CSCI 415 Computer Networks
Homework 4
Due 03/12/08

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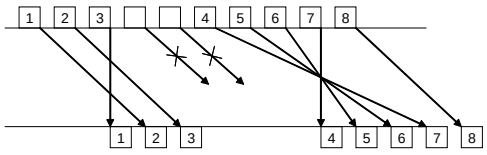
Problem 1: Sliding window algorithm
The sliding window algorithm with unbounded sequence numbers is given in the notes. Upon receiving an RN, the sender checks if $RN > SN$ and slides the window. Similarly, upon receiving an SN, the receiver checks if $SN = RN$ and slides the window. Describe the modifications needed (if any) for these two rules when the sequence numbers are sent modulo p (bounded).

Problem 2: Modulus without FIFO
Assume that a sliding window algorithm is used but the FIFO property does not hold. Instead, consider only frames that are sent and received (possibly with error). If a frame is the i^{th} frame sent and the j^{th} frame received, then $|i - j| \leq K$. Note that when $K = 0$, we have the FIFO property.
Here's an example scenario with $K = 3$.



(a) Show that if the receiver receives SN at time t, then

$$RN(t) - n - K \leq SN \leq RN(t) + n - 1$$

(b) Show that if the sender receives RN at time t, then

$$SN(t) - Kn \leq RN \leq SN(t) + n$$

(c) Assume that the receiver slides the window by one position at a time and sends the appropriate RN, but nothing is lost so it either arrives error-free or with errors. Show that part (b) can be modified as follows:

$$SN(t) - K \leq RN \leq SN(t) + n$$

(d) Based on parts (a) and (c), what would be a sufficient modulus to use for this non-FIFO setting?

Problem 3: Link initialization protocols

(a) Consider an unbalanced Master-Slave protocol for link initialization in which either A or B can be the Master at any point in time. In other words, both A and B can initialize and disconnect the link. Show by constructing a sequence of INIT and DISC messages (and appropriate ACKs) that, in the presence of message loss, A can reveice a DISC before determining that the link is up.

(b) Consider the same protocol above but with the following modification: the last ACK (whether ACKI or ACKD) is piggybacked on every INIT or DISC. Show that this modification avoids the situation in part (a) assuming that ACKs are acted upon first.

(c) Construct a sequence of INIT and DISC messages (with appropriate ACKs and piggybacked ACKs) in such a way that, in the presence of message loss, B considers the link to have gone through an up period followed by a down period, while A constantly thinks that the link is down.

(d) Show that the balanced Master-Slave protocol described in class avoids the situation in part (c) assuming that ACKs are acted upon first.