Resource Discovery and Fair Intelligent Admission Control over Scalable Internet

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A Thesis presented for the degree of
Doctor of Philosophy

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September 2004

Dedicated to

my Mum, Mrs. Ming S. Pang

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

_____

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Abstract

The Internet currently supports a best-effort connectivity service. There has been an increasing demand for the Internet to support Quality of Service (QoS) to satisfy stringent service requirements from many emerging networking applications and yet to utilize the network resources efficiently. However, it has been found that even with augmented QoS architecture, the Internet cannot achieve the desired QoS and furthermore, there are concerns about the scalability of any available QoS solutions. If the network is not provisioned adequately, the Internet is not capable to handle congestion condition. This is because the Internet is unaware of its internal network QoS states therefore it is not possible to provide QoS when the network state changes dynamically.

This thesis addresses the following question: Is it possible to deliver the applications with QoS in the Internet fairly and efficiently while keeping scalability?

In this dissertation we answer this question affirmatively by proposing an innovative service architecture: the Resource Discovery (RD) and Fair Intelligent Admission Control (FIAC) over scalable Internet. The main contributions of this dissertation are as follows:

1. To detect the network QoS state, we propose the Resource Discovery (RD) framework to provide network QoS state dynamically. The Resource Discovery (RD) adopts feedback loop mechanism to collect the network QoS state and reports to the Fair Intelligent Admission Control module, so that FIAC is capable to take resource control efficiently and fairly.

2. To facilitate network resource management and flow admission control, two scalable Fair Intelligent Admission Control architectures are designed and analyzed on two levels: per-class level and per-flow level. Per-class FIAC handles the aggregate admission control for certain pre-defined aggregate. Per-flow FIAC handles the flow admission control in terms of fairness within the class.

3. To further improve its scalability, the Edge-Aware Resource Discovery and Fair

Intelligent Admission Control is proposed which does not need the core routers involvement.

We devise and analyze implementation of the proposed solutions and demonstrate the effectiveness of the approach. For the Resource Discovery, two closed-loop feedback solutions are designed and investigated. The first one is a core-aware solution which is based on the direct QoS state information. To further improve its scalability, the edge-aware solution is designed where only the edges (not core) are involved in the feedback QoS state estimation. For admission control, FIAC module bridges the gap between "external" traffic requirements and the "internal" network ability. By utilizing the QoS state information from RD, FIAC intelligently allocate resources via per-class admission control and per-flow fairness control.

We study the performance and robustness of RD-FIAC through extensive simulations. Our results show that RD can obtain the internal network QoS state and FIAC can adjust resource allocation efficiently and fairly.

Publications List

All publications resulting from this thesis are listed as followed.

Referred Journal Papers

1. M. Li, and D. B. Hoang (2004), **FIAC: A Resource Discovery-Based Two-level Admission Control for Differentiated Service Networks**, In *Computer Communication Journal: Special Issue on End-to-End Quality of Service Differentiation* (In press), 2004.

2. M. Li, D. B. Hoang, and A. Simmonds (2004), **Fair Intelligent Admission Control over Resource-feedback Differentiated Service Network**, to appear In *Computer Communication Journal: the Special Issue of Quality of Service*, early 2005.

3. M. Li, D. B. Hoang, and A. Simmonds (2003), **Class-Based Fair Intelligent Admission Control over an Enhanced Differentiated Service Networks**, In *lecture Notes in Computer Science (LNCS) 2662*, Hyun-Kook Kahng (Ed.), Springer, 2003.

Referred Conference Papers

1. M. Li, and D. B. Hoang (2004), **Edge-Aware Resource Discovery and Fair Intelligent Admission Control over Multi-domain Differentiated Services Networks**, In *IEEE International Conference on Communications (ICC2004)*, Paris, France, June 22-26, 2004.

2. M. Li, and D. B. Hoang (2003), **Achieving Flow Fairness in DiffServ Class: Per-flow Fair Admission Control over Differentiated Service Network**, In *Proceedings of 4th International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing (SNPD'03)*, Luebeck, Germany, October 16-18, 2003.

3. M. Li, D. B. Hoang, and A. Simmonds (2003), **Fair Intelligent Admission Control over DiffServ Network**, In *Proceedings of 2003 11th IEEE International Conference on Networks (ICON2003)*, Sydney, Australia, September 28 - October 1, 2003.

4. M. Li, D. B. Hoang, and A. Simmonds (2003), **Class-Based Fair Intelligent Admission Control over an Enhanced Differentiated Service Networks**, In *IEEE International Conference on Information Networking 2003 (ICOIN2003)*, Jeju Island, Korea, February 12-14, 2003.

5. D. B. Hoang, and M. Li (2003), **Fair Intelligent Congestion Control over DiffServ: A Resource Discovery and Control Scheme for DiffServ**, In *Proceedings of the 2003 International Conference on Information and Communication Technologies (ICT 2003)*, Bangkok, Thailand, April 8-10, 2003.

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7. Q. Yu, M. Li, D. B. Hoang, and D. Feng (2002), **Fair Intelligent Feedback Mechanism on TCP Based Network**, In *The 2002 International Conference on Internet Computing (IC 2002)*, Las Vegas, California, USA, June, 2002.

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9. M. Li, and D. B. Hoang (2004), **Resource Discovery and Fair Intelligent Admission Control over Differentiated Services Networks for Variable-Length Packets**, In *Proceedings of the IEEE 10th Asia-Pacific Conference on Communications (APCC2004)*, Beijing, China, August, 2004.

Declaration

The work in this thesis is based on research carried out at the Advance Research in Networking Group (ARN), the Department of Computer System, Faculty of Information Technology, University of Technology, Sydney, Australia. No part of this thesis has been submitted elsewhere for any other degree or qualification and it all my own work unless referenced to the contrary in the text.

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Acknowledgments

I would like to acknowledge all the help and encouragement I have received in my PhD studying. I am especially grateful to my supervisor, Professor Doan B. Hoang, for teaching me how to be a independent researcher, for his continuous support and encouragement, and for his guidance throughout the years. His invaluable insight comments and ideas have greatly improved this thesis. I hope and look forward to continued collaboration with him in the future.

I am grateful to the Mr. Ury Szewcow, my associate adviser, for his advice that helped to improve my thesis.

I am indebted to Professor David Feng for his advice and inspiration when I was in University of Sydney.

Thanks for Dr. Andrew J. Simmonds, Dr. Peter Leijdekkers, and Dr. Valerie Gay for their comments on my work that helped to improve the overall quality of this dissertation.

I am also indebted to several people in our research group, in particular Chi Nguyen, Bushar Yousef, Hanh Le, and Joe, for thoughtful comments. I am going to miss our Friday night dinners that always make the hard working week on a high and enjoyable.

I would like to express my gratitude to my wife Fiona Shen for her love and understanding through my graduate years. She was always behind me and gave her unconditional support to make my studying smooth running. Finally, I would like to thank my son David who used his own way to support me by joy, happiness, and noisy.

I dedicate this dissertation to my mum, who has been the main driving force behind my research work.

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