Primary Path Effect in Multi-Path TCP: How Serious Is It for Deployment Consideration?

Subhrendu Chattopadhyay *, Sukumar Nandi†, Samar Shailendra‡, Sandip Chakraborty§

TATA CONSULTANCY SERVICES

Preliminaries

1. Personal computing devices support multiple interfaces.
2. Multi-path TCP (MPTCP) [1] uses multiple end-to-end paths through multiple interfaces attached with the end hosts.

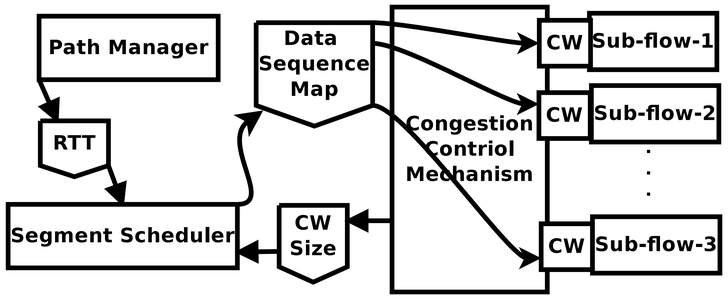

Figure 1: MPTCP Building Blocks

Major functional blocks of MPTCP:

1. *Path Manager:* Identifies the available paths.
2. *Congestion control:* Decides congestion window size for individual paths.
3. *Segment Scheduler:* Schedules segments in each path.

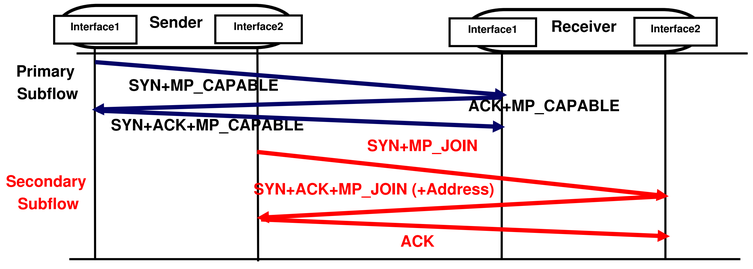

Figure 2: MPTCP Handshake

1. *Primary Path:* Path used for MPTCP connection initiation.
2. *Secondary Path:* Rest of the paths appended later.

Objectives

1. According to [2, 3], primary path selection is crucial for optimal performance.
2. Impact of primary path parameters over end-to-end transport performance.

Acknowledgement

This work is supported by TATA Consultancy Services,India through TCS Research Fellowship Program.

Contact Us

*subhrendu@iitg.ernet.in †sukumar@iitg.ernet.in	Dept. of CSE, IIT-G
‡s.samar@tcs.com	TCS Research & Innovation
§sandipc@cse.iitkgp.ernet.in	Dept. of CSE, IIT-KGP

Experimental Setup

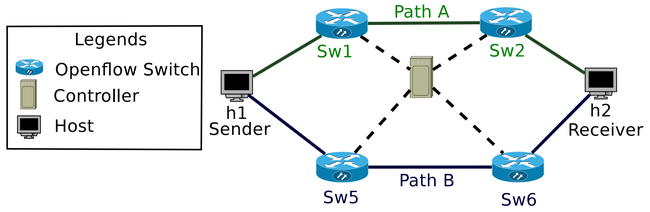

Figure 3: Emulation Topology

Exp.	Path Attributes	
	Path A	Path B
1	$\{10Mbps, 250ms, 0\%\}$	$\{10Mbps, 15ms, 0\%\}$
2	$\{5Mbps, 15ms, 0\%\}$	$\{10Mbps, 15ms, 0\%\}$
3	$\{10Mbps, 15ms, .5\%\}$	$\{10Mbps, 15ms, 0\%\}$

Table 1: Test Parameters at Two Paths

Results

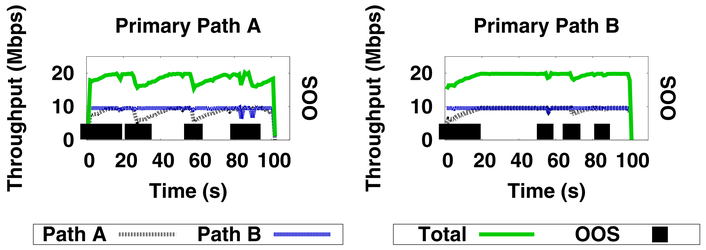

Figure 4: Effect of Delay (Exp 1)

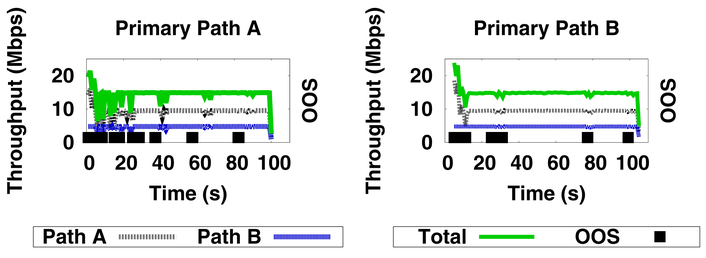

Figure 5: Effect of Bandwidth (Exp 2)

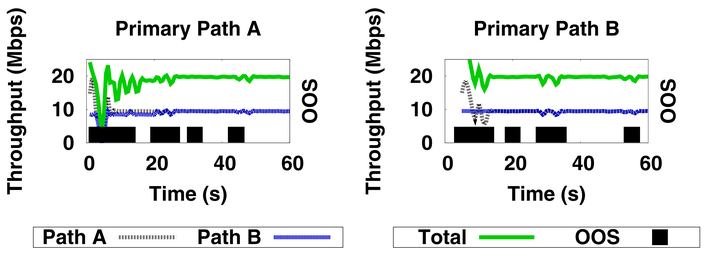

Figure 6: Effect of Loss Rate (Exp 3)

Results Contd...

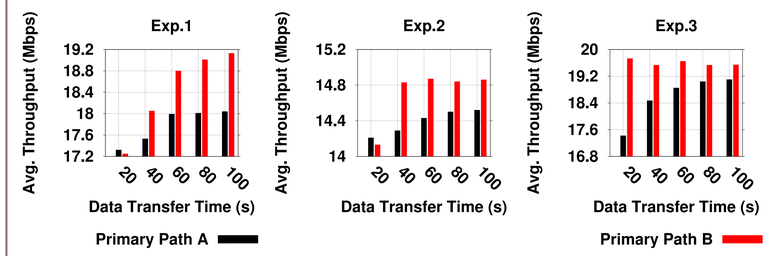

Figure 7: Effect of Flow Duration

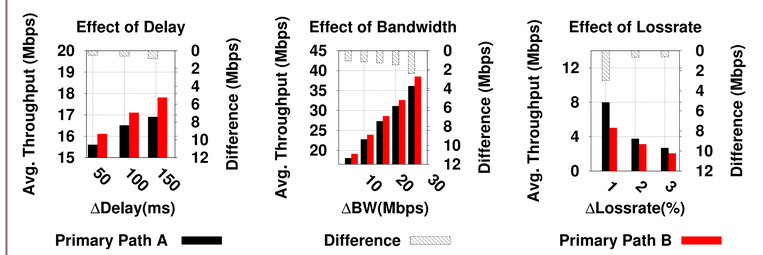

Figure 8: Throughput variation

Observations

Effect on Transport Layer Throughput

1. The overall throughput reduces significantly in case of slower path primary path.
2. Slower primary path generates higher number of out of order segments (OOS).
3. Increase in delay difference between primary path has more impact on the throughput.
4. Primary path with higher bandwidth reduces generation of OOS.
5. Primary path with higher loss-rate reduces overall throughput.

Impact of Parametric Difference Between Two Paths:

1. Selection of low loss-rate primary path can improve throughput significantly.
2. Increase in path difference increase OOS.
3. Traditional RTT based congestion control mechanism are not suitable for disparate path characteristics.

Future Research

1. *Selection of primary path:-* MPTCP performance considerations that need to be addressed properly for its practical deployment scenarios.
2. *Further studies:-* A few preliminary insights of the primary path effect on MPTCP performance. Requires more study on this problem.

References

[1] C. Xu, J. Zhao, and G. M. Muntean. Congestion Control Design for Multipath Transport Protocols: A Survey. *IEEE Comm. Surveys & Tutorials*, 18(4):2948–2969, Fourthquarter 2016.

[2] B. Sonkoly, F. Németh, L. Csikor, L. Gulyás, and A. Gulyás. Sdn based testbeds for evaluating and promoting multipath TCP. In *IEEE ICC*, pages 3044–3050, 2014.

[3] Q. De Coninck, M. Baerts, B. Hesmans, and O. Bonaventure. Poster: Evaluating android applications with multipath tcp. In *21st MobiCom*, pages 230–232. ACM, 2015.