



Information Systems Department  
Faculty of Computer and Information  
Sciences

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# Quality-of-Service Routing for Ad-Hoc Wireless Networks

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THESIS

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BY

**MOHAMED HAMDY MOHAMED EL-ELIEMY**

B.Sc., Faculty of Computer and Information Sciences,  
Ain Shams University.

SUPERVISED BY

Prof. Dr. **SAID GHONIEMY**

Vice Dean for Postgraduate Studies and Research Affairs,  
Faculty of Computer and Information Sciences, Ain Shams  
University.

Dr. **MOHAMED HASHEM**

Chairman of the Technical Research and Development  
Center, Air Defense Forces.

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# Abstract

Recently, Mobile Ad-Hoc Networks (MANETs) have received much attention as an interesting category of wireless networks that have many potential applications in which Quality-of-Services (QoS) support is an essential aspect to be achieved such as battlefield communication, disaster recovery, ...etc. However, managing link state information such as delay, bandwidth, and cost is difficult because of the ever-changing topology characteristics of the ad-hoc networks, limited resources, and host's mobility.

QoS routing is a key issue in designing these networks. A lot of work has been done to support QoS in many types of wired-line and cellular networks. Unfortunately, none of these works can be applied directly in ad-hoc networks because of their natures. Because the QoS routing problem is a hard constrained distributed application with dynamically changing constraints, and it is classified as NP-complete problem and it lends itself to heuristic algorithms.

Since routing operations are very heavy tasks for routers using traditional routing operations, the need of applying evolutionary techniques such as genetic algorithms have become increasingly interesting for research. Many routing algorithms based on genetic algorithms are introduced.

In this thesis, an introduction to cellular and ad-hoc networks is presented, and their different structures are discussed. QoS routing as a main QoS component in ad-hoc networks is introduced, its weighted graph model is presented, and unicast and multicast routing problems are classified.

Because the multi-constrained routing process in ad-hoc network environments is very exhaustive for routers (mobile hosts). Finding routes under more than one constraint is an NP-complete problem. The complexity of routing process in ad-hoc network environment becomes extreme especially

when the scalability of the network is taken into consideration. Many heuristic techniques are studied to be used in the routing process.

Ticket Based Probing routing algorithm is classified as one of the best-known routing algorithms. This thesis proposes a modified TBP algorithm that inherits the original ticket based probing algorithm while reducing the message routing overhead. The proposed algorithm uses hot and cold termination strategies to achieve this reduction. Through simulation, the proposed modified algorithm is found to have the same success ratio of finding low cost routes but with better message overhead ratio.

The second main contribution of this thesis is that, two genetic algorithms for the ad-hoc QoS routing problems are proposed. These two algorithms are different in data representation. The first one is a simple genetic-based QoS unicast routing algorithm in which a node-based encoding is applied for the route representation. The second algorithm is a QoS-aware genetic routing algorithm, which introduces a new link-based encoding approach for the chromosome representation. The simulation results and performance analysis show that the application of genetic algorithms for the solution of QoS routing problem is promising. The proposed algorithms are found to have better QoS performance measures, namely; success ratio and cost. The second algorithm achieves acceptable success ration for various delay requirements.

The major achievements of this work could be highlighted as follows:

- 1- A modified heuristic algorithm for QoS distributed routing in mobile ad-hoc networks that reduces the problem of routing message overhead is proposed.
- 2- A solution for the unicast source routing problem using genetic algorithms is evaluated.
- 3- A QoS-Aware proposed genetic algorithm for unicast source routing with a new proposed chromosomal encoding is presented, with efficient performance.

# Published Work

The work in this thesis is published in three papers as follows:

- 1- M. Hashem, M. Hamdy, S. Ghoniemy “Modified Distributed Quality-of-Service Routing in Ad Hoc Wireless Mobile Networks”, 11th IEEE Melecon, Cairo, 7-8 May 2002.
- 2- M. Hashem, M. Hamdy, S. Ghoniemy "A Genetic Algorithm for Delay-Constrained Unicast Source Routing in Ad Hoc Wireless Mobile Networks", First International Conference on Intelligent Computing and Information Systems (ICICIS'2002), June 2002, Cairo, Egypt.
- 3- M. Hashem, M. Hamdy, S. Ghoniemy “A Quality-of-Service-Aware Genetic Algorithm for The Source Routing in Ad-hoc Mobile Networks” 7<sup>th</sup> IEEE International Conference On Intelligent Engineering Systems, INES 2003, March 4-6, Assiut-Luxor, Egypt and 1<sup>st</sup> Technical Conference of Air Defence College for Cirtical Technologies, Febreuary 2003, Alexandria, Egypt and accepted paper for publication and presentation in:
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# Chapter 1

## Motivation, Research goals, and Outlines

### **1.1 Motivation**

Since 70's, studies of using different types of wireless networks in both military and civil applications have become increasingly popular in the network industry. Recently, Mobile Ad-hoc Networks have received more attention as an interesting category of wireless networks. Ad-hoc networks represent an interesting category of mobile computing. In some applications such as battlefield communications, disaster recovery etc., the wired network is not practical and multi-hop wireless networks provide the only feasible means for communication and information access.

According to the rising popularity of multimedia applications and potential commercial usage of mobile ad-hoc networks, Quality-of-Service support for mobile ad-hoc networks becomes an essential aspect to be achieved.