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**ROUTE DISCOVERY BASED ON ENERGY-DISTANCE AWARE
ROUTING SCHEME FOR MANET**



**DOCTOR OF PHILOSOPHY
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2016**



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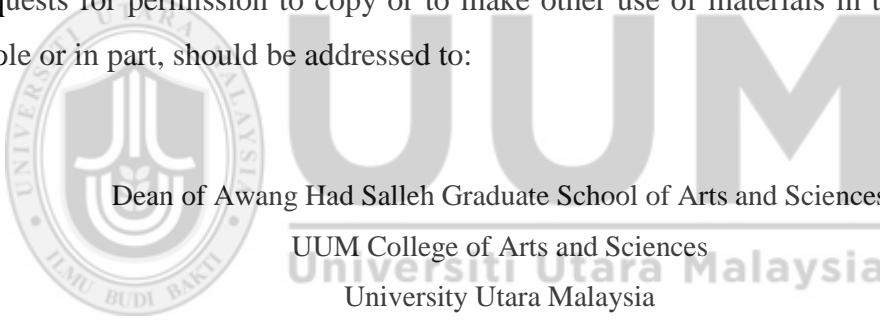
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Abstrak

Proses penemuan laluan di dalam sesebuah Rangkaian Ad hoc Bergerak (MANET) adalah mencabar disebabkan kekangan tenaga pada setiap nod rangkaian. Keterbatasan tenaga mengekang hayat hubungan rangkaian, oleh itu menjelaskan proses penghalaan. Justeru, adalah perlu bagi setiap nod dalam rangkaian mengira faktor penghalaan dari segi tenaga dan jarak dalam menentukan calon nod penyampai optimum bagi penghantaran paket. Kajian ini mencadangkan satu mekanisme penemuan laluan baharu yang dipanggil Penghalaan Peka Tenaga-Jarak (EDRA) yang menentukan pemilihan nod ketika proses penemuan laluan bagi menambahbaik hayat hubungan rangkaian. Mekanisme ini mengandungi tiga skema iaitu Peka Faktor Tenaga-Jarak (EDFA), Strategi Penghantaran Tenaga-Jarak (EDFS), dan Pemilihan Laluan Peka-Tenaga (EARS). Skema EDFA bermula dengan mengira tahap tenaga (e_i) pada setiap nod dan jarak (d_i) ke semua nod yang berjiran untuk menghasilkan nilai faktor tenaga-jarak yang digunakan bagi pemilihan nod penyampai. Seterusnya, skema EDFS menghantar paket-paket permintaan laluan dalam kawasan penemuan nod penyampai berdasarkan bilangan nod. Kemudian, skema EARS memilih laluan penghalaan yang stabil menggunakan maklumat status terkini dari EDFA dan EDFS. Mekanisme penilaian EDRA dibuat menggunakan penyalaku rangkaian Ns2 berdasarkan set tentuan metrik prestasi, senario, dan kebolehskaalan rangkaian. Keputusan eksperimen menunjukkan EDRA mencapai kemajuan yang ketara dari segi hayat hubungan rangkaian berbanding mekanisme yang serupa, iaitu AODV dan DREAM. EDRA juga mengoptimakan penggunaan tenaga dengan memanfaatkan penentuan penghantaran yang cekap pada skala nod-nod rangkaian yang berbeza. Juga, EDRA memaksimakan hayat hubungan rangkaian disamping menjaga truput dan nisbah kehilangan paket. Kajian ini menyumbang ke arah pembangunan satu mekanisme penghalaan peka-tenaga yang cekap bagi menampung hayat hubungan rangkaian yang lebih lama dalam persekitaran MANET. Sumbangan ini adalah penting bagi mempromosi penggunaan teknologi rangkaian generasi hadapan yang mesra alam dan lestari.

Kata kunci: Rangkaian ad hoc bergerak, Penghalaan peka-tenaga, Penemuan laluan penghalaan, Pemilihan nod penyampai, Protokol penghalaan.

Abstract

Route discovery proses in a Mobile Ad hoc Network (MANET) is challenging due to the limitation of energy at each network node. The energy constraint limits network connection lifetime thus affecting the routing process. Therefore, it is necessary for each node in the network to calculate routing factor in terms of energy and distance in deciding optimal candidate relay nodes needed to forward packets. This study proposes a new route discovery mechanism called the Energy-Distance Routing Aware (EDRA) that determines the selection of nodes during route discovery process to improve the network connection lifetime. This mechanism comprises of three schemes namely the Energy-Distance Factor Aware (EDFA), the Energy-Distance Forward Strategy (EDFS), and the Energy-Aware Route Selection (EARS). The EDFA scheme begins by calculating each nodes energy level (e_i) and the distance (d_i) to the neighbouring nodes to produce the energy-distance factor value used in selecting the relay nodes. Next, the EDFS scheme forwards route request packets within discovery area of relay nodes based on the number of nodes. Then, the EARS scheme selects stable routing path utilising updated status information from EDFA and EDFS. The evaluation of EDRA mechanism is performed using network simulator Ns2 based on a defined set of performance metrics, scenarios and network scalability. The experimental results show that the EDRA gains significant improvement in the network connection lifetime when compared to those of the similar mechanisms, namely the AODV and the DREAM. EDRA also optimises energy consumption by utilising efficient forwarding decisions on varying scale of network nodes. Moreover, EDRA maximizes network connection lifetime while preserving throughput and packet drop ratio. This study contributes toward developing an efficient energy-aware routing to sustain longer network connection lifetime in MANET environment. The contribution is significant in promoting the use of green and sustainable next generation network technology.

Keywords: Mobile ad hoc network, Energy-aware routing, Routing path discovery, Relay node selection, Routing protocol.

Declaration

Some of the works presented in this thesis have been published as listed below.

- [1] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, “Node Selection Based on Energy- Distance Factor in Mobile Ad-Hoc Network,” in Proceedings of the *International Postgraduate Conference on Engineering (IPCE2011)*, Universiti Malaysia Perlis (UniMAP), Perlis, MALAYSIA 22 - 23rd October 2011.
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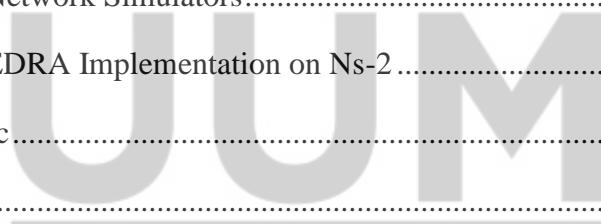
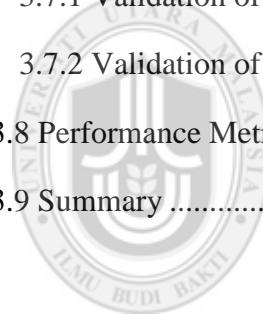
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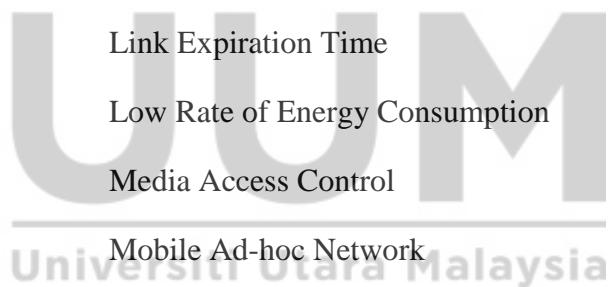
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List of Abbreviations

ABR	Associatively Base Routing
AODV	Ad-hoc On-Demand Distance Vector
AOMDV	Ad-hoc On Demand Multipath Distance Vector
AREC	Average Rate of Energy Consumption
ARQ	Automatic Repeat Request
BP	Beacon Packet
BPIT	Beacon Packet Interval Time
CBPM	Communication-Based Power Management
CBR	Constant Bit Rate
CPU	Central Processing Unit
CTR	Control Routing
CTF	Clear to Forward
DBEEP	Distance-Based Energy Efficient Placement
DEAR	Distance Energy Aware Routing
DSR	Dynamic Source Routing
DREAM	Distance Routing Effect Algorithm for Mobility
EARS	Energy Aware Routing Selection
EC	Energy Conserving
EDRA	Energy Distance Aware Routing Protocol
EDFA	Energy Distance Factor Aware
EDFS	Energy Distance Forward Strategy
EELAR	Energy Efficient Location based Routing

EM	Electromagnetic
ELT	Entry Lifetime
FEC	Forward Error Correction
FS	Forward Strategy
GPS	Global Position System
GRS	Greedy Routing Scheme
HCB	Hierarchical Cluster based Routing
HREC	High Rate of Energy Consumption
LAMOR	Lifetime Aware Multipath Optimal Routing
LAR	Location Aided Routing
DREAM	Localised Energy Aware Restricted Neighbourhood
LET	Link Expiration Time
LREC	Low Rate of Energy Consumption
MAC	Media Access Control
MANET	Mobile Ad-hoc Network
MAP	Maximum Available Power
MFR	Most Forward Radius
MN	Mobile Node
MRE	Minimum Route Energy
NFP	Nearest Forward Progress
PAMAS	Power Aware Multi-Access
PAMOR	Power Aware Multicast On-demand Routing
PAMP	Power Aware Multi Path
PAOD	Power Aware on Demand
PARAMA	Power Aware Routing Algorithm Mobile Agent



PBMA	Probability Based Method Algorithm
PDA	Personal Digital Assistant
PMRP	Power-Aware Multicast Routing Protocol
PNR	Position Neighbourhoods based Routing
PSR	Power-aware Source Routing
PTPSR	Power Traffic Path Selection Routing
Q-DIR	Quadrant Directional Routing
QoS	Quality of Service
RD	Random Direction
RE	Remaining Energy
REAR	Residual Energy Aware Routing
REC	Rate of Energy Consumption
RET	Route Expiration Time
RREP	Route Reply
RREQ	Route Request
RSSI	Received Signal Strength Index
RTF	Request to Forward
SIFS	Short Interframe Space
VANET	Vehicular Ad-Hoc Network
WMN	Wireless Mesh Network
WSN	Wireless Sensor Network
ZHLS	Zone-Based Hierarchical Link State
ZRP	Zone Routing Protocol

CHAPTER ONE

INTRODUCTION

1.1 Overview

This dissertation proposes a new extension for the current AODV protocol in the Mobile Ad-hoc Network (MANET). In this chapter, Section 1.2 provides a general background, while Section 1.3 presents the motivation and research problem. Sections 1.4 and 1.5 present the research objective and the research scope respectively. Meanwhile, Section 1.6 presents the research assumptions and key research steps respectively. Finally, Section 1.7 presents the organisation of this dissertation.

1.2 Background

Development and advancement of communication technology, especially the wireless communication system, has witnessed very rapid changes in technology, in particular the development of communication technologies. One of the fastest growing applicable technologies in the communication sector is wireless communication, such as the Mobile Ad-hoc Network (MANET). MANET technologies is infrastructure-less and substantially different from conventional wireless technology.

The concept of infrastructure-less communication refers to the wireless communication system. This means that all devices in the system are autonomous within the network system which is connected by wireless links. All processes of

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