

**GSAR: GREEDY STAND-ALONE POSITION-BASED ROUTING  
PROTOCOL TO AVOID HOLE PROBLEM OCCURRENCE IN  
MOBILE AD HOC NETWORKS**

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2014**

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## Abstrak

Proses penentuan laluan di dalam Rangkaian Mudah Alih Ad Hoc (MANET) adalah sukar disebabkan kekerapan perubahan topologi serta keterbatasan sumber. Oleh itu, mereka bentuk protokol laluan yang boleh dipercayai, dinamik serta mampu memenuhi kehendak MANET amatlah diperlukan. Strategi Penghantaran Rakus (GFS) merupakan strategi yang paling banyak digunakan dalam protokol laluan berasaskan posisi. Algoritma GFS direka bentuk sebagai protokol berprestasi tinggi yang menggunakan kiraan hop untuk mendapatkan laluan paling dekat. Walau bagaimanapun, GFS tidak mengambil kira kehendak MANET yang lain. Oleh itu, ianya tidak mencukupi untuk membuat pengiraan laluan yang boleh dipercayai. Kajian ini bertujuan mempertingkatkan GFS sedia ada kepada protokol laluan yang dinamik, sendiri, boleh bertindak balas dengan pantas terhadap kehendak MANET, serta berupaya menyediakan laluan yang boleh dipercayai dalam kalangan nod yang berhubung. Untuk mencapai matlamat ini, dua mekanisme telah diusulkan sebagai penambahbaikan terhadap GFS yang sedia ada iaitu Mekanisme Pengemaskinian Mata Arah Dinamik (DBUM) dan Mekanisme Keandalan Anggaran Dinamik dan Reaktif dengan Metrik Terpilih (DRESM). Fungsi utama algoritma DBUM adalah untuk menyediakan nod dengan maklumat baru tentang status nod di sekitarnya. Fungsi algoritma DRESM pula adalah untuk membuat keputusan penghantaran berdasarkan pelbagai metrik laluan. Kedua-dua mekanisme ini telah disepadukan di dalam GFS konvensional bagi membentuk protokol Laluan Kendiri Rakus (GSAR). Penilaian ke atas GSAR telah dilakukan menggunakan simulator rangkaian Ns2 berdasarkan set metrik prestasi, senario dan topologi yang telah ditetapkan. Hasil penilaian menunjukkan bahawa GSAR dapat mengetepikan keperluan menggunakan mod pemulihan dan mencapai peningkatan menyeluruh pada prestasi rangkaian berbanding dalam GFS. Dalam pelbagai keadaan pergerakan nod yang diuji, GSAR dapat mengurangkan masalah lubang perangkap kira-kira 87% dan 79% berbanding Protokol Laluan Tanpa Keadaan Perimeter Rakus dan Protokol Laluan Oportunistik Berasaskan Posisi. Kesimpulannya, protokol GSAR merupakan alternatif munasabah kepada protokol laluan berasaskan posisi dalam MANET.

**Kata Kunci:** Rangkaian Mudah Alih Ad-hoc, Strategi Penghantaran Rakus, Protokol Laluan Berasaskan Posisi, Protokol Laluan Kendiri Rakus

## Abstract

The routing process in a Mobile Ad Hoc Network (MANET) poses critical challenges because of its features such as frequent topology changes and resource limitations. Hence, designing a reliable and dynamic routing protocol that satisfies MANET requirements is highly demanded. The Greedy Forwarding Strategy (GFS) has been the most used strategy in position-based routing protocols. The GFS algorithm was designed as a high-performance protocol that adopts hop count in soliciting shortest path. However, the GFS does not consider MANET needs and is therefore insufficient in computing reliable routes. Hence, this study aims to improve the existing GFS by transforming it into a dynamic stand-alone routing protocol that responds swiftly to MANET needs, and provides reliable routes among the communicating nodes. To achieve the aim, two mechanisms were proposed as extensions to the current GFS, namely the Dynamic Beacons Updates Mechanism (DBUM) and the Dynamic and Reactive Reliability Estimation with Selective Metrics Mechanism (DRESM). The DBUM algorithm is mainly responsible for providing a node with up-to-date status information about its neighbours. The DRESM algorithm is responsible for making forwarding decisions based on multiple routing metrics. Both mechanisms were integrated into the conventional GFS to form Greedy Stand-Alone Routing (GSAR) protocol. Evaluations of GSAR were performed using network simulator Ns2 based upon a defined set of performance metrics, scenarios and topologies. The results demonstrate that GSAR eliminates recovery mode mechanism in GFS and consequently improve overall network performance. Under various mobility conditions, GSAR avoids hole problem by about 87% and 79% over Greedy Perimeter Stateless Routing and Position-based Opportunistic Routing Protocol respectively. Therefore, the GSAR protocol is a reasonable alternative to position-based unicast routing protocol in MANET.

**Keywords:** Mobile Ad hoc Networks, Greedy Forwarding Strategy, Position-based Routing Protocols, Greedy Stand-alone Routing Protocol

## Declaration

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

[1] Mahmoud Al-Shugran, Osman Ghazali, Suhaidi Hassan, Omar M. Almomani, and Kashif Nisar, "Adaptive and Fuzzy Management for Greedy Routing in Mobile Ad-hoc Networks," in *the Proceeding of 3ed International Conference on Network Applications, Protocols and Services (NetApps2012)*, Sintok, Malaysia, 19-20 Sep. 2012, pp. 36-41.

[2] Mahmoud Al-Shugran, Osman Ghazali, Suhaidi Hassan, Omar M. Almomani, and Kashif Nisar, "Comparative Performance Evaluation of Unicast Routing Protocol in Mobile Ad-hoc Networks," in *the Proceeding of 3ed International Conference on Network Applications, Protocols and Services (NetApps2012)*, Sintok, Malaysia, 19-20 Sep. 2012, pp. 42-47.

[3] Mahmoud Al-Shugran, Osman Ghazali and Suhaidi Hassan, " A General Framework for Greedy Routing in Mobile Ad-hoc Networks, " in *the Proceeding of International Conference on Advanced Computer Science Applications and Technologies (ACSAT2012)*, Kuala Lumpur, Malaysia, Indexed by the IEEE Xplore, 26-28 Nov. 2012.

[4] Mahmoud Al-Shugran, Osman Ghazali and Suhaidi Hassan, " Performance Comparison of Position-Based Routing Protocol in the Context of Enhancing Greedy Failure," in *the Proceeding of International Conference on Advanced Computer Science Applications and Technologies (ACSAT2012)*, Kuala Lumpur, Malaysia, Indexed by the IEEE Xplore, 26-28 Nov. 2012.

[5] Mahmoud Al-shugran, Osman Ghazali, Suhaidi Hassan, Kashif Nisar, and A. Suki M. Arif "A Qualitative Comparison Evaluation of the Greedy Forwarding Strategies in Mobile Ad Hoc Network," *Journal of Network and Computer Applications*, vol. 36, issue 2, pp. 887–897, Impact factor 1.467, Publisher Elsevier, Mar. 2013.

## Acknowledgements

*Alhamdulillah and thanks Allah (s.w.t) for His blessings to successfully complete this Ph.D thesis.* I would like to express my deepest gratitude to my supervisors, Assoc. Prof. Dr. Osman Ghazali and Prof. Dr. Suhaidi Hassan. Their guidance, support, and kindness made this work possible. I feel honoured to have had the opportunity to work with both of them. Osman was always encouraging. Although he was far away on a post-doctorate programme, whenever I had problems, he was always ready to help me resolve them. I would also like to express my sincere gratitude to my examiners Prof. Dr. Sabira Khatun and Prof. Dr. Rahmat Budiarto. Thank you for your invaluable comments and the time you took despite your hectic and busy schedule. You not only enabled me to go on the right path, but also helped me to converge my scattered and incoherent findings to structure them in harmony and consistency and bringing them to a designated end. I thank you for being so knowledgeable, enthusiastic, reassuring, committed and supportive.

This thesis is the result of many years of effort and would not have been possible without the contributions of my friends and my family, which I would like to acknowledge. First, I would like to thank Ns2 users, for improving my understanding of the tools I selected to use. I would also like to express my sincere gratitude to Mr. Tariq Alshugran, I am deeply indebted to him for his insight and suggestion to the thesis topic. He has helped me in many ways and has developed my programming skills to modify the GPSR code to meet the specific alteration for GSAR. I am grateful to Dr. Shengbo Yang, for showing me the way to better simulations with his own work on extending GPSR protocol. Grateful acknowledgment should be mentioned here to Dr. Omar Almomani who guided me through a better way to run a series of simulation experiments. In the same vein, I remain thankful to Dr. Tracy Camp for helping in the venue of selecting the proper mobility models for GSAR. Also, I thank the  $\text{T}_{\text{E}}\text{X}-\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$  users for improving my understanding of the  $\text{L}_{\text{Y}}\text{X}$  tool that I selected to text this thesis. I am thankful to Dr. Lian Tze Lim for her help to write this thesis using  $\text{L}_{\text{Y}}\text{X}$ . To many

others in the Networks Research Lab, I will forever cherish the many useful conversations and insights that helped to shape this study. I would like to thank Dr. A. Suki M. Arif for his help in translating the thesis abstract to Bahasa Melayu. My thanks go to Omar Alshugran, Salah Alshugran, and Tariq Alshugran for their financial support without which this PhD work would not have been possible.

I would like to thank my mother, Jameelah, my father, Ali, and my only sister, Basma, for their love and enthusiasm, and for offering me the stability I needed to accomplish my project. My mother taught me in my formative years and gave me the most solid foundation on which I could develop my skills. I thank her for teaching me her moral principles, for all her loving and caring attention, and her enormous effort to make sure I would survive away from home. My father has been the best example to guide me through life; he taught me the importance of hard work, dedication, persistence and honesty. My parents were the first persons that believed I was able to pursue this project - I thank them for encouraging me to expand my horizons, and for making me a better person. I thank my sister for being my eternal friend and ally, for drowning me with her kindness, and for patiently helping me to focus on my work. I hope I can bring as much happiness to her life as she has brought to mine. Also, I would like to express my gratitude to my brothers, for their moral support and prayers. Their support kept me motivated and inspired me to strive and complete my Ph.D. journey.

Finally, yet importantly, the people who deserve the greatest acknowledgement are the ones to whom this thesis is dedicated: my loving and beautiful wife, Wejdan, my stunning daughters, and my sons. Wejdan is an extraordinary person and her contribution to this work is apparent in every word, she pushed me forward at all times, she gave me constant support and stimulation, she fostered my best ideas, she listened patiently to my constant divagations, and she offered me more understanding than I could ever imagine. I love her dearly and I wish I could one day have the opportunity to help her realise her most ambitious dreams in the way she helped me to realise mine. During my PhD, I was extremely fortunate to experience one of the most rewarding and joyful moments of my life: the birth of my daughter Nor. I only wish I can offer her the same wisdom that her grandparents gave to me.

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## List of Abbreviations

<b>ACK</b>	Acknowledgement Packet
<b>AI</b>	Artificial Intelligence
<b>APU</b>	Adaptive Position Update
<b>BCF</b>	Beacon-based Cooperative Forwarding
<b>BPIT</b>	Beacon Packet Interval Time
<b>BP</b>	Beacon Packet
<b>BPsize</b>	Beacon Packet Size
<b>BTA</b>	Backtracking Based Approach
<b>Bw</b>	Bandwidth
<b>CHT</b>	Check Time
<b>COH</b>	Control Overhead
<b>CR</b>	Compass Routing
<b>CSMA/CA</b>	Carrier Sense Multiple Access/Collision Avoidance protocol
<b>CTF</b>	Clear To Forward message
<b>CUT</b>	Compulsory Update Technique
<b>DFLCH</b>	Dynamic Fuzzy Logic Controller Check-time
<b>DARPA</b>	Defence Advanced Research Projects Agency
<b>DATA</b>	Data Packet
<b>DLI</b>	Destination Location Information
<b>DBUM</b>	Dynamic Beacons Updates Mechanism,
<b>DCF</b>	Distributed Coordination Function
<b>DIFS</b>	Distributed Inter Frame Space
<b>DPsize</b>	Data Packet Size
<b>DPS</b>	Destination Prediction Scheme
<b>DRESM</b>	Dynamic and Reactive Reliability Estimation with Selective Metrics Mechanism
<b>DREAM</b>	Distance Routing Effect Algorithm for Mobility
<b>DRM</b>	Dynamic Route Maintenance algorithm
<b>DSDV</b>	Destination-Sequenced Distance-Vector
<b>DSR</b>	Dynamic Source Routing Protocol

<b>Du</b>	Duration for MAC usage
<b>EED</b>	Average End to End Delay
<b>ELT</b>	Neighbourhood Entry Lifetime
<b>FBPIT</b>	Fixed Beacon Packet Interval Time
<b>FIFO</b>	First-In-First-Out policy
<b>FLDRE</b>	Fuzzy Logic Dynamic Reliability Estimation technique
<b>FLC</b>	Fuzzy Logic Controller
<b>GEDIR</b>	Geographic Distance Routing
<b>GAs</b>	Genetic Algorithms
<b>GFS</b>	Greedy Forwarding Strategy
<b>GG</b>	Gabriel Graph Algorithm
<b>GLS</b>	Scalable Location Service for Geographic Ad Hoc Routing
<b>GPS</b>	Global Positioning System
<b>GPSR</b>	Greedy Perimeter Stateless Routing
<b>ID</b>	Node Identity
<b>IDOTM</b>	Information Distribution and Outgoing Traffic Control Management technique
<b>IDPI</b>	Inaccuracy in Destination Position Information
<b>INM</b>	Inconsistency of Neighbourhood Matrix
<b>LAR</b>	Location Aided Routing
<b>LLT</b>	link lifetime
<b>MAC</b>	Medium Access Control
<b>MANET</b>	Mobile Ad Hoc Network
<b>MFR</b>	Most Forward Within Transmission Range
<b>MNs</b>	Wireless Mobile Nodes
<b>MP</b>	Message Packet (used with the RTF, CTF, etc.)
<b>MPsize</b>	Message Packet size
<b>MPDM</b>	Mobility Prediction Using Dead-reckoning Model
<b>NAM</b>	Network Animator
<b>NAV</b>	Network Allocation Vector
<b>NBL</b>	Neighbour Break Link
<b>NFP</b>	Nearest With Forward Progress

<b>NLM</b>	Neighbourhood's Location-Matrix
<b>NMEM</b>	Neighbourhood Matrix Entries Management
<b>NPN</b>	Number of a node's Positive Neighbours
<b>Ns2</b>	Network Simulator 2
<b>NS</b>	Node Speed
<b>OTcl</b>	Object-Oriented Tool Command Language
<b>PDn</b>	Packet Distinction Number
<b>PDR</b>	Packet Delivery Ratio
<b>POR</b>	Position-based Opportunistic Routing protocol
<b>QoS</b>	Quality of Service
<b>RSGF</b>	Recovery Strategies with Greedy Failure
<b>REEF</b>	REliable and Efficient Forwarding mechanism
<b>RIN</b>	Reliability Index
<b>RLT</b>	Residual Links Lifetime
<b>RNG</b>	Relative Neighbourhood Graph algorithm
<b>RPF</b>	Random Progress Forwarding
<b>RSN</b>	Reliability Sequence Number of the candidate node
<b>RTF</b>	Request To Forward message
<b>RWP</b>	Random WayPoint mobility model
<b>SEGF</b>	Supportive Enhancement for Greedy Forwarding
<b>SIFS</b>	Short Interframe Space
<b>SLPS</b>	Self Location Prediction Scheme
<b>Tcl</b>	Tool Command Language
<b>TOD</b>	Tolerance Deviation distance
<b>TSF</b>	Local Timing Synchronization Function
<b>TTL</b>	Time To Live
<b>UBM</b>	Urgent Beacon Message
<b>VDVH</b>	Virtual Destination-based Void Handling
<b>WTSA</b>	Waiting Time to Send ACK packet



# CHAPTER ONE

## INTRODUCTION

### 1.1 Overview

This thesis proposes a new extension to the current Greedy Forwarding Strategy (GFS) in the Mobile Ad hoc Network (MANET). In this chapter, Section 1.2 provides a general background. Section 1.3 presents the motivation and research problem. Sections 1.4 and 1.5 present the research objectives and the research scope respectively. Sections 1.6 and 1.7 present research assumptions and key research steps respectively. Finally, Section 1.8 presents the organization of the thesis.

### 1.2 Background

Interest in mobile computing has grown immensely over the last decade. Mobile computing aims to provide users access to information and communication from anywhere and at any time [1]. Mobile Ad Hoc Network (MANET) is a subset of mobile computing [2]. MANET is a spontaneous network because it does not need a pre-fixed infrastructure such as a base station or access points to provide the capacity for communication [3]. MANET is a rapidly deployable, self-organized, multi-hop wireless network that is set up for a limited period of time and for a particular purpose [4].

MANET consists of wireless mobile nodes such as laptops, tablets and personal digital assistants [2]. These mobile nodes may reside in vehicles, instruments and mobile machines, thus, making the network topology highly dynamic [5]. Nodes in MANET may move arbitrarily while communicating over wireless links [3]. In MANET, mobile nodes capable of connecting and communicating with each other use limited-bandwidth radio links. They are incorporated with routing functionality and computational power so that they can perform the operations of host and router simultaneously. Mobile nodes have limited resources including CPU capacity, buffer capacity, and battery power [4]. A schematic illustration of MANET is shown in Figure 1.1 below.

The contents of  
the thesis is for  
internal user  
only

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