Design and Analysis of Evolutionary and Swarm Intelligence Techniques for Topology Design of Distributed Local Area Networks

by

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Submitted in partial fulfillment of the requirements for the degree Philosophiae Doctor

in the Faculty of Engineering, Built Environment, and Information Technology

University of Pretoria

Pretoria

July 2009

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Abstract

Topology design of distributed local area networks (DLANs) can be classified as an NP-hard problem. Intelligent algorithms, such as evolutionary and swarm intelligence techniques, are candidate approaches to address this problem and to produce desirable solutions. DLAN topology design consists of several conflicting objectives such as minimization of cost, minimization of network delay, minimization of the number of hops between two nodes, and maximization of reliability. It is possible to combine these objectives in a single-objective function, provided that the trade-offs among these objectives are adhered to. This thesis proposes a strategy and a new aggregation operator based on fuzzy logic to combine the four objectives in a single-objective function. The thesis also investigates the use of a number of evolutionary algorithms such as stochastic evolution, simulated evolution, and simulated annealing. A number of hybrid variants of the above algorithms are also proposed. Furthermore, the applicability of swarm intelligence techniques such as ant colony optimization and particle swarm optimization to topology design has been investigated. All proposed techniques have been evaluated empirically with respect to their algorithm parameters. Results suggest that simulated annealing produced the best results among all proposed algorithms. In addition, the hybrid variants of simulated annealing, simulated evolution, and stochastic evolution generated better results than their respective basic algorithms. Moreover, a comparison of ant colony optimization and particle swarm optimization shows that the latter generated better results than the former.

Keywords: Optimization, Local area networks, Fuzzy logic, Simulated annealing, Simulated evolution, Stochastic evolution, Swarm intelligence, Ant colony optimization, Particle swarm optimization, Unified And-Or operator.

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Dedicated to my beloved parents

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Acknowledgements

All praise be to God Almighty, for his limitless blessing and guidance. It is only because of his will and mercy that this thesis was made possible.

I would like to express my profound gratitude and appreciation to my supervisor, Professor Andries P. Engelbrecht, for his guidance, patience, and sincere advice throughout this thesis. I acknowledge his valuable time and constructive criticism. Each moment I spent working with him in this research was enjoyable and exciting.

All my family members, especially my parents, were a constant source of motivation and support. Their love and care carried me through some difficult moments in my life. Their prayers, guidance and inspiration led to this accomplishment. I am also very thankful to my sisters Amber and Sahar for their kind support, and to my wife Sobia for her patience and understanding.

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"For the things we have to learn before we can do them, we learn by doing them."

Aristotle

"I learned this, at least, by my experiment; that if one advances confidently in the direction of his dreams, and endeavors to live the life which he has imagined, he will meet with a success unexpected in common hours."

Henry David Thoreau