications. For example, in some military or surveillance applications it might be microscopically small. Its cost depends on its parameters like memory size, processing speed and battery [3]. Today, wireless sensor networks are widely used in the commercial and industrial areas such as for e.g. environmental monitoring, habitat monitoring, healthcare, process monitoring and surveillance. For example, in a military area, we can use wireless sensor networks to monitor an activity. If an event is triggered, these sensor nodes sense it and send the information to the base station (called sink) by communicating with other nodes. The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery lifetime. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. The failure of one node can interrupt the entire system or application. Every sensing node can be in active (for receiving and transmission activities), idle and sleep modes. In active mode nodes consume energy when receiving or transmitting data. In idle mode, the nodes consume almost the same amount of energy as in active mode, while in sleep mode, the nodes shutdown the radio to save the energy.

2. Literature survey

The purpose of this project is to find protocols that are energy efficient and support real-time traffic for environments like habitat monitoring or area surveillance. Wireless sensor nodes which are battery operated are used for detecting and collecting information from the areas where there is very little scope for manual handling to recharge or change batteries. These sensing nodes collect the information and pass them on to the network towards the sink for further actions. For a better functioning and a longer lifetime for a sensing node within the network, we need to consider its energy consumption as a major factor of concern. Here these node detect and collects information regarding any object that is moving or any event that's triggered. The network carrying this information uses an ordinary protocol stack which carries out the general process of transmission without any concerns for energy efficiency factor.

Following are the assumptions for the surveillance applications in wireless sensor networks which are used as a frame of reference in the further study [4]. Wireless sensor networks consist of a number of sensing nodes which are distributed in a wide area. They sense an event occurring in the environment and these sensing nodes are distributed or placed according to the requirements of the application. The base station (sink), which collects data from other nodes, interacts with a user (someone interested in monitoring the activity). Data can be collected in many ways from a sensing node to a sink node like using hopping techniques or transmitting data at certain frequencies. Sinks have more advanced features than sensing nodes in terms of data transmissions and processing capabilities, memory size and energy reserves. There can be multiple sinks for a network so that there is no single point of failure. Energy dissipation is a major factor in WSNs during communication among the nodes. Energy should be saved, so that the batteries do not get depleted or drained quickly as these are not easily replaceable in applications such as surveillance. Quality of service ensures the effective communication within the given or bounded delay time. Protocols should check for network stability, redundant data should be transmitted over the network for any type of traffic distribution. It also needs to maintain certain resource limiting factors, such as bandwidth, memory buffer size and processing capabilities. The transmission mode plays an important role in WSNs. Nodes can take single-hop or multi-hop depending upon the type of network topology chosen for communicating or transmitting data to other nodes within the network. In surveillance applications, sensor nodes are placed in unattended areas so it should be self-organizing and self-creating.

LEACH (Low Energy Adaptive Clustering Hierarchical) The current interest in wireless sensor networks has led to the emergence of many application oriented protocols of which LEACH is the most aspiring and widely used protocol [5]. LEACH can be described as a combination of a cluster-based architecture and multi-hop routing. The term cluster-based can be explained by the fact that sensors using the LEACH protocol functions are based on cluster heads and cluster members. Multi-hop routing is used for inter-cluster communication with cluster heads and base stations[7]. We have stated that wireless sensors sense data, aggregate them and then send data to the base station from a remote area using the radio transmission scheme as communication medium. Data which is collected by the sensors is sent to the base station. During this process a lot of problematic issues occur, such as data collision and the data aggregation. LEACH is well suited to reduce the data aggregation issues using a local data fusion which performs a compression of the amount of data that is collected by the cluster head before it sends it to the base station. All sensors form a self-organized network by sharing the role of a cluster head at least once. Cluster head is majorly responsible for sending the data that is collected by the sensors to the base station. It tries to balance the energy dissipation within the network and enhances the network's life time by improving the life time of the sensors [6]. The operations that are carried out in the LEACH protocol are divided into two stages, the setup phase and the steady-state phase. Set-up Phase In the set up phase, all the sensors within a network group themselves into some cluster regions by communicating with each other through short messages. At a point of time one sensor in the network acts as a cluster head and sends short messages within the network to all the other remaining sensors. The sensors choose to join those groups or regions that are formed by the cluster heads, depending upon the signal strength of the messages sent by the cluster heads. Sensors interested in joining a particular cluster head or region respond back to the cluster heads by sending a response signal indicating their acceptance to join. Thus the set-up phase completes [7]. The cluster head can decide the optimal number of cluster members it can handle or requires. Before it enters the steady-state phase, certain parameters are considered, such as the network topology and the relative costs of computation versus the communication. A TDMA Schedule is applied to all the members of the cluster group to send messages to the cluster head, and then to the cluster head towards the base station.

Steady State Phase As soon as a cluster head is selected for a region, all the cluster members of that region send the collected or sensed data in their allotted TDMA slots to the cluster head. The cluster head transmits this collected data in a compressed format to the base station which completes the second phase, called the Steady State Phase. Once the steady-state finishes the data transmission to the sink, the whole process comes to an end and a new search for the forming of cluster heads for a region and new cluster-member formation begins. In short, it can be said that a new set/up phase and steady state starts with the end of data transmission done to the sink. This alternative selection of cluster heads within the region, which is carried among the sensors in a self-organized way helps in reducing or lowering the energy that is utilized. There is a possibility that all the sensors might not be too close to the cluster head so the amount of energy that is utilized by the farther sensor is not equal to the amount of energy utilized by the nearest node. In order to minimize this, cluster heads formation or the role of cluster head is performed by a rotation among all the nodes in the group. LEACH minimizes global energy usage by distributing the load of the network to all the nodes or cluster members at different intervals. All the cluster heads send the data which is collected towards the base station in a compressed format. All the cluster heads may not be close to the base station so they send the compressed data to the neighboring cluster heads, and in this way, a multi-hop routing network is formed. LEACH plays a randomized rotation of the cluster head in order to save the high energy that is dissipated while transmitting data to the base station.

3. PRAPOSED WORK

DEEC uses the initial and residual energy level of the nodes for selecting the cluster-heads. DEEC evaluates the ideal value of network life-time, which is used to calculate the reference energy that each node should dissipate throughout a round.

Heterogeneous WSNs consist of two, three, or multiple types sensor nodes in terms of energy levels, hardware structure, and other special properties [8]. The DEEC protocol is based on a two-level heterogeneous WSN in which the sensor nodes are assumed to have normal and advanced battery levels [9]. However, multilevel heterogeneity can be considered for DEEC. E_0 and $E_0 a$ represent the initial energy of a normal and advanced sensor node, respectively. a indicates how many times energies advanced node has been relative to the normal node. The numbers of normal and advanced nodes in the network are N_{nml} and N_{adv} respectively. So, total numbers of nodes (N) in WSN are defined in

$$N=N_{nml}+N_{adv}$$

The total first energy (E_{nml}) of the normal nodes in the WSN is given in

$$E_{nml}=N_{nml}E_0$$

The total first energy of the advanced nodes in the WSN (E_{adv}) is given in

$$E_{adv}=N_{adv}E_0 a$$

Thus, the total first energy of the two-level heterogeneous WSNs is calculated as given in

$$E_{total}=E_{nml}+E_{adv}$$

Heterogeneous WSN becomes homogenous after many rounds due to the different energy dissipation of the sensor nodes. CH consumes more energy than sensor nodes and other member nodes. After several rounds, the energy level of all sensor nodes changes relative to each other. For this reason, a clustering network protocol that operates with heterogeneity is more significant than a homogeneous network method [8]. Energy consumption of a sensor node involves models that consume energy so that it can perform specific functions such as sensing, processing and wireless communication of collected data [10,11,12]. These models have become functional by making energy consumption calculations. For the DEEC model, it includes the idea of the probabilities of the nodes dependent on the start and the remaining energy, in addition to the average energy of the network when the CH selection is performed. The average energy of the network is given as in (5) for r round.

$$E_{avg}=1/N\, E_{total}\,(1-r/R)$$

As seen in (5), E_{avg} is found as E_{total} is the total energy of the N nodes and r. round in all rounds is defined as the number of rounds r predicted according to the available energy and energy consumed at the current round is given by (6). E_{round} refers to the energy consumed for each round.

$$R=E_{total}/E_{round}$$

At the beginning of each round, the decision as to whether or not the nodes are CH is decided by the threshold value. The threshold value is recommended as in (7). It is important to note that desired probability (P_i) is between 0 and 1, which is the fraction remaining in the inverse of the P_i with r. This is why mod is used. This residual is subtracted by 1 and $T(K_i)$ is calculated.

$$T(K_i)=\begin{cases} \dfrac{p_i}{1-p_i\left(\operatorname{mod}\left(r, 1/p_i\right)\right)} & \text{if } s_i \in G \\ 0 & \text{otherwise} \end{cases}$$

The selection for CH, G includes the appropriate set of nodes, P_i and is the desired possibility for CH. S_i is i .node within the cluster. The possibilities for CH selection in the DEEC model are given in (8). $E_i(r)$ is the energy of the node. P_{opt} is used constant probability for CH. In (8), because E_{avg} is recalculated for each round, E_{avg} is important to be here. If it is also assumed to be $E_i(r)p_{opt}=E_{avg}$, then the sum of all possible states of P_i is 1. This case is also true for (11).

$$p_i=\begin{cases} \dfrac{E_i(r)\,p_{opt}}{(1+a)E_{avg}} & \text{if normal node} \\ \dfrac{E_i(r)\,p_{opt}\,a}{(1+a)E_{avg}} & \text{if advanced node} \end{cases}$$

In this study, the DEEC model was designed as three levels because the equilibrium heterogeneous structure was considered in the simulation comparisons. Moreover, the probability of CH selection in a multilevel heterogeneous network model is as in

$$p_{multi\ level}=\frac{p_{opt}N(1+a)}{\left(N+\sum_{i=1}^{N}a_i\right)}$$

4. RESULTS

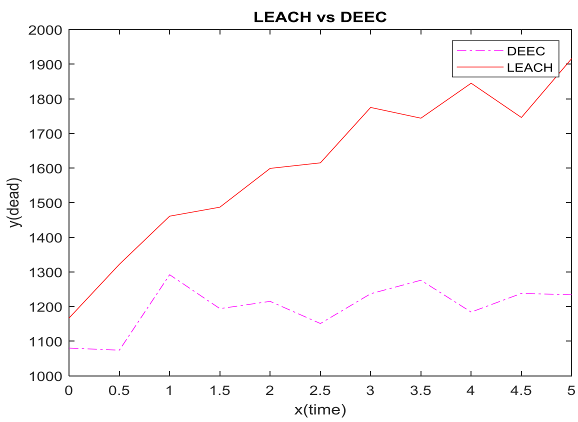

Fig 1:comparision of dead nodes LEACH vs DEEC

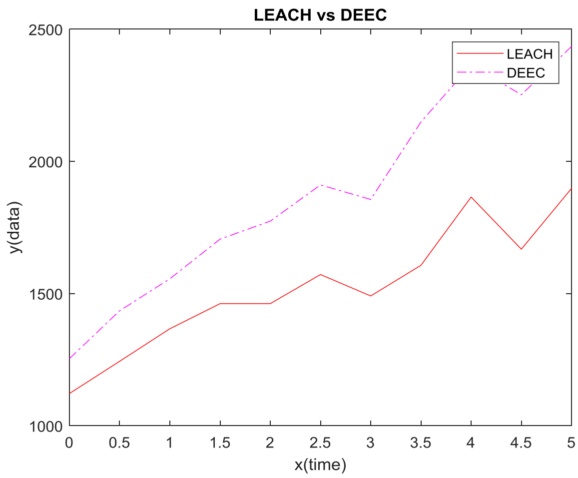

Fig 2:comparision of data transmission LEACH VS DEEC

5. CONCLUSIONS

In this research, we have discussed about Distributed Energy-Efficient (DEEC) Protocol. DEEC is an energy aware adaptive clustering protocol which is designed to deal with nodes of heterogeneous WSNs. For CH selection, DEEC uses initial and residual energy level of nodes. DEEC evaluates the ideal value of network life-time, which is used to calculate the reference energy that each node should dissipate throughout a round. In DEEC, every sensor node independently elects itself as a cluster-head based on its initial energy and residual energy. To restraint the energy disbursement of nodes by means of adaptive approach, DEEC use the average energy of the network as the reference energy. Thus DEEC does not require any global knowledge of energy at every election round. Unlike LEACH, DEEC can perform well in multi-level heterogeneous wireless sensor networks.

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