



TCP and TCP-L over Wireless Fading Channels

Stefan Alfredsson
Karlstad University
25 Aug 2004, Visby Sweden

Background and purpose

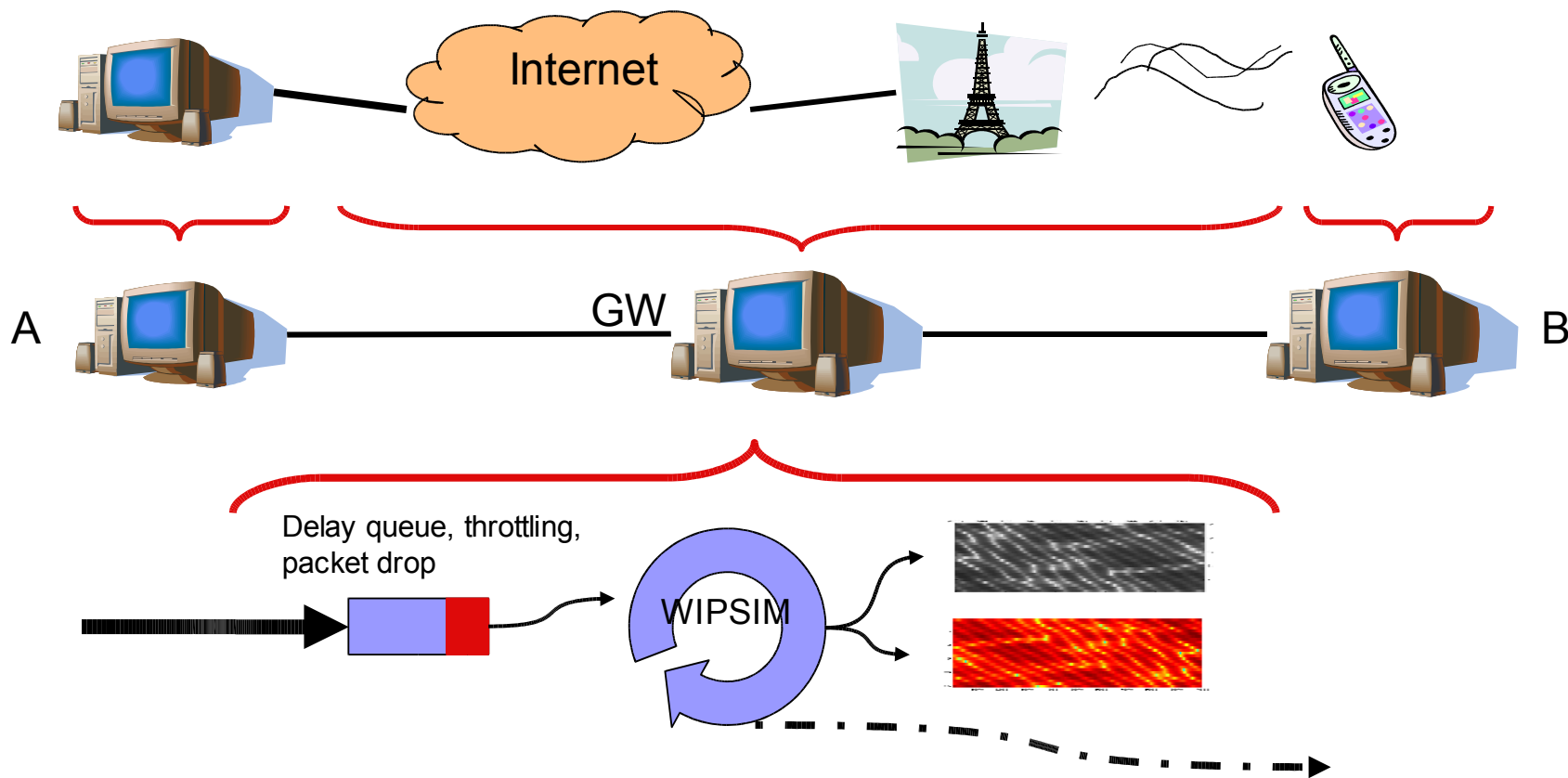
- The Wireless IP project is putting forward a 4G system proposal...
- ... but how will it interact with the existing infrastructure (TCP/IP)?
- Purpose of studies: examine the effect of different phys/link layer design decisions on upper layers, give performance expectations



Agenda

- Emulation overview and setup
- WIPSIM features
- Results from experiments with AM, TCP, TCP-L, Varying LL retransmissions
- Open questions / input
- Looking forward
- Summary

Emulation overview

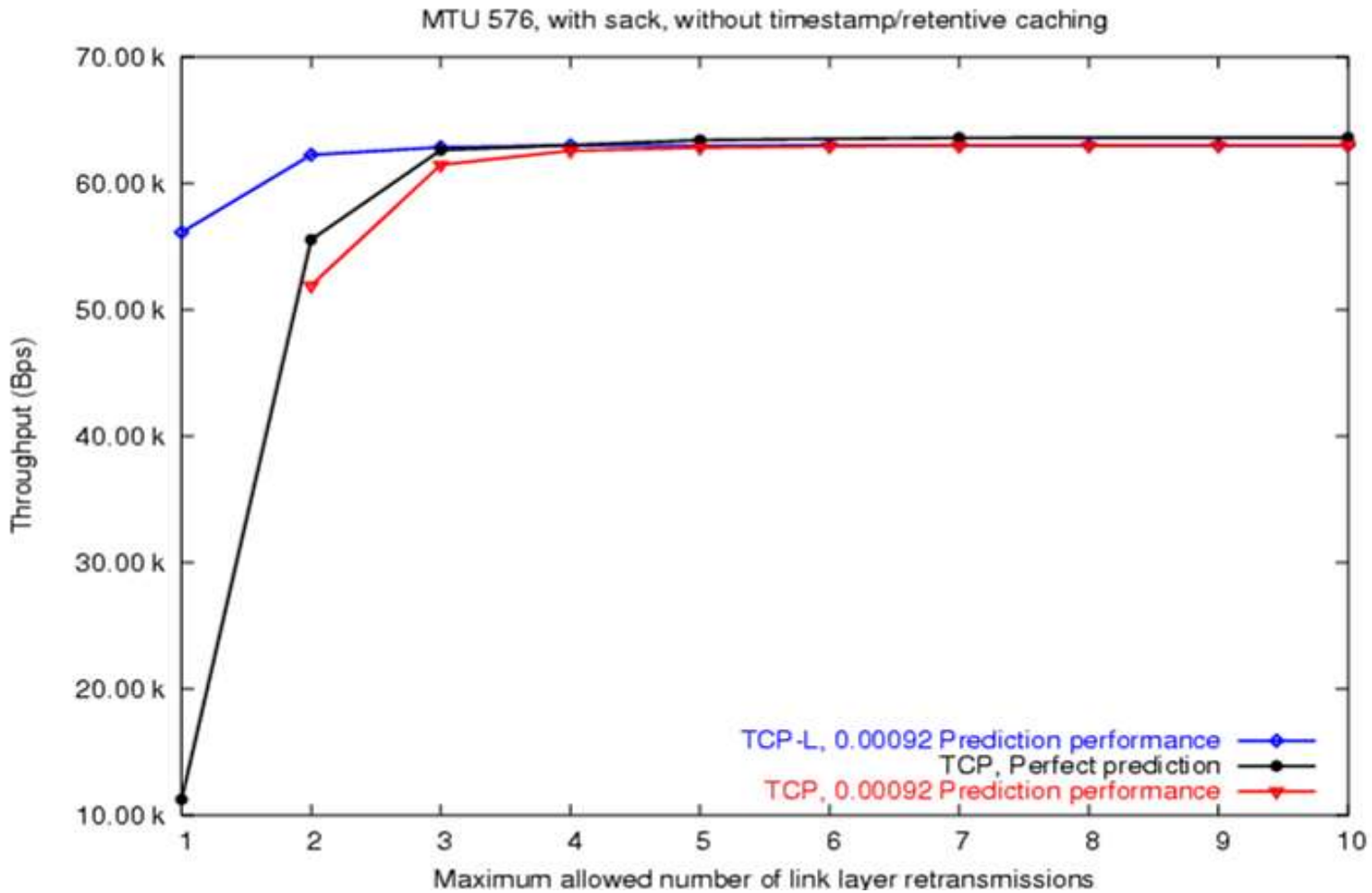


WIPSIM Features

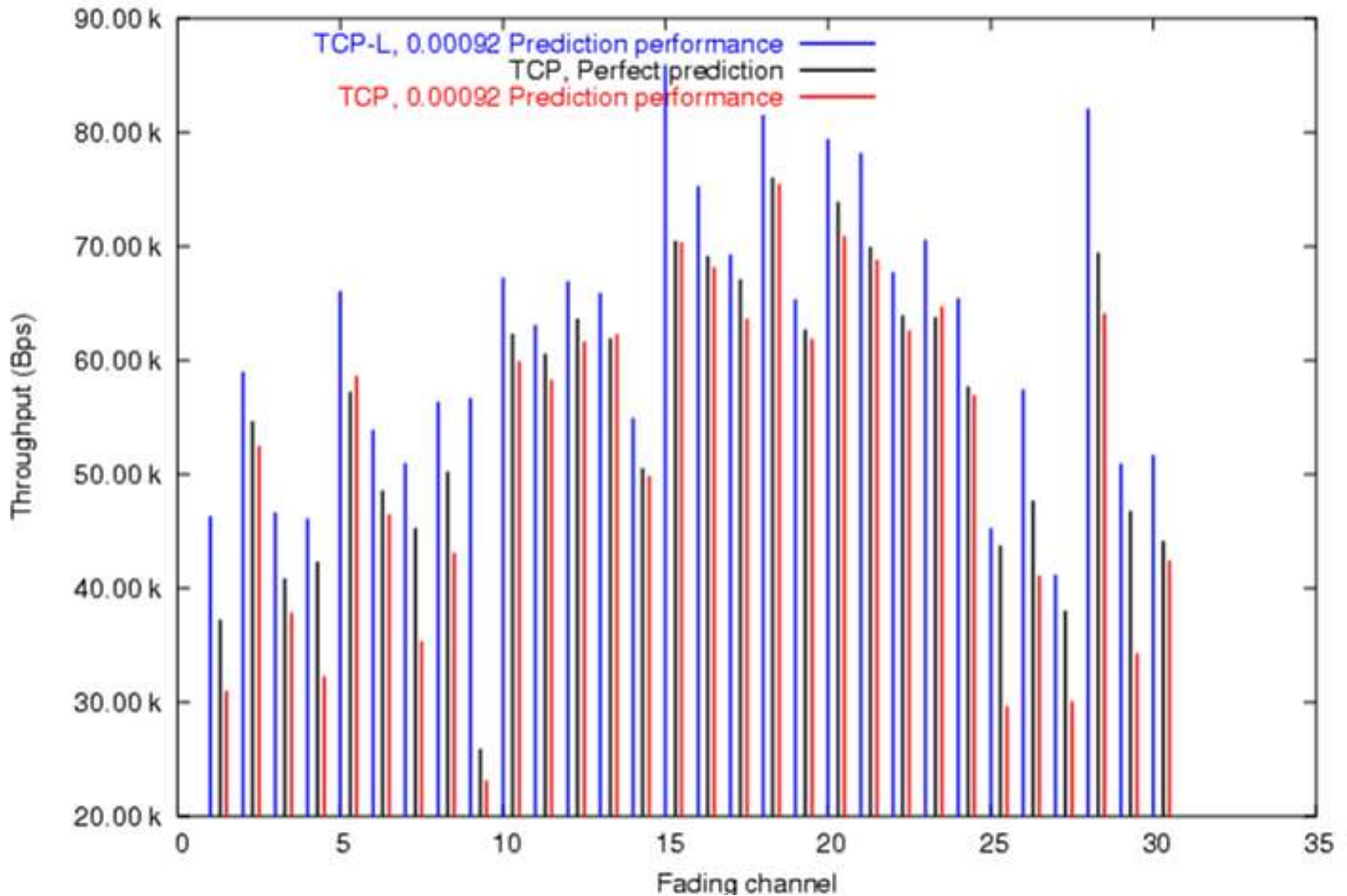
- Emulates the link layer of WIP 4G proposal
- Can use measured or simulated channel data
- Symbol level errors, derived from SINR and BER estimation
- Adjustable maximum number of link layer retransmissions
- Adjustable link layer retransmission delay
- Fixed or adaptive modulation.
- Flexible (developed entirely in-house)

Experiment parameter overview

- 30 frequency selective fading scenarios simulated in raytracing channel simulator @ 5km/h [375000 samples, 1500 samples per second ~ 4 minutes]
- Each scenario was subjected to prediction errors according to [Sternad, WINNER June 2004]. Prediction horizon 0.0167λ , predictor performance = 0.00092 @ 20dB.
- Bulk data transmitted between sender and receiver (A and B in earlier figure)
- Primary measurement is throughput, but other information is also available (# erroneous packets, retransmissions, delay variations, packet reordering)
- Transport protocols used are TCP and TCP-L (a modified TCP that trades reliability for performance by tolerating bit errors)
- Adaptive modulation is used and the number of link layer retransmissions is varied



MTU 576, with sack, without timestamp/retentive caching



Room for input

■ Channel model

- Flat use selective fading? (selective fading needed to realize multiuser-multibin gain)
- Velocities? (WIP aims for high speed, wide area coverage!)
- Use raytracing channel simulation or mathematical model? (quite long channel data wanted, ~4 minutes)

Looking forward

■ Short term

- Experiments with greater prediction errors
- TCP Westwood
- Performance metrics besides throughput?

■ Long term

- Varying other parameters (fixed net delay, queue sizes, TCP packet size, uplink characteristics, fixed modulation, ...)
- Multiuser and scheduling of bins
- Coding

Summary

- WIPSIM – finally working!
- Adaptive modulation and a low number of retransmissions work well (but be aware of the predictor performance)
- Channel scenario seems to have greater impact than prediction errors or transport protocol

References

- [Sternad, Falahati, PIMRC 2004]
 - M. Sternad and S. Falahati
**Maximizing Throughput with Adaptive M-QAM
Based on Imperfect Channel Predictions.**
IEEE PIMRC, Barcelona, Sept. 2004.
- [Sternad, WINNER June 2004]
 - M. Sternad et al, Presentation at WINNER T2.4
meeting, Stockholm, June 2004

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