PERFORMANCE EVALUATION OF LEACH PROTOCOL FOR WIRELESS SENSOR NETWORKS USING NS2

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Special dedication to my beloved family, my kind hearted supervisor Madam Zahariah binti Manap and to all my dearest friends.

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ABSTRACT

Wireless sensor network (WSN) is emerging technology which offer facilities to the wide variety of applications. WSNs introduce a new kind of data measurement for harsh environment and unreachable areas. The sensor nodes used to collect all the information from the environment phenomenon changes and will send all the information to the base station. This project focusing on two types of the WSN structure which are flat-based routing and hierarchical-based routing. The flat-based routing basically transmit the information to each neighbouring nodes as a route before send the information to the base station. Different method used in hierarchical-based routing as the sensor node will send the collected information to the central node, compress the information and transfer the information to the base station. The performance of both routing will be evaluated by using Network Simulator 2 (NS2) in term of power consumption, number of survival nodes and also the amount of data received at the base station. The simulation results show that the performance of Low Energy Adaptive Clustering Hierarchy using hierarchy-based are more energy efficient compare to Destination-Sequence Distance Vector.

ABSTRAK

Rangkaian pengesan tanpa wayar ialah teknologi baru yang muncul dengan menawarkan kemudahan kepada pelbagai jenis penggunaan. Rangkaian pengesan tanpa wayar memperkenalkan sejenis bentuk pengukuran data untuk persekitaran yang teruk dan kawasan-kawasan yang tidak boleh dicapai. Nodus pengesan digunakan untuk mengumpul semua maklumat dari perubahan fenomena persekitaran dan akan menghantar semua maklumat kepada stesen pangkalan. Projek ini memberi tumpuan kepada dua jenis struktur rangkaian pengesan tanpa wayar iaitu penghalaan berasaskan perataan dan penghalaan berasaskan hirarki. Penghalaan berasaskan perataan pada asasnya menghantar maklumat kepada setiap nodus yang menjadi jiran sebagai laluan sebelum menghantar maklumat kepada stesen pangkalan. Kaedah berbeza digunakan di penghalaan berasaskan hierarki dimana nodus pengesan akan menghantar maklumat yang telah dikumpul kepada nodus pusat, kemudian memadatkan maklumat tersebut dan hantar kepada stesen pangkalan. Prestasi kedua-dua penghalaan akan dinilai dengan menggunakan Network Simulator 2 (NS2) dari segi penggunaan kuasa, bilangan nodus yang hidup dan juga jumlah data diterima di stesen pangkalan. Keputusan simulasi menunjukkan bahawa prestasi Low Energy Adaptive Clustering Hierarchy yang menggunakan penghalaan berasaskan hierarki adalah lebih cekap dalam penggunaan tenaga berbanding dengan Destination-Sequence Distance Vector.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION OF THE PROJECT

Wireless sensor network (WSN) is one type of wireless network which is a rapidly growing field of research and it could be developed for commercial value. The WSN has a great potential to be the most fearsome technology which could replace human kind effort in monitoring process. In general, wireless sensor networks are used to monitor the changes from the environment in certain area with certain range. In WSN system, there a few hundred or could be a few thousands of small sensors or microsensors which can detect the changes from the environment. This network system operates based on three major element which are sensing, data processing and communication.

WSN is very useful network system. This network could be apply to many area of work such as for agriculture, military, environmental, and scientific applications such as medical treatment. The way in which WSN is designed requires energy is taken

as the most important element. Thus, WSN will be used in the most effective way to serve the purpose for which they were deployed in the target region.

However, WSN full operation involves time and space which related to the dimension of network coverage, location of the network and also the synchronization of the data itself. Data is the most important element in WSN as the performance and the efficiency of the network will be viewed by the ratio of data received over the data transferred to the sink in manner of time.

Basically, WSN will transfer a gigantic amount of data in time-stamped time-independent data term (Time Division Multiple Access). Thus, WSN can be said as in-network computation supported. The architecture of WSN can be categorized into two types which are hierarchical data processing and source-node data processing.

The flow of hierarchical data processing architecture start from consecutive tiers and stop processing when information about events of interest arrive at the proper administrative or decision-making point. The sensor nodes have the ability to process the data collected from the environment. The sensor nodes execute some basic computations instead of sending the raw data to the nodes that responsible to fuse and transmit the processed data to other nodes or sink.

As in this state, routing protocols play a high role which function as a key tool that can help in reducing the energy consumption required by route all the collected data from the sensors and transmitting it through the network. However, energy supply and the bandwidth of the channel transmission usually becomes major obstacles for wireless sensor network (WSN) in order to deploy a great number of nodes.

Nevertheless, different routing protocol used in the network also give different performance for the network depends on the application and the area of coverage for the network to be deployed. In this project, Low Energy Adaptive Clustering Hierarchy

(LEACH) protocol will be described in Chapter 3. In order to evaluate the performance of the LEACH protocol, a comparison to one of ad-hoc network routing protocol called Destination-Sequence Distance Vector (DSDV) routing protocol will be made.

1.2 OBJECTIVES OF THE PROJECT

The main objective of this project is to simulate LEACH-routing protocol and DSDV-routing protocol in Network Simulator 2 (NS2). The LEACH routing protocol will be run in hierarchical network structure and the DSDV routing protocol will be run in common mesh network structure as for ad-hoc network.

Besides that, this project aims to compare the performance between the flat-routing and the hierarchical-routing protocols based on the performance of the DSDV and LEACH. The performance parameters that are used for the comparison are the energy consumption, the number of nodes alive and the amount of data received by the base station.

1.3 PROBLEM STATEMENT

Ad-hoc network is one sensor network which useful technology for now and future in monitoring the environment changes for some areas that can covered. However, the conventional ad-hoc network protocol has lack on scalability. The ad-hoc network has to maintain the connection for each sensors for every time the links are break. Therefore, a maintenance and discovery for all routes which connect the sensors are required. Hence, the ad-hoc network will have a limited scalability [1].

Moreover, the conventional ad-hoc network used DSDV which in term of transmission it used table-driven routing method. For table-driven routing method, it used latest sequence number as the selection of route. When source nodes want to send some information to the base station, the nodes will use the better metric for the same sequence number given as in the routing table.

Furthermore, in order to send new information, the routing table are require to be updated regularly. Thus, consuming more battery power for each nodes and a little amount of bandwidth required even though the network in idle mode. In addition, the limited scalability of the network contributed to higher power consumption as when the network re-converges, a new sequence number need to be updated when the topology changes. The DSDV routing protocol cannot be fitted into large scale of sensor networks with dynamic topology.

1.4 SCOPE OF WORK

This work focuses on the WSN specifications itself. The WSN network will be simulated in NS2 software by using LEACH and DSDV routing protocol. Next, the network dimension is 100 meters times 100 meters will be set in order to limit the sensor nodes position. In this work, the number of sensor nodes are 100 where the sensor nodes are randomly deploy in the network. Once the WSN deployed, the sensor nodes cannot be move and change. In order to monitor the performance of the nodes energy consumption, each nodes has the same type, the same and finite energy which is 2 J. The simulation process will be stopped at 300 s.

1.5 BRIEF EXPLANATION OF METHODOLOGY

This project deals on how the hierarchical-routing technique and flat-routing technique will affect the performance of the WSN. The simulation process took place in NS2 software. The specifications of LEACH and DSDV routing protocol will be set in script file and will be executed to produce the output file. All the data collected are tabulated in Microsoft Office Excel 2013 and plotted in graph by using Matlab before to be analyzed.

1.6 REPORT STRUCTURE

Basically, this project consist of five chapters. The first chapter starts with a simple and compact explanation about the characteristic of WSN. Then, understand the theory of WSN for flat-routing and hierarchical-routing protocol. Chapter 2 discusses the theoretical background study of this research which focus on flat-routing technique in wireless sensor network WSN. Chapter 3 discusses the technique been used to simulate the flat-routing and hierarchical-routing protocol by using NS2 software. Chapter 4, the result obtained from the running scenario from NS2 are being analysed. Lastly, Chapter 5 briefly conclude all the findings and results in this project and recommend some ideas for future analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW OF WIRELESS SENSOR NETWORK

A WSN is typically a wireless network which using a sensor to collect data and WSN infrastructure has the basic element which are the sensing process, data process and communication process. These three basic elements allow the administrator to control the WSN as to react, to instrument, and also to observe the alteration or changes in the environment of the coverage area.

As stated in [6], the administrator of the WSN could be governmental, industrial entity, civil, and commercial. Thus, the environment of the WSN could be physical world, biological system, and information technology (IT) framework.

The WSN can be seen has a bright future in technology development where user see this sensor network as an important medium to get an information fetched from the environment. This kind of wireless network has a bigger range of application

such as to monitoring work, surveillance, manipulation, and also information collection once the network has been deployed.

Basically, there are four major components as in [6], in order to establish the sensor network, an assembly of distributed or localized sensors are needed. Sensor nodes are the network components that will be sensing and delivering the data [16]. Depending on the routing algorithms used, sensor nodes will initiate transmission according to measures and/or a query originated from the Task Manager. According to the system application requirements, nodes may do some computations. After computations, it can pass its data to its neighboring nodes or simply pass the data as it is to the Task Manager [16].

An interconnecting network (usually, but not always, wireless-based) is required for sensor network. A gateway is used to connect one network to another network. Gateways can be classified as active, passive, and hybrid. Active gateway allows the sensor nodes to actively send its data to the gateway server. Passive gateway operates by sending a request to sensor nodes. Hybrid gateway combines capabilities of the *active* and *passive* gateways [17].

A central point of information clustering is important part in sensor network establishment. The function of central point is to control the traffic and process of data transmission which required some algorithms to be performed. Another components in sensor network is a set of computing resources at the central point (or beyond) to control the data correlation, event trending, status querying, and also data mining.

Since WSN is based on wireless network, therefore it is based the standard produced by Institute of Electrical and Electronics Engineers (IEEE) which is IEEE 802.15.4. The IEEE 802.15.4 standard requires to transmit in medium range and low power consumption.

The IEEE 802.15.4 standard or Zigbee has average battery lifetime from 2 up to 3 years, 250 kbit/second maximum bit rate, and also 300 meters range covered without the repeaters [18]. Zigbee operates on 868 MHz, 915 MHz and also 2.4 GHz radio frequency. It is provide low power for communication in wireless network [18].

Zigbee has the capability to coordinating devices, topologies a network, and interoperability with other wireless devices.

The sensor in WSN can also be called a sensor node which has a capability in carry out some process on collecting the information from the environment and also communicate with other sensor nodes which contain in the same network system. A sensor node consists of six main components. The components are power source, controller, external memory, transceiver, ADC and also sensors.

Figure 2.1: Sensor node

The power source plays a big role in WSN. The power source could be a battery or capacitor. The source is used to power up the sensing process, data communication process and data processing. But in WSN, since each node has to transmit the collected data to the base station, the data communication process uses more power than any process in the system. In many cases, the wireless sensor node has a limited power source, typically less than 500 mAh, 12 V [6].

The function of controller in WSN is to execute a tasks such as process all the collected data from the environment and also give a command to others component in the sensor node. There are many types of controller that can be used for WSN such as microcontroller, digital signal processor, application-Specific Integrated Circuit (ASIC)

.

However the microcontroller is usually used for sensor nodes in WSN because a few factor such as low cost, easy to program, and also has a flexibility to interact or connect to other devices. As in WSN it is focus more on simpler and easier controller where micro controller meet the requirements.

As for the memory of sensor node, they used a flash external memory. This kind of memory is on-chip memory and meet the sensor node requirements which is has a good storage capacity and less cost. The flash memory can be categorized into two types based on the purpose of the memory which are the user memory and program memory.

Transceiver is a combination of transmitter and receiver in one device. To transmit and receive the data, the sensor nodes need a frequency to operate. Frequency spectrum are important to determine the operating frequency of WSN. Since sensor node operates in Industrial, Scientific and Medical (ISM) radio bands, it used a license-free frequency spectrum but has wide range of transmission media such as radio frequency, infrared, and also laser (optical) communication. The characteristic of laser and infrared it is line-of-sight (LOS) transmission and it will distract with the conditions of atmospheric. Therefore, the radio frequency is the most suitable for the WSN where it operates from 3 kHz up to 300 GHz. Usually, the frequency used for WSN application is 2.4 GHz. Four operation states in transceiver are transmit, receive, idle, and sleep.

Power consumption in receive and idle state is mostly equal. Therefore, in nowadays transceiver it execute operation automatically in which as the transceiver going to idle state, it will shut down the transceiver to reduce power consumption.