

TCP Emulation At the Receivers (TEAR)

Volkan Ozdemir, Injong Rhee
North Carolina State University

Properties

- TCP-friendly
- Receiver-based rate estimation
- Emulates TCP at the receivers
 - slow start
 - triple duplicate ACKs
 - timeout
- Sender-based rate regulation

Operation

- Each receiver maintains cwnd
- RTT is estimated for each receiver
- $\text{rate} = \text{cwnd} / \text{RTT}$
- receivers send feedback to sender
- sender regulates sending rate

Maintenance of cwnd

- If no packet loss for one RTT, then

Slow start : $\text{cwnd} = 2 * \text{cwnd}$

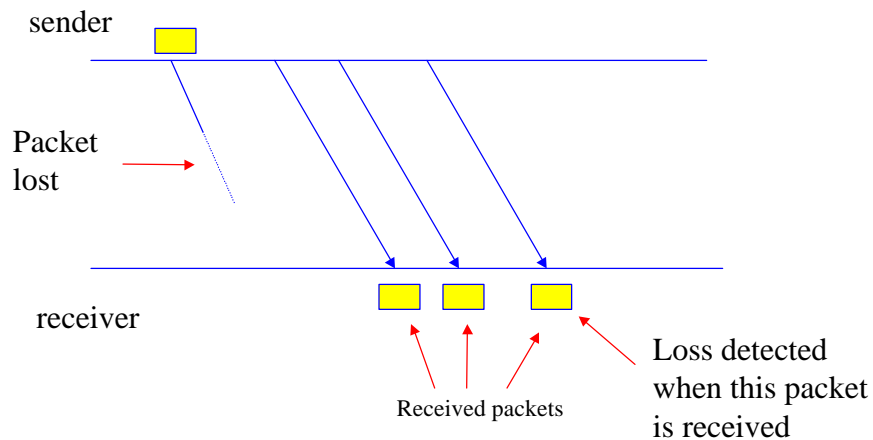
Congestion avoidance : $\text{cwnd} = \text{cwnd} + 1$

$\text{cwnd} < \text{ssthresh}$ slow start

$\text{cwnd} > \text{ssthresh}$ congestion avoidance

Packet loss

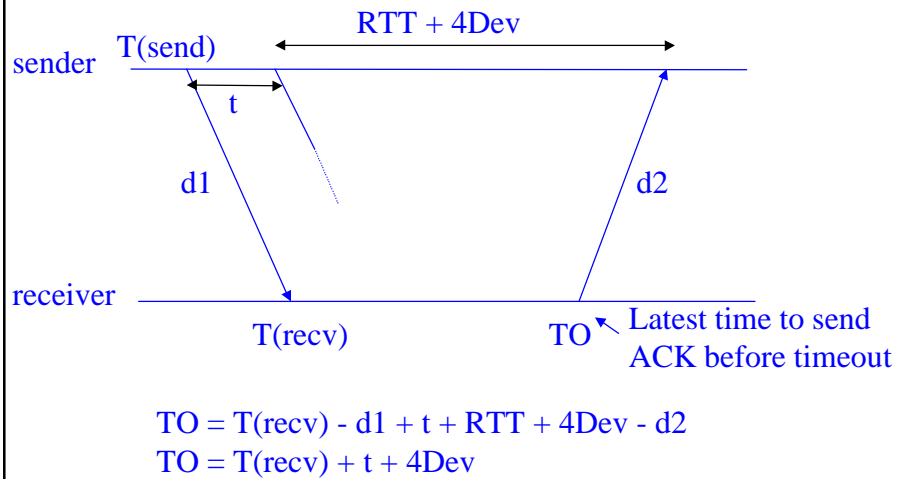
Detecting triple duplicate ACKs (TD) event



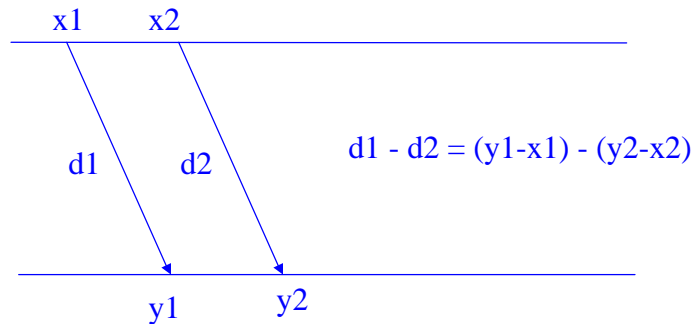
Packet Loss

- Gap in sequence numbers
 - $cwnd = cwnd / 2$
 - $ssthresh = cwnd$
 - don't change $cwnd$ for one RTT (ignore multiple packet losses)
 - after 1 RTT enter congestion avoidance

Timeout



Timeout



Calculate one-way-delay deviation using $(y_i - x_i)$ as samples

$$\text{RTTDev} = \text{sqrt}(2) * (\text{one-way-delay deviation})$$

Timeout

- $Ssthresh = cwnd / 2$
- $cwnd = 1$
- don't change cwnd for one RTT
- after 1 RTT enter slow start

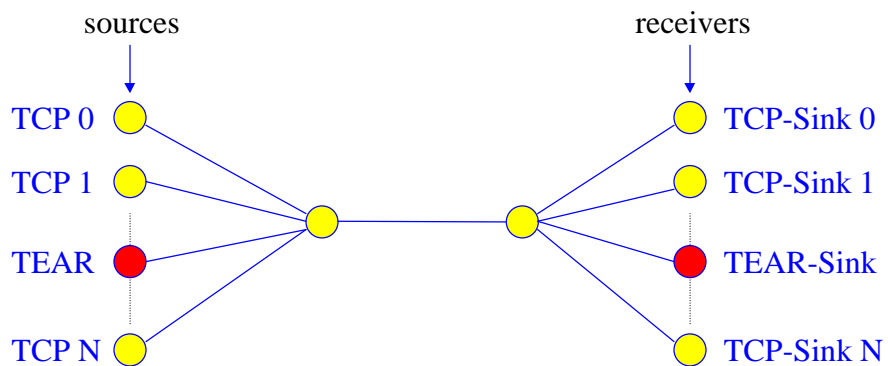
What does receiver do?

- Estimates available rate by $cwnd / RTT$
- Calculates average rate in some history
- Sends feedback to the sender

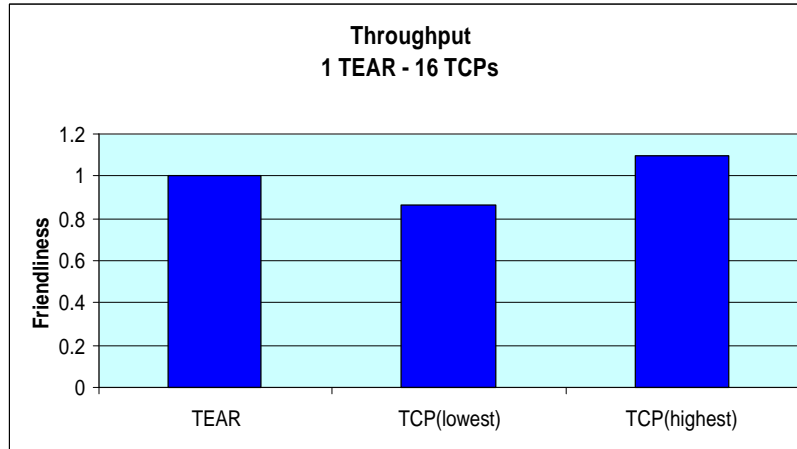
What does sender do?

- Finds $\min(\text{average rate})$, sets the sending rate to this value
- Sets the sending rate to the rate of the receiver with minimum average rate

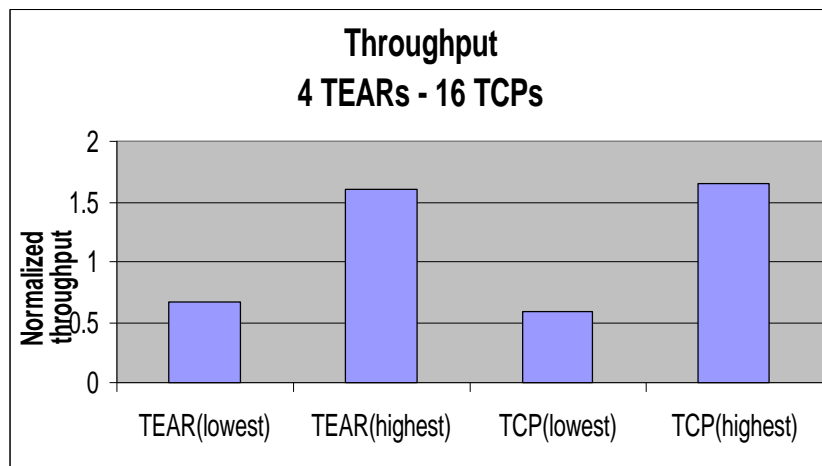
Simulations



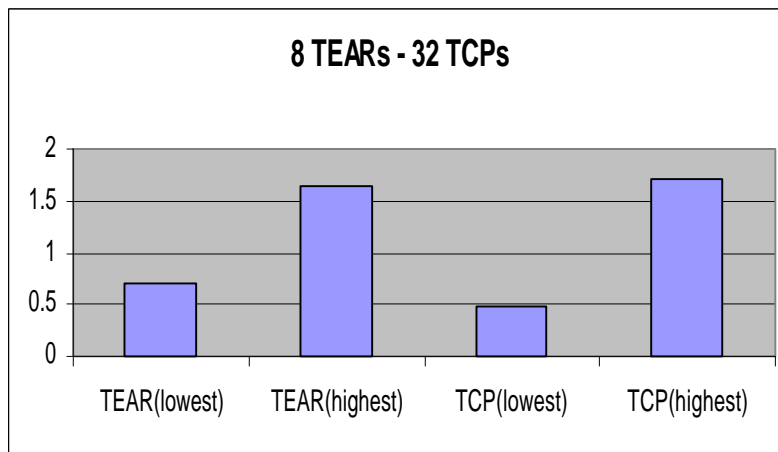
Simulations



Simulations

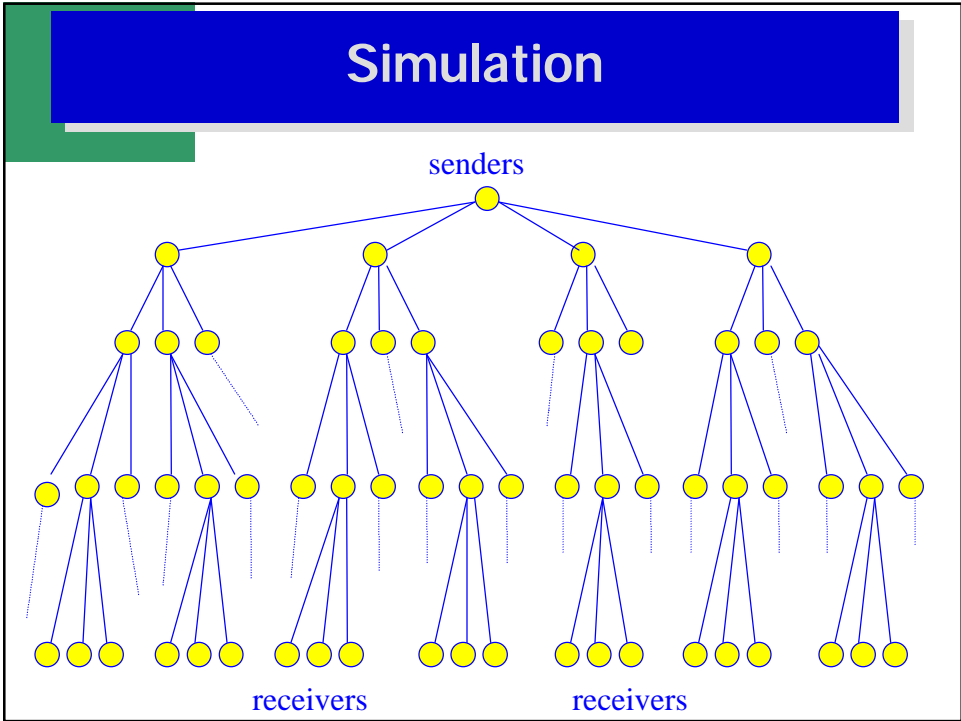


Simulations

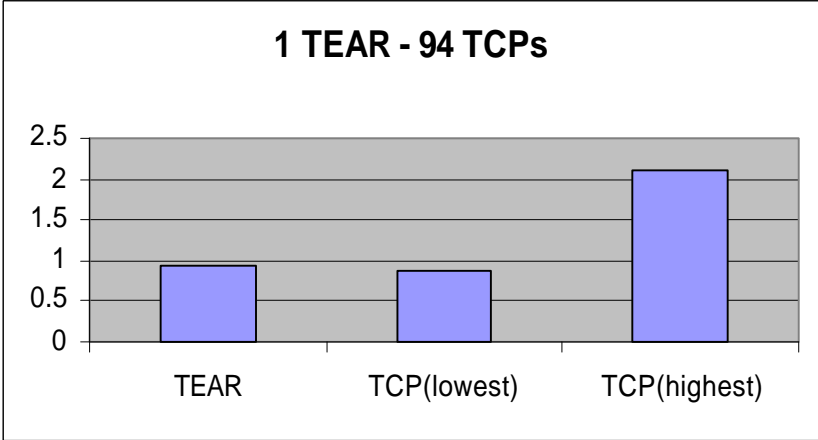


Simulations

Simulation



Simulations



Simulations

