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Design and analysis of energy efficient wireless sensor network

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Abstract— This paper reveals the designs and analysis of energy efficient techniques. Wireless sensor networks are used for various applications. In this paper, we propose an energy efficient cluster based routing protocol for WSN.In this we introduce a cluster heads, head set, for cluster based routing. Prolonged network lifetime, scalability, and load balancing are important requirement for many sensor network applications. Clustering sensor nodes is an effective technique for achieving these goals. In this work, we introduce an energy efficient clustering algorithm for sensor networks based on the LEACH protocol. The proposed protocol adds feature to LEACH to reduce the consumption of the network resource in each round. The proposed protocol is simulated and the results show a significant reduction in network energy consumption.

Keywords— Wireless sensor networks (WSN) , LEACH protocol, network lifetime. Cluster-head selection; energy balanced.

I. INTRODUCTION

LEACH is a protocol that tends to reduce energy consumption in a WSN. However, LEACH uses single-hop routing in which each sensor node transmits information directly to the cluster-head or the sink. Therefore, it is not recommended for networks that are deployed in large regions. In LEACH protocol most nodes transmit to a cluster head. Leach consists of two phase:

- Set up phase
- Steady State phase

- In set up phase, the clusters are organized and the cluster head are selected. In each round the algorithm is used which determine whether the node will become a cluster head. If a node becomes a cluster head once it can't become again the cluster head.
- In steady state phase, after selecting the cluster head the data is sent to the base station. The duration of this phase is more than the set up phase.

LEACH is a protocol which is used to reduce the energy consumption of WSN [1].For a small network, we make the following assumptions.

- The base station (BS) is located at a fixed location which is far from the sensors.
- All nodes within the network have limited energy with an indentify ID.
- All the nodes are able to reach BS and can communicate with one another.
- CH perform data compression and aggregation function.

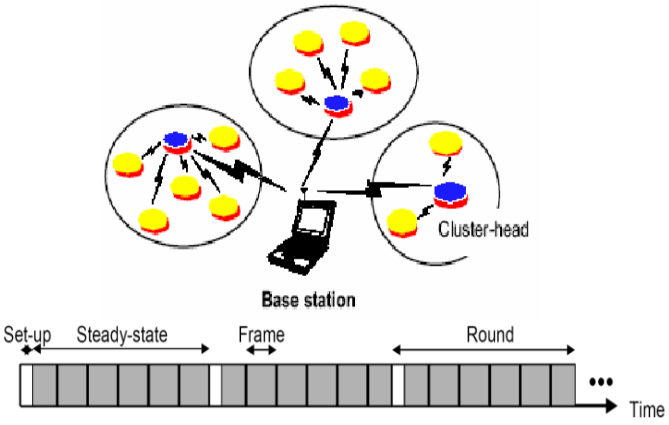

Fig.1.Timeline Show LEACH Operation

- Cluster-heads can be chosen *stochastically* (randomly based) on this algorithm:

$$T(n) = \frac{P}{1 - P \times (r \bmod P^{-1})} \quad \forall n \in G$$

$$T(n) = 0 \quad \forall n \notin G$$

Where n is a random number between 0 and 1
P is the cluster-head probability and
G is the set of nodes that weren't cluster-heads the previous rounds

- If n < T(n), then that node becomes a cluster-head.
- The algorithm is designed so that each node becomes a cluster-head at least once.

In this paper [2], Leach collects the data from the distributed micro sensor and then transmits it to the base station. Energy needed for transmission of one bit data from u to v is the same to transmit one bit data from v to u. This paper presents an improvement of LEACH's cluster-head selection algorithm the formation of clusters is not the topic of this paper. We use the same radio model with Eelec=50nJ/bit as the energy being dissipated to run the transmitter or receiver circuitry and εamp=100pJ/bit/m² as the energy dissipation of the transmission amplifier. Transmission (*ETx*) and receiving costs (*ERx*) are calculated as follows:

$$Etx(k,d) = Eelec\ k + \varepsilon amp\ kd^{\wedge} \lambda$$
$$Erx = Eelec\ k$$

with k as the length of the message in bits, d as the distance between transmitter and receiver node and λ as the path-loss exponent ($\lambda \geq 2$).
This paper gives the information about the energy dissipated on transmitter and the receiver during the data transmission. Problem formulation in this paper is the selection of cluster head. Each node n determines a random number between 0 and 1. If the number is less than a threshold *T(n)*, the node becomes a cluster-head for the current round. The threshold is set as follows:

$$T(n) = P/1 - P*(r\ mod 1/P)$$
$$T(n) = 0$$

with *P* as the cluster-head probability, *r* as the number of the current round and *G* as the set of nodes that have not been cluster-heads in the last 1/P rounds. This algorithm ensures that every node becomes a cluster-head exactly once within 1/p rounds. This paper has discussed two modifications of LEACH's cluster-head selection algorithm. With these modifications a 30 % increase of lifetime of micro sensor networks can be accomplished.

This paper [3], considers node energy and position information to improve the LEACH algorithm, proposes an energy balanced clustering algorithm named L-LEACH.

II. Cluster-head Threshold Optimization

There are many improved methods of the cluster-head election based on residual energy.

$$T(n) = P/1 - P*(r\ mod 1/P)\ *Ecur/Eo.$$

Ecur is the current energy of node and Eo is the node initial energy. This improvement takes the current energy into consideration, increase the probability of high energy nodes to become cluster-heads. We simulate both LEACH and L-LEACH by Matlab.

In this paper[4] in order to sole the drawback of LEACH protocol, we introduce the energy impact factor (1-Ece/En) and the distance impact factor (1-dn/Rc).
Ece is the remaining energy of cluster.
En is the remaining energy of the node n within the cluster.
Ece can be expressed as:
Ece=min(En)

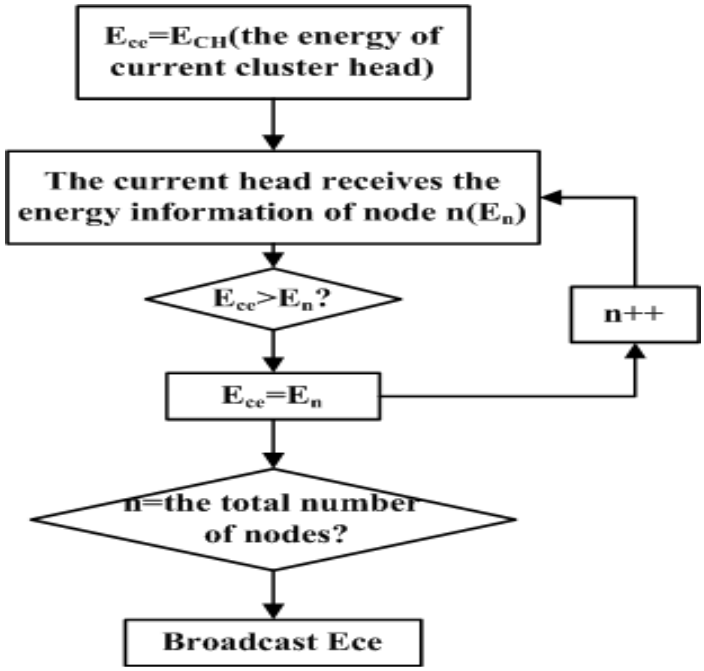

Fig 2.Flow chart of *Ece*'s formation

Rc is the radius of this circle.

dn is the distance between node n and the centre of this circle.

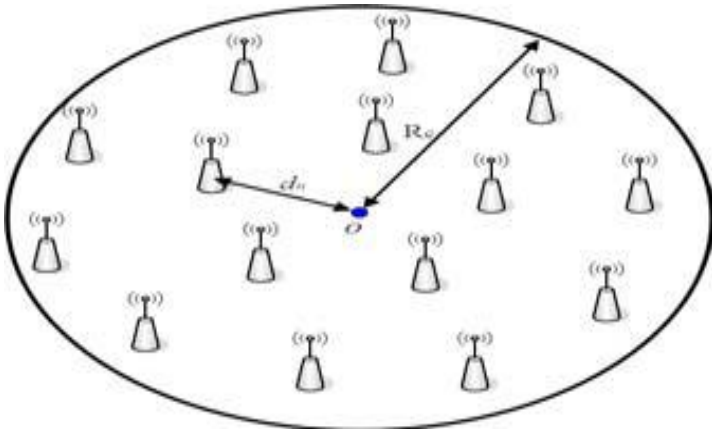

Fig.3 Rc and *dn*

The improved LEACH protocol formula:

T(n)={[p/1-p(r mod 1/p)]*[(1-Ece/En+Eec/En(1-dn/Rc)]

The above formula can be written as:

T(n)=p/1-p(r mod1/p)*(1-dn/En*Ece/Rc)

Where dn/En becomes one of the important factor to affect the probability of normal node to become a cluster head.

III. Multi-hop routing of cluster head

We introduce a multi hop routing protocol. This is based on energy and hops. Cluster head which far from the sink node can send a message to the sink node through multi-hop. Near the sink node, cluster head can send a message to the sink node directly.

In this paper[5],we talk about the routing algorithm to maximize the network lifetime in terms of first node death..In WSN data transmission is very expensive in terms of energy consumption. The lifetime of a network depend upon the energy of a node.Earlier works on the energy efficiency routing in WSN uses the minimum total energy(MTE).this is used to minimize the energy consumption to reach the deatination by sending the traffic to the same path.

The energy cost for a transmission from node m to node n:

EC(m,n)=e(mn)(Em^-1+(enm)En^-1

The energy supplies of nodes in WSN are not replaced and therefore nodes only participate in network f

Or as long as they have energy. The simulation result show that routing protocol with more routing overhead would consume more energy than routing protocol with less routing overhead, it means AODV routing algorithm has higher energy consumption than EEMLR because of higher routing overhead.

This paper show[6],WSN to increase the quality of service. The QOS of a network is affected by the lifetime and the failure of sensor. In this discrete round trip path(RTP) are compared on the bases of RTD to detect the faulty sensor node. Faulty detection depend on the neighbor nodes data. The fault detection accuracy will decrease rapidly if number of nodes are small and the node failure ratio is high.RTD times mainly depend upon number of sensor nodes present in RTP. Accuracy can be increased by reducing the RTD time for RTP by considering three node:

$$Trtd=T1+T2+T3$$

T1,T2,T3 are the delays for sensor node pairs.

$$Trtd=3T$$

Where T is the uniform time delay for all the sensor node pair in RTP.
The numbers of RTP found with n sensor nodes is given by

$$P=N(N-m)$$

Where P is number of RTP.
Fault detection efficiency is enhanced by selecting the discrete RTP. This method is used to increase the network lifetime and quality of service of WSN.

IV. CONCLUSION

The LEACH is well known routing protocol for cluster based wireless sensor network. This paper analyses the performance of LEACH-based wireless sensor networks in terms of lifetime and throughput. LEACH round is deduce to prolong the network lifetime and increase the throughput. LEACH protocol is also used for load balancing on networks. This protocol is also used for the data aggregation and multi-hop network.

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