# TCP-FIT

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### Papers:

Jingyuan Wang, Jiangtao Wen, Jun Zhang and Yuxing Han, "TCP-FIT - an improved TCP congestion control algorithm and its performance", Proc. 2011 Infocom, Shanghai, October, 2011.

Jingyuan Wang, Jiangtao Wen, Jun Zhang, Yuxing Han, "TCP-FIT - a novel TCP congestion control algorithm for wireless networks", IEEE Globecome Workshop on Advances in Communications and Networks, December, 2010, Miami, FL.

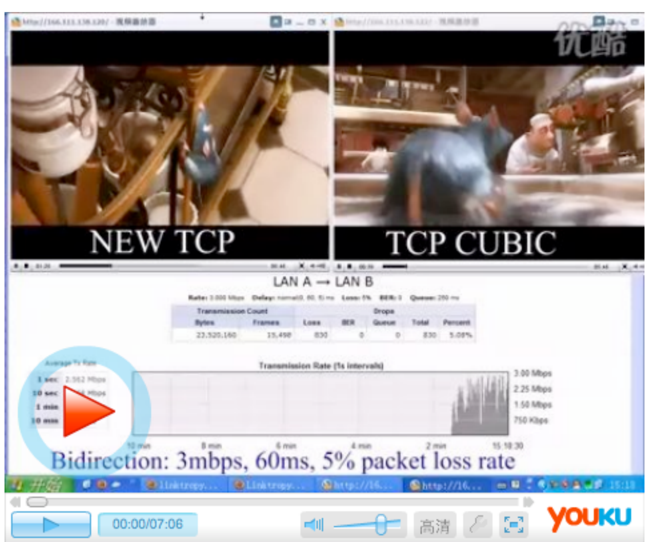
Jingyuan Wang, Jiangtao Wen, Jun Zhang, Yuxing Han, "A demonstration of a new TCP congestion control algorithm over LTE and other challenging netw MobiCom 2010 Demo, Sept. Chicago, IL. (PDF)

### Introduction

TCP-FIT is a novel congestion control algorithm targeting both emerging wireless networks such as LTE, WiMax, Wi-Fi and HSPA and high speed long (high BDP) networks.

The Transmission Control Protocol (TCP) is a reliable transport layer protocol that is widely used on the Internet. Congestion control algorithm is an in module of TCP that directly determines the performance of the protocol. Standard congestion control algorithms such as TCP-Reno and TCP-NewReno, ach great success for several decades but are found to perform poorly over wireless and/or high Bandwidth Delay Product (BDP) links. To improve TCP perform over wireless and high BDP networks, many TCP variants have been proposed, including TCP Westwood, TCP Veno for wireless applications and Comp TCP, TCP CUBIC, FAST TCP for high BDP networks. Although these algorithms have achieved success in their respective target applications, designing a congestion control algorithm that perform gracefully in both wireless and high BDP networks is still a great challenge. On the other hand however, wi deployment of wireless networks, such as LTE, WiMAX, as well as high bandwidth, real time applications such as multimedia over TCP/HTTP, it is required f TCP congestion algorithm to handle both wireless connections with random radio related losses as well as congestion-introduced issues typical for wirec BDP networks.

To address these problems, a novel TCP congestion control algorithm for the heterogeneous networks which contained high BDP links and wireless links, n TCP-FIT, is proposed. A demo comparison between TCP-FIT and existing TCP algorithms over an wireless network is shown in the following video.




As can be seen in fig. 1 to fig. 8, given the same challenging network conditions, TCP-FIT achieves significant performance improvement as compared with algorithms.

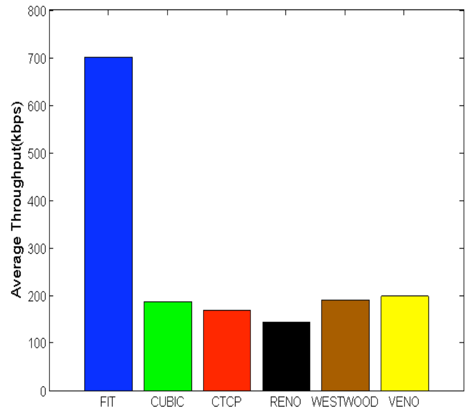



**Fig.1 Average throughput of different TCP algorithms over CHINA TELECOM CDMA 2000 3G network**

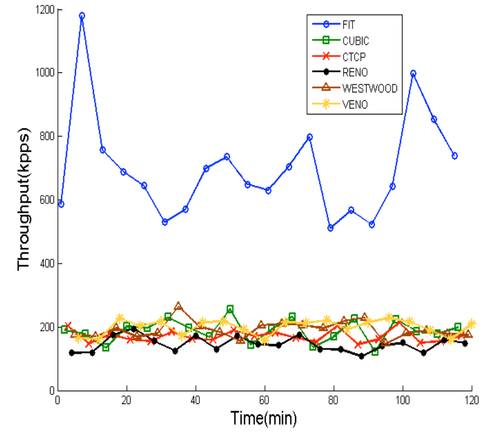



**Fig.2 Throughput variation of of different TCP algorithms over CHINA TELECOM CDMA 2000 3G network in 2 hours**

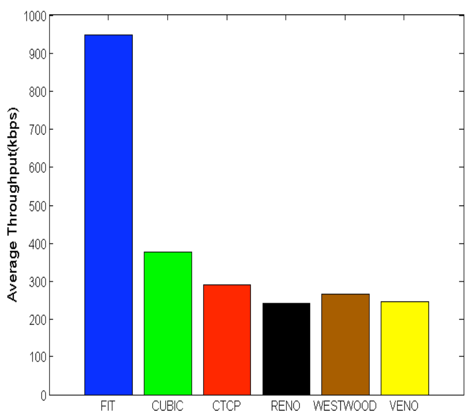



**Fig.3 Average throughput of different TCP algorithms over WIFI network in Tsinghua University**

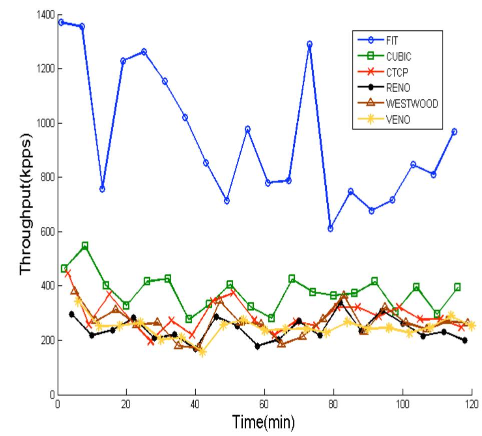



**Fig.4 Throughput variation of different TCP algorithms over WIFI network in Tsinghua University in 2 hours**

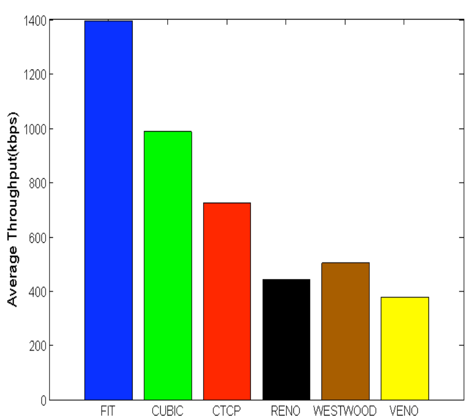



**Fig.5 Average throughput of different TCP algorithms over WIFI network at a Starbucks coffee shop in Beijing**

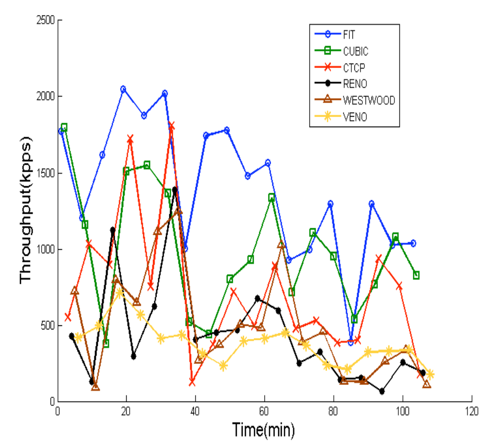



**Fig.6Throughput variation of different TCP algorithms over WIFI network at a Starbucks coffee shop in Beijing in 2 hours**

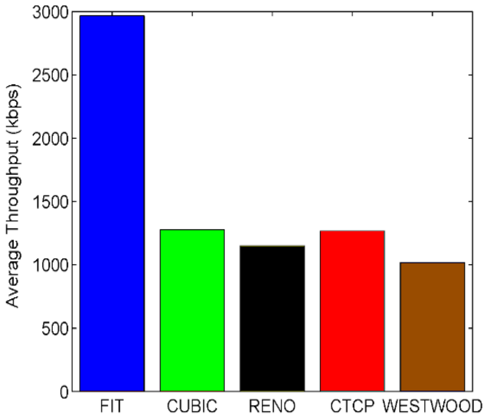



**Fig.7 Average throughput of different TCP algorithms over LTE network**

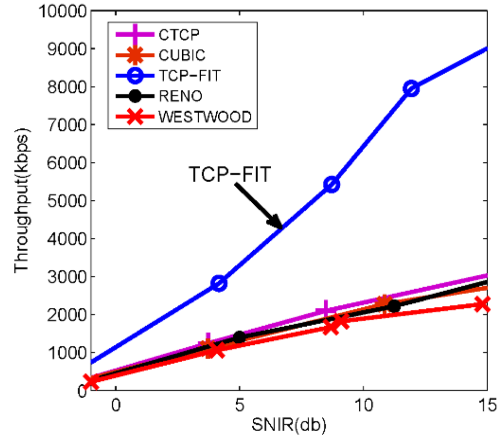



**Fig.8 Throughput comparison between different TCP algorithms for varied LTE UE SINR.**

To test the performance of TCP-FIT over live, deployed, real-world networks, we put a TCP-FIT server, which located Orange, California, US, on the Inter tested TCP-FIT using clients located in 5 different cities/towns in 4 countries (China, Switzerland, USA and India) on 3 continents. At each location, we t combination of wired line connections, Wi-Fi and whenever possible, 3G wireless networks. The location, network and OS of the test clients are listed in Tab each experiment, a script was used to automatically and periodically cycle through different TCP algorithms on the server over long durations of time (4-24 while the client collected throughput information and other useful data. The period for changing the TCP algorithms was set to about 5-10 minutes, so tha algorithms tested were able to reach close to steady-state performances; 2) the period is consistent with the durations of a reasonably large percentage of t based sessions on the Internet (e.g. YouTube streaming of a single piece of content, synchronizing emails, refreshing one web page, etc.). In the perfo measure, TCP-FIT are compared with CUBIC, CTCP, Reno in all cases. HSTCP and Illinois are compared for wired network and TCPW, Veno for wirele location, network and OS of the test clients are listed in following table:

| Figures | Location | Network | Client OS |
|---|---|---|---|
| Figure 9 | Zurich | Ethernet | Win Vista |
| Figure 10 | LA | Ethernet | Win Vista |
| Figure 11 | Beijing | ADSL | Win XP |
| Figure 12 | Zurich | WIFI | MAC OS |
| Figure 13 | LA | WIFI | Win Vista |
| Figure 14 | Beijing | WIFI | Linux |
| Figure 15 | Beijing | CDMA 2000 | Win XP |
| Figure 16 | Fujian | CDMA 2000 | Win Vista |
| Figure 17 | Bangalore | ADSL | Win Vista |

Our results are summarized in Following Figures:

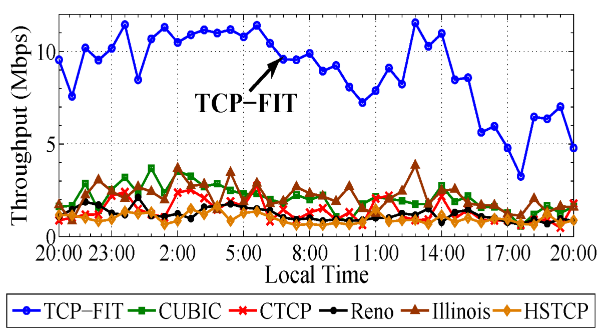



**Figure 9. Wired Network in Zurich**

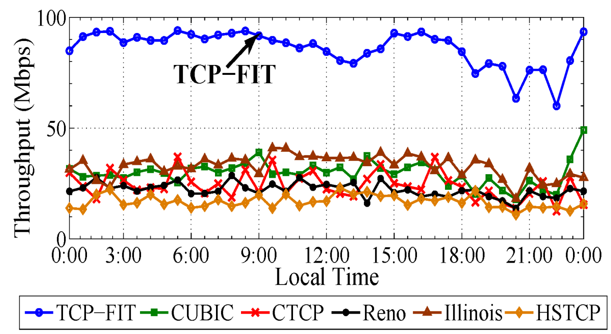



**Figure 10. Wired Network in Los Angeles**

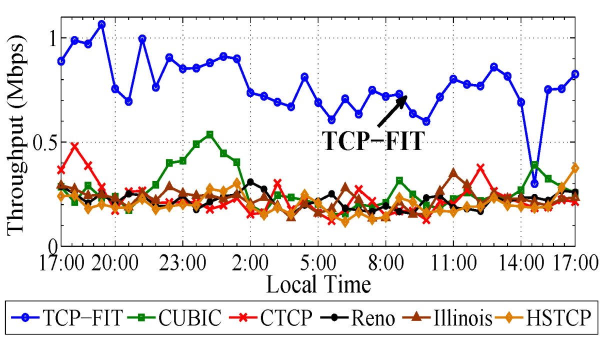



**Figure 11. Wired Network in Beijing**

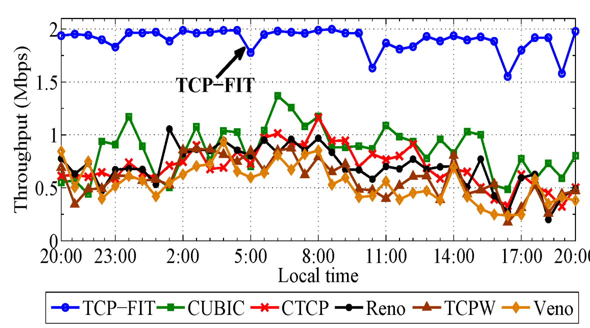



**Figure 12. Wireless Network in Zurich**

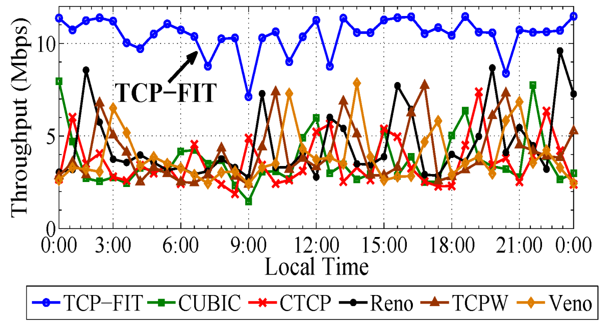



**Figure 13. Wireless Network in Los Angeles**

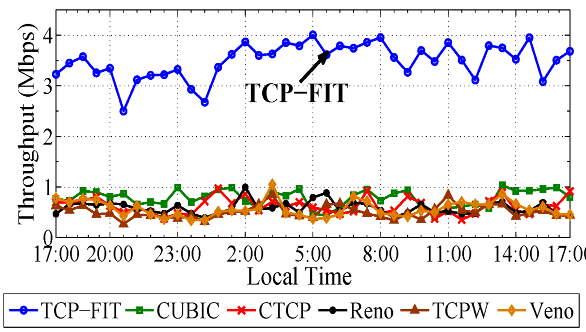



**Figure 14. Wireless Network in Beijing**

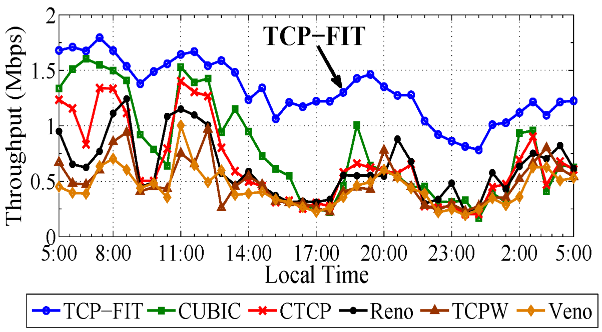



**Figure 15. 3G Network in Beijing**

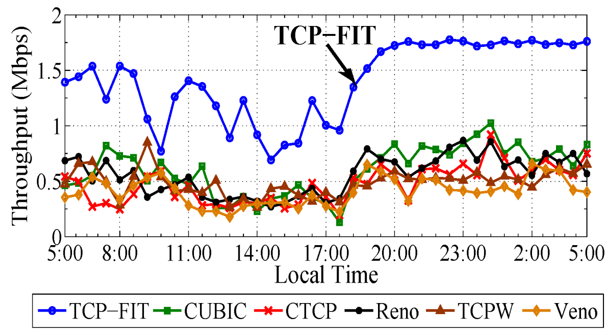



**Figure 16. 3G Network in a town of Fujian Province**

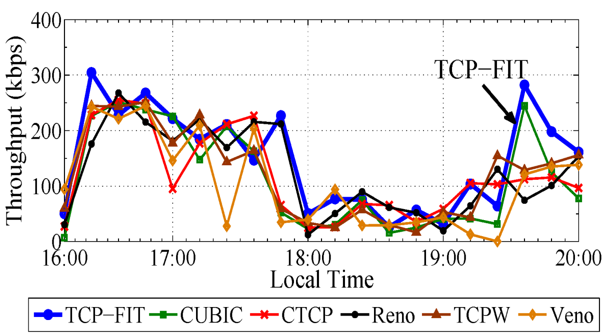



**Figure 17. ADSL Network in Bangalore**

we compared the performance of TCP-FIT with widely deployed TCP variants, TCP Reno and CUBIC, using the Planet-Lab testbed. In the experiments, 24 of the Planet-Lab test bed distributed over 192 cities in 43 countries were used to download video clips from an HTTP servers located in San Diego, C geographical distribution of these nodes is shown in Figure 18. These nodes covered 233 ISPs representative of the conditions of the current Internet.

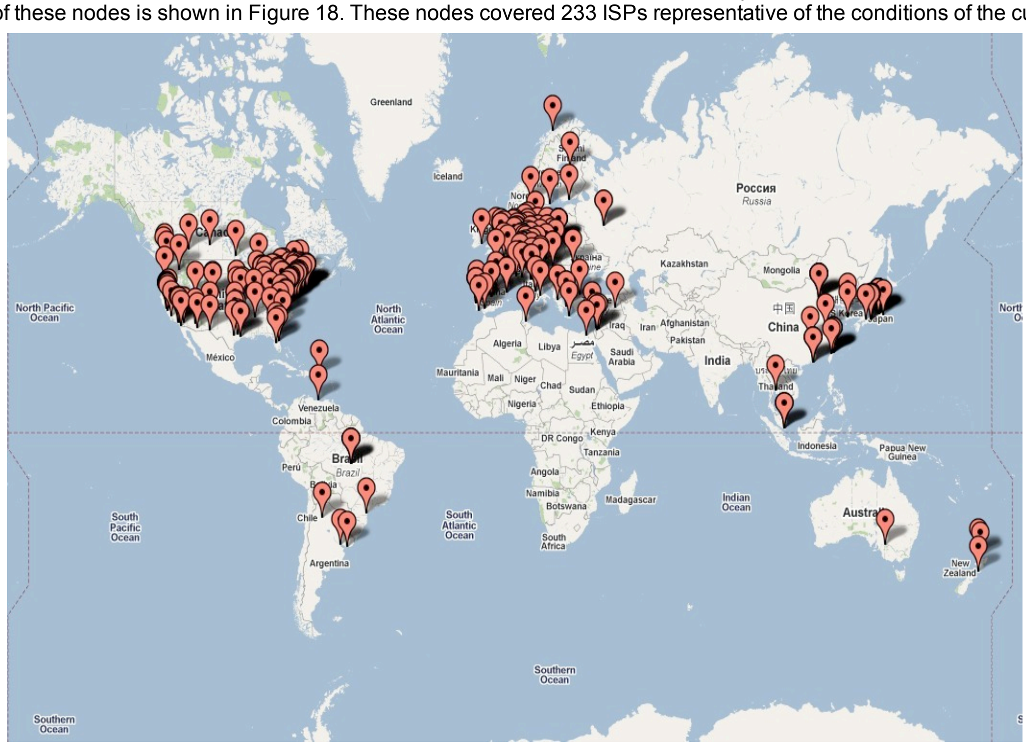


**Figure 18. Geographical Distribution of Nodes in Planet-lab Experiments**

The cumulative probabilistic function for the download throughputs of the nodes is shown in Figure 19, while the corresponding cumulative probabilistic fu for the TCP-FIT to Reno/CUBIC speedup is in Figure 20.

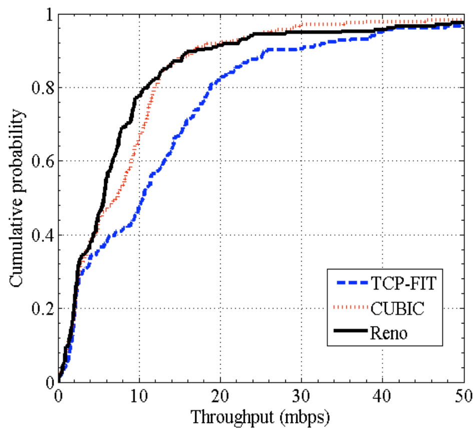



**Figure. 19 Cumulative Probabilistic Function for Throughputs**

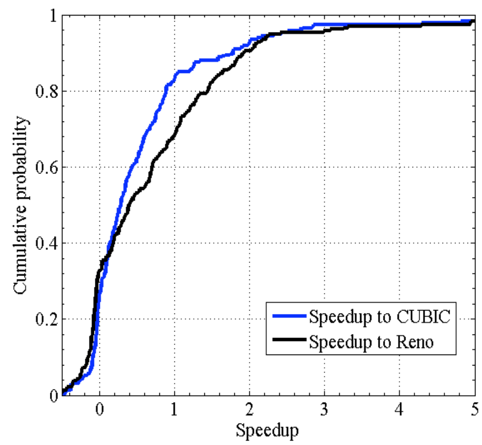



**Figure. 20 Cumulative Probabilistic Function for Speedup**

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