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UNIVERSITI PUTRA MALAYSIA

ENHANCED AD HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL FOR MOBILE AD HOC NETWORK INTERNET CONNECTIVITY

GOBI A/L GURUSAMY

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By

GOBI A/L GURUSAMY

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

February 2006

DEDICATION

To my loving parents for their endless care and support,

and who are always there for me.

Thank you.

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

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Chairman : Professor Borhanuddin Mohd. Ali, PhD

Faculty : Engineering

An ad hoc network is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration and consists of mobile nodes that use a wireless interface to communicate with each other. These mobile nodes serve as both hosts and routers so they can forward packets on behalf of each other. Hence, the mobile nodes are able to communicate beyond their transmission range by supporting multi hop communication. However, the fact that there is no central infrastructure and that the devices which can move randomly gives rise to various kinds of problems, such as routing and security and quality of service (QoS). In this thesis the problem of routing is considered.

An Ad-Hoc network has certain characteristics, which impose new demand on the routing protocol the most important characteristic is the dynamic topology, which is a consequence of node mobility. Nodes can changes position quite frequently, which means that we need a routing protocol that quickly adapts to topology changes. The nodes in ad hoc network can consist of laptops and PDA (Personal Digital Assistants) and are often very limited in resources such as CPU capacity, storage capacity, battery

power and bandwidth. This means that routing protocol should try to minimize control traffic, such as period update message. Instead the routing protocol should be reactive, thus only calculate routes upon receiving a specific request.

The Internet Engineering Task Force (IEFT) currently has a working group called mobile Ad hoc network (MANET) that is working on routing specification for Ad hoc networks. This thesis evaluates some of the routing protocols such as AODV (Ad hoc on demand Distance vector) and DSR (Dynamic Sources Routing) and DSDV (Destination Sequenced Distance vector) for performance testing and an enhanced implementation of AODV, which is able to detect Internet gateway in the proactive, reactive, and hybrid situation. This evaluation is done by means of simulation using NS-2 developed by University California Berkeley.

There are several ad hoc routing protocols, such as AODV, DSR, and DSDV that propose solutions for routing within a mobile ad hoc network. However, since there is an interest in communication between not only mobile devices in an ad hoc network, but also between a mobile device in an ad hoc network and a fixed device in a fixed network (e.g. the Internet), the ad hoc routing protocols need to be modified.

In this thesis the ad hoc routing protocol AODV is used and modified to examine the interconnection between a mobile ad hoc network and the Internet. For this purpose Network Simulator 2, NS 2, has been used. Moreover, three proposed approaches for gateway discovery are implemented; propose a forwarding algorithm, and route determination algorithm for default route and host route in MANET are investigated.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi sebahagian keperluan untuk ijazah Master Sanis

MENINGKATKAN VECTOR JARAK ATAS PERMINTAAN AD HOC DENGAN SALNG KAITAN INTERNET UNTUK RANGKAIAN BERGERAK AD HOC

Oleh

GOBI A/L GURUSAMY

Februari 2006

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Rangkaian ad-hoc ialah himpunan nod wayarles yang bergerak secara dinamik yang dapat membentuk satu rangkaian sementara tanpa menggunakan rangkaian infrastruktur yang sedia ada atau tidak menggunakan pentadbiran pusat serta mempunyai nod pergerakan yang digunakan sebagai gelombang wayarles untuk berhubung antara satu sama lain.Pergerakan nod ini berfungsi sebagai hos dan penghala supaya dapat mengemukakan paket bagi pihak satu sama lain. Justeru, nod pergerakan ini dapat berhubung melebihi had transmisi dengan sokongan berbagai-bagai hop. Namun, disebabkan tiada infrastruktur pusat serta alatan itu dapat bergerak secara rawak. Situasi ini menimbulkan pelbagai masalah seperti penghalaan, keselamatan dan perkhidmatan yang berkualiti. Dalam tesis ini, masalah penyambungan Internet protokol penghalaan diberi perhatian.

Sesuatu rangkaian Ad-hoc mempunyai cirri-ciri tertentu yang menuntut permintaan baru dalam protokol penghalaan. Ciri yang terpenting ialah topologi dinamik. Hal ini tertimbul akibat pergerakan nod. Kedudukan nod boleh bertukar dengan cepat dari

semasa ke semasa. Hal ini bermakna satu protokol penghalaan diperlukan yang boleh menyesuaikan diri dengan penubuhan topologi dengan cepat. Nod dalam rangkaian ad-hoc boleh terdiri daripada laptop dan PDA dan biasanya sumber- sumber seperti kemampuan CPU, kemampuan penyimpanan, kuasa bateri dari bandwith adalah terhad. Hal ini bermakna protokol penghalaan seharusnya cuba mengawal trafik secara minimum, seperti tempoh mengemaskinikan maklumat. Sesungguhnya, protokol penghalaan patut diaktifkan semula untuk membolehkan penghalaan diambil kira sebaik sahaja permintaan tertentu diterima.

Pada masa ini, pasukan petugas kejuruteraan Internet IEFT mempunyai satu kumpulan kerja yang mengendalikan usaha membuat spesifikasi penghalaan untuk rangakaian ad-hoc. Tesis ini menilai beberapa protocol seperti AODV, DSR dan DSDV untuk menguji prestasi serta perlaksanaaan secara meluas AODV yang boleh meneroka serta mengesan get-laluan secara proaktif,pengsktifan semula dan dalam situasi hybrid penilaian dibuat secara simulasi dengan menggunakan rangkaian NS-2 diciptakan oleh universiti California Berkeley.

Terdapat beberapa protokol penghalaan ad-hoc seperti AODV, DSR dan DSDN yang mencadangkan penyelesaian untuk penghalaan dalam lingkungan rangkaian pergerakan ad-hoc. Walau bagaimanapun, keperluan komunikasi adalah tidak terhad kepada peralatan bergerak sahaja tetapi juga dalam komunikasi antara peralatan bergerak dengan peralatan tetap dalam rangkaian seperti internet. Justeru, protokol pnghalaan perlu diubah suai untuk situasi tersebut.

Dalam tesis ini, protokol penghalaan ad-hoc seperti AODV diguna pakai serta diubah suai untuk menilai penyambungan antara rangkaian pergerakan sementara dan internet. Untuk tujuan ini, Rangkaian Simulasi 2 (NS2) digunakan. Tambahan pula, tiga pendekatan dicadangkan untuk penemuan get laluan, seperti proaktif, pengaktifan semula dan get laluan hybrid serta mengemukakan algorithm dan penentu penghala algorithm untuk penyelesaian masalah penghala dan hos dalam MANET dikaji.

ACKNOWLEDGEMENTS

Firstly, I’m grateful and thankful to THE ALL MIGHTY GOD for this entire blessing, which has enabled me to complete my thesis. We are sure that he was watching us closely throughout the thesis.

I would like to take this opportunity to thank my supervisor, Prof. Dr. Borhanuddin Mohd. Ali for his patient in guiding me accomplishes this thesis. Appreciation also goes to the author's co-supervisors, Saiful Jahari for assisting in solving various difficulties that was encountered throughout the project.

Apart from them, special thanks also go to lecturers especially, Dr. Ashraf Gasim Abdalla and Dr. Prakash for all their bright ideas and suggestions. Special thanks to fellow colleagues from the Broadband Group for their encouragement, fruitful discussions and willingness to listen.

Lastly, the author wishes to express sincere appreciation to his parents and family for never doubting him and enabling him to be what he is today.

I certify that an Examination Committee has met on 6th February 2006 to conduct the final examination of Gobi a/l Gurusamy on his Master of Science thesis entitled "Enhanced Ad Hoc On-Demand Distance Vector Routing Protocol For Mobile Ad-Hoc Network Internet Connectivity'' 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. Member of the Examination Committee 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.

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GOBI A/L GURUSAMY

Date:

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LIST OF ABBREVIATIONS

AODV	Ad hoc On –Demand Distance Vector
CBR	Constant Bit Rate
DSR	Dynamic Source Routing
DSDV	Destination Sequenced Distance vector
TORA	Temporally Ordered Routing Algorithm
TCP	Transmission Control Protocol
ICMP	Internet Control Message Protocol
IP	Internet Protocol
LLC	Logical Link Layer
MAC	Medium Access Control
NS	Network Simulator
OTcl	Object Tool Command language
PDA	Personal Digital Assistant
FSR	Fish Sources Routing
OLSR	Optimized Link State Routing Protocol
OSI	Open System Interconnection
NAM	Network Animator
ZRP	Zone Routing Protocol
MANET	Mobile Ad hoc Network
UDP	User Data gram Protocol
IEEE	Institute of Electrical and Electronics Engineer
LMR	Lightweight Mobile Routing
WRP	Wireless Routing Protocol
DAG	Directed Acyclic Graph

CGSR	Cluster head Gateway switch Routing
ABR	Associatively Based Routing
BQ	Broadcast Query
RREP	Route REPLY
RREQ	Route REQUEST
TTL	Time to Live
IEFT	Internet Engineering Task Force
GWADV	Gateway Advertisement
IPv6	Internet Protocol version
GSM	Global System for Mobile Communication
DARPA	Defense Advanced Research Project Agency
TCL	Tool Command Language
WG	Work Group

CHAPTER 1

INTRODUCTION

In the coming years, information technology will be mainly based on wireless technology. Future wireless is totally multidimensional; also wireless mobile and access will be converged to be more ad hoc and reconfigurable. Ad hoc will be one of the next storms in the wireless communications, large area mobile multi-hop wireless and personal access networks. A mobile ad hoc network is an autonomous system of mobile routers (and associated hosts) connected by wireless links .The routers and hosts are free to move randomly and organized arbitrarily, thus the networks wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion or be connected to the larger Internet.

Since their emergence in 1970's, wireless networks have become increasingly popular in the computing industry. These networks provide mobile users with ubiquitous computing capability and information access regardless of the location. There are currently two variations of mobile wireless networks-infra-structured and infrastructure less networks. The infra-structured networks, also known as cellular network, have fixed and wired gateways. They have fixed base stations that are connected to other base stations through wires. The transmission range of a base station constitutes a cell. All the mobile nodes lying within this cell connect to and communicate with the nearest bridge (Base station). A "hand off" occurs as mobile host travels out of range of one base station and into the range of another

and thus, mobile host is able continue communication seamlessly throughout the network.

The other type of network, infrastructure less network, is known as Mobile Ad network (MANET). These networks have no fixed routers. All nodes are capable of movement and can be connected dynamically in arbitrary manner. The responsibilities for organizing and controlling the network are distributed among the terminals themselves. The entire network is mobile, and the individual terminals are allowed to move at will relative to each other. In this type of network, some pairs of terminal may not be able to communicate directly to with each other and relaying of some messages is required so that they are delivered to their destinations.

With recent performance advancements in computer and wireless communications technologies, advanced mobile wireless computing is expected to see increasingly widespread use and application, much of which will involve the use of the Internet Protocol (IP) suite. The vision of mobile ad hoc networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Such networks are envisioned to have dynamic, sometimes rapidly changing, random, multi-hop topologies, which are likely composed of relatively bandwidth-constrained wireless links.

Within the Internet community, routing support for mobile hosts is presently being formulated as "mobile IP" technology. This is a technology to support nomadic host "roaming", where a roaming host may be connected through various

means to the Internet other than its well-known fixed-address domain space. The host may be directly connected to the fixed network on a foreign subnet, or be connected via a wireless link, dial-up line, etc.

Supporting this form of host mobility requires address management, protocol interoperability enhancements and the like, but core network functions such as hop-by-hop routing still presently rely upon pre-existing routing protocols operating within the fixed network. In contrast the goal of mobile ad hoc networking is to extend mobility into the realm of autonomous, mobile, wireless domains, where a set of nodes, which may be, combined routers and hosts themselves form the network routing infrastructure in an ad hoc fashion.

Mobile ad hoc networking allows users to exchange information in a wireless environment without the need for a fixed infrastructure. Each user (or node), equipped with one or more radios, is free to roam about while communicating with others. The path between any pair of users can traverse multiple wireless links and the radios themselves can be heterogeneous, thus enabling an assortment of different types of links to be part of the same ad hoc network.

The mobility of the nodes results in a network whose topology is dynamic. The of the network is to discover the links between the mobile nodes and to build paths so that any user can communicate with any other user, as long as each has a link to the ad hoc network. Within the ad hoc network, each node acts as a router and forwards packets on behalf of others, some sort of routing protocol is necessary to make the routing decisions.

1.1 Mobile Ad hoc Networks (MANET)

A mobile ad hoc network is a collection of mobile nodes that cooperatively and spontaneously form a wireless network without the use of any fixed infrastructure (e.g., base stations or access points), or centralized administration. The system may operate in isolation, or may have gateways connected with a fixed network. In the latter mode, it is typically envisioned as a sub network connected to a fixed network. The mobile devices used in ad hoc networks could include an evolution of current cell phones, PDA, or laptops equipped with wireless interfaces.

In a MANET, each mobile node is equipped with a wireless transmitter and receiver using antennas. Nodes can communicate directly with other nodes within its wireless transmission range. However, wireless links have significantly lower capacity and transmission range than their hardwired counterparts due to effects, such as signal fading, noise and limited battery power. Consequently, multiple hops may be needed for one node to exchange data with another across the network. Thus, each node must be capable of acting as a host and as a router. Packet forwarding, routing and other network operations are distributed and carried out by individual nodes. In general, mobile nodes in ad hoc networks are free to move randomly and organize themselves arbitrarily. The network topology may change with time as the nodes move or adjust their transmission or power, so it can change rapidly and unpredictably.

1.2 MANET Internet Engineering Task Force