ImTCP HighSpeed: Inline Network Measurement for High-Speed Networks

Cao Le Thanh Man, Go Hasegawa and Masayuki Murata

Graduate School of Information Science and Technology, Osaka University
{mlt-cao, hasegawa, murata}@ist.osaka-u.ac.jp

Foreword. We introduce a new measurement method that can cope with interrupt coalescence techniques common in high-speed network adapters and reduce the impact of CPU overhead and other difficulties with system clocks. The proposed method adjusts the number of packets that are transmitted in a burst of an active TCP connection and estimates the available bandwidth by observing the inter-intervals of the bursts. The measurement results show that the method performs well in Gigabit networks.

Extended Abstract

In high-speed (1-Gbps or faster) network paths, active measurement tools based on packet spacing must overcome the following problems. First, measurement in fast networks requires short transmission intervals of the probe packets. However, regulating such short intervals causes a heavy load on the CPU. Second, network cards for high-speed networks usually employ Interrupt Coalescence (IC) [1], which rearranges the arrival intervals of packets and causing bursty transmission, so that the algorithms utilizing the packet arrival intervals do not work properly.

We develop an inline measurement method that overcomes the above-mentioned two problems. Inline measurement is the idea of "plugging" the active measurement mechanism into an active TCP connection. This method has the advantage of requiring no extra traffic to be sent on the network, and provides fast and accurate measurement. We introduce a new version of TCP, called ImTCP HighSpeed (Inline measurement TCP for high-speed networks) that can measure the available bandwidth of the network path between the sender and the receiver. The main idea of ImTCP HighSpeed is to exploit the burst of data packets formed in TCP connection under the effects of IC. The TCP sender adjusts the number of packets involved in a burst and checks the intervals of the corresponding ACK packet bursts to investigate the available bandwidth.

The measurement principle is as follows. Suppose that two bursts of packets are sent at the interval S. The number of packets in the first burst is N. C is the capacity of the bottleneck link. C_{Cross} is the average transmission rate of the cross traffic over the bottleneck link, and P is the packet size. Then, the amount of traffic that enters the bottleneck link during the period from the point at which the first packet of the first burst reaches the link until the point at which the first packet of the second burst reaches the link will be: $C_{Cross} \cdot S + N \cdot P$. If the amount is larger than the transfer ability of the link during this period, considered to be $C \cdot S$, then second burst will go to the buffer

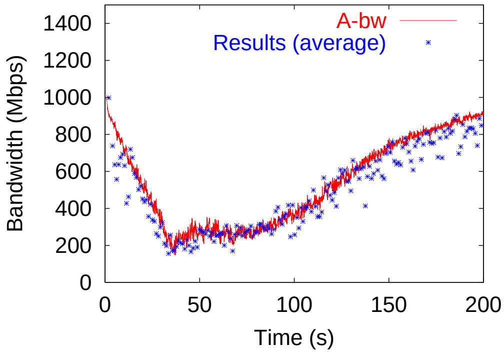

Fig. 1. Measurement results for ImTCP HighSpeed

of the link. This results in a tendency for the interval between the two bursts to increase after leaving the bottleneck link. We can write that the burst interval will be increased if

$$C_{Cross} \cdot S + N \cdot P > C \cdot S \quad (1)$$

or,

$$\frac{N \cdot P}{S} > C - C_{Cross}$$

Note that $C - C_{Cross}$ is the available bandwidth (A) of the bottleneck link. Therefore, Eq. (1) becomes

$$\frac{N \cdot P}{S} > A$$

Thus, by sending numerous bursts with various values of NP/S (by changing N), we can search for the value of the available bandwidth A.

We examine the measurement results for ImTCP HighSpeed through ns-2 simulations. The sender and receiver are connected through 1-Gbps access links and a bottleneck link. The cross traffic on the bottleneck link is made up of Web traffic involving a large number of active Web document accesses. Figure 1 shows the average measurement results for ImTCP HighSpeed for each second. The available bandwidth is calculated as the capacity of the bottleneck link minutes the total amount of Web traffic passing the link, and shown by the curved line "A-bw". We can see that ImTCP HighSpeed can quickly detect the A-bw, even in such a high-speed network.

At present, we are evaluating the performance of ImTCP HighSpeed in a real network environment and investigating the measurement mechanism for the capacity of high-speed networks.

References

1. Intel, "Interrupt Moderation Using Intel Gigabit Ethernet Controllers," available at http://www.intel.com/design/network/applnots/ap450.pdf (2003).