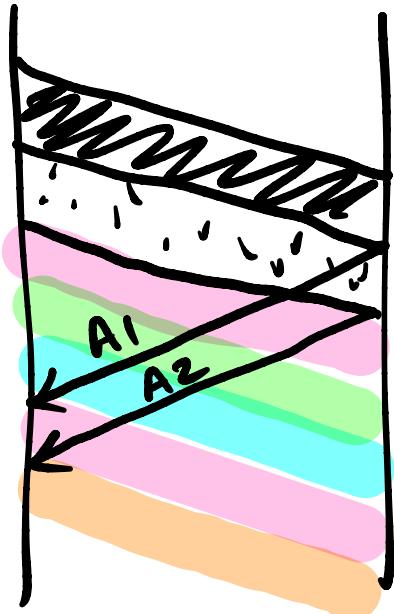


# Lecture 12 :

- ④ Efficiency → Pipelining → Throughput
- ④ Sliding Window protocols
  - window base/tail
- ④ 2 pipelined protocols  $\xrightarrow{\text{GBN}}$   $\xrightarrow{\text{SACK}}$
- ④ What should W be? That's the TCP question

Pipelining  $\Rightarrow$  The Tx can send N packets w/o an ACK from the receiver.

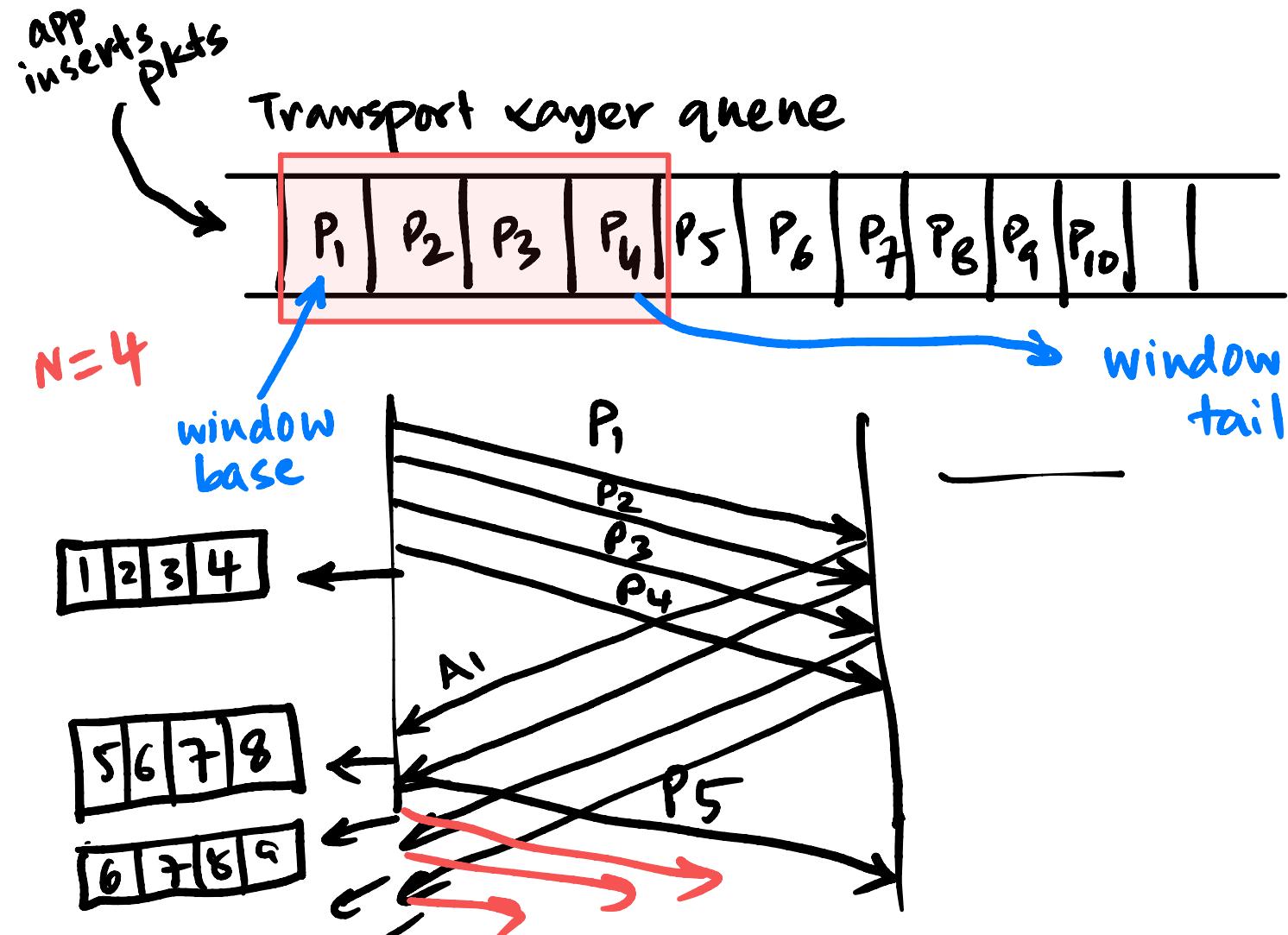


Stop & go  $\Rightarrow$   $N=1$

$$\text{Max eff} = 1$$

$$\text{Max throughput} = \frac{N \cdot L}{RTT}$$

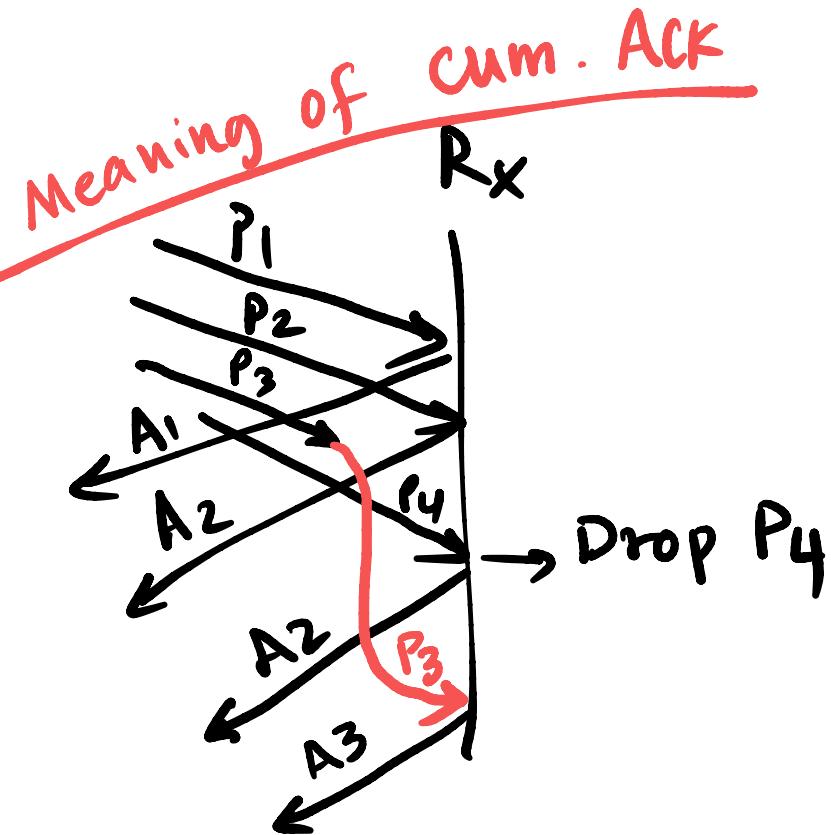
$$\text{where } N = \frac{RTT}{\text{max T.T.}}$$



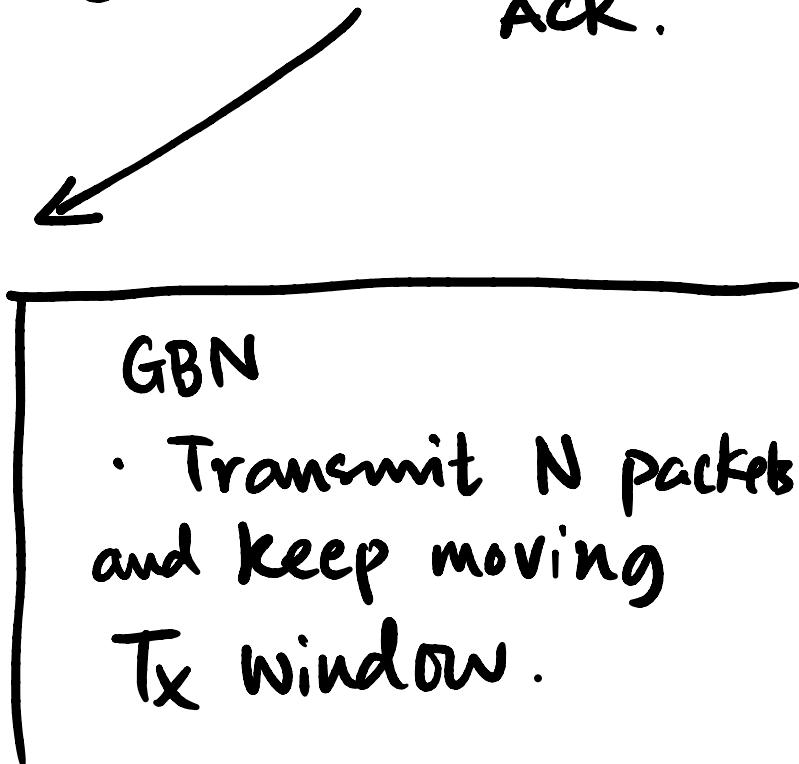
# Pipelined Protocols



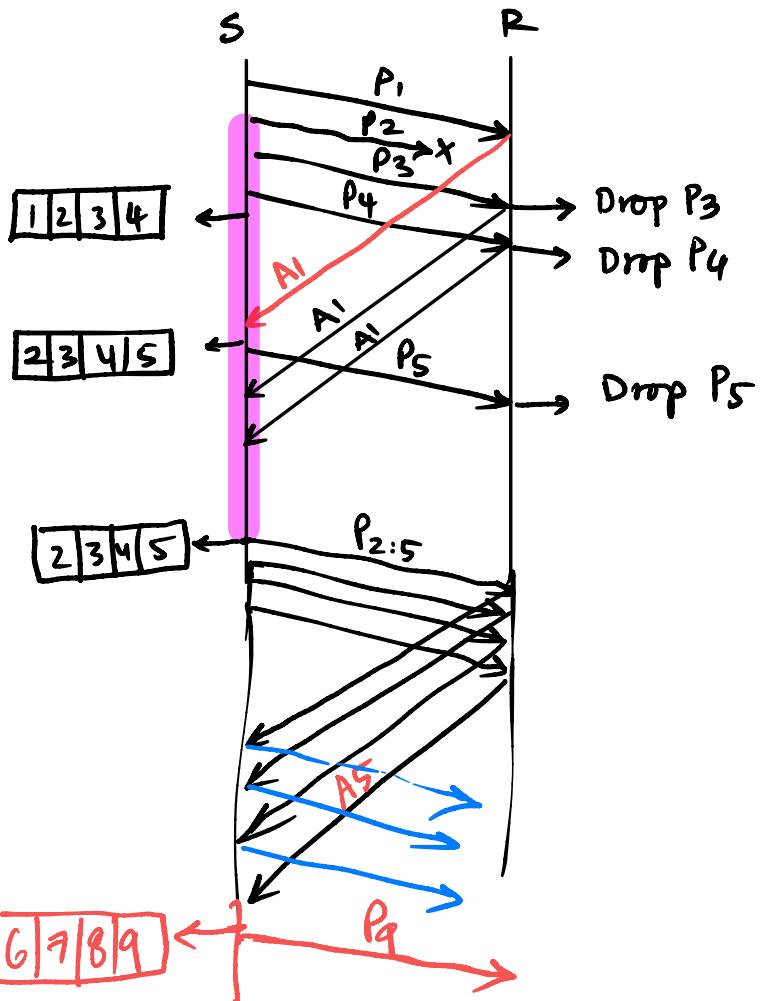
# Go BACK N (GBN)



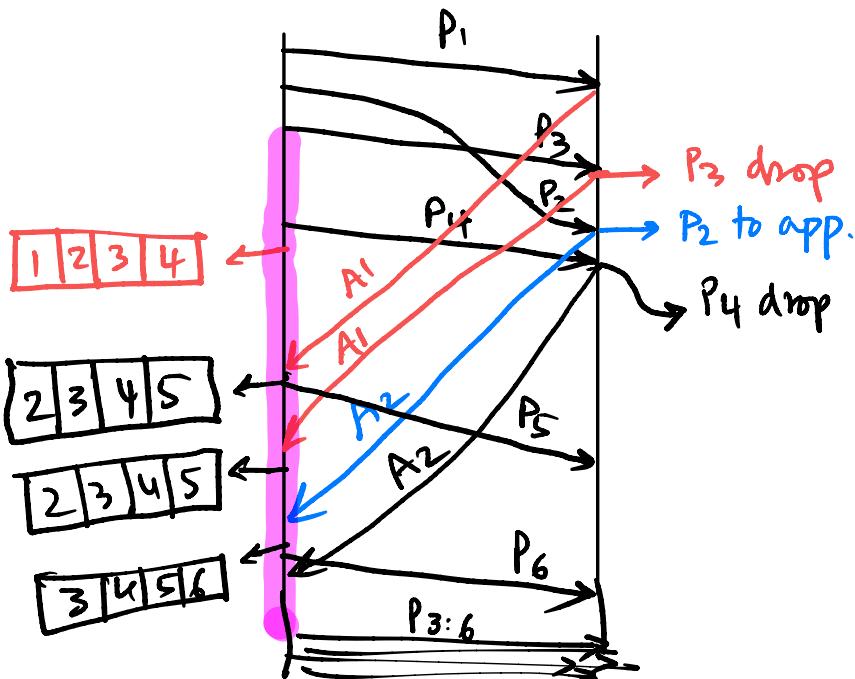
- ①  $R_x$  has no buffer
- ② Tx uses a fixed N
- ③  $R_x$  sends cumulative ACK.

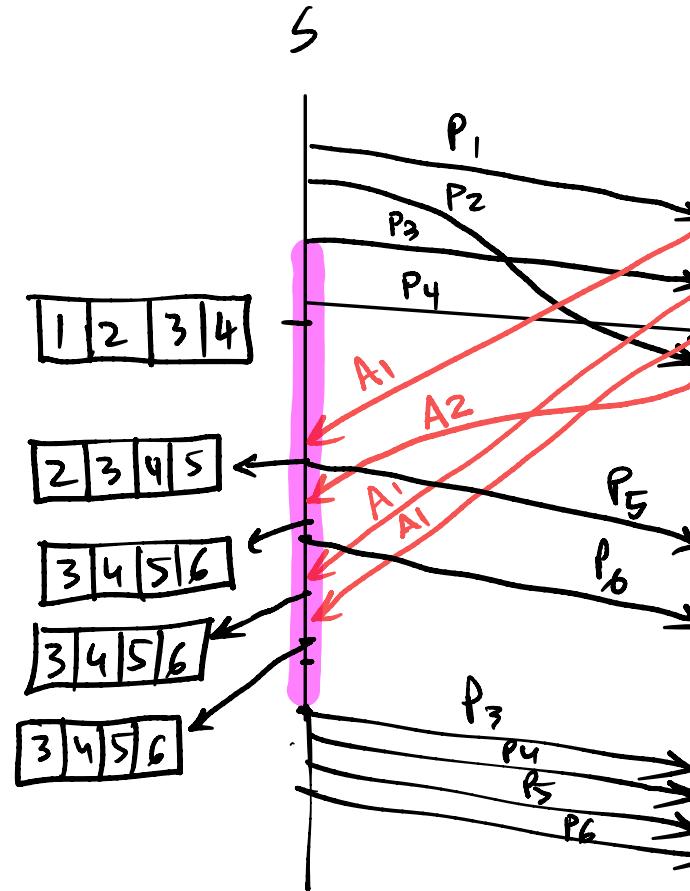


$N=4$



. Upon timeout, ret<sub>x</sub> all N packets in the current window



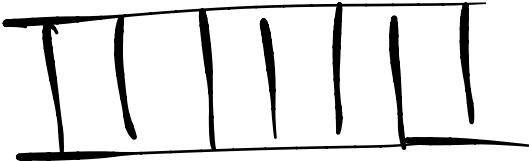
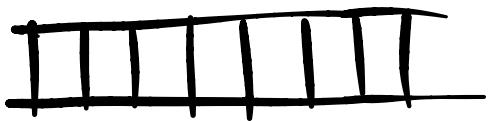


P<sub>1</sub> to app  
P<sub>3</sub> drop  
P<sub>4</sub> drop  
P<sub>2</sub> app

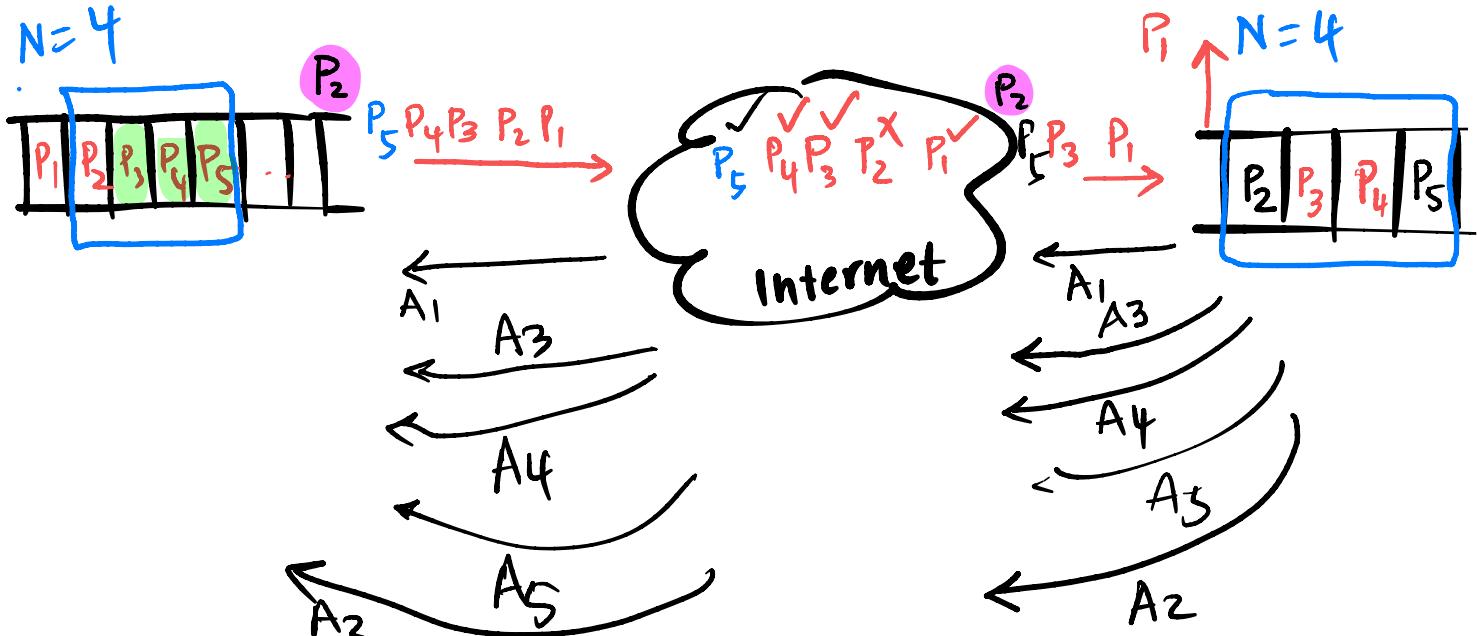
T/F:

If  $A_x$  is the first DropAck that the sender receives, then  $P_{x+1}$  must have been dropped by the receiver.

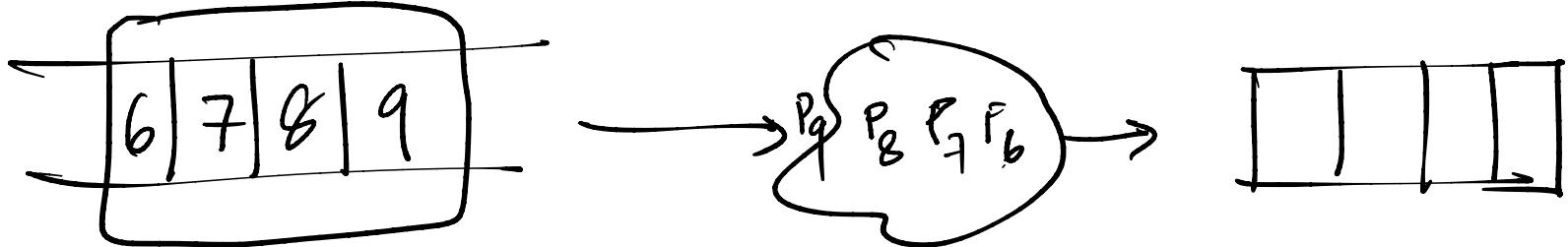
## Selective ACK (SACK)

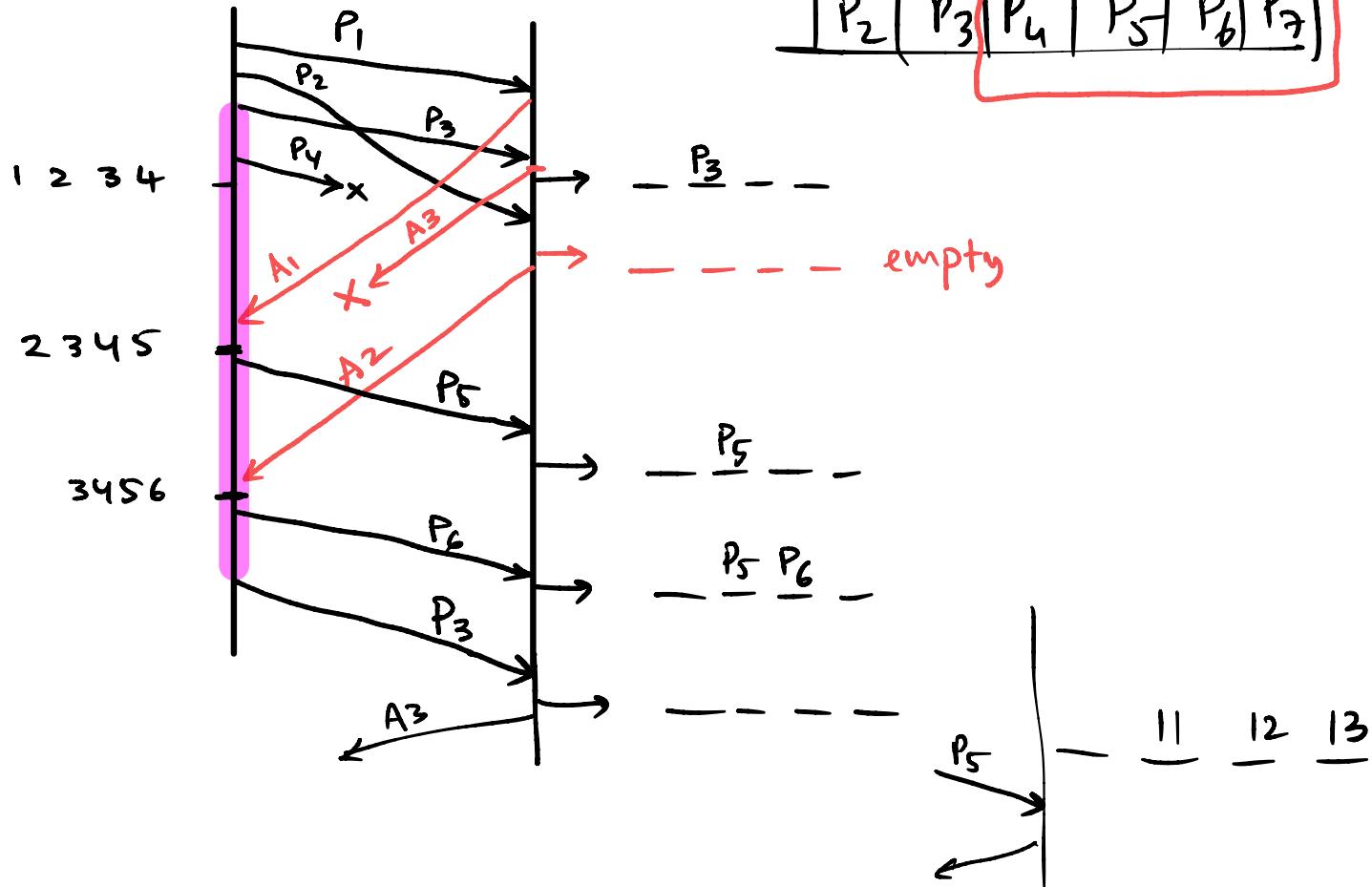


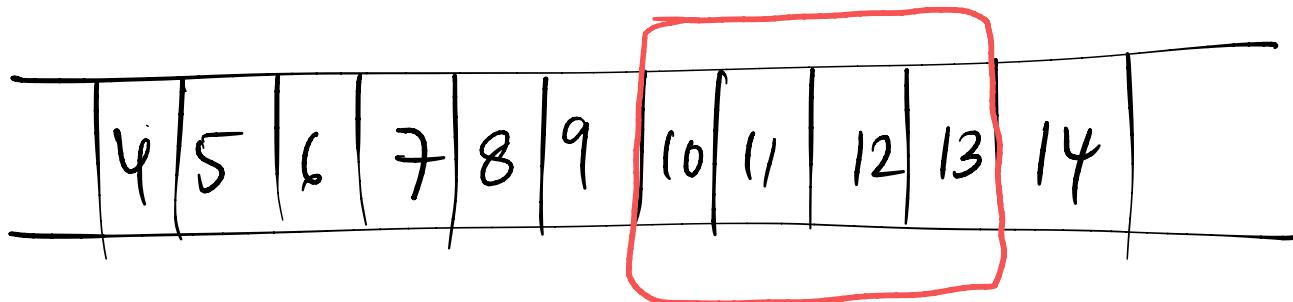
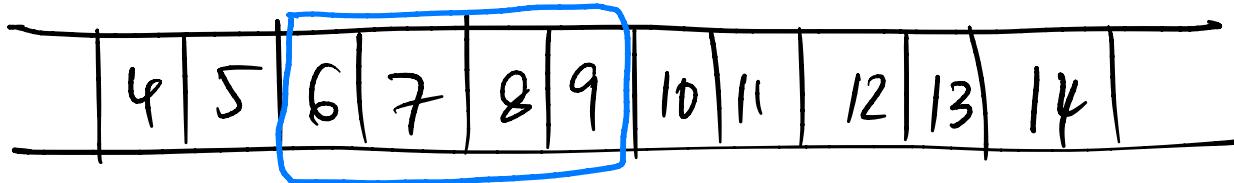
- Rx can buffer 000 packets.
- Rx also have a window
- Rx will only ACK packets they have received (not cum. ACK)
- Tx will retransmit *only* the packet for which it has timed out.



Timeout on  $P_2 \Rightarrow$  Retx  $P_2$







$$B = 10$$

For packet  $P_x$ , receiver must send  $A_x$   
only if  $x \geq B - N$

