

Multilevel modeling for short TCP Transfers

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Motivation

- A TCP connection inevitably timeouts if the sender does not receive three duplicate ACKs.
- RFC2988: Conservative value of RTO is chosen (1 sec.). Hence RTO has a very harmful effect on the TCP Latency.
- A single packet loss provokes a timeout if
 - ▶ Congestion Window is small.
 - ▶ One of the last three packets is lost.



Calculation of the TCP latency

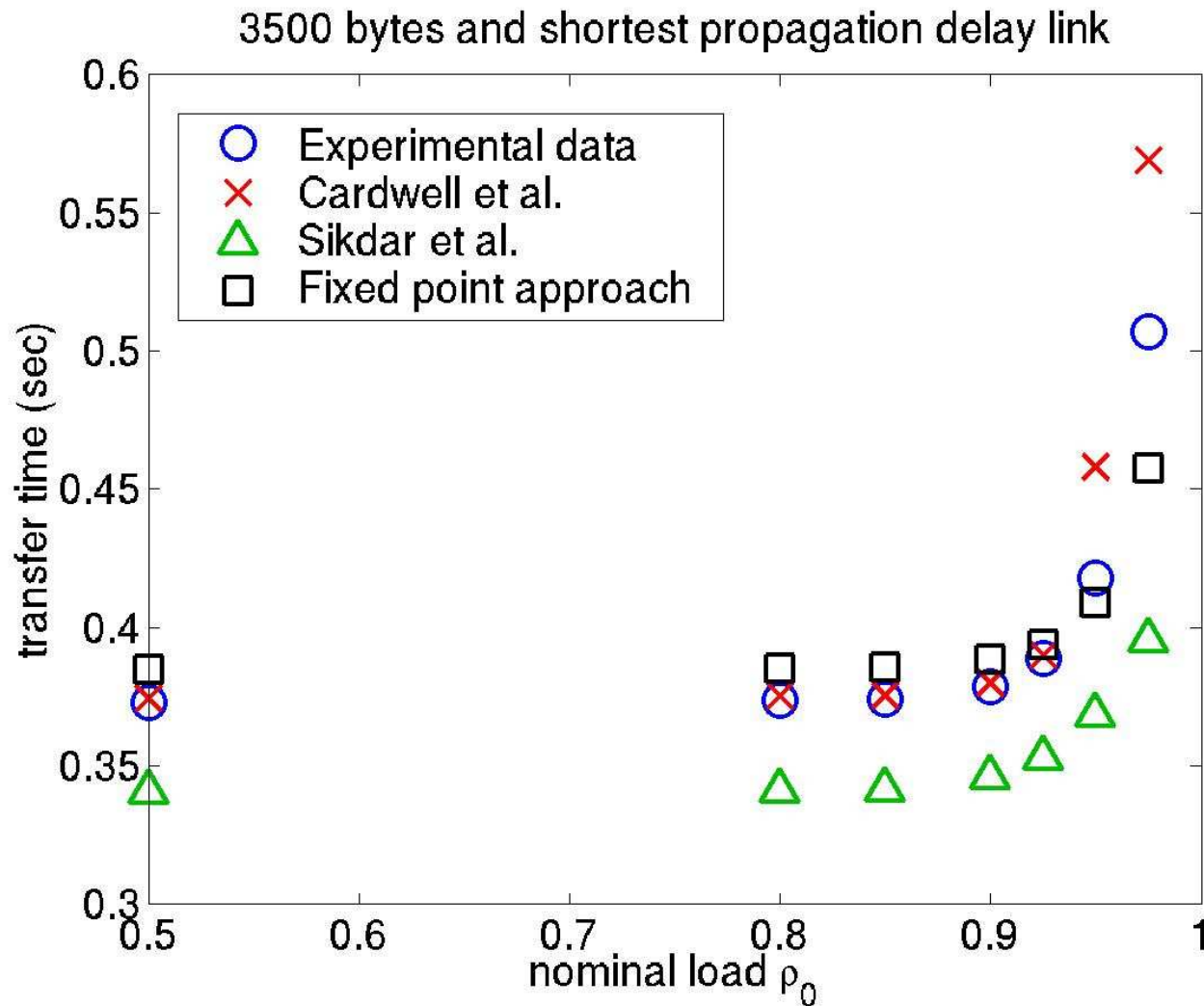
The expected latency for the document size of n packets is calculated by conditioning on the number of losses.

$$L(p, RTT, n) = \sum_{k=0}^{\infty} p(k | n) L(p, RTT, n | k)$$

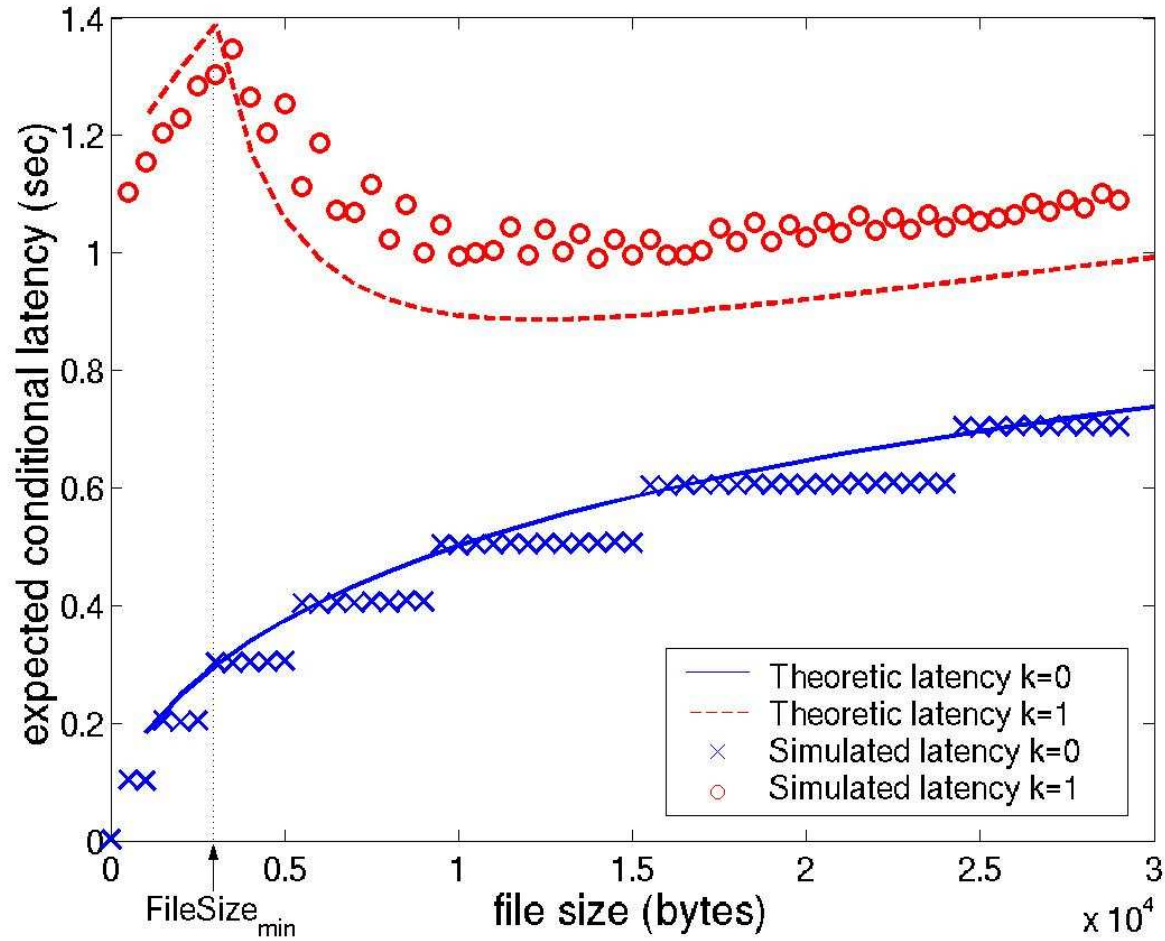
where $L(p, RTT, n | k)$ is computed recursively
and

$$p(k | n) = p^k (1-p)^n C_{n+k+1}^k$$

Average Transfer time

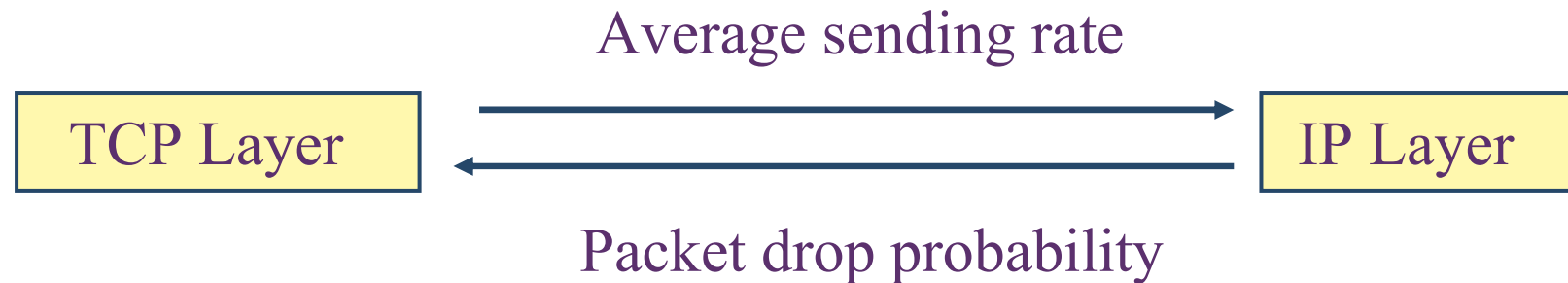


Non-Monotonicity of the transfer time





Calculation of the packet loss probability: Fixed Point Approach

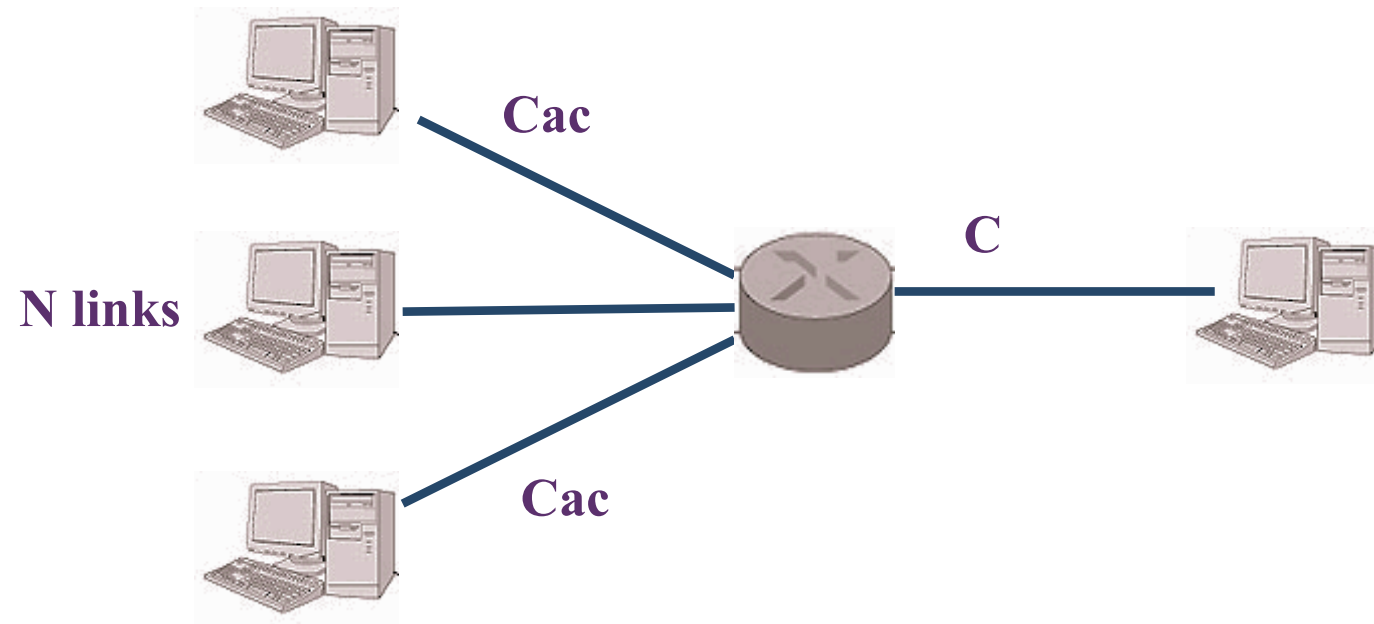


$$\rho_0 = \frac{E[doc_size] \sum_{i=1}^N \lambda_i}{C_{link}}$$
$$\rho = \frac{\rho^K (1 - \rho)}{1 - \rho^{K+1}}$$

Proposition: If $\rho_0 < 1$ the solution of the system exists and is unique



Study of the Packet Arrival process

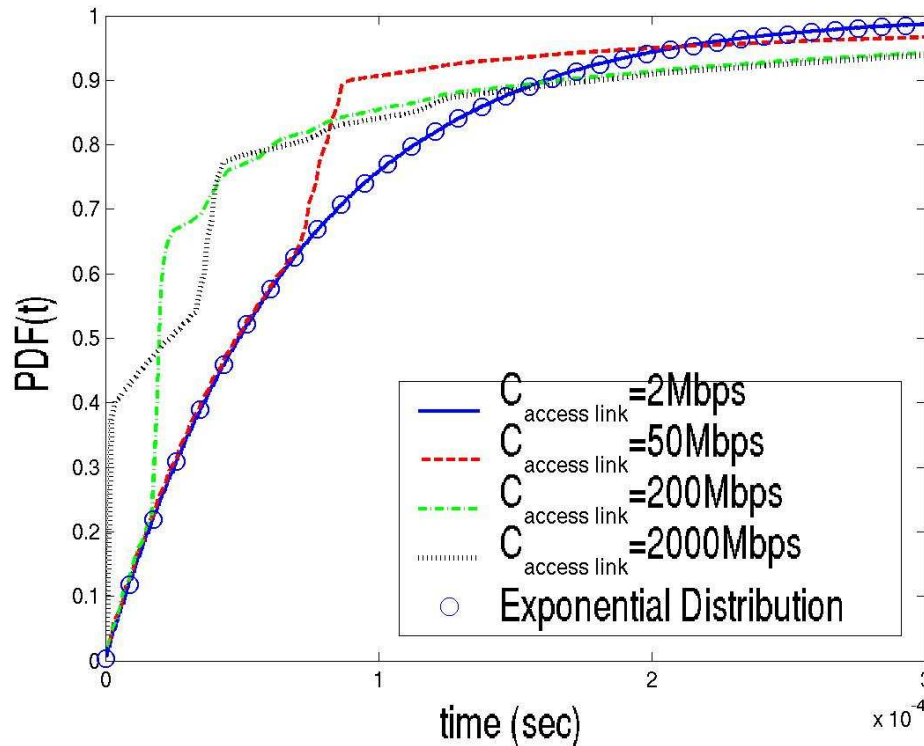


→ We simulate with NS:

- ▶ Files arrive as Poisson.
- ▶ File size exponential and Pareto.



Study of the Packet Arrival process



Bottleneck 100 Mbps,
100 access links, load 0.6

► If

$$C_{ac} \approx \frac{2.C}{N},$$

inter-arrival time distribution is
close to exponential,

► However the correlation is not
negligible.



Conclusions

- ➔ Simulation analysis of the arrivals of TCP packets to a router:
 - ▶ Approaches exponential when the access links are slow compared to the bottleneck (traffic spread at the access before arriving at the bottleneck).
 - ▶ Correlation is not negligible under any parameter setting.

 - ➔ To avoid the harmful effect of RTO, the Early Retransmit mechanism calls for lowering the duplicate ACK threshold when:
 - ▶ The amount of outstanding data is small.
 - ▶ No unsent data are queued.
- M. Allman, K. Avrachenkov, U Ayesta, J. Blanton,
« Early Retransmit for TCP and SCTP » IETF I-D, work in progress.