A Literature Survey on Different Type of Energy Efficiently Routing Protocol in Wireless Sensor Network

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Abstract— Wireless sensor network is an emerging technology which has an immense scope of research and development. It has the potential of quick capturing, processing and transferring data with high resolution to the base station. WSN consists of multiple sensor nodes, these nodes have low storage capability and limited battery life which dies due to the computation and transmission of data. It is not feasible to replace these batteries due to their placement in isolated areas. In this paper we will emphasize on maximizing energy efficiency and improvement of life span of network. Clustering is the technique which balances the load on sensor network and reduces energy dissipation. LEACH is one of the self-organized clustering routing protocols which will be explored and modified. Further we will compare various LEACH protocols on the basis of their features and we will throw some light on future possibilities and outdo.

Keywords—WSN, Clustering, LEACH, Base Station

I. Introduction

The vast advancement in wireless communication has given us an opportunity to produce small, durable, easy to handle, low cost sensors that can monitor the surrounding compute the data and transmit signal to the user from a distant location. WSN is used in various supplication like forecasting environmental pollution and weather conditions, providing health care in remote area, checking air traffic, monitoring and tracking enemy and force protection in military, early warning system and post disaster response(search and rescue) [1],[2].

The sensor nodes used in wireless sensor network require energy to communicate and transmit data to other node and base station. All the sensor nodes are battery operated, and recharge or replacement of battery is difficult due to their placement in remote and hostile environment. As we know data is routed from one node to other and reaches to the user through a specified path using a routing protocol.[13][14][15]

The real challenge of this technology is to provide energy efficient routing protocol. The purpose of routing protocol is to minimize energy consumption and maximize sensor nodes capacity, to improve network lifetime.

II. Types of Protocols in WSN

There are large numbers of protocols developed for WSN.
2.1Flat Routing Protocol-
This protocol is implemented in flat network where every sensor node collects and distribute its routing information to its neighbors. All nodes are treated equally and have same function. Example- SPIN, Directed diffusion. [1][6]

2.2 Location Based Routing Protocol-
In this routing protocol sensor nodes are addressed with the help of their location. Their location is obtained by GPS (Global Positioning System) and receiving radio signals.   Example- GEAR

2.3 Hierarchical Routing Protocol-

This routing protocol plays an important role in scalability and stability of network. In hierarchical structure higher energy nodes are used to aggregate and send the information whereas low energy nodes are used to sense the data. This is an energy efficient routing protocol which improves network lifetime Example- LEACH, TEEN, A.PTEEN.
Among them clustering based hierarchical protocol, proves to be most feasible for energy efficient routing in wireless network. Some of them are

- LEACH (Low energy adaptive clustering hierarchy)
- PEGASIS (Power efficient gathering in sensor information system)
- TEEN (Threshold sensitive energy efficient sensor network protocol)
- APTEEN(Adaptive threshold sensitive energy efficient sensor network protocol)

3. LEACH (Low Energy Adaptive Clustering Hierarchy)-

This protocol uses the radio model to estimate energy consumption in transmission of data. Leach consists of large number of associate nodes along with a cluster head. The responsibility of a cluster head is to congregate the data from member node, compress and transmit it to the base station. Every node is provided with a time slot to respond in order to prevent collision.

3.1 Leach Model –

LEACH is one of the energy efficient hierarchical routing protocol. This routing protocol use a clustering method to transmit data in order to obtain advantage on reduction of energy consumption. [1][2][3] In this method sensors are gathered into a disjoint set known as cluster and one of the sensor node acts as the head of a cluster, which communicates compressed information to the base station. Nodes that are not cluster head only communicate with the cluster head in a TDMA fashion, according to the schedule created by the cluster head. [6][7]**.**
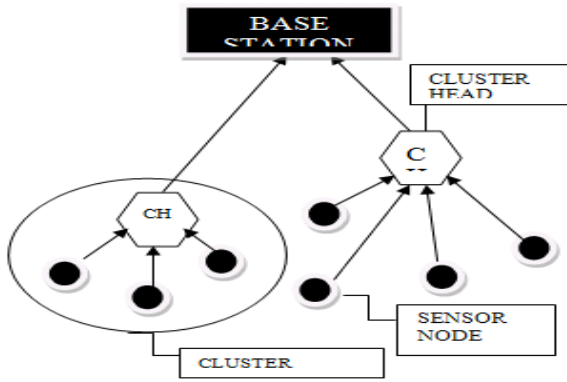
Figure 2. Clustering In LEACH PROTOCOL

They do so using the minimum energy required to reach the cluster head. These sensor nodes need to keep their radio on during a time slot provided by cluster head which reduces energy consumption. As transmission is done through cluster head, it requires more energy to survive in network thus this problem was solved by randomly rotating the selection of cluster head. This will save the battery life of every node and provides stability to network.

LEACH routing protocol operations are based on rounds. Each round goes through two phases.

SETUP PHASE- Cluster and Cluster head are created in this phase. Cluster head is selected randomly among the nodes whose dissipated energy is less than all the other nodes. In this phase all the nodes select a random number between 0 and 1. Sensor node whose number is lesser than the pre-defined threshold T (n). That node becomes a cluster head and this is determined by a formula.

$$T(N) = \frac{P}{1 - P\left(r \, mod \frac{1}{P}\right)} \forall n \in G$$

Where T (n) is threshold,

P is probability of selection of node as cluster head, r is the present round, and G is the node that is not selected as cluster head in 1/p round. [2][3]

In this way every node has an equal opportunity to serve as a cluster head and to reduce energy consumption of network, making it more stable.

STEADY STATE PHASE -Selected cluster head will broadcast a message to all the nodes and provide a time slot for a response from other sensor nodes. These nodes will sense a data from surrounding and sends it to their respective cluster head. Nodes communicate with the cluster head for a given time duration and otherwise remains idle. This reduces the energy dissipation and improves the network lifetime. The data received by cluster head is aggregated, compressed and sent to the base station.

LEACH protocol also uses CDMA so that each cluster uses a different set of CDMA codes, to minimize interference between clusters. [1][11][12]

3.2 Advantages of Leach–

Every sensor node has the equal probability to be a cluster head, which makes the energy depletion of every node to be relatively balanced. In LEACH protocol, time is divided into many rounds, in each round, all the nodes contend to be cluster head according

to a predefined criterion. Cluster head acts as an intermediate between sensor nodes and base station , which helps in reducing number of data transmission by compression technique.[2][3]. Non cluster head node remains idle till there turn arrive, thus increasing the network lifetime and making it more stable.

4. Comparison Of Leach And Its Modified Leach Protocols -

Every protocol has some limitations along with the benefits. To improve the functioning of protocols we need to study the comparison between these protocols, and further modify them for better result [1].

4.1 V LEACH-

Working of v leach protocol is similar to LEACH protocol. According to LEACH protocol CH is the node which is responsible for sending and receiving of data to base station.
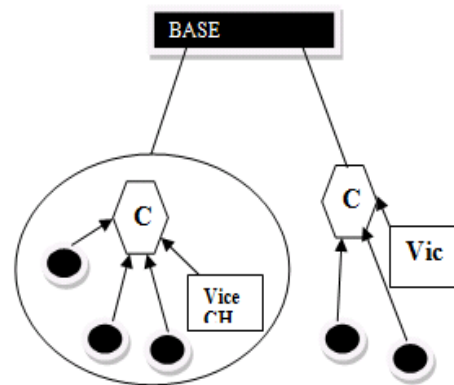

Figure 3 - Clustering in V LEACH protocol

So energy dissipation is most in CH rather than the member nodes.[4][5] This could lead to death of a CH and network to stop working. To prevent this V LEACH protocol consists of a vice CH along with a CH. So that when the CH dies, vice CH will take over the role of CH. So the network performance is not affected.

4.2 TL LEACH -

This is two level leach protocol used to reduce the energy dissipation by cluster head situated far away from base station.
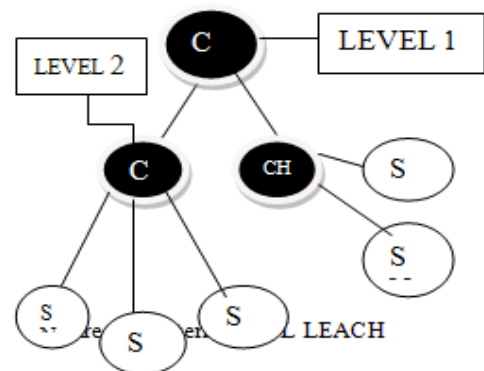

Figure 4 Clustering in TL LEACH

As we know transmission requires energy and if it is faraway it will require more energy and CH will die soon. So in this protocol the processed data is transmitted to other CH which is

located in between the path of CH and Base station. Thus reducing the burden of transmitting data through single CH. It works as a relay station and helps in reducing energy consumption of CH.[5][15]

4.3 MULTI HOPLEACH –

MULTI HOP LEACH is similar to LEACH protocol but communication path from cluster head to base station is converted from single hop to multi hop.[1][6] Data is transmitted to base station through various cluster head .It transfers data from one cluster head to corresponding cluster head which is nearest to base station. It selects optimal path with lesser number of hop count between first cluster head and base station. In this type of LEACH protocol energy is efficiently used by network because far away cluster head require low energy for sending data than nearer cluster head. This reduces the energy dissipation of single CH if it is situated far away from base station. Thus increasing the life span of network.

4.4 S LEACH–

Solar- Aware Low Energy Adaptive Clustering Hierarchy
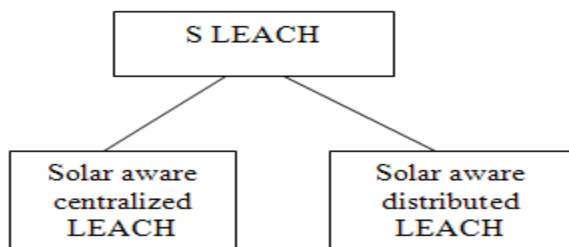
The goal of inventing S LEACH is to extend the lifetime of the sensor nodes and thus increasing the stability of network .Solar powered sensor nodes are chosen for intensive task by cluster head. This protocol is used to enhance energy of the isolated sensor nodes using solar power. As these sensor nodes are used in battlefield, search and rescue operation in remote areas where replacement of batteries is not feasible .To overcome this limitation S LEACH was proposed in which some nodes are provided with solar power and these nodes acts as cluster head. Selection of cluster head is on the basis of solar power along with the energy present within the sensor nodes.[1][6][7].

4.4.1 Solar Aware Centralized LEACH -

This routing protocol uses centralized algorithm for the selection of cluster head , it is selected by base station. Selection of a cluster head is on the basis of solar power, nodes transmit their solar status along with energy possessed by them. Base station selects a node with higher solar power as cluster head.

4.4.2 Solar Aware Distributed LEACH -

This protocol selects solar powered nodes as cluster head, these sensor node have higher probability than battery driven node. In S Leach a node that has been solar powered while being a cluster head should be able to become a cluster head again even during the next 1/p rounds [6].
Selection of cluster head is done by

$$ T(n) = Sf(n) * \frac{P}{1 - \left(\frac{C\ heads}{Num\ nodes} \right)} $$

Sf(n) is a scaling factor , which is >1 for solar powered nodes and set to the reciprocal for battery powered node.
P is percentage of optimal cluster.
C heads are number of cluster heads since last round.
Num nodes are total number of nodes.

5. PEGASIS (Power efficient gathering in sensor information system) –

This is an improvised version of LEACH protocol. In PEGASIS protocol clusters are not formed instead every node communicate to its nearest node to transmit and receive the data and among them one node is selected to communicate with the base station. This chain formation is performed in a greedy way to improve the network life span by reducing overhead energy dissipation and bandwidth usage.

6. TEEN (Threshold sensitive energy efficient Sensor network protocol) –

It is one of the hierarchical clustering protocol in which hierarchy of sensor nodes is present. In this protocol data is accumulated from sensor nodes and transmitted from cluster head of first level to cluster head of next level and so on until it reaches to the base station. TEEN executes its function on the basis of a threshold value. It is the best energy efficient protocol as it implies a constraint on when the sensor should transmit the data thus reducing number of transmissions.

7. APTEEN (Adaptive threshold sensitive energy efficient sensor network protocol)-

It is an enhancement of TEEN protocol in order to overcome its drawbacks. It uses the same concept of TEEN to reduce energy dissipation. This protocol provides a time critical information as well as constant transmission of sensed data to user. It works on the combination rule from both the LEACH and TEEN protocol. Its efficiency is between the two protocols as it performs the function of both the protocol.

8. Conclusion -

In this paper we have described about various energy efficient routing protocols in wireless network. Among them LEACH is one of the important routing protocol which reduces energy dissipation and increases network lifetime with the help of clustering technique. We have discussed about some modified versions of LEACH and analyze that each routing protocol addresses specific problem and tries to improve prevalent clustering routing protocol LEACH. Further improvement in energy efficiency is possible in routing protocols by improving cluster head selection techniques.

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