Fairness Characterization in Contemporary IEEE 802.11 Deployments with Saturated Traffic Load

Aleksandr Ometov
http://winter-group.net

24.04.2014
FRUCT 15
St.-Petersburg, Russia

TAMPERE UNIVERSITY OF TECHNOLOGY

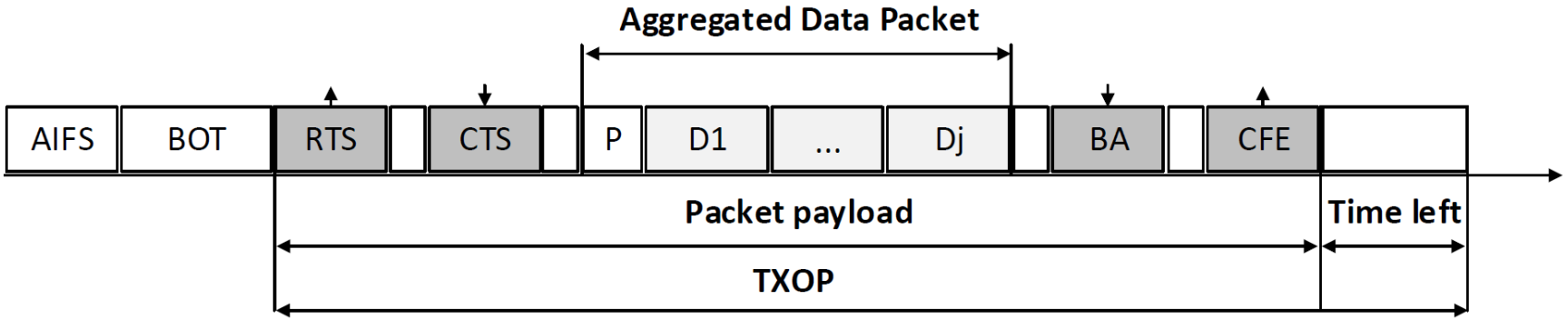
Goals

- Focus on the Capture Effect Issue
- System Fairness Estimation
- IEEE 802.11n simulator

Modeling Assumptions

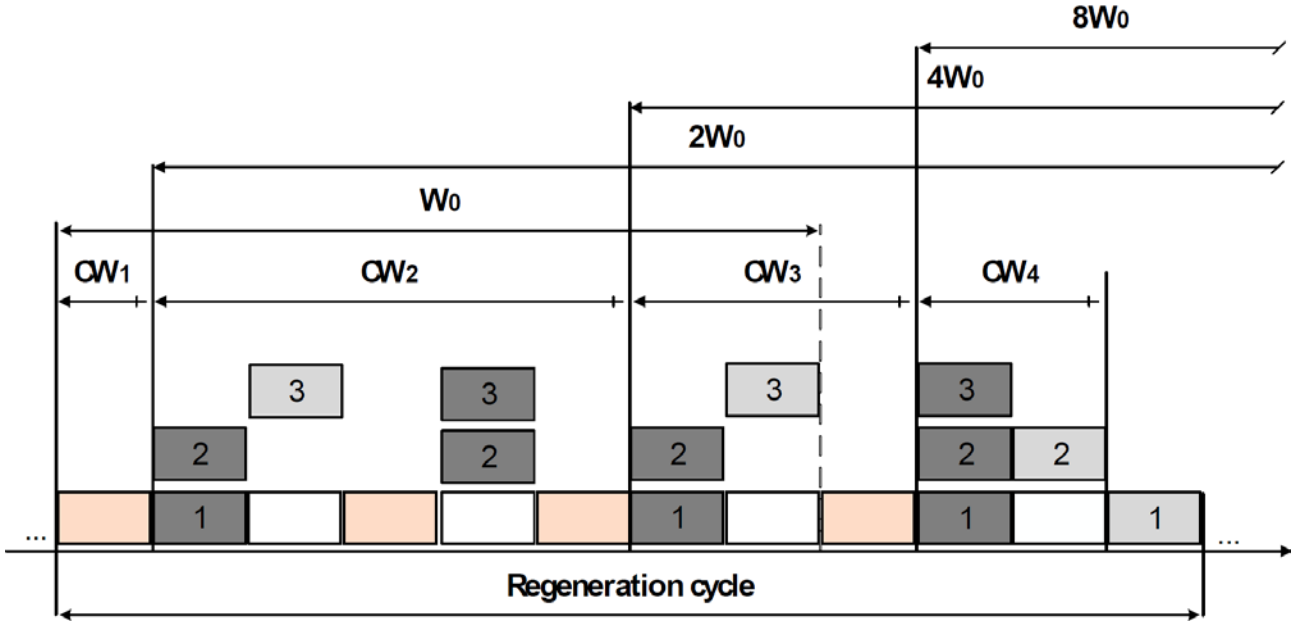
- Communication system
  - Fixed topology
  - Synchronization
- Transmission Channel
  - IEEE 802.11-2014 timings
  - Saturated traffic
  - Noise-free environment
- Retransmissions
  - Lossless System (Conventional)
  - Lossy System (Limited number of retries)

Binary Exponential Backoff (BEB)



- IEEE 802.11-based network
- Uplink analysis
- M users
- Same data type
- Saturated traffic
- **Jain's Fairness Index –** $J(P_{s1}, P_{s2}, .., P_{sn}) = \frac{(\sum_{i=1}^{n} P_{si})^2}{n \sum_{i=1}^{n} {P_{si}}^2}$

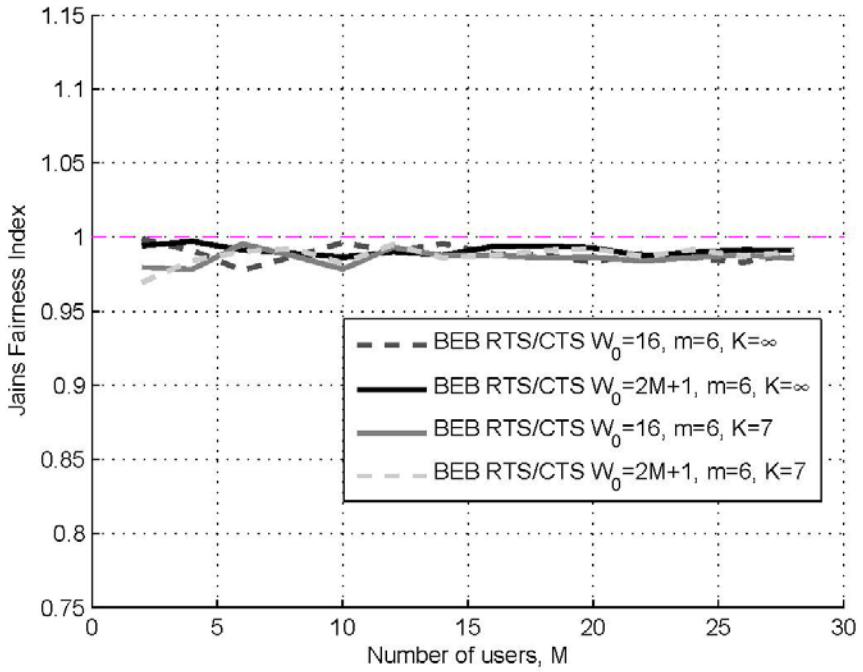
Regenerative analysis



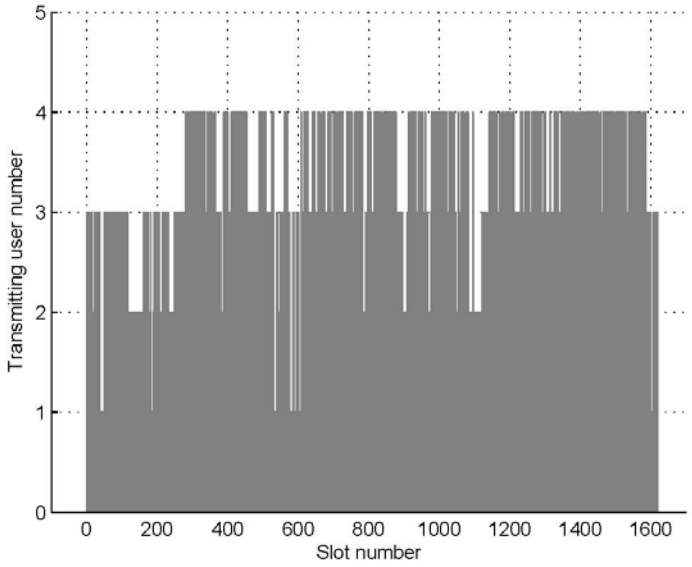
- Lossy model
- **BEB stages** number *m*; *W0* **initial backoff window** size, **M** number of users
- Retransmission **attempts** number *K*

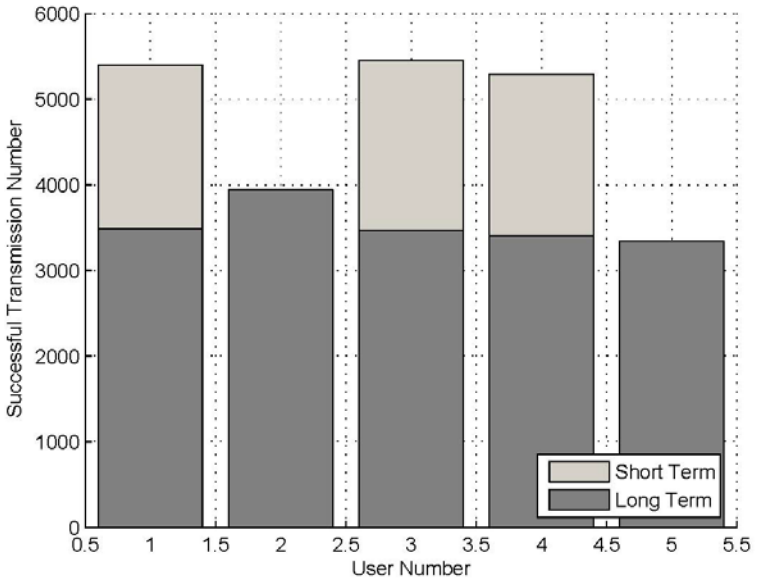
Facing Fairness Issues

- For small number of users
- For small initial backoff window



Channel Access by Users



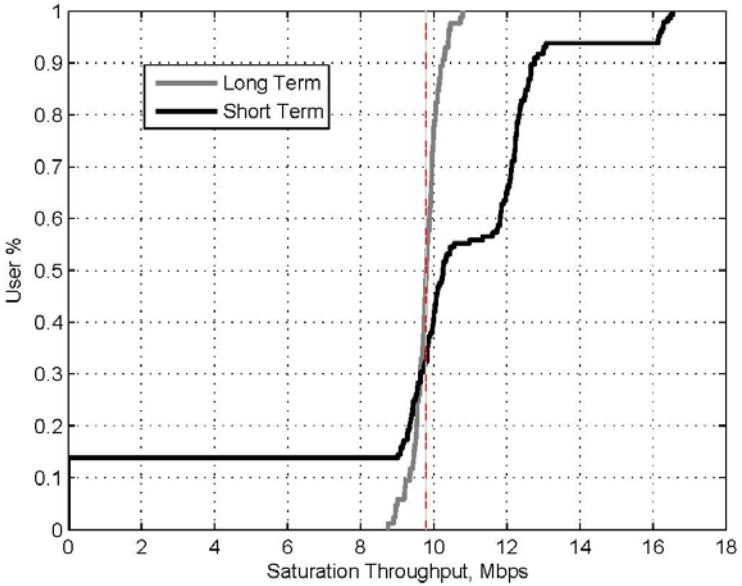


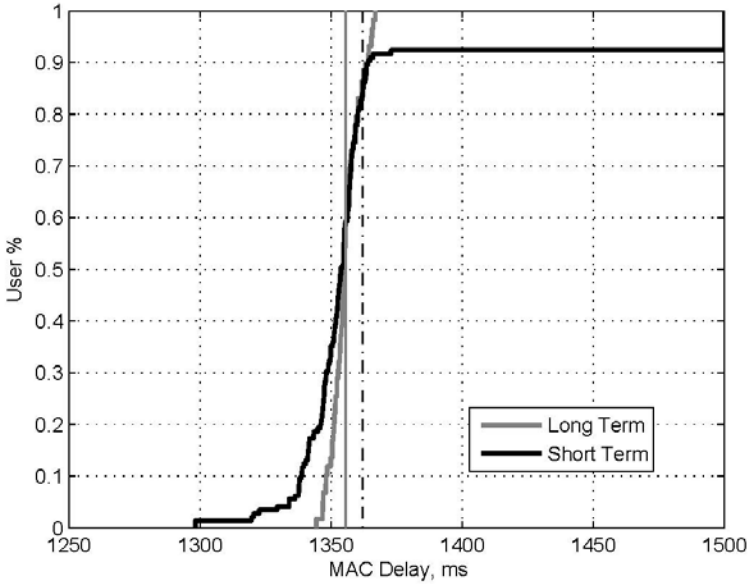
W0 = 16, m = 6, K = 7

802.11n for *65 Mbps* rate and 5 users in the system

*Number of successful transmissions for the long term is divided by a number of short terms in it for the perception ease

Throughput and Delay





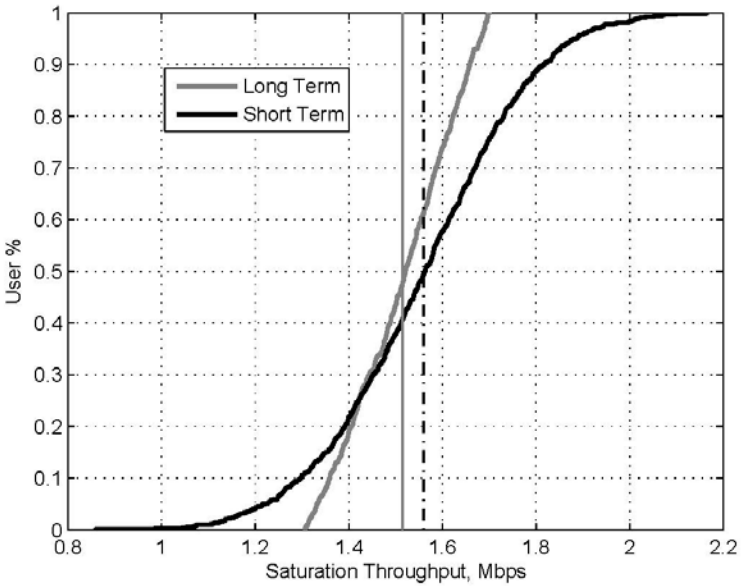
System is not fair in the short term due to the user capture effect

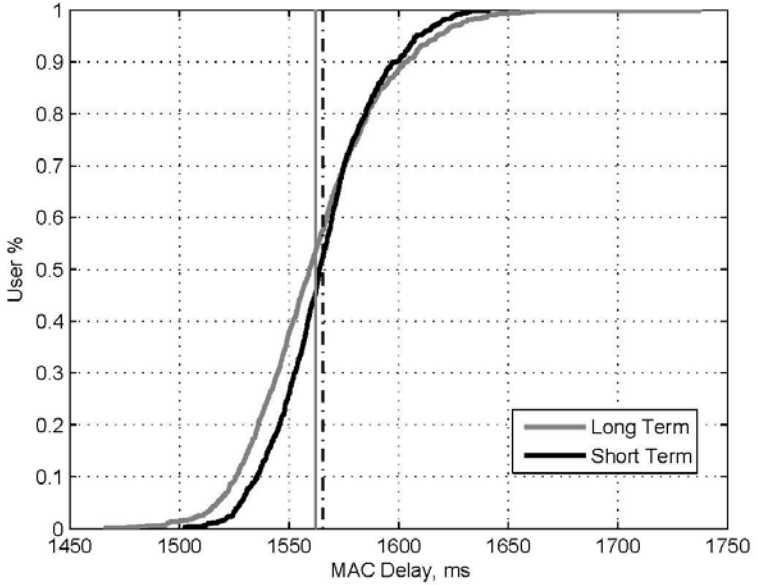
Delay estimation:

$$\theta = \frac{T_s + T_c + \sigma}{St_i}$$

where T_s is a duration of a successful transmission one, T_c - collision, σ -idle slot, St_i is a number of successful transmission for *i-th* user.

Throughput and Delay M=30





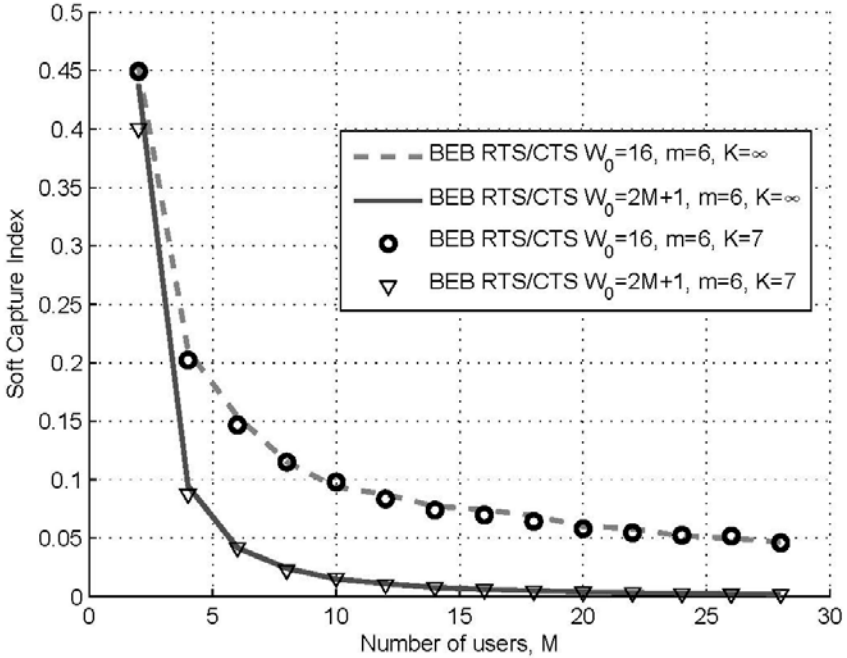
Facing no significant difference

- System is meanly fair from the very beginning and stable for all the users during the simulation

Soft Fairness Index

$$F_{sc} = \frac{\sum_{i=1}^{n} R_i}{\sum_{i=1}^{n} (S_i + C_i)},$$

where R_i is a number of the successful transmissions in a row for *i-th* user, S_i is a number of successful transmissions and C_i is a number of collisions.



Conclusions

- Fairness Characterization
  - Proposed metric, which can present if the BEB-based system is fair (not depending on the simulation duration)

Thank you
for your attention