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

JAILANI ABDUL KADIR

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2016

Awang Had Salleh
Graduate School
of Arts And Sciences

Universiti Utara Malaysia

PERAKUAN KERJA TESIS / DISERTASI
(Certification of thesis / dissertation)

Kami, yang bertandatangan, memperakukan bahawa
(We, the undersigned, certify that)

JAILANI ABDUL KADIR

calon untuk Ijazah PhD
(candidate for the degree of)

telah mengemukakan tesis / disertasi yang bertajuk:
(has presented his/her thesis / dissertation of the following title):

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

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.
(as it appears on the title page and front cover of the thesis / dissertation).

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada : ***28 Julai 2015.***
That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on: ***July 28, 2015.***

Pengerusi Viva: *(Chairman for VIVA)*	Prof. Dr. Zulkhairi Md Dahalin	Tandatangan *(Signature)*
Pemeriksa Luar: *(External Examiner)*	Prof. Dr. R. Badlishah Ahmad	Tandatangan *(Signature)*
Pemeriksa Dalam: *(Internal Examiner)*	Dr. Ahmad Suki Che Mohamed Arif	Tandatangan *(Signature)*
Nama Penyelia/Penyelia-penyelia: *(Name of Supervisor/Supervisors)*	Assoc. Prof. Dr. Osman Ghazali	Tandatangan *(Signature)*
Nama Penyelia/Penyelia-penyelia: *(Name of Supervisor/Supervisors)*	Prof. Dr. Suhaidi Hassan	Tandatangan *(Signature)*

Tarikh:
(Date) ***July 28, 2015***

Permission to Use

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from University Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to University Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School of Arts and Sciences
UUM College of Arts and Sciences
University Utara Malaysia
06010 UUM Sintok

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 menjejaskan 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 meggunakan maklumat status terkini dari EDFA dan EDFS. Mekanisme penilaian EDRA dibuat menggunakan penyelaku rangkaian Ns2 berdasarkan set tentuan metrik prestasi, senario, dan kebolehskalaan 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 memanafaatkan 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.

[2] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, Mohammad Firdaus, "Node Selection Based on Energy Consumption in MANET," in Proceedings of *International Arab Conference on Information Technology(ACIT2011)*, Naif Arab University for Security Science (NAUSS), Riyadh, Saudi Arabia, 11st – 14th December 2011.

[3] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, "Probability based Method for Node Selection in MANET," in Proceedings of *International Engineering Education Conference (IEEC2011)*, Madinah, Kingdom of Saudi Arabia, 25th -27 December 2011.

[4] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, "Concept of an Energy-Efficient with Probability based Method for Node Selection in route discovery of MANET," in Proceedings of 3rd *International Conference on Network Applications, Protocols and Services; (NetApps2012)*, IEEE, Sintok, Kedah, Malaysia, 2012.

[5] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, "Energy efficient with Location Forward Strategy in MANET," in Proceedings of 3rd *International Conference on Network Applications, Protocols and Services; (NetApps2012)*, IEEE, Sintok, Kedah, Malaysia, 2012.

[6] Jailani Kadir, Osman Ghazali, Suhaidi Hassan, ."Node Discovery Based on Energy-Distance Factor in MANET," in *International Journal of Engineering Research & Technology (IJERT)* Vol.1, Issue 7, September 2012.

Acknowledgements

First, I would like to express my utmost gratitude to Almighty Allah for His creation and making me submissive to Him.

I would like to gratefully acknowledge the enthusiastic supervision of my thesis supervisor, Associate Professor Dr. Osman Ghazali and my co-supervisor Professor Dr. Suhaidi Hassan. I could not have imagined having a better advisor and mentor for my Ph.D., and without their inspiration, stimulating suggestions, sound advice, guidance, and active participation in the process of work, I would never have finished parts of this work. Also, this dissertation would not have been possible without the active contribution of my colleagues in InterNetWorks Research Laboratory (IRL). I thank them for the long discussions we had, the papers they helped improve, and their valuable feedback; among them are Dr. Ahmad Suki, Dr. Hasbullah, Dr. Shahrudin, Mahmoud Alshogran, and many others.

Throughout this work I have met with many great people; among them are Professor Dr. Rahmat, my deep gratitude to them for their valuable suggestions and comments. Their proactive support, advice, and ideas have been critically essential to this research.

I am also grateful to School of Computing, UUM College of Arts and Sciences, for providing research facilities and related resources that facilitated my study. It was an enjoyable place to work and study.

Finally, I am immeasurably grateful to my family for their kindness and support. They have always been there and encouraged me; without their selfless love, I know I could not have successfully completed my doctoral studies.

Table of Contents

List of Tables

List of Figures

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

The contents of the thesis is for internal user only

REFERENCES

[1] M. S. Thompson, A. B. Mackenzie, and V. Tech, "A Retrospective Look at the MANIAC Challenge," *IEEE Commun. Mag.*, no. July, pp. 121–127, 2012.

[2] A. P. S.S.Dhenakaran, "An Overview of Routing Protocols in Mobile Ad-Hoc Network," *Int. J. Adv. Res. Comput. Sci. Softw. Eng.*, vol. 3, no. 2, pp. 251–259, 2013.

[3] "Mobile Ad-hoc Networks (MANETs) Are Not A Fundamentally Flawed Architecture." [Online]. Available: http://seminarprojects.net/t-mobile-ad-hoc-networks-manets-are-not-a-fundamentally-flawed-architecture.

[4] A. Gill, "Behavioural Study of Issues And Challenges In Mobile Adhoc Network," *Int. J. Adv. Res. Comput. Sci. Softw. Eng.*, vol. 2, no. 5, pp. 291–295, 2012.

[5] P. S. CSaleh Ali K.Al-Omari, "An Overview of Mobile Ad-hoc Networks for the Existing Protocols and Applications," *Int. J. Appl. Graph Theory Wirel. Ad-Hoc Networks Sens. Networks*, vol. 2, no. 1, pp. 87–110, 2010.

[6] P. Ghosekar, "Mobile Ad-hoc Networking : Imperatives and Challenges," *Int. J. Comput. Appl.*, pp. 153–158, 2010.

[7] D. E. C. Hallenges and F. O. R. E. Nergy, "Design challenges for energy-constrained ad-hoc wireless networks," *IEEE Wirel. Commun.*, vol. 9, no. August (4), pp. 8–27, 2002.

[8] A. Mei and J. Stefa, "ACM international symposium on Mobile ad-hoc networking and computing(MobiHoc),2008.," in *Routing in Outer Space : Fair Traffic Load in Multi-Hop Wireless Networks*, 2008, pp. 23–31.

[9] A. Junior, R. Sofia, U. Lusófona, and A. Costa, "International Conference on Network Protocols," in *Energy-efficient Routing*, 2011, pp. 295–297.

[10] H. Wang and W. Chen, "Proceedings of 9th International Conference on Mobile Wireless Communications Networks, IFIP.," in *Maximum Path Lifetime Routing for ad-hoc wireless networks*, 2007, pp. 166–170.

[11] K. Kim and S. Min, "Proceedings of 3rd International Symposium on Wireless Pervasive Computing, ISWPC 2008.," in *Maximising the lifetime of wireless ad-hoc networks using Minimising the Maximum used Power Routing*, pp. 557–561.

[12] B. Zhang and H. T. Mouftah, "Energy-aware on-demand routing protocols for wireless ad-hoc networks," *Wirel. Networks*, vol. 12, no. 4, pp. 481–494, May 2006.

[13] D. J. Vergados, N. a. Pantazis, and D. D. Vergados, "Energy-Efficient Route Selection Strategies for Wireless Sensor Networks," *Mob. Networks Appl.*, vol. 13, no. 3–4, pp. 285–296, Aug. 2008.

[14] H.-C. Wang and Y.-H. Wang, "IEEE International Symposium on Personal, Indoor and Mobile Radio Communications.," in *Energy-Efficient Routing Algorithms for Wireless ad-hoc Networks*, 2007, pp. 1–5.

[15] M. Yu, A. Malvankar, and S. Y. Foo, "IEEE Communications Society (IEEC ICC 2006)," in *An Energy-Efficient Path Availability Routing Algorithm For Mobile Ad-hoc Sensor Networks*, 2006, vol. 00, no. c, pp. 1885–1890.

[16] S. K. Dhurandher, S. Misra, M. S. Obaidat, V. Bansal, P. Singh, and V. Punia, "Proceedings of 15th IEEE International Conference on Electronics, Circuits and Systems, ICECS 2008.," in *An Energy-Efficient On-Demand Routing algorithm for Mobile Ad-Hoc Networks*, 2008, pp. 958–961.

[17] M. Maleki, K. Dantu, and M. Pedram, "Proceedings of the International Low Power Electronics and Design, 2002. ISLPED '02.," in *Power-aware source routing protocol for mobile ad-hoc networks*, 2002, pp. 72–75.

[18] J. Harms, "Position-based routing with a power-aware weighted forwarding function in MANETs," *IEEE Int. Conf. Performance, Comput. Commun. 2004*, pp. 347–356, 2004.

[19] N. Meghanathan and a. Farago, "Maximising Network Lifetime under a Fixed Energy Budget in Mobile Ad-hoc Networks," *Proceedings. IEEE SoutheastCon, 2005.*, pp. 319–326, 2005.

[20] I. Stojmenovic and X. Lin, "Power-aware localised routing in wireless networks," *IEEE Trans. Parallel Distrib. Syst.*, vol. 12, no. 11, pp. 1122–1133, 2001.

[21] R. Wattenhofer, L. Li, P. Bahl, and Y.-M. Wang, "Twentieth Annual Joint Conference of the IEEE Computer and Communications Society INFOCOM 2001.," in *Distributed topology control for power efficient operation in multihop wireless ad-hoc networks*, 2001, vol. 3, pp. 1388–1397.

[22] C.-K. Toh, "Maximum battery life routing to support ubiquitous mobile computing in wireless ad-hoc networks," *IEEE Communications Magazine*, vol. 39, no. 6, pp. 138–147, Jun-2001.

[23] L. L. Halpem, Joseph Y, "IEEE International Conference on Communications(ICC, 2001).," in *Minimum-Energy Mobile Wireless Networks Revisited*, 2001, pp. 278–283.

[24] L. B. Woo K, Yu C, Youn HY, "Proceedings of Int'l Symp. on Modelling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS 2001)," in *Non-Blocking, Localised Routing Algorithm for Balanced Energy Consumption in Mobile Ad-hoc Networks*, 2001, pp. 117–124.

[25] M. R. H. Vijayakumar, "National Conference on Innovations in Emerging Technology," in *Efficient Location Management of Mobile Node in Wireless Mobile Ad-hoc Network*, 2011, pp. 77–84.

[26] Y. Barowski, "IEEE Conference Wireless Communications and Networking, (WCNC),05.," in *Towards the Performance Analysis of IEEE 802 . 11 in*

Multi-hop Ad-Hoc Networks, 2005, pp. 100–106.

[27] S. D. Sachin Sharma, H.M. Gupta, "EAGR : Energy Aware Greedy Routing Scheme for Wireless Ad-hoc Networks," in *EAGR : Energy Aware Greedy Routing Scheme for Wireless Ad-hoc Networks*, 2008, pp. 122–129.

[28] C. L. -, S. M. L. -, and I. L. -, "Review of Location-Aware Routing Protocols," *Int. J. Adv. Inf. Sci. Serv. Sci.*, vol. 2, no. 2, pp. 132–143, Jun. 2010.

[29] P. Agrawal and J. Y. H. C. Chen, "A Survey of Energy Efficient Network Protocols for Wireless Networks ∗," *Kluwer Acad. Publ.*, vol. 7, no. 4, pp. 343–358, 2001.

[30] S. Kodesia, A. Prof, and P. Narayan, "A REVIEW OF ENERGY EFFICIENT ROUTING PROTOCOLS FOR MOBILE AD- HOC NETWORK," *J. Glob. Res. Comput. Sci.*, vol. 3, no. 5, pp. 46–50, 2012.

[31] F. Koushanfar, A. Davare, D. T. Nguyen, A. Sangiovanni-Vincentelli, and M. Potkonjak, "Techniques for maintaining connectivity in wireless ad-hoc networks under energy constraints," *ACM Trans. Embed. Comput. Syst.*, vol. 6, no. 3, p. 16–es, Jul. 2007.

[32] S. Basagni, I. Chlamtac, V. R. Syrotiuk, and B. a. Woodward, "ACM/IEEE international conference on Mobile computing and networking, (MobiCom) '98.," in *A distance routing effect algorithm for mobility (DREAM)*, 1998, pp. 76–84.

[33] and G. . G. Geetha Jayakumar, "Ad-hoc Mobile Wireless Networks Routing Protocols – A Review," *J. Comput. Sci.*, vol. 3, no. 8, pp. 574–582, 2007.

[34] O. Ercetin, O. Gurbuz, K. Bulbul, and E. Ciftcioglu, "A Practical Routing and MAC Framework for Maximum Lifetime Sensor Telemetry," *IEICE TRANSACTIONS on Communications*, no. 11, pp. 3146–3157, 2007.

[35] S. H. Hosseini Nazhad Ghazani, J. Jabari Lotf, and R. Alguliev, "International Conference on Computer Engineering and Technology (ICCET)," in *A New Survey of Routing Algorithms in Ad-hoc Networks*, 2010, pp. 407–411.

[36] A. Network, S. Ktari, and H. Labiod, "IEEE International Conference on Communication systems, (ICCS).," in *Load Balanced Multipath Routing in Mobile*, 2006, pp. 1–5.

[37] M. Node, "Proceedings of International Conference on ITS Telecommunications 2006," in *Hotspot Mitigation With Measured Node Throughput in Mobile Ad-hoc Networks*, pp. 749–752.

[38] D. S. J. De Couto, B. A. Chambers, and R. Morris, "Performance of Multihop Wireless Networks : Shortest Path is Not Enough," *ACM SIGCOMM Comput. Commun. Rev.*, vol. 33, no. 1, pp. 83–88.

[39] G. Wang and G. Wang, "An Energy-Aware Geographic Routing Protocol for Mobile Ad-hoc Networks," *Int. J. Softw. Informatics*, vol. 4, no. 2, pp. 183–196, 2010.

[40] Y. Wang, "Study on Energy Conservation in MANET," *J. Networks*, vol. 5, no. 6, pp. 708–715, Jun. 2010.

[41] D. G. Anand, H. G. Chandrakanth, M. N. Giriprasad, and A. Pradesh, "Energy Efficient Coverage Problems in Wireless Ad-hoc Sensor Networks," *Adv. Comput. An Int. J. (ACIJ)*, vol. 2, no. 2, pp. 42–50, 2011.

[42] N. Tantubay, D. R. Gautam, and M. K. Dhariwal, "A Review of Power Conservation in Wireless Mobile Adhoc Network (MANET)," *IJCSI Int. J. Comput. Sci. Issues*, vol. 8, no. 4, pp. 378–383, 2011.

[43] F. X. and P. R. Kumar, "The Number of Neighbours Needed for Connectivity of Wireless Networks.," *Wirel. Networks J.*, vol. 10, no. 2, pp. 169–181.

[44] E. M. Royer, P. M. Melliar-smitht, and L. E. Mosert, "IEEE International Conference on Communications, ICC 2001.," in *An Analysis of the Optimum Node Density for Ad-hoc Mobile Networks*, 2001, pp. 857 – 861 vol.3.

[45] M. Heissenbüttel, T. Braun, M. Wälchli, and T. Bernoulli, "Evaluating the limitations of and alternatives in beaconing," *Ad-hoc Networks*, vol. 5, no. 5, pp. 558–578, Jul. 2007.

[46] S. Yang, C. K. Yeo, and B. S. Lee, "Toward Reliable Data Delivery for Highly Dynamic Mobile Ad-hoc Networks," *IEEE Trans. Mob. Comput.*, vol. 11, no. 1, pp. 111–124, Jan. 2012.

[47] J. Kuruvila, A. Nayak, and I. Stojmenovic, "Progress and Location Based Localised Power Aware Routing for Ad-hoc and Sensor Wireless Networks," *Int. J. Distrib. Sens. Networks*, vol. 2, no. 2, pp. 147–159, 2006.

[48] N. N. Qadri and A. Liotta, "Computer Communications and Networks, Pervasive Computing," in *Analusis of Pervasive Mobile Ad-hoc Routing Protocols*, 2010, pp. 433–453.

[49] A. Gupta, S. D. Sharma, and B. T. Proactive, "A Survey on Location Based Routing Protocols in Mobile Ad-hoc Networks," vol. 5, no. 2, pp. 994–997, 2014.

[50] A. M. Popescu, I. G. Tudorache, B. Peng, and A. H. Kemp, "Surveying Position Based Routing Protocols for Wireless Sensor and Ad-hoc Networks," *Int. J. Commun. Networks Inf. Secur.*, vol. 4, no. 1, pp. 41–67, 2012.

[51] K. Abrougui, R. Werner Nelem Pazzi, and A. Boukerche, "2010 IEEE International Conference on Communications," in *Performance Evaluation of Location-Based Service Discovery Protocols for Vehicular Networks*, 2010, pp. 1–5.

[52] S. Jain and S. Sahu, "Topology vs Position based Routing Protocols in Mobile Ad-hoc Networks : A Survey," *Int. J. Eng. Res. Technol.*, vol. 1, no. 3, pp. 1–11, 2012.

[53] J. Kuruvila, A. Nayak, and I. Stojmenovic, "Progress and Location Based Localised Power Aware Routing for Ad-hoc and Sensor Wireless Networks," *Int. J. Distrib. Sens. Networks*, vol. 2, no. 2, pp. 147–159, 2006.

[54] S. V Alone, "International Conference on Power, Automation and Communication (INPAC), 2014," in *Implementation on Geographical Location based Energy Efficient Direction Restricted Routing in Delay Tolerant Network*, 2014, pp. 129–135.

[55] L. K. Qabajeh, "A Qualitative Comparison of Position-Based Routing Protocols for Ad-Hoc Networks," *IJCSNS Int. J. Comput. Sci. Netw. Secur.*, vol. 9, no. 2, pp. 131–140, 2009.

[56] H. Mauve, M. ; Widmer, J. ; Hartenstein, "A survey on position-based routing in mobile ad-hoc networks," *IEEE Journals Mag.*, vol. 15, no. 6, pp. 30–39, 2001.

[57] V. Govindaswamy, W. L. Blackstone, and G. Balasekara, "International Conference on Computer Modelling and Simulation," in *Survey of Recent Position Based Routing Mobile Ad-hoc Network Protocols*, 2011, vol. 1, pp. 467–471.

[58] I. Stojmenovic, "Location updates for efficient routing in ad-hoc networks," in *Handbook of Wireless Networks and Mobile Computing*, 2002, pp. 1–17.

[59] W. Feng, L. Zhang, and J. M. H. Elmirghani, "Energy saving geographic routing in ad-hoc wireless networks," *IET Commun.*, vol. 6, no. 1, pp. 116–124, 2012.

[60] A. Maghsoudlou, M. St-hilaire, and T. Kunz, "A Survey on Geographic Routing Protocols for Mobile Ad-hoc Networks," 2011.

[61] F. Cadger, K. Curran, J. Santos, and S. Moffett, "A Survey of Geographical Routing in Wireless Ad-Hoc Networks," *IEEE Commun. Surv. Tutorials*, vol. 15, no. 2, pp. 621–653, 2013.

[62] S. Capkun, M. Hamdi, and J. Hubaux, "International Conference on System Sciences," in *GPS-free positioning in mobile Ad-Hoc networks*, 2001, vol. 00, no. c, pp. 1–10.

[63] G. L. O. Localisation, N. Bulusu, J. Heidemann, and D. Estrin, "GPS-less low-cost outdoor localisation for very small devices," *IEEE Pers. Commun.*, vol. 7, no. October(5), pp. 28–34, 2000.

[64] S. Capkun, M. Hamdi, and J.-P. Hubaux, "International Conference on System Sciences," in *GPS-free positioning in mobile ad-hoc networks*, 2001, vol. 0, p. 10.

[65] V. C. Giruka and M. Singhal, "Sixth IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks," in *Hello Protocols for Ad-Hoc Networks: Overhead and Accuracy Tradeoffs*, 2005, pp. 354–361.

[66] M. Ayaida, H. Fouchal, L. Afilal, and Y. Ghamri-Doudane, "2012 IEEE Vehicular Technology Conference (VTC Fall)," in *A Comparison of Reactive, Grid and Hierarchical Location-Based Services for VANETs*, pp. 1–5.

[67] S. M. Das, Y. C. Hu, and W. Lafayette, "INFOCOM 2005. 24th Annual Joint Conference of the IEEE Computer and Communications Societies.," in *Performance Comparison of Scalable Location Services for Geographic Ad-*

hoc Routing, vol. 00, no. C, pp. 1228 – 1239 vol. 2.

[68] K. Michael, "A Reactive Location Service for Mobile Ad-hoc Networks," 2002.

[69] G. Pei, M. Gerla, and X. Hong, "ACM international symposium on Mobile ad-hoc networking & computing.," in *LANMAR : Landmark Routing for Large Scale Wireless Ad-hoc Networks with Group Mobility*, 2000, pp. 1–8.

[70] J. Le Boudec, "Challenges in Self-Organisation in Mobile Ad-hoc Networks : The Approach of Terminodes," *IEEE Communications Magazine*, no. June, pp. 166–174, 2001.

[71] Rei-Heng Cheng and Chiming Huang, "Efficient Prediction-Based Location Updating and Destination Searching Mechanisms for Geographic Routing in Mobile Ad-hoc Networks," *J. Inf. Sci. Eng.*, vol. 129, no. 28, pp. 115–129, 2012.

[72] A. V. Vidyapeetham and B. Campus, "International Conference on Advances in Computing, Communications and Informatics (ICACCI)," in *ZEEP: Zone based Energy Efficient Routing Protocol for Mobile Sensor Networks*, 2013, pp. 990–996.

[73] N. Aitha and R. Srinadas, "A Strategy to Reduce the Control Packet Load of AODV Using Weighted Rough Set Model for MANET," *Int. Arab J. Inf. Technol.*, vol. 8, no. 1, pp. 108–116, 2011.

[74] M. Frikha and J. B. E. N. Slimane, "International conference on Mobile technology, applications & systems(Mobility)," in *Conception and Simulation of Energy-Efficient AODV protocol in Ad-hoc Networks*, 2006, pp. 1–7.

[75] J. Gomez and A. T. Campbell, "Using Variable-Range Transmission Power Control in Wireless Ad-hoc Networks," *IEEE Trans. Mob. Comput.*, vol. 6, no. 1, pp. 1–13, 2007.

[76] J. Choi, Y. Ko, and J. Kim, "IEEE International Conference on Networking (ICN '04).," in *Utilising Directionality Information for Power-Efficient Routing in Ad-hoc Networks **, 2004, pp. 588 – 594.

[77] U. M. Pesovic, J. J. Mohorko, K. Benkc, and Z. F. Cucej, "Single-hop vs . Multi-hop – Energy efficiency analysis in wireless sensor networks," pp. 471–474, 2010.

[78] L. Zhang and L. J. Cimini Jr., "IEEE Conference Wireless Communications and Networking," in *Hop-by-Hop Routing Strategy for Multihop Decode-and-Forward Cooperative Networks*, 2008, pp. 576–581.

[79] H. Takagi and L. Kleinrock, "Optimal Transmission Ranges for Randomly Distributed Packet Radio Terminals," *IEEE Trans. Commun.*, vol. 32, no. 3, pp. 246–257, Mar. 1984.

[80] T. I. On, "Transmission Range Control in Multihop Packet Radio Networks," *IEEE Trans. Commun.*, vol. 34, no. 1, pp. 38–44, 1986.

[81] N. N. RelayYuvaraju, B N.Chilunkar, "Enhancing the Performance of a

Nodes in Ad-hoc Networks using Mobile Relay," *Int. J. Comput. Sci. Commun.*, vol. 1, no. 2, pp. 65–70, 2010.

[82] M. R. Communications, "No Title," pp. 1741–1745, 2010.

[83] M. Ghane and A. Rajabzadeh, "International Symposium on Computer Architecture and Digital Systems (CADS), 2010," in *Remaining-Energy Based Routing Protocol for Wireless Sensor Network*, 2010, pp. 67–73.

[84] M. Abdoos, K. Faez, and M. Sabaei, "First Asian Himalayas International Conference on Internet, (AH-ICI 2009).," in *Position Based Routing Protocol With More Reliability In Mobile Ad-hoc Network*, 2009, pp. 1–4.

[85] E. Kranakis, H. Singh, and J. Urrutia, "Proc. in 11 Th Canadian Conference on Computational Geometry," in *Compass routing on geometric networks*, 1999, pp. 1–4.

[86] Y. Ko and N. H. Vaidya, "Location-Aided Routing (LAR) in Mobile Ad-hoc Networks," Texas, USA., 2000.

[87] A. T. Kalhor, S.; Anisi, M.; Haghighat, "Systems and Networks Communications, 2007. ICSNC 2007. Second International Conference on," in *A New Position-Based Routing Protocol for Reducing the Number of Exchanged Route Request Messages in Mobile Ad-hoc Networks*, 2007, vol. 1, no. Icsnc, pp. 13 – 13.

[88] J. Li and P. Mohapatra, "LAKER: Location aided knowledge extraction routing for mobile ad-hoc networks," *Wirel. Commun. Networking, ...*, vol. 2, no. C, pp. 1180–1184, 2003.

[89] S. Nanda and R. S. Gray, "IEEE Wireless Communications and Networking Conference, WCNC.," in *Multipath Location Aided Routing in 2D and 3D*, 2006, vol. 1, no. c, pp. 311–317.

[90] C. Yu, T. Shen, J. Lee, Y. Suh, and A. Arbor, "IEEE Conference on Computer Communications (INFOCOM).," in *Multihop Transmission Opportunity in Wireless Multihop Networks*, 2010, vol. 1, no. c, pp. 1–9.

[91] and D. A. M. D.B. Johnson, "Dynamic source routing in ad-hoc wireless networks. In Mobile Computing," *Kluwer Acad. PubUshers, Dordrecht,* pp. 153–181, 1996.

[92] Y. Ko and N. H. Vaidya, "Location-Aided Routing (LAR) in mobile ad-hoc networks ∗," *Wirel. Networks*, vol. 6, pp. 307–321, 2000.

[93] Y. Kim, J. Lee, A. Helmy, and L. Angeles, "Modelling and Analysing the Impact of Location Inconsistencies on Geographic Routing in Wireless," *Mob. Comput. Commun. Rev.*, vol. 8, no. 1, pp. 48–60, 2004.

[94] L. A. Latiff, A. Ali, C. Ooi, N. Fisal, and M. Ismail, "Network Performance of a Multi-hop Quadrant- based Directional Routing Protocol (Q-DIR) in Wireless Mobile Ad-hoc Network," pp. 4–8, 2006.

[95] L. a. Latiff, a. Ali, and N. Fisal, "Power reduction quadrant-based directional routing protocol (Q-DIR) in Mobile Ad-hoc Network," *2007 IEEE Int. Conf.*

Telecommun. Malaysia Int. Conf. Commun., no. May, pp. 208–213, 2007.

[96] S. Gupta and A. Mathur, "2014 International Conference on Electronic Systems, Signal Processing and Computing Technologies," in *Enhanced Flooding Scheme for AODV Routing Protocol in Mobile Ad-hoc Networks*, 2014, pp. 316–321.

[97] I. T. Haque, I. Nikolaidis, and P. Gburzynski, "International Symposium on Performance Evaluation of Computer & Telecommunication Systems,(SPECTS), 2009.," in *Expected Path Length for Angle and Distance-based Localised Routing*, 2009, pp. 137–141.

[98] M. Al-Jemeli, F. A. Hussin, and B. B. Samir, "A link-quality and energy aware routing metric for mobile wireless sensor networks," in *4th International Conference on Intelligent and Advanced Systems (ICIAS2012)*, 2012, pp. 211–216.

[99] S. A. Hamid and G. Takahara, "Routing for Wireless Multi Hop Networks – Unifying and Distinguishing Features Technical Report 2011-583," 2011.

[100] A. Ghaffari, S. Taghipour, and M. Attari, "EART : Energy Aware Routing Algorithm for Realising the Reliability and Timeliness in Wireless Sensor Networks," *World Appl. Sci.*, vol. 17, no. 9, pp. 1205–1210, 2012.

[101] J.-C. Cano, "Investigating performance of power-aware routing protocols for mobile ad-hoc networks," *Int. Mobil. Wirel. Access Work.*, pp. 80–86, 2002.

[102] C. S. R. S. Singh, M. Woo, "ACM/IEEE International conference on Mobile computing and networking (MobiCom).," in *Power Aware Routing in Ad-hoc Networks*, 1998, pp. 70 – 75.

[103] P. S. Priya, V. Seethalakshmi, and G. M. Kumar, "EFFICIENCY ENHANCEMENT OF ENERGY AWARE AD-HOC ROUTING PROTOCOLS," *Int. J. Comput. Networking, Wirel. Mob. Commun.*, vol. 3, no. 1, pp. 209–220, 2013.

[104] M. M. a. Azim, "Proceedings of the 4th International Conference on Ubiquitous Information Technologies & Applications, 2009. ICUT '09.," in *MAP: Energy Efficient Routing Protocol for Wireless Sensor Networks*, pp. 1–6.

[105] J. Wang, I. J. De Dieu, A. D. L. D. Jose, S. Lee, and Y.-K. Lee, "International Symposium on Applications and the Internet (SAINT), 2010 10th IEEE/IPSJ," in *Prolonging the Lifetime of Wireless Sensor Networks via Hotspot Analysis*, pp. 383–386.

[106] L. Ren, Z. Guo, and R. Ma, "3rd IEEE Conference on Industrial Electronics and Applications, 2008. ICIEA 2008.," in *Distance-based energy efficient placement in wireless sensor networks*, pp. 2031–2035.

[107] Y. Shi, F. Jia, and Y. Hai-tao, "3rd IEEE Conference on Industrial Electronics and Applications, ICIEA 2008.," in *An improved router placement algorithm based on energy efficient strategy for wireless networks*, pp. 2031 – 2035.

[108] Y. Zhang, L. Feng, W. Chen, and L. Zhu, "International Conference on

Embedded Software and Systems Symposia, 2008. ICESS Symposia '08.," in *Power-Aware Routing Algorithm Based on Mobile Agents (PARAMA) in Mobile Ad-hoc Networks*, vol. 2, pp. 312 – 317.

[109] N. Wang and Y. Su, "The IEEE Conference on Local Computer Networks, 2005. 30th Anniversary.," in *A power-aware multicast routing protocol for mobile ad-hoc networks with mobility prediction*, p. 8 pp.–417.

[110] S. Banerjee and A. Misra, "Wireless Optimiation Workshop (WiOpt'03).," in *Adapting Transmission Power for Optimal Energy Reliable Multi-hop Wireless Communication*, 2003, pp. 1–20.

[111] J. S. Yang, K. Kang, Y.-J. Cho, and S. Y. Chae, "Procceding of IEEE Wireless Communications and Networking Conference, 2008. WCNC 2008.," in *PAMP: Power-AwareMultiPath Routing Protocol for a Wireless Ad-hoc Network*, pp. 2247–2252.

[112] A. a., G. R. Sakthidharan, and K. M. Miskin, "Procceding of Second International Conference on Machine DREAMing and Computing (ICMLC), 2010," in *Study of Energy Efficient, Power Aware Routing Algorithm and Their Applications*, pp. 288–291.

[113] W. Kun, X. U. Yin-long, C. Guo-liang, and W. U. Ya-feng, "Proceedings of 24th International Conference onDistributed Computing Systems Workshops, 2004.," in *Power-aware on-demand routing protocol for MANET*, pp. 723–728.

[114] Y. Y. Wen and H. Y. Ang, "Proccedings of 6th International Conference on Information, Communications & Signal Processing, 2007," in *A routing protocol with energy and traffic balance awareness in wireless ad-hoc networks*, pp. 1–5.

[115] S. Banerjee, P. Bera, and S. Choudhury, "Proccedings of 2nd International Conference on Computer Technology and Development (ICCTD), 2010," in *A Power Aware Multicast On-demand Routing with Load Balancing*, no. Icctd, pp. 677–681.

[116] M. Z. Liansheng Tan, L.Xie, King-Tim K., M. Lei, "Proccedings of IEEE 63rd Vehicular Technology Conference, VTC 2006-Spring. (Volume:2)," in *Lifetime -Aware Multipath Optimised Routing Algorithm for Video Transmission over Ad-hoc Networks*, vol. 00, no. c, pp. 623–627.

[117] P. S. M. K.Y. Shin, J.Song, J.Kim, M.Yu, "Proceedings of The 9th International Conference on Advanced Communication Technology, (Volume:1)," in *REAR: Reliable Energy Aware Routing Protocol for Wireless Sensor Networks*, pp. 525–530.

[118] P. Murali, K. Rakesh, C. Hota, and A. Yla-Jaaski, "Wireless Days, 2008. WD '08. 1st IFIP," in *Energy-aware routing in Mobile Ad-Hoc Networks*, 2008, pp. 1–5.

[119] T. Camp, J. Boleng, B. Williams, L. Wilcox, and W. Navidi, "IEEE Conference of Computer and Communications Societies, (INFOCOM), 2002.," in *Performance Comparison of Two Location Based Routing*

Protocols for Ad-hoc Networks, 2002, vol. 00, no. c, pp. 1678–1687.

[120] Y. Wang, W. Song, W. Wang, X. Li, and T. A. Dahlberg, "DREAM : Localised Energy Aware Restricted Neighbourhood Routing for Ad-hoc Networks," vol. 00, no. C, pp. 508–517, 2006.

[121] J. Li and P. Mohapatra, "PANDA: A novel mechanism for flooding based route discovery in ad-hoc networks," *Wirel. Networks*, vol. 12, no. 6, pp. 771–787, Apr. 2006.

[122] J. Li and P. Mohapatra, "Proceedings of IEEE Global Telecommunications Conference, GLOBECOM '03.(Volume:2)," in *A novel mechanism for flooding based route discovery in ad-hoc networks*, vol. 12, no. 6, pp. 692 – 696 Vol.2.

[123] L. Tassiulas, "IEEE INFOCOM Conference on Computer Communications.," in *Energy conserving routing in wireless ad-hoc networks*, 2000, vol. 1, pp. 22–31.

[124] Q. Li, J. Aslam, and D. Rus, "Proceedings of the 7th annual international conference on Mobile computing and networking - MobiCom '01," in *Online power-aware routing in wireless Ad-hoc networks*, 2001, no. 1, pp. 97–107.

[125] I. Stojmenovic and X. Lin, "Power-Aware Localised Routing in Wireless Networks," *IEEE Trans. Parallel Distrib. Syst.*, vol. 12, no. 10, pp. 1–12, 2001.

[126] S. Doshi and T. X. Brown, "Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies. INFOCOM 2002.," in *Minimum Energy Routing Schemes for a Wireless Ad-hoc Network*, 2002, pp. 1–11.

[127] S. Banerjee and A. Misra, "ACM International symposium on Mobile ad-hoc networking & computing - MobiHoc '02," in *Minimum energy paths for reliable communication in multi-hop wireless networks*, 2002, p. 146.

[128] S. Narayanaswamy, V. Kawadia, R. S. Sreenivas, and P. R. Kumar, "Proceedings of European Wireless 2002," in *Power Control in Ad-Hoc Networks : Theory , Architecture , Algorithm and Implementation of the COMPOW Protocol*, 2002, pp. 1–7.

[129] B. Chen, K. Jamieson, H. Balakrishnan, and R. Morris, "Proceedings of Int'l Conf. on Mobile Computing and Networking (MobiCom'2001)," in *Span : An Energy-Efficient Coordination Algorithm for Topology Maintenance in Ad-hoc Wireless Networks*, 2001, pp. 1–12.

[130] Y. Xu, "Proceedings of the 7th annual international conference on Mobile computing and networking MobiCom '01.," in *Geography-informed Energy Conservation for Ad-hoc Routing*, 2001, pp. 70–84.

[131] G. Girling, J. Li, K. Wa, and P. Osborn, "Wireless Communications and Networking Confernce, 2000. WCNC. 2000 IEEE (Volume:3)," in *The Design and Implementation of a Low Power Ad-hoc Protocol Stack*, 2000, pp. 1521–1529.

[132] S. Mueller, R. P. Tsang, and D. Ghosal, "2nd International Conference on Current Trends in Engineering and Technology (ICCTET), 2014," in *Energy efficient routing issues and challenges in mobile Ad-hoc networks*, 2014, pp. 26 – 31.

[133] W. Naruephiphat and C. Charnsripinyo, "Symposia and Workshops on Ubiquitous, Autonomic and Trusted Computing," in *Routing Algorithm for Balancing Network Lifetime and Reliable Packet Delivery in Mobile Ad-hoc Networks*, 2009, pp. 257–262.

[134] L. Li, D. Alderson, and J. Doyle, "Special Interest Group on Data Communication (SIGCOMM)," in *A First-Principles Approach to Understanding the Internet ' s Router-level Topology*, 2004, pp. 1–12.

[135] J. Wang, "International Conference on System Simulation and Scientific Computing," in *Methodology of simulation science and technology*, 2008, pp. 989–994.

[136] B. M. E. Moret, "Algorithms and Experiments : The New (and Old) Methodology," vol. 7, no. 5, pp. 434–446, 2001.

[137] R. B. Deal, A. M. Law, and W. D. Kelton, "Simulation Modelling and Analysis," *Technometrics*, vol. 36, no. 4, p. 429, Nov. 1994.

[138] S. Buchegger, "Proceedings of the 3rd ACM international symposium on Mobile ad-hoc networking & computing MobiHoc '02:," in *Performance Analysis of the CONFIDANT Protocol (Cooperation Of Nodes : Fairness In Dynamic Ad-hoc NeTworks)*, pp. 226 – 236.

[139] R. Puigjaner, U. De, and I. Balears, "Proceedings of the 2003 IFIP/ACM Latin America conference on Towards a Latin American agenda for network research. LANC '03:," in *Performance Modelling of Computer Networks Workload Characterisation Performance modelling techniques*, pp. 106–123.

[140] I. S. Ibrahim, P. J. . King, and R. Pooley, "Fourth International Conference on Systems and Networks Communications, 2009. ICSNC '09.," in *Performance Evaluation of Routing Protocols for MANET*, pp. 105–112.

[141] and D. T. S. W. D. Kelton, R. P. Sadowki, *Simulation With Arena*, Second. MCGraw-Hill, 2004.

[142] A. Maria, "Proceedings of the 1997 Winter Simulation Conference," in *Introduction To Modelling and Simulation*, 1997, pp. 7–13.

[143] J. Mwanza, "Performance Evaluation of Routing Protocols in Mobile Ad-hoc Networks (MANETs)," no. January, 2009.

[144] "TCL homepage." [Online]. Available: http://www.tcl.tk.

[145] "Virtual InterNetwork Testbed Collaboration." [Online]. Available: http://www.isi.edu/nsnam/vint,.

[146] "Visual Studio C++." [Online]. Available: http://msdn.microsoft.com/en-us/vstudio.

[147] D. E. Sandeep Ba ja j, Lee Breslau, "Improving Simulation for Network Research," 1999.

[148] J. Heidemann, K. Mills, and S. Kumar, "Expanding confidence in network simulations," *IEEE Netw.*, vol. 15, no. 5, pp. 58–63.

[149] K. Pawlikowski, H. J. Jeong, and J. R. Lee, "On Credibility of Simulation Studies of Telecommunication Networks," *IEEE Communications Magazine*, vol. 40, pp. 1–15, 2001.

[150] P. Meeneghan and D. Delaney, "An Introduction to NS , Nam and OTcl scripting," Ireland, 2004.

[151] "Installation Procedures for NS-2 (ns-allinone-2.34)," 2009. [Online]. Available: http://nsnam.isi.edu/nsnam/index.php/Downloading_and_installing_ns-2.

[152] T. Youcef, A. Hania, A. Arab, and M. Demri, "Position Location Technique in Wireless Sensor Network Using Rapid Prototyping Algorithm," 2009.

[153] V. Rodoplu and T. H. Meng, "Minimum energy mobile wireless networks," *IEEE J.*, vol. 17, no. 8, pp. 1333–1344, 1999.

[154] L. M. Feeney and M. Nilsson, "IEEE Conference of Computer and Communications Society," in *Investigating the energy consumption of a wireless network interface in an ad-hoc networking environment.*, 2001, vol. 3, pp. 1548–1557.

[155] I. Al Ajarmeh, K. El-Zayyat, and J. Yu, "International Conference on Wireless Communications, Networking and Mobile Computing Networks,(2008).," in *A Hybrid Routing Protocol for Mobile Ad-hoc and Wireless Sensor*, 2008, pp. 1–5.

[156] A. S. Arezoomand and M. Pourmina, "Proceedings of the 2nd International Conference on Computer and Automation Engineering (ICCAE), 2010 (Volume:4)," in *Prolonging network operation lifetime with new maximum battery capacity routing in wireless mesh network*, vol. 4, pp. 319–323.

[157] Z. Guo and B. Malakooti, "International Conference on Wireless Algorithms, Systems and Applications (WASA)," in *Energy Aware Proactive MANET Routing with Prediction on Energy Consumption*, 2007, pp. 287–293.

[158] W. Feng and J. M. H. Elmirghani, "Proceedings of Third International Conference on Next Generation Mobile Applications, Services and Technologies, NGMAST '09.," in *Energy-Efficient Geographic Routing in 2-D Ad-hoc Wireless Networks*, 2009, pp. 383–388.

[159] L. L. Halpem, Joseph Y, "IEEE International Conference on Communications (ICC).," in *Minimum-Energy Mobile Wireless Networks Revisited*, 2001, pp. 278–283.

[160] a. P. Jardosh, E. M. Belding-Royer, K. C. Almeroth, and S. Suri, "Real-world environment models for mobile network evaluation," *IEEE J. Sel. Areas Commun.*, vol. 23, no. 3, pp. 622–632, Mar. 2005.

[161] X. Zhang, M. Tao, and C. S. Ng, "Global Telecommunications Conference (GLOBECOM).," in *Non-Cooperative Power Control for Faded Wireless Ad-hoc Networks*, 2007, pp. 3689–3693.

[162] J. Kuruvila, A. Nayak, and I. Stojmenovic, "Progress and Location Based Localised Power Aware Routing for Ad-hoc and Sensor Wireless Networks," *Int. J. Distrib. Sens. Networks*, vol. 2, no. 2, pp. 147–159, 2006.

[163] B. Wang, C. Huang, and W. Yang, "International Conference on Wireless Communications, Networking and Mobile Computing," in *A Novel Routing Protocol Based on an Energy Model in Ad-hoc Networks*, pp. 1–4.

[164] S. A. Meybodi, "Wireless Plug and Play Control Systems : Hardware , Networks , and Protocols," AALBORG University, 2012.

[165] S. Vural and E. Ekici, "On Multihop Distances in Wireless Sensor Networks with Random Node Locations," *IEEE Trans. Mob. Comput.*, vol. 9, no. 4, pp. 540–552, Apr. 2010.

[166] O. In and D. Hoc, "Routing in Ad-hoc Networks : A Case for Long Hops," *Commun. Mag. IEEE*, vol. 43, no. 10, pp. 93–101, 2005.

[167] F. Cuckov, M. Song, and K. Hall, "IEEE Vehicular Technology Conference (VTC,07).," in *Hop Distance Based Routing Protocol for MANET*, 2007, pp. 11–15.

[168] D. Niculescu and B. Nath, "IEEE International Workshop on Sensor Network Protocols and Applications.," in *Localised positioning in ad-hoc networksAd-hoc Networks*, 2003, vol. 1, no. 2–3, pp. 247–259.

[169] H. Feng and L. J. Cimini, "IEEE Conference Publications," in *On Optimum Relay Deployment in a Multi-Hop Linear Network with Cooperation*, 2012, pp. 1 – 6.

[170] A. Raverkar, "International Conference on Electronics Computer Technology (ICECT).," in *Route discovery in insecure mobile ad-hoc network*, 2011, pp. 340–342.

[171] A. Jambli, M.N. ; Lenando, H. ; Zen, K. ; Suhaili, S.M. ; Tully, "International Conference on Wireless Communications and Applications (ICWCA)," in *Transmission Power Control in Mobile Wireless Sensor Networks : Simulation-based Approach*, 2012, pp. 1–6.

[172] L. Bao and J. J. Garcia-Luna-Aceves, "International symposium on Mobile ad-hoc networking & computing(MobiHoc)," in *Topology management in ad-hoc networks*, 2003, p. 129.

[173] H. Pucha, W. Lafayette, S. M. Das, and Y. C. Hu, "ACM International Symposium on Modelling, Analysis and Simulation of Wireless and Mobile Systems(MSWiM)," in *The Performance Impact of Traffic Patterns on Routing Protocols in Mobile Ad-hoc Networks*, 2004, pp. 1–9.

[174] R. E. Hebner, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications," 2003.

[175] H. Chen, Y. Li, and S. Member, "With Variable Packet Length," *IEEE Commun. Lett.*, vol. 8, no. 3, pp. 186–188, 2004.

[176] J.-C. Cano and P. Manzoni, "IEEE Wireless Communications and Networking, (WCNC 2003).," in *A bounding algorithm for the broadcast storm problem in mobile ad-hoc networks*, 2003, vol. 2, no. 1, pp. 1131–1136.

[177] E. M. Royer, S. Leet, and C. E. Perkinst, "IEEE Wireless Communications and Networking Confernce, (WCNC. 2000)," in *The Effects of MAC Protocols on Ad-hoc Network Communication*, 2000, pp. 543–548 Vol.2.

[178] S. G. Silviagiordanoepfhch, "Position Based Routing Algorithms for Ad-hoc Networks : A TAXONOMY," 2001.

[179] J. Deng, "Multi-hop / Direct Forwarding (MDF) for Static Wireless Sensor Networks," *Trans. Sens. Networks(TOSN)*, vol. 5, no. 9, pp. 1 – 25, 2008.

[180] S. Tao, A. L. Ananda, and M. C. Chan, "IEEE International Conference Communications (ICC).," in *Greedy Hop Distance Routing using Tree Recovery on Wireless Ad-hoc and Sensor Networks*, 2008, pp. 2712–2716.

[181] L. A. Latiff, A. Ali, and N. Fisal, "Asia-Pasific Conference on Applied Electromagnetics," in *Reduced Latency in Restricted Flooding Routing Protocol for Mobile Ad-hoc Network*, 2007, pp. 1–5.

[182] L. Tassiulas, "IEEE Conference on Computer Communications Societies. (INFOCOM)," in *Energy conserving routing in wireless ad-hoc networks*, 2000, vol. 1, pp. 22–31.

[183] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, Second Edi. McGraw- Hill and MIT Press, 1990, 1990.

[184] T. S. Rappaport, K. Blankenship, and H. Xu, "Propagation and Radio System Design Issues in Mobile Radio Systems for the GloMo Project," 1997.

[185] J. Boyer, D. Falconer, and H. Yanikomeroglu, "IEEE Global Telecommunications Conference (GLOBECOM).," in *A theoretical characterization of the multihop wireless communications channel with diversity*, 2001, vol. 2, no. 1, pp. 841–845.

[186] J. Broch, D. a. Maltz, D. B. Johnson, Y.-C. Hu, and J. Jetcheva, "ACM/IEEE international conference on Mobile computing and networking, (MobiCom),98.," in *A performance comparison of multi-hop wireless ad-hoc network routing protocols*, 1998, pp. 85–97.

[187] V. N. Talooki and K. Ziarati, "Asia-Pacific Communications Conference (APCC '06)," in *Performance Comparison of Routing Protocols For Mobile Ad-hoc Network*, 2006, vol. 00, no. 0, pp. 1–5.

[188] "The Language of Technical Computing." [Online]. Available: www.mathworks.com/products/datasheets.

[189] L. Song and D. Hatzinakos, "Broadcasting Energy Efficiency Limits in Wireles Networks," *IEEE Trans. Wirel. Commun.*, vol. 7, no. 7, pp. 2502–2511, 2008.

[190] C. E. Perkins, M. Park, and E. M. Royer, "Mobile Computing Systems and Applications (WMCSA '99)," in *Ad-hoc On-Demand Distance Vector Routing*, 1999, pp. 90–100.

[191] V. D. Park and M. S. Corson, "IEEE Computer and Communications Societies (INFOCOM).," in *A Highly Adaptive Distributed Routing Algorithm for Mobile Wireless Networks*, 1997, pp. 1405–1413.

[192] A. K. J. Marc, K. Okada, K. Kanai, and Y. Onozato, "IEEE International Symposium on Personal, Indoor and Mobile Radio Communications," in *Greedy Routing for Maximum Lifetime in Wireless Sensor Networks*, 2009, pp. 1888–1892.

[193] R. Khalaf and I. Rubin, "IEEE Vehicular Technology Conference (VTC2004)," in *Enhancing the Throughput-Delay Performance of IEEE802 . 11 Based Networks through Direct Transmissions*, 2004, vol. 00, no. C, pp. 2912–2916.

[194] G. Feng, S. Member, and G. Y. Li, "IEEE International Conference on Communications (ICC, 08).," in *A Survey of Energy-Efficient Wireless Communications*, 2013, vol. 15, no. 1, pp. 167–178.

[195] Q. Chen and M. C. Gursoy, "International Conference on Computer Communications and Networks (ICCCN).," in *Energy Efficiency and Goodput Analysis in Two-Way Wireless Relay Networks*, 2011, pp. 1–6.