Applying Artificial Intelligence for an Efficient Internet

The Integration of a Set of Experts into TCP RTT Estimation

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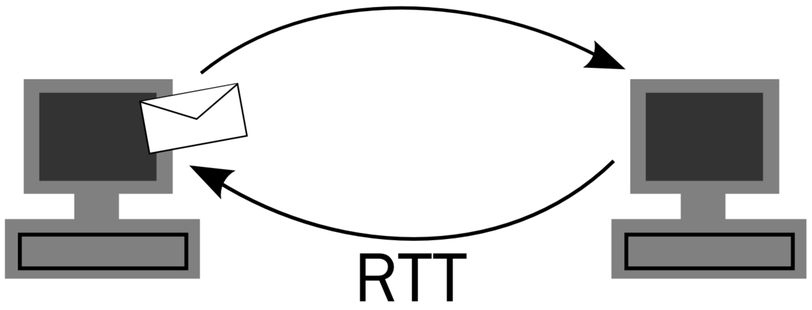
Motivation

Streaming media and 24 hour connectivity drastically increases bandwidth requirements.

Ever-decreasing cost/CPU cycle allows for further optimizations with regard to internet protocols.

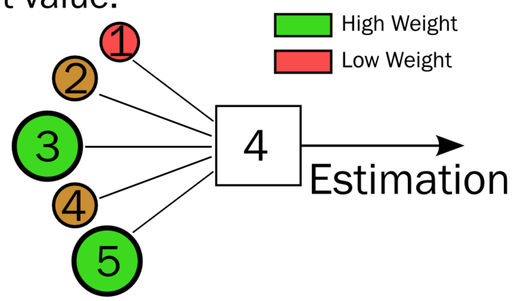
The Transmission Control Protocol (TCP) calculates Round Trip Time (RTT) of each packet with a naive weighted average.



Approach

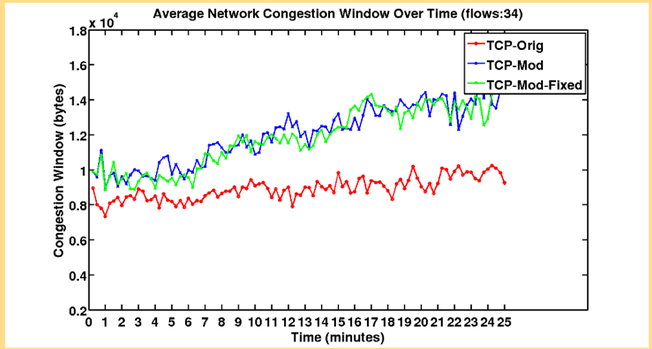
The Set of Experts Algorithm tracks the success rate for a given number of "experts" of whom each vote for a constant value.

Better experts receive a higher weight when it comes to the final estimation.

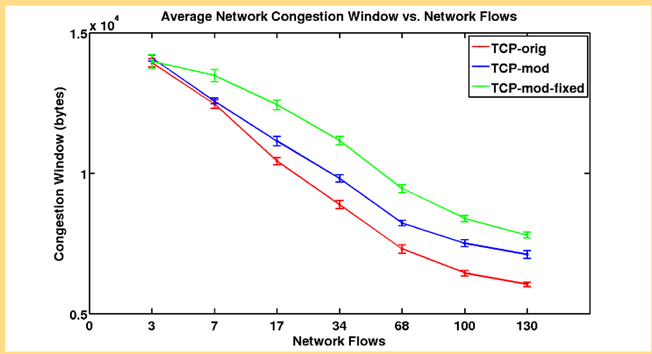


We developed a Linux kernel module that applies the Set of Experts strategy to RTT estimation within the standard TCP stack.

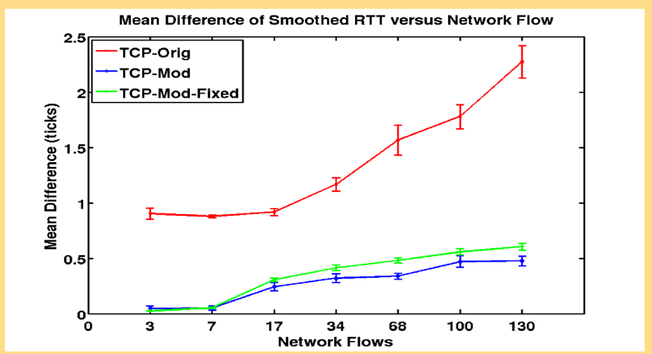
Results



The congestion window is the calculation of the current network congestion by an instance of TCP. Higher values are better.



A large congestion window suggests that few network packets are being lost and that communication can take place at a high rate.



Difference of Smoothed RTT is an accuracy measurement of RTT estimation algorithms. It is calculated as `abs(SRTT - RTT)`. Lower values are better.

Conclusions

Simulation results demonstrate that a Set of Experts significantly outperforms standard TCP.

As network traffic builds, error in RTT calculations increases relatively slowly.

Pan-network congestion remains at a lower level, allowing for greater total throughput.

Delivery ratio is consistently improved across varying numbers of network flows.

	Mean Difference (ticks)	Average CWND (bytes)
TCP-Orig	1.354	9354.6
TCP-Mod	0.277	10654.9
TCP-Mod-Fixed	0.348	10952.9

Future Work

Reimplement algorithm to function on a per-connection basis.

Re-run experimental scenarios on real-world network devices and topologies.

Optimize fixed point math unit and kernel module for everyday use.

Study side effects of heterogeneous TCP implementations within local networks