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Survey on Energy Efficient Algorithm of LEACH over Wireless Sensor Network

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***Abstract*— Wireless Sensor Network contains the sensor nodes which are small in size. They are depends on the battery. One of issue in wireless sensor network is because of the limited battery power on which sensor nodes are works. The power of battery plays an important role to increasing the lifetime of the node. Wireless sensor network with such issues are very critical because of the resource constrain such as utilization of efficient energy, lifetime of network and drastic environmental condition. Wireless sensor network proposed many routing protocol for optimize the efficiency to remove the above constrains. Among many routing protocol clustering protocol is more important for improving the network lifetime of Wireless Sensor Network because of the clustering proses, data aggregation and cluster-head selection. Low Energy Adaptive Cluster Head (LEACH) protocol is the first cluster based routing protocol in WSN. In this paper survey of different cluster based routing protocol are elaborate and compare factored with each other**

***Keywords*— wireless sensor network, LEACH, Cluster selection, Clustering, Cluster Head.**

I. Introduction

Wireless sensor network of collection of tiny nodes which are small sensor devices. These devices sense the data from the different location and also use to know the environmental condition based on collected data by those nodes. The emerging field of wireless sensor networks combines sensing, computation and communication by the single tiny device. As soon as people understand the capabilities of WSN hundreds of applications spring into mind. It seems like straightforward combination of modern technology. It combines sensor, radio and CPU's into effective wireless sensor network requires to detail understanding of capabilities and limitation of each hardware component and also detail understanding of distributed system theory and modern networking technologies. The design of WSN depends significantly on the application and they must consider the some factor such as the environment, cost, application design objectives and hardware and application constraints. Current Wireless Sensor Networks deployed on land, underground and underwater. Depending on the environment a sensor node faces different challenges and constraints. There are some types of wireless sensor network are: Terrestrial WSN, Underground WSN, Underwater WSN, Multi-media WSN and Mobile WSN.

The lifetime of wireless sensor networks lies in the ability to deploy large number of tiny nodes which are assembled and configure themselves. In WSN most applications are battery powered so it is very difficult to replace the battery or recharge the battery as soon as nodes are deployed. Another constrain that reduce the efficiency of nodes data redundancy based on this constrain each cluster has the Cluster Head which aggregate the data and transmitted it to the base station node. Many routing techniques proposed to increase the network lifetime and optimize the efficient energy. Hierarchical routing protocol is one of the interesting techniques to increase the lifetime of network as well as optimize the efficient energy. In the cluster based network, the networks are partition into smaller clusters. This protocol uses the concept of clustering and assigning the special task to the sensor node to cluster head of each cluster. Hierarchical routing is an efficient technique to reduce the energy consumption by doing the data aggregation and fusion in order to reduce the number of transmission to the Base-Station.

In this review paper we define the different hierarchical protocols. LEACH is the first hierarchical routing protocol for wireless sensor networks. LEACH enhance the energy consumption since the transmission only be done by the cluster head rather than all clusters node. Many hierarchical protocols emerged based on the technique or methodology of LEACH. There are many factors are affected to that hierarchical protocol are compare in this paper.

II. Research on Hierarchical Routing Protocol

A) LEACH

Low **E**nergy **A**daptive **C**lustering **H**ierarchy (LEACH) is the first hierarchical routing cluster based protocol for wireless sensor networks. LEACH partition the network in to the parts known as clusters, and each cluster has a dedicated node with extra privileges called cluster head(CH) responsible for creating and manipulating TDMA schedule and sending aggregated data from a nodes to Base-Station using the CDMA.

The operation of the LEACH is broken into the rounds. LEACH is the completely distributed is requires global knowledge of networks. In order to achieve a designing goal the key task perform by the LEACH are as follows [2]:

- Randomized rotation of the cluster heads and the corresponding clusters.
- Global communication reduction by the local compression.
- Localized co-ordination and control for cluster creation and operation.
- Low energy media access control.
- Application specific data processing.

LEACH divided in to the two phases **Set-Up phase** and **Steady phase.**

In the **Set-Up** phase initially the node becomes the cluster head with the probability **p** and send the advertise message in the network. The regular node chooses their cluster head based on the strength of the data receiving and sending to the cluster head. The role of cluster head keeps rotating among the nodes of the cluster to enhance the network life time. The selection of cluster head is depending on decision made by the node randomly generated number between 0 and 1. After cluster head section and generating the clusters of the network then next all the cluster head gives the TDMA schedule to its member nodes.

In the **Steady** phase after cluster creation and TDMA gives the time to each member node data transmission begins. Member nodes send the data to the cluster head during that allocated transmission time remaining node in the transmission time are turnoff until the time of its turn for data transmission comes. The cluster head keeps on and receiving the data from the member node and after receiving data from member nodes cluster head aggregate the data and send it to the base station. After the certain time the next round is begin.

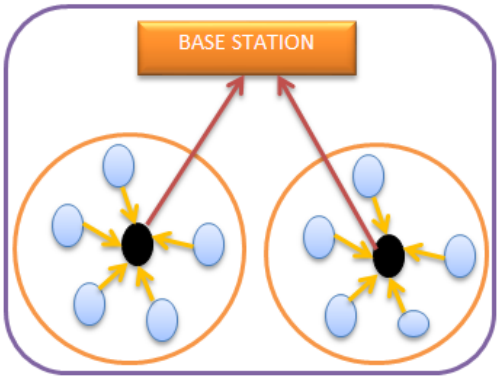

Fig. 1 LEACH PROTOCOL

B) Centralized LEACH

Centralized LEACH is the improvement over the LEACH protocol. In LEACH-C protocol set-up phase is same as the LEACH but the steady phase is changing in the LEACH-C the base station know the location of the nodes and reaming life time of the node. The node having enough energy is participating in the cluster head selection process.

Base station have the threshold value the remaining energy of nodes compare with the threshold value if it is greater than threshold then the node becomes the cluster head and remaining nodes are the member node of the different cluster which is decide same as LEACH.

C) Multi-Hop LEACH

In LEACH sensor nodes are randomly selected as cluster head and new cluster are periodically reconfigured. After the cluster was formed member node in cluster forward their information to their CH. CH then aggregate all information receiving from cluster and forward it to the Base Station. Thus CHs which are far from the base station requires more energy compare to the CHs which are near to the base station. So, the variance of the LEACH M-LEACH is proposed with multi-hoping transmission of the data to the base station.

In **Multi-hoping LEACH** Set-Up phase is smiler to the LEACH protocol. During the data transmission, data transmit using multi-hoping concept. After data receiving by the CH, CH aggregate the data and transmit data to the its nearer cluster head(CH), which is transmit the data to its next hop and continue till the one CH which is nearer to the Base Station. Now that nearer CH transmits the aggregated data to the Base Station.

There is one another form of improvement in Multi-hop LEACH in that form nodes which are near to the Base Station are not transmit the data via the cluster head but they are directly transmit its data to the Base Station. And the nodes which are far from the Base Station they are send the data through the CHs.

D) Hierarchical Tree-LEACH

Hierarchical Tree LEACH paper modified version of LEACH is proposed known as HT-LEACH. In LEACH energy consumption normal nodes derived from data collection and data transmission to the Cluster Head. CH's energy consumption derived mainly from the data reception, aggregating data and data transmission to Base Station. In which data transmission from Cluster Head to Base Station require more energy.

In this protocol Cluster formation is same as the LEACH but end of this stage Cluster Heads are not directly connected to the Base Station.

In this protocol one new stage included known as Hierarchy Tree Routing formation: in which at the very first step nearest and fastest distance from the BS are find. In the next step draw the arc from the Base Station with the radius r(i) of the network, and then divide network into the n number of parts. Divide CHs into the n group according to the parts.

In Steady phase node start to transmit its data when routing formation is done. Now joining of Clusters are done in the tree layer starting of that is at bottom layer. Bottom layer CHs are join its nearer upper layer CHs and after joining of all layer from the same manner data aggregation done at every layer of the tree. Root node is one who only

connected with the Base Station. Only root node is transmitting aggregated information to Base Station.

E) Vice -LEACH

In V-LEACH author define the main three terms Cluster Head which is responsible for receiving data from member nodes and transmit data to the Base Station, Vice Cluster Head it is the node which become a CH of the cluster when CH is die, Member node which are responsible for gathering the data from environment and send it to the Cluster Head.

In the LEACH CHs are receiving the data from member nodes then aggregate the information and then transmit it to the Base station weather it is nearer or far away from it. So, because of that CHs require more energy compare to the member nodes so if CHs are dies earlier then the member nodes then cluster of that CHs are useless. Data send by member nodes to that die Cluster Head are never reach to the base station so for that V-LEACH user the concept of the Vice LEACH. In V-LEACH every cluster have one Cluster Head and one Vice Cluster Head node when CHs die at that time Vice Cluster Head takes the responsibilities of CHs and continue the operation of that cluster and clusters are note useless data of that clusters are also send via the Vice Cluster Head to the Base Station.

F) Enhanced LEACH

In LEACH due to the random generation of the CHs and non-uniform distribution of clusters, energy requiring in the networks are uneven, some node might be run out of energy very soon compare to the other nodes in the network.

In the **Enhanced LEACH (E-LEACH)** whole network divide into smaller and equal sub-regions. In E-LEACH LEACH algorithm is run individually to the each sub-region where as in LEACH algorithm is run for whole deployment network.

Therefore nodes in one sub-region do not affect the activities of other sub-regions. The node which have elect themselves as CH send the message in to its sub-region using CSMA. Each normal node decides its cluster by choosing the CH that requires minimum communication energy according the receiving signal strength of advertised message from the CH. Steady state same as the LEACH protocol but every region CHs send the aggregated data to the Base Station Directly.

G) Check point Based LEACH

In most of the routing protocols fault-tolerance has not been taken into the considerations. LEACH also not consider fault tolerance so, in this paper author proposed modified form of the LEACH based on the Checkpoint approach so LEACH becomes fault tolerance protocol.

The Checkpoint approach is one of the approach use to prove the fault tolerance on unreliable and in distributed system. It is a collection of the snapshots of the whole network and records it temporary or make as well as stable storage. So if any crash occurs in the application then using that record continues with the last stage at which task has been stop because of the application crash. Efficiency of this approach is depends on the length of the Check-pointing period. Checkpoint approach they use the Base Station to store topology information's contained in the Cluster Heads. Each CH send periodically a message to the Base Station to advise it that it is always available. So, if during a period, the Base Station dose note receive a message from a Cluster Head, it consider as a faulted node, so as the using of this approach Base Station send the advertised message to the member node of that CH concerned to elect novel Cluster Head among them. The member which has a greater reaming energy elect as a Cluster Head for the reaming time of the period. Using this approach gives more optimize energy compare to LEACH.

Clustering Routing Protocols	**Distributed**	**Centralized**	**Hop Count**	**CH Selection**
LEACH	Yes	No	Single hop	Randomly
CENTRALIZED LEACH	No	Yes	Single hop	Based on residual energy
MULTI-HOP LEACH	Yes	No	Multi hop	Based-on residual energy and location
HIERARCHICAL TREE LEACH	Yes	No	Single hop	Based on residual energy and distance and degree
VICE LEACH	Yes	No	Single hop	Based on residual energy
ENHANCED LEACH	Yes	No	Single hop	Based on residual energy and distance and degree, also randomly
CHECKPOINT BASED LEACH	Yes	No	Single hop	Based on residual energy

Fig. 2 Comparison Table of Different Protocol of LEACH

III. CONCLUSION

In this survey, basics of LEACH protocol and different enhance algorithm for LEACH are define and compassion of different hierarchical protocol are compare with each other. Finally it can be conclude from the given survey that for energy efficient and prolonged wireless sensor networks, still it is needed to find more efficient, scalable and robust clustering scheme.

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