TCP Congestion Control

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TCP Congestion Control

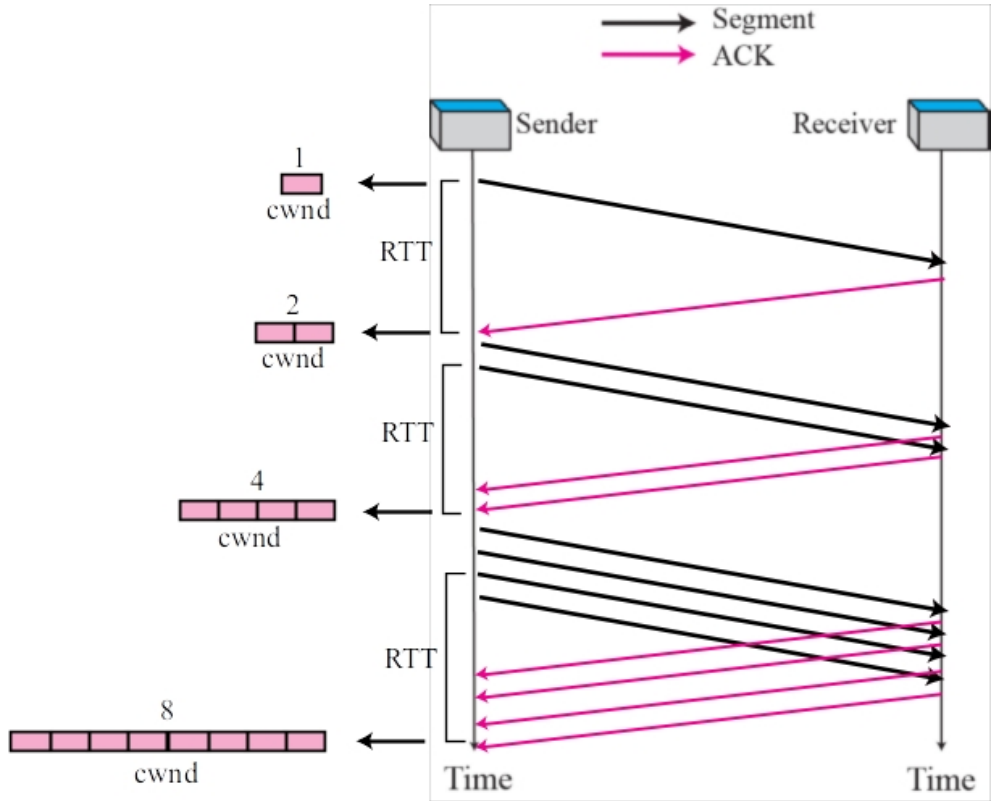
- TCP uses a congestion window and a congestion policy
- TCP flow control
  - Sender window size is determined by the available buffer space in the receiver (`rwnd`)
- Underlying network's ability to deliver packets also influences sender window size
- Sender has two pieces of information: the receiver-advertised window size and the congestion window size
- `Actual window size = minimum (rwnd, cwnd)`

Congestion Policy

- Based on three phases: `slow start, congestion avoidance, congestion detection`

Slow Start: Exponential Increase

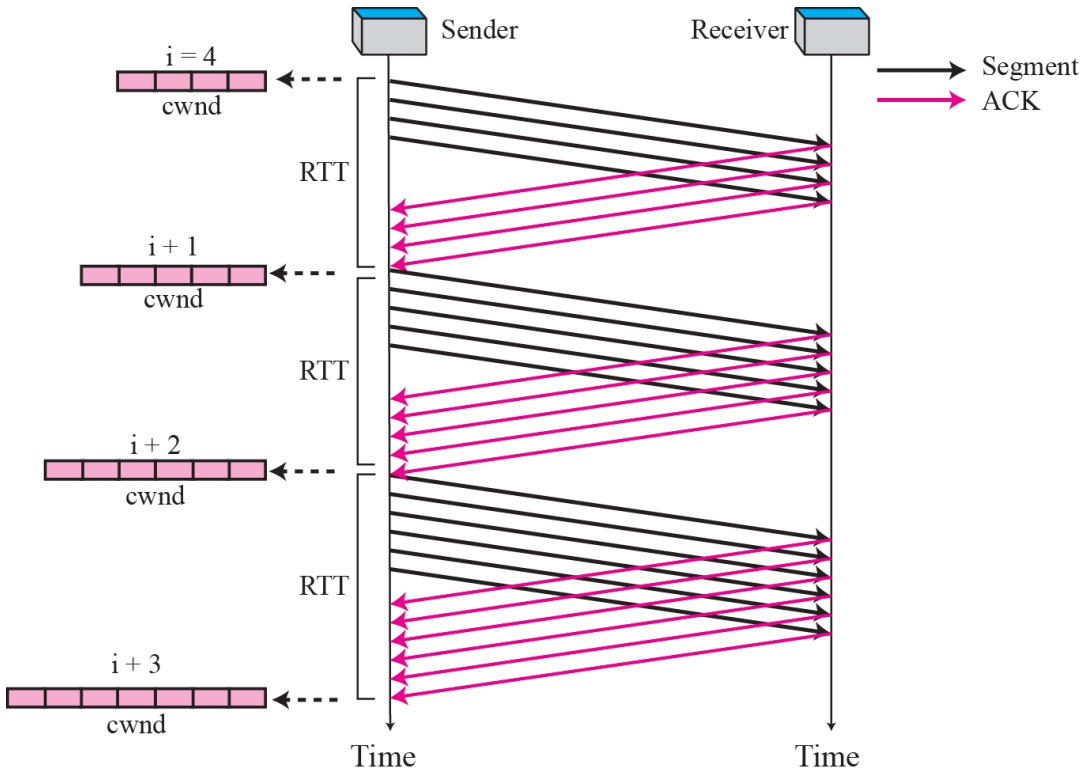
- Size of `cwnd` starts with one maximum segment size (MSS)
  - MSS is determined during connection establishment
- Size of `cwnd` increases one MSS each time one acknowledgement arrives
- The algorithm starts slowly, but grows exponentially
- Assumption:
  - `rwnd` is much longer than `cwnd`
  - Each segment is acknowledged individually



- Slower in the case of delayed acknowledgments
- Size of `cwnd` increases exponentially until it reaches the slow start threshold `ssthresh`

Congestion Avoidance: Additive Increase

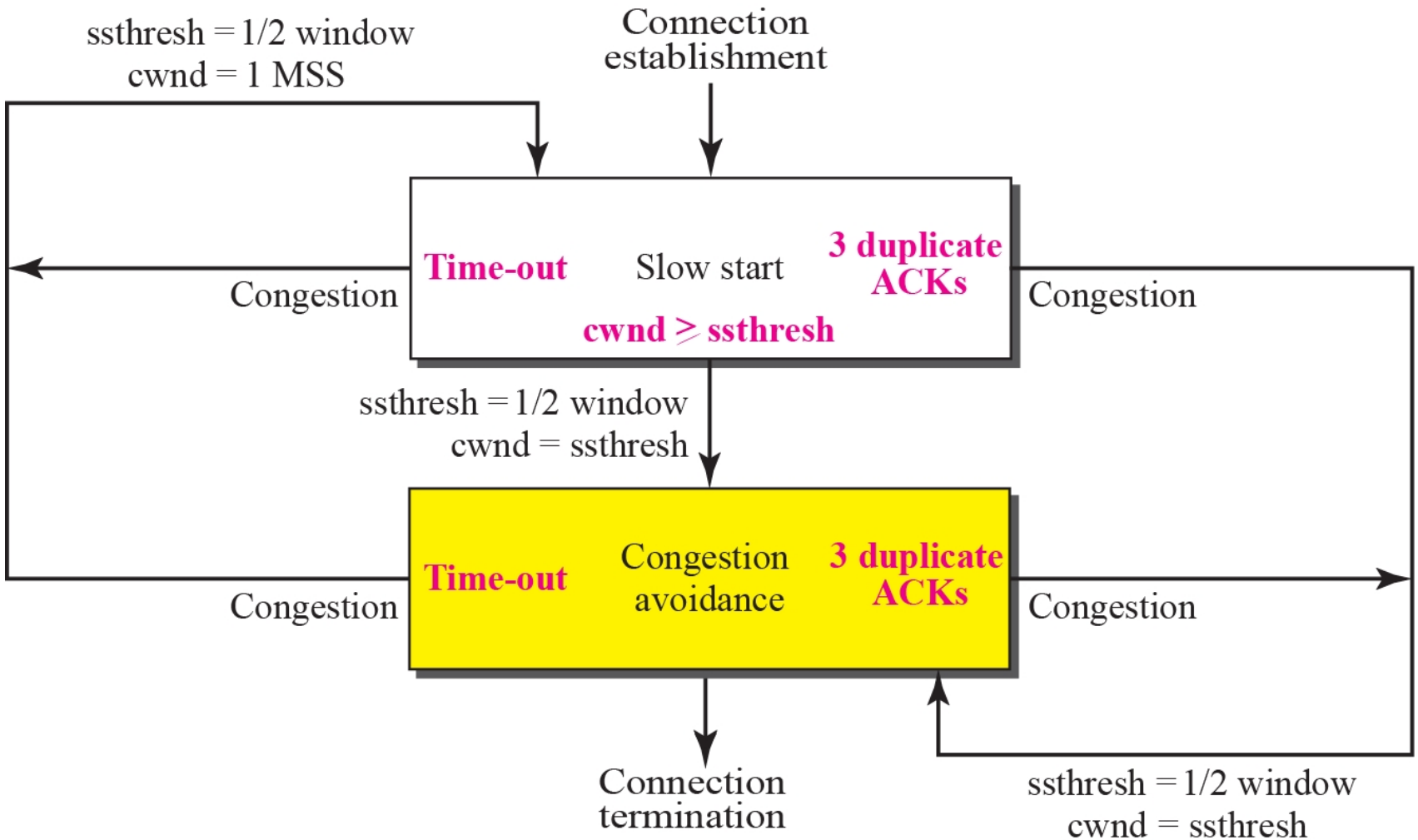
- Increases the `cwnd` additively instead of exponentially
- Each time the whole "window" of segments is acknowledged, the size of the congestion window is increased by one



Congestion Detection: Multiplicative Decrease

- Indicator of congestion: need to retransmit a segment
- Retransmission occurs when
  - The RTO timer times out
  - Three duplicate ACKs are received
- If time out occurs - stronger possibility of congestion
  - It sets the value of the threshold to half of the current window size
  - It reduces cwnd back to one segment
  - It starts the slow start phase again
- If three duplicate ACKs are received - weaker possibility of congestion
  - It sets the value of the threshold to half of the current window size
  - It sets cwnd to the value of the threshold (some implementations add three segment sizes to the threshold)
  - It starts the congestion avoidance phase

TCP Congestion Policy Summary



Congestion Example