Université d'Ottawa
Faculté de génie

École de science informatique
et de génie électrique

uOttawa

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University of Ottawa
Faculty of Engineering

School of Electrical Engineering
and Computer Science

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Professor: Miguel Garzón
Room: STE 5026B
Phone: (613)562-5800 x 2129
Email: mgarzon@uottawa.ca

Assignment 2
Weight: 5%
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1. **[9 marks]** Test if the following code words are correct, assuming they were created using an **even parity Hamming Code**. If one is incorrect, indicate what the correct code word should have been. Also, indicate what the original data was. **(3 marks each)**
   a. 010101101011
   b. 111110001100
   c. 000000001010

2. [5 marks] The sequence XXXXXXXX1010100100010101 represents the computed codeword after performing the **checksum** operation. What are the unknown values (Xs)?

3. [15 marks] A 7000-byte TCP segment (6980 of data and 20 bytes of header) is carried by an IP datagram with **one-byte option**. The IP datagram with Identification of 0000H is to be transmitted and needs to be fragmented because it will pass through an Ethernet (N1) with a MTU of 1200 bytes. Show the Identification, Total Length, More Flag, and Fragment Offset values in each of the resulting fragments. The above fragmentations will have to go through another Ethernet (N2) with a MTU of 700 bytes. Again, show the Identification, Total Length, More Flag, and Fragment Offset values in each of the resulting fragments. Assume all the fragments will have one-byte option like the original IP datagram.

4. **[12 marks]** A German company called SevenOne obtains a Class B block address**, 190.100.0.0.** Please help the company partition the network into the needed number of sub-networks, by identifying the subnet mask, assigning addresses to each of the sub-networks and assigning needed IP addresses computers. The company requires 500 subnets and around 120 hosts per subnet. Show all the details of your work.

5. [10 marks] Assume that fifteen 800-bps terminals, a number of 400-bps terminals, and thirty 200- bps terminals are to be time-multiplexed in a character-interleaved format over a 20,800-bps synchronous line. All the terminals are asynchronous and send 10 bits/character (7 bits of data, 1 parity bit, 1 start bit and 1 stop bit). In the synchronous frame, one synchronization

character start the frame that can be no longer than 200 characters (including synchronization characters). Define following multiplexer requirements for maximum efficiency:
   a. Determine the number of bits in characters received from the terminals that are saved in the multiplexer's frame.
   b. Determine the number of 400-bps terminals that can be accommodated.

6. [5 points] Data is transmitted on a half-duplex link at a bit rate of 9.2 kbps using the Stop and Wait strategy. The frames have a length of 1024 bits. If the propagation delay is 15 ms and the processing and confirmation time can be neglected,
Determine:
   a) Throughput without the presence of errors
   b) Throughput in the presence of a 10-4 BER

7. [16 marks] Your task in this question is to analyze a link between two computer systems and recommend a configuration. One system is located in Halifax and the other in Vancouver. A service provider of a physical link, that includes two modems, has provided the following information:
   - The propagation delay is 18 ms.
   - The provider guarantees a minimum SNRdB=38 dB.
   - The provider guarantees a maximum BER=10^{-9}.
   - The provider guarantees a minimum bandwidth of 30000 Hz (in each direction).
   - The modems use QAM-64.

In your analysis, you have been requested to determine the following:
   1) **[5 marks]** The maximum baud rate and data rate of the modems. (Assume that the maximum capacity of the channel may not exceed 80% of the Shannon capacity).

   2) **[6 marks]** The computer systems employ the HDLC protocol for data exchange. Determine how HDLC is configured to maximize the data rate across the link. In particular, determine the connection type (NRM, SABM, etc.), sequence numbers used, and the size of the sliding window. Assume
      a. That the Go-Back-N error recovery protocol is used.
      b. That data frames (i.e. I-frames) can be as long as 200 bytes.
      c. That the CRC-16 is used for error detection.
      d. That error rate is negligible for your analysis.
   3) **[5 marks]** Determine the effective data rate can be exchanged across the data link.

8. [16 marks] A block of addresses 190.100.0.0/17 is allocated to an ISP (service provider to Internet). The ISP should distribute these addresses to three groups of customers as follows:

The first group has 128 clients; each customer needing 60 addresses
The second group has 64 clients; every customer needing 122 addresses
The third group has 256 clients; every customer needing 28 addresses

Show the address distribution for each group. Include the subnet mask, the first, second and last address of each group. In addition, answer the following questions:

- What is the total number of addresses allocated to the ISP? _____
- What is the total number of addresses allocated by the ISP? _____
- What is the total number of available addresses (unallocated)? _____

9. [12 marks] The HDLC is used. Both the N(S) and N(R) are 3 bits. The sliding window size is 7. Before sending from "I,0,0", the frames in the sender sliding window of A and B are 0, 1, 2, 3, 4, 5, and 6. Draw A's and B's sender sliding window after steps (1), (2), (3), (4), (5), (6), (7), (8) and (9) by clearly identifying left wall, middle wall, and right wall of the sliding window.