Throughput of Stop-and-wait

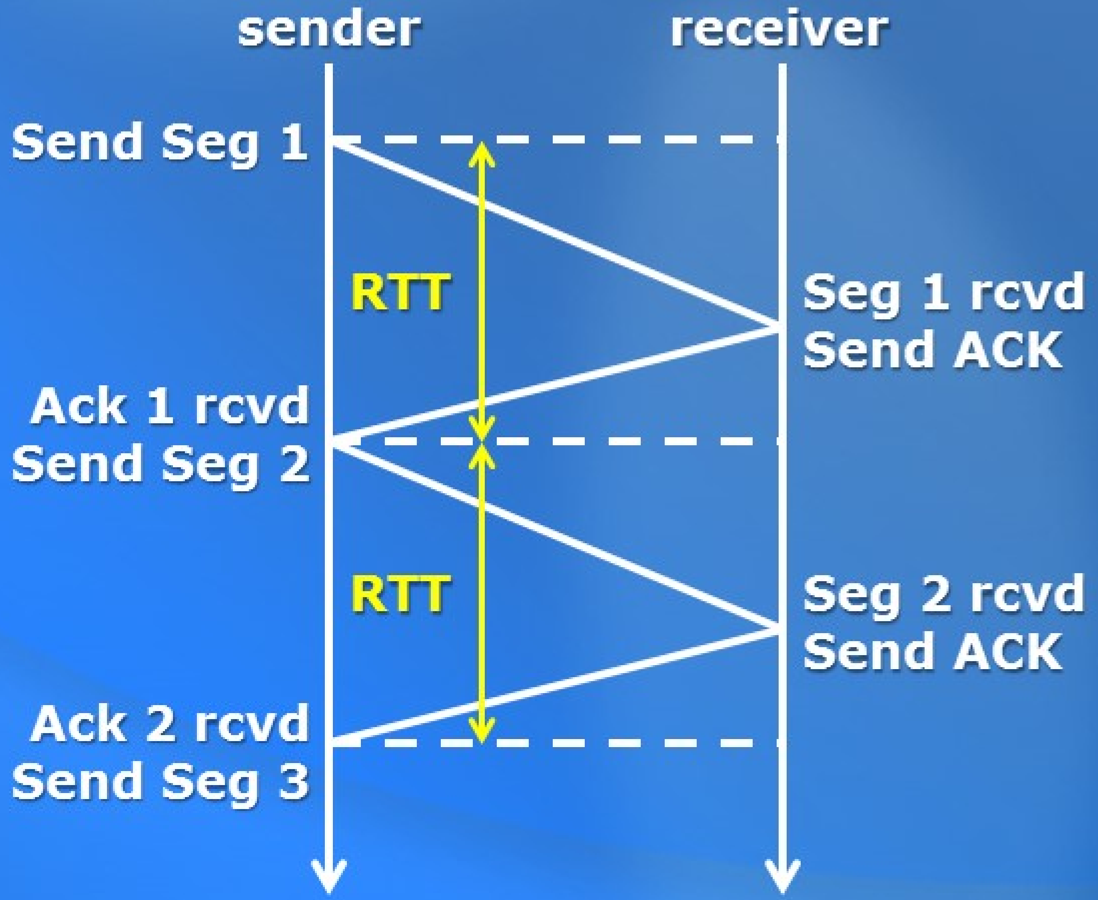
Throughput

- We measure throughput of the transport layer in terms of segments (packets) per unit time (e.g. second).
- We estimate throughput as the reciprocal of T, the expected time between sending a packet and getting its ACK.

$$\text{Throughput} = \frac{1}{T}$$

- We consider only the effect of packet loss.
- We assume
  - No variability in the time to deliver a packet
  - Time to transmit a packet is negligible.

Throughput (no losses)

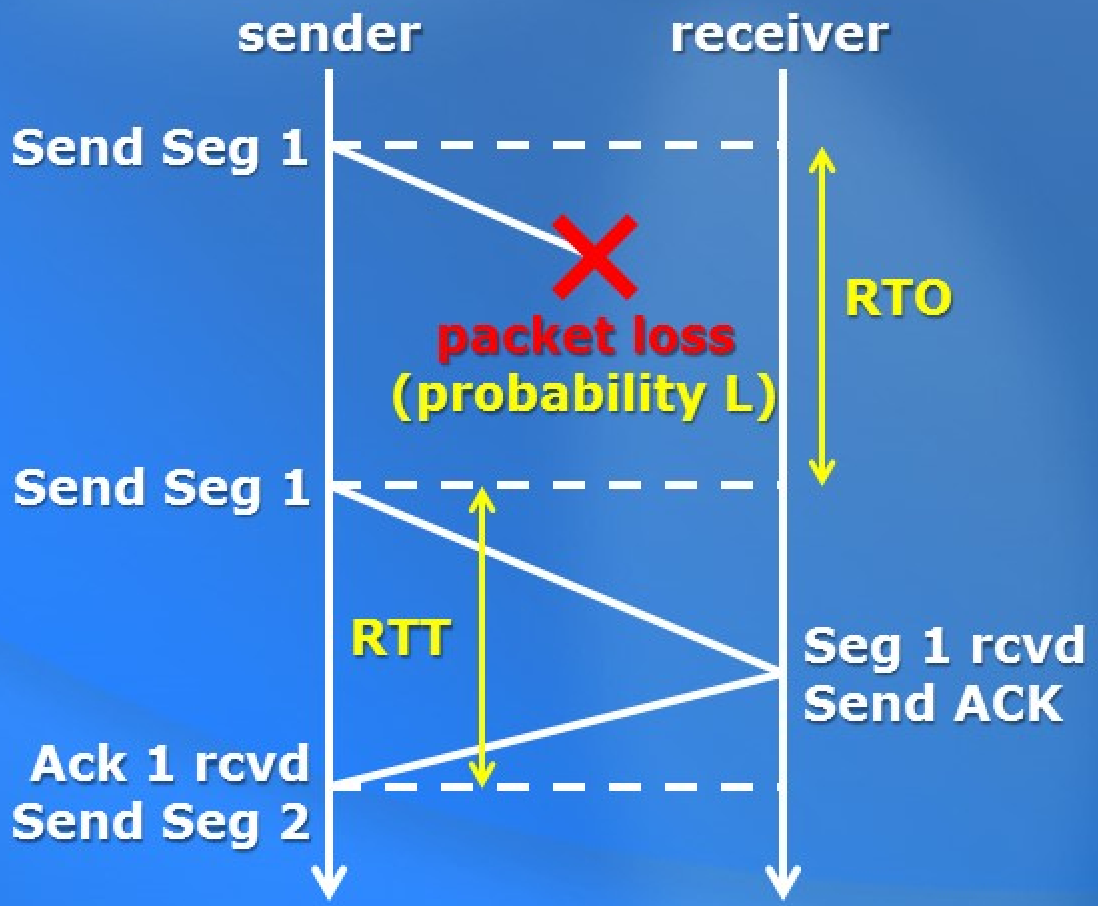


$$T = RTT$$

$$\text{Throughput} = \frac{1}{T} = \frac{1}{RTT}$$

RTT = Round-trip time

Throughput (losses)



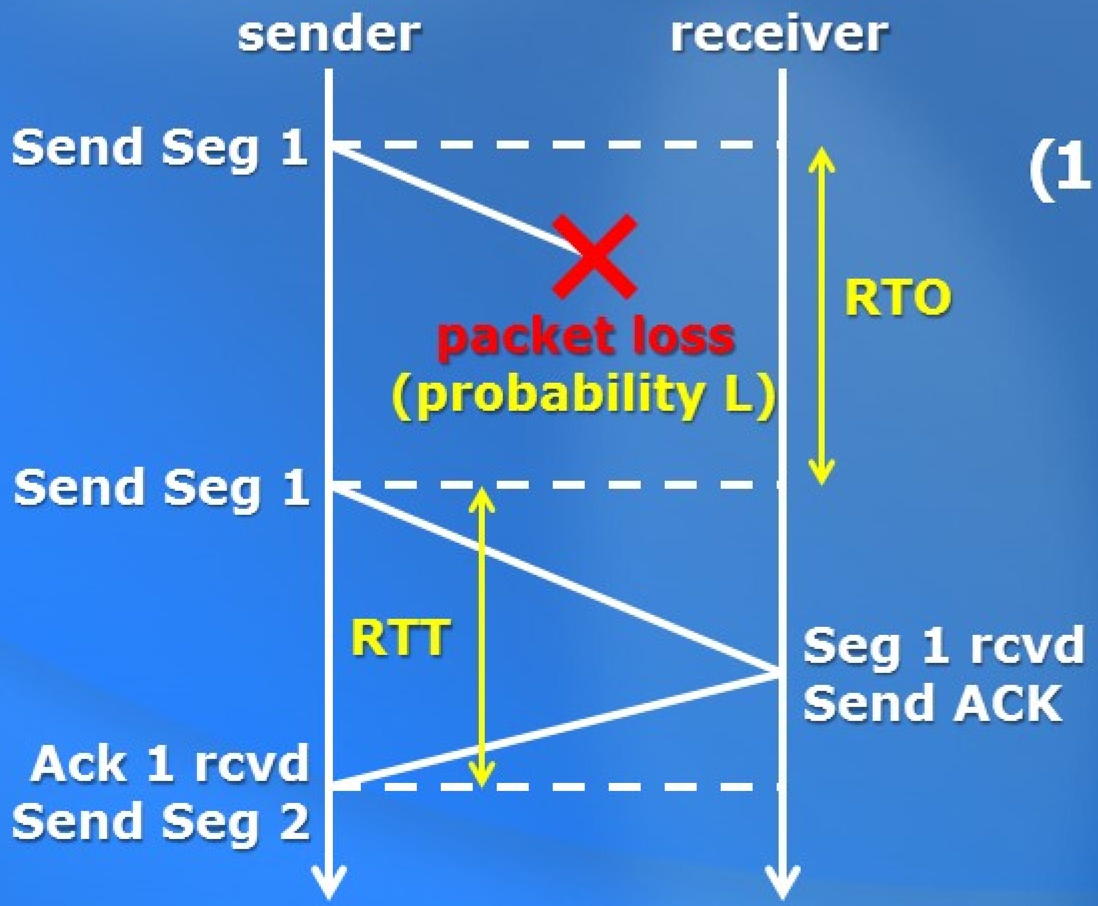
$$T = \underbrace{(1 - L)}_{\text{probability of no packet loss}} \cdot RTT + \underbrace{L}_{\text{probability of packet loss}} \cdot (RTO + T)$$

RTT = Round-Trip Time

RTO = Retransmission Time Out

L = round-trip segment Loss probability

Throughput (losses)



$$T = (1 - L) \cdot RTT + L \cdot (RTO + T)$$

$$(1 - L) \cdot T = (1 - L) \cdot RTT + L \cdot RTO$$

$$T = RTT + \frac{L}{1 - L} \cdot RTO$$

RTT = Round-Trip Time

RTO = Retransmission Time Out

L = round-trip segment Loss probability

Choosing RTO

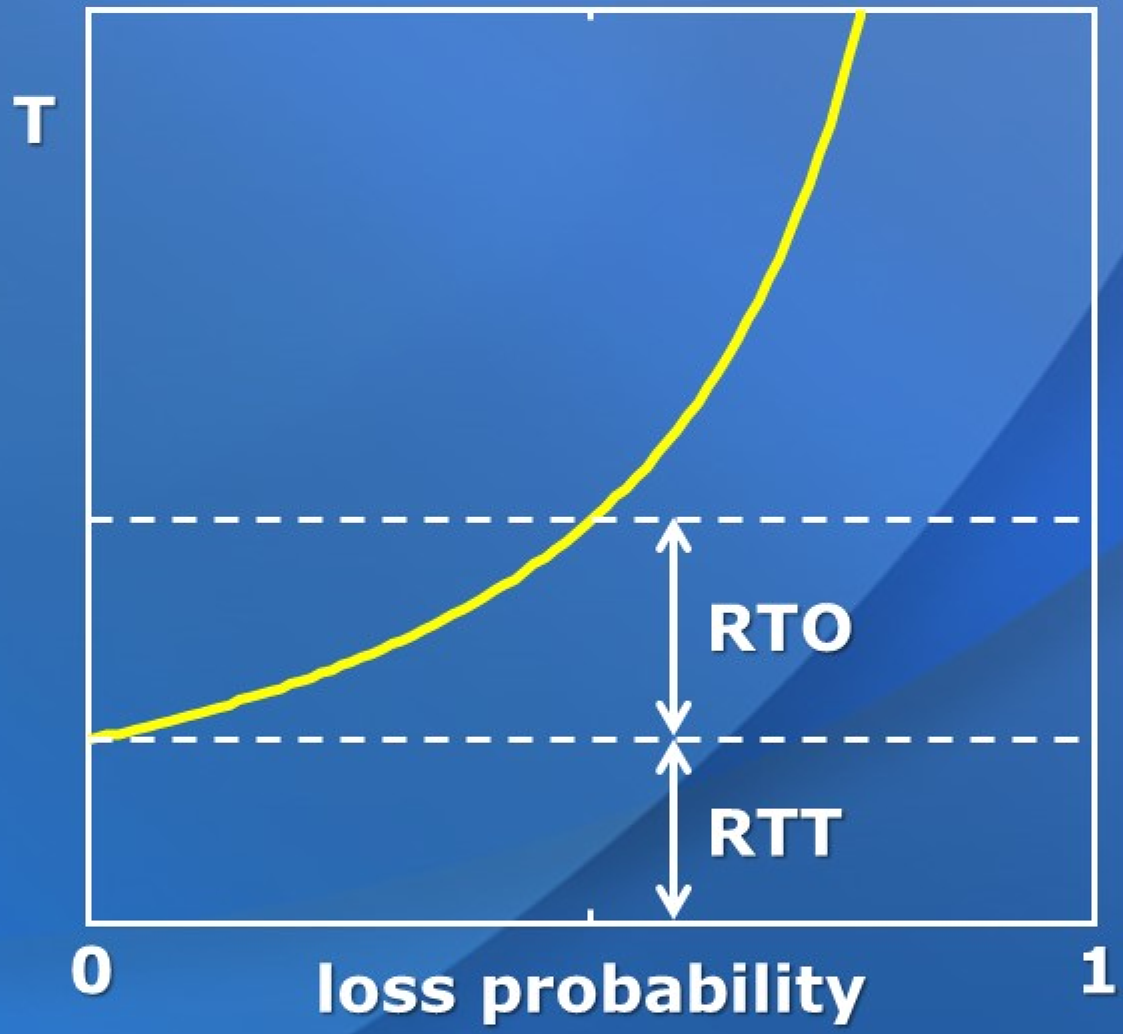
Choose

RTO > RTT

to avoid unnecessary retransmission.

If RTT is random, choose RTO so probability of unnecessary retransmission is low.

Requires estimation of the statistics of RTT.



Best Case Throughput

If RTT is constant, we should choose RTO just slightly larger than RTT.

$$\begin{aligned} T &= RTT + \frac{L}{1-L} \cdot RTO \\ &= \frac{1-L}{1-L} \cdot RTT + \frac{L}{1-L} \cdot RTT \\ &= \frac{RTT}{1-L} \end{aligned}$$

$$\text{Best case throughput} = \frac{1-L}{RTT}$$

Using Stop-and-wait

Advantage of stop-and-wait: simplicity!

Use when

- when throughput isn’t a concern, but good reliability important
- when the network path has a small RTT (i.e. on order of the segment transmission time)