

TCP High Speed Variants

High-Speed TCP Variants

There have been numerous ideas for improving [TCP](#) over the years. Some of those ideas have been adopted by mainstream operations (after thorough review). Recently there has been an uptake in work towards improving TCP's behavior with LongFatNetworks. It has been proven that the current [congestion control](#) algorithms limit the efficiency in network resource utilization. The various types of new TCP implementations introduce changes in defining the size of congestion window. Some of them require extra feedback from the network. Generally, all such congestion control protocols are divided as follows.

- explicit congestion control protocols (Uses explicit feedback from the router)
 - [Source Quench](#)
 - [Explicit Congestion Notification \(ECN\)](#) published by K. Ramakrishnan, S. Floyd, D. Black
 - [eXplicit Congestion Protocol \(XCP\)](#) developed by Dina Katabi from MIT Computer Science & Artificial Intelligence Lab
 - [Rate Control Protocol \(RCP\)](#) developed by Nandita Dukkkipati from Stanford University's Computer Systems Laboratory
 - [Quick-Start TCP](#), focusing on permission to use a large [Initial Window](#)
 - [DCTCP](#) and [Prague TCP](#), to optimize use in large datacenter networks with [Incast](#) etc.
- implicit congestion control protocols (Relies on implicit measurements of congestion such as loss or delay)
 - [HS-TCP](#) (HighSpeed TCP) by [Sally Floyd](#) et al. uses modified AIMD parameters when the congestion window gets larger than some boundary.
 - [H-TCP](#) by Doug Leith et al. from the Hamilton Institute
 - [TCP Vegas](#) from the University of Arizona
 - [TCP Westwood](#) proposed by UCLA Computer Science Department
 - [TCP Westwood+](#) from C3LAB at Politecnico de Bari
 - [Compound TCP](#) by Microsoft (included in Microsoft Vista)
 - [FAST](#) from Caltech
 - [BIC](#) (Binary Increase Congestion Control)
 - [CUBIC](#)
 - [Scalable TCP](#) by Tom Kelly
 - [TCP Fusion](#) by Kazumi Kaneko et al.
 - [YeAH-TCP](#) from University of Roma
- [Layered TCP](#)
 - [SABUL](#)
 - [Sync-TCP](#), Michele Weigle's Ph.D. work at UNC
 - [BBR \(Bottleneck Bandwidth and RTT\) TCP](#), by Neal Cardwell and others from Google

An orthogonal technique for improving TCP's performance is [automatic buffer tuning](#).

Comparative Studies

All papers about individual TCP-improvement proposals contain comparisons against older TCP to quantify the improvement. There are several studies that compare the performance of the various new TCP variants, including

- [TCP Stack Measurements on Lightly Loaded Testbeds](#), Les Cottrell (SLAC), 2002-2003
- [Evaluation of Advanced TCP Stacks on Fast Long-Distance Production Networks](#), H. Bullot, R. Les Cottrell, R. Hughes-Jones, J. Grid Comput. 1 (4): 345-359 (2003)
- [FAST TCP in High-Speed Networks: An Experimental Study](#), S. Hegde, D. Lapsley, B. Wyrowski, J. Lindheim, D. Wei, C. Jin, S. Low, and Harvey Newman, GridNets 2004
- [Protocols for long-distance networks](#), Guy Almes, TERENA Networking Conference 2004, [PowerPoint presentation](#). This presentation walks through the problem space of transferring large amounts of data over [LFNs](#), and briefly presents many of the TCP variants in this section, as well as some non-TCP approaches.
- [Measured Comparative Performance of TCP Stacks](#), S. Jansen and A. McGregor, Proc. PAM 2005
- [A step toward realistic evaluation of high-speed TCP protocols](#), S. Ha, Y. Kim, L. Le, I. Rhee, and L. Xu, 2006
- [TCP Evaluation Discussion Forum](#), <http://www.hamilton.ie/net/eval/>

Other References

- [Gigabit TCP](#), G. Huston, The Internet Protocol Journal, Vol. 9, No. 2, June 2006. Contains useful descriptions of many modern TCP enhancements.
- [Faster](#), G. Huston, June 2005. This article from ISP Column looks at various approaches to TCP transfers at very high rates.
- [Congestion Control in the RFC Series](#), M. Welzl, W. Eddy, July 2006, Internet-Draft (work in progress)
- [ICCRG Wiki](#), IRTF (Internet Research Task Force) ICCRG (Internet Congestion Control Research Group), includes bibliography on congestion control.
- [RFC 6077: Open Research Issues in Internet Congestion Control](#), D. Papadimitriou (Ed.), M. Welzl, M. Scharf, B. Briscoe, February 2011

Related Work

- [PFLDnet](#) (International Workshop on Protocols for Fast Long-Distance Networks): [2003,2004,2005,2006,2007,2009, 2010](#). (The 2008 pages seem to have been removed from the Net.)
- [Internet2 Land Speed Record](#) competitions

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