ENHANCED AODV FOR EFFICIENT ROUTING PROTOCOL IN WSN

MIOW KY LUEN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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MIOW KY LUEN

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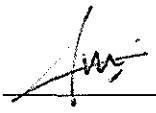
MOHD KHANAPIAH BIN NOR
Pensyarah
Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 12/6/2015

Tarikh: 12/6/2015

DECLARATION

I declared that this thesis entitled "Enhanced AODV for Efficient Routing Protocol in WSN" is the result of my own research except as cited in the reference.

Signature : 

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ABSTRACT

Wireless sensor network is consists of randomly or fixed distributed sensor nodes to monitor physical or environmental conditions, such as temperature, pressure, wind speed, sound and etc. These nodes will sense the surrounding conditions and send their data through the network to administrator. However, the network efficiency is restricted due to the issue of the energy conservation in sensor nodes as it is powered by batteries with limited capacity. Thus, an enhanced Ad-hoc On Demand Vector (AODV) routing protocol which has the potential to increase the sensor network's lifetime was introduced. An algorithm of the enhanced AODV routing protocol are designed, simulated and analyzed in this study by using TinyOS software. Simulation and analysis of data were carried out for various distributed sensor nodes and simulation time to determine the efficiency of the sensor network. The average throughput (kbps) of the enhanced AODV routing protocol shows an increment of 351%, packet delivery ratio by 1.2% and the end-to-end delay (ms) is reduced by 75% when compared to the AODV routing protocol for the 10 nodes with simulation time of 100 seconds. From the results shown, this modified routing protocol has the optimum simulation time of 150 seconds for all three different numbers of distributed sensor nodes which shown the highest efficiency of the sensor network.

ABSTRAK

Rangkaian sensor tanpa wayar terdiri daripada nod sensor yang diagihkan secara rawak atau tetap untuk memantau keadaan fizikal atau alam sekitar, seperti suhu, tekanan, kelajuan angin, bunyi dan lain-lain. Nod ini akan mengesan keadaan sekelilingnya dan menghantar data melalui rangkaian untuk pentadbir. Namun, kecekapan rangkaian adalah terhad disebabkan oleh isu penjimatan tenaga dalam nod sensor kerana ia dikuasakan oleh bateri yang mempunyai kapasiti yang terhad. Oleh itu, peningkatan Ad-hoc Atas Permintaan Vektor (AODV) protokol laluan ini mempunyai potensi untuk melanjutkan tempoh hayat rangkaian sensor telah diperkenalkan. Algoritma protokol laluan peningkatan AODV direka bentuk, disimulasikan dan dianalisis dalam kajian ini dengan menggunakan perisian TinyOS. Simulasi dan analisis data telah dijalankan atas pelbagai taburan nod sensor dan masa simulasi untuk menentukan kecekapan rangkaian sensor. Daya pemprosesan purata (kbps) protokol laluan peningkatan AODV menunjukkan peningkatan sebanyak 351%, nisbah penghantaran paket sebanyak 1.2% dan penangguhan masa (ms) dikurangkan sebanyak 75% berbanding dengan protokol routing AODV untuk 10 nod dengan masa simulasi 100 saat. Dari hasil yang ditunjukkan, protokol laluan yang diubahsuai ini mempunyai masa simulasi optimum 150 saat untuk ketiga-tiga nombor keagihan nod sensor yang berlainan menunjukkan kecekapannya adalah tertinggi dalam rangkaian sensor.

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CHAPTER 1

INTRODUCTION

1.1 Research background

Wireless sensor networks (WSNs) have gained significant interest from researchers and industry since 2000s [1]. Researchers observe WSNs as a domain of multi layered network systems of low power wireless sensor nodes with a little amount of CPU and memory, and a large interconnecting network for high quality sensing of the environment [2]. Basically, a WSN consists of sensor network with sensor nodes to sense, control, and enable administrator to observe and react to certain events happen in surrounding environment. Sensor network is a specific area that involves networking, processing of signal, artificial intelligence (AI), management of database, system architectures for administration, optimization of resources, power management algorithms, and a platform including hardware, software as well as operating system [3]. Network sensor systems are emerged as an important technology that will go through

major deployment in the next few years [4] for the application of collecting data, controlling, monitoring and inspection. The four basic components in a sensor networks are sensors, network,–central point of information clustering and a set of computing resources. In the early stage of WSN, it was being used as radar networks for air traffic control, the national electrical power grid and also use as weather detection. However, these kinds of services required special computers to control the system which lead to high expenses. So, WSNs are being considered to be used in a much less expensive application which is in security, commerce and health monitoring. Besides that, there are many other applications that use WSN such as environmental monitoring, traffic control, industrial sensing and infrastructure security. It is impossible to deliver important information from the environment in real time with wired sensor networks. However, this could be made possible with wireless sensor networks which are used for collection of data and processing the data in real time from environment [5]. The surroundings conditions in the environment are measured and processed by the sensors in order to assess the surrounding situation accurately. The deployment of WSNs can be in manual or random manner, then the sensor nodes will self organize themselves and start communicating each other by sending the sensed data. The two main applications of WSNs can be categorized as monitoring and tracking for various application areas.

1.2 Motivation and significance of research

Wireless sensor networks setup can be done without needed infrastructure which is able to be implemented at unreachable places such as deep forest, mountains, sea and rural area. It can be used to measure different parameters such as temperature, humidity, wind speed and direction. When there is some events happening that may cause serious incident, this can allow the administrator to detect events that occurring and take action immediately. Therefore, many dangerous and disastrous events can be prevented with WSN. Besides, WSN is flexible and the cost for implementation is cheap.

1.3 Problem Statement

There are a few problems in WSN such as packet losses due to transmission errors and mobility, stimulated change of route and battery constraints. One of the most critical issues is energy conservation since nodes will be powered by batteries with limited capacity. Nodes in WSN are always portable devices powered by battery. It will be limited or impossible to replace the power of battery altogether. The main function of a sensor node is to detect event, processing data and transmit the processed data. Energy consuming also should be considered in routing in WSN as sensor nodes power consumption are used in sensing, communication and data processing. Data processing in WSNs involve overwhelming tasks to be performed at the microprocessor in sensor nodes and can cause a significant energy consumption even when compared to the energy consumption during transmission or reception. The power level basically affects many features of the operation in the network including the throughput of the network. So, routing protocol takes an important role in wireless sensor networks in order that the data transmission from source to destination takes time in a short interval. Therefore the energy efficient protocol is a must to increase the lifetime of node as well as the lifetime of network.

1.4 Objectives

The basic objectives of this project are as follows:

1. To study the routing protocol for WSN.
2. To design a routing protocol for WSN.
3. To evaluate and determine the effectiveness of the routing protocol for WSN.

1.5 Scope

The scope of this project is to determine the routing algorithm based on energy efficient, latency and packet loss in WSN. Therefore, other aspects will not be taken in consideration in developing the algorithm. The limitation of the project is that the algorithm is a part of a system to be implemented in wireless sensor communication system. TinyOS software will be used for simulation in order to do comparison between proposed routing protocol and AODV. Hardware is not available.

CHAPTER 2

LITERATURE REVIEW

2.1 Basic Sensor Network Architectural Elements

A sensor network consists of huge number of sensor nodes that are closely arranged. Sensor network can be placed in an open space, on a battlefield, inside the industrial machine, at the bottom of the water, in a biologically contaminated place, in home, or in or on a human body. A sensor node basically is an embedded system with the capability to process and store data. The sensor node can have one or a few sensors operating to detect signals such as seismic, infrared, magnetic, optical, acoustic, radio and chemical or biological data. These nodes communicate through wireless link with neighborhood nodes to send data to the gateway of sensor node. Besides, some of the sensor node has location and positioning knowledge that is obtained through a global positioning system (GPS), however this kind of system can be costly to be implemented.

Sensor nodes are placed in an area which is sensor field and each of the sensors typically has the capability to collect and analyze data and route the data to the destination point. Figure 2.1 shows a basic WSN arrangement. Even though there are many environments need to be considered, but all the wireless networks are assume to have the same functionality. There are several parameters need to be concerned for WSNs, such as sensor type, sensor power consumption, sensor arrangement, operating environment, connectivity, sensing capabilities and signal processing.

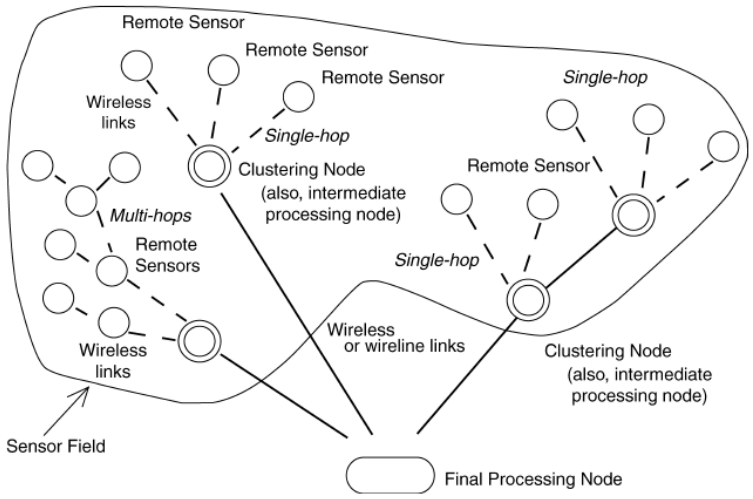

Figure 2.1: Typical sensor network arrangements.

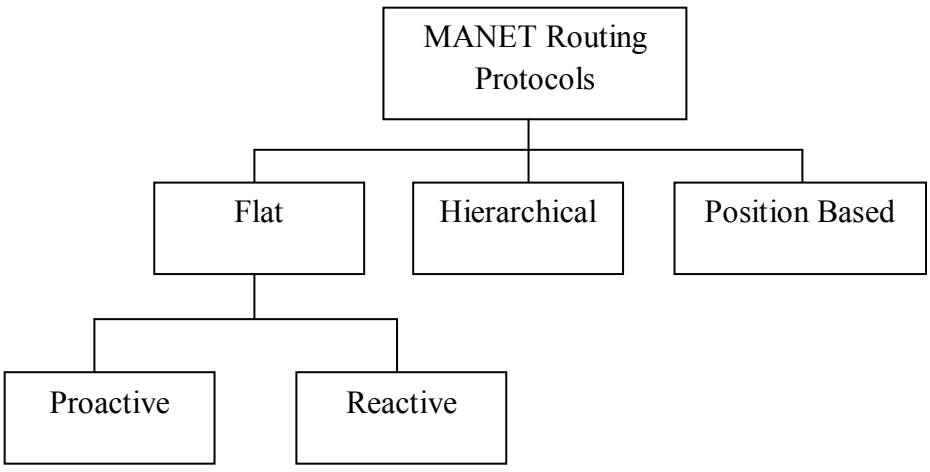

Figure 2.2: Classification of MANET routing protocols.

2.2 Review of Related Works

There are many researchers study the routing protocol of WSNs from different aspects such as node deployment, energy consumption, data reporting model, node heterogeneity, fault tolerance, scalability, network dynamics, transmission media, connectivity, coverage, data aggregation and Quality of Service (QoS). For energy efficiency routing protocol of WSN, numerous designs of routing protocol have been suggested to achieve better performance. Therefore, the study of research has been done by other researchers is important to get a rough idea of designing a routing protocol for WSN.

2.3 Proactive Routing Protocols

A proactive routing protocol is also named as table driven routing protocol. The nodes in this protocol constantly evaluate routes with all accessible nodes and try to maintain reliable and up-to-date routing information. So, a source node can immediately determine a routing path if it needs. When the network topology changes, there must be respective updates need to be changed by propagating the information throughout the network. The proactive routing protocols are Wireless Routing Protocol (WRP)[6], Destination Sequence Distance Vector (DSDV)[6] and Fisheye State Routing (FSR)[6].

2.3.1 Destination Sequence Distance Vector Routing (DSDV)

Destination Sequence Distance Vector Routing (DSDV) [7] is a routing protocol that has a table driven algorithm based on the classic Bellman-Ford routing mechanism.

Several improvements are made including freedom from loops in routing tables. The mobile nodes in the network create a routing table for every possible destination in the network and the number of hops to each destination node. The routing table consists of all available destinations, the metric and the next hop to each destination. A sequence number is marked for each entry and the number is assigned by the destination node. The routing table was update from time to time throughout the network as to maintain the table consistency with the changing topology of the network. The routes selected are always with the later sequence number, when the sequence numbers are similar, the route with the smallest metric are selected. For a huge amount of network traffic, the route updates can employ two types of packets which are full dump and incremental routing. Full dump will cover many packets by sending the full routing table to its neighbor's nodes, whereas in incremental routing update those entries in the routing table that with metric change since last update and it must fit in a packet. When the network is rather stable, incremental updates were sent in order to avoid extra traffic and full dump is inactive. In a rapid changing network, incremental packets will grow big and full dumps will be more active.

2.3.2 Sensor Protocols for Information via Negotiation (SPIN)

Heinzelman et.al. in [8] proposed a family of adaptive protocol that distribute all the information at each node to other node assume that all the nodes in a network are potential base stations. User was able to query any node and get the required information immediately by using data negotiation and resource adaptive algorithms. The nodes in this protocol names their data using high level descriptors called meta-data which is used to negotiate and avoid the transmission of redundant data. The transmission of data is based on the application of specific knowledge of data and the knowledge of the resources available which enables the sensors use the energy and bandwidth efficiently. SPIN was able to overcome the limitation of the classical flooding major obstacles

which is implosion, overlap and resource blindness by negotiation. SPIN's meta-data approach was used to differentiate between various data and identify the redundant data inside a network. It only ensures relevant information is being transmitted. The two main protocols for SPIN are SPIN-1 and SPIN-2, which mainly incorporate in negotiation before data transmission. SPIN-1 protocol is a 3 stage protocol as its sensor nodes use 3 types of message which is ADV, REQ and DATA for communication. SPIN-2 is an extension to SPIN-1 with an additional of threshold based resource awareness mechanism for negotiation. SPIN's advantages are having high performance at low cost in term of energy, computation, communication and complexity.

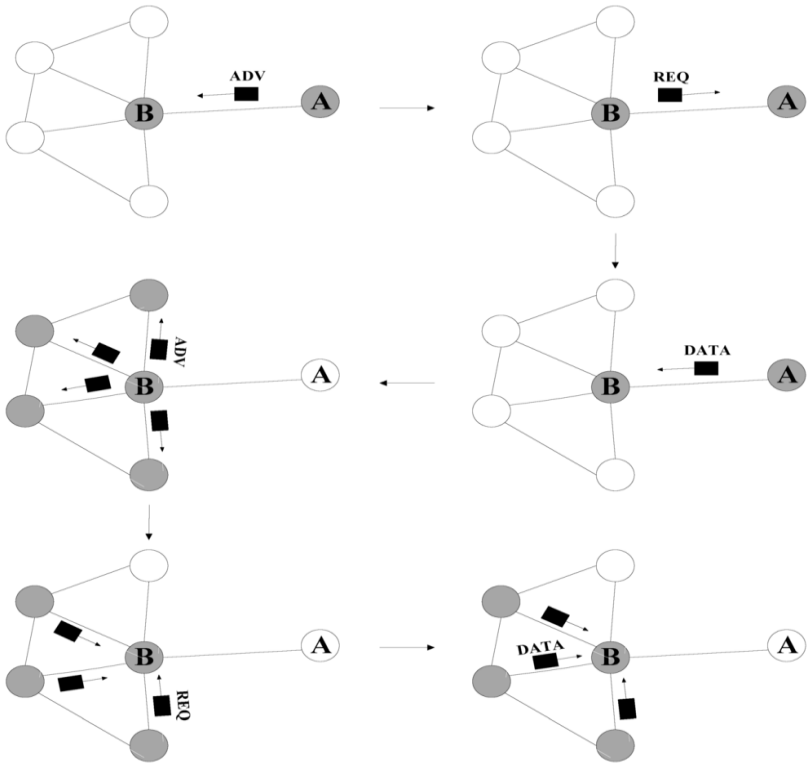

Figure 2.3: Sensor Protocols for Information via Negotiation (SPIN) routing.