

# A Location Based Clustering Algorithm for Wireless Sensor Networks<sup>1</sup>

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**Abstract** – One of the main objectives of wireless sensor network design is to improve the energy efficiency. How to efficiently utilize sensor nodes to prolong the lifespan of a wireless network has long been a research topic. This paper presents a location based LEACH clustering algorithm, which is an extension to the LEACH routing algorithm. Armed with distributed and local network based routing decision-making mechanism, this algorithm fully utilizes the location information of network nodes in routing to reduce the routing cost. Simulation results indicate that this algorithm can balance nodes' energy consumption and prolong the network's life span. It also has good stability and extensibility.

**Index Terms** – Wireless sensor networks, LEACH protocol, geographic location information, network lifetime.

## 1. INTRODUCTION

Wireless sensor networks (WSN) are wireless network composed of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. Due to the deployment flexibility and maintenance simplicity, WSN applications have been seen in many areas [1][2][3][4].

Energy is the scarcest resource of WSN nodes, and it determines the lifetime of WSNs. Compared with traditional ad hoc network design, one of the most important design objectives of WSNs is to minimize node energy consumption and maximize the network lifetime. Because the routing protocol design is driven by the improvement of mobile service quality, the widely applied and mature routing protocols used in traditional ad hoc networks are not suitable for WSNs[5][6]. In recent years, clustered routing protocol has gained increasing attention from researchers because of its potential of extending WSN lifetime. Heizelman and Kopa [9] designed and implemented the first distributed and clustered routing protocol with low energy consumption, LEACH. After that, some modified algorithms based on LEACH were proposed, such as

LEACH-C, LEACH-E, and LEACH-F [7][8]. This paper presents a new improved LEACH algorithm.

The rest of the paper is organized as follows: Section 2 presents the new protocol with its key management mechanism and operation procedures. Section 3 analyzes the performance of the new protocol. Section 4 summarizes the paper.

## 2. PROBLEM FORMULATION

The routing protocol design for WSNs is challenging because WSNs differ from traditional wireless ad hoc networks in many aspects [9][10][11][12][13]:

- No global ID: The number of sensor nodes could be very large in a WSN and maintaining global IDs for them is too expensive and unrealistic. Therefore, no global ID is maintained in a WSN, which is different from traditional IP-based routing protocols.
- Many-to-one communications : Almost all applications require multiple sensor nodes to send data to a specific node.
- Data redundancy: In many cases many sensors nodes may obtain large amount of the same or similar data. So there is a huge data redundancy in the network.
- Limited resources: Each sensor node is equipped with limited resources, such as power, computation capability and memory.

LEACH cluster head is selected using a threshold  $T(n)$ , as shown in Fig. 1, where  $T(n)$  is calculated according to:

$$T(n) = \begin{cases} \frac{p}{1 - p(r \bmod (1/p))} & n \in G \\ 0 & \text{others} \end{cases}$$

In this formula,  $p$  is the percentage of cluster heads over all nodes in the network, i.e., the probability that a node is selected as a cluster head;  $r$  the number of rounds of selection; and  $G$  is the set of nodes that are not selected in round  $1/p$ . As we can see here, the selection of cluster heads is totally randomly.

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