

# Computer Networks

## Mid-term Test

with partial answer

Fall Semester 2023

Answer ALL Questions 1~4 (100%)

Question 5 (20%) are bonus questions. These questions are optional. However, if you complete these question, you will receive additional bonus.

1. (10%) What are the 7 layers of OSI reference model? Please use 1~2 sentences to describe each layer.

2. **Physical Layer:**

- (10%) Suppose "Cat-5" twisted-pair cable has a bandwidth of about 100MHz, and the signal-to-noise ratio (SNR) is 30dB. What's the theoretical maximum data rate for this channel?
- (15%) Two users share a communication channel by CDMA. The chip sequence of user 1 and user 2 are  $s_1 = (+1, +1, -1, -1, +1, -1, -1, +1)$  and  $s_2 = (-1, -1, -1, -1, +1, +1, +1, +1)$  respectively. Suppose the vector received is  $(-2, -2, 0, 0, 0, +2, +2, 0)$ . Find the data sent by user 1. Show your steps.

3. **Data link Layer (include MAC sublayer):**

- (15%) What are hidden and exposed terminal problems in wireless LAN? Please explain the detailed steps.
- (15%) In the *Go-Back-N* sliding window protocol, suppose the number of bits for sequence number is 4bits. What's the *valid range* of sending window size  $W_s$ ? Explain why.

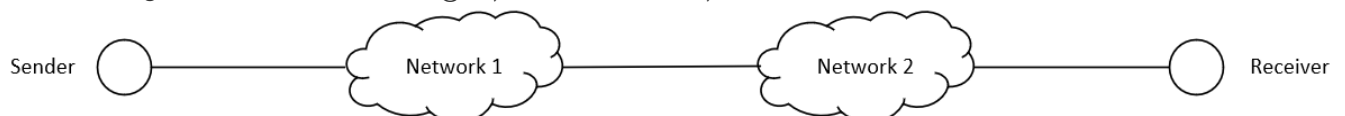
**Answer:**

The valid range is  $1 < W_s \leq 15$ .

In order to avoid ambiguity of acknowledgement, the advanced window after acknowledgement should have no overlap with original one. So sliding window protocol require  $W_s + W_r \leq 2^m$ , where  $m$  is the number of bits for sequence number. In this question,  $m = 4$  and  $W_r = 1$  for Go-Back-N. Then  $1 < W_s \leq 2^4 - 1$ .

4. **Network Layer:**

- (20%) An IPv4 packet has the following field (all values are in decimal): IHL = 5, Total Length = 20, Identification = 100, MF = 0, DF = 0, Offset = 0. Suppose this IP packet is forwarded through two different networks. The MTU for the first network is 1500Bytes, and the MTU for the second network is 596Bytes. Assume this packet is fragmented when traversing those two networks. Please show the detailed process of fragmentation, and give the values for the following IP header fields in each IP fragmentation: Total Length, Identification, MF and Offset.



**Answer:**

The size of payload of the IP packet is 2000Bytes.

When the IP packet traverses the first network with  $MTU = 1500$ , it will be fragmented into two pieces:

- (1) Total Length = 1500, Identification = 100, MF = 1, Offset = 0
- (2) Total Length = 540, Identification = 100, MF = 0, Offset = 185

When the IP packet traverses the second network with  $MTU = 596$ , the first piece is further divided into three pieces:

- (1.1) Total Length = 596, Identification = 100, MF = 1, Offset = 0
- (1.2) Total Length = 596, Identification = 100, MF = 1, Offset = 72
- (1.3) Total Length = 348, Identification = 100, MF = 1, Offset = 144
- ⋮

ii. (15%) A router has the following entries in its routing table (using CIDR):

Address/mask	Next hop
213.219.56.0/22	Interface 0
213.219.60.0/22	Interface 1
219.48.40.0/23	Router 1
0.0.0.0/0	Router 2

For each of the following IP addresses, what does the router do if a packet with that address arrives?

- (a). 213.219.63.10
- (b). 213.219.52.2
- (c). 219.48.40.7

5. **Bonus Questions (Optional):**

- i. (10%) The Stop-and-Wait protocol is used on a link with data rate of 50Kbit/s. Suppose the transmission delay of the link is 10ms, and the size of acknowledgements and processing time are all ignored. In order to achieve at least 50 link utilization, what's the minimum size of data frame?

**Answer:**

$$1/(2BD + 1) = 50\% \Rightarrow BD = 0.5$$

$$BD = 50\text{Kbps} \times 0.01\text{s} / \text{Frame Size} = 0.5$$

Thus, the data frame should be at least 1000bits = 125Bytes.

- ii. (10%) Under the CIDR, try to aggregate the following four prefixes:

212.56.132.0/24, 212.56.133.0/24, 212.56.134.0/24, 212.56.135.0/24

**Answer:**

The first two bytes are equal. So we only need to focus on the third byte:

For 212.56.132.0/24, its third byte in binary is: 10000100

For 212.56.133.0/24, its third byte in binary is: 10000101

For 212.56.134.0/24, its third byte in binary is: 10000110

For 212.56.135.0/24, its third byte in binary is: 10000111

The first six bits are equal. So we can use the first two bytes and the first six bits in third bytes as the new prefix. The aggregated prefix is 212.56.132.0/22.