UNIVERSITI PUTRA MALAYSIA

Stability Improved of Improved Low Energy Adaptive Clustering Hierarchy Routing Protocol for Wireless Sensor Network

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Thesis Submitted to the School of Graduate Student, University Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Computer science

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DEDICATION

This thesis is dedicated to:

The sake of Allah, my Creator and my Master,

My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life,

My beloved Parents,

My Wife,

My Son

My Brother and Sister,

And all my friends,

For

Their Endless Patience and Support

ABSTRACT

Abstract of the thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

Stability Improved of Improved Low Energy Adaptive Clustering Hierarchy Routing Protocol for Wireless Sensor Network

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January 2017

Supervisor: Mr. Ahmad Alauddin Ariffin
Faculty: Computer Science and Information Technology

Wireless Sensor networks (WSN) consist of a large number of homogeneous or heterogeneous sensor nodes. These nodes are equipped with limited battery capacity and connected wirelessly. They are deployed at various geographical locations to provide the functions of monitoring and tracking of physical events. Gathering sensed data from real world for long period of time in an energy efficient manner is a typical operation in many applications of WSNs. Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the prominent WSN protocol which is developed to prolong the network lifetime by utilizing energy efficient clustering technique. However, there are many limitation in LEACH. An Improved LEACH is one of LEACH variant that was

able to reduce power consumption and prolong the overall network life time at the expense of reduced stability period (the time span before the death of first node). Nevertheless, the network stability period is important for many applications that require reliable feedback from the network. Hence, it is motivated us to enhance Improved LEACH algorithm to provide higher stability. In this project, a protocol named Stable Improved LEACH is designed to overcome the shortcomings of Improved LEACH. It balances the load among nodes by utilizing node residual energy and its distance to Base Station in the process of cluster head selection and utilizing node distance to Base Station during the process of Cluster formation. The simulation results revealed that our proposed protocol significantly outperforms Improved LEACH in terms of stability period and network life time.

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APPROVAL SHEET

This thesis submitted to the faculty of Computer Science and Information Technology of University Putra Malaysia and has been accepted as partial fulfillment of the requirement for the degree of Master of Computer Science.

Supervisor: Mr. Ahmad Alauddin Ariffin
Department of Communication Technology and Network
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Date: _____

DECLARATION

I declare that the thesis is my original work except for quotation and citations which have been duly acknowledge. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at University Putra Malaysia or other institution.

Al-Zubaidi Ammar Sabah Talib

Date: _____

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LIST OF ABBREVIATIONS

BS	Base Station
CH	Cluster Head
CHs	Cluster Heads
CPU	Central Processing Unit
LEACH	Low Energy Adaptive Clustering Hierarchy
SILEACH	Stable Improved LEACH
WSNs	Wireless Sensor Networks
WSN	Wireless Sensor Network
GPS	Global Positioning System
ADCs	Analog to digital converters
NCH	Non Cluster Head node
MR-LEACH	Multi-hop Routing with Low Energy Adaptive Clustering Hierarchy
LEACH-F	Fixed Low Energy Adaptive Clustering Hierarchy
TDMA	Time Division Multiple Access
TH(r)	Threshold Value
P	Percentage of Cluster Heads
r	Rounds number
NDEA	Node Degree and Energy-Aware routing protocol
TLHCLP	Three Level Hierarchical Clustering Protocol
DB-LEACH	Distance Based -Low Energy Adaptive Clustering Hierarchy
A-LEACH	Assisted LEACH
K-LEACH	Kmedoids-LEACH protocol
MRE	Maximum Residual Energy
ILEACH	Improved LEACH
EE-LEACH	energy efficient - Low Energy Adaptive Clustering Hierarchy
Q-LEACH	Quadrature-LEACH
DBEA-LEACH	Distance-Based Energy Aware - Low Energy Adaptive Clustering Hierarchy
CEED	Centralized Energy Efficient Distance

H-LEACH	Hybrid-Low Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks
HEED	Hybrid Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network
SNR	Signal-to-Noise Ratio
Eelec	is the energy dissipated per bit to run the transmitter or the receiver circuit
єfs , Єmp	Amplification factor depend on the transmitter amplifier model
d	is the distance between the sender and the receiver
ETx	energy spent per-bit during transmission
ERx	energy spent per-bit during reception
K	is number of message bits
FDN	First Dead Node
HDN	Half Dead Node

CHAPTER 1

INTRODUCTION

1.1 Overview

In this chapter, we introduce a review of wireless sensor networks, a brief background about the scope of this thesis, an idea about our research problem and how it has been addressed, our objective, and the outline of the thesis chapters.

1.2 Wireless Sensor Networks

Wireless Sensor Networks (WSNs) may consist of several thousand of homogeneous or heterogeneous sensor nodes which are deployed to make a smart environment that depends on sensed data from real world as shown in Figure 1.1. These Networks are wirelessly connected which enabling the function of monitoring and tracking.

The sensor node usually consists of at least one sensing unit, a central processing unit, a transmission unit, a Global Positioning system, a power unit, which is a small battery and a mobilizer, which is optional. These sensors also can communicate with each other or send data to Base-station (BS) directly. BS is a node that has a powerful energy supply. It can be a mobile or fixed node and it provides connectivity between the Network and the user who can access to the sensed data [1][2].

The deployment of WSNs in the sensor field depends on the application. It may be distributed randomly. For instance, large number of sensors may be thrown down from an airplane for disaster monitoring applications. It may also be planted manually. For

example, a fire alarm systems where sensor nodes are placed in pre specified locations [3].

WSNs are used in vast range of application such as patient monitoring systems, environment monitoring, vehicle motion control, military operations, earthquake detection, surveillance system and target tracking , pollution control system etc. [4]. These applications require to communicate data between sensors and BS. Routing protocol is used to find an efficient route between them. However, the design of an efficient WSN routing protocol is influenced by many challenging factors. Some these factors are represented in the sensor architectural constraints, which includes limited supply of energy (Battery supply), the node deployment constraints, where the nodes may be deployed in a harsh environment, which make the nodes replacement and charging their batteries to be impossible, the data reporting model that depend on the application types, node heterogeneity, fault tolerance, scalability[1][2]. These challenges motivate the researchers to investigate this area widely.

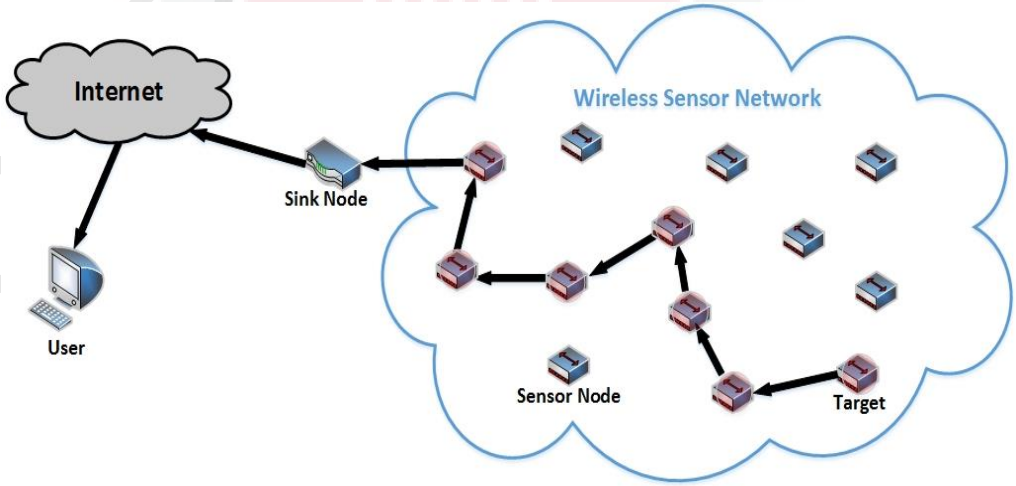

Figure 1.1: General Overview of Wireless Sensor Networks

1.3 Wireless Sensor Networks Applications

Applications of wireless sensors networks are various, but the most direct application is monitoring the low frequency data of remote environments such as manufacturing of plants, demining, farms, long distance oil and gas lines, military field etc.[4] .

In long distance oil and gas lines, it's very difficult or even impossible to detect the leakage point or spot points in traditional inspection methodologies and techniques. The overall measurements of such lines are capable to be done using the wireless sensor networks protocol and technology. The use of WSN enables to detect all variables and measurements of such long distance line with high security and reliability instead of uncertainty problems solving, cost, difficulty of installations, and other problems in wired and traditional measurement procedures [5].

The main categories of wireless sensors networks applications can be divided into three categories and any application will fall into one of these categories; those are:

1. Data collection for environmental applications.
2. Security, surveillance, and monitoring.
3. Object tracing.

1.4 Wireless Sensor Node Architecture

A sensor node is typically made up of four main parts as shown in Figure 1.2 below

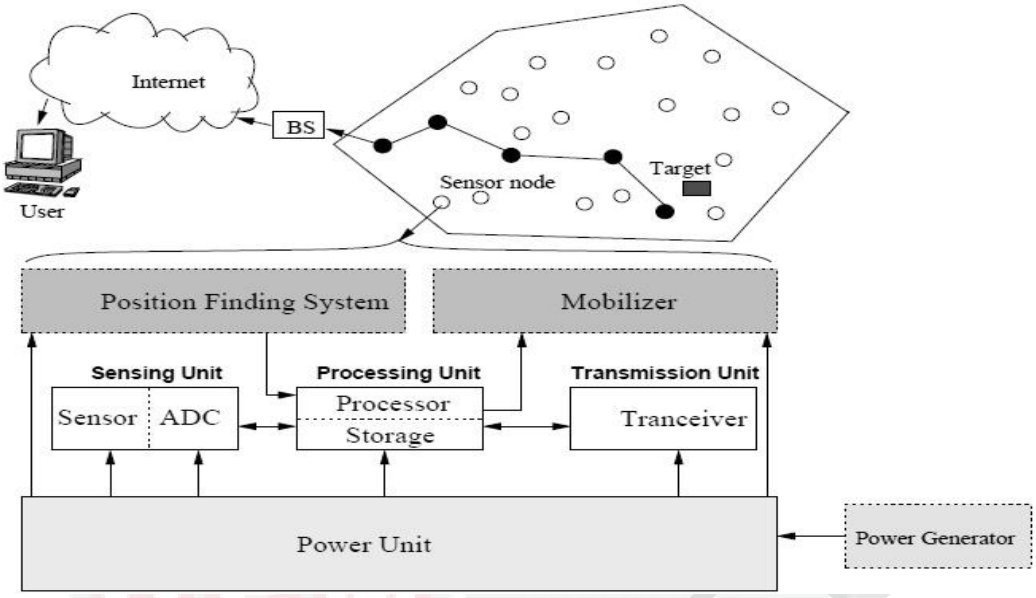

Figure 1.2: The component of Sensor Node

1- Sensing Unit: The sensing unit usually consists of one or more sensors and analog to digital converters (ADCs). The sensors observe the physical phenomenon and generate analog signals based on the observed phenomenon. The ADCs convert the analog signals into digital signals, which are then fed to the processing unit [3].

2- Processing Unit: The processing unit provides intelligent control to the sensor node, which usually consists of a microcontroller or microprocessor with memory.

3- Communication Unit: this unit connects the nodes to the networks, which uses a short range radio to perform data transmission and reception over a radio channel.

4- Power Unit: The power unit is one of the most important component of a sensor node, which consists of a small battery for supplying power to drive all other components in the system. In addition, a sensor node can also be equipped with some other units such as GPS (Global Positioning System) or Mobilizer, depending on specific applications[3].

1.5 WSN Protocol Stack

The protocol stack used by WSN is consisted of five layers as shown in Figure1.3.

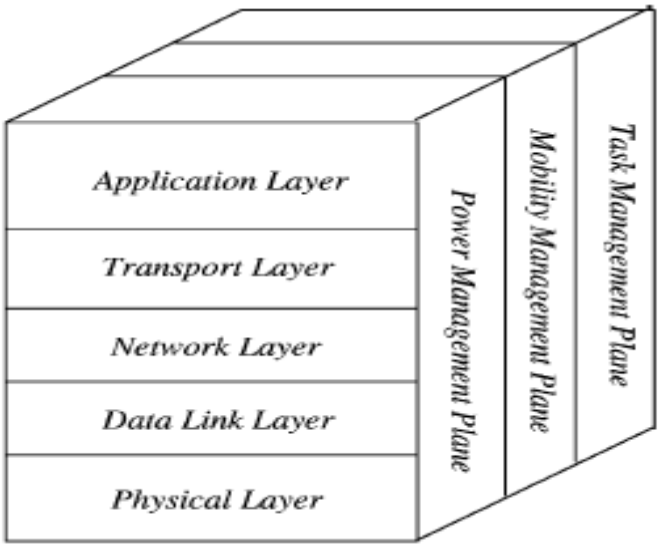

Figure 1.3: Architectural Layers of a WSN

1. Physical Layer: It provides an interface to transmit a stream of bits over physical medium. In addition, it is responsible for frequency selection, carrier frequency generation, signal detection, Modulation and data encryption.

2. Data link layer: The data link layer's function is to achieve data streams multiplexing, error control, frame detection and ensuring reliable connections.

3. Network layer: the function of this layer is to address and route packets through the network.

4. Transport layer: Transport Layer Protocols are used to maintain the follow of data such as congestion control, lost packet recovery and increased reliability.

5. Application layer: it provides software for different applications that translate the data in an understandable form or send queries to obtain certain information. There are different types of applications software can be built and used on this layer, for instance military applications, environment applications, medical applications, etc.

1.6 Problem definition

Since the power consumption is a critical issue in the life of a WSN network, cluster based routing protocol used to decrease the power consumption and prolong the network life time . One of the most prominent protocol that use this technique is Low Energy Adaptive Cluster Hierarchy (LEACH). This protocol has abled to conserve the energy consumption and prolong network life time by selecting cluster head (CH) randomly and forming clusters. However, this protocol has many limitations, which are addressed in literature. This protocol does not consider node residual energy in cluster heads selection, which may lead cluster head with less residual energy to fail. Furthermore, it does not consider the distance between the nodes and Base station (BS) in the process of cluster head selection. Therefore, the power consumption of the CH node that lies far for the base station will be more compared to the power consumption of the CH nodes that lie near the BS. In literature, there are various ideas have been proposed to overcome these drawbacks [[6], [7], and [8]]. The latest work [9] propose an Improved LEACH to decrease the power consumption and enhance the network life time by considering the remaining energy of nodes and their distance to BS in the process of CH selection. In addition, he considered the distance among non-cluster head, CH and BS in the cluster formation. However, the network stability period (in term of the first dead node) is still considered low for many applications that require reliable feedback from the network [10].

1.7 Objective

The main objectives of this thesis are:

1. To implement and simulate a wireless sensor networks using MATLAB simulator.
2. To implement an Improved LEACH algorithm that solves the energy consumption problem in wireless sensor networks.
3. Improve stability period of Improved LEACH

1.8 Project Scope

This thesis, describes and clarifies the item used to develop this project. We will modify the algorithm of LEACH protocol by considering Node residual energy and its distance to BS in the CH selection process. Also, we will consider the NCH node distance in the process of cluster formation. The aim of our work is to improve the stability period of Network. We simulate the network using MATLAB 2014a.

1.9 Motivation

With the rapid growth of WSN technology, many routing protocol algorithms has been proposed to preserve data communication and energy consumption. However, sensor nodes limited power supply, which is one of the most important constraints in designing a WSN routing protocol, motivates us to investigate LEACH and its variants to find optimize solutions to overcome the limitations.

1.10 Organization of thesis

This research is divided into five chapters, covering this chapter that introduces a review of wireless sensor networks, a brief background about the scope of this thesis,

an idea about our research problem and how it has been addressed, our objective, and scope of this research. The fundamental idea of remaining chapter can as follow:

Chapter Two: presents a brief background about WSN applications, routing protocols, design issues, LEACH protocol, and most related work in the literature that related to our study.

Chapter Three: presents our algorithm and the benchmarking that we followed to compare and evaluate our algorithm with the previous work.

Chapter Four: presents the simulation results through implementation of our proposed algorithm and compare it with improved Low Energy Adaptive Cluster Hierarchy routing protocol.

Chapter Five: presents work conclusion and future work.

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