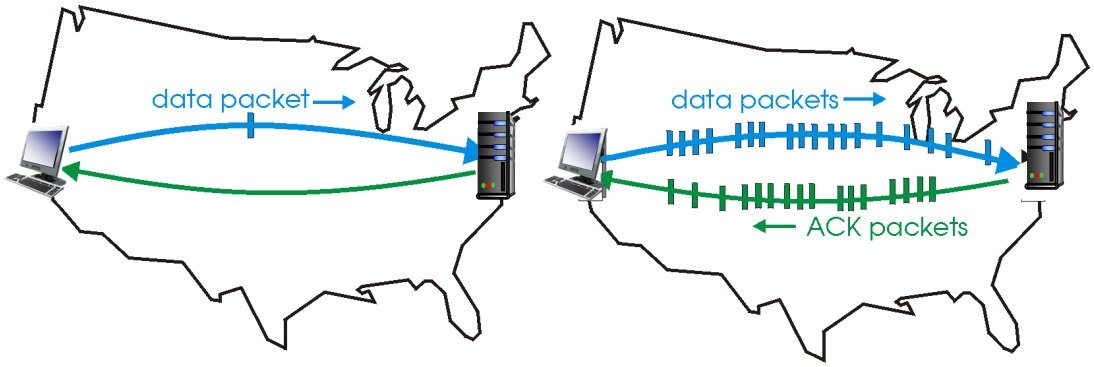
Pipelined rdt

- pipelining: sender allows multiple, “in-flight”, yet-to-be-acknowledged packets
  - range of sequence numbers must be increased
  - buffering at sender and/or receiver



(a) a stop-and-wait protocol in operation (b) a pipelined protocol in operation

Pipelining can improve utilization

- example: 1Gbps link, 15ms propagation delay, 8000-bit packet

$$U_{\text{sender}} = \frac{3 \cdot \frac{L}{R}}{\frac{L}{R} + RTT} = \frac{3 \cdot 0.008}{30.008} = 0.00081$$

  - 3-packet pipelining improves utilization by a factor of 3.