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LEACH and PGASIS Protocols in wireless sensor network: Study and Simulation

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ABSTRACT

In wireless sensor networks, minimizing the energy consumed by the sensor node when transmitting or receiving data between nodes or with the base station maximizes the lifetime of networks for long-term monitoring time. For that in sensor networks, Energy consumption is the major constraint that influences the architecture of the sensor network; in general the sensor network is limited in energy. In most cases, change the battery of sensor is not possible. This means that the lifetime of a sensor depends greatly on the lifetime of the battery. To solve this problem, it is necessary to choose routing protocols that consume less energy, namely hierarchical routing protocols. The aim of this paper is in first to evaluate the performance of two hierarchical routing protocol cluster based approach and chain based approach, namely Low-Energy Adaptive Clustering Hierarchy (LEACH) and Power-Efficient Gathering in Sensor Information System (PEGASIS) in terms of energy consumption by each node in sensor network, and secondly detailed our proposed method based on hierarchical routing protocols to minimize the energy consumption of each node to increase the life time of network sensor.

Key words: Network Sensor, LEACH, PEGAIS, Cluster-based approach, chain-based approach
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1. INTRODUCTION

Sensor networks have emerged as a promising tool for monitoring the physical worlds, utilizing self organizing networks of battery-powered wireless sensors that can sense, process and communicate, in the other a wireless sensor network (WSN) consists of a large number of small-sensor nodes used to monitor areas, collect and report data to the base station (BS), and each node serves as transmitter and router, these sensors (node) are used to control an environment and transmit the captured data to the base stations [1].

In general Wireless Sensor Network (WSN) is a set of communicating sensors using wireless links The nodes are usually powered by batteries with finite capacity and it is always impossible to replenish the power [2], for that the failure of the energy sensor can significantly modify the topology of the network and impose an expensive reorganization of the network [3] and many characteristics of WSN must be considered for efficient deployment of the network, to know: Low cost, Energy efficient, computational power, communication capabilities security and Privacy, distributed sensing and processing, dynamic network topology, Self-organization, Multi-hop communication, Application oriented, Robust Operations and Small physical size [4].

In general the important constraint is the energy consumption by each node that influence the lifetime of a network because the nodes in WSNs are usually powered by batteries with finite capacity and it is always impossible to replenish the power, and The failure of the energy sensor can significantly modify the topology of the network and impose an expensive reorganization of the network. Therefore, the applications are hindered by limited energy supply, and one design challenge in sensor networks is to save limited energy resources to prolong the network lifetime [5].

Minimize energy consumption of each node in the network, several routing approaches have been proposed. Among these protocols, the Cluster-based approach and chain-based approach, in which one node (CH) is responsible to transmitting the data to the BS [6].

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In this paper we study the performances and overview of LEACH protocol and PEGASIS protocol to compared the result simulation between each approach and compared all result to developed new approach in our future work.

In section 2 presents an overview of LEACH and PEGASIS protocols.

Section 3 detailed the simulation results of each method algorithm in Matlab simulink in terme of energy consumption to compare the life time of network sensor using each protocol, Finally Section 4 and 5 concludes a comparative results simulation between LEACH and PEGASIS protocol, and our perspective for future works.

2. LEACH AND PEGASIS PROTOCOLS IN WIRELESS SENSOR NETWORKS

In sensor networks there are two types of architecture for networks, flat architecture that constitutes a homogeneous network where all nodes have the same in terms energy resources, calculation and memory [7], and another hierarchical architecture where all nodes do not have the same roles and therefore the same resources, the result simulation of energy consumption in each architecture show that the hierarchical architecture is more than flat architecture [1].

It is for this reason that our research work is based on the hierarchical routing protocols (Cluster-based approach and chain-based approach) to put at the end a minimized protocol of energy more than the already existing methods.

1) LEACH Protocol

LEACH (Low Energy Adaptive Clustering Hierarch) is a self organizing adaptive protocol based on clustering, which uses randomized rotation of cluster heads to evenly distribute the energy load among sensor nodes in the network. It is considered one of the first hierarchical routing approaches based on clustering, the idea behind LEACH is to form clusters of nodes sensors depending on the strength of the received signal and to use local cluster heads (cluster head , CH) as routers to route data to the base station[8].

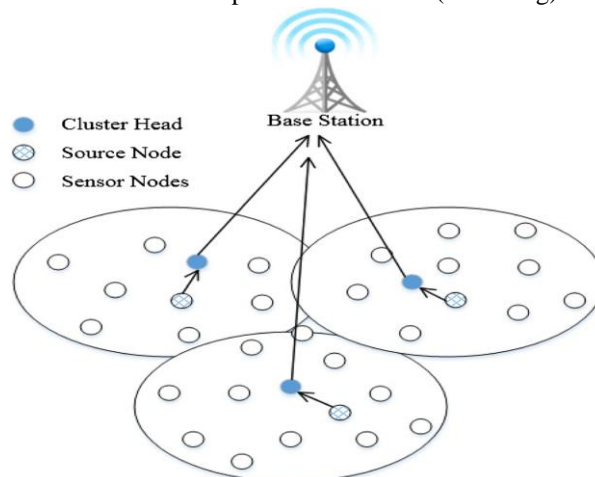LEACH is one of the protocols based on the concept of classification (clustering) shown in Figure 1.

Fig. 1 Clustering based appraoch Protocol

The operations of LEACH are generally separated into two phases: the setup phase and the steady-state phase.

In the setup phase, CHs are selected and clusters are organized. In the steady-state phase, the data transmissions to the BS take place. The role of the CH is assigned by the node getting a random number between 0 and 1. If the number is less than the threshold values T(n), the node becomes a CH for the current round [9] ,the following equation (1) bellow shows how to compute T(n) :

$$T(n) = \begin{cases} p/(1 - p * (r * \mathrm{mod}(1/p)) & \text{if} \quad n \in G \\ \\ 0 & \text{else} \end{cases} \qquad (1)$$

Where n is the given node, P is the predetermined percentage of CHs (P = 5%), r is the current round, and G is the set of nodes that have not been selected as CHs in the last 1/P rounds.

Using this threshold, each node will be a CH at some round with in 1/p. After the election of CH nodes, each ordinary node will determine the optimal CH to join in terms of minimum energy required for transmission.

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In the other, after the formation of the clusters, the CHs construct Time Division Multiple Access (TDMA) tables based on the number of nodes in their clusters. In these tables each node is associated with a time slot which it can transmit these messages (the transmission is Over the entire bandwidth allocated for the transmission of Data), that is to say that each node that tries to make a Transmission during its time-slot it is sure that the channel is clean.

Finally to prevent interference between cluster messages which are close, each CH randomly selects a code in a list of CDMA codes (Code Division Multiple Access) and transmits it to the nodes belonging to its group to use it during transmission, so all nodes use the same bandwidth but with Frequency modulations that are specified in the code Sent by the CH [10].

2) PEGASIS Protocol

PEGASIS (Power Efficient Gathering in Sensor Information Systems) is a protocol based on the chains. The protocol of the basic idea is that in order to prolong the lifetime of the network, the nodes will be organized so that they form a chain, and will have need to communicate with only their closest neighbors and take turns in communicating with the base station. Indeed, PEGASIS has two main objectives. First, increasing the lifetime of each node by using collaborative techniques and thus increase the lifetime of the network. Secondly, allow only the local coordination between neighboring nodes so that the bandwidth consumed in the communication is reduced [11].

PEGASIS is one of the protocols based on the concept of chain (chain based approach) shown in Figure 2.where C_i is a node in sensor network.
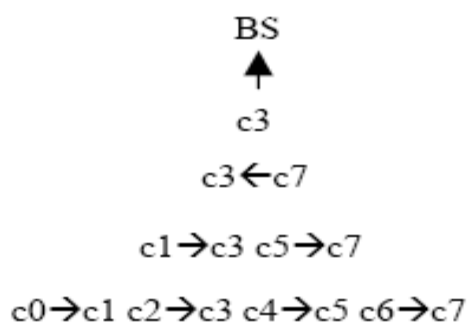

$$BS$$
$$\uparrow$$
$$c3$$
$$c3 \leftarrow c7$$
$$c1 \rightarrow c3 \quad c5 \rightarrow c7$$
$$c0 \rightarrow c1 \quad c2 \rightarrow c3 \quad c4 \rightarrow c5 \quad c6 \rightarrow c7$$

Fig. 2 Chain based appraoch Protocol

3. RESULTS SIMULATION OF ALGORITHM LEACH AND PEGASIS PROTOCOLS

Parameters of simulation Protocols LEACH and PEGASIS

To simulate the LEACH and PEGASIS protocols using Matlab Simulink we chose the parameters of simulation shown in the table 1 bellow:

Table -1 Simulation parameters of LEACH   and PEGASIS

Parameters	Values
Number of nodes	100
Simulation Surface	(100m,100m)
Energy transmission	50*0.000000001 (J)
Energy reception	50*0.000000001 (J)
Initial Energy	0,1 J
Simulator	Matlab
Rounds	1500

Results Simulation using LEACH Protocol

The figure 3 shows the simulation results representing the number of node dead after number of rounds (1500 rounds) using LEACH protocol.
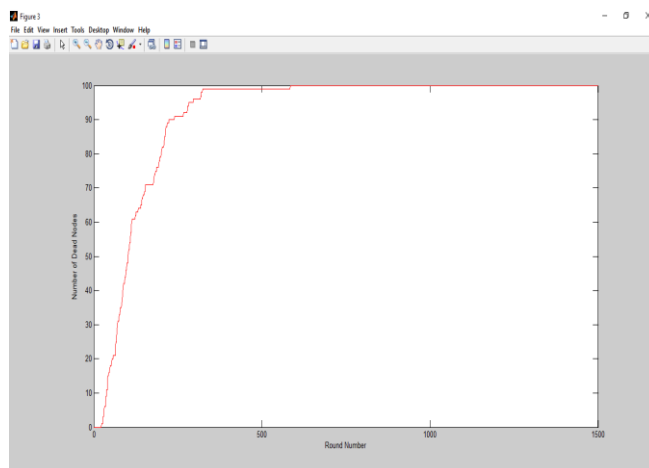
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Fig. 3 Number of node dead after 1500 rounds using LEACH Protocols

Results Simulation using PEGASIS Protocol Existing Method
The figure 4 shows the simulation results representing the number of node dead after number of rounds (1500 rounds) using PEGASIS protocol.
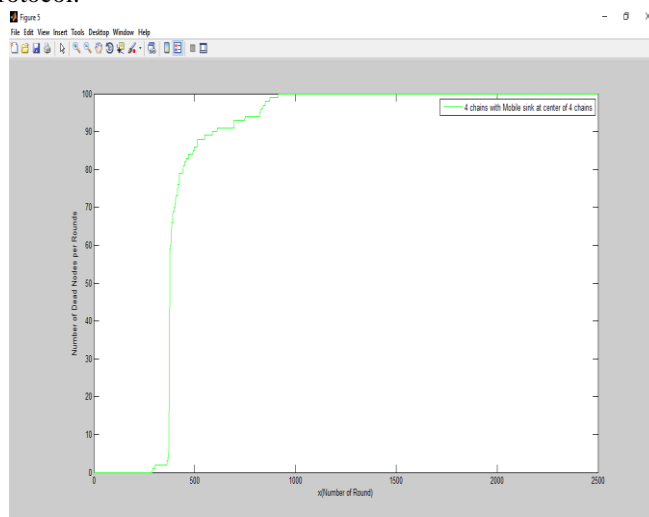

Fig. 4 Number of node dead after 1500 rounds using PEGASIS Protocol.

4. DISCUSS RESULTS SIMULATION OF LEACH AND PEGASIS

The results of the simulation shown in the Figure 3 and figure 4 clearly show that there is an extension of the network lifetime using chain-based approach more than using cluster-based approach as shown in the table 2 bellow

Table -2 Number of round when 100 % of node are dead using LEACH and PEGASIS

Protocols	Round Number when 100 % of node are dead
LEACH	650
PEGASIS	1100

In this table (table 2) we see that:
- In LEACH Protocol all node dead in 650 rounds.
- In PEGASIS Protocol all node dead in 1100 rounds.

5. CONCLUSION AND PERSPECTIVE

In this paper we introduce wireless sensor networks routing algorithms using hierarchical routing protocols (LEACH and PEGASIS), we have simulated and detailed each methods using for each approach to minimize energy consumption in wireless sensor network, the simulation results show that PEGASIS protocol ensures the low energy consumption and improves the network lifetime than LEACH protocol.

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As perspective this work can be used in different directions in our future works to propose a protocol with better consumption of energy and increase more the lifetime of Wireless Sensor Network based on all method using by LEACH and PEGASIS Protocols.

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