

18-345
Introduction to Telecommunication Networks
Homework 3

October 1, 2007

Due: October 8, 2006

1.

Find the optimum frame length n_f that maximizes transmission efficiency for a channel with random bit errors by taking the derivative and setting it to zero for the following protocols:

- a. Stop-and-Wait ARQ.
- b. Go-Back-N ARQ (approximation ok, i.e. $1-(1-p)^n \approx np$ for $np \ll 1$).
- c. Selective Repeat ARQ.
- d. Find the optimum length in all the above protocols for a 1 Mbps channel with 10 ms reaction time, 25-byte overhead, 25-byte ACK frame, and $p = 10^{-4}$, 10^{-5} , and 10^{-6} .

2.

A point-to-point communication system uses 20 Kbyte data packets (including header and CRC) and 100 byte acknowledgment packets. A CRC is calculated over each of the packets, and is sent with the packet. Consider a situation which has information packets flowing only from node A to node B. Assume that the sequence number ranges from 0 to 5 and then wraps-around to 0.

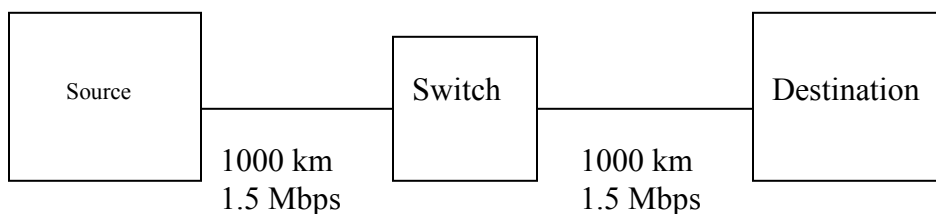
Draw what happens if the second and third packets transmitted by node A are corrupted, and the fourth packet transmitted by node B is corrupted for each of the cases given below. The rest of the packets are successfully received.

By restricting your attention to the time-span in which 6 successful information packets are transmitted from node A to node B (6 distinct packets, not duplicates), calculate the efficiency from each drawing. Assume that the timeout period is slightly greater than $T_{\text{TRANS-P}}$ (packet transmission time) + $T_{\text{TRANS-A}}$ (ack transmission time) + $2 * T_{\text{PROP}}$ (propagation time), and that the processing time is negligible.

- a. The two nodes use Stop and Wait ARQ, and only positive acknowledgment packets (ACK) are sent by B.
- b. The two nodes use the GBN ARQ protocol, where only positive acknowledgment packets (ACK) are sent by B. Assume the window size is 3.

- c. The two nodes use SRP ARQ, where only positive acknowledgment packets (ACK) are sent by B. Assume the window size is 3.

3. A 64KB message is transmitted from source to destination, as shown below. The network limits packets to a max size of 2KBytes of payload and each packet also has a 32-bit header. The transmission lines in the network have a bit error rate of 10^{-6} , and Stop and Wait ARQ is used in each transmission line. How long does it take on average to get the message from source to destination? Assume the signal propagates at speed 2×10^5 km/second, and that all processing times and the transmission times for ACKs are negligible. Also, remember that 1KB = 1024 bytes



4. Consider the virtual-circuit packet network shown in Figure 7.23 in Leon-Garcia. Suppose that node 4 in the network fails. Reroute the affected virtual circuits and show the new set of routing tables.

5. M terminals are attached to a dedicated pair of lines to a hub in star topology. The distance from each terminal to the hub is d meters, the speed of transmission is R bits/s all frames are of length 12,500 bytes, and the signal propagates on the line at a speed of 2.5×10^8 meters/s. For the four combinations of the following parameters ($d=25$ meters, $d=2500$ meters; $R = 10$ Mbps, $R=10$ Gbps), compare the maximum network throughput achievable when the hub is implementing slotted ALOHA and CSMA-CD.

What conclusions can be drawn about these two methods?