Duke UNIVERSITY

HW 1: ECE 356/ COMPCSI 356: Computer Network Architectures

Homeworks must be done individually. The homework is due at 11:59 PM on 02/19/2024. Please submit your solutions as a single PDF file via Canvas. Show all steps of your derivations.

1. (10 pts) Suppose a 128-Kbps point-to-point link is set up between Earth and a rover on Mars. The distance from Earth to Mars (when they are closest together) is approximately 55 Gm, and data travels over the link at the speed of light 3×10^8 m/s.
(a) Calculate the minimum RTT for the link.
(b) Calculate the delay × bandwidth product for the link.
(c) A camera on the rover takes pictures of its surroundings and sends these to Earth. How quickly after a picture is taken can it reach Mission Control on Earth? Assume that each image is 5 MB in size.

2. (5 pts) Show the 4B/5B encoding, and the resulting NRZI signal, for the following bit sequence:
1110 0101 0000 0011

3. (5 pts) Assuming a framing protocol that uses bit stuffing, show the bit sequence transmitted over the link when the frame contains the following bit sequence:

110101111001011111101011111110

Mark the stuffed bits in bold.

4. (5 pts) Suppose the following sequence of bits arrives over a link:

110101111101011111001011111110

Show the resulting frame after any stuffed bits have been removed. Indicate any errors that might have been introduced into the frame.

5. (10 pts) Suppose we want to transmit the message 11001111 and protect it from errors using the CRC polynomial x^3+1.

(a) Use polynomial division to determine the message that should be transmitted.

(b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of receiver's CRC calculations? How does the receiver know that an error has occurred?

6. (10 pts) Suppose you are designing a sliding window protocol for a 1-Mbps point-to-point link to the stationary satellite evolving around the Earth at an altitude of 3×10^4 km. Assuming that each frame carries 1 KB of data, what is the minimum number of bits you need for the sequence number in the following cases? Assume the speed of light is 3×10^8 m/s.

(a) RWS=1

(b) RWS=SWS

7. (10 pts) Draw a timeline diagram for the sliding window algorithm with SWS = RWS = 3 frames. Assume frame 4 is lost. Use a timeout of approximately 2 x RTT. Frame index starts from 1.