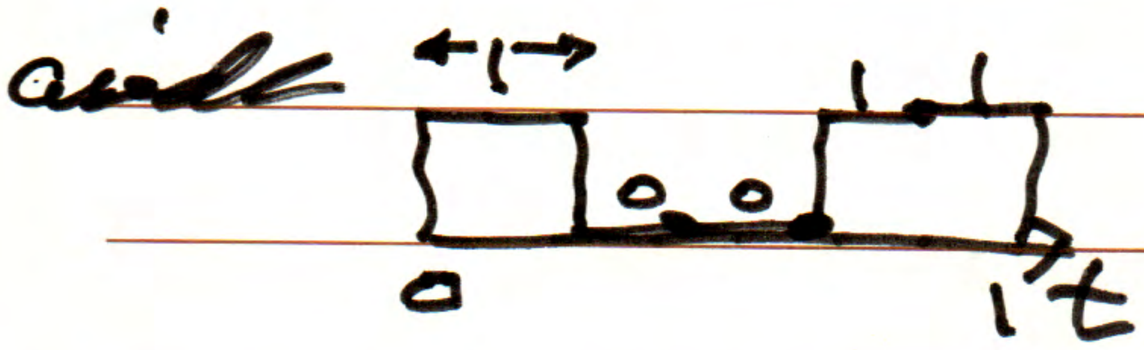
Delay

Deterministic — Random (EE 503)

- Transmission Time
- Propagation delay.

Transmission Time: Time elapsed from the moment you transmit the first of your message till the time you transmit the last bit of your message.

$$T_t = \frac{\text{message length (bits)}}{\text{Transmission (Bit) rate (bps)}}$$



Bit Rate

$R_b = 5$ bps

T_b = Bit Transm. Time

$= \frac{1}{R_b} = 0.2$ secs.

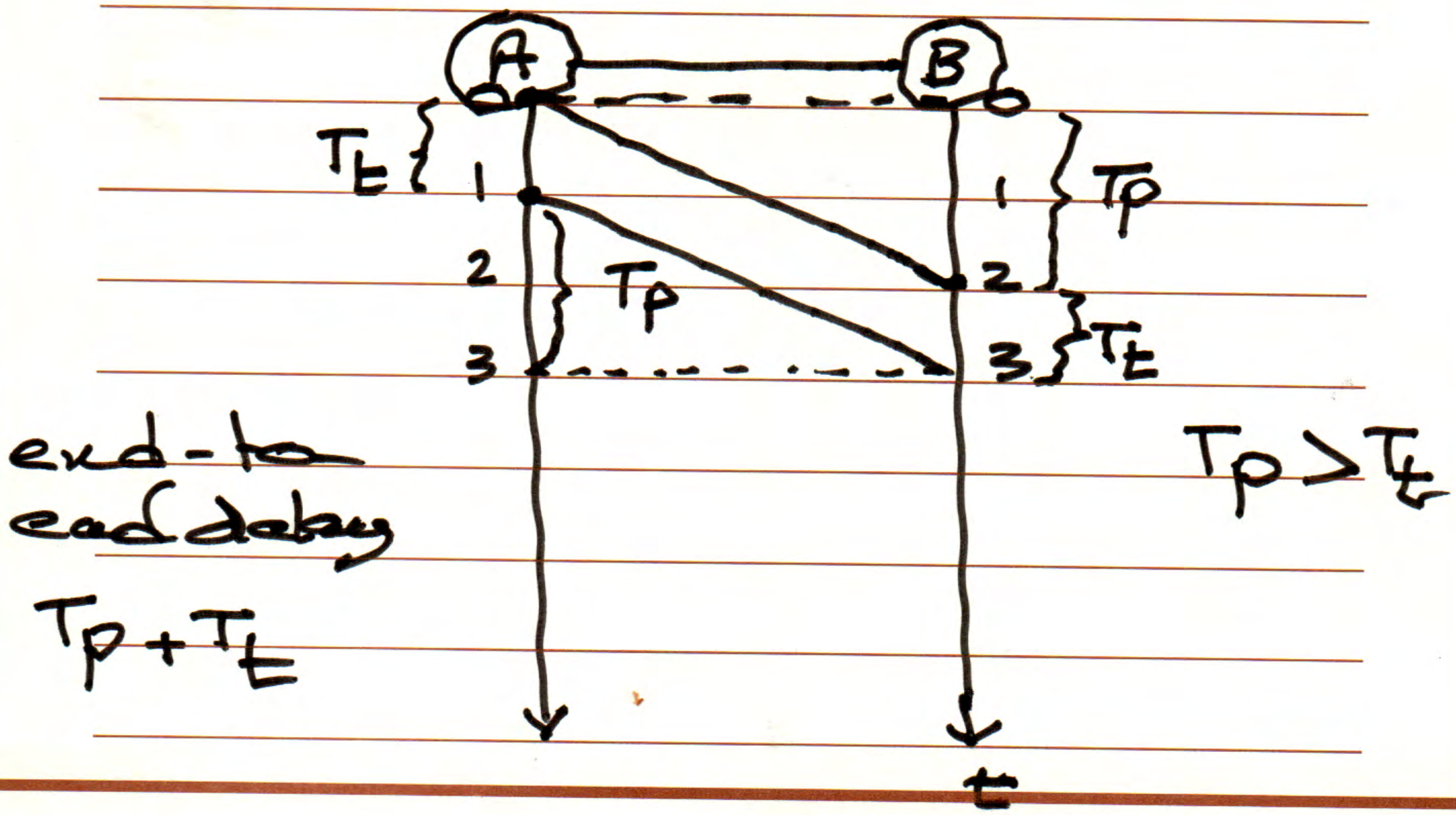
② Propagation Delay.

T_p = The time elapsed from the moment you transmit a bit (any bit) till the moment that bit is received.

$$T_p = \frac{\text{length of the Link } (m)}{\text{velocity of propagation (m/sec)}}$$

$\simeq$ Speed of Light

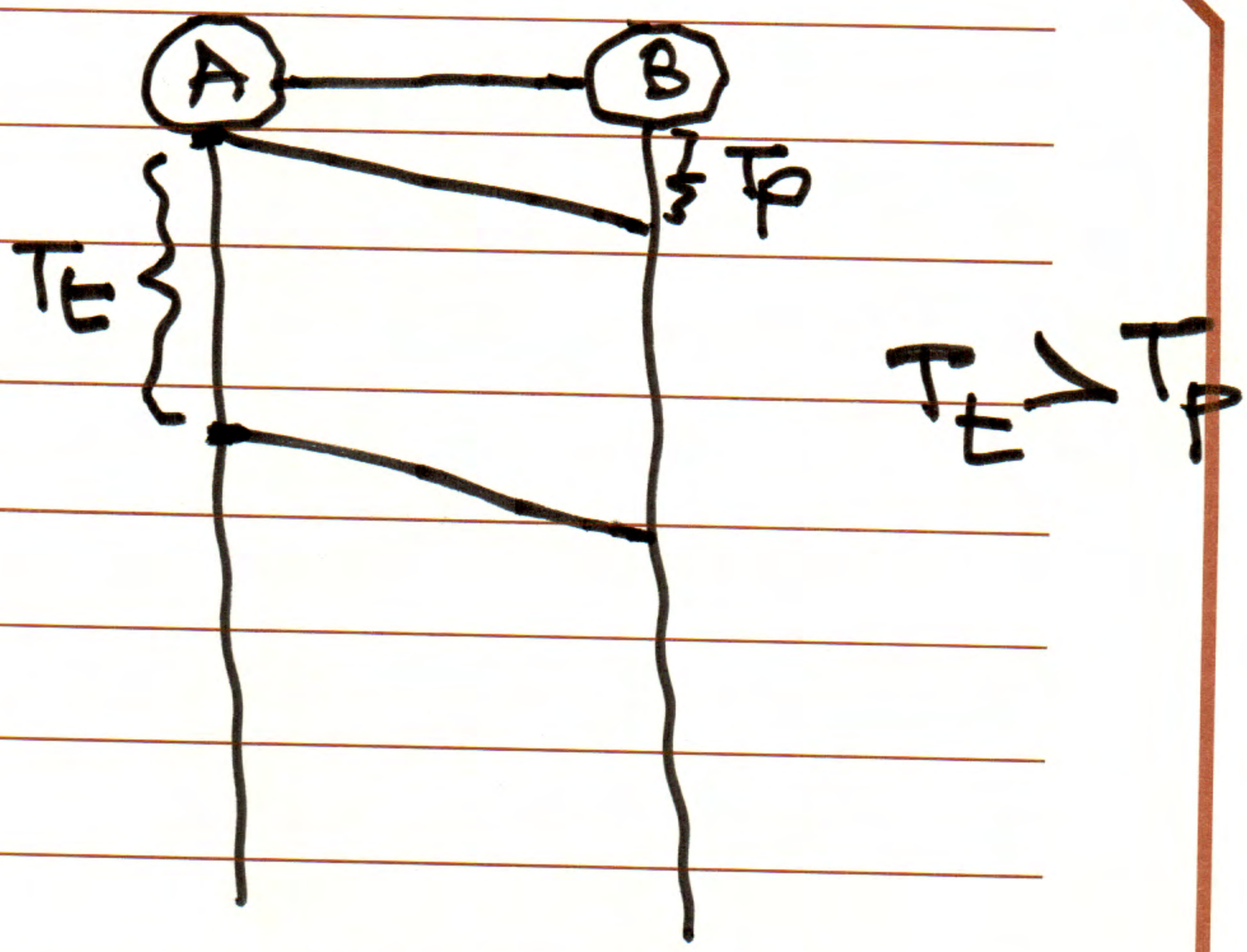
3×10^8 m/sec



end-to-end delay

$T_p + T_t$

$T_p > T_t$



Random components

processing delay

negligible

Routers are extremely powerful.

Queueing delay.

End_to_End delay (Transfer Delay)

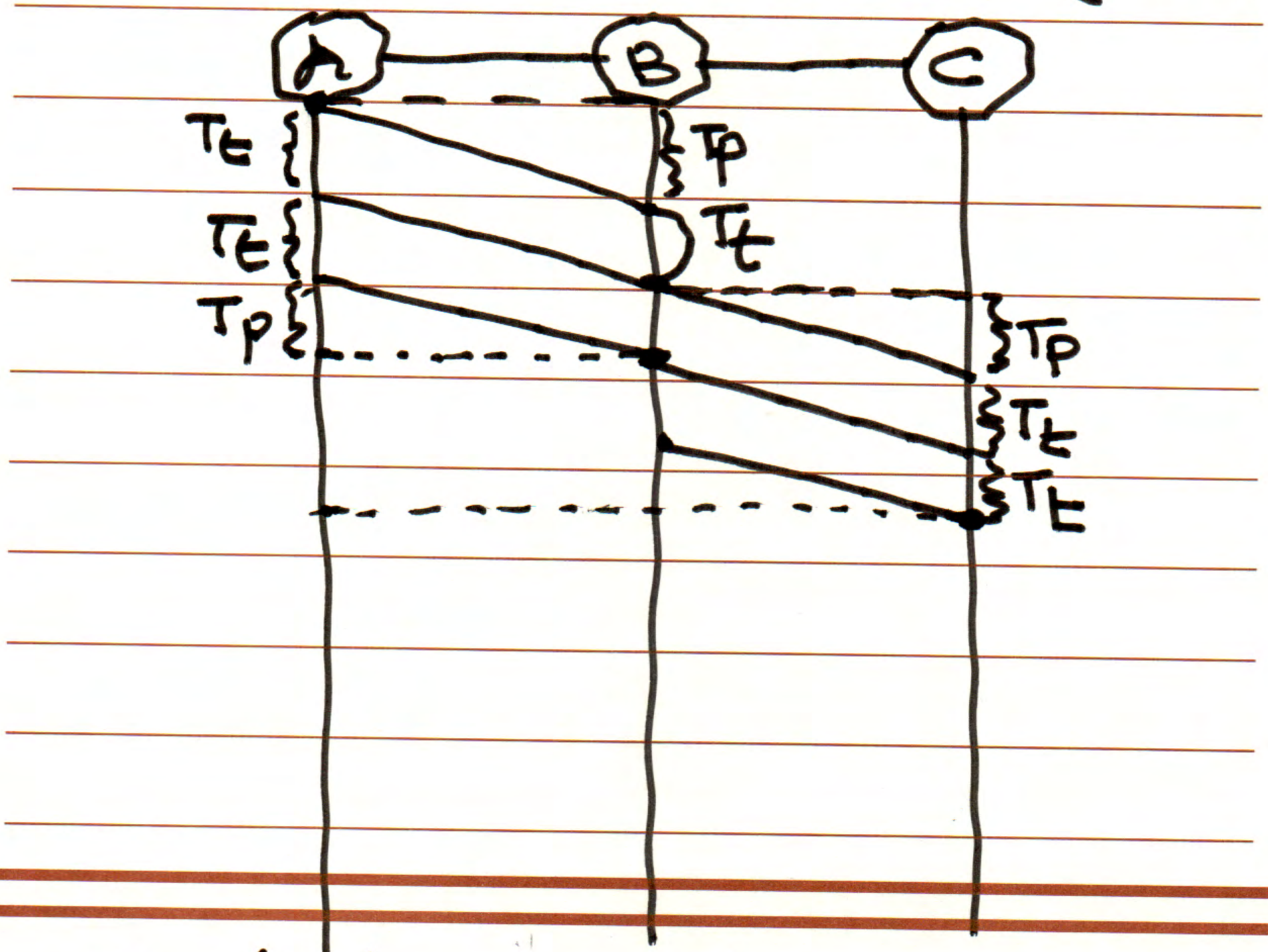
= Time elapsed from the moment your transmit the first bit of your message till the time the last bit is received.

End-to-End Delay

$T_p + T_t + T_Q + T_p + T_t$

$= 2T_p + 2T_t + T_Q$.

Sending 1000 packets back-to-back. Ignore Queueing delay.



End_to_End delay.

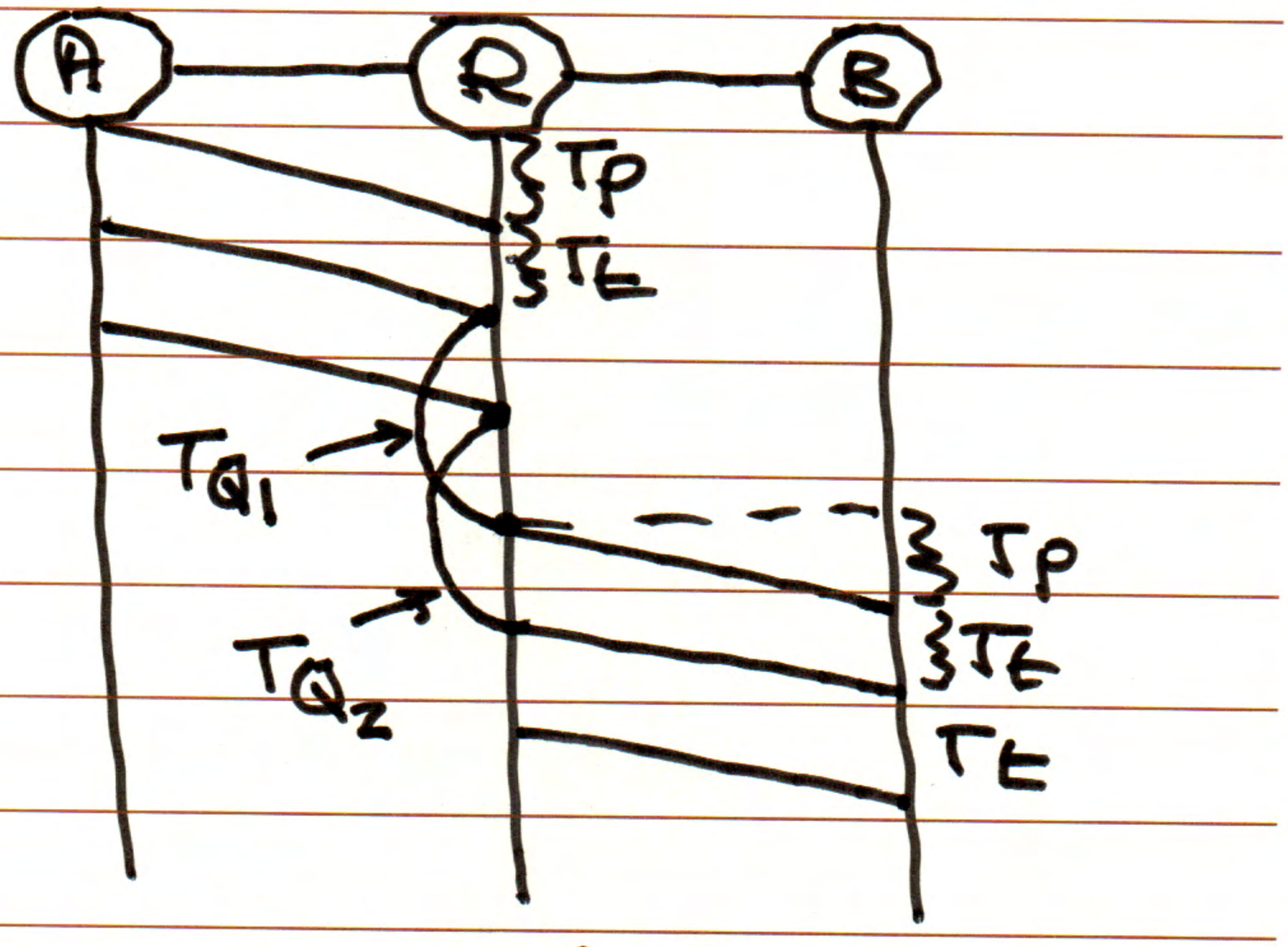
$$T_p + T_t + T_p + T_t + T_t$$

$$= 2T_p + 3T_t .$$

Do @ home the same.

M packets

N Links (ignore T_Q).

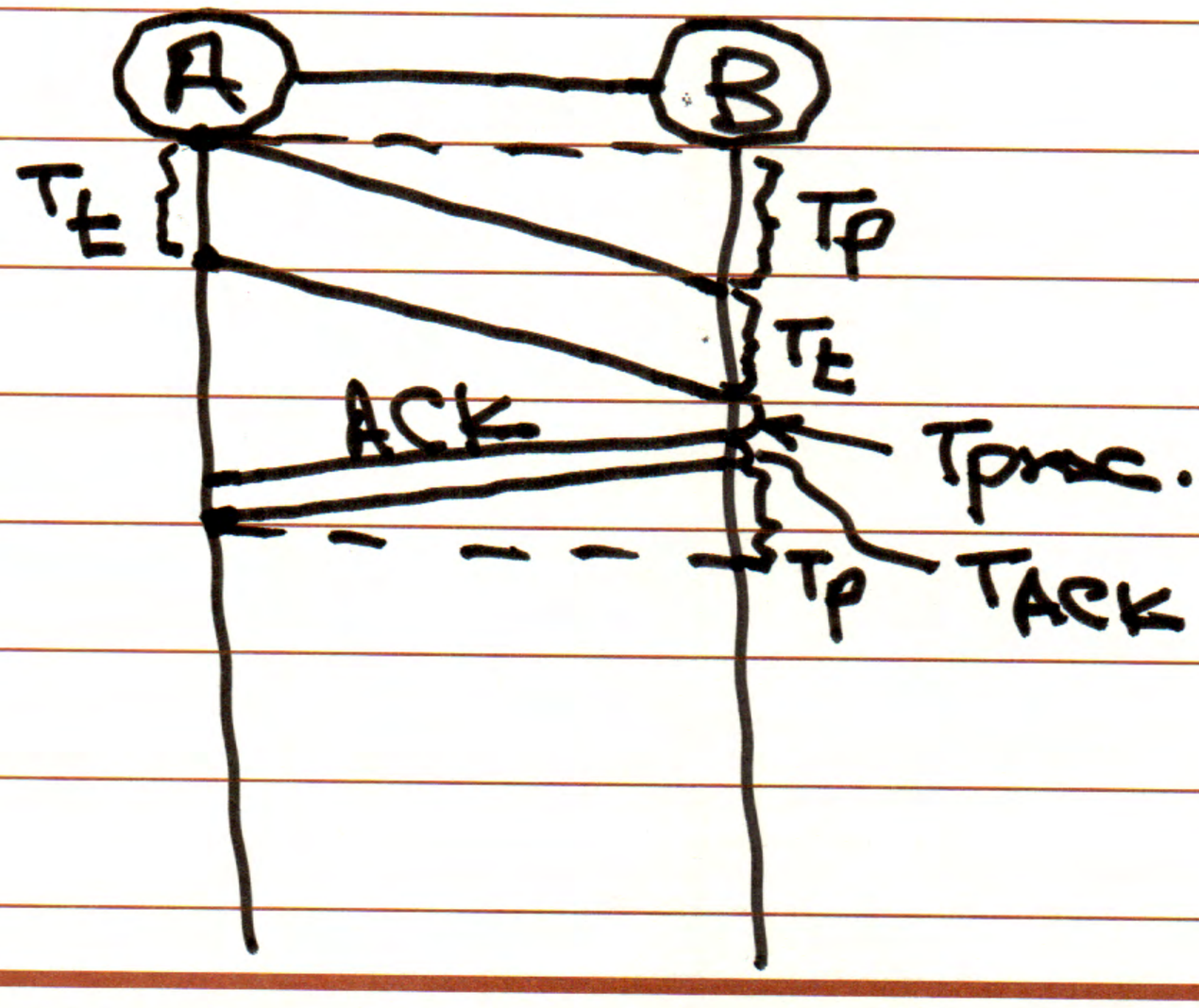


End-to-End delay

$$T_p + T_t + T_{Q_1} + T_p + T_t + T_t$$

$$= 2T_p + 3T_t + T_{Q_1}$$

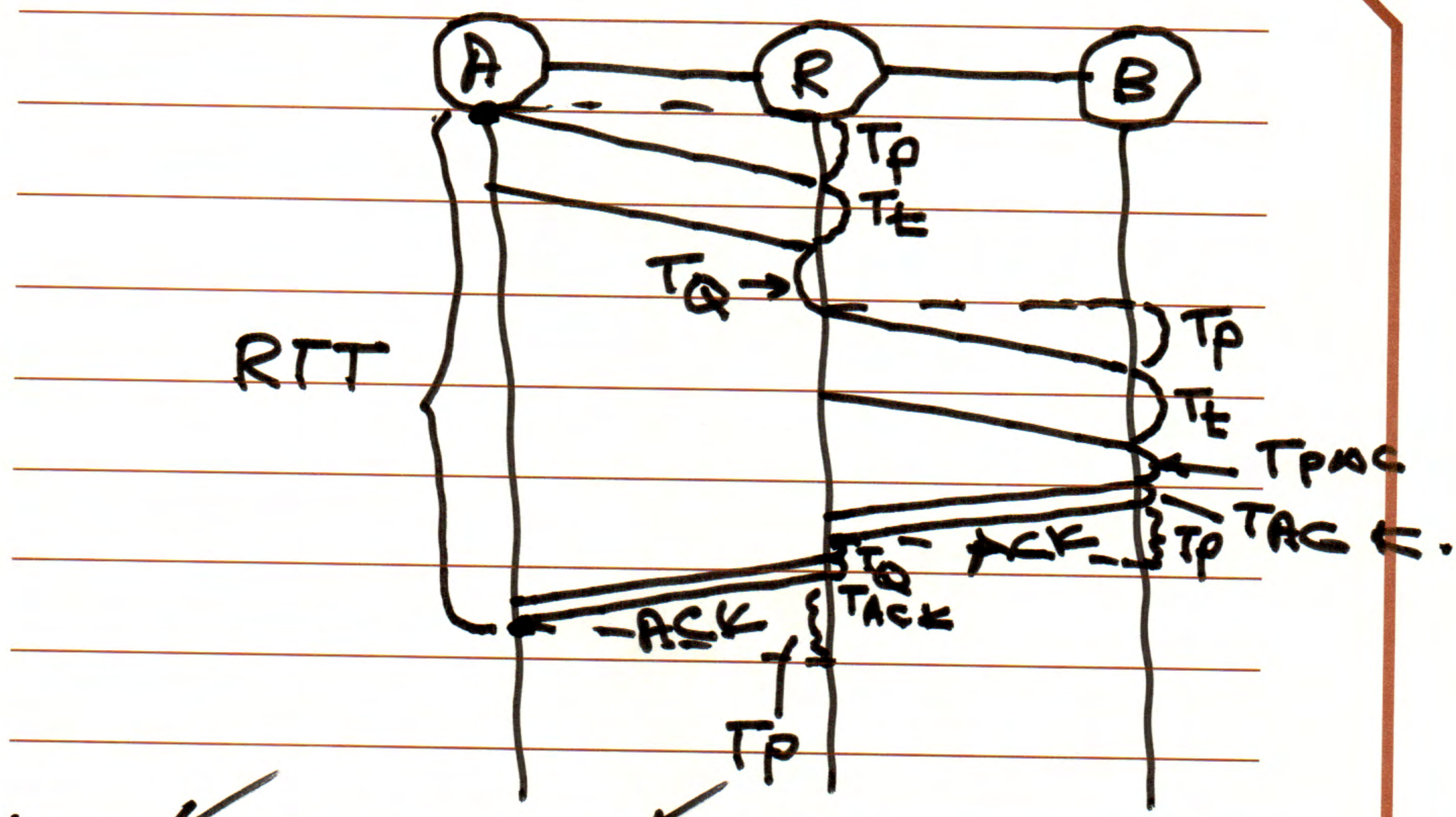
RTT: Round Trip Time



Def. 1 $RTT = T_p + T_t + T_{proc} + T_{ACK} + T_p$

$= T_t + 2T_p +$ ↓

Def 2 $RTT \cong 2T_p$



Def 1 $T_p + T_t + T_Q + T_p + T_t + T_{proc} +$

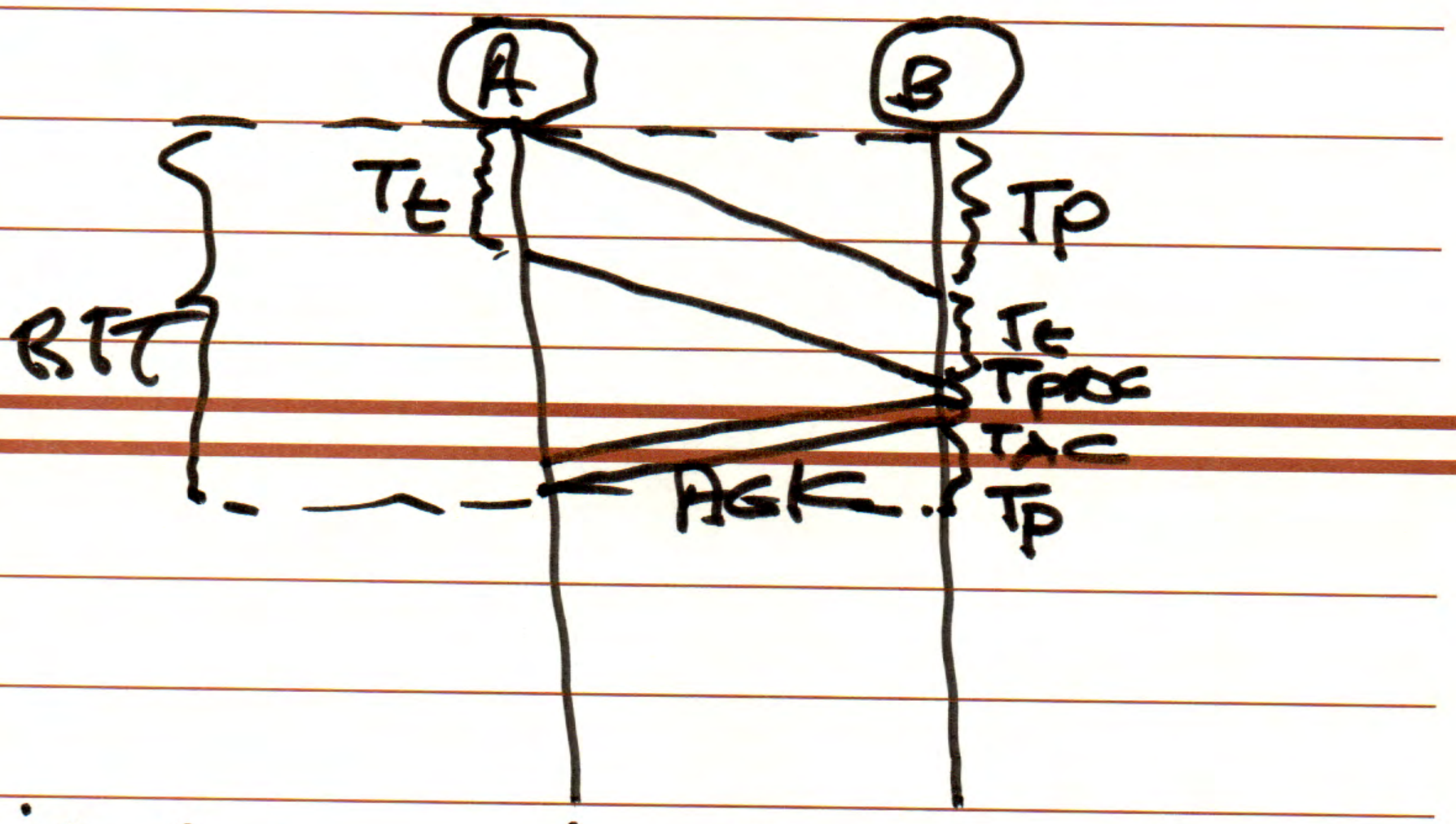
$T_{ACK} + T_p + T_Q + T_{ACK} + T_p$

~~Def~~ 2 $RTT \simeq 4T_p$

Realize that RTT is NOT fixed.

Throughput (bps)

: Rate at which the message is delivered reliably and recognizable fashion.

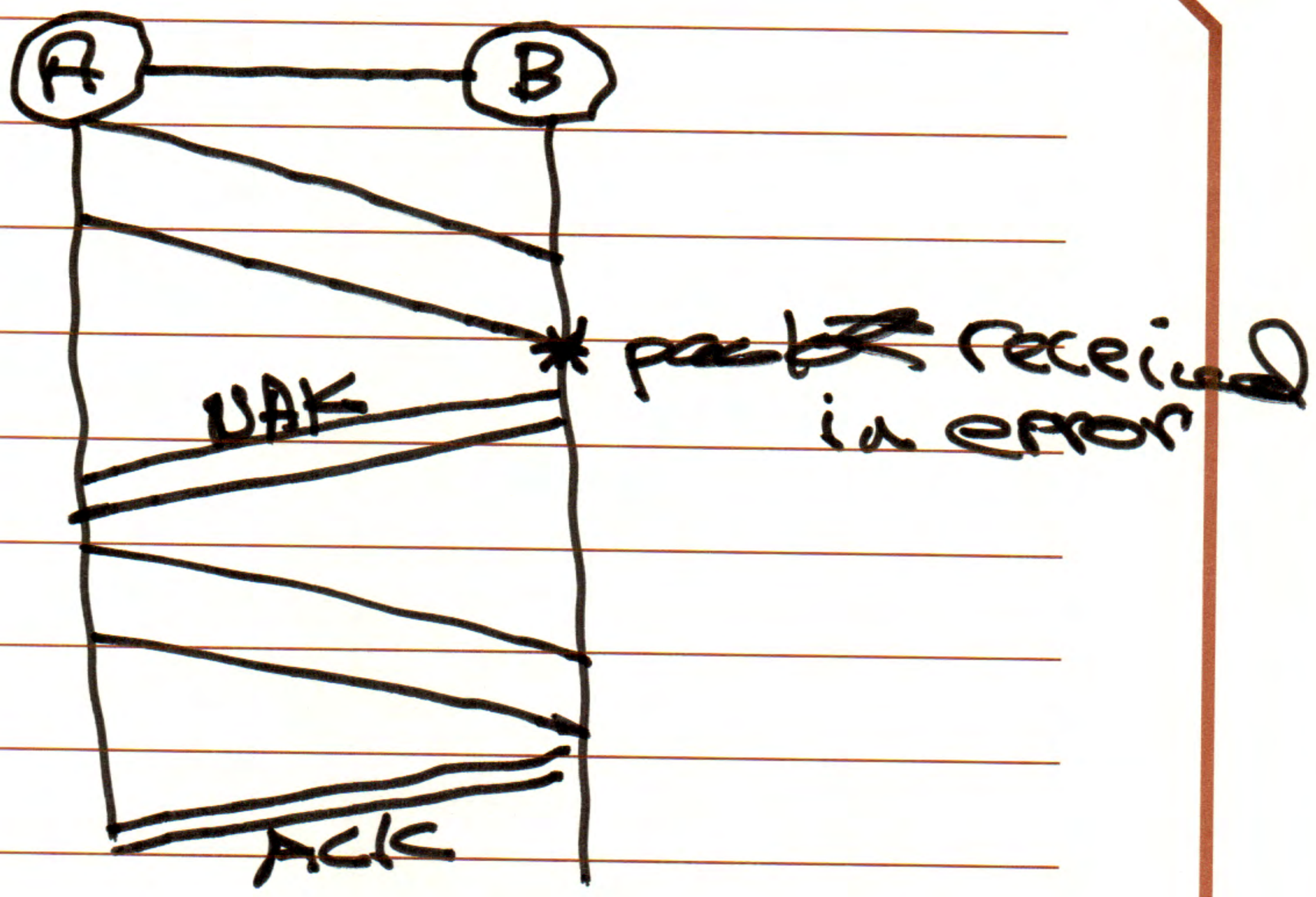


BL (Transmission Time)

$$= \frac{\text{Message length (bit)}}{Tt\ (sec)}$$

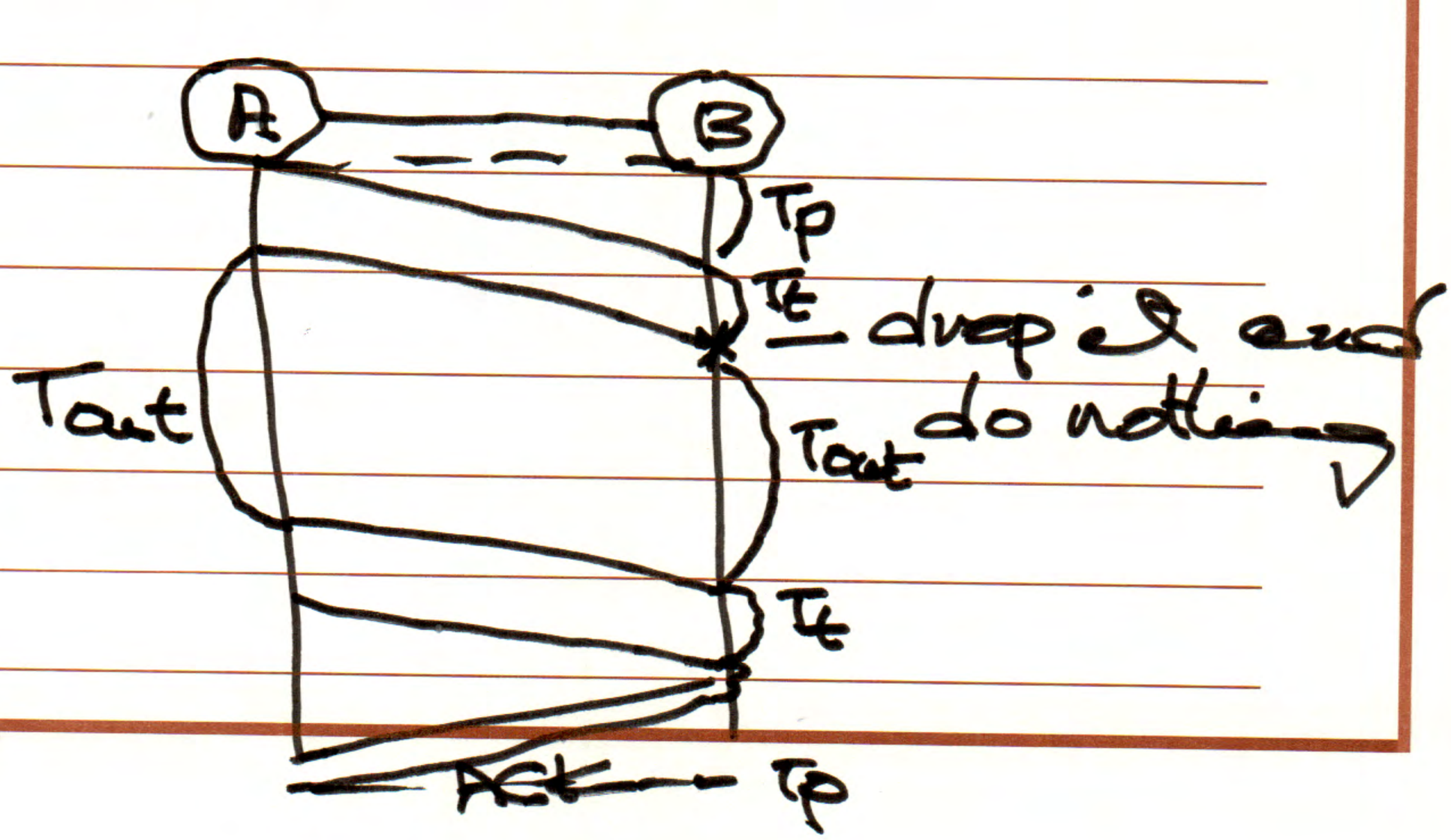
$$\text{Throughput} = \frac{\text{message length (bit)}}{RTT}$$

Bit Rate > Throughput.



Bit rate = $\frac{\text{message length}}{T_t}$

Throughput = $\frac{\text{message length (one)}}{2RTT}$



Bit rate is same.

$$\text{Throughput} = \frac{\text{message length}}{2T_t + 2T_p + T_{out} + \ldots}$$