1.

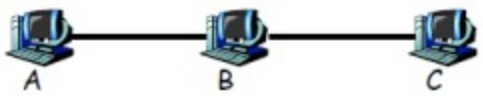
Device A is sending frames to device C via another device B. Devices A and B use a Go-back-N Sliding window protocol with SWS = 3. Devices B and C use SR sliding window with SWS=RWS=4. There are a total of 7 frames (starting with F_0 and ending with F_6) generated at device A and destined to device C. The following information is given:

- Frame length = 1000 bits
- Frame Transmission Time = 1 sec
- One-way Propagation Delay (on each link) is 1 sec.
- Transmission Time for Acknowledgment = 0 (negligible)
- Processing/Queuing Delay = 0 (negligible, at any node)
- Time-out (at both devices A and B) is 4 seconds. The timer, for any frame, starts immediately after the device finish transmitting that frame.
- Acknowledgements are sent on a link per link basis and are NOT relayed (which means when device C receives a frame from device B, device B does not relay the acknowledgement to device A. Sequence number for ACK is that of the "next" frame expected to be received (similar to class notation)
- No accumulative acknowledgements are used (i.e. each frame is acknowledged separately)

Sketch, side-by-side, the Timing diagram for frame transmissions over links A---> B and B---> C under the following scenario:

F_1 and F_4 get lost in their first transmission from A---> B
F_4 gets lost in its first transmission from B---> C

Calculate the Throughput over each link and the end-to-end throughput.



2. Consider the use of 1000 bits frames on a 1 Mbps satellite link with a 270 msec propagation delay.. Find the maximum link utilization for
   a. Stop and Wait Flow Control
   b. Continuous Flow Control with window size 7
   c. Continuous Flow Control with window size 127