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Analysis of Energy and Lifetime Using Energy Efficient Routing Protocol in Wireless Sensor Network

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Abstract: **Now a day's a research in wireless sensor network is growing .One of the major issue is the energy efficient routing. If the wireless sensors energy is utilized efficiently then network lifetime of the wireless sensor network can be improved. LEACH is a very effective protocol to enhance the network lifetime. It is a clustering based protocol which balanced the energy usage by giving equal chance to all nodes to become cluster head. In this paper performance of percentage of cluster head is analyzed on energy and network lifetime parameter for wireless sensor network.**

Keywords: Wireless sensor network, cluster, LEACH

I. INTRODUCTION

Wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and cooperatively pass their data through the network to a main location[1]. The more modern networks are bi-directional, enabling also to control the activity of the sensors. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. Today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine, health monitoring and so on.

Wireless sensor network (WSN) contain a large number of sensor nodes and these sensor nodes have the ability to communicate with either among each other or directly to the base station. These sensor nodes are battery powered so the capacity is very limited and very difficult to replace the battery. Therefore the energy saving of route protocol for wireless sensor network is the main research. The protocol which uses clustering is the low energy route protocol and it separate the whole wireless sensor network into several areas called clusters. All clusters are having one cluster head which perform data collection and data fusion and ordinary node of the cluster is responsible for sending the data to cluster head.
Hierarchical routing uses the concept of clustering. It performs energy-efficient routing in WSN and contributes to overall system scalability and lifetime. LEACH (Low Energy Adaptive Clustering Hierarchy) is a clustering based protocol proposed by Heinzelmon [2] .LEACH utilizes randomized rotation of cluster head to evenly distribute the energy load among the sensors in the network [3].

II. LEACH

It is the FIRST hierarchical cluster-based routing protocol for wireless sensor network [4]. In LEACH the nodes are partitions into clusters [5] and in each cluster there is a dedicated node with extra privileges called Cluster Head

(CH). This CH creates and manipulates a TDMA **(**Time division multiple access**)** schedule for the other nodes (cluster member) of that cluster. Those CHs aggregate and compress the sensing data and send to base Station (BS) .Thus it extends the lifetime of major nodes as shown in Fig. 1.

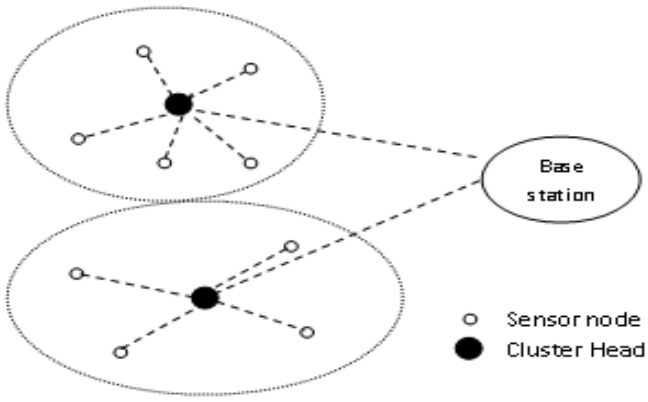

Figure 1. LEACH protocol.

This protocol is divided into rounds [2]; each round consists of two phases.

A. Set-Up Phase

(1) Advertisement Phase
(2) Cluster Set-up Phase

B. Steady-State Phase

(1) Schedule Creation
(2) Data Transmission

A. Set-Up Phase

CH selection is done by considering two factors. First the desired percentage of nodes in the network and second the history of node that has served as CH. This decision is made by each node n based on the random number (between 0 and 1) generated. If the generated random number is less than a threshold value T (n) then the corresponding nodes becomes CH for that round. The threshold value T (n) is calculated from equation as

$$T(n) = \begin{cases} \dfrac{P}{1 - P * (r \bmod \frac{1}{P})} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where P is the desired percentage of cluster-head, r is the number of round and G is the set of nodes that have not been Cluster-heads in the last 1/P rounds. Nodes that have been cluster heads cannot become cluster heads again for P rounds. Thereafter, each node has a 1/p probability of becoming a cluster head in each round. In the following advertisement phase, the CHs inform their neighborhood with an advertisement packet that they become CHs. Non-CH nodes pick the advertisement packet with the strongest received signal strength.

In the next cluster setup phase, the member nodes inform the CH that they become a member to that cluster with "join packet" contains their IDs using CSMA .After the cluster setup sub phase, the CH knows the number of member nodes and their IDs. Based on all messages received within the cluster, the CH creates a TDMA schedule, pick a CSMA code randomly and broadcast the TDMA table to cluster members. After that steady-state phase begins.

B. Steady-State Phase

Nodes send their data during their allocated TDMA slot to the CH. This transmission uses a minimal amount of energy (chosen based on the received strength of the CH advertisement). The radio of each non-CH node can be turned off until the nodes allocated TDMA slot, thus minimizing energy dissipation in these nodes. When all the data has been received, the CH aggregates the data and sends it to the Base Station (BS). LEACH is able to perform local aggregation data in each cluster to reduce the amount of data that transmitted to the BS.

III. SIMULATION

To simulate the LEACH protocol, ITS NS2 extension for LEACH patch is used.[6][7]

NS2.27 version is used for the simulation. To evaluate the performance we simulated the LEACH protocol for different number of cluster heads. The energy consumption model used is described below.

Energy Consumption model:

We assumed a simple model for energy consumption. In wireless sensor network, nodes have transmitter, receiver and other devices used to process the signal and control.

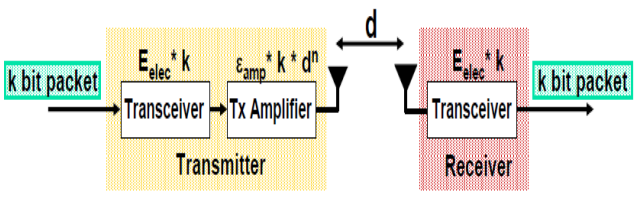

Figure2: Energy consumption model used

The transmitter dissipates energy to run the radio electronics and amplifier to transmit "k" bit message as:

$$E_{tx} = E_{ele}*k + E_{amp}*k*d^2 \quad joule \quad if\ d<d0$$

For free space

$$= E_{ele}*k + E_{tworay}*k*d^4\ joule \quad if\ d>d0$$

For two ray ground propagation

And the receiver dissipates energy to run the radio electronics to receive k bit message as

$$E_{rx} = E_{elec}*k$$

Where d is the distance between transmitter and receiver. d0=crossover distance.

$$d0 = (4*pi*sqrt(L)*ht*hr)/ Lamda$$

$$Lamda = c/f$$

Where L=loss factor=1

Table 1. Simulation parameters:

Parameter	**Value**
Network area	1000*1000 m^2
Number of nodes	100 + one base station node
Base station position	X=50,y=175
Simulation time	600 sec
E_{amp}	100pj/bit/m^2
$E_{two\ ray}$	0.013pj/bit/m^4
E_{elec}	50nj/bit
Height of receiving and transmitting antenna(ht and hr)	1.5m
Loss factor(L)	1
Transmitting and receiving antenna gain	1
Radio	914MHz

IV. SIMULATION RESULTS

The simulation results are shown in the figure 3 and figure 4 These figures shows the effect of change in number of cluster heads on energy consumed by the network and lifetime of the sensor network. Lifetime is measured as the time at which first node dies in the network.

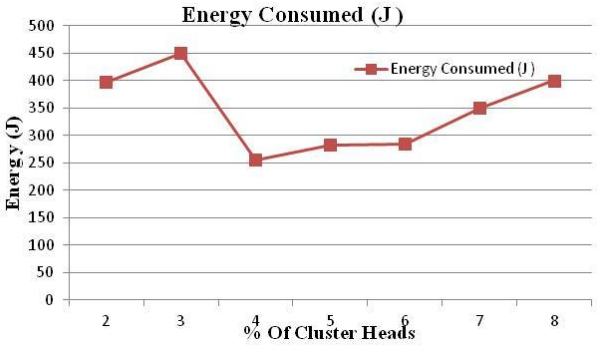

Figure3: Analysis of energy by varying no. of cluster heads

Figure 3 shows energy consumption is comparatively less for 4 to 6 percent of cluster heads.

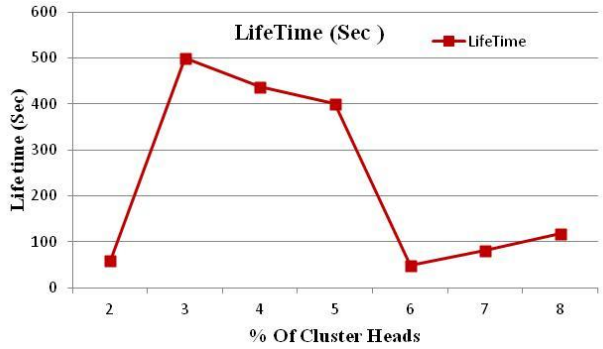

Figure 4: Analysis of lifetime by varying no. of cluster heads

Figure 4 shows lifetime is comparatively high for 3 to 5 % of cluster heads.

CONCLUSION

In this paper we have analyzed the performance of cluster heads on energy and life time of sensor network. Results of our simulation shows that for 4% of cluster heads the energy consumed by the network is comparatively less and for 3% of cluster heads the life time of sensor network is comparatively high.

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