Assignment - 1

1. For each of the following four networks, discuss the consequences if a connection fails.

   a. Five devices arranged in a mesh topology
   b. Five devices arranged in a star topology (not counting the hub)
   c. Five devices arranged in a bus topology
   d. Five devices arranged in a ring topology

2. Assume a system uses five protocol layers. If the application program creates a message of 100 bytes and each layer (including the fifth and the first) adds a header of 10 bytes to the data unit, what is the efficiency (the ratio of application layer bytes to the number of bytes transmitted) of the system?

3. Protocol layering can be found in many aspects of our lives such as air travelling. Imagine you make a round-trip to spend some time on vacation at a resort. You need to go through some processes at your city airport before flying. You also need to go through some processes when you arrive at the resort airport. Show the protocol layering for the round trip using some layers such as baggage checking/claiming, boarding/unboarding, takeoff/landing.

4. If the bandwidth of the channel is 5 Kbps, how long does it take to send a frame of 100,000 bits out of this device?

5. What is the transmission time of a packet sent by a station if the length of the packet is 1 million bytes and the bandwidth of the channel is 200 Kbps?

6. We want to transmit 1000 characters with each character encoded as 8 bits.
   a. Find the number of transmitted bits for synchronous transmission.
   b. Find the number of transmitted bits for asynchronous transmission.

7. Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth.

8. We need to use synchronous TDM and combine 20 digital sources, each of 100 Kbps. Each output slot carries 1 bit from each digital source, but one extra bit is added to each frame for synchronization. Answer the following questions:
   a. What is the size of an output frame in bits?
   b. What is the output frame rate?
   c. What is the duration of an output frame?
   d. What is the output data rate?
   e. What is the efficiency of the system (ratio of useful bits to the total bits)?

9. Ten sources, six with a bit rate of 200 kbps and four with a bit rate of 400 kbps, are to be combined using multilevel TDM with no synchronizing bits. Answer the following questions about the final stage of the multiplexing:
   a. What is the size of a frame in bits?
   b. What is the frame rate?
   c. What is the duration of a frame?
   d. What is the data rate?

10. Four channels, two with a bit rate of 200 kbps and two with a bit rate of 150 kbps, are to be multiplexed using multiple-slot TDM with no synchronization bits. Answer the following questions:
   a. What is the size of a frame in bits?
   b. What is the frame rate?
   c. What is the duration of a frame?
   d. What is the data rate?

11. Two channels, one with a bit rate of 190 kbps and another with a bit rate of 180 kbps, are to be multiplexed using pulse-stuffing TDM with no synchronization bits. Answer the following questions:
   a. What is the size of a frame in bits?
   b. What is the frame rate?
   c. What is the duration of a frame?
   d. What is the data rate?

12. Show the contents of the five output frames for a synchronous TDM multiplexer that combines four sources sending the following characters. Note that the characters are sent in the same order that they are typed. The third source is silent.
   a. Source 1 message: HELLO
   b. Source 2 message: HI
   c. Source 3 message:
   d. Source 4 message: BYE

13. What is the minimum number of bits in a PN sequence if we use FHSS with a channel bandwidth of B = 4 KHz and Bss = 100 KHz?

14. What is the Hamming distance for each of the following codewords?
   a. d (10000, 00000) b. d (10101, 10000)
   c. d (00000, 11111) d. d (00000, 00000)

15. Given the dataword 101001111 and the divisor 10111, show the generation of the CRC codeword at the sender site (using binary division).

16. A multiple access network with a large number of stations can be analyzed using the Poisson distribution. When there is a limited number of stations in a network, we need to use another approach for this analysis. In a network with N stations, we assume that each station has a frame to send during the frame transmission time (Tfr) with probability p. In such a network, a station is successful in sending its frame if the station has a frame to send during the vulnerable time and no other station has a frame to send during this period of time.
    a. Find the probability that a station in a pure Aloha network can successfully send a frame during the vulnerable time.
    b. Find the probability that a station in a slotted Aloha network can successfully send a frame during the vulnerable time.

17. There are only three active stations in a slotted Aloha network: A, B, and C. Each station generates a frame in a time slot with the corresponding probabilities pA = 0.2, pB = 0.3, and pC = 0.4 respectively.
    a. What is the throughput of each station?
    b. What is the throughput of the network?

18. In a bus CSMA/CD network with a data rate of 10 Mbps, a collision occurs 20 μs after the first bit of the frame leaves the sending station. What should the length of the frame be so that the sender can detect the collision?

19. We have a pure ALOHA network with a data rate of 10 Mbps. What is the maximum number of 1000-bit frames that can be successfully sent by this network?

20. Assume that there are only two stations, A and B, in a bus CSMA/CD network. The distance between the two stations is 2000 m and the propagation speed is 2 × 108 m/s. If station A starts transmitting at time t1:
    a. Does the protocol allow station B to start transmitting at time t1 + 8 μs? If the answer is yes, what will happen?
    b. Does the protocol allow station B to start transmitting at time t1 + 11 μs? If the answer is yes, what will happen?

**********The End**********