

Course Code: CS-307	Course Name: Computer Networks
Instructor Names: Dr. Sufian Hameed, Dr. Nadeem Kafi, Dr. Hassan Jamil, Dr. Aqsa Aslam, Mr. Shoaib Raza, Mr. Abdullah Zarshaid	
Student Roll No:	Section No:

Instructions:

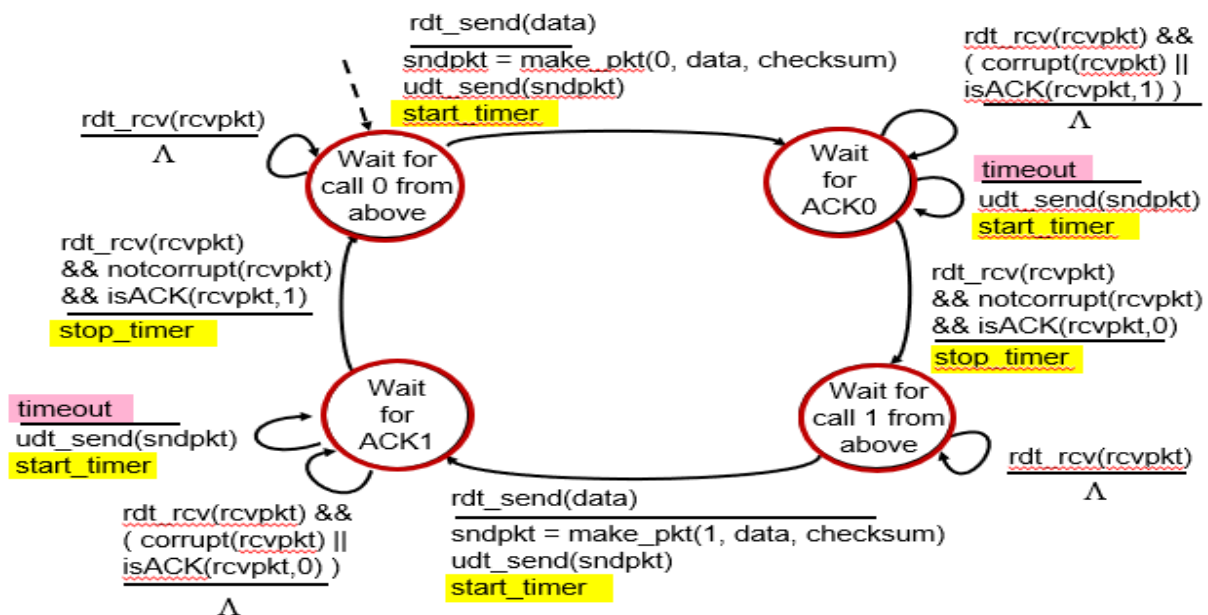
- Return the question paper.
- **All questions must be answered in answer script and according to the sequence given in the question paper.**
- Each question carry 10 marks.
- In case of any ambiguity, you may make an assumption, however, your assumption should not contradict any statement in the question paper.

Time: 60 minutes.

Max Marks: 50

**Question 1:** Design a reliable data transfer protocol between the sender and receiver, operating over a channel that can lose or corrupt packets (data or ACKs) and is error-prone. Specify the protocol using finite state machine for the sender side.

Solution:

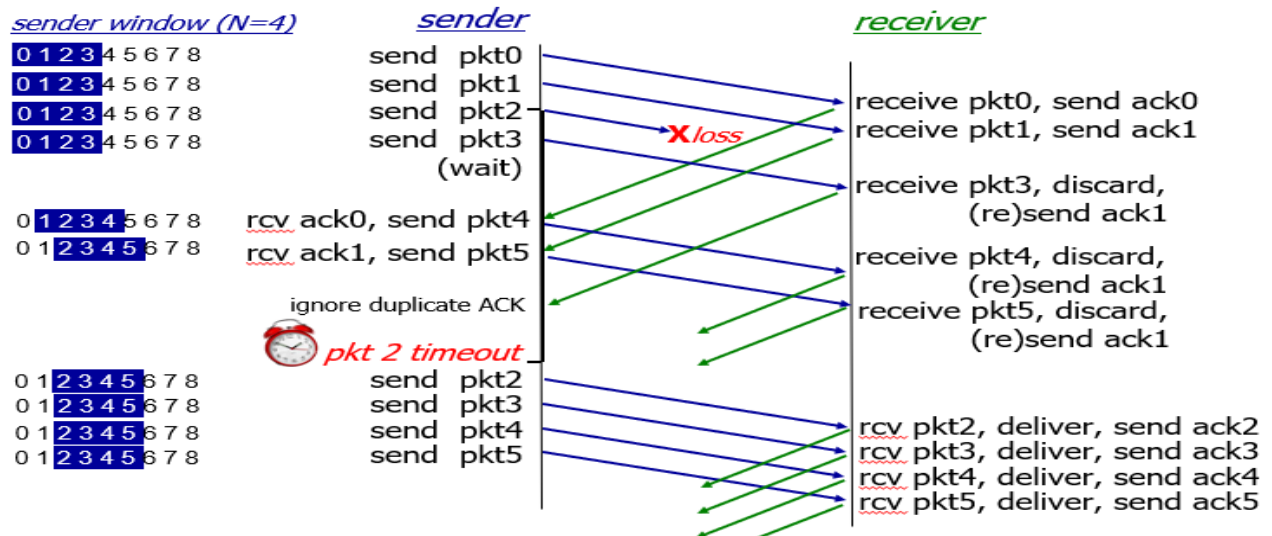


**Question 2:** For a p2p file-sharing application, do you agree with the statement, "There is no notion of client and server sides of a communication session"? Why or why not?

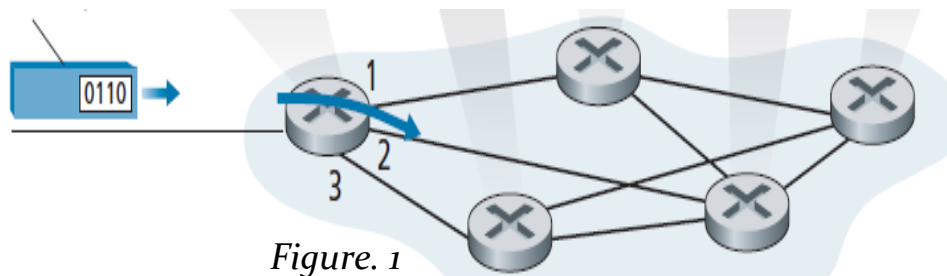
Solution:

No. All communication sessions have a client side and a server side. In a P2P file-sharing application, the peer that is receiving a file is typically the client and the peer that is sending the file is typically the server.

**Question 3:** Draw a time-sequence diagram for the Go-Back-N algorithm with the sender's window size equal to 4. Assume at  $t=0$ , the sender sends packets 0, 1, 2, 3 and packet 2 will be lost.



**Question 4:** Consider a group of routers in the core network as shown in the figure. 1 below.



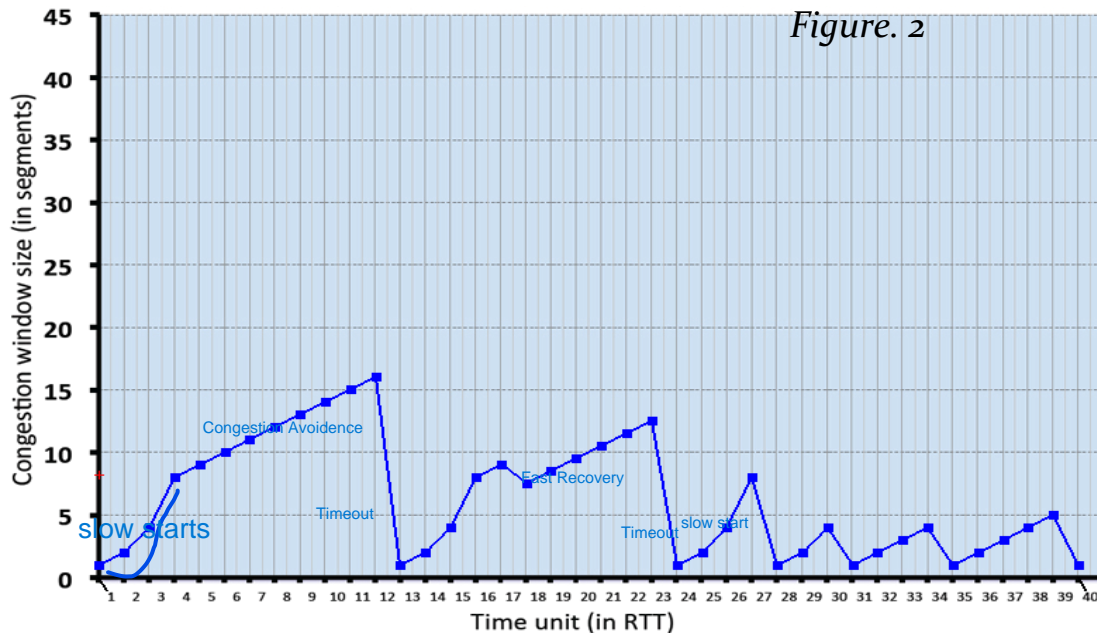
- a) Show in steps, how data packets entering one interface of a router are forwarded to an output interface of the same router.

Step 1: IP address is extracted from the IP packet header.

Step 3: The IP packets is sent to the output interface queue for further processing.

**Solution:**

**Question 5:** Consider the figure. 2, which plots the evolution of TCP's congestion window at the beginning of each time unit (where the unit of time is equal to the RTT). In the abstract model for this problem, TCP sends a "flight" of packets of size  $cwnd$  at the beginning of each time unit. The result of sending that flight of packets is that either (i) all packets are ACKed at the end of the time unit, (ii) there is a timeout for the first packet, or (iii) there is a triple duplicate ACK for the first packet. In this problem, you are asked to reconstruct the sequence of events (ACKs, losses) that results in the evolution of TCP's  $cwnd$  shown below.



(a) Give the time unit(s) (in RTT) at which TCP is in slow start.

Solution:

The times where TCP is in slow start are: 1,2,3,13,14,15,24,25,26,28,29,31,35,40.

(b) Give the time unit(s) (in RTT) at which TCP is in congestion avoidance.

Solution:

The times where TCP is in congestion avoidance are:

4,5,6,7,8,9,10,11,12,16,17,19,20,21,22,23,27,30,32,33,34,36,37,38,39

(c) Give the time unit(s) (in RTT) at which TCP is in fast recovery.

Solution:

The times where TCP is in fast recovery are: 18.

(d) Give the time unit(s) (in RTT) at which packets are lost via timeout.

Solution:

The times where TCP has a loss by timeout are: 12,23,27,30,34,39.

(e) Give the time unit(s) (in RTT) at which packets are lost via *triple ACK*.

Solution:

The times where TCP has a loss by triple duplicate ACK are: 17

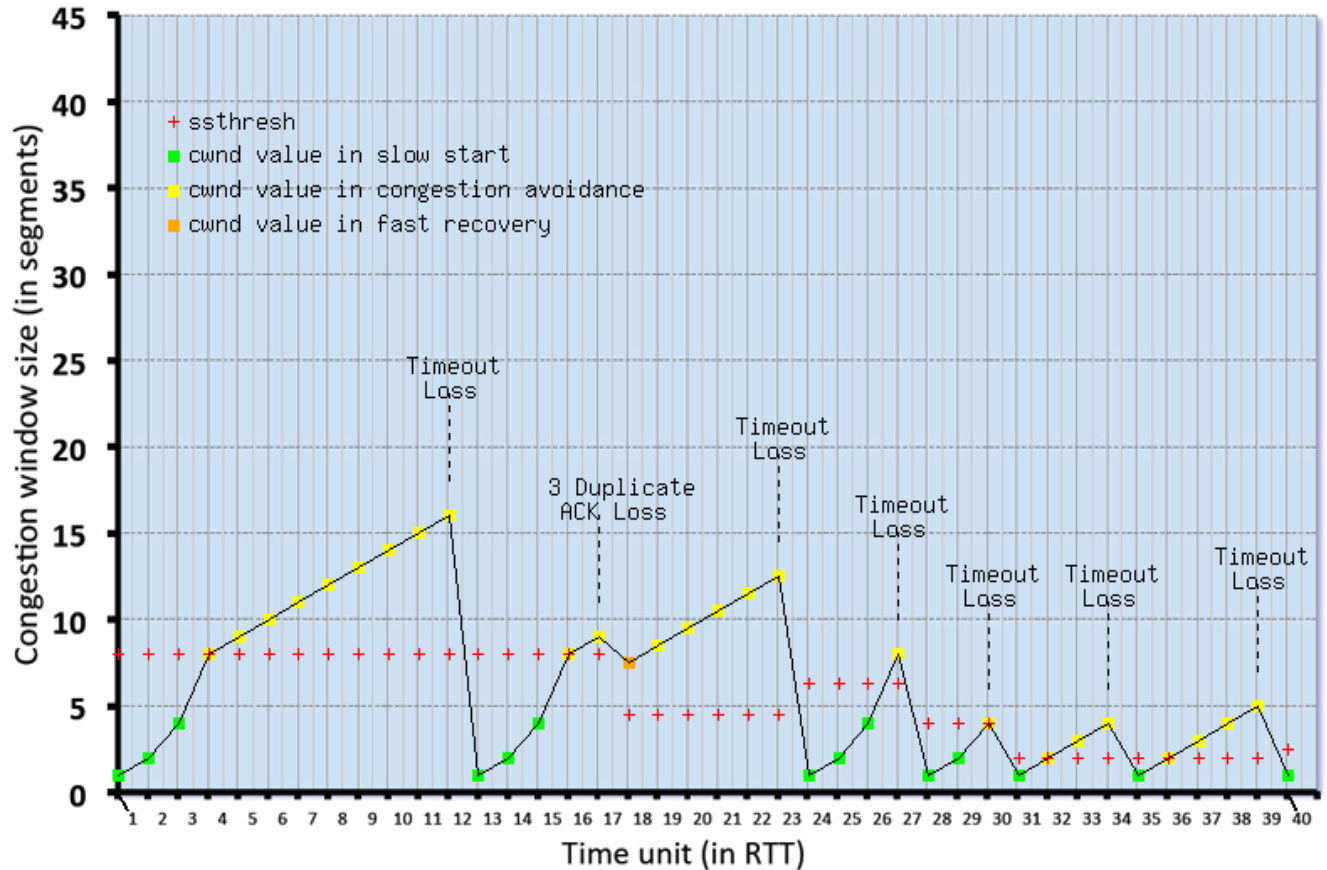
(f) Give the time unit(s) (in RTT) at which the value of  $ssthresh$  changes (hint: if it changes between  $t=3$  and  $t=4$ , use  $t=4$  in your answer)

Solution:

The times where the  $ssthresh$  changes are: 18,24,28,31,40.

The complete solution is shown in the figure below:

- For intervals of time when TCP is in slow start, the plotted value of cwnd is shown as a green square
- For intervals of time when TCP is in congestion avoidance, the plotted value of cwnd is shown as a yellow square
- For intervals of time when TCP is in fast recovery, the plotted value of cwnd is shown as an orange square
- The values for ssthresh are shown following a change as a red plus sign
- A flight of packets experiencing a loss has the loss type (which determines the next value of cwnd) labeled above



**BEST OF LUCK!**