National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	**Computer Networks**	**Course Code:**	**CS3001**
Degree Program:	**BS (CS), BS (SE), BS (DS), BS (Robotics)**	**Semester:**	**Fall 2023**
Exam Duration:	**60 Minutes**	**Total Marks:**	**50**
Paper Date:	**8-November-2023**	**Weight**	**15%**
Section:	**ALL**	**Page(s):**	**6**
Exam Type:	**Mid-II**		

Name:_____ **Roll No.**_____ **Section:**_____

Instruction/Notes:
- Attempt all questions on the provided question paper.
- You can ask the invigilator for rough sheets.
- In case, you have used rough sheets, they should NOT be attached with final paper.

Question #	1	2	3	4	5	6	
Total Marks	5	13	6	8	6	12	50
Obtained Marks							
CLO #	1	1	2	2	3	3	

Problem 1: Answer the following multiple-choice questions by filling the following table. **[5 Marks] (CLO 1)**

Any answers outside the table will NOT be marked. Moreover, Cutting and overwriting is not allowed.

1.1	A	**1.2**	D	**1.3**	C
1.4	B	**1.5**	C		

1.1. The first 8 bits of IPv4 datagram will be --------- if all optional fields are included in header of datagram.
- A. 01001111
- B. 01000101
- C. 01001101
- D. 01001100

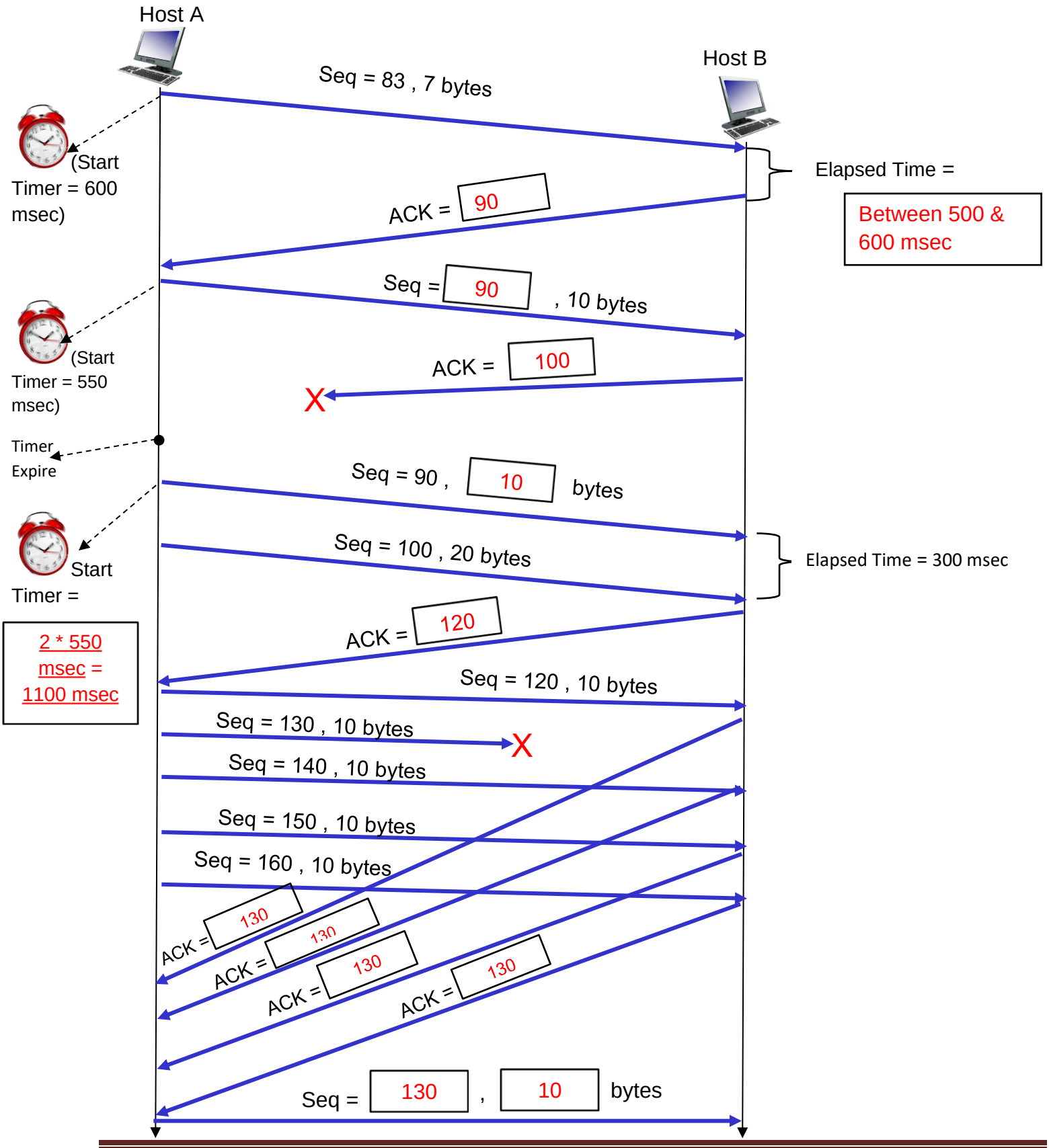
1.2. Stop and Wait operation is performed by:
- A. Go Back N (GBN)
- B. Selective Repeat (SR)
- C. Both GBN and SR
- D. None of the above

1.3. Which of the following field is present in a IPv6 datagram header?
- A. Checksum
- B. Options
- C. Hop Limit
- D. None of the above

1.4. Using OpenFlow, only destination based forwarding is possible.
- A. True
- B. False

1.5. Which of the following is not a middlebox?
- A. Firewall
- B. Load Balancer
- C. IP Router
- D. None of the above

Problem 2: Refer to the TCP segments exchange between Host A to Host B. Fill in the missing values in the space provided in boxes. [ ] **[13 Marks] (CLO 1)**



Problem 3: Consider Go-Back-N (GBN) and Selective Repeat (SR) protocols with window size equal to ***N (****here, N means N packets****)***. Answer the following questions: **[2+2+2 = 6 Marks]** **(CLO 2)**

(i) How many timers are required at the sender side of GBN and how many timers at the sender side of SR?

Answer:

GBN: 1 timer

SR: **N** timers

(ii) If memory is expensive and network bandwidth is abundant, which mechanism, GBN or SR, will you choose to transfer data and why?

Answer:

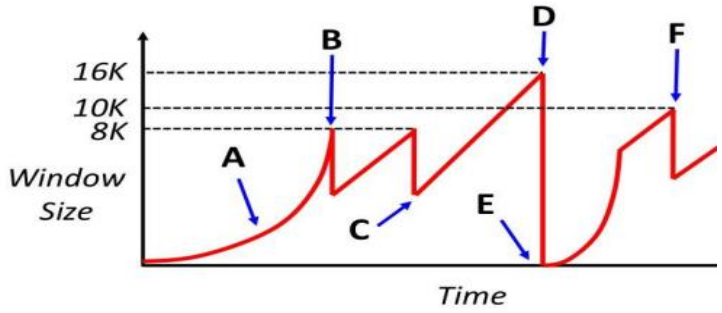
GBN: memory requirement on the end hosts is very small.

(iii) If your users care the most about download delay, which mechanism, GBN or SR, will you choose to transfer data and why?

Answer:

SR: the delay is shorter when there are losses

Problem 4: The following figure depicts TCP Reno approach (with window size, in bytes, on Y-axis and time on X-axix). For example, 16K means 16K bytes. **[1+1+3+3 = 8 Marks] (CLO 2)**



You are required to answer the following question with respect to occurrence of various events at point A, B, C, D, E and F:

a) The event at B causes the sender to decrease its window. Write the name of this event.
Answer: Triple Duplicate ACK

b) event at D causes the sender to decrease its window. Write the name of this event.
Answer: Timeout

c) Why is the progression of the TCP window in the time period between A and B is different than the same in the time period between C and D?
Answer:
The region A is the slow start phase, where we double the window size after each RTT, assuming we receive ACKs within expected time. So, during this phase, window size growth is exponential.

The time period between C and D indicates linear window size growth, which is due to the congestion avoidance phase. During this phase, after each RTT, we increase window size by 1 MSS, assuming we receive ACKs on time.

d) How much time has passed between event C and event D, assuming MSS is 1000 bytes and RTT is 100ms?
Answer:

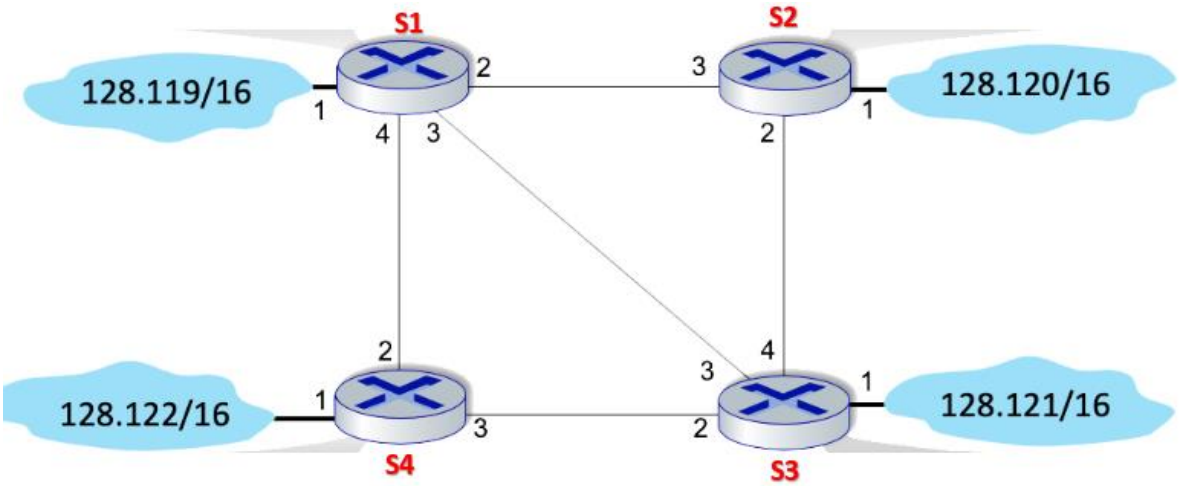
At event C, window size is halved, from 8K bytes to 4K bytes. At event D, window size is 16K bytes. This is the congestion avoidance phase thus window size is increased by 1 MSS (1000 bytes) after each RTT.

16K – 4K = 12K bytes.

12K bytes / 1 MSS = 12K bytes / 1000 bytes = 12 (therefore, we need 12 RTTs)

12 * 100ms = 1200 ms

Problem 5: Consider the network shown below that comprises of 4-routers, where packet forwarding is controlled by flow tables. Complete the match and action field(s) by providing necessary values in flow table of all routers (i.e., S1, S2, S3, and S4), which get involved during the following forwarding behavior of packets to be implemented: UDP packets coming from the source network attached to S1 and destined to the network attached to S2 should be forwarded along the path: S1 -> S4 -> S3 -> S2. **[1.5x 4 = 6 Marks] (CLO 3)**



Router	Match	Action
S1	IP_Src=128.119/16, IP_Dst=128.120/16, IP_Protocol=UDP	Forward (4)
S2	Ingress port = 2, IP_Src=128.119/16, IP_Dst=128.120/16, IP_Protocol=UDP	Forward (1)
S3	Ingress port = 2, IP_Src=128.119/16, IP_Dst=128.120/16, IP_Protocol=UDP	Forward (4)
S4	Ingress port = 2, IP_Src=128.119/16, IP_Dst=128.120/16, IP_Protocol=UDP	Forward (3)

Problem 6: An organization is granted a block of addresses starting with 144.100.24.0/22 (1024 addresses). The organization needs to have five sub-blocks of addresses to use in its five subnets. Sub-blocks are designed in such a way that 1st sub-block requires 400 addresses, 2nd sub-block needs 256 addresses, 3rd sub-block requires 100 addresses, and the remaining two sub-blocks require 50 addresses each. With reference to this scenario, answer the following (you are required to write all your answers in dotted decimal notation):**[4+4+4 = 12 Marks] (CLO 3)**

a) Write the subnet mask for first four sub-blocks.
Subnet mask for the 1st sub-block: 255.255.254.0
Subnet mask for the 2nd sub-block: 255.255.255.255
Subnet mask for the 3rd sub-block: 255.255.255.128
Subnet mask for the 4th sub-block: 255.255.255.192

b) Write the subnet ID and broadcast ID for 1st and 4th sub-blocks (provide subnet mask using slash notation).
Subnet ID for 1st sub-block: 144.100.24.0/23
Broadcast ID for 1st sub-block: 144.100.25.255/23
Subnet ID for 4th sub-block: 144.100.27.128/26
Broadcast ID for 4th sub-block: 144.100.27.191/26

c) Write the 1st and 50th host address for 1st and 5th sub-blocks (provide subnet mask using slash notation).
1st host address for 1st sub-block: 144.100.24.1/23
50th host address for 1st sub-block: 144.100.24.50/23
1st host address for 5th sub-block: 144.100.27.193/26
50th host address for 5th sub-block: 144.100.27.242/26