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ENERGY-EFFICIENT ROUTING PROTOCOL FOR WIRELESS SENSOR NETWORKS

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Abstract **-Wireless Sensor Networks (WSN) services are applied in many civilian, engineering, medical monitoring, automation and military scenarios. WSN are distributed network of sensors, it has different parameters like temperature, humidity, alsohas initiated various security threats, especially in unattended environments. Network consists of three basic components such as Nodes, Base Station, and Batteryunit. This network first sense the data by using sensing element ,because nodes are act as a sensor and process the data .finally data is transmitted using low battery power Because of less battery powered it will get die out quickly . So energy efficiency routing is the important issues in WSN. Nodes are consumes energy while transmitting data, therefore it affects the lifetime of the network. Hence we have to develop an efficient routing algorithm in which nodes consumes less energy .Many algorithms are developed in order to achieve less energy consumed routing algorithm in different layer. Such as Network layer, application layer and data link layer. In this paper the Modified Low EnergyAdaptive Cluster Hierarchy (M_LEACH) routing protocol has been discussed. Implementation has been done by using MATLAB software.**

Key words—LEACH, wireless sensor network, cluster head, energy consumes, dead nodes

1. INTRODUCTION

Wireless Sensor Networks (WSNs) consist of several sensor nodes and are battery powered. The performance of the sensor nodes are affected when the battery die below the predefined level. Each node in this network has restricted energy resources due to limited amount of power .So, the routing protocol should be energy efficient. Nodes are send all the date to a base station (central unit),as shown in figure 1

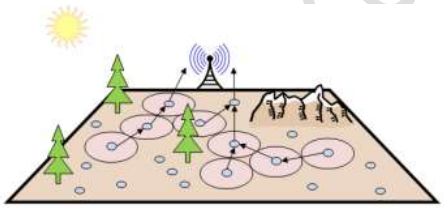

Fig1 : wireless sensor network

The routing protocols gives information about data transmission through the network and also defines the communication between nodes. The routing protocol can be classified in many types as shown in figure2.

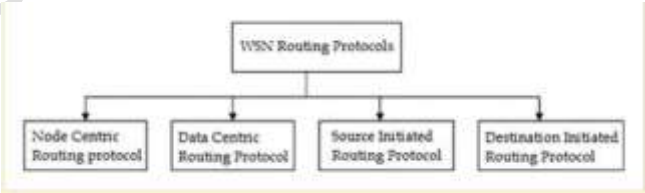

Fig2 : classification of routing protocols

LEACH (the Low Energy Adaptive Clustering Hierarchy), a hierarchical based routing protocol that arranges cluster systematically, such that energy is distributed equally in all the nodes in the network. Cluster consists of several nodes among these nodes one node is considered as a cluster head, that act as a routing node to all other nodes in network. In this way Minimizes the energy dissipation in WSN .

The cluster head is selected before starts the communication between nodes, due to battery dies cluster head fails to communicate.In this proposed M_LEACH the cluster head is selected randomly from the group among several nodes on temporary basis to avoid battery die. This random selection of cluster node is done by themselves under some probability criteria, and is defined in the routing algorithm. Once cluster node is selected it can be informed to the other nodes in the network.

The member nodes communicate directly with the cluster head, Cluster heads receive the data and forwarded it to the

Base Station. The example of clustering is shown in Figure 3.

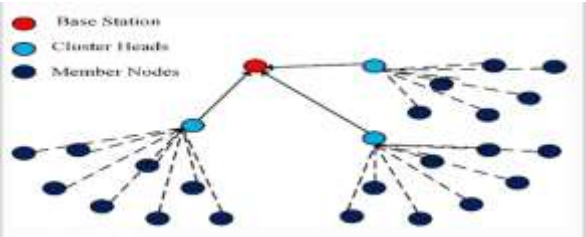

Fig3: example of clustering

2.WORK DONE

WSNs are randomly distributed in a particular region to develop different types of parameters and transmit information to the base station (BS) for monitoring and detecting applications [1]. WSN been applied in forest fire detection, surveillance, military, human health detection, medical monitoring and automation etc., hence WSN have most interesting area to researchers in recent years [2,3].Sensor nodes are less battery powered .hence recharging or replacing the batteries are very difficult, which brings some challenges [4–6]. . To overcome these drawbacks, the researchers design a protocols to achieve efficient use of battery energy [7]. Therefore, several routing protocols have been proposed to render the sensor network more energy efficient [8,9].

In general, cluster-based routing protocols can efficiently use the SNs in the network, compared with non-clustering protocols [10]. The cluster head (CH), will remove the correlated data that can reduce the number of data. Then, the CH will transmit the aggregated data to the BS [11–13]. In cluster-based routing protocols, for long distance communication the Nodes are divided into many number pf clusters to minimize energy consumption and workload is distributed equally to all cluster, which is caused by the large difference in the energy reduction in the numberbetween the CHs and other member nodes. Therefore, clustering is an energy-efficient solution for increasing network lifetime and improving energy efficiency. Most clustering protocols adopt optimal CH selection to avoid death of the Sensor Nodes and further extend the lifetime of the network [14–16].

Obaidat, M.S.; Misra, S.et.al., shows thatduring communicationconsume more energy than the computation process. In contrast, multi-hop communication protocol, thenodes close to the BS have excessive transmission overhead, leading to energy holes in the sensorfield [18].The low-energy adaptive clustering hierarchy(LEACH) is the most important hierarchical routing protocol in terms of saving energy compared with traditional non-culstering routing protocols [19].

3. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

Low Energy Adaptive Clustering Hierarchy (LEACH) isthe first hierarchical cluster-based routing
protocol for wireless sensor network. Nodes in the system partitions into small bunches called as clusters and picks one of them as the group head have extra privileges called as cluster head (CH).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 neededusing CDMA (Code division multipleaccess).

In traditional clustering formation method , selection of Clustering Head is simple and it is fixed all through the whole system lifetime , and sensor picks the cluster heads would frequently die. To over the above drawback in LEACH randomly select the clustering heads based on the high energy, the cluster head is selected .The position of cluster head rotates among the different sensors so as it not deplete the battery .Hence sensors itself select the cluster head based on threshold predefined probability value. Therefore every sensor node decides, to which cluster it needs to have a place by picking the cluster head that requires the less communication energy. Sensor nodes are arranged in its cluster and, each cluster head allocate a time slot for nodes in cluster. After allocation is completed,the sensor node send the information to the heads. The cluster head compress the data which received from every sensor nodes and then send to base station. This protocol is divided into rounds, and each round consists of two phases;

(i) Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
(ii) Steady-state phase:
(1) Schedule Creation
(2) Data Transmission

Setup Phase: Each node act independent of other nodes, if it will become a Cluster Head or not, depends on rate of cluster set out time towards network. By taking this information, find which node act as a cluster head for last time. Election of cluster head is calculated using threshold value, it is given below

$$temp\_rand <= (p/(1-p*mod(r,round(1/p)) \quad \forall temp\_rand \in G \qquad (1)$$

Where temp_rand is a random number between 0 and 1.

P is the cluster head probability

r is the current number of rounds

G is the set of nodes that were not cluster heads in previous1/P rounds temp_rand depends upon desired rate of cluster heads of network. Each node who wants to be the cluster head select value, somewhere in the range of 0 and 1. If this arbitrary number is less than temp_randthe node turns into the cluster head for thatparticular round. The

nodes that are cluster heads in currentround cannot be cluster head till next 1/Pth round.

In advertisement phase, the Cluster Heads inform their neighborhood by sending an advertisementpacket that they become Cluster Heads. Non-Cluster Head nodes pick the advertisement packet with the strongest received signal strength, then it requires minimum energy for data transmission.The non-cluster head nodes makes a decision to form a cluster.

Grouping the Nodes into Clusters & caclulating the distance between node and cluster head

(SN(i).role==0) && (SN(i).E>0) && (CLheads>0) (2)

Where
SN(i).role=0; node acts as normal if the value is '0', if elected as a cluster head it gets the value '1' (initially all nodes are normal)

SN(i).E>0 has energy in it

In cluster setup phase, the member nodes send the joint packet to cluster head, to become a member of the cluster. The join packet contains their IDs,by using IDs cluster head produce the time slots for each sensor node and pick the CSMA code , and broadcast the time slot table to all members in the cluster. The time slot is depends on total number of nodes present in the network.

Steady-state phase: Data transmission begins; Nodes send their data during their allocated TDMA slot to the Cluster Head. This transmission uses a minimal amount of energy (chosen based on the received strength of the Cluster Head advertisement). The radio of each non-Cluster Head node can be turned off until the nodes produce TDMA slot, thus minimizing energy dissipation in these nodes.

4. PROPOSED MODEL

The proposed network model represents implementation of Modified LEACH algorithm including clustering and routing. Inthe proposed model, considered 200 nodes and all are having same initial energy. In this model considered single-hop communication between both' cluster head and base station' ,'sensing node and cluster head'. Sensors periodically sense the environment and send the data to the Base Station. Following Table I shows the parameters used for simulation

TABLE 1
SIMULATION PARAMETERS

Parameters	Values
Network size	100 x 100m^2
Base station co-ordinates	x=50, y=200
Etx and Erx transmitter and Receiver energy per node	50nJ
Efsamplification energy	100pJ/bit/m2
Number of nodes	100
Data Aggregation Energy	5nJ/bit/signal
Packet size of normal node(pn)	4000 bits
Packet size of cluster head(pCH)	6400 bits
Initial energy of each node	1J
Broadcast range	50

ENERGY CALCULATIONS

Energy Dissipation for normal nodes
(SN(i).cond==1) && (SN(i).role==0) && (CLheads>0) Node is working and not a cluster head (3)

Where
SN(i).cond=1; States the current condition of the node. when the node is operational its value is =1 and when dead =0

SN(i).role=0; node acts as normal if the value is '0', if elected as a cluster head it gets the value '1' (initially all nodes are normal)
CLheads=0 Reseting Previous Amount Of Cluster Heads In the Network

Dissipation for cluster head during reception

SN(SN(i).chid).E>0 && SN(SN(i).chid).cond==1 && SN(SN(i).chid).role==1 Describing that node belongs in a cluster with 'id' and is conditional

```
ERx=(Eelec+EDA)*k;
energy=energy+ERx;(4)
SN(SN(i).chid).E=SN(SN(i).chid).E - ERx
```

Energy Dissipation for cluster head nodes
SN(i).E>0 %It has energy in it

```
ETx= (Eelec+EDA)*k + Eamp * k * SN(i).dts^2;
                                        (5)
SN(i).E=SN(i).E - ETx;
energy=energy+ETx;
```

5. RESULTS AND ANALYSIS

To measure the performance of Modified LEACH protocol, the following three parameters in consideration:
1) Throughput
2) Lifetime of network
3) Total energy dissipated

Throughput: Throughput is maximum rate of successful message delivery at the base station. We measure throughput in terms of data packets (bits)
Lifetime of Network: Lifetime of sensor nodes describes how many nodes arealive and how many nodes are dead(out of all the nodes presentin system). Lifetime of network indicates the number of nodesthat are alive at periodic interval of time

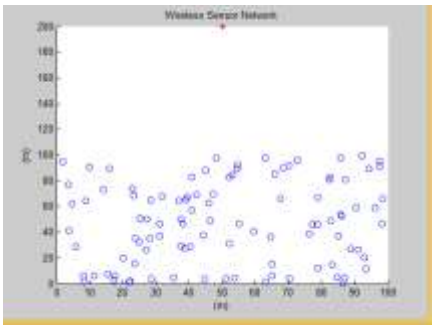

Fig. 4. Simulation in 2500t h round

Figure. 4shows lastround operation in network which is 2500th round, there isno cluster head is present

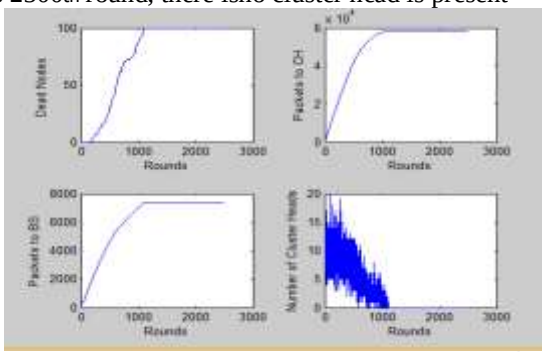

Fig. 5 number of packets base station, cluster heads

Figure 5 gives informationabout number of packets tobase station, and cluster heads as well as are live and dead and current number of round. Also shows that the Amount of Transmitted Data, The total quantity of data sent from the nodes (including the CHs and other nodes) in the WSN to the BS can be calculated by

data = dataCHtoBS + dataNtoBS, (6)

where

dataCHtoBSis the amount of transmitted data by the CHs to the BS,

dataNtoBS is theamount of transmitted data by nodes to BS.

In this paper, dataNtoBS concerns nodesnear the station of the base, and which does not contribute to the formation of clusters.

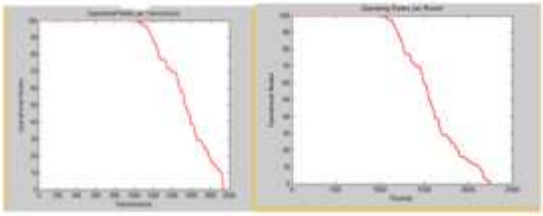

Fig. 6 number of nodes to base station, and cluster heads

.Figure 6shows thatnumber of nodes to base station, and cluster headsIn ourproposed system we considered size of data packet for normalnode to be 200 bits/round and size of data packet for cluster head to be 2400 bits/round. After the simulation, from fig 5 the throughput of 7.85 10_7 bits(approx.) during the lifetime ofnetwork.

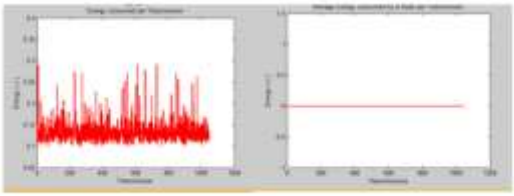

Fig. 7 network energy consumption of the protocols versus Transmission.

Figure. 7shows network energy consumption of the protocols versus Transmission. The proposed Algorithms consumes very less energy when the transmission increases, which is 0.16(J) (approx.).

6. CONCLUSIONS

In this paper, a novel clustering protocol, named IEE-LEACH, is proposed to reduce energy consumption and improve the lifetime of WSNs.Furthermore, to decrease the energy consumption, we consider that the nodes closer to the BS do not participate in cluster formation.Therefore, the proposed approach decreases the overall communication cost and significantly improves the network lifetime.

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