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Threshold Energy Based LEACH Algorithm for Wireless Sensor Networks

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Abstract— This Paper Presents A New Protocol Called Threshold Energy Based Leach Algorithm (Tela) For Wireless Sensor Networks (Wsn)Which Aims To Reduce Energy Consumption Within The Wireless Network. Efficiency Of A Wireless Network Mainly Depends On Energy Of Nodes. In Cluster Based Protocols, Changing Of Clusters And Cluster Head Also Consumes More Energy But The Procedure Depends On Random Time. So, In This Proposed Protocol, We Are Reducing The Wastage Of Energy While Selecting Or Changing The Clusters/Cluster Heads. We Evaluate Both Leach Andtela Through Simulations Using Ns-2 Simulator Which Shows That Tela Performs Better Than Leach Protocol.

Index Terms— Clustering, Energy, LEACH protocol, TELA, NS-2.

I. INTRODUCTION

A wireless Sensor Network (WSN) consists of spatially distributed autonomous devices called sensors, and a base station (BS) to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. Sensor nodes can be networked to gather sensory data and each sensor performs two main responsibilities, namely, (i) sensing activities, and (ii) routing the sensed data to the base station or a controller.

Wireless sensor networks are attracting great interest in a number of application do-mains concerned with monitoring and control of physical phenomena, as they enable dense andeffective deployments at low cost.However, application development is still one of the main hurdles to a wide adoption of WSNtechnology. In current real-world WSN deployments, programming is typically carried out veryclose to the operating system, therefore requiring the programmer to focus on low-level systemissues. This not only distracts the programmer from the application logic, but also requires atechnical background rarely found among application domain experts.

The rest of the paper is organized as follows: Section II gives an insight on clustering. Section III details LEACH protocol. Section IV gives an overview on the proposed protocol .Section V gives the simulation results and analysis. Finally section VI VII gives concluding remarks and future works.

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II. CLUSTRING

Grouping sensor nodes into clusters has been widely pursued by the research community in order to achieve the network scalability objective. Every cluster has a leader, often referred to as the cluster-head (CH). The cluster membership may be fixed or variable. Of the benefit, clustering may conserve communication bandwidth since it limits the scope of inter-cluster Cluster-based routing, originally proposed in wire line networks, are well-known techniques with special advantages related to scalability and efficient communication. As such, the concept of cluster-based routing is also utilized to perform energy-efficient routing in WSNs. In the architecture, higher energy nodes can be used to process and send the in- formation while low energy nodes can be used to perform the sensing in the proximity of the target. This means that creation of clusters and assigning special tasks to cluster heads (CH) can greatly contribute to overall system scalability, lifetime, and energy efficiency[4].

The members which are connected to the cluster head will sense the physical environment and transmit it to the cluster head according to some time intervals.Aggregated data is compared and the mean data is generated at the cluster head. The mean data generated at the cluster head will be sent to the base station through the discovered path.

III. LEACH PROTOCOL

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA (Time division multiple access) schedule and sending aggregated data from nodes to the BS where these data is needed using CDMA (Code division multiple access). Remaining nodes are cluster members.

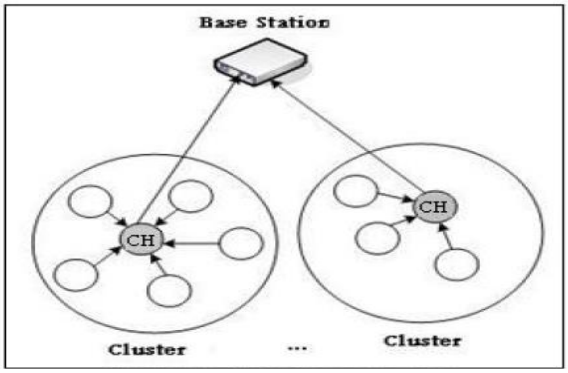

Fig. 1: LEACH Protocol

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A Operation

LEACH operations can be divided into two phases:-

1. Setup phase
2. Steady phase

In the setup phase, the clusters are formed and a cluster-head (CH) is chosen for each cluster. While in the steady phase, data is sensed and sent to the central base station. The steady phase is longer than the setup phase. This is done in order to minimize the overhead cost.

BArchitecture

LEACH was developed to monitor remote environment. Since individual nodes' data are often correlated in a micro-sensor network, the end user does not require all the redundant data, rather the end user needs a high-level function of the data that describes the events occurring in the environment.

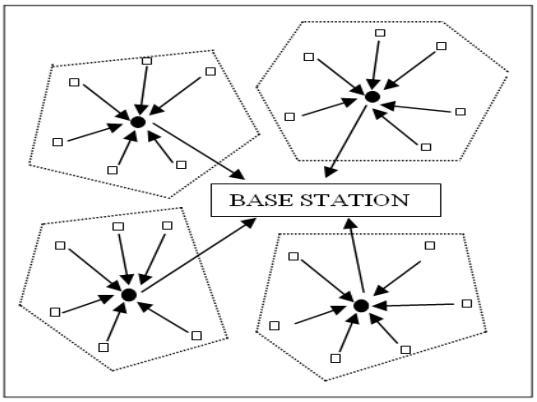

Fig.2: LEACH Protocol Architecture

The motivation behind LEACH protocol is to correlate data among nodes that are close to each other by using data aggregation techniques to reduce the amount of raw data, this is mostly done by the elected cluster head before transmission to the base station. The architecture of LEACH protocol is shown in fig.2.

IV. TELA PROTOCOL

The proposed Threshold Energy based LEACH Algorithm (TELA) protocol differs by the variables on which the criteria of changing the cluster head depends. In LEACH the clustering and the process of cluster head selection totally depends on random time. Whereas, in our proposed technique the change of cluster head totally depends on the energy variable. The cluster head is only changed whenever the current cluster loses its energy below that of the threshold value. The threshold is defined manually, depending on the requirement of the network we are using.

A Algorithm

Initialization: There are number of sensor nodes which are spatially distributed in a network as shown in fig. 3. The information of locations of all nodes will be stored in the base station.

Fig. 3: Sensor Node Deploy in the Region

Initial process of clustering is done by the base station. The base station initiates the process by sending an energy request message to all the nodes to respond regarding the energy level. Base station selects the cluster head depending on the residual energy of nodes and also on the basis of response time. Node with highenergy gets a chance to become the cluster head.

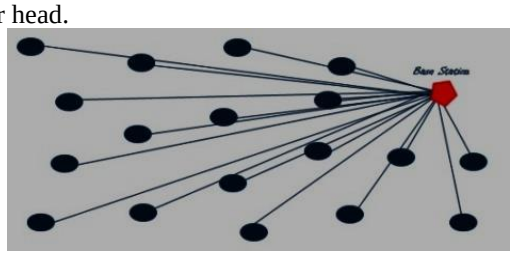

Fig. 4: Sensor Nodes Sending their Energy to BS

Cluster Formation: The node which is having the highest energy will be elected as a cluster head by the base station.

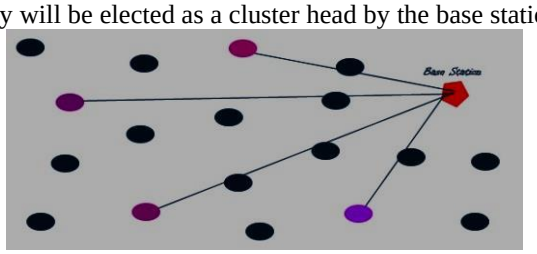

Fig. 5: Cluster Heads are Selected by the BS

Node which gets chance to become cluster head initially sends a hello message to the nodes which are there in a range (R0). The neighboring nodes which get the hello message will respond to the message and becomes the members for the respective cluster head. Similarly, the procedure is repeated until all clusters are formed. Formula for Range of a node is being given as follows:

$$R0 = \frac{\text{Total Area to be covered}}{\text{Total Number of Nodes}} \text{ X Number of Clusters}$$

The process of changing the cluster head in a cluster is shown in fig. 6

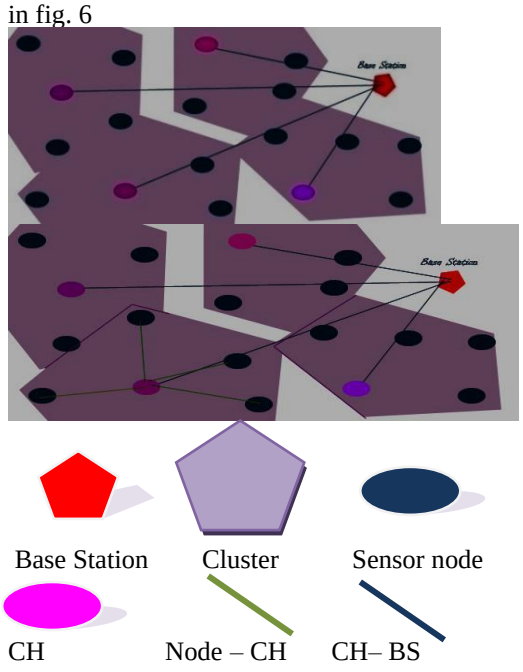

Fig. 6Concept of Initial Clustering Scheme

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All the nodes which are there in the range of a cluster will receive a hello packet. If a node has accepted a hello packet from some cluster head and again receives a hello packet from some other cluster head, then it will not accept the hello packet and drops the same. If a node which is already a member for a cluster gets a chance to become cluster head from the base station then, it will not accept the chance to become the cluster head. So, the node which joins a cluster will only respond to the respective cluster head.

If any node which not being a member of any cluster or a node being a cluster head but no nodes in its cluster, will wait for a specified amount of time and then starts advertising themselves to become a member of any nearby cluster to it. Similarly all the nodes will become the member for one or the cluster. This way all the initial clusters are formed by the base station.

Cluster Reformation:The process of cluster reformation or changing the cluster head will occur only when the cluster head's energy is reduced below that of the threshold energy value. The threshold value is manually changed. The steps of changing the cluster head are mentioned below

1. The process is initiated when the energy of the cluster head is less than that of the threshold value.
2. As soon as the energy of the cluster head goes down the threshold, the information is conveyed to the base station.
3. The base station will be responsible for the change of the cluster head of all the clusters.
4. Base station having all the information about the location of the nodes, will take the information of the residual energy of the nodes which are near to the BS.
5. Then depending on the energy again the new cluster head will be selected by the base station.

Routing and Data Aggregation:The process of routing and data aggregation is same as that of the LEACH protocol. The new cluster head will attempt to get a path to reach the base station. Routing may be of single-hop or multi-hop as per the distance between the cluster head and base station. The route path between two nodes or base station will be stored in the routing tables of all the nodes.

V. SIMULATION AND RESULTS

NS2 is used as a simulation platform.NS is a discrete event simulator, where the advance of time depends on the timing of events which are maintained by scheduler. NS simulator is based on two languages: C++, and aOTcl(an object oriented tool command language) interpreter used to execute users command scripts.

Simulations for both LEACH and TELA were done by keeping the number of nodes, clusters and simulation time constant. Numbers of trials were considered and the mean of all the trials was considered to fetch the required results. The simulation parameters are as shown in table 1.

Table 1.Summery of the Parameters

Parameter	Value
Simulation Time	3600 sec
Topology size	200 X 200 m^2
Number of nodes	100
Number of clusters	9
Number of trials	10
Initial node Energy	20 Joule
Nodes distribution	Nodes are randomly distributed
BS position	Located at (50, 120)

Simulated result is compared with cluster based LEACH protocol.Energy consumed by TELA protocol is less when compared to LEACH protocol. The following fig.7explains the same. The fig. 8 and 9 represent the comparison between LEACH and TELA with respect to the total number of data packets transmitted and the number of alive nodes after every intervals of time with respect to simulation time respectively.

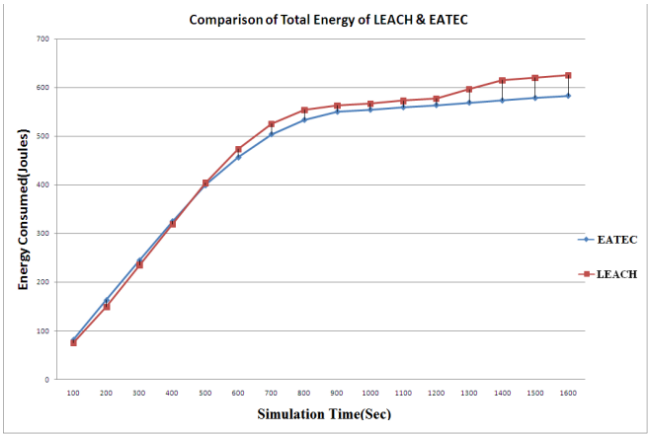

Fig. 7: Comparison of Total Energy Utilized by LEACH and TELA

Both the protocols are compared with same simulation time and equal number of nodes. Ten trials were taken and the mean of those were taken and our proposed protocol TELA was found to be more efficient. Efficiency was increased by 32.15% with respect to LEACH protocol. Energy used by the individual nodes is comparatively less. The nodes can be alive for longer time and will not die soon. Thus we can say that the protocol uses less amount of energy when compared to the other protocols.

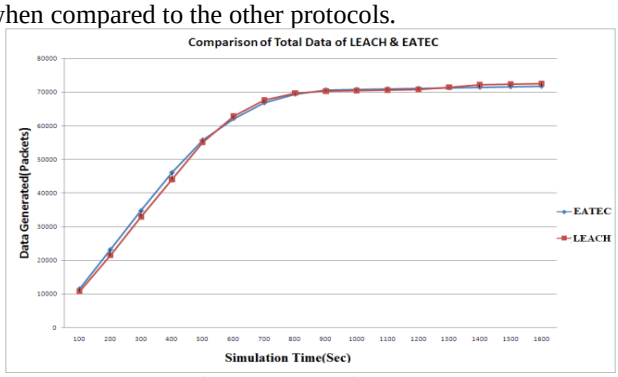

Fig. 8: Comparison of Total Number of Data Packets Transmitted by LEACH and TELA

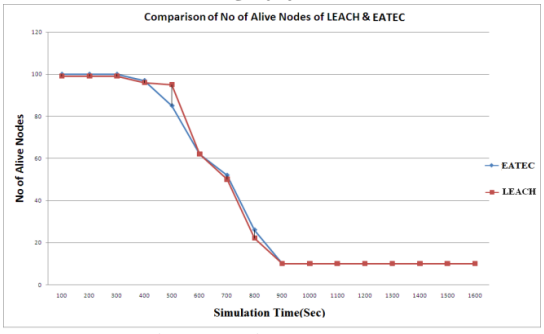

Fig.9: Comparison of Number of Alive Nodes in LEACH and TELA

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The fig. 10 and fig. 11 represent the comparison of energy histogram of individual nodes of LEACH and TELA protocols at 800 Sec and 1600 Sec respectively. Energy is equally used by almost all nodes except that of the cluster head nodes.

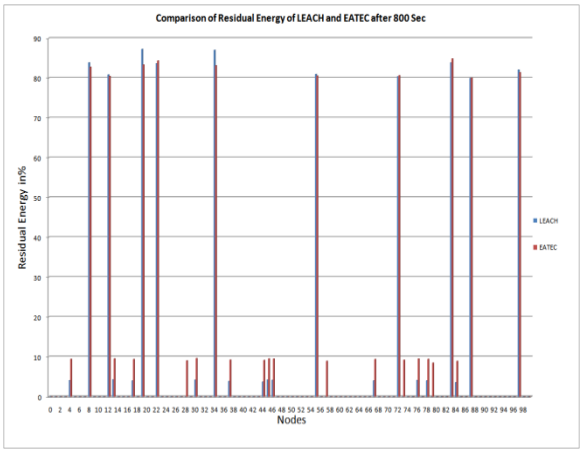

Fig. 10: Comparison of Energy Histogram of LEACH and TELAafter 800 Sec

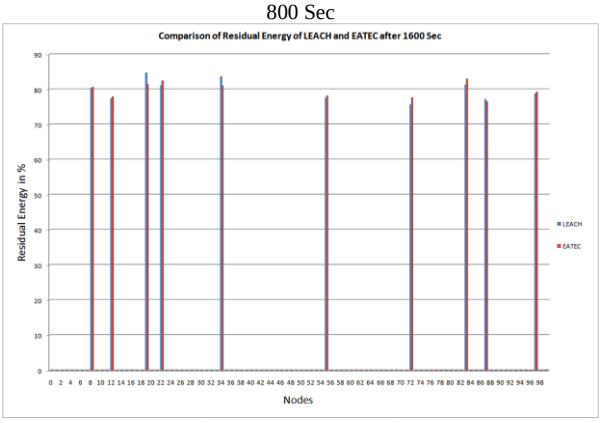

Fig.11: Comparison of Energy Histogram of LEACH and TELAafter 1600 Sec

VI. CONCLUSION

In this work an attempt has been made to enhance the network lifetime. The process of clustering plays a very important role in utilizing the energy. So, we have attempted to change the criteria and process of clustering and cluster head rotation.

An improvement over LEACH has been proposed by incorporating energy parameter in the cluster head selection process. In this proposed protocol (TELA) the process of changing the cluster head is managed based on the energy criteria. The cluster heads will be reformed by the base station if any of the cluster heads energy goes below the preset threshold. The simulations were carried out in NS 2.34. It is observed from the simulation results that TELA achieve 32.15% better energy efficiency than LEACH protocol. The node may or may not join the old cluster again.

VII. FUTURE WORKS

In this work, only the procedure of changing cluster head or clusters in a network is observed. But the energycriteria could be efficiently used in many other procedures like: (i) Network Initialization, (ii) Data Aggregation, etc. The procedure of changing the clusters/ cluster heads can also be made still efficient.

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