Lecture-21
SDC

classmate
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Page

Congestion control in TCP

Congestion Window:

Sender window size = min(rwnd, cwnd)

where, rwnd = receiver-advertised window size
cwnd = congestion window size

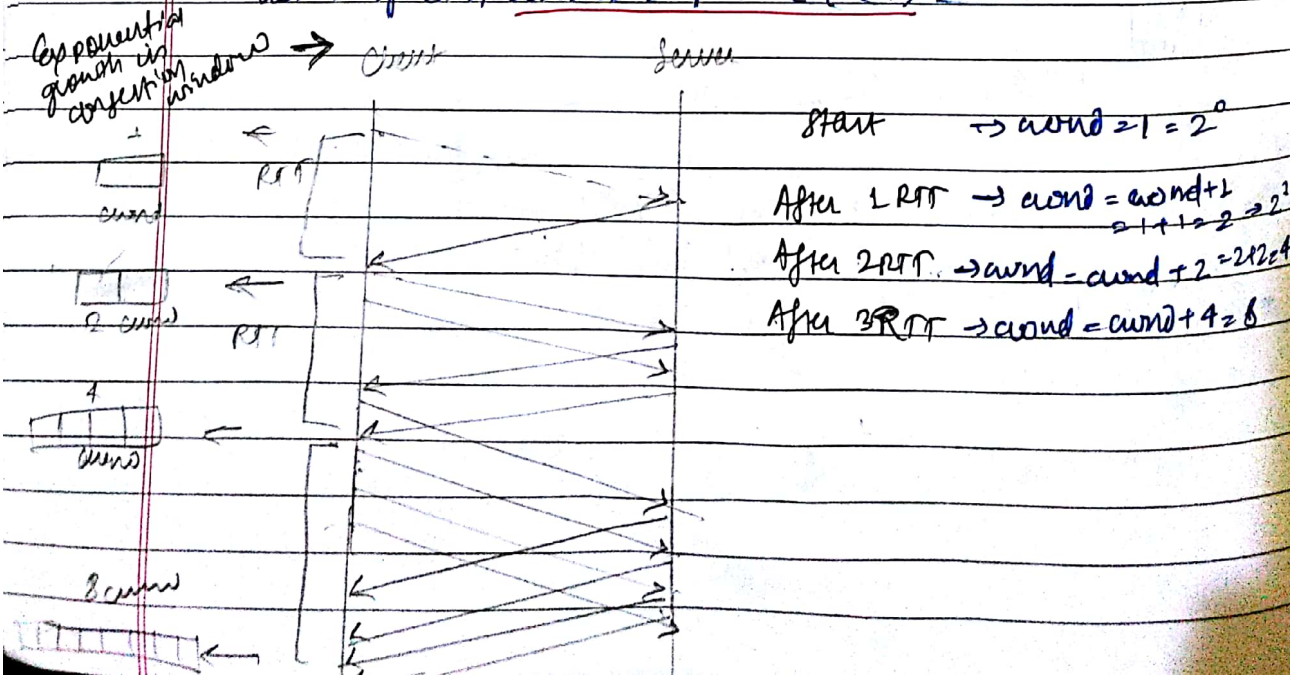
Congestion Policy:

TCP policy for congestion handling:

- Slow start, exponential increase
  - slow start threshold (ssthresh)
- Congestion avoidance, additive increase
- Congestion detection, multiplicative decrease

Basic algorithm of the TCP slow start

- In the slow start algo, size of congestion window (cwnd) starts with one maximum segment size (MSS).
- Size of the congestion window increases exponentially until it reaches a threshold.
- Growth rate of congestion window is exponential in terms of each round trip time (RTT).



Start → cwnd = 1 = 2^0

After 1 RTT → cwnd = cwnd + 1 = 1 + 1 = 2 = 2^1

After 2 RTT → cwnd = cwnd + 2 = 2 + 2 = 4

After 3 RTT → cwnd = cwnd + 4 = 8

TCP congestion avoidance

- Congestion avoidance uses a linear growth function (additive increase).
- Once slow start threshold (ssthresh) is reached, cwnd is increased by at most on segment per RTT.
- Cwnd window continues to open with this linear rate until a congestion event is detected.
- When congestion is detected (through timeout and/or duplicate Acks), ssthresh is set to half the cwnd.
- Once congestion detection, data rate is reduced in order to let the network recover.

Congestion avoidance → Additive increase in window size

cwnd = cwnd + 1

cwnd = cwnd + 2

⋮

Congestion detection → Multiplicative decrease

$$cwnd = cwnd + \frac{1}{cwnd}$$

when Ack arrives (congestion avoidance)

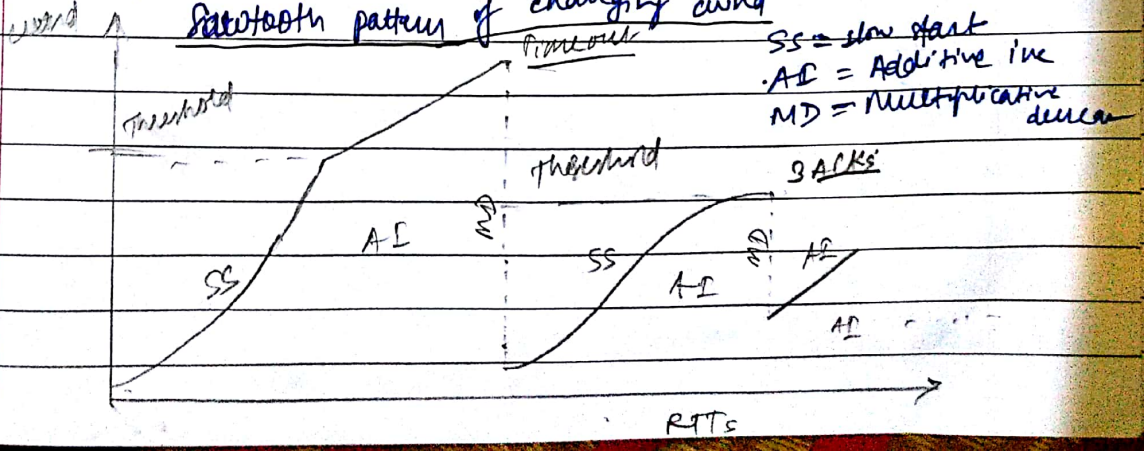
$$cwnd = \frac{cwnd}{2}$$

← TCP congestion window is

→ In a long TCP connection ignore slow start states and short exponential growth during fast recovery, the

- If detection is by timeout, a new slow start phase starts
- If detection is by 3 Acks, a new congestion avoidance phase starts.

Sawtooth pattern of changing cwnd



TCP congestion policy summary