ECE363 Assignment 2

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1. A bit stream 10011101 is transmitted using the standard CRC method.
   a. The generator polynomial is x^3 + 1. Show the actual bit string transmitted.
   b. Suppose that the third bit from the left is inverted during transmission. Can this error be detected at the receiver's end? If yes, how?
   c. Give an example of bit errors in the bit string transmitted that will not be detected by the receiver, along with a **detailed explanation** of why these errors remain undetected.

Ans: a) The frame is 10011101. The generator is 1001. The message after appending three zeros is 10011101000. The remainder on dividing 10011101000 by 1001 is 100. So, the actual bit string transmitted is 10011101100. b) The received bit stream with an error in the third bit from the left is 10111101100. Dividing this by 1001 produces a remainder 100, which is different from zero. Thus, the receiver detects the error and can ask for a retransmission. c) All kinds of examples are correct as long as they indicate the remainder is non-zero and give some analysis about their example.

2. Please compare and analyze the pros and cons of CSMA/CD protocol and TDMA.

Ans: CSMA/CD is a **dynamic random access method** for shared channel communication, whereas **Time Division Multiplexing (TDM)** is a **static channel allocation method**. In terms of channel utilization, **CSMA/CD allows users to share the channel flexibly**, improving overall efficiency. In contrast, **TDM allocates fixed time slots to users**, which leads to **wasted bandwidth** when a user has no data to transmit.

However, since **CSMA/CD relies on shared access**, collisions occur when multiple users transmit simultaneously, reducing channel efficiency. In **TDM**, users do not interfere with each other within their assigned time slots, ensuring no collisions.

For **local area networks (LANs)**, where users are geographically close and bandwidth is relatively high, **TDM** may lead to increased idle time when users have no data to send, resulting in poor channel utilization.

In **computer communication**, where data transmission is often **bursty**, TDM is even less suitable due to its rigid time-slot allocation.

3. Assume a CSMA/CD network with a length of 1 km and a data rate of 1 Gb/s. The propagation speed of signals on the network is 200,000 km/s. Find the minimum frame length that can be used with this protocol. (**Hints**: *The minimum frame length in CSMA/CD is determined by ensuring that a sender can detect a collision before it finishes transmitting the frame. This is based on the round-trip time of the signal propagation in the network.*)

Answer:

For a 1 km cable, the one-way propagation time is:

1÷200000=5×10−6s=5μs1 \div 200000 = 5 \times 10^{-6} \text{s} = 5 \text{μs}

Thus, the round-trip propagation time is 10 μs.

To ensure proper operation of CSMA/CD, the minimum frame transmission time must be at least 10 μs.

At a 1 Gb/s transmission rate, the number of bits that can be sent in 10 μs is:

10×10−61×10−9=10000 bits\frac{10 \times 10^{-6}}{1 \times 10^{-9}} = 10000 \text{ bits}

Therefore, the minimum frame size is 10,000 bits or 1,250 bytes.

4. There are 10 stations connected to an Ethernet network. Analyze the bandwidth that each station can obtain in the following three scenarios:
    a. 10 stations connected to a 10 Mbit/s Ethernet hub
    b. 10 stations connected to a 100 Mbit/s Ethernet hub
    c. 10 stations connected to a 10 Mbit/s Ethernet switch

Answer:

1. 10 stations share 10 Mbit/s.
2. 10 stations share 100 Mbit/s.
3. Each station has an exclusive 10 Mbit/s.

5. Host A wants to send an IP datagram (source: 10.0.0.1, destination: 10.0.0.5) to Host B via a router (MAC: RR:RR:RR:RR:RR:RR).
    - Construct the Ethernet frame headers for:

      a. The frame from Host A to the router.

      b. The frame from the router to Host B.

    - Why is the MAC source address different in the two frames?

Ans:
Frame 1: A → Router
    Source MAC: AA:BB:CC:DD:EE:FF
    Destination MAC: Router’s MAC (RR:RR:RR:RR:RR:RR)
    IP Payload: Source IP: 10.0.0.1; Destination IP: 10.0.0.5
Frame 2: Router → B
    Source MAC: Router’s MAC (RR:RR:RR:RR:RR:RR)
    Destination MAC: Host B’s MAC (resolved via ARP)
    IP Payload: Source IP: 10.0.0.1; Destination IP: 10.0.0.5
Why MAC Changes:

Each link layer (segment) handles MAC addressing locally. The router’s MAC becomes the source for the next segment.