HHS-TCP: A Novel High-Speed TCP Based on Hybrid Congestion Control

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Abstract—**This paper presents a new congestion control algorithm of TCP, called HHS-TCP (Hybrid High-Speed TCP), and provides its effective result through simulations and implementations. Recently, towards high-speed networks with large bandwidth delay product (BDP), a number of different approaches have been proposed to improve TCP performance. However, adopting more aggressive loss-based congestion control algorithm may severely decrease the throughput of other regular TCP flows sharing the same network path. On the other hand, pure delay-based approaches may not work well if they compete with loss-based flows. Some new approaches combing a loss-based protocol and a delay-based protocol have been proposed. Our HHS-TCP also belongs to this category. HHS-TCP exploits three useful characteristics of TCP-CUBIC, FAST-TCP, TCP-Reno in its congestion avoidance strategy. In short, congestion window is increased fast when the link is underutilized, and the increment becomes negative when the throughout comes to the network saturation point. Its friendliness to the TCP-Reno is sufficiently satisfied at the same time.**

Keywords-High-speed Network; TCP; Congestion Control; Hybrid; delay-based; loss-based

I. INTRODUCTION

TCP (Transmission Control Protocol)[1] is the most important transmission protocol, providing the reliable transmission control and congestion control end to end. Now the Internet is evolving to high-speed networks with large BDP (Bandwidth Delay Product) as the developing of the technique and scale of it. However it is well known that current TCP (e.g. TCP-Reno) throughput deteriorates in such high-speed networks. This is due to the Reno whose congestion window size is increased by 1 MSS/RTT and halved upon packet loss regardless of the network condition, thus it's unrealistic to maintain a big window with a minimal packet loss rate.

To overcome this issue, a number of different approaches have been proposed, and they are collectively referred to as "high-speed TCP". These approaches can be classified into three categories. The first category called loss-based protocol, which modifies the AIMD (Additive Increase Multiplicative Decrease) mechanism of TCP congestion avoidance phase to quickly increase and slowly decrease the congestion window, and then achieve high throughput in high-speed networks. The typical examples of this category are BIC[2], CUBIC[3], High-Speed TCP (HSTCP)[4] and Scalable TCP[5]. In contrast to these loss-based protocols, the second category called delay-based protocol uses the RTT as the network indicator and achieves excellent steady state performance. Examples are TCP-Vegas[6], FAST TCP[7]. The third category is called hybrid congestion control. The key idea is using RTT metrics on the loss-based protocol to manage efficiency and friendliness tradeoffs simultaneously. Examples are Compound TCP (CTCP)[8], TCP-Fusion[11], TCP-Africa[9], TCP-Adaptive Reno[10].

There are some weak points of these three categories of high speed TCP. The loss-based protocol is essential to be highly aggressive to efficiently utilize the link capacity. However, this aggression also causes severe unfairness to coexisting TCP (Reno) flow. Although the second category can achieve high efficiency and good RTT fairness in networks where the majority flows are delay-based, it will suffer from significant low throughput if most competing flows are loss-based. Besides the simulations and implements show there is room for improvement of the current third category protocol.

In this paper we propose a new hybrid congestion control algorithm called Hybrid High-Speed TCP (HHS-TCP) which makes use of three useful characteristics of TCP-Reno, CUBIC, and FAST TCP to improve these weaknesses, and also belongs to the third category above. The key concept is to use the different mechanisms in the various congestion control stages. The congestion window size is increased aggressively when the network is under-utilized. Once the link is fully utilized, we need to maintain the window size as long as possible to decrease the packet loss. Our goal is to use the potential bandwidth more effective and be friendliness to the regular TCP. The simulation and actual test show the effective performance.

The paper is organized as follows. In Section II, we introduce the related works of the high speed TCP. Section III describes the HHS-TCP algorithm. We provide the simulation and implementation result in Section VI. Finally we conclude this paper in Section V.

II. RELATED WORKS

The standard TCP has a poor performance in high-speed networks with large BDP. Some high speed TCP variants are emerged to improve the performance.

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