CENTRALIZED WIRELESS SENSOR NETWORK DEPLOYMENT

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Date **: …….**

Dedicated to my beloved family especially my father and mother, brother, and also to all my friends

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ABSTRAK

Rangkaian Sensor Wayarles telah menjadi tren baru untuk mengesan parameter seperti suhu, kelembapan, tekanan dan sebagainya Walaupun teknologi telah diciptakan akhir era 90-an tapi teknologi ini masih baru untuk Malaysia. “Sensor node” akan bertanggungjawab untuk memindahkan data dari parameter yang dikesan ke stesen pengkalan. Terdapat banyak topologi yang boleh digunakan untuk menetapkan “Sensor Node”. Topologi yang dimaksudkan adalah “Star” (terpusat), “Mesh”, “Tree” dan lain-lain topologi bergantung pada penggunaan dan persekitaran “SensorNode“ ditempatkan. Projek ini adalah tentang penggelaran Rangkaian Sensor Wayarles menggunakan topologi berpusat merasakan suhu dan kelembapan. Topologi berpusat digunakan kerana kesederhanaan dan lebih luas cakupan. Semua nod yang disambungkan kepada satu stesen pengkalan. Stesen pengkalan memerlukan penanganan mesej yang lebih besar, “routing”, dan kemampuan mengambil keputusan daripada node lain. Dalam hal ini “base station” adalah simpul sensor itu sendiri. Masalah utama tentang Rangkaian Sensor Wayarles ini adalah konsumsi tenaga “Sensor Node”. Ini kerana, “Sensor Node” menggunakan bateri sebagai catu daya, sehingga konsumsi energi harus dikurangkan supaya “Sensor Node” akan tahan lebih lama. Optimasi konsumsi tenaga daripada nod sensor akan dilakukan dengan memanipulasi “RF Power” dan “Sampling Rate” untuk setiap sensor node.

ABSTRACT

Wireless Sensor Network has become the new trend of sensing parameter such as temperature, humidity, pressure and etc. Even though the technology has been invented late of 90‟s but this technology is still new for Malaysia. The Sensor node will be responsible to transfer the data of sensed parameter to base station. There are many topologies that can be used to arrange the sensor nodes. These topologies are star (centralized), mesh, tree and etc. The topology depends on the usage and the environment of the sensor nodes placed. This project is about the deployment of the Wireless Sensor Network using the centralized topology to sense the temperature and humidity. Centralized topology is used due to simplicity and wider range of coverage. All nodes are connected to a single base station. The base station requires greater message handling, routing, and decision-making capabilities than the other nodes. The main issue about this Wireless Sensor Network is the energy consumption of the sensor nodes. Since the sensor node using battery as the power supply, so the energy consumption must be reduced so that the sensor node‟s life span will be higher. The optimization of the energy consumption of sensor node will be done by manipulating the RF Power and Sampling Rate of the each sensor node.

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LIST OF ABBREVIATION

CCD	-	Clear Channel Assesment
DSSS	-	Direct Sequence Spread Spectrum
ED	-	Energy Detection
IEEE	-	The Institute of Electrical and Electronics Engineers
GUI	-	Graphical User Interface
LOS	-	Line of Sight
LQI	-	Link Quality Indicator
MAC	-	Medium Access Control
MIMO	-	Multiple Input Multiple Output
nesC	-	Network Embedded System C
NLOS	-	None Line of Sight
OEM	-	Original Equipment Manufacturer
OS	-	Operating System
OTAP	-	Over the Air Programming
PHY	-	Physical
PSM	-	Projek Sarjana Muda
RF	-	Radio Frequency
SAP	-	Service Access Point
USB	-	Universal Serial Bus
WSN	-	Wireless Sensor Network

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CHAPTER I

INTRODUCTION

1.0 Project Background

The focus of this project is on deployment of Wireless Sensor Network (WSN) using centralized (star) topology to analyze the propagation scenario of the sensor nodes and to optimize the energy level of the sensor nodes.

1.1.1 Wireless Sensor Network

Wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, at different locations [1]. Wireless sensor networks can be designed in a variety of ways to address different priorities and make the appropriate technology trade-offs based on the requirements of the application. Self-organizing wireless sensor network architectures have enabled new wireless machine-to-machine applications, including motion-detection sensors used on the battlefield; thermometers gauging the temperature of food products and pharmaceuticals in transit; and medical devices monitoring patient vital signs. All wireless sensor networking systems share a set of common requirements. These include:

- **Low power consumption** - To support long-term operation, the power consumption of the radio link must be minimized so that devices can be powered by compact, lightweight batteries such as a coin cell battery for long periods of time.
- **Ease of Use** - The network protocol allows the sensor network to initialize itself in a highly ad hoc, self-organizing manner.
- **Scalability** - The network must support the number of nodes required immediately and must also be able to support future growth without causing exponential growth of overhead.
- **Responsiveness** - Topology discover and re-discovery must be efficient, especially for applications where sensor nodes are mobile, such as in mobile machines or equipment or for wearable sensors.
- **Range** - The sensor nodes able to transmit data up to range of 500 meters. The range is depends on the type of sensor nodes used.

1.1.2 Topology

Network topology plays an important role in setting up the WSN for deployment. As we know there are many type of network topology such as star, mesh, tree, ring, bus and etc [2]. For this project purpose star or centralized topology is chosen and from there the advantages of the topology will analyze by creating a test-bed.

1.1.2.1 Star Topology

A star topology is a single-hop system in which all wireless sensor nodes are within direct communication range usually 30 to 100 meters to the a gateway. All sensor nodes are identical and the gateway serves to communicate data and commands to the sensor endpoints [2]. The base station requires greater message handling, routing, and decision-making capabilities than the other nodes. In this case the base station is the sensor node itself.

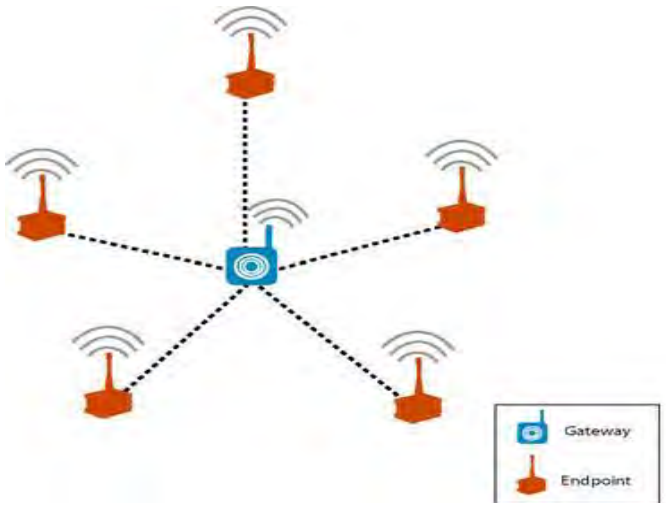

Figure 1.0 Star Topology

1.1.2.2 Star Hybrid

A star-mesh hybrid seeks to take advantage of the low power and simplicity of the star topology, as well as the extended range and self-healing nature of a mesh topology. A star-mesh hybrid organizes sensor nodes in a star topology around routers which, in turn, organize themselves in a mesh network. The routers serve both to extend the range of the network and to provide fault tolerance. Since wireless sensor nodes can communicate with multiple routers, the network reconfigures itself around the remaining routers if one fails or if a radio link experiences interference Figure 1.1.

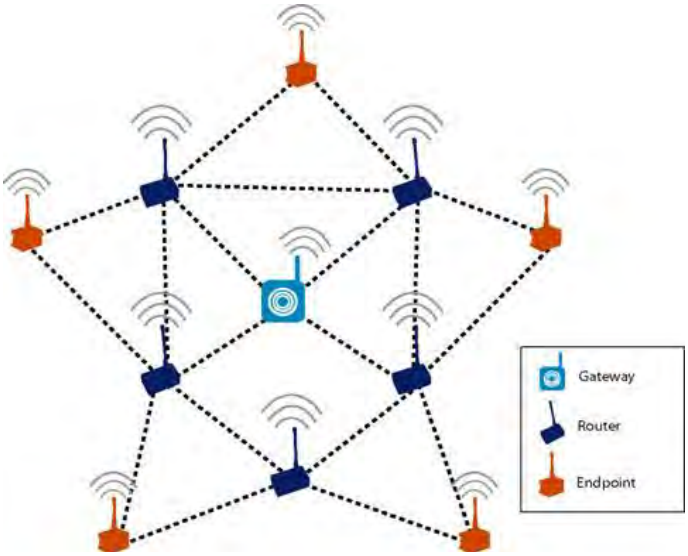

Figure 1.1 Star Hybrid Topology

1.2 Problem Statement and Objective

1.2.1 Problem Statement

Most of existing device to measure the temperature and humidity are wired type, which means wires or cables need (e.g USB cable) to be attached to the control center (computer) to obtain required sensed data. There are some problems in using wired device where it involves lots of wire to be connected with the control center if data needed for different location. Another problem is when temperature and humidity need to be measured in long range of distance. It will be tedious to connect the device to the control center. So, by using wireless sensor network we can measure the temperature and humidity for different node and retrieve the data from a long distance.

Usage of WSN also has some problems. One of the main issues in WSN is the energy consumption of the sensor node. Since most of the sensor node will use batteries as the power supply, the issue of optimization is desperately needed as to make sure the battery can last long. Sensor node will be in "ON" state for 24 hours and it consumes lot of energy because even

though at times the sensor node does not sense any parameter but it will transmit signal to the base station to stay connected with the topology. This makes the lifespan of the sensor node lower, thus the voltage of the sensor node must be monitored so that there are enough voltages for the sensor node to sense and send the data to the control center. For this project IRIS motes which are a Crossbow‟s product is used as the sensor nodes and base station. The user guide says the battery can last long till a year. A test is conducted to find out the voltage drop each day and the result obtained is plotted. From figure 1.2, the observation is each day the battery voltage drop is drastic and critical. In 5 days the battery voltage dropped from 3.0 V to 2.5 V. This proves that with the original settings of the IRIS sensor node, the battery cannot last long till a year.

The significant of this project is to deploy WSN in centralized topology with an optimum energy consumption. Since the main issue in WSN sensor nodes is the energy consumption, it will be ideal if a minimum energy is used by the sensor nodes to transfer the packets and data to the base station.

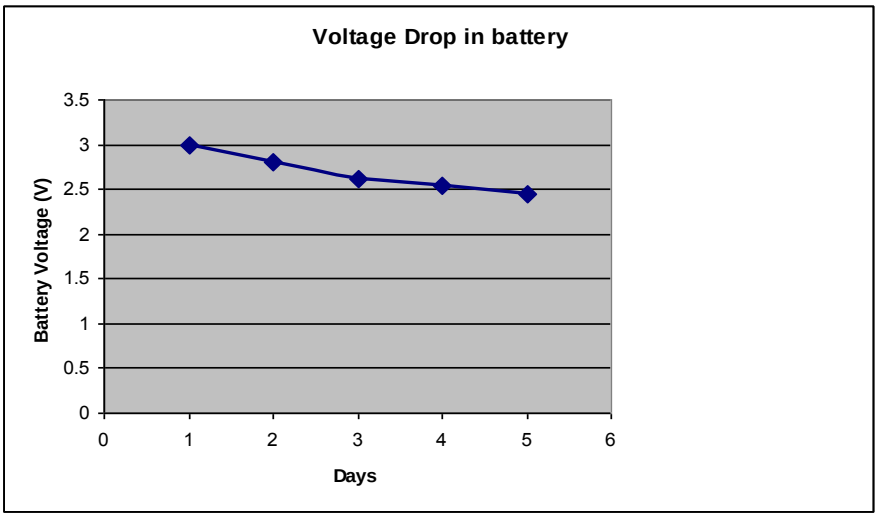

Figure 1.2: Voltage drop of IRIS sensor node per day

1.2.2 Objectives

- To deploy wireless sensor nodes in centralized topology for different propagation scenarios (test-bed implementation)
    - Indoor (LOS)
    - Outdoor (LOS)

- To monitor the node time-by-time to make sure it remain in centralized topology.

- To ensure RF Power (P_{TX}) and Sampling Rate modification optimize the energy consumption of the sensor nodes.

- To come out with a best solution of parameter modification that produces the lowest energy consumption thus increases the lifespan of the sensor node.

1.3 Scope of Work

The scope of work involved in this project can be divided into four which are deployment, monitoring and data collection, analysis, and optimization.

1.3.1 Deployment

This part involves the understanding on all the theories on WSN and network topology. Also the understanding also includes the process of indentifying the hardware and software involved and the requirements. A test-bed must be also implemented for this project.

1.3.2 Monitoring and Collection

Monitoring involves monitoring the sensor node to observe whether the data of sensed parameters has been send correctly to the control center. Then the data form the control center need to be collected in a specific location such as database, MS Excel and etc. The collection is very useful for further analysis.

1.3.3 Optimization

Optimization process involves two matters which are manipulating the RF Power and changing the sampling rate. Both of this optimization process is done by using appropriate software.

1.3.4 Evaluation

Evaluation is mainly on the sensor nodes energy consumption of the sensor nodes. This analysis is done by tabulating and plotting graphs using the collected data to do a comparison between the normal sensor nodes and optimize sensor nodes.

1.4 Contribution of Project

A project is considered successful if there is some contribution from the project done. As for this project, the main contribution is in terms of energy optimization of the sensor nodes. For this, two parameters will be modified to observe the effect on the energy consumption of the sensor node. The first parameter is the RF power and the second parameter is the sampling rate. The second contribution of the project is on the analysis of propagation scenario of the centralized topology. The analysis of performance of the sensor node is done for two propagation scenarios which are Line of Sight (LOS) and None Line of Sight (NLOS).

1.5 Thesis Organization

This thesis contains five chapters. First chapter is the Introduction where by the introduction about the project title, the problem statement, objectives and scopes were stated. The second chapter is the Literature Review which contains all the theoretical study related to the project. The study includes the hardware part and also the software part. Next will be Methodology where in here the flow of the project will be shown using a flow chart. In addition, all the works related to the project will be well explained in this section. The fourth chapter is the Result and Analysis which contains all the result of the project or findings visually and textually. Visual representation is shown by plotting graphs, tables, diagrams and charts. The last chapter will be the Conclusion and Recommendation which will conclude the achievement of the project based on the objectives stated. The recommendations are for further development of the project.