TCP congestion control algorithm

→ detecting congestion

pkt loss is the indicator of congestion

→ timeout

→ 3 dupACKs

two phases

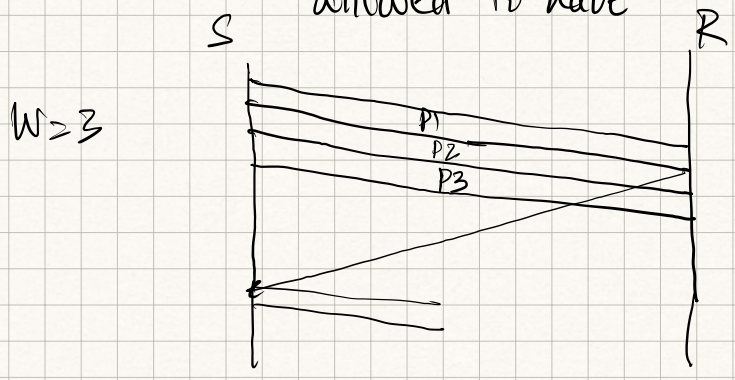
→ (a) how to decrease the rate at which pkts are being transmitted when congestion is detected?

(b) How to increase the rate at which pkts will be transmitted afterwards

Rate of pkt transmission

- Windowed protocol (pipelined protocol)

W is the number of unacknowledged pkts/segments that the sender is allowed to have



$$\text{Rate of pkt transmission} = \frac{W}{RTT + t_{trans}} \text{ pkt/sec}$$

t_{trans}: transmission of a pkt

$RTT\ (\sim ms) >> t_{trans}\ (\sim \mu s)$

Given an RTT the rate is determined by the window size W

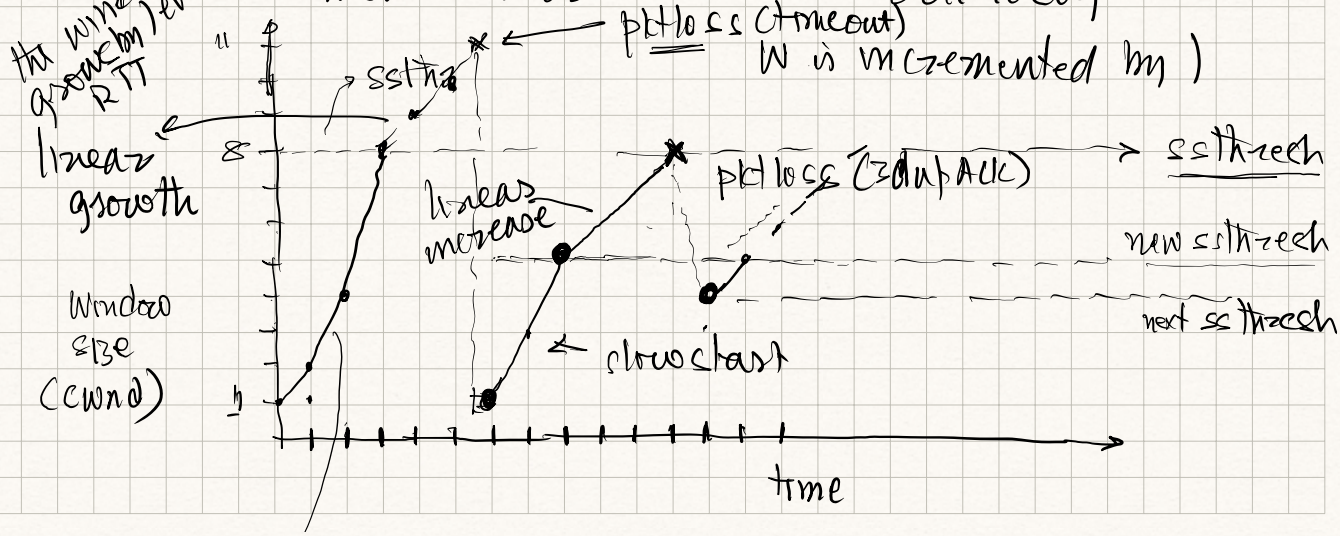
$W \downarrow \rightarrow$ Rate $\downarrow$

$W \uparrow \rightarrow$ Rate $\uparrow$

AIMD: Additive Increase and Multiplicative Decrease

On detecting congestion reduce the rate multiplicatively W is halved

Then increase the rate additively



RTT is constant

Slow start phase
the window grows exponentially
(doubles every RTT)

ssthresh : slow start threshold
the window size upto which the slow start is applied

Two cases

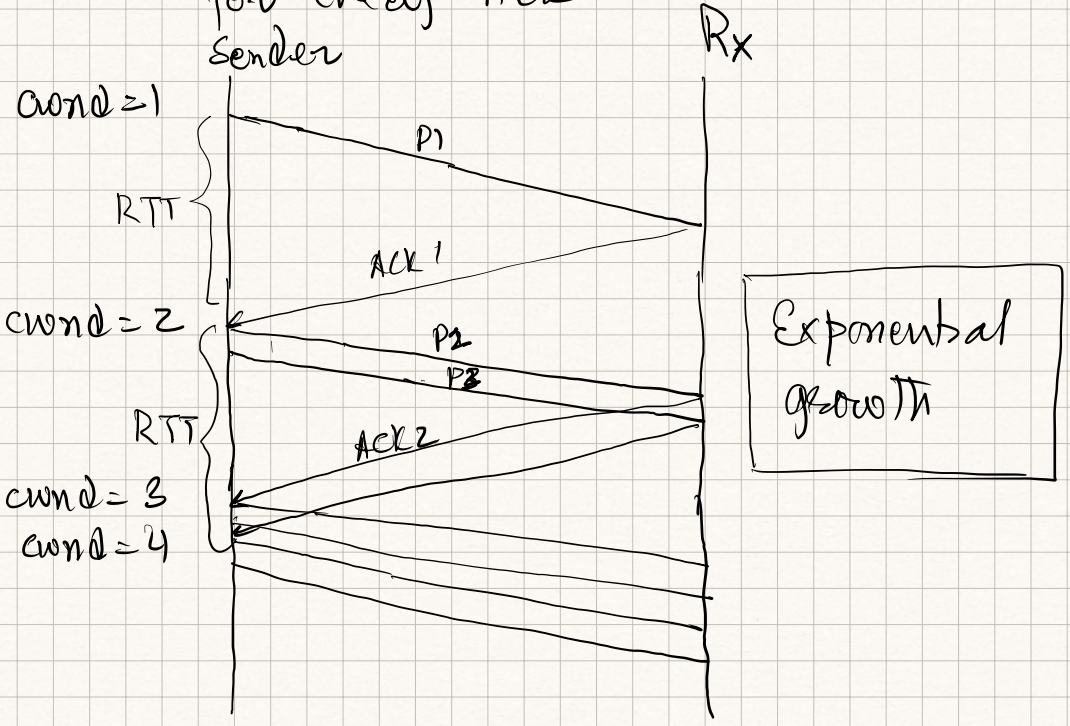
① If pkt loss is detected by Timeout
ssthresh ← $\frac{1}{2}$ cwnd
cwnd ← 1
slow start → followed by additive increase

② If pkt loss is detected by 3dupACKs
ssthresh ← $\frac{1}{2}$ cwnd
cwnd ← ssthresh
Additive increase

- While what is shown is "plotted" with RTT in reality it is ACK driven

Slow Start Algorithm

The window size in increased by 1 for every ACK



Linear Growth : Congestion Avoidance phase

→ probing

→ slowly increasing to get more bandwidth

↓

This is opposed to if you increased multiplicatively (exponentially) which is too aggressive

AI
Additive increase

→ Congestion window size (cwnd) W is increased by $\frac{1}{W}$ for every ACK

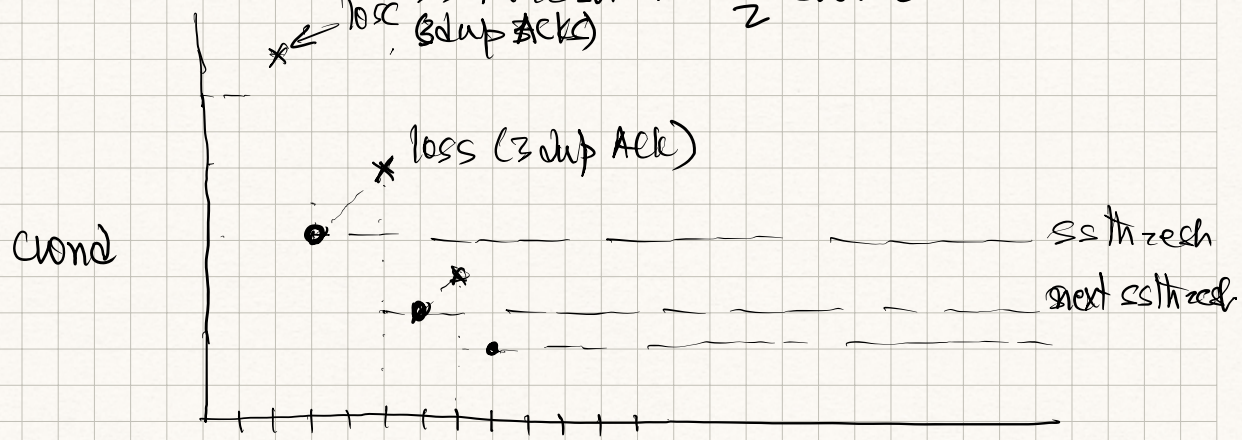
⇒ this yields linear growth

What is the Multiplicative Decrease (MD)?

→ decreasing the ssthresh by ½ on detecting congestion

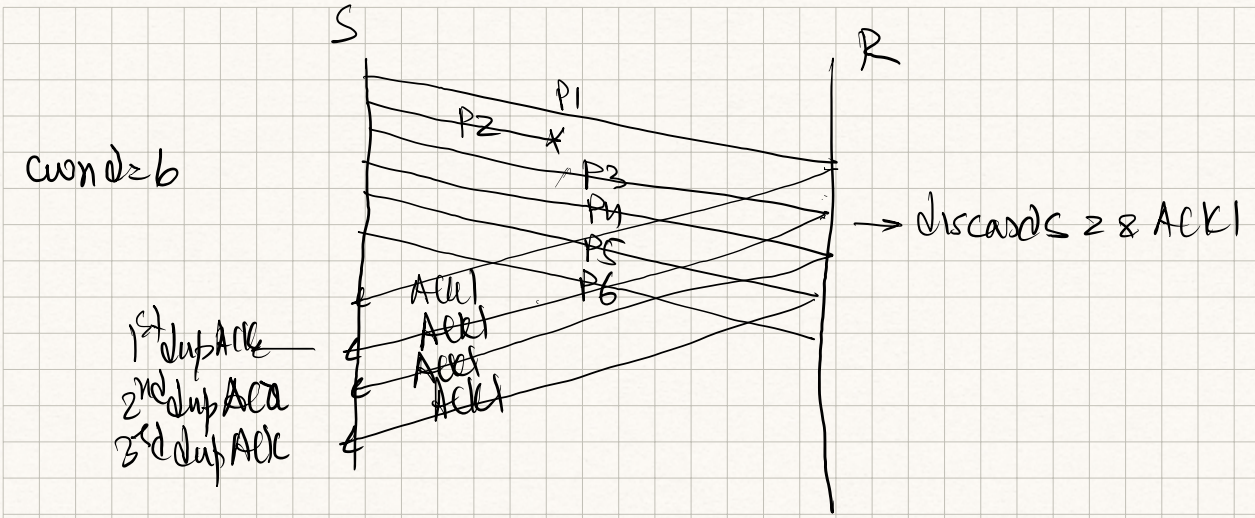
→ On detecting congestion

ssthresh ← ½ cwnd



decreasing ssthresh to ½ cwnd is decreasing the rate of packets into the network multiplicatively

Why the difference between timeout & 3dupACKs?



Timeout → heavy congestion

3 Dup Ack → yes there is congestion
but pkts are being delivered

What is really difference between doing slow start & not doing slow start ?

→ In slow start the cwnd increases exponentially
→ fast growth