Power Optimization Using Leach Protocol in Wireless Network

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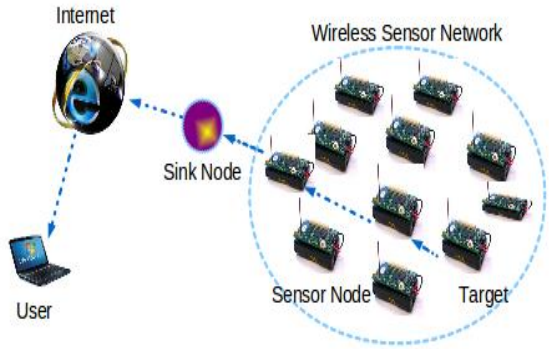
Abstract – In recent years, Wireless Sensor Networks are in great demand as there is a vast growth of wireless devices including cellular phones, laptops, mobiles, PDA's etc. Wireless Sensor Networks consists of thousands of tiny sensor nodes. The power resource of each sensor node is limited in wireless sensor networks. The important issues in the designing the routing protocols for sensor networks are minimizing energy dissipation and maximizing network lifetime. A node in a wireless sensor network will not be of use when its battery dies. To avoid this problem many protocols were introduced, but most of the rank is given to hierarchical routing protocols. This paper proposes a new improved cluster algorithm of LEACH protocol whose intention is increase the lifetime of the sensor nodes and to balance the energy consumption of the entire network. We analyze LEACH protocol, its phases, advantages and disadvantages and also various kinds of attacks on this routing protocol.

Index Terms – Wireless Sensor Networks, Routing Protocols, Energy, LEACH.

1. INTRODUCTION

Wireless sensor network (WSN) has a wide range of applications in military, environmental monitoring which includes agriculture monitoring, habitat monitoring, greenhouse monitoring and forest monitoring, health care monitoring, industrial monitoring, space exploration and so on. Wireless Sensor Networks are described as autonomous system consisting of lots of sensor nodes designed to monitor physical or environmental conditions. WSN use gateways to intercommunicate by wireless radio collaborate in real time monitoring, perceiving and collecting information of monitored objects and transfer this information to the base station. It does not need a fixed network support and it has rapid employment, survivability and other characteristics which makes it more applicable in many environments.

The research on sensor network generally has gone through two stages, the first stage is primarily intended for node, the second one is for network-level issues. The main research works in involves in the network layer and MAC layer protocol based on energy optimization, node localization technology, clock synchronization technology and data fusion technology.



Wireless Network

LEACH stands for Low Energy Adaptive Clustering Protocol. LEACH is one of significant hierarchical routings algorithm. Most of the hierarchical routing protocols are based on LEACH protocol which makes it a milestone in hierarchical routing protocols.

A wireless sensor networks consist of tiny sensor nodes to monitor physical or environmental conditions such as temperature, pressure, sound, humidity etc. as the positions of the sensor nodes are not predefined, the network must possess self-configuration capabilities

In WSN, Routing strategies and security issues are of great challenge nowadays. A number of routing protocols have been proposed for WSN but the most well-known hierarchical protocols is LEACH. So a study on LEACH is made in this paper.

Hierarchical protocols are defined to reduce energy consumption by aggregating data and to reduce the transmissions to the Base Station. LEACH is considered as the

most popular routing protocol that use cluster based routing in order to minimize energy consumption.

LEACH (Low-Energy Adaptive Clustering Hierarchy) follows cluster based approach in which a sensor node elects itself to be cluster head using some probability. The sensor node broadcasts an advertisement message to all the other nodes in the network. A non-cluster head node selects a cluster head to join based on the received signal strength. Since the cluster head needs to handle data from all nodes in its cluster, cluster head consumes more energy than a non-cluster head node. All nodes in the network have the potential to be cluster head during some periods of time. The TDMA scheme starts every round with a set-up phase to organize the clusters. After the set-up phase, the system goes to steady-state phase for a certain amount of time. The steady-state phases consist of several cycles where all nodes have their transmission slots periodically. The nodes send their data to the cluster head that aggregates the data and send it to its base station at the end of each cycle. After a particular period of time the TDMA round ends and the network re-enters into the set-up phase.

2. LEACH PHASES

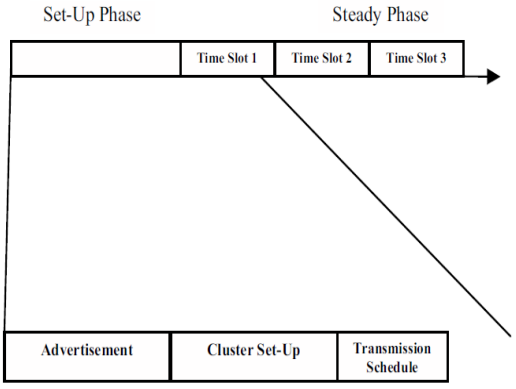
The operation of LEACH consists of several rounds with two phases in each round. Based on the received signal strength working of LEACH begins with the formation of clusters based.

The algorithm for LEACH protocol is as follows. The first phase of LEACH is Set-up phase and it has three fundamental steps.

1. Cluster Head advertisement

2. Cluster setup

3. Creation of Transmission Schedule



Time Slot Operation for LEACH Protocol

During the first step cluster head sends the advertisement packet to inform the cluster nodes that they have become a cluster head on the basis of the following formula

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

Let n be any random number between 0 and 1.

Where

n is the node

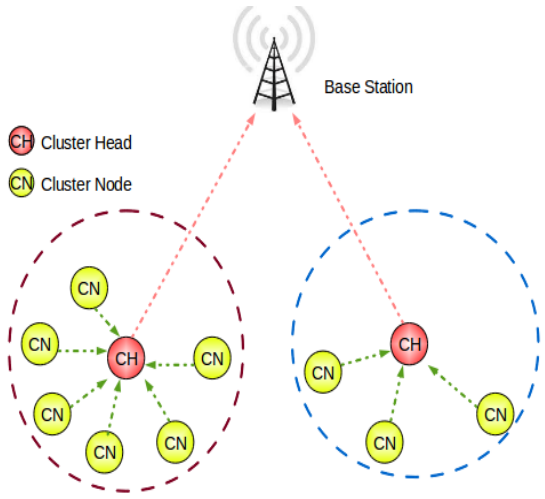
p is the probability

r is the current round

G is the set of nodes that were not cluster heads in the previous round,

T(n) is the Threshold.

The node becomes cluster head for the current round if the number is less than threshold T(n). Once the node is elected as a cluster head it cannot become cluster head again until all the nodes of the cluster have become cluster head once. This helps in balancing the energy consumption.



Cluster Formation in LEACH Protocol

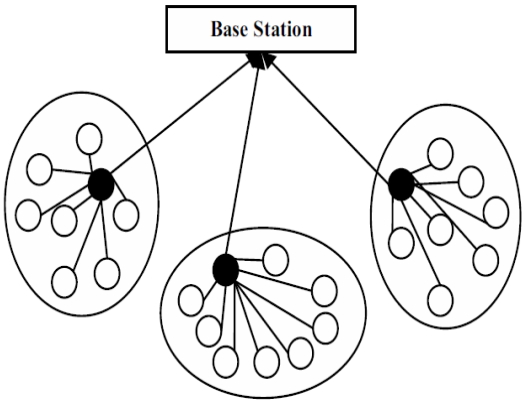
The non-cluster head nodes receive the cluster head advertisement in the second step and then send cluster join request to the cluster head informing that they are the members of the cluster under that cluster head.

By turning off the transmitter all the time, these non-cluster head nodes save a lot of energy and they turn it ON only when they have some data to transmit to the cluster head.

In the third step, each of the chosen cluster head creates a transmission schedule for the member nodes of their cluster. TDMA schedule is created according to the number of nodes

in the cluster. Each node then transmits its data in the allocated time schedule.

The Steady phase is second phase of LEACH during which the cluster nodes send their data to the cluster head.



Steady Phase in LEACH Protocol

The sensors in each cluster communicate only with the cluster head via a single hop transmission. The cluster head then aggregates all the collected data and forwards this data to the base station either directly or via other cluster head along with the static route defined in the source.

After the certain predefined time, which is decided beforehand, the network again goes back to the Set-up phase.

3. ADVANTAGES

The various advantages of LEACH protocol are:

1. LEACH protocol uses single hop method for communication from sensor nodes to cluster head which saves the energy.
2. Increases the lifetime of the sensor nodes.
3. Role of clusterhead(CH) is distributed among all the members.
4. Scalability of the network is provided.
5. Location of sensor nodes is not necessary for cluster formation.

4. LIMITATIONS & CONCLUSIONS

Wireless Sensor Networks would be of great use in critical applications. On analyzing the previous research, we observe that a lot of work is being carried out on routing protocols. In this paper, we have discussed how LEACH protocol works and its advantages and disadvantages. LEACH protocol is also vulnerable to various kinds of attacks which have been described above. In LEACH protocol, clusters result in uneven distribution of clusters as they are divided randomly. Also the number of cluster heads in the network is also not defined.

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