EEL4598/5718: Computer Communications

Homework 3

3.60

Let $g(x) = x^3 + x + 1$. Consider the information sequence 1001.

a. Find the codeword corresponding to the preceding information sequence.

b. Suppose that the codeword has a transmission error in the first bit. What does the receiver obtain when it does its error checking?

4.3

Suppose that a frequency band W Hz wide is divided into M channels of equal bandwidth.

a. What bit rate is achievable in each channel? Assume all channels have the same SNR.

b. What bit rate is available to each of M users if the entire frequency band is used as a single channel and TDM is applied?

c. How does the comparison of (a) and (b) change if we suppose that FDM requires a guard band between adjacent channels? Assume the guard band is 10% of the channel bandwidth.

4.4

In a cable television system (see section 3.8.2), the frequency band from 5 MHz to 42 MHz is allocated to upstream signals from the user to the network, and the band from 550 MHz to 750 MHz is allocated for downstream signals from the network to the users.

a. How many 2 MHz upstream channels can the system provide? What bit rate can each channel support if a 16-point QAM constellation modem is used?

b. How many 6 MHz downstream channels can the system provide? What bit rates can each channel support if there is an option of 64-point or 256-point QAM modems?

4.49

Explain where the following fit in the OSI reference model:

a. A 4 kHz analog connection across the telephone network.

b. A 33.6 kbps modem connection across the telephone network.

c. A 64 kbps digital connection across the telephone network.

4.61

Suppose that setting up a call requires reserving N switch and link segments.

a. Suppose that each segment is available with probability p. What is the probability that a call request can be completed?

b. In allocating switch and transmission resources, explain why it makes sense to give priority to call requests that are almost completed rather than to locally originating call requests.

5.11

Consider the Stop-and-Wait protocol as described in the chapter. Suppose that the protocol is modified so that each time a frame is found in error at either the sender or receiver, the last transmitted frame is immediately resent.

a. Show that the protocol still operates correctly.

b. Does the state transition diagram need to be modified to describe the new operation?

c. What is the main effect of introducing the immediate-retransmission feature?

5.12

In Stop-and-Wait ARQ why should the receiver always send an acknowledgment message each time it receives a frame with the wrong sequence number?

5.15

A 1 Mbyte file is to be transmitted over a 1 Mbps communication line that has a bit error rate of $p = 10^{-6}$.

a. What is the probability that the entire file is transmitted without errors? Note for n large and p very small, $(1-p)^n \approx e^{-np}$.

b. The file is broken up into N equal-sized blocks that are transmitted separately. What is the probability that all the blocks arrive without error? Is dividing the file into blocks useful?

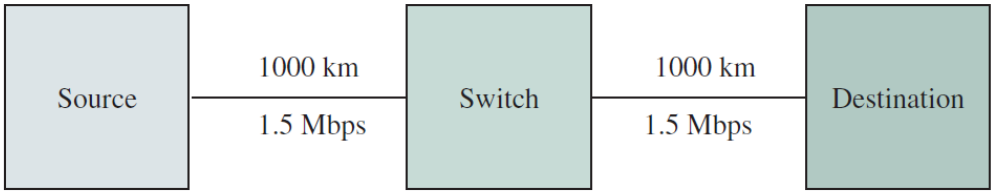
c. Suppose the propagation delay is negligible, explain how Stop-and-Wait ARQ can help deliver the file in error-free form. On the average how long does it take to deliver the file if the ARQ transmits the entire file each time?

d. Now consider breaking up the file into N blocks. (Neglect the overhead for the header and CRC bits.) On the average how long does it take to deliver the file if the ARQ transmits the blocks one at a time? Evaluate your answer for $N = 80$, 800, and 8000.

e. Explain qualitatively what happens to the answer in part (d) when the overhead is taken into account.

5.18

A 64-kilobyte message is to be transmitted from the source to the destination, as shown on the next page. The network limits packets to a maximum size of two kilobytes, and each packet has a 32-byte 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 the average to get the message from the source to the destination? Assume that the signal propagates at a speed of 2×10^5 km/second.



5.25

Consider the Go-Back-N ARQ protocol.

a. What can go wrong if the ACK timer is not used?

b. Show how the frame timers can be maintained as an ordered list where the time-out instant of each frame is stated relative to the time-out value of the previous frame.

c. What changes if each frame is acknowledged individually instead of by using a cumulative acknowledgment (R_{next} acknowledges all frames up to $R_{next} - 1$)?

5.32

Suppose that Selective Repeat ARQ is modified so that ACK messages contain a list of the next *m* frames that the transmitter expects to receive.

a. How does the protocol need to be modified to accommodate this change?

b. What is the effect of the change on protocol performance?

5.33

A telephone modem is used to connect a personal computer to a host computer. The speed of the modem is 56 kbps and the one-way propagation delay is 100 ms.

a. Find the efficiency for Stop-and-Wait ARQ if the frame size is 256 bytes; 512 bytes. Assume a bit error rate of 10^{-4}.

b. Find the efficiency of Go-Back-N if three-bit sequence numbering is used with frame sizes of 256 bytes; 512 bytes. Assume a bit error rate of 10^{-4}.

Additional problems:

A1.

a. Give a daily life example for Time Division Multiplexing.
b. Give a daily life example for Frequency Division Multiplexing.
c. Give a daily life example for Code Division Multiplexing

A2.

Give a scenario in which circuit switching is more efficient than the packet switching. Give an example to show that packet switching is better than circuit switching.

A3.

Assuming that the largest sequence number for GBN is 15, explain why the transmission window size cannot be chosen to be 16.

A4.

For the stop-and-wait protocol, under perfect channel condition (i.e., there is no channel error), what would happen if the acknowledgment is not used by the receiver while only negative acknowledgment is used? What would happen to GBN under the same scenario?