# TCOM 370-99 Homework 7 Due: April 8, 1999

Do All Problems, but turn in only Problems 4, 5, 6, 7, 8, 9

**Problem 1:**

A link has a data rate of 5 Kbps and a propagation delay of 20 ms. For what range of I-frame sizes does the stop-and-wait protocol give an efficiency of at least 50% ? (Error rate is negligible).

**Problem 2:**

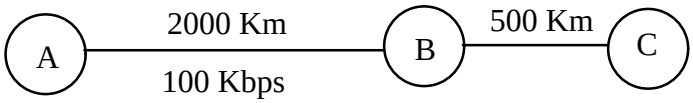
Consider the use of 5000-bit frames on a 1 Mbps satellite channel with a 270 ms. propagation delay. What is the maximum link utilization for

(a) Stop-and-wait flow control?
(b) Continuous flow control with a window size of 7
(c) Continuous flow control with a window size of 255?

**Problem 3: Exer. 4.17 (Halsall)**

**Problem 4: Exer. 4.18 (Halsall)**

**Problem 5:**




In the transmission system above, frames are generated at node A and sent to node C through B.

- Propagation delay is 8 μsec/Km on both links.
- Both links are full-duplex
- Data frames are 800-bit long, ACK frames have negligible length.
- Between A and B, a sliding-window protocol with window size 3 is used.
- Between B and C, stop-and-wait is used.

Determine the minimum data transmission rate required between nodes B and C to ensure that the buffers at node B are not flooded, assuming no errors on the links. (This requires the average number of frames entering and leaving node B over a long time interval to be the same.)

**Problem 6:**

Two transmission links are connected in series. The first is a 10-Km, half-duplex, 10-Kbps coaxial cable. The second is a 5-Km, half-duplex, 5-Kbps coaxial cable. The I-frames in each link are 1000 bits long, and both use Idle-RQ with 100-bit ACK frames. The I-frame and ACK frame error probabilities on the first link are both 0.1. The *bit error probability* for both I and ACK frame bits is $10^{-5}$ on the second link. The propagation speed through the coaxial cables is $2.5 \times 10^5$ Km/s.

What are the minimum time-out periods at the individual transmitters? (ignore processing delays and processing times)
What are the probabilities that frames will require re-transmission on the individual links?
What are the utilization efficiencies on the individual links?
What is the transmission rate achievable through the two links?

**Problem 7:**

A satellite transmission link is to be designed for a rate of 64 Kbps. The propagation time is the time for a signal to propagate up and down through the satellite between the two earth stations, the total travel distance being 90,000 Km. The I-frames and ACK frames are all 1000-bit long, (the ACK frames are "piggybacked" onto return channel I-frames) and processing times are 5 ms. The link is full-duplex between the earth stations. You propose to use the selective-repeat protocol.

What is the minimum window size K that you would recommend?
Assume a frame error probability of 1%. What is the average packet delivery rate with your window size? Compare with a go-back-N protocol.

(propagation speed of electromagnetic waves in free space = speed of light = $3 \times 10^5$ Km/s)

**Problem 8: (from 1997 Exam 2)**

A Go-Back-N ARQ scheme using ACKs and NACKs is implemented on a full-duplex link with the following parameters:

*Transmit window size* K=2, transmitter re-uses a *minimum set of sequence numbers*
*ACK and NACK* frames are of *negligible duration*
*I-frames* are of fixed time-duration $T_{ix}$
One-way *propagation delay = one I-frame duration*
*Processing times* for I-frames, ACK and NACK frames = *half of I-frame duration*
Transmitter *time-out interval = seven I-frame durations;* no receiver time-out interval implemented

(Note that the I-frame duration is the unit of time measurement in this description).

Draw the *frame sequence diagram* for the case where the *second transmitter frame is lost* in transit; all other frames are propagated without error. Indicate when frames are accepted by the receiver. (Extend your diagram to 13 I-frame durations from start of transmission.)

**Problem 9: (from 1997 Exam 2)**

Consider a full-duplex, 30,000 Km satellite link between two earth stations. Each I-frame is no longer than 1200 bits, ACK and NACK frames are 300 bits long, and all frames include 4 bits for a sequence number. Data rate in both directions is 60 Kbps. Propagation delay is 3.33 μsec/Km. Processing delays and processing times are negligible. You have a choice of using Idle RQ, Go-Back-N, or Selective Repeat (SR). For this link,

(a) What is the maximum utilization factor for Idle RQ ?

(b) What are the maximum transmit and receive window sizes for SR ?

(c) What are the maximum transmit and receive window sizes for Go-Back-N?

(d) What are the maximum utilization factors for (i) SR and (ii) Go-Back-N?

(e) Suppose I-frames are badly hit and have an error rate of $P_f = 10^{-1}$. (ACK and NACK frames always come through without error.) Which protocol will give you the best utilization factor ?

[Given: For Go-Back-N with transmit window size K, frame error probability $P_f$, and considering *only* propagation delay $T_p$ and I-frame duration $T_{ix}$, the utilization factor is

$$\mathbf{U_{with\ error} = U_{no\ error}} \frac{\mathbf{1-P_f}}{\mathbf{1-P_f + \min\{(1+2a),K\}P_f}} \qquad \text{where } a=\frac{T_p}{T_{ix}} \ ]$$

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***Do Problems 3 and 4 in TCOM 370 1998 Exam 3 as part of your review of this material. (Do not turn in).***

**also**

**You should be able to do problems like the following from Halsall:**
**(Do not turn in)**
**Exercise 4.8**
**and**
**Exercises 4.1, 4.3, 4.4, , 4.9, 4.10, 4.12, 4.15 (you may ignore selective reject)**
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