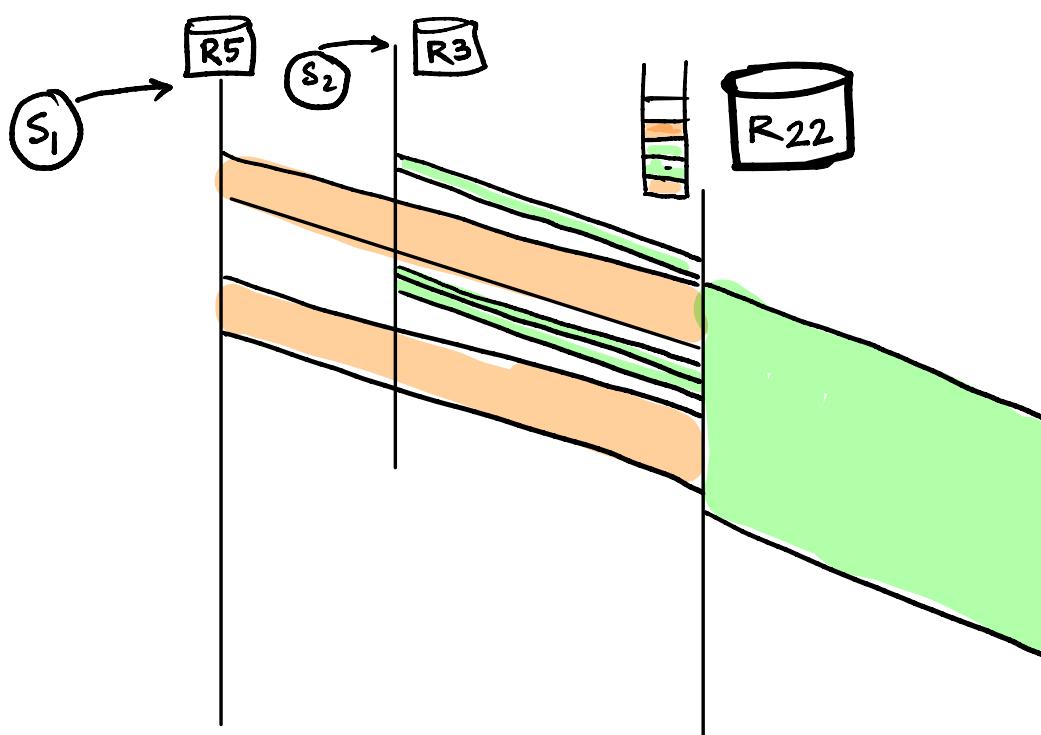
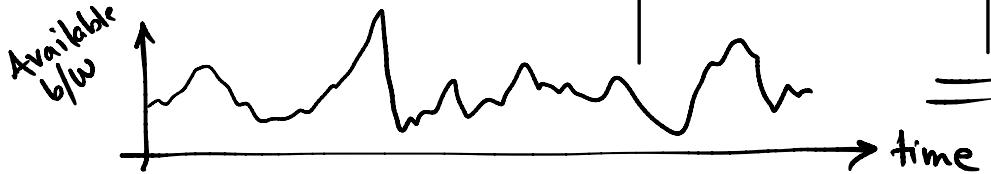


Lecture 13

- Fixed N → time varying N → $f(\text{measured RTT})$ ↗
fill available b/w
- TCP intuition → chemical factory
- TCP protocol
 - ↳ Best of GBN + SACK
 - ↳ Connection set-up / teardown
 - ↳ 3 way handshake
- Congestion window adaptation (N)
 - ↳ Slow start
 - ↳ Cong. avoidance
- Recovery from errors
 - Lost ACK
 - Out of order or delayed Ack
 - Packet loss (AIMD)

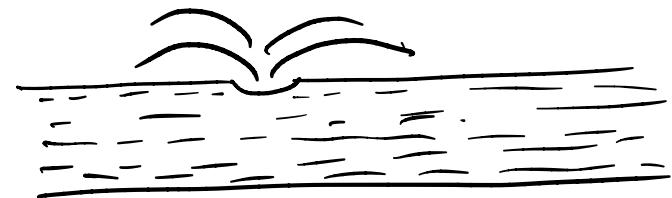


Available b/w constantly changing. \Rightarrow N must be time varying.



How can I pick the correct window size N to keep the available/bottleneck router always occupied.

Rational thing to do is $N = f(RTT)$



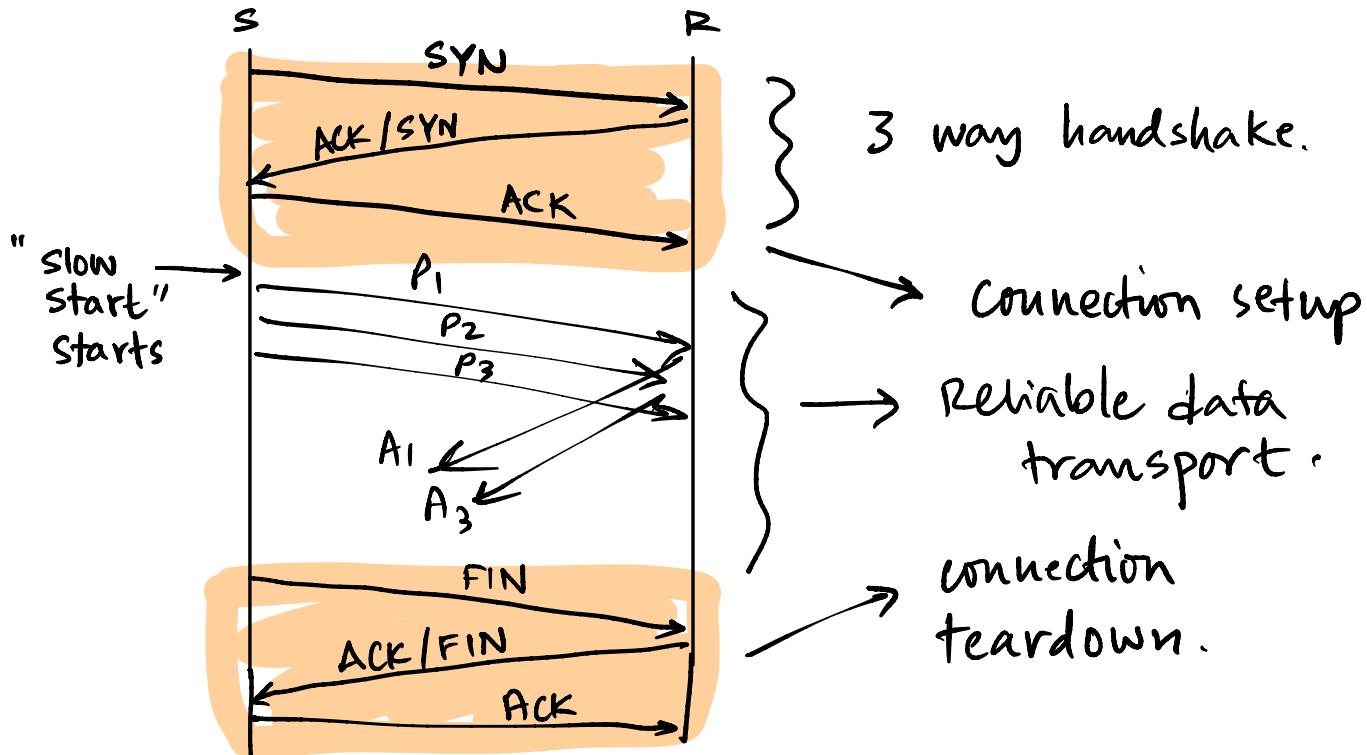
TCP Protocol :

Combines best of GBN and SACK

↓
Cumulative ACK

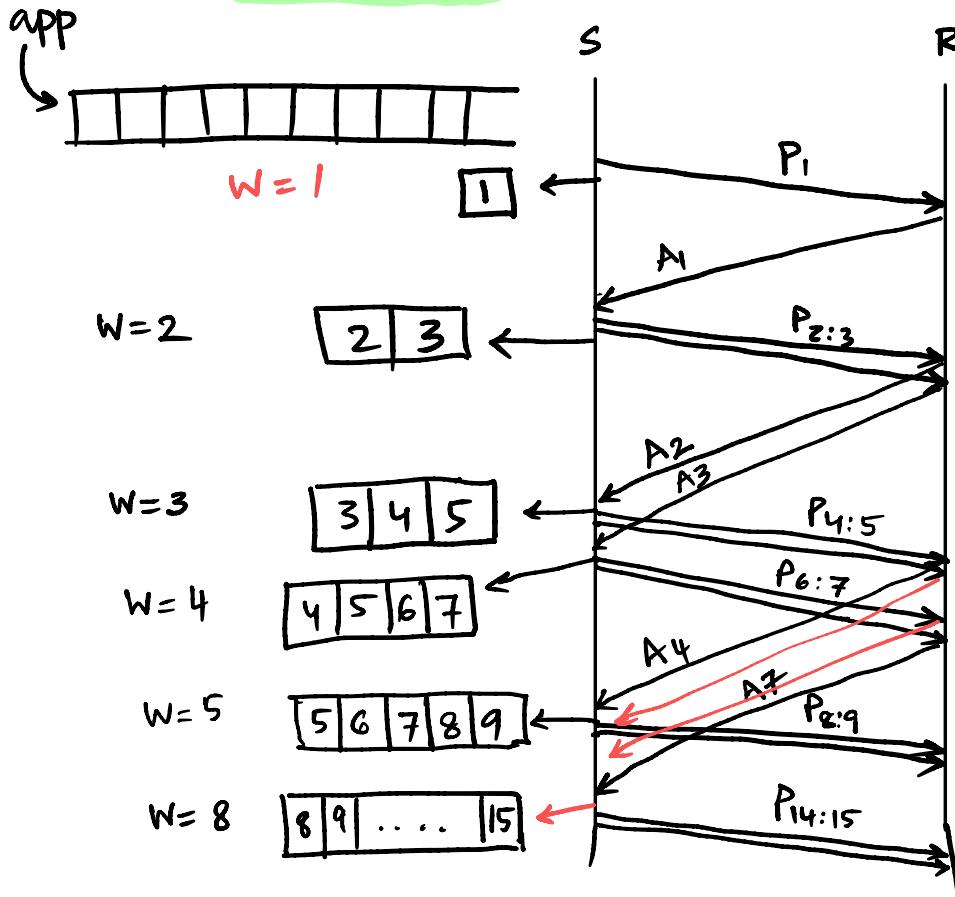
and ³ Receiver buffering.

- ② 3 way handshake.



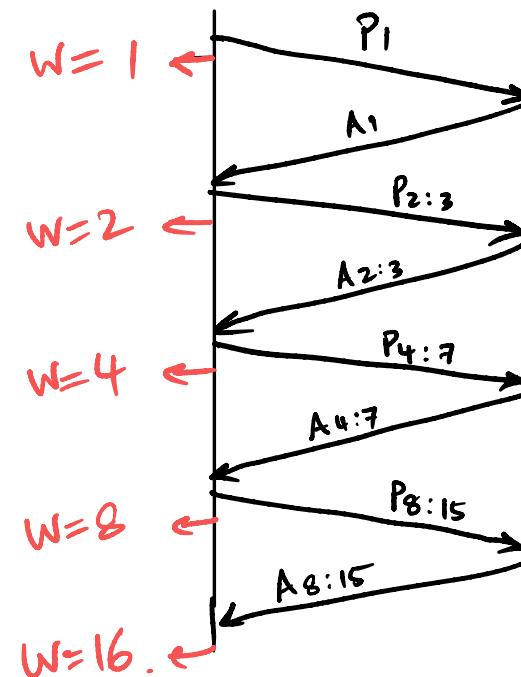
Congestion Window (cw) adaptation

Slow Start

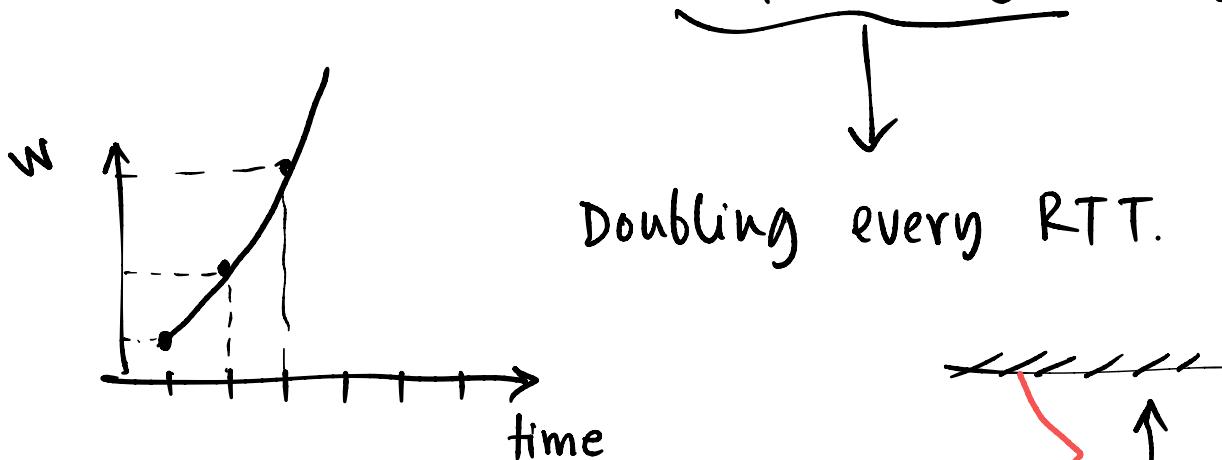


window = congestion window (W)

$CW = CW + 1$ for every new ACK

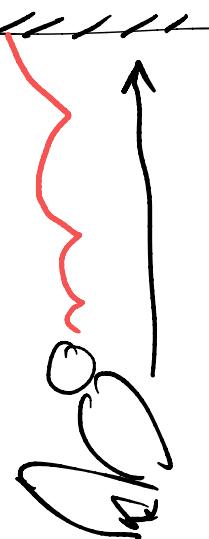


w is increasing exponentially during slow start



Doubling every RTT.

Slow start \rightarrow linear increase of CW.



→ congestion avoidance → slow down the rate of increasing W.

slow start threshold = SST = 4 say

For every new ACK

$$CW^{new} = CW^{old} + \frac{1}{\lfloor CW^{old} \rfloor}$$

increase CW by 1
every new ACK

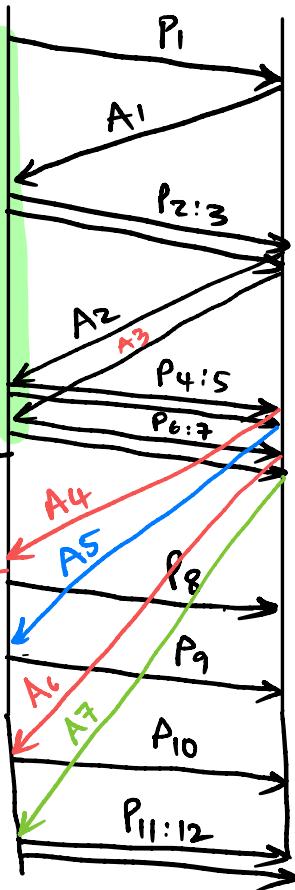
$W = 4$
equals SST

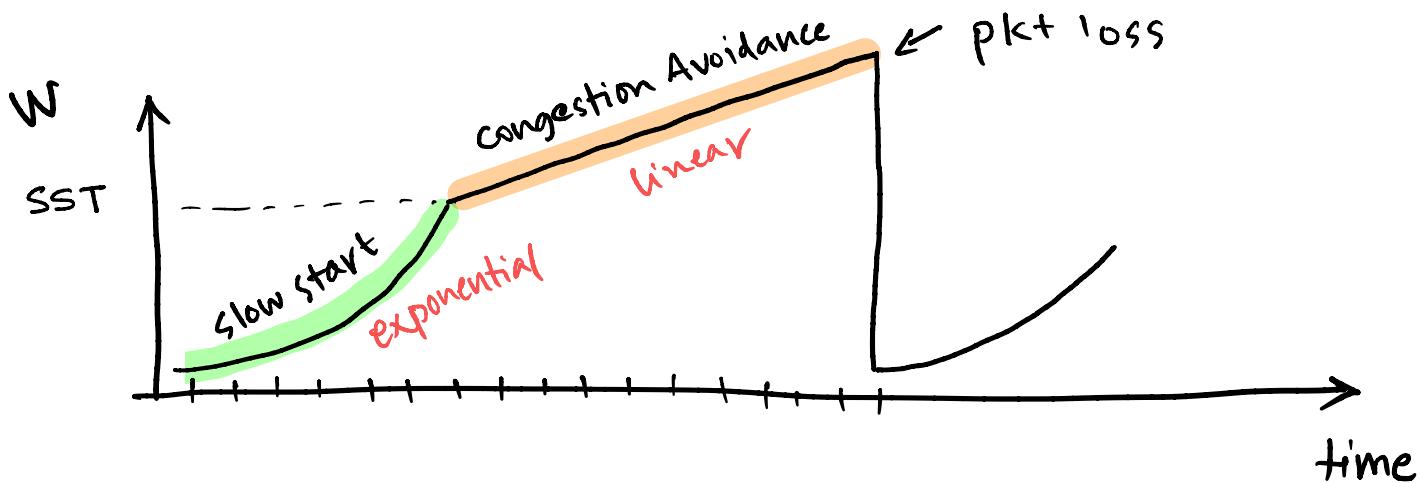
$W = 4 \frac{1}{4}$

$W = 4 \frac{1}{2}$

$W = 4 \frac{3}{4}$

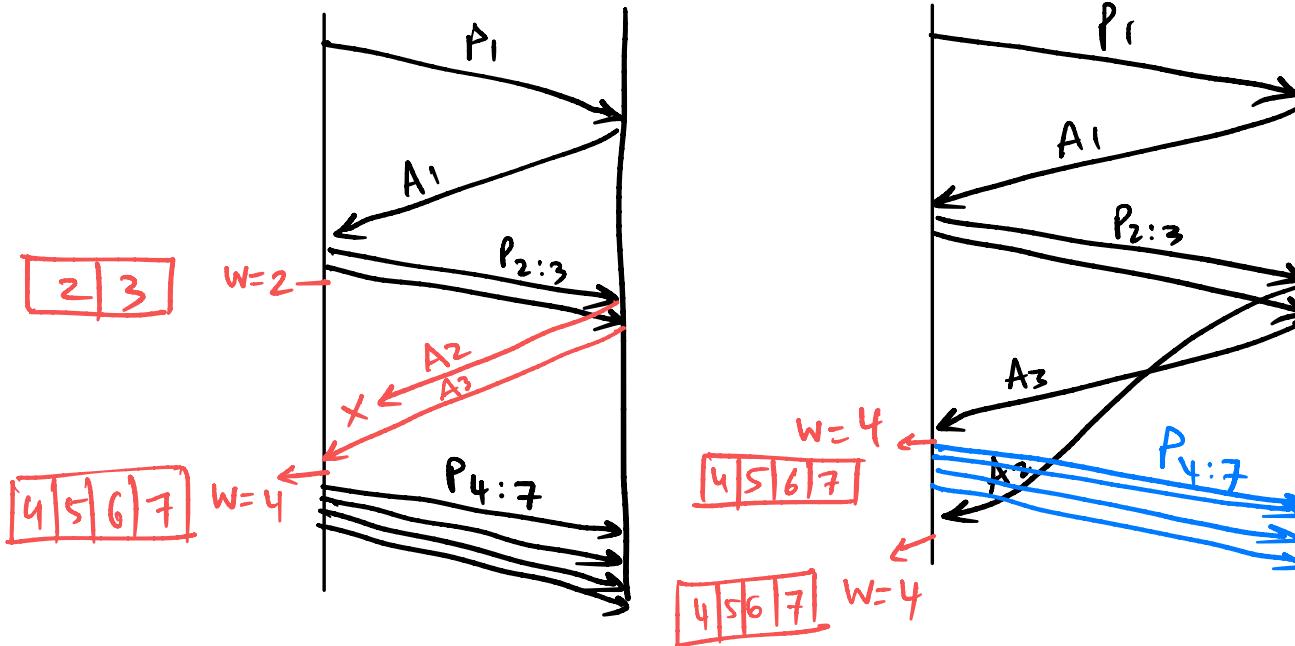
$W = 5$

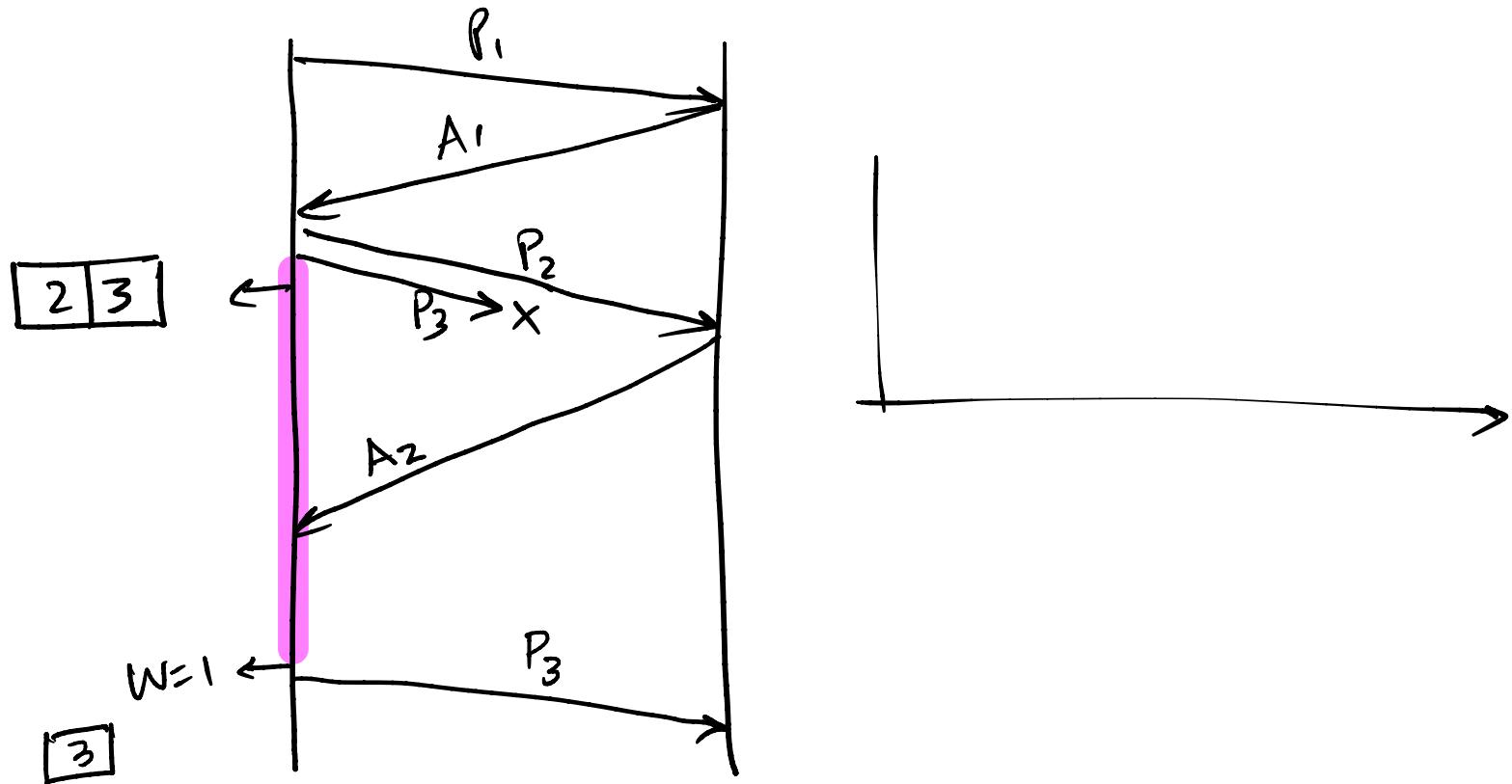




Recovery from Errors

ACK lost





End

