

- Recap \swarrow Slow Start \searrow Congestion Avoidance
- TCP congestion Control: Fast Recovery
- State Diagram of TCP Cong. Control
- Throughput Cal. of TCP
- Is TCP fair? \rightarrow what fairness it offers

TCP Congestion control

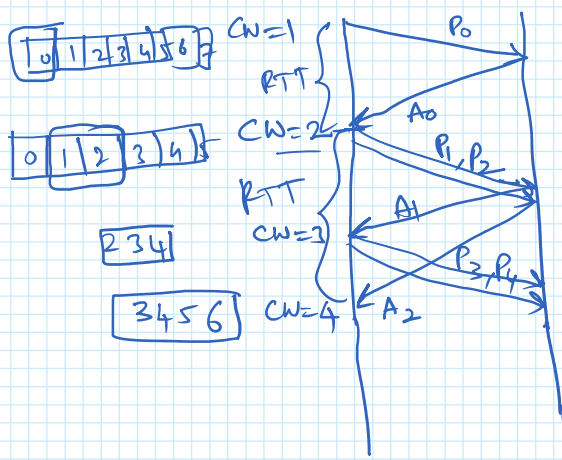
\rightarrow Start with some small CW.

\downarrow
Congest. rate at being sent.

Slow start phase

$$CW = 1$$

for every new Ack $\rightarrow CW = CW + 1$



$$CW = x$$

one RTT

CW acks new

$$CW = x + x$$

$$= 2x$$

In 1 RTT, CW doubles.

Exponential inc. phase.

Congestion Avoidance

- SST threshold.

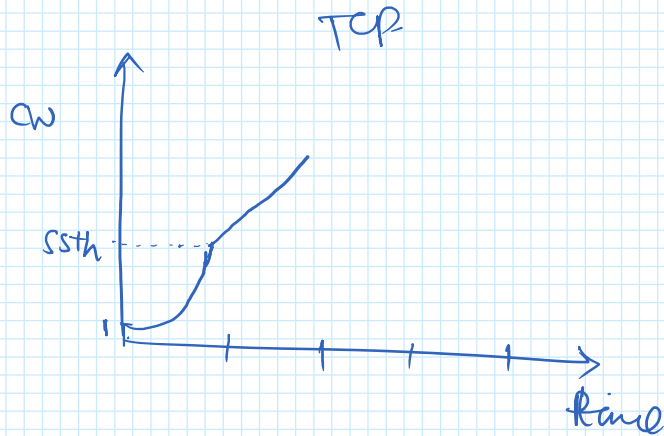
if $CW > \underline{Csth} \Rightarrow$ "CA" phase

$$C_W = C_W + \frac{1}{[C_W]}$$

$$\Rightarrow 1 \text{ RTT}$$

$$CW = CW + 1$$

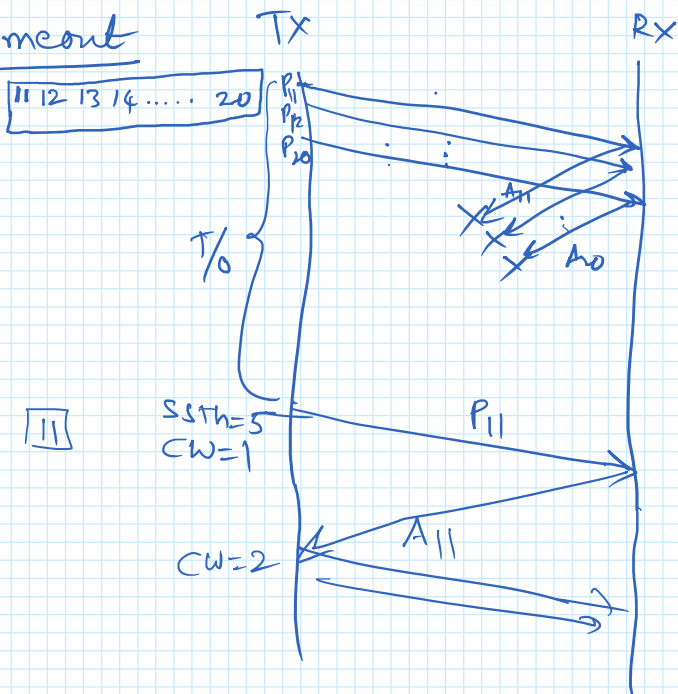
~~$S_{\text{str}} = 64 \text{ kB}$ (initial value)~~



$ss_{th} = 8$ packets ✓

$CW = 10 \checkmark$

Timeout



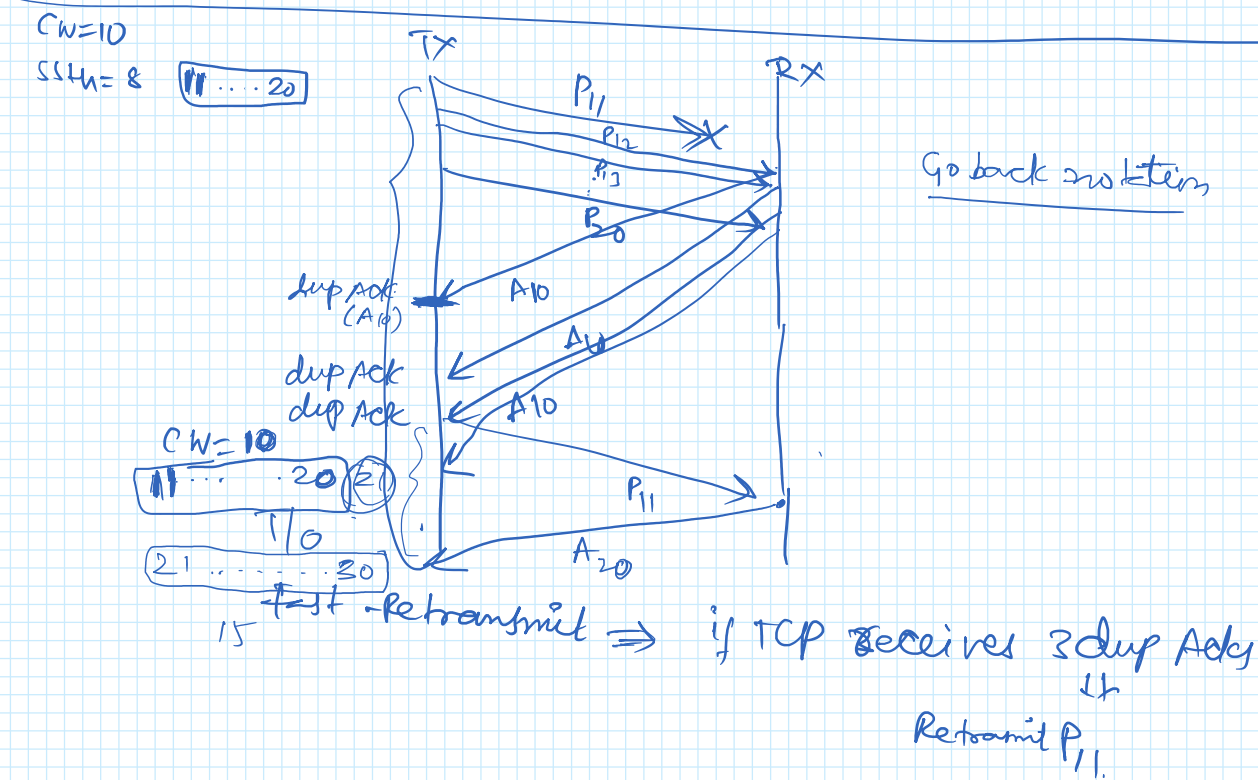
timeout occurs

↳ TCP panics and thinks n/w is congested

① $\xrightarrow{\text{Reset}} STh = CW/2 \checkmark$

② $\rightarrow C_W = 1 \checkmark$

③ CA → Slow start
↳ enters slow start phase.



Congestion window:

TCP Tahoe \Rightarrow Treat 3 dup Ack \equiv Timeout:

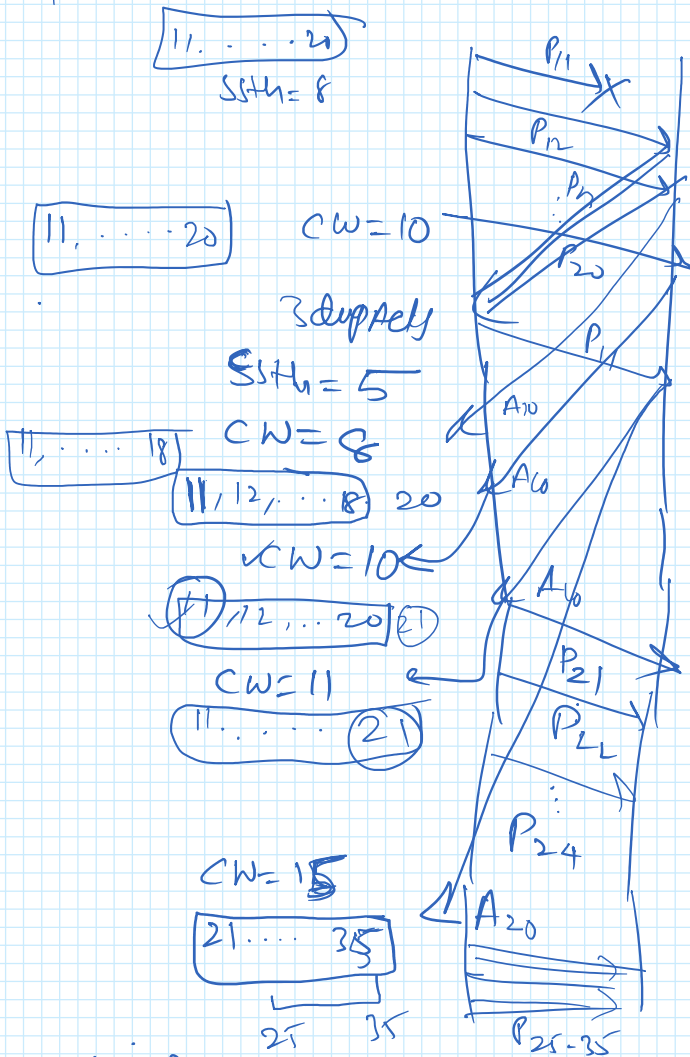
$$\begin{aligned} &\hookrightarrow SSN = CW/2 \\ &\hookrightarrow CW = 1 \end{aligned}$$

Fast Recovery (TCP Reno)

- True that one Pkt is lost, lot of other Pkts getting delivered
- N/w might not be too congested.
- Enters into (fast recovery) if 3 dup Acks are recv.
Phase
- Instead of setting $CW=1$, if set $SSN = CW/2$
 $CW = SSN$

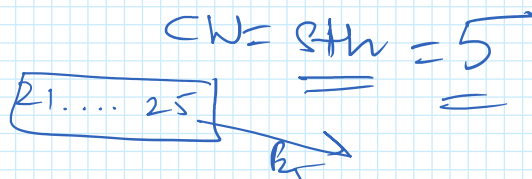
- Temporarily inflate $CW = CW + 3$

Fast Recovery Entering & exiting



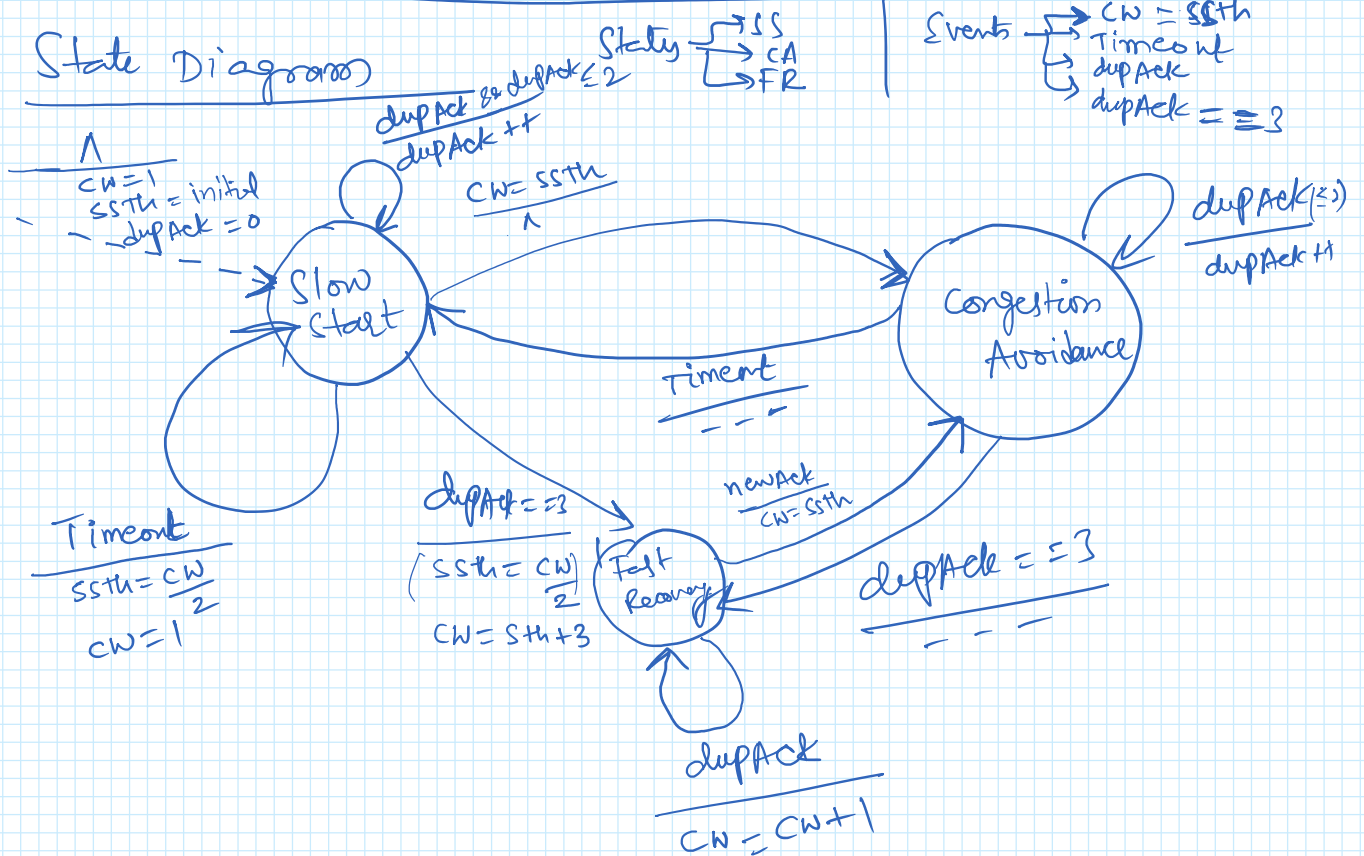
Exiting Fast Recovery

Reset inflation



↓
"CA" avoidance ✓

State Diagram



Summary: TCP Congestion Control

The complete state diagram (done with missing details) from the book slides.

