Sliding Window ARQ

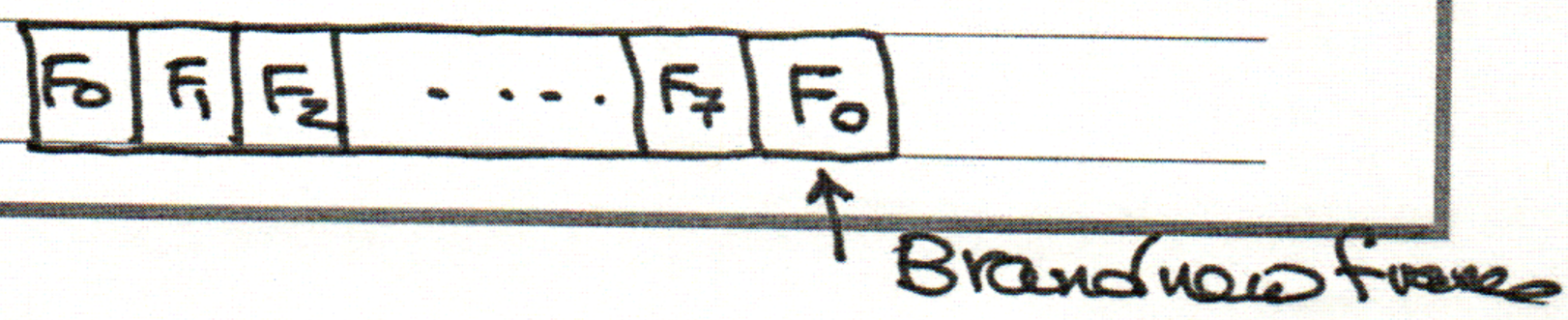
① Here the sender can transmit multiple frames continuously before he has to stop.

Where should he stop?

# of frames sent in one RTT can't exceed the BW x Delay Product.	you ran out of sequence numbers

let m = # of bits used for sequencing the frames (recall $m = 1$ for S&W ARQ)

for ex. Suppose $m = 3$



2 Acknowledgments could be accumulative
i.e. the RK has the option of Acks
multiple frames accumulatively

Two sets of Windows need to be
maintained @ each side (Link is FDX)

SWS : Sender window size
= Max # of unacknowledged
frames the sender can send.
(before it has to stop)

note: if SWS < BW x Delay Product
⇒ the Link is not utilized 100%.

RWS : Receiver window size
: The max # of frames (in-order
& out of order) the receiver
is willing to accept (i.e. to
buffer).

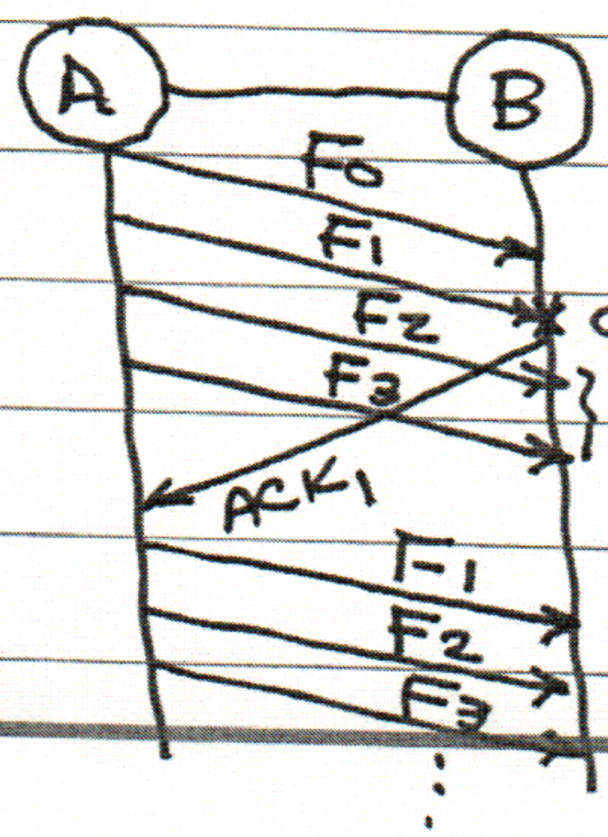
Go_Back_N ARQ

In this version, the receiver is NOT willing to accept any out-of-order frames. If he detect a frame to be error, he will drop it and all subsequent frames and ask the sender to retransmit that frame and all subsequent ones.

In Go-back-N ARQ

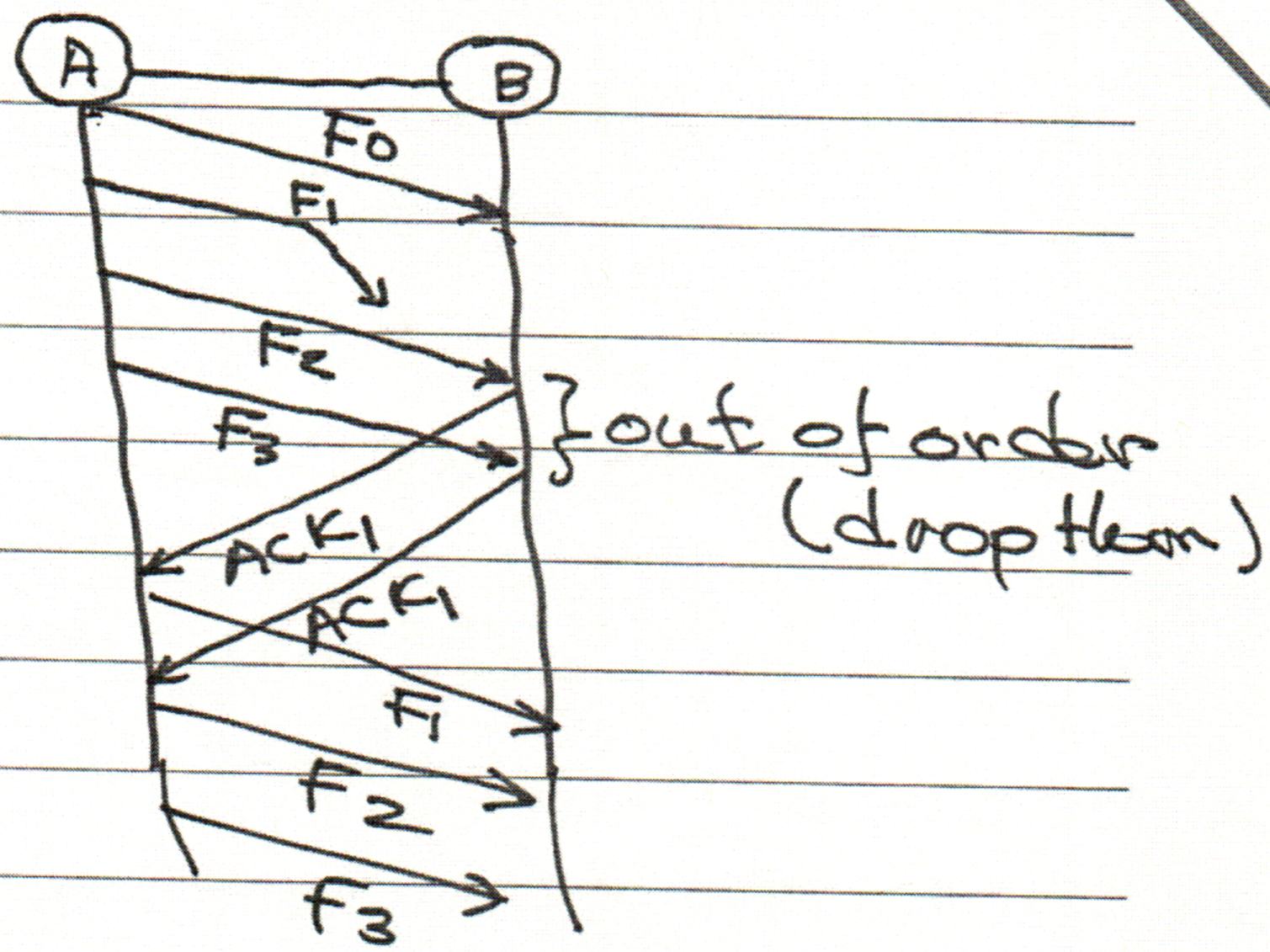
$SWS \leq 2^m - 1$ why?

$RWS = 1$ (R/X is only willing to accept the in-order frame



detected in error

out of order (dropped)

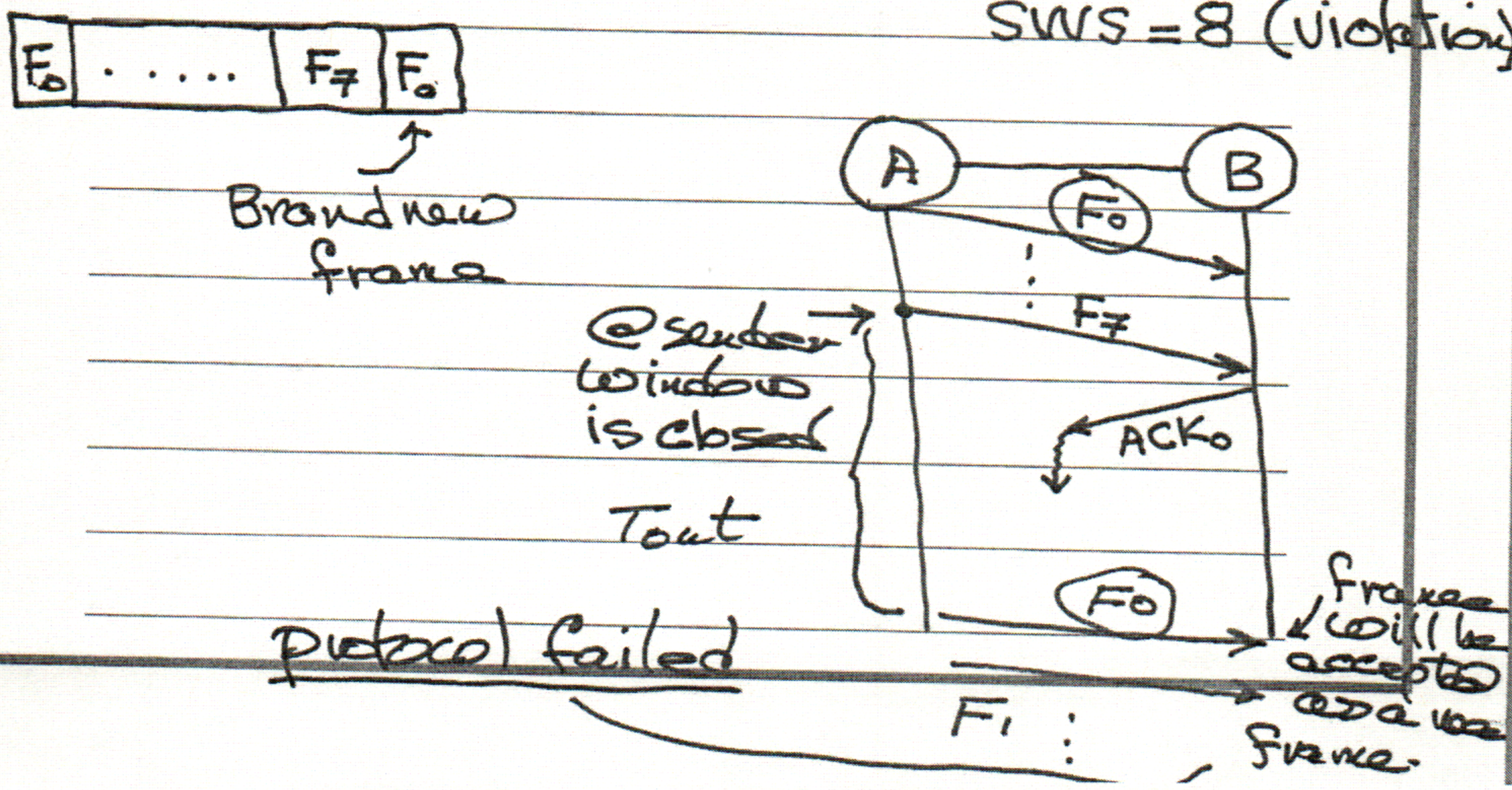


Why SWS is not $\leq 2^m$

$SWS \leq 2^m - 1$

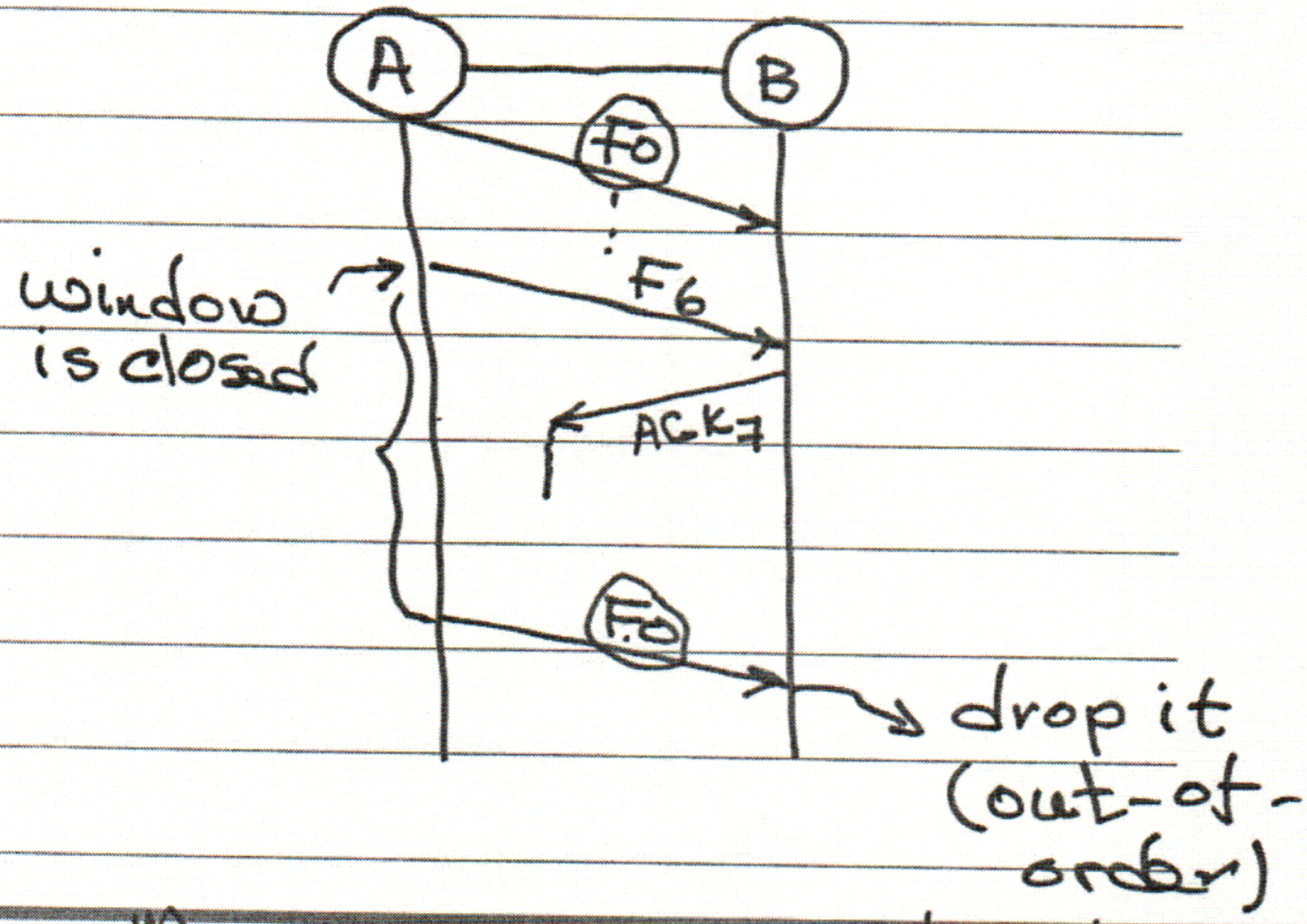
Ex: $m = 3$

SWS = 8 (violation)



Protocol failed

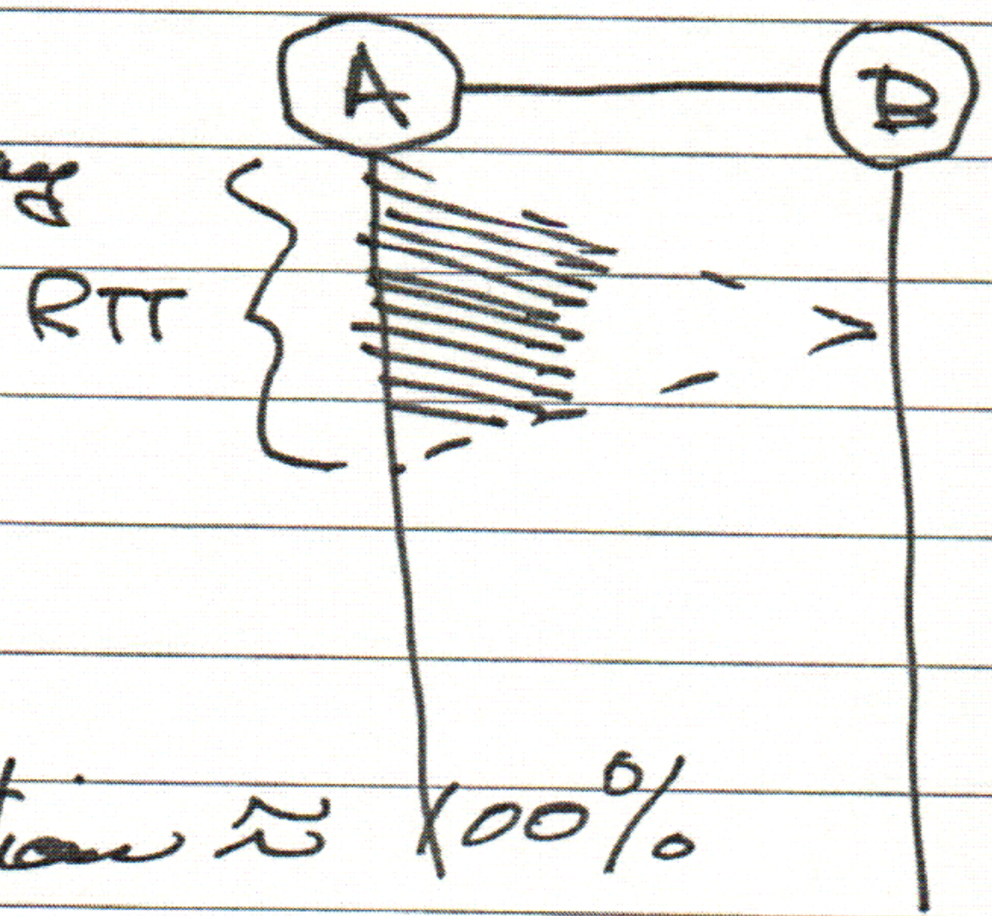
SWS = 7 (No violation)



$SWS \le 2^m - 1$ (m) protocol passed.

Throughput:

if SWS $\geq$ BW x Delay product

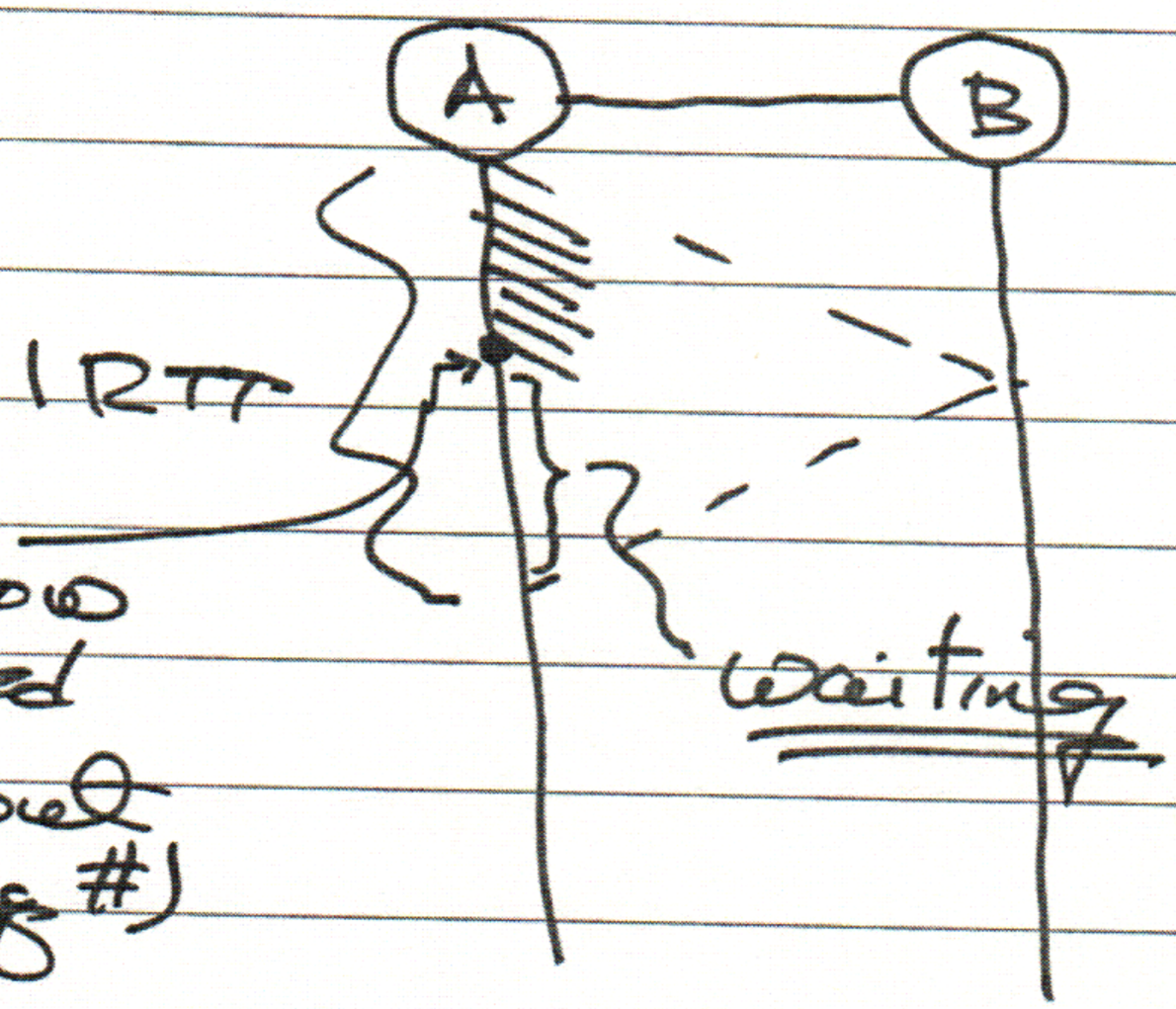


window will not close in one RTT.

$\Rightarrow$ Link utilization $\approx$ 100%

$$\text{Throughput} = \frac{(BW)(Delay)}{Delay} \simeq BW\ !$$

If SWS < BW x Delay Product



Throughput $= \frac{SWS}{RTT}$ Link utilization $= \frac{(SWS)(T_f)}{RTT}$

For "max utilization"

$$\Rightarrow \underbrace{SWS}_{\text{frames}} = \underbrace{BW \times \text{Delay Product}}_{\text{Bits}}$$

$$\frac{\text{Bits}}{\text{Bits}} \div \frac{\text{Bits}}{\text{frame}}$$

aside $M = 7$

$$SWS \leq 2^7 - 1 = 127$$

Selective Repeat ARQ (a.k.a Selective Reject)

In this version, the receiver is willing to accept out-of-order frames, i.e. buffering them (but not Ack them) up to RWS frames

in SR ARQ

$SWS \leq 2^{m-1}$ why?

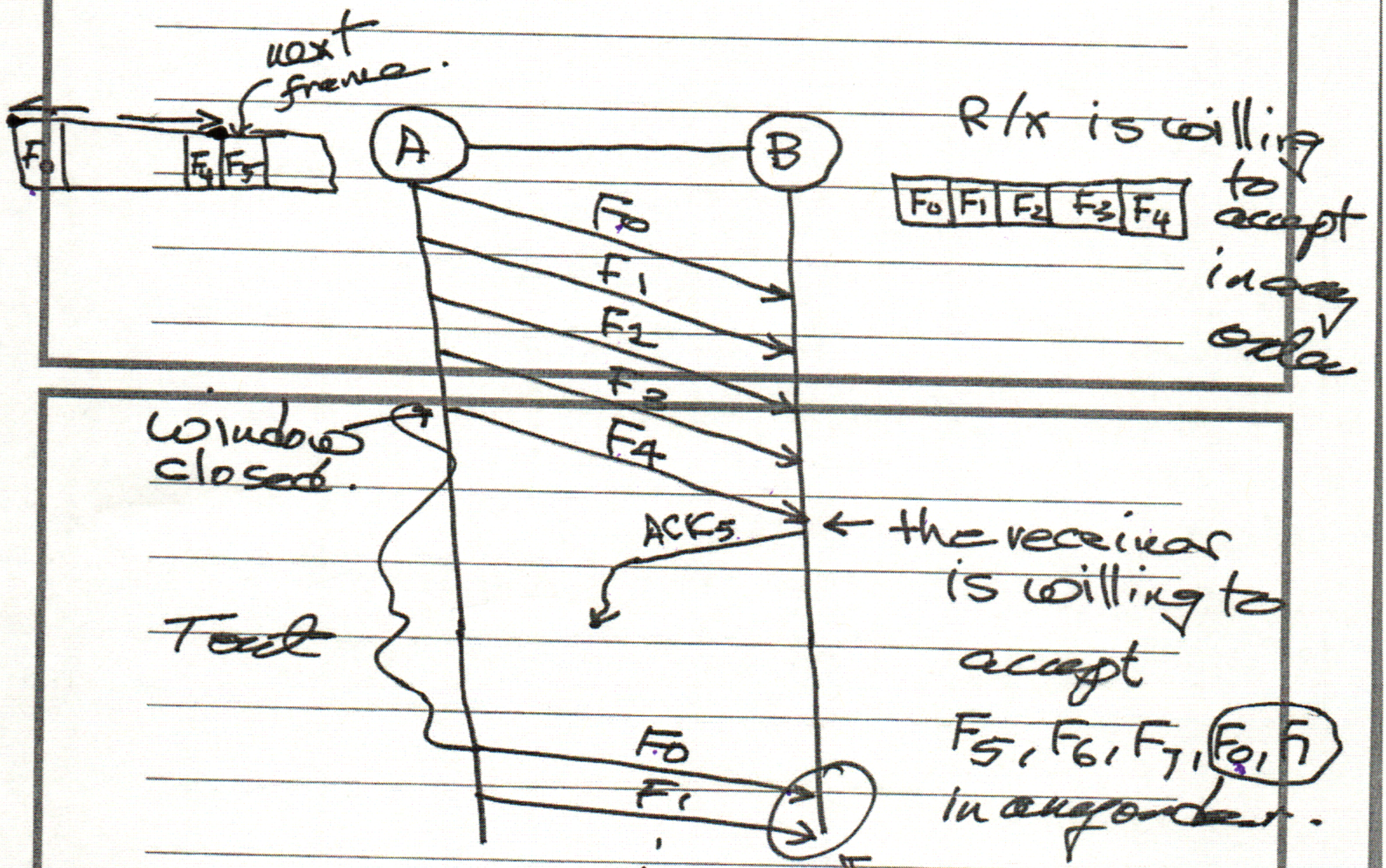
$RWS \leq SWS$ (we are going to assume always $RWS = SWS$.

when R/X receives a frame in error, he will only ask the sender to retransmit that frame only.

Ex: $m = 3$

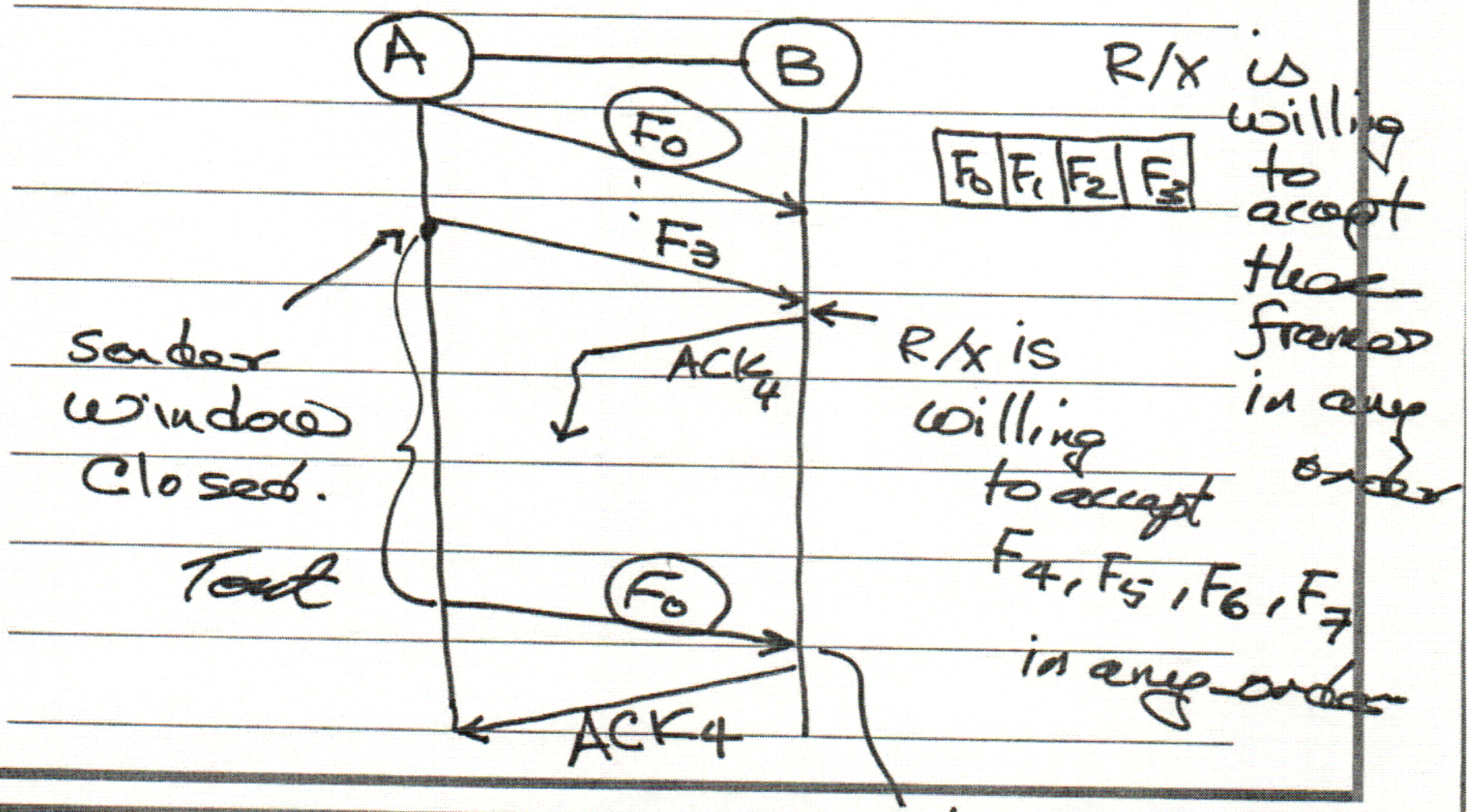
$SWS \leq 2^{m-1}$ $\quad$ $SWS \leq 4$

assume $SWS = RWS = 5$ (violation)



⇒ Protocol fails.

SWS = RWS = 4 (no violation)



dropped because it is outside his RWS.

protocol passed.