Sample Problems (From Previous Exams)

1)

Frames are generated at node A and sent to node C through node B. Determine the minimum data rate on the link connecting nodes B and C so that the buffer at node B does not overflow. The following is given

- Data Rate on link A-B is 100 Kbps
- Propagation delay is 5 μsec/km on both links
- Links are FDX
- Data Frames are 1000 bits long. ACK frames are of negligible length
- Link A-B is 4000 Km, Link B-C is 1000 Km
- "A" can transmit 3 frames to "B" before it has to stop and wait for ACK from "B". While "B" can transmit ONLY one frame to "C" before it has to stop and wait for ACK from "C".

2)

Sender wants to transmit MSG=10011010. The generator pattern is 1101. What is the FCS pattern? What is the transmitted pattern? Suppose the MSB and LSB of the transmitted pattern are flipped (i.e. in error), will the receiver be able to detect the error?

3)

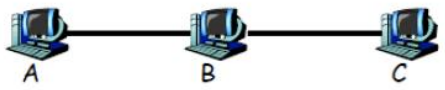
Device A is sending frames to device C via another device B. Devices A and B use a Go-back-N Sliding window protocol with SWS = 3. Devices B and C use SR sliding window with SWS=RWS=4. There are a total of 7 frames (starting with F_0 and ending with F_6) generated at device A and destined to device C. 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.
- On the first link which employs Go–back–N ARQ, the sequence number of the ACK is that of the next frame the receiver expects to receive. On the second link (which uses SR ARQ, the sequence number of the ACK is the same as the frame just received. In addition, the receiver in SR can acknowledge out of order frames individually.
- 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.



Solution

- A -> B:

  Propagation time = 4000 x 5 μsec = 20 msec

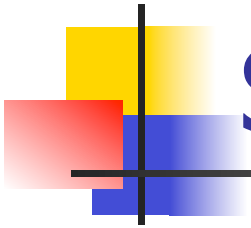
  Transmission time per frame = $\frac{1000}{100 \times 10^3} = 10\text{msec}$

- B -> C:

  Propagation time = 1000 x 5 μsec = 5 msec

  Transmission time per frame = x = 1000/R

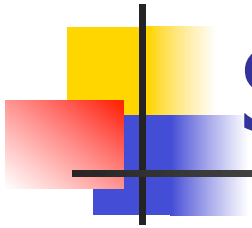
  R = data rate between B and C (unknown)



Solution Continued

- A can transmit three frames to B and then must wait for the acknowledgment of the first frame before transmitting additional frames. The first frame takes 10 msec to transmit; the last bit of the first frame arrives at B 20 msec after it was transmitted and therefore 30 msec after the frame transmission began. It will take an additional 20 msec for B's acknowledgment to return to A.

  Thus, A can transmit 3 frames in 50 msec.



Solution Continued

- B can transmit one frame to C at a time. It takes 5 + x msec for the frame to be received at C and an additional 5 msec for C's acknowledgment to return to B. Thus, B can transmit one frame every 10 + x msec, or 3 frames every 30 + 3x msec. Thus:

$$30 + 3x = 50$$

$$x = 6.66 \text{ msec}$$

$$\underline{\boldsymbol{R = 1000/x = 150 \text{ kbps}}}$$

Sender: Example

- Sender wants to transmit MSG=10011010

  MSG=10011010 , n=8 corresponds to $M(x) = x^7 + x^4 + x^3 + x^1$

  Divisor=1101 , k=3 corresponds to $G(x) = x^3 + x^2 + 1$

- Multiply $M(x)$ by x^k

  In this example, we get:

  $M(x).x^3 = x^{10} + x^7 + x^6 + x^4$ =10011010000

- Divide result by $G(x)$ =1101 (Subtraction or addition is XOR in polynomial arithmetic)

  The remainder is $E(x) = x^2 + 1$ = 101

- Send $P(x) = M(x).x^k + E(x)$ which is exactly divisible by $G(x)$

  i.e. Send 10011010000 + 101 = 10011010101, since this is exactly divisible by $G(x)$ =1101

5. A→B Throughput = 7000/19 = **368.4bps**. B→C Throughput = 7000/(24-2) = **318.2 bps**. A→C Throughput = 7000/24 = **292 bps**