An Improved Network Congestion Control Strategy Based on Active Source and Link Management

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ABSTRACT

When a source end adopted FAST TCP to actively control the sending window, and the link end adopted active queue management algorithm, if the network parameters were improperly set, the system can be unstable. The relationship between the stability and network parameters was quantitatively analyzed. Aiming at the defect of network instability caused by radical window halving strategy, a new method based on stability analysis was proposed to make full use of the historical change information obtained by the source-end and to improve the window adjusting strategy of FAST TCP protocol according to the congestion status. Thus, the parameters of the active queue controller was modified indirectly to improve the stability of the system. Ns-2 simulation result verified the accuracy of the stability theory analysis and the effectiveness of the improvement strategy.

KEYWORDS

Active Queue Management, Active Window Control, Cooperatively, Stability

1. INTRODUCTION

FAST TCP (Koo, Choi, & Lee, 2008; Wei, Jin, Low et al., 2006; Li et al., 2016; Zhang & Chen, 2016) was a new network transmission control protocol proposed by Steven H. Low of Network Lab in California institute of technology, which was mainly used for the next generation high performance network with high speed, long delay and large capacity. Based on the balanced design idea of the FAST TCP, the stability, throughput, fairness and fast response were better than TCP Reno, HSTCP and STCP (Wei, Jin, Low et al., 2006; Deng, Chen, & Zhang, 2004). However, the above good performance was assumed that the bottleneck link end had a large enough cache, and adopted tail-drop queue management algorithm (DropTail) (Samreen, 2018). There was no packet loss in the network (Koo, Choi, & Lee, 2008; Wei, Jin, Low et al., 2006; Chen & Chen, 2016; Zhang & Chen, 2016). However, the packet queue cache management (Liu, Zhong, He et al., 2018) of intermediate nodes (such as routers) generally adopted the stochastic early detection active queue management algorithm (Random Early Detection, RED) recommended by RFC2309. According to the average queue length in the cache, RED algorithm will actively drop some packets at a certain probability (Huang, Lin, & Ren, 2006; Tan, Zhang, Peng et al., 2006; Zhang, Tan, & Peng, 2009). By analyzing the code of FAST

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TCP protocol (CUBINLAB, University of Melbourne, Australia http://www.cubinlab.ee. unimelb. edu.au/ns2fasttcp/), like other network transport protocols, FAST TCP will halve the size of sender window when the source end received three duplicate acknowledgment frames (packet loss). When there was packet loss, the above FAST TCP protocol good performance, especially the stability of the network could not be guaranteed. The reason was that FAST TCP protocol and Reno protocol adopted different window adjustment strategies, so the RED parameter setting guided by TCP Reno/RED stability analysis results based on low-speed network cannot ensure the stability of FAST TCP/RED system in high-speed network (Zhang, Tan, & Peng, 2009; Prakash, Tripathi, Pal et al., 2018).

Considering the two case that the good performance of FAST TCP and RED active queue management algorithm was the most widely used in the routers. But there were few studies on FAST TCP/RED model, so it was very necessary to establish a FAST TCP/RED network congestion control model to quantitatively analyze the relationship between the system stability of this model and the RED parameter setting of the controller. According to the quantitative analysis results of reference (Deng, Chen, & Zhang, 2004; Samreen, 2018), the main reason for the instability of FAST TCP/RED was that the control gain parameters p_{max} at the link end was set to larger. Since the FAST TCP was based on end-to-end congestion control (Singh & Vidyarthi, 2019), when FAST TCP/RED system was unstable, the source side could not modify RED parameters on the router side to make the system stable. At the same time, RED algorithm will actively discard some packets according to network conditions, and if there was no congestion or only slight congestion at the time of packet loss, then the sending window halving strategy of FAST TCP would be too hasty and radical, and reduce the stability of network system and link utilization rate (Wang, Gong, & Chen, 2008). This was because the window halving strategy at the source end only adopted the feed-back information of packet loss and did not make full use of other feedback information that could be obtained by the source side. Therefore this paper proposed an improved window adjustment strategy, when the packet loss was found by the source end, the congestion status of the network (unblocked, light congestion, heavy congestion) should be detected cooperatively according to the source end information of queueing delay and packet loss frequency, and appropriate window adjustment strategy was designed according to the congestion status of the network. This strategy could make full use of the historical information that could be obtained from the source end and judge the network running status more accurately. When the network was unblocked or slightly congested, a smaller window adjustment strategy was adopted for packet loss, which indirectly reduced the RED control gain parameters p_{max}, thus indirectly realized to actively manage queue of link end, and to improve the stability of FAST TCP/RED system. And only when the network was heavily congested, FAST TCP adopted the strategy of halving the window.

The following details are arranged as follows: In section 2, we quantitatively analyzed the relationship between FAST TCP/RED network system stability and RED control gain parameters p_{max} in equilibrium point. In section 3, we put forward a method to make full use of source information to judge network congestion and adopt reasonable window adjustment strategy according to network congestion. Finally, NS-2 simulation results verified the effectiveness of the above theoretical analysis results and improvement strategy.

2. ACTIVE MANAGEMENT NETWORK CONGESTION CONTROL MODEL AND STABILITY ANALYSIS

2.1. Active Management Network Congestion Control Model

Assume that the network topology adopts dumbbell structure. According to reference (Wei, Jin, Low et al., 2006; Huang, Lin, & Ren, 2006), when the source end adopted FAST TCP protocol and the link end adopted RED active queue management algorithm, the network congestion control model of FAST TCP/RED system was described as follows:

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