Simulation Based Study of TCP Fairness in Multi-Hop Wireless Networks

M.Sc. thesis by Kunal Shah

Kari Kähkönen
Contents

• Why study TCP fairness in wireless networks?
• Background information
• Fairness criteria
• Simulation model
• Results and future work
• Critique
Why study TCP fairness in wireless networks?

• Current TCP versions are optimized for wired networks
• high bit error rate
• mobility
• continuously changing topology
• few formal studies of the subject
Background

• congestion control
• TCP Tahoe
• TCP Reno
• TCP New Reno
• TCP SACK
Background (2)

- Flows with different round-trip times can cause unfairness
- Flows that got head-start can starve new flows
- Different solutions for increasing TCP performance have been suggested (ECN, Split TCP, Snoop TCP, etc.)
Fairness criteria

• Closeness of achieved throughput to its fair share
• Properties of good fairness measurements
Fairness criteria (2)

- Max-Min Fairness

\[ U = \max_i \left| \frac{A_i - F_i}{F_i} \right| \]

\[ F_i = \text{MMF}_i (C, d_1, d_2, \ldots, d_n) \]
Simulation model

- OPNET modeller was used
- Five stationary sender and receiver nodes
- Each FTP flow starts at the same time
- Simulation parameters follow IEEE 802.11b standard
- Packet size, receive buffer size and traffic loads are varied (with and without RTS/CTS)
Results

• Only tentative conclusions
• TCP is more fair at higher loads without RTS/CTS and vice versa with RTS/CTS
• Large TCP receive buffer improves fairness
• Packet size is dependent on receive buffer size for yielding a higher TCP fairness
• TCP Tahoe is least unfair but its throughput is poor
Critique

• A lot of good background information…
• …but in some parts unnecessary details are covered
• It’s difficult to say if TCP fairness is a minor or major problem in wireless networks based on this study
• Effect of error rates in network is not covered
• No mobility
• Only one network topology