Tutorial 6 Solutions

Instructions

1. Form ad-hoc groups of 2 to 3 students to solve this week's exercise.
2. Each group must answer the following review Q's
3. Each group will use shared google docs to work with all group members and tutor. The document must include the group members' names and the tutorial sheet number.

Review Questions

1. Q5-1. Distinguish between communication at the network layer and communication at the data-link layer.

   Communication at the network layer is host-to-host; communication at the data-link layer is node-to-node.

2. List some basic functions performed at the Data Link Control (DLC)
   The data link control deals with procedures for communication between two adjacent nodes in the network. Functions include:
   - framing - how to organize the bits that are carried by the physical layer.
   - flow and error control - Techniques for error detection are discussed at the end of this section.
   - Error detection and correction.

3. List some basic functions performed at the MAC layer.
   - On transmission, assemble data into a frame with address and error-detection fields.
   - On reception, disassemble frame, and perform address recognition and error detection.
   - Govern access to the LAN transmission medium.

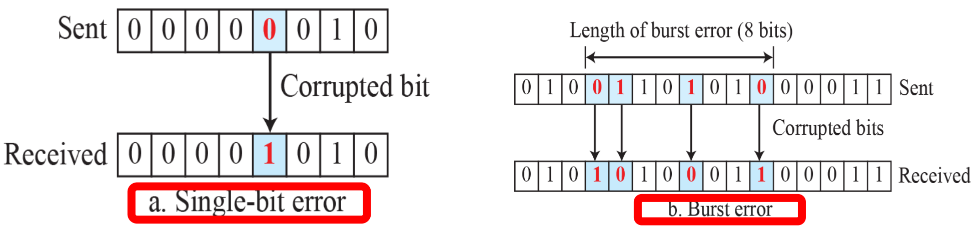
4. List some basic functions performed at the LLC layer.
   - Frames the network layer packet
   - Identifies the network layer protocol
   - Provides flow control
   - Provides error control
   - And perform Link management.

5. Q5-3. Explain why flags are needed when we use variable-size frames.

   In variable-size framing, flags are needed to separate a frame from the previous one and the next one.

6. Q5-5. How does a single-bit error differ from a burst error?

   In a single-bit error, only one bit of a data unit is corrupted; in a burst error more than one bit is corrupted (not necessarily contiguous).



7. Q5-7. In a block code, a dataword is 20 bits and the corresponding codeword is 25 bits. What are the values of k, r, and n according to the definitions in the text? How many redundant bits are added to each dataword?

   In this case,
   k =DATAWORD= 20,
   r= REDUNDANT-BITS = 5, and
   n= CODEWORD = 25.
   Five redundant bits are added to the **dataword** to create the corresponding **codeword**.

8. Q5-9. What is the minimum Hamming distance?

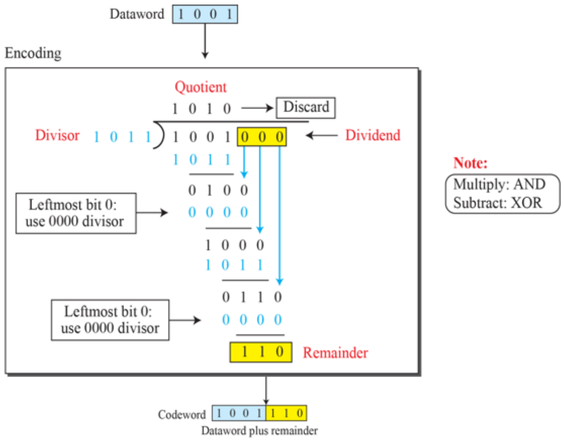
   The minimum Hamming distance is the smallest Hamming distance between all possible pairs in a set of words.
   Hamming Distance: *In information theory, the Hamming distance between two strings of equal length is the number of positions at which the corresponding symbols are different. In other words, it measures the minimum number of substitutions required to change one string into the other, or the minimum number of errors that could have transformed one string into the other.*
   Example:

   1. The Hamming distance ***d***(000, 011) is 2 because (000 ⊕ 011) is 011 (two 1s).
   2. The Hamming distance ***d***(10101, 11110) is 3 because (10101 ⊕ 11110) is 01011 (three 1s).

9. If the Divisor is 10011 and the **Dataword** is **"1010101010"** Find the **Codeword** with the help of Figure-5.13, which shows the method to calculate the Cyclic Redundancy check (CRC) encoder at the Transmitter. *Note this is also called as Frame Check Sequence (FCS) used in the Datalink layer for FRAMES in error detection*?

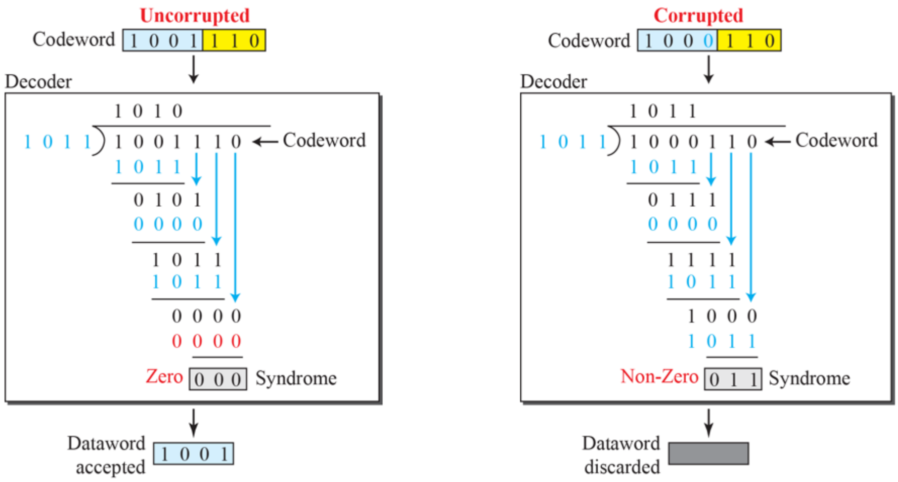
   In the second part of the calculations if the received **Codeword** is **"10101010100110"** verify with the help of Figure-5.14, if the data Integrity of codeword is Valid or NOT?

Figure 5.13: Division in CRC encoder

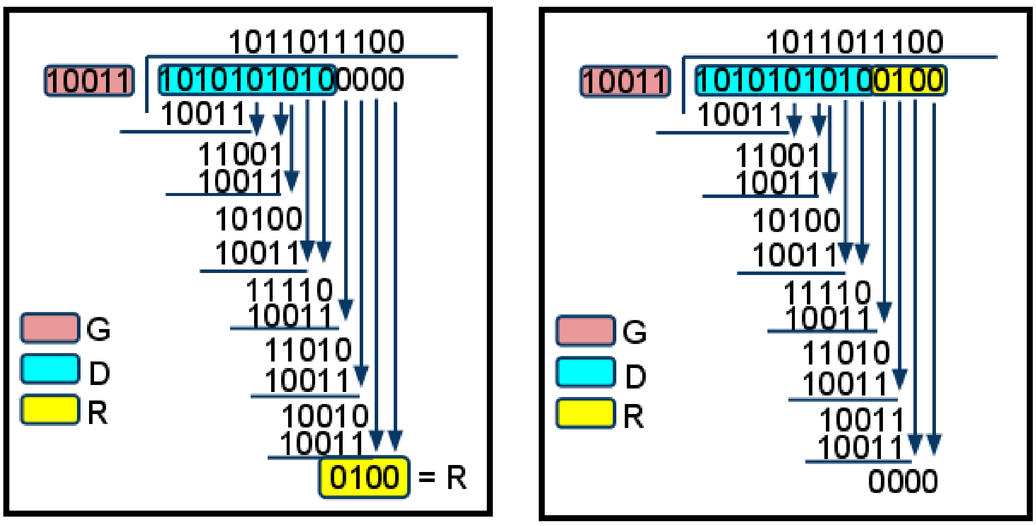


A	B	A **XOR** B
0	0	0
0	1	1
1	0	1
1	1	0

A	B	A **AND** B
0	0	0
0	1	0
1	0	0
1	1	1



Solution:



10. Q5-19. Explain why there is only one address field (instead of two) in an HDLC frame.

    The address field in the HDLC network defines the address of the secondary station (as the sender or receiver); the primary station, which is always unique, does not need an address.

11. List and briefly define three versions of ARQ?

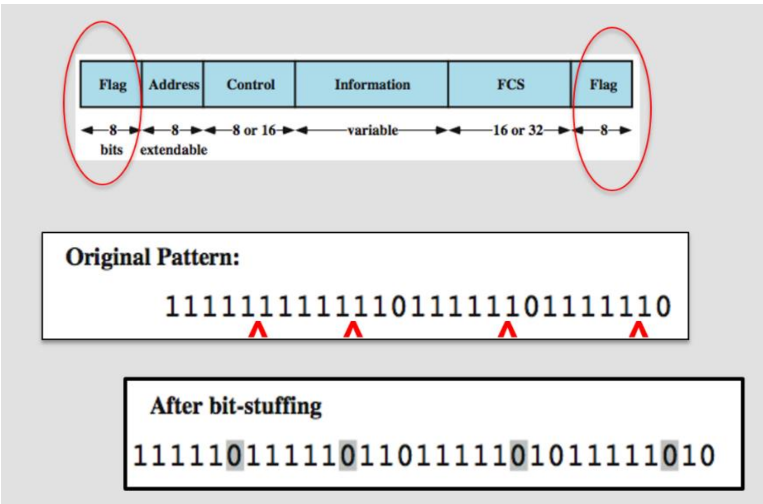
    - **Stop-and-wait ARQ:** Based on stop-and-wait flow control. A station retransmits on receipt of a duplicate acknowledgment or as a result of a timeout.
    - **Go-back-N ARQ:** Based on sliding-window flow control. When an error is detected, the frame in question is retransmitted, as well as all subsequent frames that have been previously transmitted.
    - **Selective-reject ARQ**. Based on sliding-window flow control. When an error is detected, only the frame in question is retransmitted.

12. Define what data transparency or bit stuffing is HDLC protocol? Explain how bit stuffing is achieved?

    Data transparency or bit stuffing refers to the ability to include arbitrary bit patterns in the data field of a frame without any pattern being confused with part of the control information in the frame. This is achieved by bit stuffing.

    Flag fields **delimit** the frame at both ends with the unique pattern **01111110**. A single flag may be used as the **closing flag for one frame and the opening flag for the next**. On both sides of the user-network interface, receivers are continuously hunting for the flag sequence to synchronize on the start of a frame. While receiving a frame, a station continues to hunt for that sequence to determine the end of the frame.

    Because the protocol allows the presence of arbitrary bit patterns, there is no assurance that the pattern 01111110 will not appear somewhere inside the frame, thus destroying synchronization. To avoid this problem, a procedure known as **bit stuffing is used.**



For all bits between the starting and ending flags,

- 0 inserted after every sequence of five 1s

- if receiver detects five 1s it checks next bit
- if next bit is 0, it is deleted (was stuffed bit)
- if next bit is 1 and seventh bit is 0, accept it as flag sequence
- if sixth and seventh bits 1, sender is indicating abort

With the use of bit stuffing, arbitrary bit patterns can be inserted into the data field of the frame. This property is known as data transparency.

13. What are the three frame types supported by HDLC? Describe each of them.

- **Information frames (I-frames):** carry the data to be transmitted for the user (the logic above HDLC that is using HDLC). Additionally, flow and error control data, using the ARQ mechanism, are piggybacked on an information frame.

- **Supervisory frames (S-frames)**: provide the ARQ mechanism when piggybacking is not used.

- **Unnumbered frames (U-frames):** provide supplemental link control functions.

14. A World Wide Web server is usually set up to receive relatively small messages from its clients but to transmit potentially very large messages to them. Explain, then which type of ARQ protocol (selective reject, go-back-N) would provide less of a burden to a particularly popular WWW server.

The **selective-reject** approach would burden the server with the task of managing and maintaining large amounts of information about what **has** and **has not** been successfully transmitted to the clients;

The **go-back-N** approach would be **less** of a burden on the server.

15. Q5-21. Stations in a pure Aloha network send frames of size 1000 bits at the rate of 1 Mbps. What is the vulnerable time for this network? (refer to Figure 5.31)

The transmission rate of this network is T_{fr} = (1000 bits)/(1Mbps) = 1 ms. The vulnerable time in pure Aloha is $2 \times T_{fr} = 2$ ms.

16. QP5-7 Using the code in Table 5.2(Simple **EVEN** parity-check code) what is the data word if one of the following codeword is received?

Datawords	Codewords	Datawords	Codewords
0000	00000	1000	10001
0001	00011	1001	10010
0010	00101	1010	10100
0011	00110	1011	10111
0100	01001	1100	11000
0101	01010	1101	11011
0110	01100	1110	11101
0111	01111	1111	11110

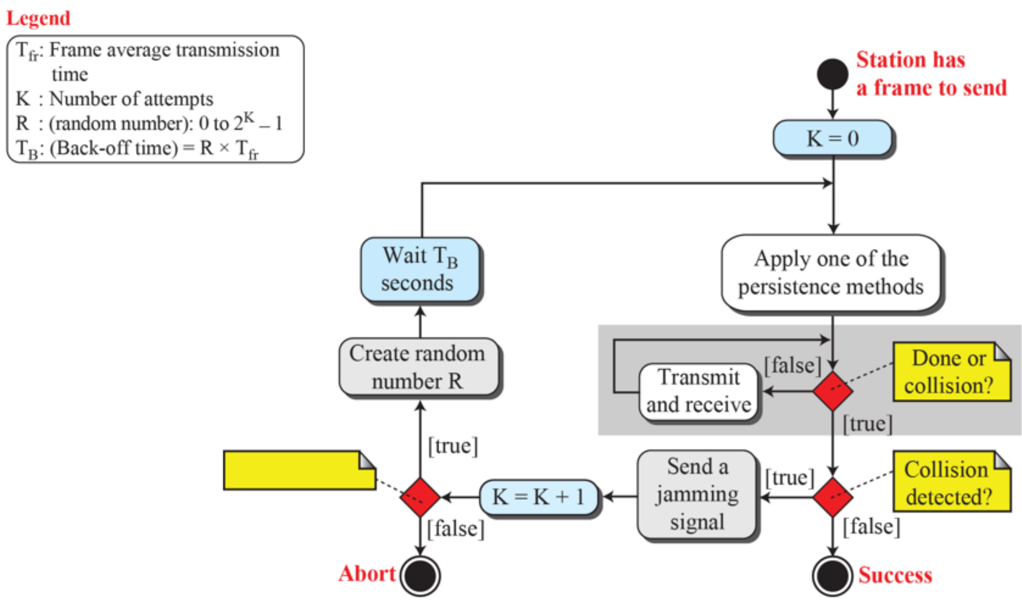
a. 01011 b. 11111 c. 00000 d. 11011

a.error b. error c. 0000 d. 1101

17. Q5-23. To understand the uses of K (number of attempts) in CSMA/CD in Figure 5.40, find the probability that a station can send immediately in each of the following cases:

a) After **one** failure.
b) After **three** failures.

Figure 5.40: Flow diagram for the CSMA/CD



The use of **K in the figure decreases** the probability that a station can immediately send when the **number of failures increases**. This means decreasing the probability of collision.

- After one failure (K = 1), the value of R =0 to $2^k - 1$ => 0 - 1. The probability that the station gets is 0 (send immediately) or 1; Therefore the chance is fifty-fifty 1/2 or 50%.
- After three failures (K = 3), the value of R=0 to $2^k - 1$ => 0 - 7. The probability that the station gets 0 (send immediately) or 7, Therefore the chance is 1/8 or 12.5%.