TCP WESTWOOD+ MODIFICATION FOR WIRELESS MULTIPATH HOST TO ACHIEVE FAIRNESS IN A SHARED BOTTLENECK LINK

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Abstrak

Multi-path adalah teknik untuk meningkatkan kehandalan koneksi internet di dalam jaringan IP. Penerapan dari teknik ini bisa digambarkan seperti sebuah sumber data dengan lebih dari satu jalur TCP bekerja bersamaan, ketika salah satunya putus maka jalur yang lain akan menjadi cadangan bagi jalur yang lain. Permasalahan fairness muncul ketika sumberdata yang menggunakan multipath menggunakan jalur sempit secara bersamaan dengan sumber data singlepath biasa. Permasalahan ini bisa diselesaikan dengan memperkecil setiap sub-flow pada multipath dengan memodifikasi Kendali Kongesti pada TCP. Penelitian ini akan merancang protocol multipath yang akan menggunakan metode pembobotan yang sama pada BMC dan beberapa modifikasi pada perhitungan bobot dengan menggunakan Bandwidth Estimation pada Kendali Kongesti pada TCP Westwood+. Protokol multipath ini akan disebut sebagai Normalize Uniform High-Adaptability (NUHA) TCP. Simulasi dilakukan pada air interface HSDPA untuk mewakili kondisi wireless dengan menggunakan network simulator 2. Hasil dari percobaan menunjukkan bahwa protocol multipath NUHA TCP bekerja dengan lebih baik dalam menghasilkan fairness dari pada menggunakan kendali kongesti biasa pada jaringan nirkabel dengan tingkat loss tinggi.

Kata Kunci : Westwood+, Wireless Multi Path, Fairness, Kendali Kongesti

Abstract

Multi-path is a technique to increase the reliability of the internet connection in IP network. The implementation of this technique can be described as a host with more than one TCP paths that work simultaneously, when one of them fails the others back up the connection. The problem of fairness arises when multi-path host uses the same bottleneck link with another single-path host. This problem can be solved by scaling down each sub-flow on the multi-path by modifying the Congestion Control on TCP. This study designs a Multi-path protocol which uses the same weighing method on BMC and a few modification on weight calculation by exploiting the Bandwidth Estimation on Westwood+ congestion control, this multi-path protocol is called Normalize Uniform High-Adaptability (NUHA) TCP. The simulation was conducted on HSDPA air interface to represent the wireless condition using network simulator 2. The results show that the multi-path protocol NUHA TCP works better than using standard congestion control in achieving fairness in high loss wireless network.

Keywords : Westwood+, Wireless Multi-path, Fairness, Congestion Control

CHAPTER I

THE PROBLEM

1.1 Rationale

Nowadays, wireless technology consumption is widely used and people keen on 3G and 3.5G Technology especially Highspeed Downlink Packet Access (HSDPA). However, the previous technology such as General Packet Radio Service(GPRS) is never absolutely abandoned since GPRS has been implemented most of coverage areas. The network interface devices also become very cheap. Those high availabilities of network interface devices enable mobile devices to use multiple wireless connections concurrently[10].

A host or a device which has multiple Transmission Control Protocol(TCP) connections is called multipath-host. Multipath is a technique to increase the reliability of the internet connection for an IP network. The implementation of this technique can be depicted as a host with two connection paths working simultaneously, when one of them fails the other will back up the connection[8]. This technique can be used on a mobile device with more than one air interface from one account from the Internet Service Provider. Since most of the modifications lied on the host, the fairness problem appears. For example, on a bottleneck condition where a multipath host has 3 connections and there are another 3 normal hosts which each of them has one connection. The multipath host will dominate 3/6 bandwidth of the bottleneck since the network treats each connection as single connection. Since the multipath host has only one account, in term of fairness, the multipath host should only have ¼ bottleneck bandwidth since there are only 4 hosts exist.

This study designs the solution of that problem. Since most of the customers use mobile devices using wireless, this study discusses this problem on a HSDPA upstream case using TCP Westwood+ that is usually suitable for wireless condition[15]. The objective of the research is to design the modification on transport layer to achieve fairness on a bottleneck link for a multipath host. Since TCP congestion control has main role for a packet delivery algorithm, the TCP congestion control is modified. Previous works such Bi-dimensional-

Probe Multipath Congestion Control(BMC)[8] which modifies congestion control for wired network and designed for TCP Reno is the consideration for the research.

1.2 Theoretical Framework

As described above, Multipath TCP is TCP with multiple connection paths but working like a single TCP. Normal TCP only uses a single path to send data from source to destination, but Multipath TCP splits the data and sends them using different paths.

1.3 Conceptual Framework

From the theories, normal network treats each connection of Multipath TCP as a single connection which causes Multipath TCP consumes more bandwidth on a bottleneck and violates fairness. The main measured metric is throughput, since throughput represents the bandwidth consumptions.

1.4 Problem Identification

The main problems discussed in this research are:

a. What is the design of the Congestion Control on wireless multipath connections that maintains the fairness on shared bottleneck link?
b. What is the quality of the Congestion Control to adapt the condition of wireless lossy network?

1.5 Hypothesis

Premises :

- Bi-dimensional-Probe Multipath Congestion Control(BMC) giving each connection static weight depends on each connection’s maximum bandwidth so that each connection’s throughput can be controlled to maintain the fairness of total throughput[9].
- The current BMC is designed for wired using TCP Reno[8].

Hypothesis :

- The best TCP variant for wireless is TCP Westwood+ which adapts the congestion window according to the bandwidth if packet-loss occurred. If the weighting method is designed for TCP Westwood+ on each wireless multipath connection, the utilization is higher without damaging the network fairness.

1.6 Assumption

The assumptions used in this study are:

a. The experiments assume all the air interface type are homogenous.

b. The bytestreams segmentation and reassembling mechanism is not discussed in detail.

1.7 Scope and Delimitations

The scopes of this research are:

a. The research covers system design and experiments are tested using Network Simulator 2.

b. The channel model is wireless High Speed Downlink Packet Access(HSDPA) which is characterized by long distance from the base station and fluctuating bandwidth.

c. The research only discusses the congestion control algorithm of the protocol and does not discuss the protocol structure.

1.8 Importance of the Study

The study has four objectives, namely:

a. Designing the weighing algorithm for Congestion Control for TCP Westwood variant to keep the fairness of shared bottleneck network.

b. Evaluating the adaptability of the congestion control on wireless network.

c. Increasing the performance of the host which has multiple wireless interfaces without interfering another host spare bandwidth.

d. Increasing the utilization of the networks because all interfaces are used simultaneously.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusion and some recommendation for future studies.

5.1 Conclusions

From the analysis of the performance of NUHA TCP, it can be concluded that:

a. In Bottleneck condition, by changing the increment factor (a) value of TCP Westwood+ connection with another value between 0 and 1, throughput value can be scaled down. However, in a non-bottleneck condition or under-utilized link, the connection behaves like normal connection with value a = 1. This behavior becomes very advantageous to maintain the fairness on a host with multiple connections.

b. NUHA TCP can reduce the dominations of a multipath host. NUHA TCP changes the increment factor of each connection with comparison of maximum bandwidth with total connections bandwidth to keep its fairness. This method successfully reduces the domination of multipath host in bottleneck condition. In non-bottleneck condition, multipath host with NUHA TCP uses the remaining unused bandwidth as many as its total connection.

5.2 Recommendations for Future Works

For the future studies, there are several things that can be carried out:

a. Another TCP variants behavior and modification on a multipath host must be evaluated. There are so many kinds of environment condition that need a different kind of TCP behavior.

b. Another study can be conducted to investigate the proper value for bwe_max, since on heterogeneous air interface, the bwe_max for each air interface is different.

c. An NUHA TCP implementation on a wi-fi is very useful and easy tool to evaluate its performance on a real world. Since most parameters and requirements of NUHA TCP are available on linux, this study will be very challenging.

d. Resource pooling principle on disjoint bottleneck cases must be investigated further to be able exploiting its advantages. Once a mathematical model for disjoint bottleneck is formulated, a study of advanced congestion control can be conducted for many multipath cases.

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