CSE/EE 461 – Lecture 15

Retransmission and Timers

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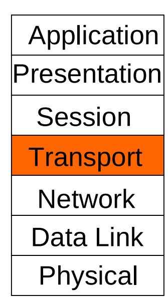
Last Time …

- More on the Transport Layer
- Focus
  - How do we manage connections?
- Topics
  - Three-Way Handshake
  - Close and TIME_WAIT

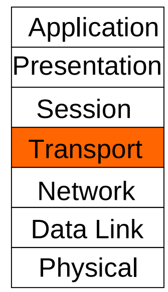


This Lecture

- More on the Transport Layer

- Focus
  - How do we decide <u>when to retransmit</u>?

- Topics
  - RTT estimation
  - Karn/Partridge algorithm
  - Jacobson/Karels algorithm



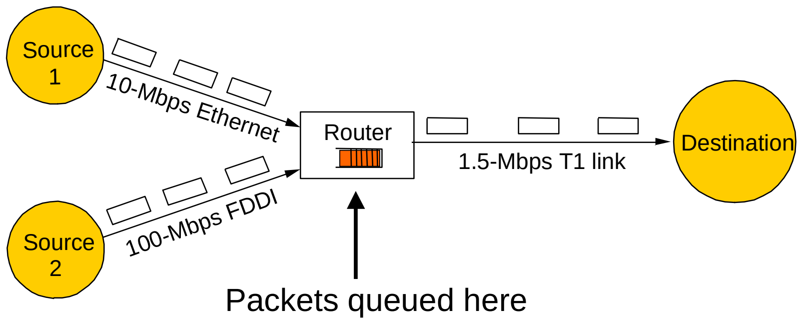
Deciding When to Retransmit

- How do you know when a packet has been lost?
  - Ultimately sender uses timers to decide when to retransmit

- But how long should the timer be?
  - Too long: inefficient (large delays, poor use of bandwidth)
  - Too short: may retransmit unnecessarily (causing extra traffic)
  - A good retransmission timer is important for good performance

- Right timer is based on the round trip time (RTT)
  - Which varies greatly in the wide area (path length and queuing)

A Simple Network Model



- Buffers at routers used to absorb bursts when input rate > output
- Loss (drops) occur when sending rate is persistently > drain rate

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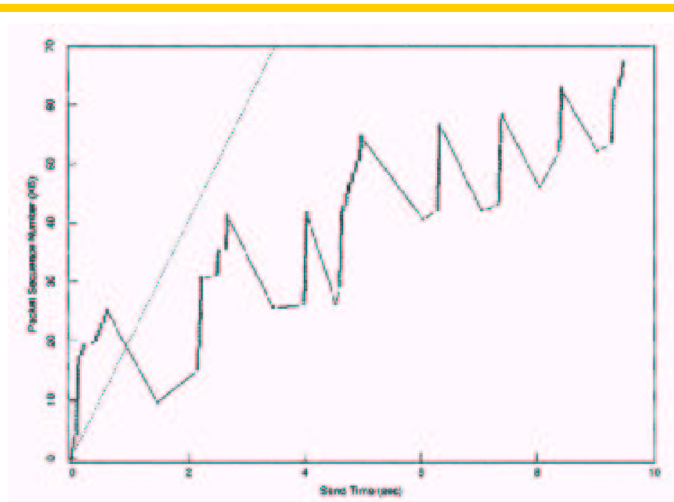
Effects of Early Retransmissions



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Congestion Collapse

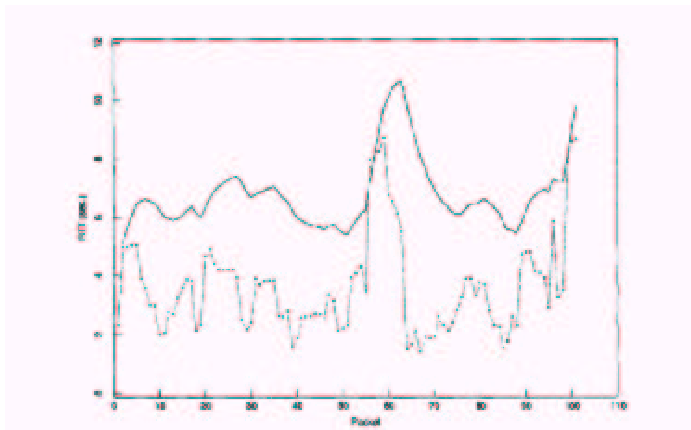
- In the limit, early retransmissions lead to congestion collapse
  - Sending more packets into the network when it is overloaded exacerbates the problem of congestion
  - Network stays busy but very little useful work is being done
- This happened in real life ~1987
  - Led to Van Jacobson's TCP algorithms, which form the basis of congestion control in the Internet today

  [See "Congestion Avoidance and Control", SIGCOMM'88]

Estimating RTTs

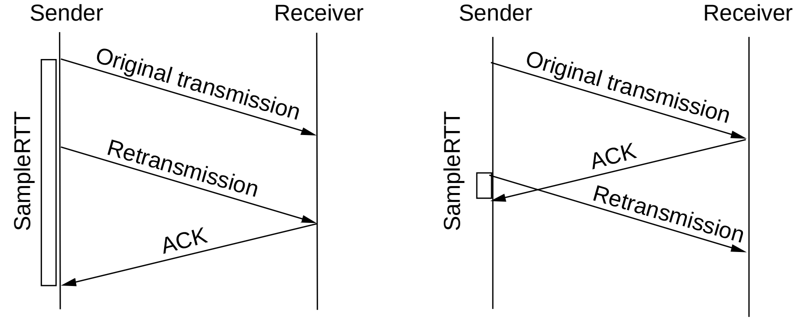
- Idea: Adapt based on recent past measurements
- Simple algorithm:
  - For each packet, note time sent and time ack received
  - Compute RTT samples and average recent samples for timeout
  - EstimatedRTT = α x EstimatedRTT + (1 - α) x SampleRTT
  - This is an exponentially-weighted moving average (low pass filter) that smoothes the samples. Typically, α = 0.8 to 0.9.
  - Set timeout to small multiple (2) of the estimate

Estimated Retransmit Timer



Karn/Partridge Algorithm

- Problem: RTT for retransmitted packets ambiguous

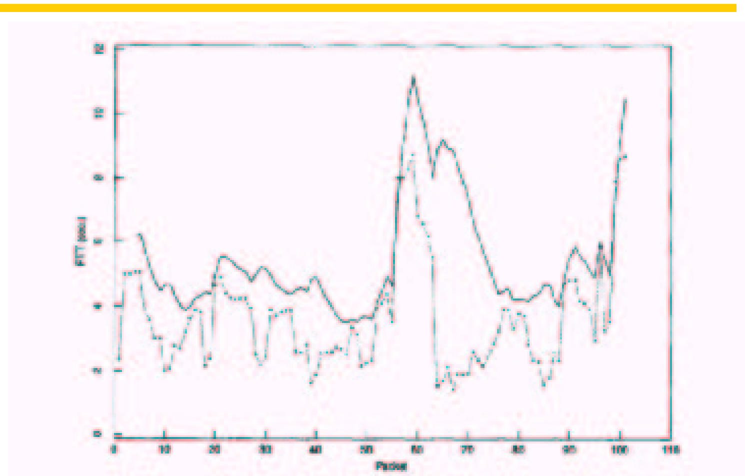


- Solution: Don’t measure RTT for retransmitted packets and do not relax backed of timeout until valid RTT measurements

Jacobson/Karels Algorithm

- Problem:
  - Variance in RTTs gets large as network gets loaded
  - So an average RTT isn't a good predictor when we need it most
- Solution: Track variance too.
  - Difference = SampleRTT – EstimatedRTT
  - EstimatedRTT = EstimatedRTT + (δ x Difference)
  - Deviation = Deviation + δ(| Difference | - Deviation)
  - Timeout = μ x EstimatedRTT + ϕ x Deviation
  - In practice, $\delta = 1/8$, $\mu = 1$ and $\phi = 4$

Estimate with Mean + Variance



Key Concepts

- A good retransmit timer is important for good performance
  - Too long leads to poor performance
  - Too short leads to wasted bandwidth
- An estimated timeout must adapt to Internet queuing
  - High variance at high load