PERFORMANCE ANALYSIS OF LOW ENERGY-ADAPTIVE CLUSTERING HIERARCHCAL(LEACH) IN WIRELESS SENSOR NETWORK USING NS2

NURUL HIDAYAH BINTI MAT JAMIL

BACHELOR OF COMPUTER SCIENCE (COMPUTER NETWORK SECURITY) WITH HONOURS UNIVERSITI SULTAN ZAINAL ABIDIN

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DECLARATION

I hereby declare that this report is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Sultan Zainal Abidin or other institutions.

Name: NURUL HIDAYAH BINTI MAT JAMIL

Date:…………………………..

CONFIRMATION

This is to confirm that:

The research conducted and the writing of this report was under my supervisor.

Name   : Dr Nor Aida Binti Mahiddin

Date   : ……………………………………

DEDICATION

Thanks Alhamdulillah to Allah S.W.T for giving me enough health, time and maturity of mind to complete this study in such a form. Millions of thanks that I feel I have not been able to return to the end of my life to the main supervisor Dr. Nor Aida Binti Mahiddin for such great help, guidance, reprimand and advice that is so useful throughout this study. With his extensive expertise helped further strengthen my enthusiasm to complete this study. I also thank the Faculty of Informatics and Computing, and all lecturers for helping me complete my study.

Not forgetting the appreciation and thanks to both my parents Encik Mat Jamil b Abd Rahman and Puan Umi Kalsom bt Othman who provided support and encouragement to overcome all the difficulties faced. Also to the friends who have shared knowledge and guidance throughout this study.

Finally, a word of appreciation and thanks to all parties directly and indirectly involved in the process of completing this study. Indeed, your contribution has helped me a lot in completing this study well and smoothly. Only Allah S.W.T can reward you all and may all of them be blessed by Him.

ABSTRACT

A wireless sensor network(WSN) holds the promise of facilitating large-scale and real-time data in a complex environment such as defense military service, medical services, disaster management, wildlife monitoring, etc. Sensor networks have fault tolerance and rapid tolerance functionality. In the field mentioned above, progress makes them very promising. The main task of WSN is to send and collect data(nodes) from the target, process the data(nodes), and send the data(nodes) back to the specific sites. These nodes for sensors are Communicate to exchange data and information with each other to monitor a particular area. Usually, a sensor node is made up of sensors, processors, transceivers, and power units. In contrast to these functions, a sensor node also has the capability of routing. Routing data in WSN have resource management capability and deployment capability. Due to the distant existence of WSN deployment, sensor nodes face energy optimization. This is because WSN has a limited battery power that shortens the network lifetime. The main purpose is to analyze the performance of Low Energy-Adaptive Clustering Hierarchical (LEACH) protocols in WSN. WSN routing protocol has two network structure which is hierarchical routing and flat routing protocols. In this project we will focuses on hierarchical routing to improve the energy consumption of wireless sensor networks. Different routing strategies have been suggested to solve these problems which is Low Energy Adaptive Clustering Hierarchy (LEACH). In addition, the performance metrics considered in this study is measured based on average packet delivery ratio, throughput and average energy consumption. This performance analysis is implemented using a discrete-event NS2 simulation tool.

ABSTRAK

Rangkaian sensor tanpa wayar (WSN) memegang janji untuk memfasilitasi data berskala besar dan masa nyata dalam persekitaran yang kompleks seperti perkhidmatan ketenteraan pertahanan, perkhidmatan perubatan, pengurusan bencana, pemantauan hidupan liar, dll. Rangkaian sensor mempunyai toleransi kesalahan dan fungsi toleransi pesat . Dalam bidang yang disebutkan di atas, kemajuan menjadikannya sangat menjanjikan. Tugas utama WSN adalah mengirim dan mengumpulkan data (node) dari sasaran, memproses data (node), dan mengirim data (node) kembali ke laman web tertentu. Node untuk sensor ini Berkomunikasi untuk bertukar data dan maklumat antara satu sama lain untuk memantau kawasan tertentu. Biasanya, simpul sensor terdiri daripada sensor, pemproses, pemancar, dan unit kuasa. Berbeza dengan fungsi ini, simpul sensor juga memiliki kemampuan routing. Data penghalaan di WSN mempunyai kemampuan pengurusan sumber dan kemampuan penyebaran. Oleh kerana wujudnya penyebaran WSN yang jauh, node sensor menghadapi pengoptimuman tenaga. Ini kerana WSN mempunyai kuasa bateri terhad yang memendekkan jangka hayat rangkaian. Tujuan utamanya adalah untuk menganalisis prestasi protocol Hierarki Pengelompokan Adaptasi Tenaga Rendah (LEACH) di WSN. Protokol routing WSN mempunyai dua struktur rangkaian yang merupakan protokol routing hierarki dan routing rata. Dalam projek ini kami akan memfokuskan pada hierarki routing untuk meningkatkan penggunaan tenaga rangkaian sensor tanpa wayar. Strategi penghalaan yang berbeza telah disarankan untuk menyelesaikan masalah-masalah ini iaitu Hierarki Pengelompokan Adaptasi Tenaga Rendah (LEACH). Di samping itu, metrik prestasi yang dipertimbangkan dalam kajian ini diukur berdasarkan nisbah penghantaran paket purata, kendandahan dan penggunaan tenaga purata. Analisis prestasi ini dilaksanakan menggunakan alat simulasi NS2 acara diskrite.

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LIST OF ABBREVIATIONS

WSN   Wireless Sensor Network

LEACH   Low Energy-adaptive Clustering Hierarchical

NS2   Network Simulation Version2

TDMA   Time Division Multiple Access

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CHAPTER 1

INTRODUCTION

1.1   Background

Wireless Sensor Network (WSN) is the system that holds the multiple sensing modules sensor that can monitor in a complex environment such as temperature, vibrations, surrounding pressures and geographical conditions(Jamatia et al., 2015) . WSN is built of sensor "nodes", These sensor nodes communicate with each other to exchange information and send or collect data from the target, process the sensed data, and send the data back to specific sites or host. Sensor nodes relay data to the same location is called WSN sink or base station. A sensor node is made up of sensors, processors, transceiver, and power units (Jamatia et al., 2015).

These can be implement in many application field such as medical service, defense military service, disaster management, wildlife monitoring, etc. Sensor networks have characteristics of fault tolerance and rapid tolerance functionality that make them very promising in the field mentioned above (Jamatia et al., 2015).

Furthermore, the studies were focuses of the performance analysis for Low Energy-adaptive Clustering Hierarchical (LEACH) in wireless sensor network (WSN). LEACH are the method that

used to improve the lifespan of wireless sensor network and to reduce the energy consumption of wireless sensor networks.

Moreover, this project can be applying in various industries for example, health care monitoring. There may be two types of medical applications such as, wearable and implanted. Wearable devices are used on the surface of a human body or just in close proximity to the user, and those inserted into the human body are implantable medical devices. There are many other applications, such as body position measurement and person location, overall monitoring in hospitals and homes of ill patients. Body-area networks can collect data about the health, fitness and energy expenditure of an individual (Parmar et al., 2014). [9]

This performance analysis is implemented using discrete-event Network Simulation Version2 (NS2) tool. NS2 is an open source event-driven simulator developed specifically for research in computer communication networks and freely. It is sufficient for the development of new protocols, comparing different protocols and traffic evaluations.

Therefore, to simulate wireless sensor networks in NS2, it is requiring to have additional module to represent the protocols that specific to wireless sensor networks. Mannasim is a framework for wireless sensor networks simulation based on NS2. It is extending NS2 with presenting new modules for designing, development and analyzing various wireless sensor networks applications. The aim of Mannasim is to build a detailed simulation framework that can accurately model different sensor nodes and applications while providing a versatile testbed for algorithm and protocols (Yassine & Ezzati, 2015).

1.1.1   Wireless Sensor Network Routing Protocols

The routing protocol is a mechanism by which the right route is chosen for the data to pass from source to destination. When choosing the path, which depends on the type of network, channel characteristics and efficiency parameters, the method faces many difficulties. Usually, the data sensed by the sensor nodes in a wireless sensor network (WSN) is transmitted to the base station that links the sensor network to the other networks where the data is stored, processed and any action is taken accordingly.

In very narrow sensor networks where the base station and sensor nodes are so similar that they can communicate directly with each other than single-hop communication, but the coverage area is so broad in most WSN implementations that thousands of nodes are needed to be located and this scenario involves multi-hop communication because most sensor nodes are so far from the sink node (gateway). Direct communication is also called single-hop communication, and indirect communication is called multi-hop communication.

The sensor nodes not only generate and deliver their material in multi-hop communication, but also act as a route for other sensor nodes towards the base station. Routing is the method of discovering an acceptable route from the source node to the destination node, and this is the primary task of the network layer.

Depending on the network configuration, routing in WSN in general can be categorized into flat-based routing, hierarchical-based routing, and location-based routing that show in figure 1.1. All nodes are usually allocated equivalent functions or features in flat-based routing. However, in hierarchical-based routing, nodes can perform multiple network functions. In location-based routing, the locations of sensor nodes are exploited to route network data. When such device

parameters can be controlled in order to conform to the current network conditions and usable energy levels, a routing protocol is called adaptive. (Al-Karaki & Kamal, 2004)

In this project, we focus on the hierarchical routing that was under the categories of network structure in wireless sensor network. it works as to maintain the energy consumption of the sensor node in WSN due to reductant of redundant data transmission by data aggregation and reduction of transmission to the base station.
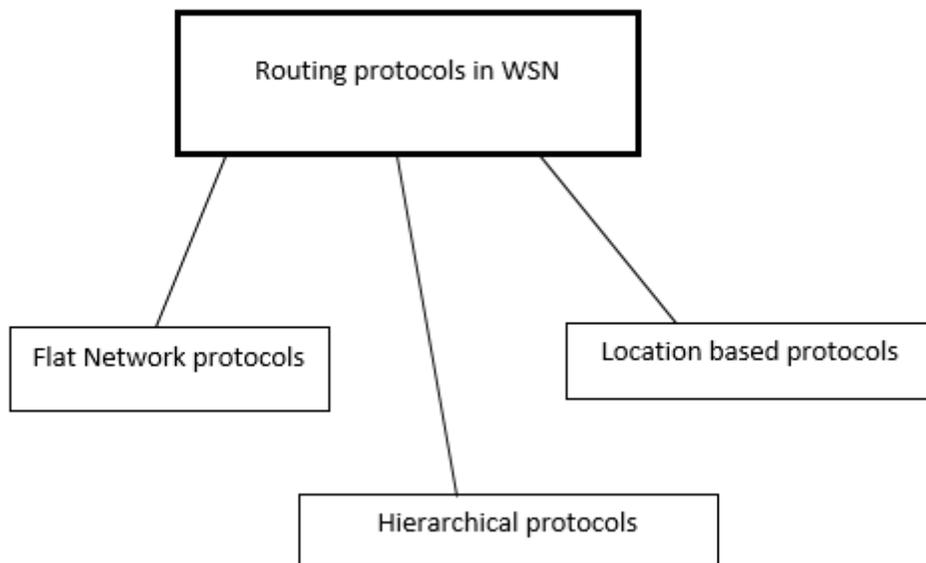

Figure 1.1: Routing protocols classification in WSN

1.1.2   Hierarchical Routing Protocols

Due to the reduction in redundant data transmission, hierarchical-based routing is a viable solution for reducing the energy consumption of WSNs. In addition, the load between sensor nodes can be effectively balanced by assigning different tasks to each sensor node according to its capabilities.

If the density of sensors increases, a single-tier network may cause the gateway to overrun. Such overload can induce communication latency and insufficient event detection, and with a broader range of sensors covering a wider region of interest, the single-gateway architecture is not scalable as the sensors are usually not capable of long-haul communication. The key purpose of the hierarchical routing protocol is to effectively manage the energy usage of sensor nodes by involving them within a single cluster in multi-hop communication and by conducting data consolidation and fusion to minimise the number of messages sent to the sink nodes.

A single-tier network can cause the gateway to overload with the increase in sensors density. Such overload might cause latency in communication and inadequate tracking of events and the single-gateway architecture is not scalable for a larger set of sensors covering a wider area of interest since the sensors are typically not capable of long-haul communication. The main goal of hierarchical routing protocol is to efficiently maintain the energy consumption of sensor nodes by involving them in multi-hop communication within a particular cluster and by performing data aggregation and fusion in order to decrease the number of transmitted messages to the sink nodes.

1.1.3 Low-Energy Adaptive Clustering Hierarchical (LEACH) Protocols

The first and most common energy-efficient hierarchical clustering algorithm for WSNs that has been proposed to minimise power consumption is the low-energy adaptive clustering hierarchy (LEACH) (Parmar et al., 2014). In the wireless sensor network, LEACH is one of the most popular distributed cluster-based routing protocols. In order to enable scalability and robustness for complex networks, it uses localized synchronization and introduces data fusion into the routing protocol to minimise the amount of information that must be transmitted to the base station (Parmar et al., 2014). In order to increase the lifespan of a wireless sensor network, the key purpose of the LEACH protocol is to use less energy needed to build and sustain clusters. LEACH is a hierarchical protocol that transmits most nodes to cluster heads, and the data is aggregated and compressed by the cluster heads and transmitted to the base station (sink) and each node uses a stochastic algorithm at each round to decide if this round will become a cluster head that shown in figure 1.2 (Patel et al., 2011). The number of transmitting and receiving activities can be minimised. Randomized CH rotation and matching clusters, local compression to minimise global connectivity, and regional alignment and control for cluster setup and operation are the main features of LEACH.
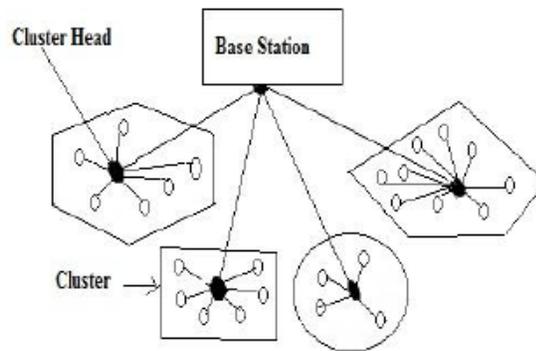

Figure 1.2: Cluster based of Leach in WSN (Patel et al., 2011)

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These protocol has two processing phase which is, the set-up phase and steady-state phase. in the setup phase, sensor is constructed into group for example cluster. A random number between 0 and 1 is selected by each sensor node. Then, in steady-state the data aggregation and transmitting the sensed data are performed. This phase is split into frames, where nodes send their data at most once per frame during their assigned slot to the cluster head that shown in figure 1.3 (Patel et al., 2011). Data transmission take place based on the TDMA schedule and the cluster-head performs data aggregation through local computing contributes to energy consumption.
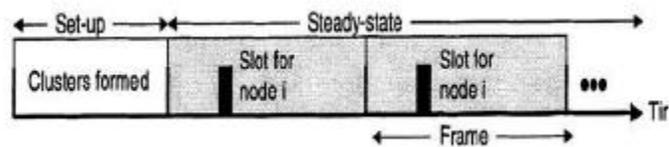

Figure 1.3:Time Line operation of LEACH (Patel et al., 2011)

1.2   Problem Statement

Due to the distant existence of WSN deployment, sensor nodes face energy optimization. This is because WSN has a limited battery power that shortens the network lifetime. Thus, to reduce the energy used by sensor nodes, it is crucial to apply energy-efficient routing protocol to extend the lifetime of whole WSN.

1.3   Objectives

The three main objective of this project are:

     i.   To study LEACH protocol in WSN.

    ii.   To simulate the LEACH protocol in NS2 simulation tools

   iii.   To analyze and evaluate the performance of LEACH protocol in WSN

1.4   Scopes

The propose of this are to evaluate the performance of LEACH protocol in Wireless Sensor Network(WSN). furthermore, it is to implement the routing protocols using NS2 simulation tool.

1.5   Limitation of work

There is some limitation in this project which is:

- Highest cost needed to implement in the real environment.

- The efficient of power usage is low because the energy source of sensors are mainly from battery, it hard to charge or recharge the batteries because of amount of sensors node and it can affect the network lifespan for sensor node in wireless network

1.6   Summary

This chapter explain about the introduction of WSN, wireless sensor network routing protocol, the hierarchical protocol and algorithm which is LEACH protocol. it also discusses about problem statement, objective, scope and limitation of this project. Chapter two is a review of all related study with reference to this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Some research was done on the published literature that was related to this topic before the implementation of the proposed project. The summarization of literature reviews related to this project was discussed in this chapter. The main objective of the literature review is to define the methods and techniques for study that should be used in this project. The literature review is therefore carried out to be used as a guide and as an inspiration for the proposed simulation to be created.

As clarify in chapter 1, it is described the definition of routing protocol in WSN. Low-Energy Adaptive Clustering Hierarchical (LEACH) is a hierarchical routing algorithm protocol that transmits most nodes to cluster heads, and the data is aggregated and compressed by the cluster heads and transmitted to the base station (sink). Because WSN has a limited battery power that shortens the network lifetime. To reduce the energy used by sensor nodes, it is important to apply energy-efficient routing protocol to extend the lifetime of whole WSN.

2.2 Related Works

The previous analyses of the proposed network output review were reviewed in this section of the chapter and will be discussed. In order to provide some information and understanding of these previous findings, some examples, along with their advantages and drawbacks, will be addressed for each listed article.

Title	Number of nodes	Simulation area	Simulation time	Data packet	Speed of nodes	Simulation tool
Performance Analysis of Hierarchical and Flat Network Routing Protocols in Wireless Sensor Network Using Ns-2(2015)	50,75,100,125, and 150	600x500m	100 s	512 bytes	8kbps	Ns2
Evaluation and Comparative Study of Wireless Sensors Networks Hierarchical Protocols(2016)	60,80,100,120,140	100mx100m	1000ms	512mb	2 joule	Ns2
Performance Evaluation of Evaluation of Routing Protocols in Wireless Sensor Networks (2018)	50-400	40mx40m	Not stated	2000bits	0.5 joule	Ns2
Performance Evaluation of LEACH Protocol for Wireless Sensor Network(2014)	11	300x300	300ms	Not stated	Not stated	Ns2
A Review on Hierarchical Routing Protocols for Wireless Sensor Networks(2013)	100	100mx100m	Not stated	500 bytes	2 joule	Ns2
Energy and Throughput Analysis of Hierarchical Routing Protocol (LEACH) for Wireless Sensor Network(2011)	100	1000x1000	600s	Not stated	Not stated	Ns2

Table 2.1: Comparison of Performance Metric

The main purpose of these paper "Performance Analysis of Hierarchical and Flat Network Routing protocols in wireless Sensor Network Using Ns-2" (Jamatia et al., 2015) from Anupam

Jamatia, Kunal Chakma, Nirmalya Kar, Dwijen Rudrapal, and Swapan Debbarmai, they analyze the performance of two categories routing protocol which is Hierarchical and Flat network routing protocol in wireless sensor network. For the purpose of simulation, the researcher has mostly using Temporally-Ordered Routing Algorithm (TORA), Low Energy Adaptive Clustering Hierarchy (LEACH), and INtrusion-tolerant wireless SEnsor NetworkS (INSENS) protocol routing protocols. Furthermore, to analyze the objective of this paper, the researchers used discrete event simulator ns-2, which is a powerful method for simulating ad-hoc networks on the Linux platform, i.e. ubuntu 12.04 LTS, to examine the purpose of this article. To simulate WSN in ns-2, however, it needs to provide an additional module to display WSN-specific protocols. Mannasim is a system for ns-2 based WSN simulation. By adding new modules for architecture, development and study of various WSN applications, it extends ns-2. Mannasim's aim is to build a comprehensive simulation system that can effectively model various sensor nodes and applications while supplying algorithms and protocols with a scalable test bed. Likewise, to simulate the purpose of this performance, the researchers used the traffic source which is CBR(bit-rate-continuous). Connectionless UDP was the traffic type. 512 bytes is the data packet size. The node's bandwidth is 8kbps. In a rectangular file of 600m x 500m with variable nodes 50, 75, 100, 125, and 150, the mobility model uses a random waypoint model. Each sensor node begins its journey from a fixed chosen location to a fixed chosen destination in this mobility model. It stops until the destination is reached. It arbitrarily chooses its path from start point to destination, it goes ahead to destination after a pause period. Different network scenarios are created for different node numbers, pause time, and speed. Complete time of simulation is 100 seconds. As a result, in order to evaluate the efficiency of three WSN protocols, they using the following three performance metric. The following efficiency indicators will be considered: Packet Delivery Fraction (PDF): The

percentage ratio of data packets sent to destinations to those destinations currently generated by the sources via the traffic generator. Throughput: The ratio between the data packets transmitted to the destinations and the source packets produced. "Normalized Routing Load (NRL): The number of "transmitted" routing packets per "delivered" data packet at the destination.

In this paper," Evaluation and Comparative Study of Wireless Sensors Networks Hierarchical Protocols" (Hassan Echoukairi et al., 2016) from Hassan Echoukairi, Khalid Bouragba and Mohammed Ouzzif, they observe the performance of wireless sensor network in Hierarchical protocols LEACH, LEACH-C, and PEGASIS have been analyze as to energy dissipation, throughput, PDR (packet delivery ratio) as a function of the nodes density and base station location by using NS2 simulator. NS2 (network simulator version 2), is a packet level discrete event simulator, developed by UC Berkeley is a widely used tool for computer simulations. It's becoming one of the first selected software to implement network simulation in the academic field. Furthermore, NS2 is a software package that include of some basic components like Tcl/Tk, OTcl, NS2, Tclcl, etc. Besides they also discuss about the effect of the varying node density for each position of a base station in the sensor filed on the parameters metric. All nodes are homogeneous and they randomly distributed on 100m × 100m area with initial energy of 2 Joule. In each of scenario, the BS (base station) is located at (50, 175) m, (50, 75) m and (50, 50) m. In this work, simulation results provide an insight into varying the location of base stations and the number of nodes over the network and analyzing its impact on the various performance metrics. In all three scenarios, LEACH and LECAH-C protocols are better than PEGASIS in energy consumption and throughput. PEGASIS and LECAH protocols are better than LECAH-C in term of PDR.

The author Koteswara Rao Seelam, Nanda Kishor Jeripothula, Krishna Chaitanya Rao Kathala and Sathvik Thogaru in this paper "Performance Evaluation of Routing Protocols in Wireless Sensor Networks" (Koteswara Rao Seelam, Nanda Kishor Jeripothula, 2018) . They discuss about wireless sensor network that refer to a set of scattered sensor designed to monitor and record the physical conditions of the environment and to organize data collected at the central location. The efficiency of these WSN is heavily dependent on the routing protocols. Guidance is a major challenge for computing networks, as it is a trade of between responsiveness and efficiency. The hierarchal layer if routing protocols provides a structure on network stability, energy efficiency and scalability. There are many protocols in this category. In this paper, the researcher focus on analyze the Low Energy Adaptive Clustering Hierarchical(LEACH) and Power Efficient Gathering in Sensor Information system(PEGASIS) hierarchical protocols. It is analyses these protocols on the basis of total mechanical sensors, overhead cost and lifetime availability. The NS2 simulator was used to analyze these protocols. As a result, in order to evaluate the efficiency of two WSN protocols, they using the following performance metric such as delay, latency, packet delivery ratio and throughput. Contract number changed for each simulation of 50-400. They use several routing protocols such as, LEACH and PEGASIS. These routing protocols are analyzed in terms of communications overhead, total power consumption and network life. The result of analysis shows that PEGASIS performs better than LEACH in terms of network lifetime, and connectivity Overheads and Node Death Rate. PEGASIS also offers a longer network life Due to energy efficiency.

"Performance Evaluation of LEACH Protocols for Wireless Sensor Network" (Leena Y.Barai, 2014) from Leena Y.Barai and Mahendra A. Gaikwad. This paper introduces LEACH

protocol efficiency. LEACH is the first network protocol that uses hierarchical routing to maximise the network lifespan for wireless sensor networks. Both nodes in a network are grouped into local clusters, with the cluster-head serving as one node. Both non-cluster head nodes send their data to the cluster head, while the cluster head node collects data from all members of the cluster, conducts data signal processing functions for examples data aggregation and sends data to the remote base station. Therefore, it is far more energy intensive to be a cluster-head node than to be a non-cluster-head node. Thus, all the nodes that belong to the cluster lose communication ability when a cluster-head node dies. This paper provides performance considering parameters such as, Packet Delivery Ratio, Throughput, Delay and the lifetime of the LEACH protocol. they evaluate the performance of LEACH protocol using NS2 simulator. They, observed end to end delay is linearly increases with time. So this is drawback that must be overcome to increase lifetime of network and make LEACH protocol energy efficient.

On the contrary, this paper "A Review on Hierarchical Routing Protocols for Wireless Sensor Networks" (Manap et al., 2013) from Zahariah Manap,Borhanuddin Mohd Ali, Chee Kyun Ng, Nor Kamariah Noordin, and Aduwati Sali. They discuss about routing protocols for Wireless Sensor Networks(WSN) was clarify as the manner of data dissemination from the network source to the base station. Based on the network topology, there are two types of routing protocols in WSN such as, flat routing protocols and hierarchical routing protocol. hierarchical routing protocols are much more energy efficient and scalable compared to flat routing protocols. This paper discusses how topology management and network application influence the performance of cluster-based and chain-based hierarchical networks. It reviews the basic features of sensor connectivity problems used in five common HRPs, such as power control in topology set-up,

sleep/idle pairing and data transmission control, and also examines their impact on the performance of the protocol. A good picture of their respective performances indicates how the network performance will be determined by network applications, i.e. whether reactive or proactive, and topology management, i.e. whether centralised or distributed. The HRPs that they use are, Low-energy Adaptive Clustering Hierarchy (LEACH), Threshold Sensitive Energy Efficient sensor Network (TEEN), Adap- tive Periodic TEEN (APTEEN), Power-efficient Gathering in Sensor Information Systems (PEGASIS) and Power Efficient Data Gathering and Aggregation Protocol-power Aware (PEDAP-PA). These were simulated using NS2 simulator. They simulate all five HRPs on a 100m × 100m network field with 100 sensor nodes that are randomly deployed. The Base Station is located 75m from the sensor field. All nodes are heterogeneous with initial energy supply of 2 J. The energy for the radio electronics, *Eelec* is set to 50 nJ/bit. The energy for radio transmitter, *_amp* is set to 10 pJ/bit/m2 for transmission distances less than 87m (*do*). For the transmission distances greater than 87m, the energy for radio transmitter, *_two-ray-ground* is set to 0.0013 pJ/bit/m4. The energy consumed for data aggregation, *EDA* is set to 5 nJ/bit/signal and the size of each data message is 500 bytes. Finally, from the ensuring debate, it is shown that, compared to cluster-based HRPs, chain-based HRPs ensure a longer network life by three to five times.

Lastly, Rajesh Patel, Sunil Pariyani, and Vijay Ukani. Conducted in this paper "Energy and Throughput Analysis of Hierarchical Routing Protocol(LEACH) for Wireless Sensor Network" (Patel et al., 2011), both the research community and real users, wireless sensor networks (WSNs) have gained growing interest. In a sensor node, the efficient utilization of the energy source is the most relevant conditions for extending the existence of the wireless sensor network are very

important. Many new protocols specially developed for sensor networks have been explored for wireless sensor networks, where energy concern is very important. Most of the importantly, better scalability is given to hierarchical clustering-based routing protocols. Since sensor nodes are typically battery-powered systems, how to reduce the energy usage of nodes, so that the network lifespan can be extended to acceptable periods, is a crucial factor to face. Among this popular LEACH protocol, we have simulated LEACH in NS2 and evaluated LEACH's efficiency in terms of energy, throughput and lifespan, there are several energy-efficient hierarchical routing protocols. simulated the MIT's LEACH cluster based routing protocol using NS 2.27. By varying the parameter Percentage of cluster head in the MIT's LEACH configuration file, they analyzed the performance of the network in terms of lifetime of the sensor network, throughput achieved and total energy consumption by the sensor network. For the experiment, the percentage of cluster heads 2,3, 4, 5, 6, 7 and 8 sensor nodes are taken.

2.3 Summary

The method and parameters applied in the research paper related to this project are concluded in this chapter. The diverse methods and strategies used help to create a better future for project analysis. The thesis in this literature review is undertaken in order to prevent the development of the same concept.

CHAPTER 3

METHODOLOGY

3.1 Introduction

To achieve the objectives of the study that have been attached in chapter 1, method and alternatives way will be discussed from the beginning till the end of the project. The simulation tool that will be used of the project will also be discussed. The network simulation tool that used is NS2 simulator. In addition, the research of methodology and flowchart of the project will also be reviewed. This can produce better understanding of visualization in the implementation phase.

3.2 Research of Methodology

In the research of methodology, the preparation and planning of the project is important to the development of the project. Based on the figure shown below, a few phases of methodology are usable for this project. The first phase is to identifying the problem based on the field of research for better understanding about WSN. For this project, the problem that occurred in WSN are clarify in this phase. The second phase is designing and developing. It is solely focus on to find, analyze and implemented to the project. For this project, LEACH routing protocol algorithm is used in WSN environment. Next, the third phase in methodology is the simulation of project. The simulation that will be used in this project is Network Simulator 2 (NS2). Lastly, the final phase is the performance evaluation. The performance metrics which is packet delivery ratio, average energy consumption and throughput will be evaluate and analyze in this project.
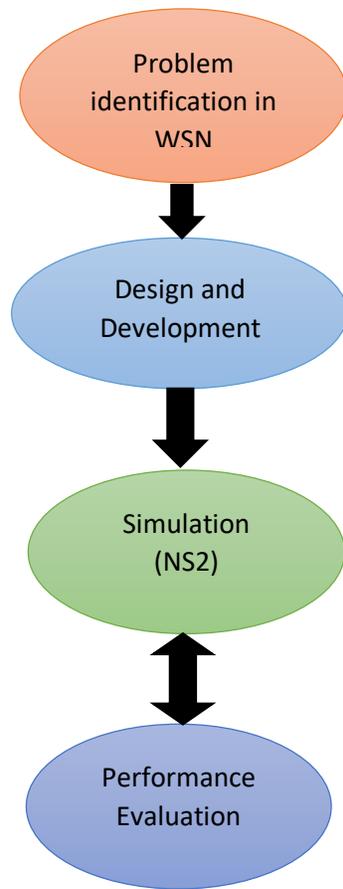
Figure 3.1: Research Methodology

3.3 Simulation

Network Simulator 2 (NS-2) is considered a platform for discrete event simulation and has proven its utility in complex communication network analysis. NS-2 is an open source network simulator that run on various platforms which are Linux, windows and Mac system. These simulator was based on real network simulator. It offers major support for simulation of TCP, routing, and multicast protocol emulation over wired and wireless (local and satellite) networks. Wireless network support was later introduced. Simulation of cellular LAN protocols, ad-hoc mobile networks and networks with wireless sensors. The simulator relies on the ISO/OSI model being followed.

NS-2 is based solely on the programming of Object Oriented (OO), so it is also known as the Object Oriented Discrete Event Simulator. It consists of two languages which is, C++ and the Command Language Object-oriented Method (OTcl). C++ is mostly used to implement different protocols and extend simulation libraries, while OTcl scripts are responsible for configuring simulator, setting network topology, generating network scenarios, and showing effects of simulation. By using TclCL, C++ and OTcl are binded together. It provides a visualization tool called NAM (Network AniMator). It is an animation tool used to graphically represent the network and packet traces. Next, the table below shown the comparison of network simulators (Nayyar & Singh, 2015).

Name of simulator	Simulator type	Programming language	License	Features	limitations
NS-2	Discrete-event simulation	C++&OTCL	Open Source	- Easy to add new protocols. - Availability of a visualization tool.	- Support only two wireless MAC protocols, 802.11, and a single-hop TDMA protocol.
SENS	Discrete-event simulation	C++	Open Source, Commercial	- Platform-independent - User can assemble application-specific environments.	- Not accurately simulate a MAC protocol. - Provides support for sensors, actuators, and physical phenomena only for sound.
J-Sim	Discrete-event simulation	Java	Open Source	- Provides support for energy modeling, with the exception of radio energy consumption. - Support mobile wireless networks and sensor networks.	- Low efficiency of simulation. - The only MAC protocol provided for wireless networks is 802.11.
UW Sim	Discrete-Event	C++	Open Source	- Publicly available and designed solely for UWSN.	- Supports only a limited number of functionalities and calls for extension.

Table 3.1: Comparison of Network Simulator
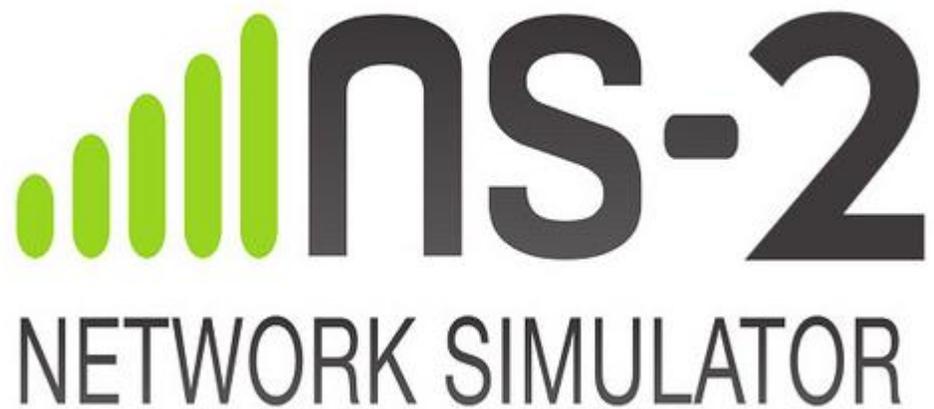
Figure 3.2: Ubuntu Operating System

Figure 3.3: Network Simulation 2 tools
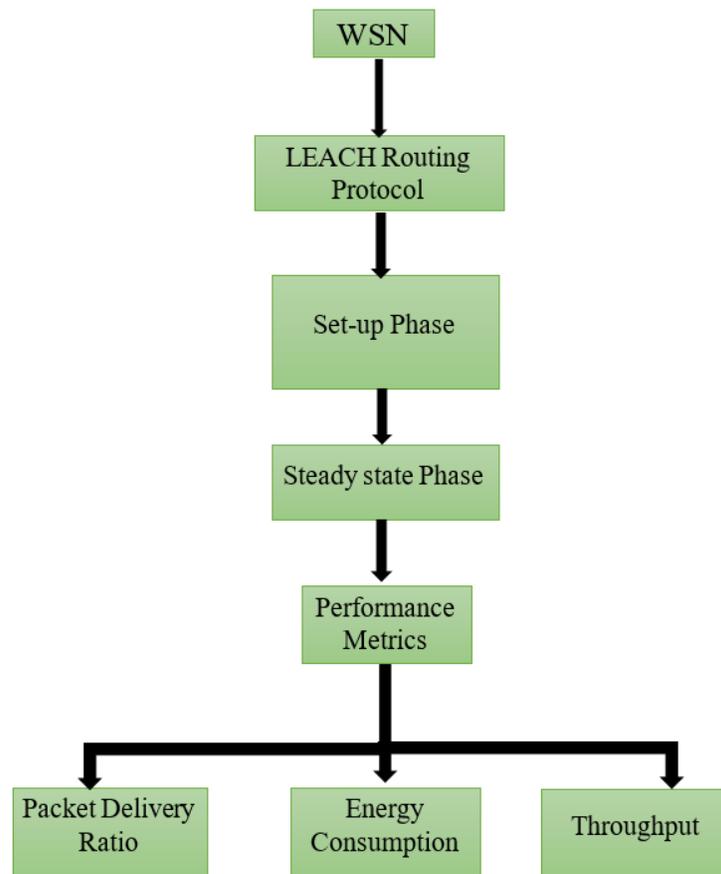
3.4 Project Framework

Figure 3.4: Framework of Leach Routing Protocol

LEACH algorithm protocol consists two phase such as set-up phase and steady state phase. Leach operates in rounds and the round starts with the set-up phases, in which clusters are arranged, followed by a steady state phase in which information is transmitted to the base station. The steady state step is longer compared to the setup stage to decrease the overhead (Dhingra & Mandoria, 2015). In the set-up phase it been divided into two part which is, cluster head advertisement and cluster set-up. Followed by steady phase is also divided into two part such as schedule creation and data transmission. In this project, we focus on the set-up phase to improve the network lifetime wireless sensor network (Shukla, 2014).

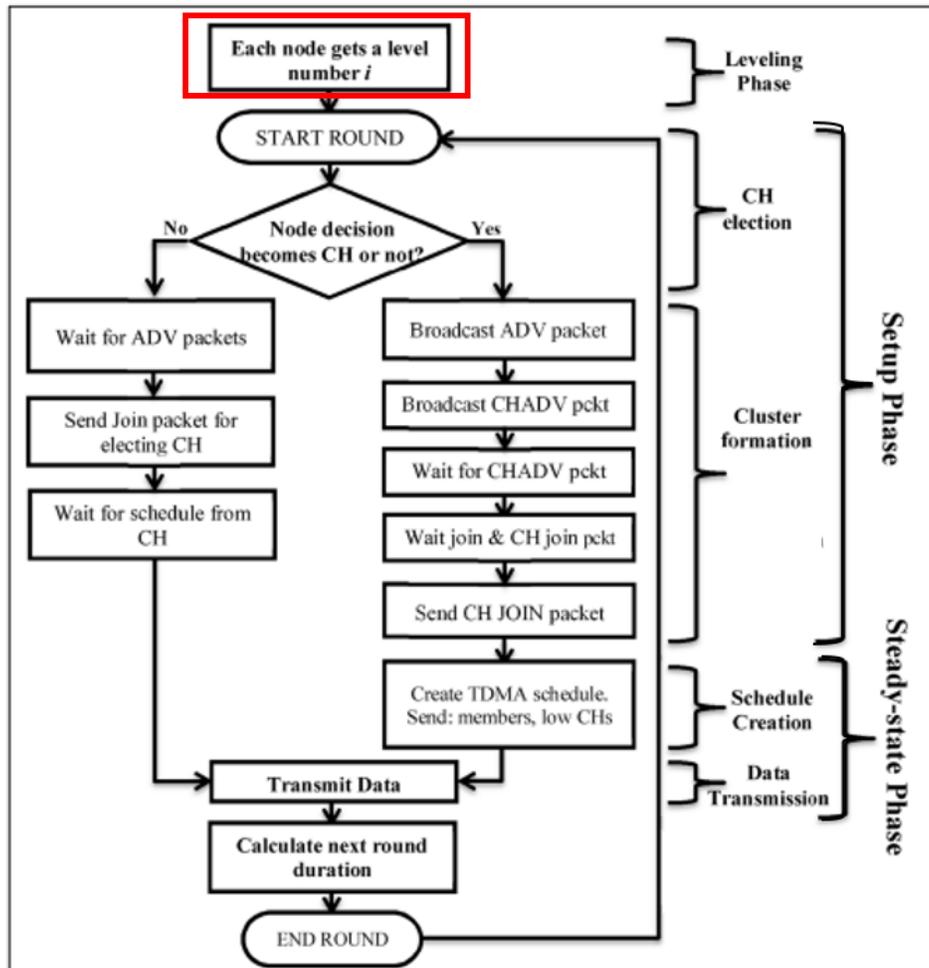## 3.5 Project Flowchart of the Route Selection Technique

Figure 3.5: Flowchart of LEACH protocol (Al-Sodairi & Ouni, 2018)

In the figure above shown, the flow process of the leach protocol. it divided into two phase which are setup phase and steady-state phase. The setup phase was sub into two part, cluster head selection and cluster formation and steady-state phase also sub into two-part schedule creation and data transmission. In addition, before going through phase it will go to the level phase which is each node will get a level number i.
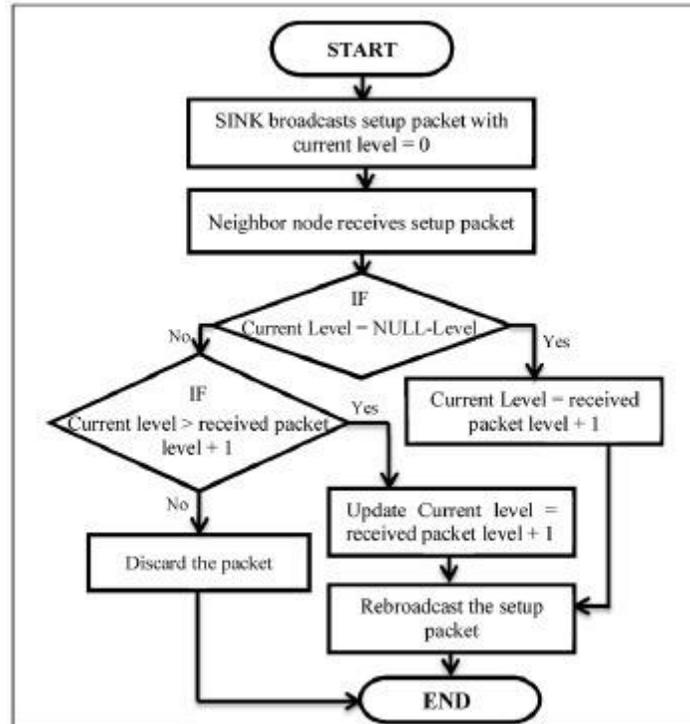
Figure 3.6: Flowchart of level phase (Al-Sodairi & Ouni, 2018)

The level phase of the process operates as below:

i.   Start and the sink broadcast setup the current level which is 0.

ii.   Then, the neighbor node will receive setup packet.

iii.   Next is relationship to determine whether the current level higher or lower than received packet.

iv.   If "Yes" which is current level 0, it will receive packet level and plus 1 to current level. Then send to the rebroadcast. It will setup packet and end.

v.   If "No" the new relationship create which is to determine the current of level.

vi.   If the current level higher than receive packet, and if "Yes" it will receive packet level and plus 1 to update current level and send it to the rebroadcast setup packet and end.

vii.   If "No" it will discard the packet and end it.

3.6 Summary

This chapter explains the concept of the research methodology, framework, and flowchart of the project. It provides a better understanding for the implementation of the simulator that we choose for this project.

CHAPTER 4

IMPLEMENTATION AND RESULT

CHAPTER 5

CONCLUSION

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APPENDIX

GANTT CHART FINAL YEAR PROJECT 1

Activity/week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Topic Discussion and method	■													
Project title proposal		■												
Title, abstract and project scope submission			■											
Introduction				■										
Literature Review				■	■									
Proposal, slide and Gantt chart preparation					■									
Proposal presentation						■								
Detail methodology							■							
POC methodology conference								■						
Format writing conference									■					
Proposal draft preparation and discussion										■				
Proposal draft submission											■			
Final report and presentation preparation												■		
Final presentation & panel's evaluation													■	
Proposal report submission														■

Gantt Chart 1: Activities and milestones of FYP 1

GANTT CHART FINAL YEAR PROJECT 2