National University of Singapore
School of Computing

CS2105 **Problem Set 4** Semester 2 05/06

1. **(KR, Chapter 3, Problem 16)** Consider the Go-Back-N protocol with a sender window size of 3 and a sequence number range of 1,024. Suppose that at time $t$, the next in-order packet that the receiver is expecting has a sequence number of $k$. Assume that the medium does not reorder messages. Answer the following questions:
   (a) What are the possible sets of sequence numbers inside the sender's window at time $t$? Justify your answer.
   (b) What are the possible values of the ACK field in all possible messages currently propagating back to the sender at time $t$? Justify your answer.

2. **(KR, Chapter 3, Problem 18)** Consider the Go-Back-N and selective-repeat protocols. Suppose the sequence number space is of size $k$. What is the largest allowable sender window that will avoid the occurrence of problems such as that in Figure 3.27 for each of these protocols?

3. **(CS2105 Final Exam, Nov 2005, Question 3)**

   *This question assumes slightly different protocols, where packets are retransmitted immediately upon receiving duplicate ACK due to packet corruption. The protocols developed in our class retransmit only after timeout. Although the protocols are different, the principles behind answering this question remains the same.*

   Consider a data communication channel with a sending rate $R = 1.5 \times 10^6$ bps and a propagation delay of $d = 5$ ms, and a transport layer protocol with 5000 byte segments, no headers and neglible-sized acknowledgements. Suppose we wish to send a file of size $1.5 \times 10^8$ bits:
   (a) Given that 10% of the packets are corrupted, how long will it take, on average, to send the file using Stop-and-Wait ARQ? Assume that resent packets are always received correctly.
   (b) Calculate the link utilization for part (a).
   (c) Given a Go-Back-N sliding window protocol with window size of $N$, derive for the worst-case scenario, an expression relating, the number of packets re-sent (due to packet corruption) to the RTT. Assume a propagation delay of $d$, all packets are $L$ bits long and the transmission rate is $R$ bits per second.
   (d) In general, in the worst-case scenario, the number of packets that need to be re-transmitted due to packet loss is more than the number of packets that need to be re-transmitted due to packet corruption. Why?