CS 542 – Computer Networks I: Fundamentals
Fall 2023 HW2 (60 points)

Submission instructions

– ***Due date: Wednesday, Dec. 6, 11:59 pm Central Time***

– ***Late submissions and submissions violating these instructions will NOT be accepted.***

– ***No handwritten submissions. No credit will be given for handwritten submissions.***

– ***Teamwork is allowed (max. 4 students/team). Individual submissions are also OK.***

– ***Upload your assignment (pdf format only) to Blackboard. Submissions in formats other than pdf will be disregarded. The Beacon students: upload your submissions to Lumina.***

– ***One submission per team only. Write down names, A#, and section numbers of all the team members on the front page. Do not submit multiple copies of your HW (e.g. by each team member). It is very confusing and will be penalized. Clearly indicate how each team member contributed to your teamwork.***

– ***Show your work and explain every step of your solution for full credit. Only partial credit will be given for a correct final answer with missing calculations, no supporting explanations or unclear justifications.***

– ***My TAs Pranav Saji (psaji@hawk.iit.edu) and Aditya Sai Kolluru(akolluru@hawk.iit.edu) are responsible for grading this assignment. Feel free to ask questions is something is not clear but don't send me or my TAs:***
- Your partial solutions with inquiries "Is that what you expect?".
- Questions the answers to, may give explicit hints on how to solve the HW problems.

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1. Given an IP datagram with the fragmentation offset of 0000001011010_2, HLEN of 5_{16} and the total length of $007A_{16}$, find the numbers of the first byte and the last byte of data in this datagram **(3 points)**

2. Consider fragmenting an original IP datagram whose total size is 6000_{10} bytes with a base header only. The offset of the second fragment is 98_{16} . Answer the following questions: **(6 points)**
    a. How many fragments are there? Give the data range for each of them. (Assume that all the fragments except the last one are equal.) **(3 points)**
    b. What is the total size of each fragment? **(2 points)**
    c. What is the fragmentation offset of the last fragment? **(1 point)**

3. The first few hexadecimal digits of an IP datagram are as follows: 4E00 00B4 0034 408F. Find the total length, the header length and the data size. Is there the next fragment? Can this datagram be fragmented? **(5 points)**

4. An IP packet with HLEN = E_{16} carries 2540_{10} bytes of data. What is the size of the "*Options"*? What is the value (in the hexadecimal format) of the "*Total length"* field? **(2 points)**

5. An original IP datagram, that carries 3470_{10} bytes of data and has only the base header, was fragmented. The first fragment contains bytes from 0 to 399. All the fragments except the last one are equal. What is the total overhead (in bytes) needed to send all the data of the original datagram to the destination? **(2 points)**

6. An IP packet has arrived with a "*D"* bit value of 0, an "*M"* bit value of 0, and fragmentation offset value to zero. Is this packet the first fragment, the last fragment, the middle fragment, or the only fragment? **(2 points)**

7. A header of a UDP datagram is (in the hexadecimal format): 0315 C43B 00B3 001C (give your answers in the decimal format) **(4 points)**
    a. What is the source port number?
    b. What is the destination port number?
    c. What is the total length of this UDP datagram?
    d. Is this UDP datagram sent from client to server or vice versa?

8. An IP packet has the base header and the total size of 1200_{10} bytes. A UDP datagram is encapsulated in this IP packet. How many bytes of data does this UDP datagram carry? **(3 points)**

9. The initial sequence number in the TCP client-server transmission was 4357. The highest ACK number that the server sent to the client was 10842. How many bytes of data were successfully transmitted from the client to the server? **(2 points)**

10. The following TCP header dump is given in the hexadecimal format: CB5A00D3 00B41234 00003021 50100EB4 00500000 (give your answers in the decimal format). **(6 points)**

a. What are the source and destination port numbers?
b. What is the sequence number?
c. What is the acknowledgment number?
d. What is the header length?
e. Which flags are set?
f. What is the window size?

11. A TCP client-server connection was established with the initial sequence number of 1003_{10}. The client sent 500_{10} bytes of data in the first segment. What is the sequence number of this segment and the range of the transferred bytes? What is the sequence number of the second segment sent by this client? **(3 points)**

12. The current *cwnd*=12 and *rwnd*=26. The last acknowledgment received is 430. Draw the diagram showing this TCP window. A new TCP segment has just arrived with an acknowledgment number of 433 and *rwnd=x*. What is the minimum value of *x* to avoid shrinking the window? **(4 points)**

13. Is the size of the ARP packet fixed? Explain you answer. **(2 points)**

14. A host with an IP address 171.65.22.101 and a physical address A9:27:BB:F3:29:56 has a packet to send to a host in another network. The destination IP and physical addresses are 119.254.100.1 and AC:45:9D:E2:DD:67, respectively (this physical address is unknown to the sender). The next hop for this destination found in the sender's routing table is router R2 with an IP address 118.254.100.1 and a physical address AC:45:9C:52:66:B9 (this physical address is unknown to the sender). Show the ARP request and reply packets. Fill all the necessary fields. Ethernet and IPv4 protocols are implemented at the data link layer and the network layer, respectively. **(10 points)**

15. What destination address is used in the Ethernet frame carrying an ARP request? Explain your answer. **(2 points)**

16. Router R1 has received an ARP request. Can this ARP packet be used to update a cache table of R1? Explain your answer. Note that R1 has received an ARP request not an ARP reply. **(4 points)**