Analysis and Design of Active Queue Management for TCP-RED Congestion Control Strategies

By

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Declaration

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

Signed:____

Abstract

This thesis investigates the problems of the Active Queue Management (AQM) techniques for congestion control in TCP networks. Random Early Detection (RED) and the RED-based stratgies, which adopt the AQM approach, are evaluated through simulation. Two main problems of RED, and its variants, are considered. The first problem is the mismach between the average and actual queue sizes. The second problem is the parameter configuration. This thesis proposes three new RED-based strategies and simulates them using the NS-2 simulator. These novel strategies are evaluated and compared with current RED based strategies. The proposed strategies are: Queue Sectors RED (QSRED), Risk Threshold RED (RTRED) and Weighted RED (WTRED). The performance of these strategies is evaluated using performance indicators such as: throughput, link utilization, packet loss and delay.

QSRED divides the router buffer into equal subsectors and monitors the queue dynamics. The actual drop probability p_a and maximum drop probability max_p are adjusted depending on the position of the actual and average queue sizes; q and avg respectively.

Currently, RED maintains a maximum threshold max_{th} and minimum threshold min_{th}. The second RED modification, RTRED, adds a third dropping level. This new dropping level is the risk threshold $risk_{th}$ which works with the actual and average queue sizes to detect the immediate congestion in gateways. Congestion reaction by RTRED is on time. The reaction to congestion is neither too early, to avoid unfair packet losses, nor too late to avoid packet dropping from time-outs.

The third proposed RED modification, WTRED, adjusts the weight parameter w_q dynamically, to reduce the mismatch between the average and actual queue size. WTRED also adjusts the maximum and minimum thresholds, to increase network throughput and link utilization.

The simulation results demonstrate the shortcomings of RED and RED-based strategies. The results also show that QSRED, RTRED and WTRED achieve greater network performance over other strategies.

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Dedication

"...My Lord, enable me to be grateful for Your favor which you have bestowed upon me and upon my parents and to do righteousness of which You approve. And admit me by Your mercy into (the ranks of) Your righteous servants."[An'naml, 19].

I lovingly dedicate this thesis to my brothers, sisters and my fiancee Sheraz for their love and support. Deepest appreciation to my eldest brother Safwan for his financial support.

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Publications

- Nabhan Hamadneh, David Murray, Michael Dixon, and Peter Cole: *Dynamic Weight Parameter for the Random Early Detection (RED) in TCP Networks,* International Journal of New Computer Architectures and their Applications, Vol. 2 No. 2, (2012).

This paper presents a new configuration for the weight parameter in RED. The dynamic weight parameter enhances the performance of RED. This paper is edited in Chapter 5.

- Nabhan Hamadneh, David Murray, Michael Dixon, and Peter Cole: *Weighted RED (WTRED) strategy for TCP congestion control*, Communications in Computer and Information Science, Vol. 252 No. 2 pp. 421-434, (2011).

This paper presents WTRED strategy for congestion handling. The strategy uses adjustable weight parameter to avoid the mismatch between the microscopic and macroscopic behaviours of AQM strategies. This paper is edited in Chapter 5. The paper also won the prize of the best paper in the ICIEIS 2011 conferance, Kuala Lumpur, Malaysia.

- Nabhan Hamadneh, Michael Dixon, Peter Cole, and David Murray: *A third drop level for TCP-RED congestion control strategy*, Proceedings of World Academy of Science, Engineering and Technology, Vol. 81 No. 57 pp. 892-898, (2011).

This paper presents RTRED congestion control strategy. The strategy adds a third threshold to enhance the performance of RED. This paper is edited as Chapter 4.

- Nabhan Hamadneh, David Murray, Michael Dixon, and Peter Cole: *QSRED, An Algorithm To Solve The Mismatch Between The Microscopic and Macroscopic Behavior of RED Gateways,* International Journal of Computer Science and Network Security, Vol. 10 No. 11 pp. 63-70, (2010).

This paper presents QSRED congestion control strategy. The strategy adjusts the algorithm of ERED to enhance the network performance. This paper is edited as Chapter 3.