H-TCP Protocol for High-Speed Long-Distance Networks

D.J.Leith, R.Shorten

Hamilton Institute
NUI Maynooth, Ireland
www.hamilton.ie

Extended Abstract

The current TCP protocol is known to perform poorly on links with high delay-bandwidth product. In this paper we consider a proposed modification to TCP, referred to as H-TCP, that aims to address this issue. Our strategy is based by the following design criteria.

- *Friendliness*. New TCP protocols should be backward compatible with current TCP. Specifically, they should behave as standard TCP on communication links with small delay-bandwidth product, and ensure that on links with high delay-bandwidth product that standard TCP sources competing for bandwidth should be guaranteed some (small) share of the available bandwidth.
- *Fairness*. TCP sources running the new protocol and competing against each other should receive a fair share of the bandwidth.
- *Responsiveness*. TCP sources should be responsive so that when a new flow starts/stops the networks rapidly re-allocates bandwidth.
- *Efficiency*. TCP sources should make efficient use of the available bandwidth. The emphasis is on achieving reasonable levels of efficiency across a wide range of network conditions.

To motivate our approach, we present a simplified model of a network of AIMD sources that compete for a shared bandwidth. This model incorporates drop-tail queuing, time-varying network delay and AIMD congestion control. Under the assumption of synchronised drops (certainly a strong assumption, but one which does seem relevant to long distance links), we establish that stability is unconditional and obtain conditions for the fair co-existence of traffic in networks employing heterogeneous AIMD algorithms. This analysis also provides insight into the responsiveness (rate of convergence to fairness) of AIMD flows. It is thereby established that flows operating the Scalable TCP protocol do not converge to fairness under drop-tail queuing, while flows operating the High-Speed TCP protocol exhibit slow rates of convergence (e.g. see figure 1)

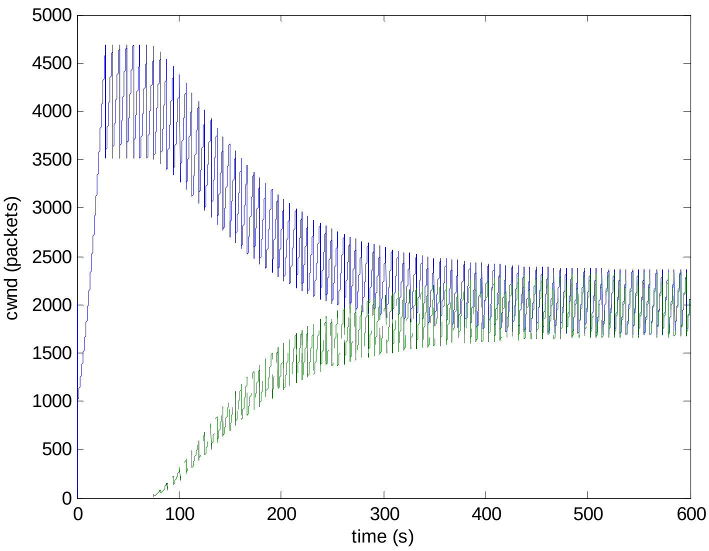

Figure 1 Example of two High-Speed TCP flows illustrating convergence to fairness - the second flow experiences a drop early in slow-start focussing attention on the responsiveness of the congestion avoidance algorithm (NS simulation, network parameters: 500Mb bottleneck link, 100ms delay, queue 500 packets).

We consider amending TCP to include a new high-speed and low-speed mode. This H-TCP switching strategy differs from previous proposals in two key respects. Firstly, for high-speed networks a mode switch takes place in every congestion epoch. Secondly, the strategy leads to a symmetric network; that is, one where the *effective* AIMD increase/decrease parameters are the same for all H-TCP sources experiencing the same duration of congestion epoch. We present NS simulation results for simple dumb-bell topologies to confirm our analytical results, and also present extensive simulation results for a wide range of network conditions and topologies. We discuss our experience implementing the H-TCP proposal in Linux and the results of initial tests on the DataTAG test-bed network between CERN and Starlight.