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# Improvement on LEACH Protocol in Wireless Sensor Networks

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**Abstract**
Wireless sensor network (WSN) is a network consists of large number of low power sensor nodes. Leach is a less energy adaptive clustering hierarchy protocol. The main goal of cluster based sensor networks is to decrease system delay and reduce energy consumption. Leach is a cluster based protocol for micro sensor networks which achieves energy efficient, scalable routing and fair media access for sensor nodes. Many improvements are done in wireless sensor network. Security is very essential in wireless sensor network. This paper describes LEACH protocol, their advantages, disadvantages etc. The paper is organized as follows: In section I, contains introduction, section II contains description of LEACH protocol, and section III contains literature review.

**Keywords:** Wireless Sensor Networks, LEACH Protocol, Cluster, Cluster Head, Attacks

## 1. Introduction
A wireless sensor networks consist of tiny sensor nodes to monitor physical or environmental conditions such as temperature, pressure, sound, humidity etc. The network must possess self configuration capabilities as the positions of the individual sensor nodes are not predetermined. Routing strategies and security issues are a great research challenge now days in WSN but in this paper we will emphasize on the routing protocol. A number of routing protocols have been proposed for WSN but the most well known are hierarchical protocols like leach [1] and pegasis [2]. 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. In this paper firstly we analyze LEACH protocol and then in the third section we will discuss the phases of LEACH protocol. In the fourth section we define various possible attacks on it and in the fifth section there are the advantages and disadvantages of LEACH. In the last section we compare LEACH with other protocols.

## 2. Leach Protocol
Leach protocol is a TDMA based MAC protocol. The main aim of this protocol is to improve the lifespan of wireless sensor networks by lowering the energy. Leach protocol consists of two phases:
1) Set-up phase
2) Steady phase
Operation of leach protocol consists of several rounds with two phases in each round. Leach protocol is a typically representation of hierarchical routing protocol. It is self-adaptive and self-organized [2]. Leach protocol uses round as unit, each round is made up of cluster set-up stage and steady state storage for the purpose of reducing unnecessary energy costs.

## 3. Set-up phase
In the set-up phase, the main goal is to make cluster and select the cluster head for each of the cluster by choosing the sensor node with maximum energy [3]. Set-up phase has three fundamental steps:
i. Cluster head advertisement
ii. Cluster set up
iii. Creation of transmission schedule
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:

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

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 previous rounds T (n) is the threshold Node becomes cluster head for the current round if the number is less than threshold T (n). Once node is elected as a cluster head then it cannot become cluster head again until all the nodes of the cluster have become cluster head once. This is useful for balancing the energy consumption. In the second step, non-cluster head nodes receive the cluster head advertisement and then send join request to the cluster head informing that they are members of the cluster under that cluster head. All non-cluster head nodes save a lot of energy by turning off their transmitter all the time and turn it on only when they have something to transmit to the cluster head [2].

**2. Steady phase**

In steady phase, cluster nodes send their data to the cluster head. The member sensors in each cluster can communicate only with the cluster head via a single hop transmission. Cluster head aggregates all the collected data and forwards data to the base station either directly or via other cluster head along with the static route defined in the source code. After predefined time, the network again goes back to the set-up phase.

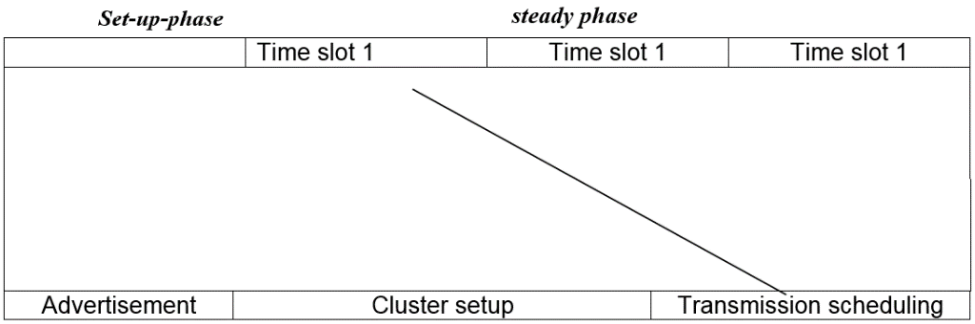


**Fig 1:** Time Line Operation of leach

**2.1. Cluster head selection algorithm in leach**

Two phases are in LEACH protocol which is (i) the cluster formation and (ii) data receiving and transmission phase and round as defined the time slot gap between two phases. In the cluster head selection phase sensor node generates a random number which lies within 0 and 1, if that number is less than threshold value T (n) then in that round it selects that node to act as cluster head, and acknowledge that node to the other neighbor [11]. The formula for T (n) is given below:

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

r indicates the present round, selection of a node to be a cluster head with probability, p and those nodes are still not become cluster head in previous (r-1) round, will form another set G. We consider here N as the total number of nodes in the network, the approximate number of cluster head to be considered as k, where p =k/N. Each node has opportunity to become a cluster head once by this algorithm, if one node become cluster head in a particular round, it will lose to become another time cluster head in other round.

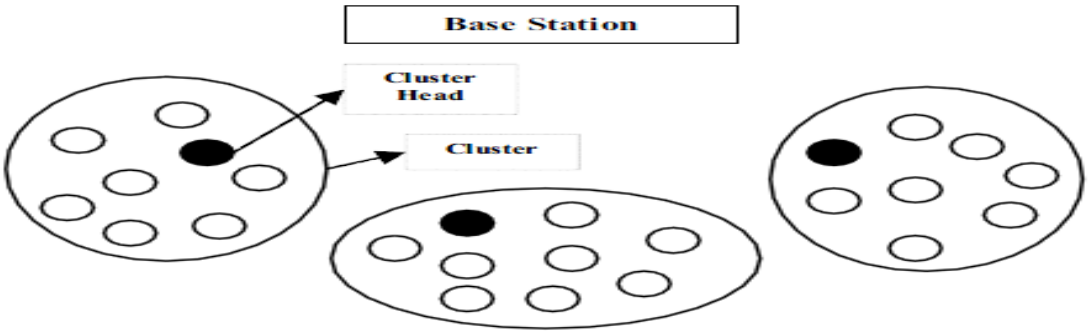


**Fig 2:** Cluster Formation in LEACH

**Modified leach protocol**

**3.1 Our Energy Model**

In our protocol we consider energy for each round. We consider our energy model as given below:

$$Energy = Energy + S(i).E\frac{i-1}{r\,max-i} \quad (1)$$

Where i stands for number of iteration, r max is maximum number of rounds, Energy as our initial energy and S(i). E consider as energy level of each node after rounds.

### 3.2 Analysis of Modified LEACH

Energy consumption of the network under different number of rounds for LEACH and Modified LEACH protocol has been carried out and from simulated result it is observed using Eq. (1) our protocol reduces energy consumption than LEACH protocol, which has been shown in Fig. 2.

#### 3.2.1 Simulation of Modified LEACH

In our simulation we consider 100 nodes randomly distribute within the square area of the 100m*100m, the base station is located in the centre of the region, the base station coordinates is (50, 50). It can be seen from the Fig. 1 that the nodes' are distributed randomly.

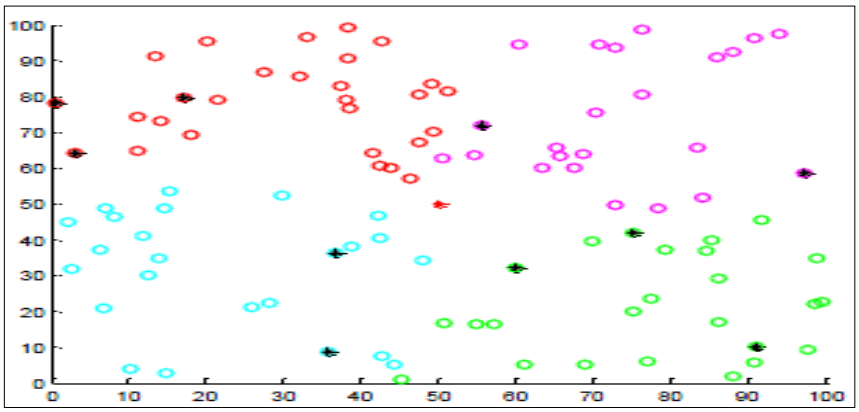


**Fig 3:** Randomly Distributed Nodes

In Fig. 1 cluster head are selecting from nodes and transmitting data to base station. Energy consumption is more in LEACH than Modified LEACH. We Consider 100 nodes for simulation LEACH and Modified.

#### 3.3.2 Data Received by Base Station

Fig. 8 shows the comparison between the amounts of data received by base station with time. There are effective broadcast by cluster head, because of the effective data transmission fail means retransmission is needed that will send more data to the base station. Here the simulation has been done upto 500s and cluster head stop sending data until the transmitted data reached at destination. Our protocol, Modified LEACH protocol under optimum number of cluster head can improve efficiency of the wireless sensor networks.

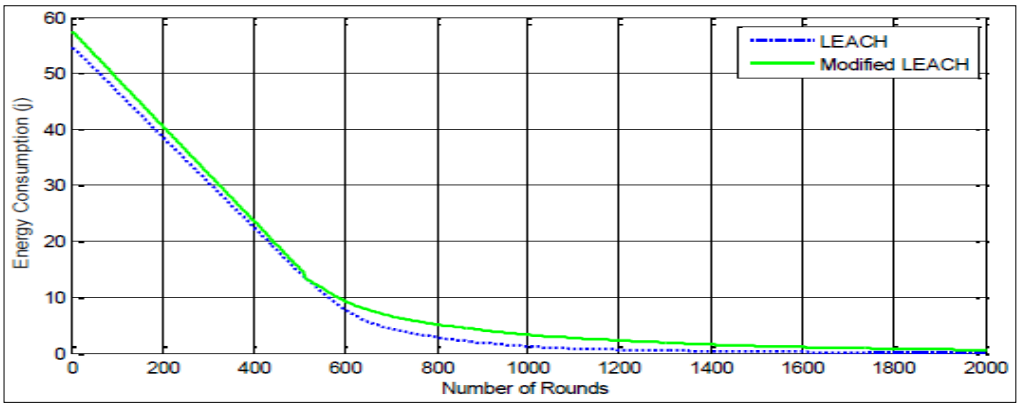


**Fig 4:** Comparison of energy Consumption between our protocol & LEACH

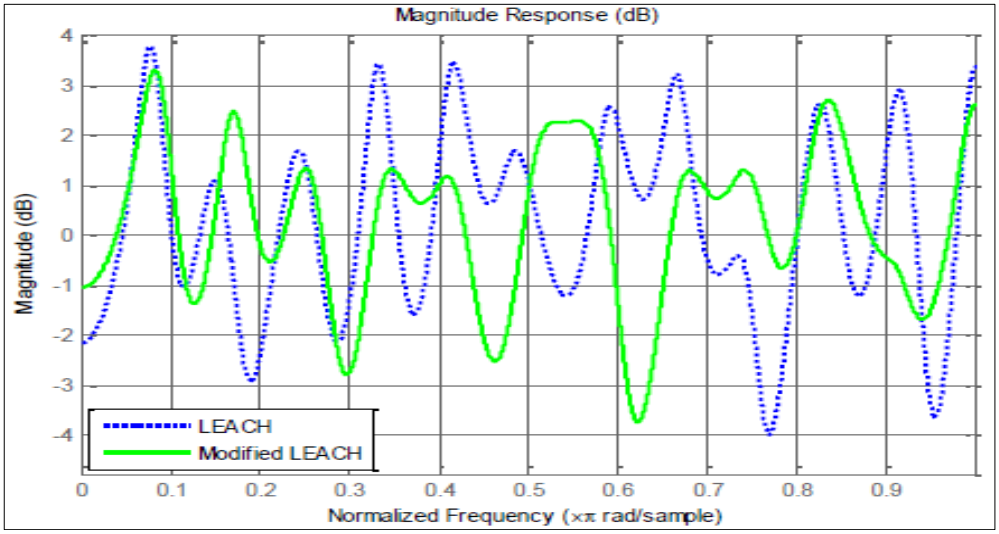


**Fig 3:** Comparison of magnitude of data transmission between our protocol and EACH

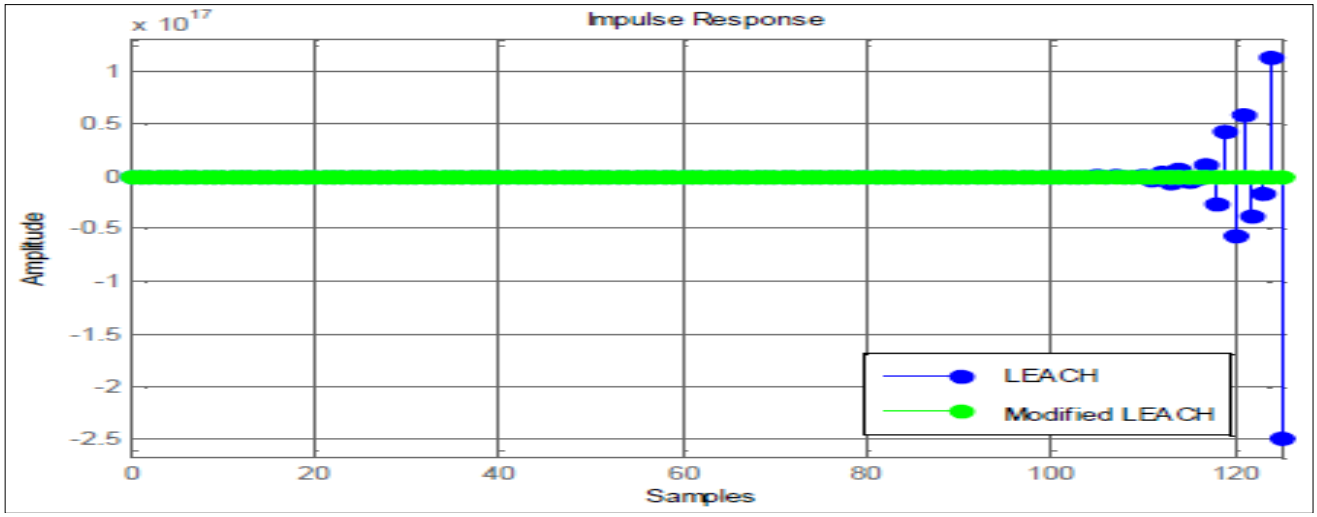


**Fig 7:** Amplitude of transmission of modified EACH & LEACH

## 5. Performance Analysis

Heuristic simulation carried out by using MATLAB for both LEACH and Modified LEACH. In Fig.2 compares energy consumption with increasing on nodes in the network and shows Modified LEACH prolong system lifetime. Fig. 4 explains node broadcast with time is increasing than LEACH protocol. The result in Fig. 5 shows better perform of modified LEACH indicates for long run Modified LEACH will be much more applicable than LEACH.

## 6. Conclusion

LEACH and Modified LEACH protocols were implemented in Tiny OS with some degree of success. The basic evaluation of these protocols was carried out and different phase comparison has been made and showed by different graphs. During the design and implementation of the protocols it was clear that performance gains by Modified LEACH better than LEACH. The implemented protocols might prove to be more successful when used for routing packets in sensor networks.

## 7. References

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