

LEONARDO SERILLI (UBINET)

PROBLEM 2

$$\text{DOWN-LINK} = 10 \text{ Mbps} = 1250000 \text{ B}$$

$$\text{UP-LINK} = 1 \text{ Mbps}$$

$$\text{PACKET-SIZE} = 1500 \text{ B}$$

$$\text{ACK-SIZE} = 60 \text{ B}$$

$$\text{RTT} = 200 \text{ ms} = 0,2 \text{ s}$$

① If 100% of download link capacity is used, the size of the TCP WINDOW would be:

$$W = \text{DOWN-LINK} \cdot \text{RTT} = 1250000 \cdot 0,2 = 250000 \text{ B}$$

• To store W, 18 bits are needed, but the TCP HEADER's field for the window size is 16 bits only; so the only way to store it is by putting a multiplicator in the OPTION FIELD, and by rescaling W in 16 bits.

② To receive a packet of $\text{PACKET-SIZE} = 1500 \text{ B}$ with a $\text{DOWN-LINK} = 1,25 \text{ MB/s}$, to send a single Byte we need $\frac{1,25}{1500}$, so to send an ACK of $\text{ACK-SIZE} = 60 \text{ B}$ it takes $\frac{1,25}{1500} \cdot 60 = 0,05 \text{ MB/s}$, so $0,05 \cdot 8 = 0,4 \text{ Mb/s}$. So we use 60% of UPLINK.

③ - A

After a loss the window is halved, then is incremented of PACKET-SIZE every RTT. If there is a loss every 5s, then between two consecutive loss the congestion window is incremented by:

$$W = \frac{5s}{\text{RTT}} \cdot \text{PACKET-SIZE} = 25 \cdot 1500 = 37500 \text{ B}$$

// Here W does not refer to the window size

③ - B

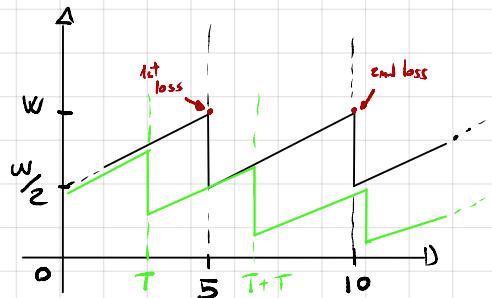
Considering that the window W always back to its original dimension between 2 consecutive loss, the throughput is:

$$X = \frac{L}{S} = \frac{\frac{3}{2}W^2}{\text{RTT} \cdot \frac{W}{2}} \approx 937500 \text{ B/s}$$

4-A

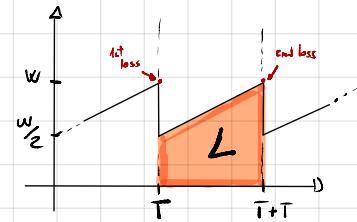
- To permit W , halved for a fail, to get back to its original dimension we need $T=S$ (BLACK FUNCTION IN THE RIGHT DRAWING)

If $T>S$, the window W will decrease after in each fail
on the throughput too (GREEN FUNCTION ON THE RIGHT DRAWING)



- To express X in function of w we just have to consider that L is the AREA under the function W in the interval between 2 consecutive crashes so:

$$X = \frac{L}{S} = \frac{\int_T^{T+S} W dT}{S}$$



4-B

- With $T>S$ Nothing happens until the NETWORK CAPACITY is reached.
- The dimension W of the window must be at most the DOWNLOAD-LINK capacity.
We know that after a failure $W=W_2$ and there is increased of one PACKET-SIZE every RTT,
this means that after each second 7500 B are added to the window size.

Given T :

$$\frac{W}{2} + 7500T \leq \text{DOWNLOAD-LINK} \Rightarrow$$

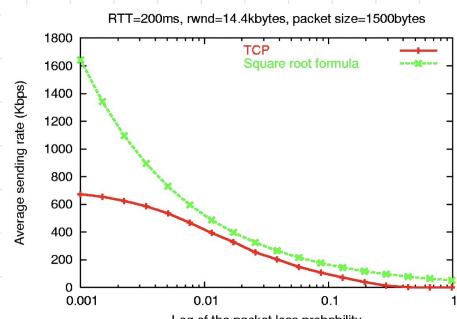
$$\Rightarrow 125000 + 7500 \cdot T \leq 1250000 \Rightarrow$$

$$\Rightarrow T \leq \frac{1250000 - 125000}{7500} = 150$$

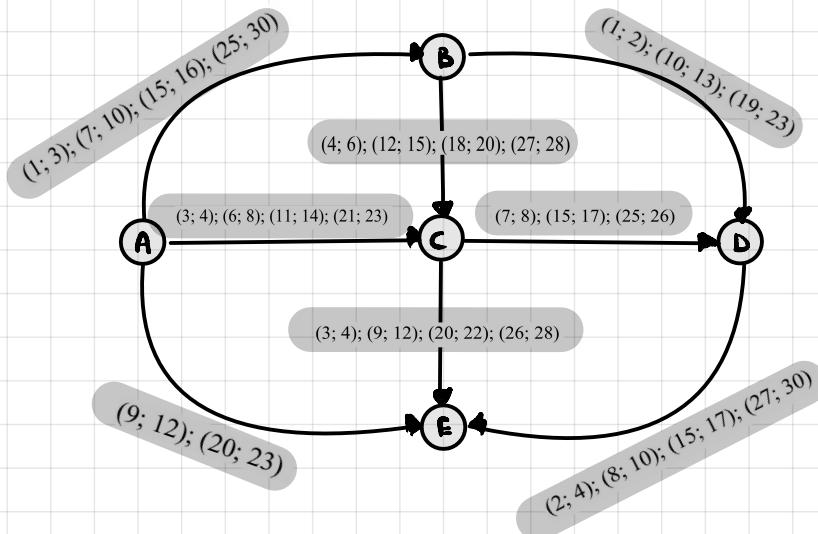
- So for $T \geq 150$ W hits the network capacity

- ## 4-C
- When $T > T_0 | T_0 = 150$ if a new packet is sent, it will be lost for sure, so the probability $p = P(\text{losing a packet}) = 1$

- The Throughput goes down because time-out becomes too frequent as showed in the slides.

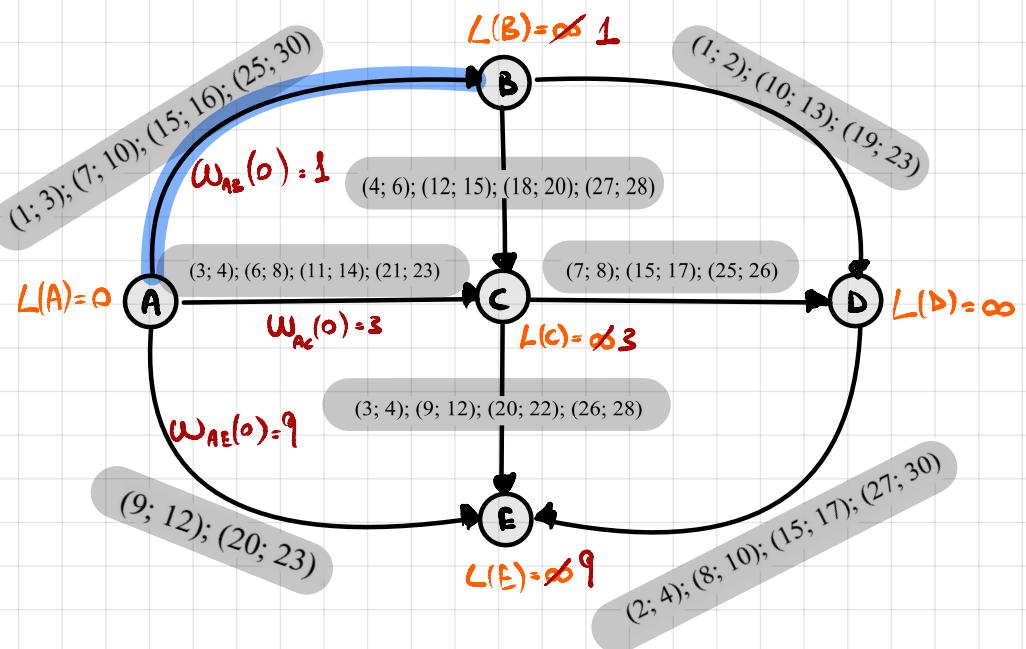


PROBLEM 1

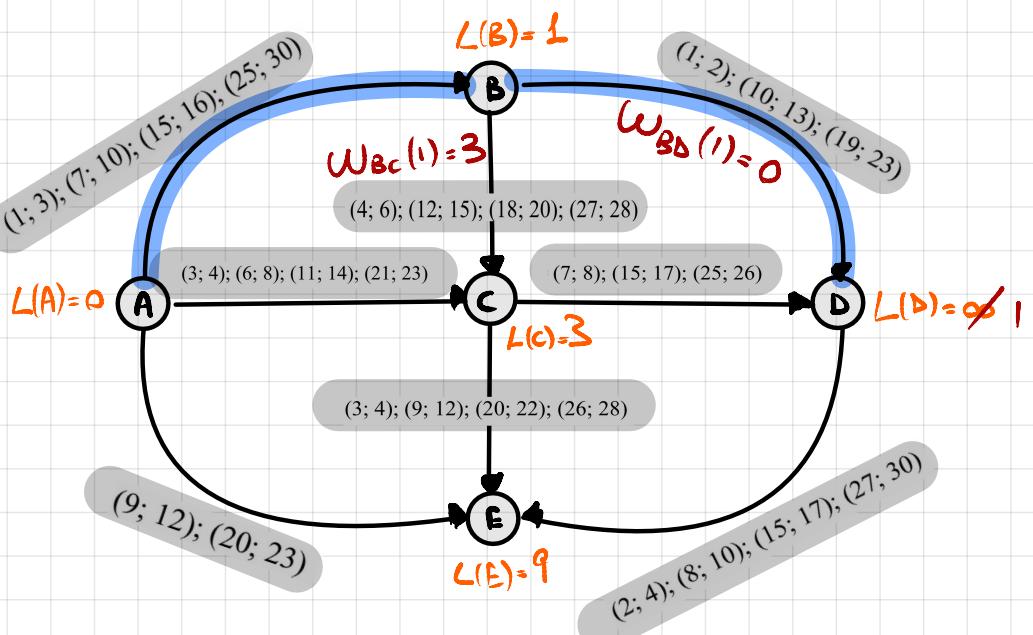


(A)

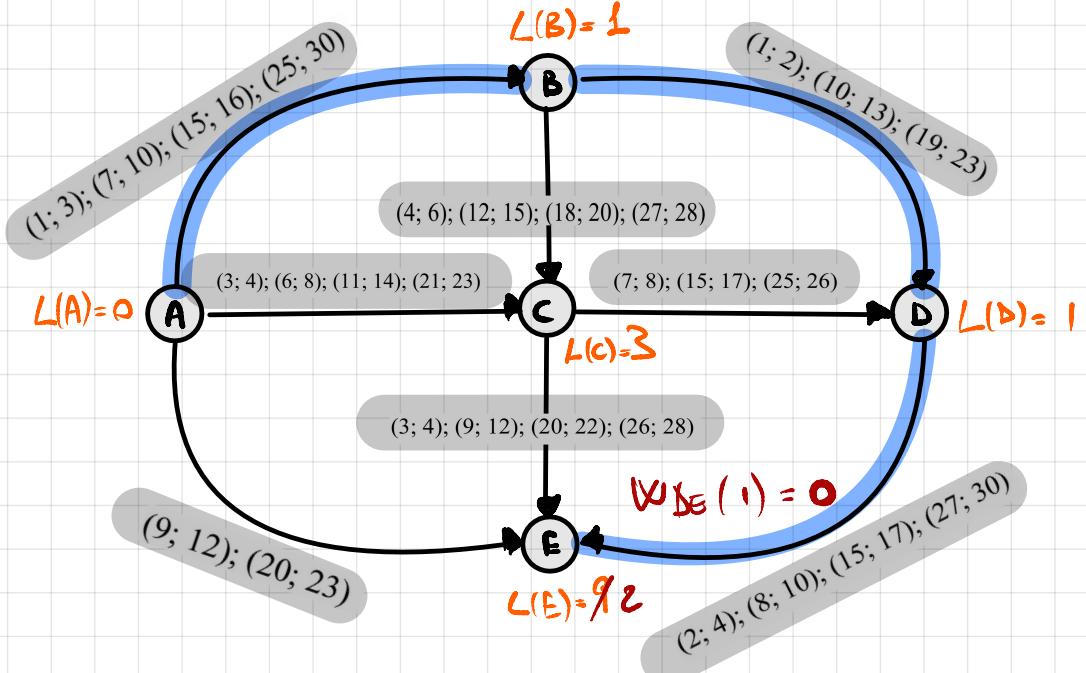
$t = 0$



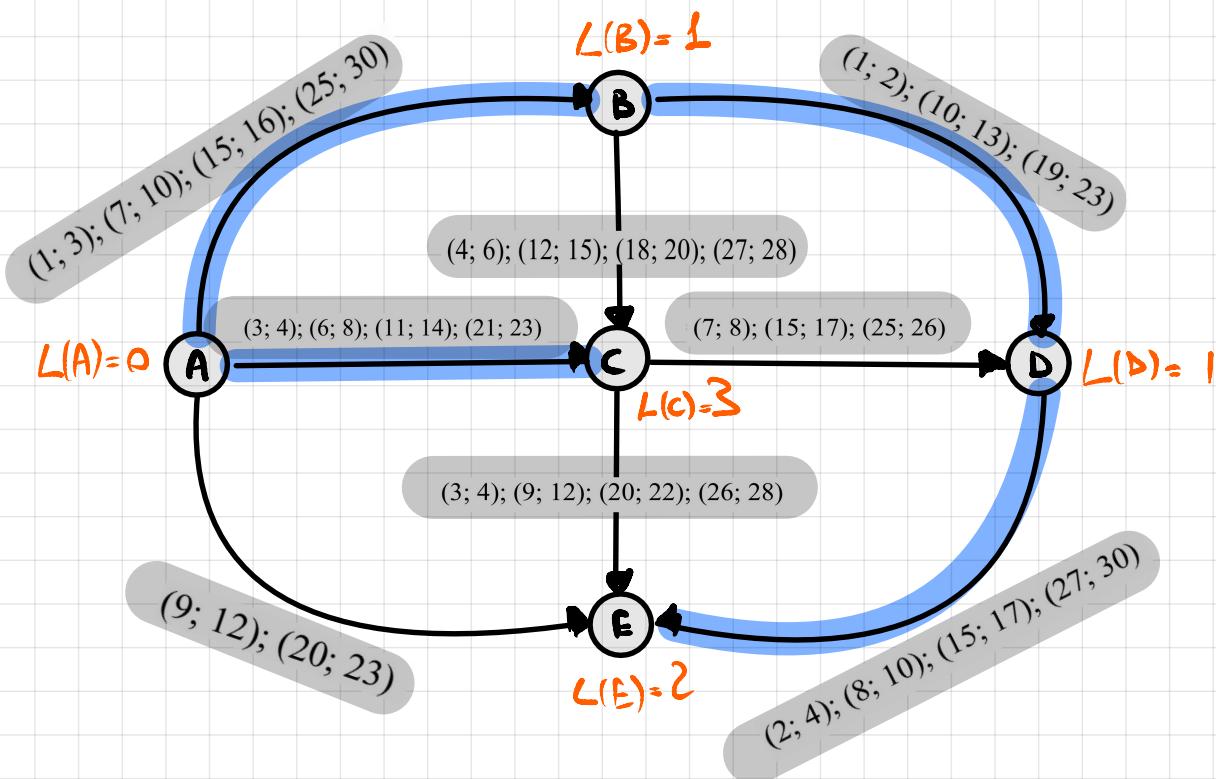
$t = 1$



$t=2$



• FINAL CONFIGURATION



- B** The path doesn't hold; If $t=5$ the mode A cannot send any message, in our path it must wait $t=7$ to reach B and then $t=10$ to finally reach D. Of course we can use the path $A \rightarrow C \rightarrow D$ to deliver at $t=7$.