The effect of router buffer size on the TCP performance

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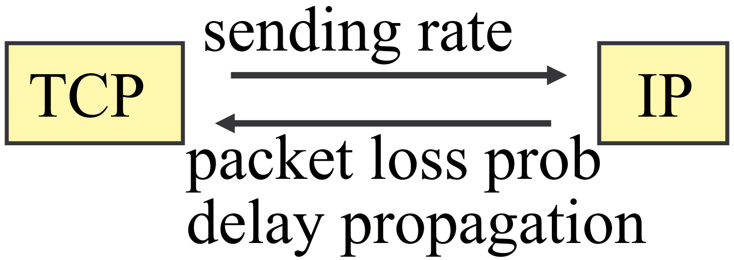
Outline

- Is there an optimal value for the buffer size in IP routers?

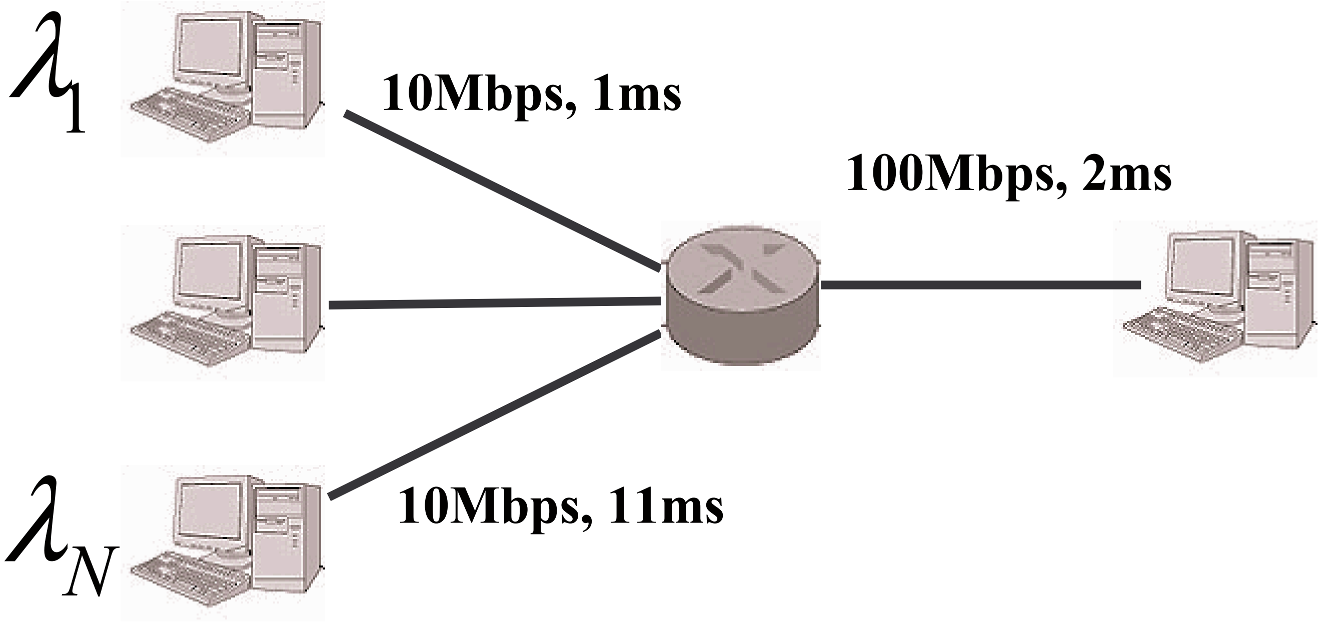
- Fixed Point Approach.



- Persistent TCP connections:
  - Average sending rate and goodput.

- Short TCP connections:
  - Latency

Simulated Scenario



- **Persistent Connections:** 100 connections.
- **Short Transfers:** New sessions arrive according to a Poisson distribution.

Persistent TCP Connections: Fixed Point (I)

$$\rho = \frac{1}{C}\sum_{i=1}^{N} T_i\left(p, RTT_i\right) \qquad p = \rho^K \frac{1-\rho}{1-\rho^{K+1}}$$

Mean queueing delay

Prop Delay

$$RTT_i = 2 * d_i + \frac{MSS}{C}\left[\frac{1}{1-p} - K\frac{\rho^K}{1-\rho^K}\right]$$

For the formula for $T_i = T_i(p, RTT_i)$ see for example:

J.Padhye, V.Firoiu,D. Towsley, and J. Kurose, « Modeling TCP Throughput: a Simple Model and its Empirical Validation », in Proceedings of ACM SIGCOMM ’1998 conference.

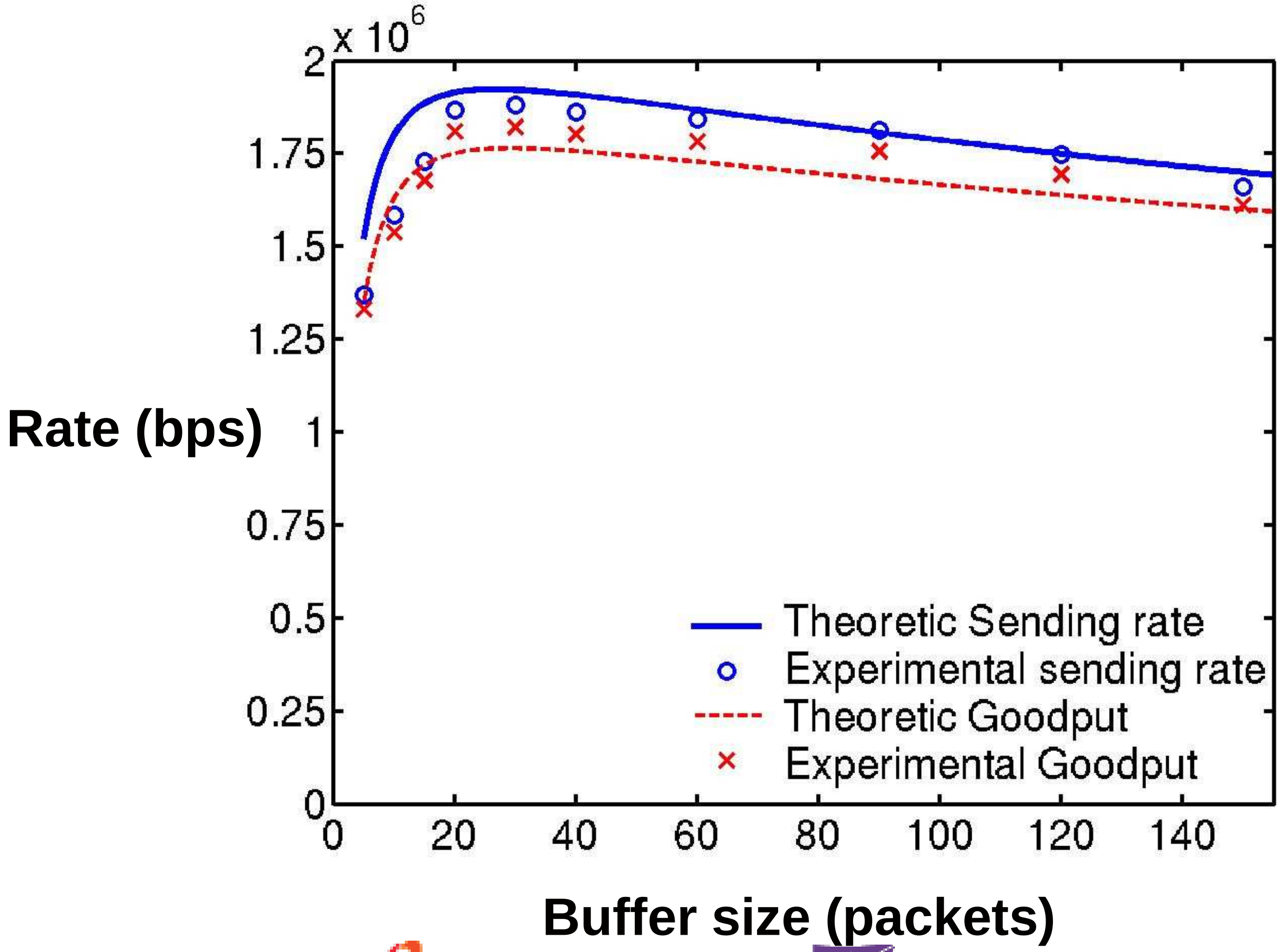
Persistent TCP Connections: Fixed Point (II)

$$\rho = \frac{1}{C}\sum_{i=1}^{N} T_i\left(\rho^K \frac{1-\rho}{1-\rho^{K+1}}, d_i + \frac{MSS}{C}\left[\frac{1}{1-\rho} - K\frac{\rho^K}{1-\rho^K}\right]\right)$$

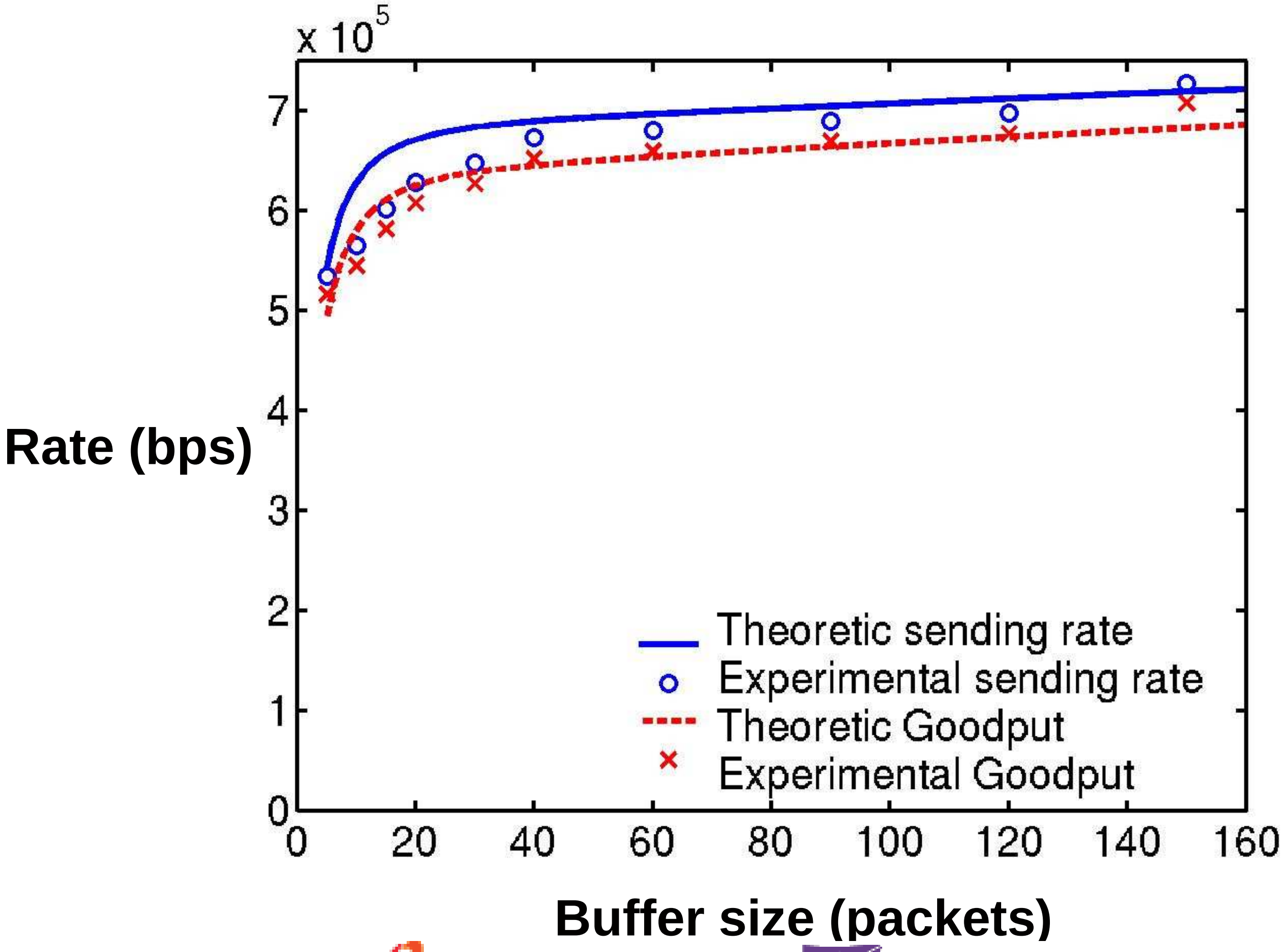
Solved iteratively

Substituting we get the values for p,RTT$_i$ and T$_i$.

Persistent TCP connections: Result (I)



Persistent TCP connections: Result (II)



Short TCP Transfers: Fixed Point (I)

$$\rho_0 = \frac{E[doc\_size]\sum_{i=1}^{N}\lambda_i}{C_{link}}$$

$$\rho = \frac{E[doc\_size]\sum_{i=1}^{N}\lambda_i}{C_{link}(1-P)} \qquad P = \frac{\rho^{K}(1-\rho)}{1-\rho^{K+1}}$$

Solved iteratively

$$\rho_{i+1} = \rho_0 \frac{1-\rho_i^{K+1}}{1-\rho_i^{K}}$$

Short TCP Transfers: Fixed Point (II)

Substituting we get the values for RTTi and Latency.

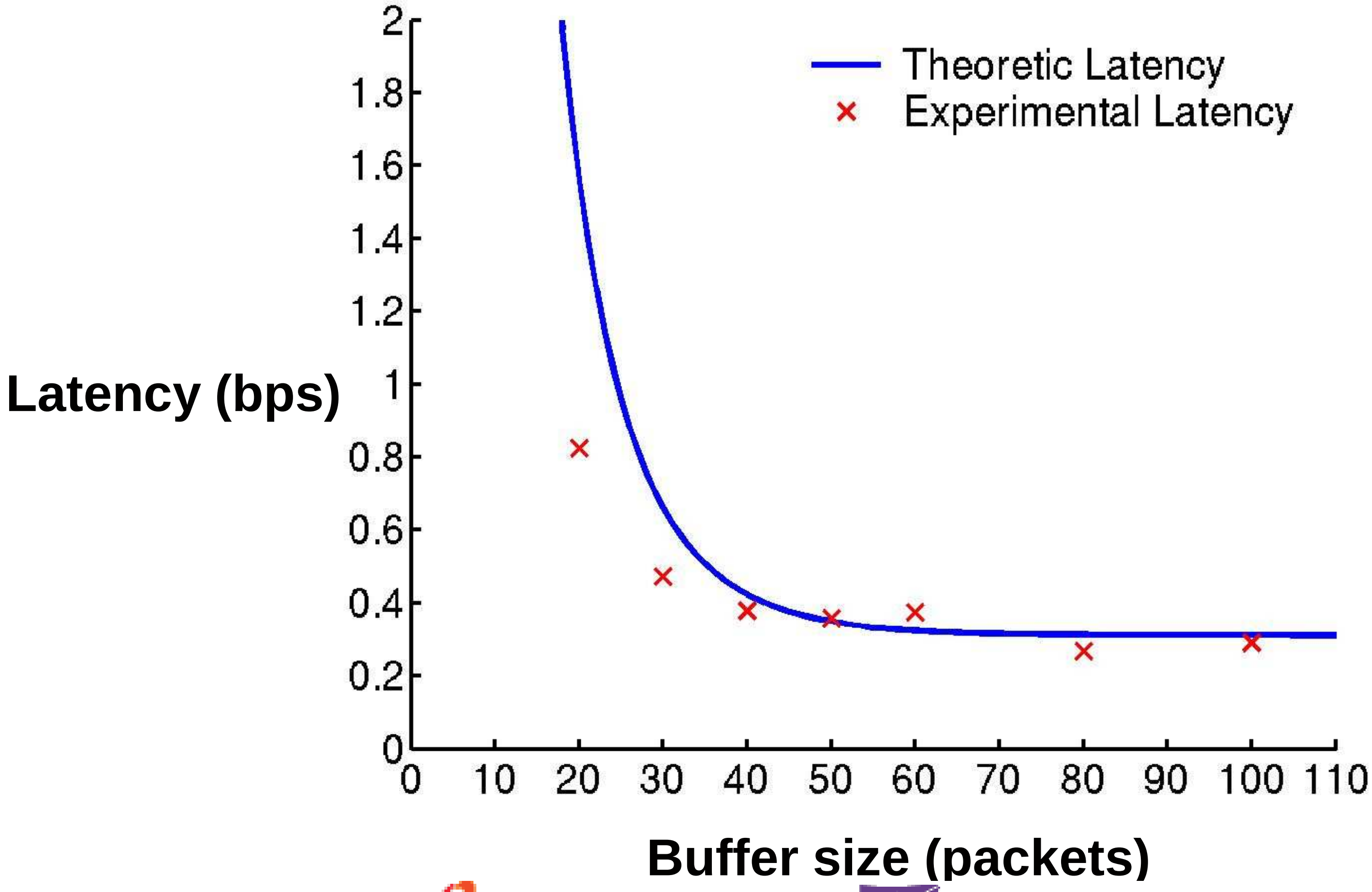
$$L(m) = RTT\left(\log_{1.57}(m) + f(p, RTT)m + 4p\log_{1.57}(m) + 20p + \frac{10 + 3RTT}{4(1-p)W_{\max}\sqrt{W_{\max}}} m \right)^{*}$$

$$f(p, RTT) = \frac{2.32\left(2p + 4p^2 + 16p^3\right)}{(1 + RTT)^3} N + \frac{1 + p}{RTT10^3}.$$

$$RTT_i = 2 * d_i + \frac{MSS}{C}\left[\frac{1}{1-p} - K\frac{\rho^K}{1-\rho^K} \right]$$

*) B. Sikdar et. al. An integrated model for the latency and steady-state throughput of TCP connections. Perf .Eval. 01

Short TCP Transfers: Result



Conclusions

- **Persistent TCP connections** has poor sending rate and goodput in the cases of small and large buffer sizes.

  Consequently there is an optimal value of the buffer size.

- **Short TCP transfers.** There seems not to be an optimal value for the IP router buffer size. The larger the buffer size, the better.

- **Fairness** improves with increasing buffer size.

  Connections with large propagation delays get more bandwith and those with short propagation delays less.

Future work

- More sophisticated network topologies with several bottleneck links.

- Formula of Sikdar et al. Does not work well in the case of large number of packet losses.

Formula for the Sending rate

$$T_i\left(p,RTT_i\right)=MSS_i\frac{\dfrac{1-p}{p}+W\left(p\right)+Q\left(p,W\left(p\right)\right)}{RTT_i\left(\dfrac{b_i}{2}W\left(p\right)+1\right)+\dfrac{Q\left(p,W\left(p\right)\right)F\left(p\right)T_0^i}{1-p}},\qquad if \quad W\left(p\right)<W_{\max}^i$$

$$T_i\left(p,RTT_i\right)=MSS_i\frac{\dfrac{1-p}{p}+W_{\max}^i+Q\left(p,W_{\max}^i\right)}{RTT_i\left(\dfrac{b_j}{8}W_{\max}^i+\dfrac{1-p}{pW_{\max}^i}+2\right)+\dfrac{Q\left(p,W_{\max}^i\right)F\left(p\right)T_0^i}{1-p}},\qquad otherwise,$$

$$W\left(p\right)=2/3+2\sqrt{\left(1-p\right)/\left(3p\right)+1/9},$$

$$Q\left(p,w\right)=\min\left\{1,\frac{\left(1-\left(1-p\right)^3\right)\left(1+\left(1-p\right)^3\left(1-\left(1-p\right)^{w-3}\right)\right)}{1-\left(1-p\right)^w}\right\},$$

$$F\left(p\right)=1+p+2p^2+4p^3+8p^4+16p^5+32p^6,$$