

# TCP Congestion Control Mechanisms

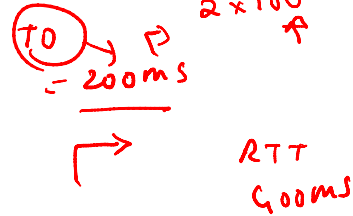
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Seminal Paper: Congestion Avoidance and Control  
by Van Jacobson and Michael J. Karels

# Conservation at Equilibrium

- Don't put a packet unless a packet is removed

- Particularly important when the network is congested



- Can potentially happen on timeouts → proper RTT estimation crucial

- Delayed packets should not be interpreted as lost

# RTT Estimation: Original Algorithm

- Measure SampleRTT for sequence/ack combo
- $\text{EstimatedRTT} = a * \text{EstimatedRTT} + (1 - a) * \text{SampleRTT}$ 
  - Small  $a$  heavily influenced by temporary fluctuations
  - Large  $a$  not quick to adapt to real changes
  - $a$  is between 0.8-0.9
- $\text{Timeout} = 2 * \text{EstimatedRTT}$ 
  - variability* ←

# Jacobson/Karels Algorithm

- Algorithm takes into account variance of RTTs
  - If variance is small, EstimatedRTT can be trusted
  - If variance is large, timeout should not depend heavily on EstimatedRTT

- $\text{Difference} = \text{SampleRTT} - \text{EstimatedRTT}$
- $\text{EstimatedRTT} = \text{EstimatedRTT} + (d * \text{Difference})$
- $\text{Deviation} = \text{Deviation} + d (|\text{Difference}| - \text{Deviation})$ , where  $d \sim 0.125$
- $\text{Timeout} = u * \text{EstimatedRTT} + q * \text{Deviation}$ , where  $u = 1$  and  $q = 4$  → 0 → dominate
- Exponential Timeout backoff: controls spacing between retransmits

