UNIVERSITI PUTRA MALAYSIA

LOCATION-BASED APPROACH FOR ROUTE MAINTENANCE IN DYNAMIC SOURCE ROUTING PROTOCOL

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By

Muhammad Farhan Sjaugi

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for Degree of Master of Science

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DEDICATION

Dedicated to my lovely parents,

to my lovely fiancee and

to Indonesia

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

LOCATION-BASED APPROACH FOR ROUTE MAINTENANCE IN DYNAMIC SOURCE ROUTING PROTOCOL

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Muhammad Farhan Sjaugi

November 2008

Chairman: Associate Professor Mohamed Othman, PhD
Faculty: Computer Science and Information Technology

Earlier, the idea of mobile computers and ad hoc networks was not on the mind of anyone. All specifications and implementations for the computer networks during that time were designed for wired systems. This is a big challenge for computer engineer since these two systems have different characteristics. Wireless network means dynamic topology, dynamic structure and no infrastructure, while wired network is the opposites. Basically mobile wireless network has the same standard layers of structure, with modifications and functionality that differ from the earlier networks because of the absence of infrastructure.

To facilitate communication within the network, a routing protocol is used to discover routes between nodes. Building a MANET routing protocol is not an easy job, since efficiency and correctness become the main concern. Some approach had been proposed to make routing protocol becomes efficient and correct.

Dynamic Source Routing (DSR) protocol is known to be a simple routing protocol in MANET. DSR is based on the concept of source routing. For this protocol, mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated as new routes are learned. There are two major phases of the protocol - route discovery and route maintenance Route discovery uses route request and route reply packets. Route maintenance uses route error packets and acknowledgments.

Although DSR can respond a route quickly, it yields a long delay when a route is rebuilt. This is because when source node receives RERR packet, it will try to find alternative routes from route cache. If alternative routes are not available, source node, then, will enter route discovery phase to find new routes. Finding a route in wireless network require considerable resources, such as time, bandwidth, and power because it relies on broadcasting. In some case any packets may still reach its destination, but with some delay. This delay is very expensive and leads to undesired effect, especially in real time networks and the networks with QoS, where the packet delay and packet delivery is the main concern.

The objectives of this research are to propose new algorithm to detect route failure as early warning message to the protocol to take further action, and to propose new algorithm for DSR route maintenance to response the early warning message from route failure detection algorithm. The proposed algorithms based on node location information that may be collected through Global Positioning System (GPS).

This thesis introduces two new route maintenance strategies by utilizing node location information. These new route maintenance strategies are called as DISTANCE (DIstance baSed rouTe maintenANCE) and ADISTANCE (Adaptive DISTANCE). The algorithms work by adding another node (called bridge node) into the source list to prevent the link from failure. From the simulation result, both algoritmns improves the performance of DSR in terms of packet sending ratio, delay and routing overhead.

Abstrak disertasi yang diserahkan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk ijazah master sains

PENDEKATAN BERASASKAN LOKASI BAGI PENYELENGGARAAN PENGHALAAN LALUAN DALAM PROTOKOL PENGHALAAN SUMBER DINAMIK

Oleh

Muhammad Farhan Sjaugi

November 2008

Pengerusi: Profesor Madya Mohamed Othman, PhD
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Pada peringkat awal tiada siapa pun terfikir tentang komputer mudah alih dan rangkaian ad hoc. Pada masa itu, semua spesifikasi dan perlaksanaan untuk rangkaian komputer hanya menggunakan rangkaian berwayar sahaja. Ini merupakan satu cabaran yang besar kepada jurutera komputer kerana kedua-dua rangkaian ini mempunyai sifat-sifat yang berbeza. Rangkaian tanpa wayar bercirikan struktur yang dinamik dan tanpa infrastruktur, manakala rangkaian berwayar membawa maksud yang sebaliknya. Pada asasnya rangkaian mudah alih tanpa wayar mempunyai lapisan piawai yang sama dengan rangkaian berwayar kecuali dengan beberapa pengubahsuaian dan fungsi yang berbeza daripada rangkaian berwayar kerana kekurangan dari segi infrastruktur.

Untuk memudahkan komunikasi dalam rangkaian, protokol penghalaan laluan digunakan untuk mencari laluan diantara nod-nod. Membina protokol pencarian laluan MANET bukanlah suatu kerja yang mudah kerana kecekapan dan ketepatan menjadi hal yang utama. Beberapa pendekatan penyelidikan telah dicadangkan untuk menjadikan protokol penghalaan laluan lebih cekap dan tepat.

Protokol Penghalaan Sumber Pantas (DSR) adalah satu protokol pencarian laluan yang ringkas dalam MANET. Protokol ini berdasarkan kepada konsep laluan daripada sumber. Protokol ini mengekalkan simpanan laluan sementara yang mengandungi laluan-laluan sumber yang diketahui oleh setiap nod. Simpanan laluan sementara dikemaskini secara berterusan apabila laluan yang baru dikenalpasti. Terdapat dua fasa utama dalam protokol ini - Pencarian Laluan dan Penyelenggaraan Laluan. Pencarian Laluan menggunakan paket permintaan-laluan dan paket laluan-balas. Penyelenggaraan Laluan menggunakan paket ralat-laluan dan paket perakuan.

Walaupun DSR boleh bertindak balas dengan cepat, ia menghasilkan kelewatan apabila laluan dinina semula. Ini kerana apabila nod sumber menerima paket ralat-laluan, ia akan cuba untuk mencari laluan alternatif daripada simpanan laluan sementara. Jika tiada laluan alternatif yang boleh digunakan, nod sumber akan memasuki fasa Pencarian Laluan untuk mencari laluan yang baru. Mencari laluan didalam rangkaian tanpa wayar memerlukan pertimbangan sumber yang banyak, seperti masa, lebar jalur dan tenaga kerana ia bergantung kepada penyiaran. Dalam kes tertentu, paket boleh sampai ke destinasi tetapi dengan lewat. Kelewatan ini boleh menyebabkan kesan yang tidak diingini, terutama

sekali dalam rangkaian masa nyata dan rangkaian dengan QoS, dimana kelewatan paket dan penghantaran paket merupakan hal yang paling utama.

Objektif penyelidikan ini adalah untuk mencadangkan algoritma yang baru untuk mengesan kegagalan laluan sebagai mesej amaran awal kepada protokol supaya tindakan selanjutnya boleh diambil dan juga mencadangkan algoritma baru untuk penyelenggaraan laluan DSR agar boleh bertindak balas terhadap mesej amaran awal daripada algoritma pengesan kegagalan laluan. Algoritma yang dicadangkan adalah berdasarkan maklumat lokasi nod yang dikumpul menggunakan Sistim Kedudukan Global (GPS).

Tesis ini memperkenalkan dua strategi penyelenggaraan laluan dengan menggunakan maklumat lokasi nod. Strategi penyelenggaraan laluan ini dipanggil sebagai Penyelenggaran Laluan Berasaskan Jarak (DISTANCE) dan Penyelaggaran Laluan Adaptif Berdasarkan Jarak (ADISTANCE). Algoritma ini bertindak dengan menambah nod lain (dipanggil nod jambatan) ke dalam senarai sumber untuk mengelakkan kegagalan sambungan. Berasaskan kepada hasil eksperimen simulasi, kedua-dua algoritma ini memperbaiki prestasi DSR dalam penghantaran paket, kelewatan dan beban laluan.

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Muhammad Farhan Sjaugi

Date: 16 September 2008

I certify that an Examination Committee met on 22^{nd} of August 2008 to conduct the final examination of Muhammad Farhan Sjaugi on his Master of Science thesis entitled "Location-Based Approach for Route Maintenance in Dynamic Source Routing Protocol" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members if the Examination Comittee are as follows:

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DECLARATION

I hereby declare that the thesis 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 UPM or other institutions.

Muhammad Farhan Sjaugi

Date: 16 September 2008

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CHAPTER 1

INTRODUCTION

1.1 Background

Earlier, the idea of mobile computers and ad hoc networks was not on the mind of anyone. All specifications and implementations for the computer networks during that time were designed for wired systems. This is a big challenge for computer engineer since these two systems have different characteristics. Wireless network means dynamic topology, dynamic structure and no infrastructure, while wired network is the opposites. Most of wired network design and implementation must be modified or redesigned in order to operate in the wireless network. Basically mobile wireless network has the same standard layers of structure, with modifications and functionality that differ from the earlier networks because of the absence of infrastructure.

There are currently two variations of mobile wireless networks. The first is known as infrastructured network. The bridges for these networks are known as base stations. A mobile unit within these networks connects to, and communicates with, the nearest base station that is within its communication radius. As the mobile travels out of range of one base station and into the range of another, a "handoff" occurs from the old base station to the new, and the mobile is able to continue communication seamlessly throughout the network. Typical applications of this type of network include office wireless local area networks (WLANs).

The second type of mobile wireless network is Ad-hoc network. Unlike infrastructured network, in this type of network a base station is needless. Mobile nodes communicate to each other by either directly or through intermediate nodes. Ad-hoc network becomes popular since it can be applied in many situations, such as emergency search-and-rescue operations, classroom, meetings or conference, and many more. Ad-hoc network also can be mobile, called Mobile Ad-hoc Network or MANET.

To facilitate communication within the network, a routing protocol is used to discover routes between nodes. Building a MANET routing protocol is not an easy job, since efficiency and correctness become the main concern. Some approach had been proposed to make routing protocol becomes efficient and correct.

Today there is quite a lot of mobile device such as cell phone and Personal Digital Assistance, which is equipped with Global Positioning System (GPS). Mostly the application of GPS is intended for navigation purposes such as road tracking. Besides using GPS to knowing current location, it also can be used for routing purposes. Each node may know another nodes location by exchanging their current location (in this thesis, the current location is referred as location information).

Dynamic Source Routing (DSR) protocol is known to be a simple routing protocol in MANET. DSR is based on the concept of source routing. For this protocol, mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated

as new routes are learned. There are two major phases of the protocol - route discovery and route maintenance. Route discovery uses route request and route reply packets. Route maintenance uses route error packets and acknowledgments [8].

An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery, and if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility. Since the routes stored in the route cache will be valid longer. Another advantage of DSR is that it does not require any periodic beaconing (or hello message exchanges), therefore nodes can enter sleep node to conserve their power. This also saves a considerable amount of bandwidth in the network [1].

1.2 Problem Statement

Although DSR can respond a route quickly, it yields a long delay when a route is rebuilt. This is because when source node receives RERR packet, it will try to find alternative routes from route cache. If alternative routes are not available, source node, then, will enter route discovery phase to find new routes. Finding a route in wireless network require considerable resources, such as time, bandwidth, and power because it relies on broadcasting. In some case any packets may still reach its destination, but with some delay. This delay is very expensive and leads to undesired effect, especially in real time networks and the networks with QoS, where the packet delay and packet delivery is the main concern.

1.3 Objective

The objectives to be achieved in this thesis are:

1. Propose new algorithm to detect route failure as early warning message to the protocol to take further action, i.e route maintenance. The proposed algorithm will be based on geographical location information that may be collected through Global Positioning System (GPS).

2. Propose new algorithm for DSR route maintenance to response the early warning message from route failure detection algorithm. Once the message is received, several action will be to be taken to reconstruct the routing path. The proposed route maintenance algorithm also will be based on geographical location information.

1.4 Scope

This research will focus on:

1. The exploitation of node location information into MANET routing protocol for route maintenance purpose, in this case this research will focus on DSR routing protocol.

2. Route failure because of node movement only is considered in this thesis. Route failure because of node disappearance or dropped from the network is not considered.

3. Network/Routing layer only.