ABSTRACT

MICHELE AYLENE CLARK WEIGLE: Investigating the Use of Synchronized Clocks in TCP Congestion Control.
(Under the direction of Kevin Jeffay.)

In TCP Reno, the most common implementation of TCP, segment loss is the sole indicator of network congestion. TCP Reno only adjusts to congestion when segment loss has been detected in the network, thus TCP Reno's congestion control is tied to its error recovery mechanism.

My dissertation thesis is that precise knowledge of one-way transit times can be used to improve the performance of TCP congestion control. Performance is measured in terms of network-level metrics, including packet loss and average queue sizes at congested links, and in terms of application-level metrics, including HTTP response times and throughput per HTTP response.

A connection's forward path OTT is the amount of time it takes a packet to traverse all links from the sender to the receiver, including both propagation and queuing delays. Queues in routers build up before they overflow, resulting in increased OTTs. If all senders directly measure changes in OTTs and back off when the OTT indicates that congestion is occurring, congestion could be alleviated. I introduce a variant of TCP, called Sync-TCP, which uses synchronized clocks to gather a connection's OTT data. I use Sync-TCP as a platform for investigating techniques for detecting and responding to changes in OTTs.

This dissertation makes the following contributions:

- a method for measuring a flow's OTT and returning this exact timing information to the sender
- comparison of several methods for using OTTs to detect congestion
- Sync-TCP – a family of end-to-end congestion control mechanisms based on using OTTs for congestion detection
- study of standards-track TCP congestion control and error recovery mechanisms in the context of HTTP traffic

I will show that Sync-TCP provides lower packet loss, lower queue sizes, lower HTTP response times, and higher throughput per HTTP response than TCP Reno. Additionally, I will show that Sync-TCP offers performance comparable to that achieved by using router-based congestion control mechanisms. If all flows use Sync-TCP to react to increases in queuing delay, congestion could be alleviated quickly. This would result in overall shorter queues, faster response for interactive applications, and a more efficient use of network resources.