INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, SRI CITY

TERM-II EXAMINATION – SPRING 2024

Computer and Communication Networks

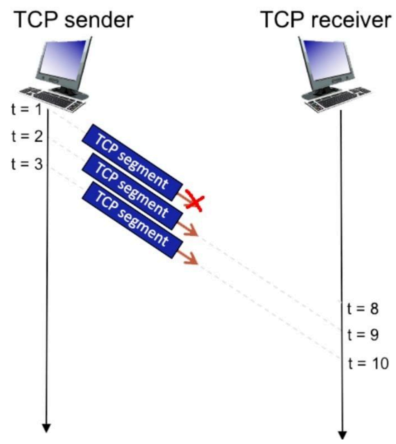
CSE and ECE:UG 2 (IC) **Date: 19-03-2024**

Duration: 90 Mins (03:30 PM-05:00 PM) **Max. Marks: 20**

Instructions: **Roll No:________________**

1. Closed book exam
2. Assumptions made should be clearly stated
3. All sub-parts of the question should be written together
4. Calculators are allowed. Sharing a calculator in the exam hall is not allowed
5. **Attach Question paper to the answer booklet otherwise, your answer sheet will not be evaluated**.

1.	**a.** We consider a congestion control system with an infinite buffer size, where the capacity from the input link to the output link is 100 Mbps. Host-A transmits data to host-B at a rate of 90 Mbps, and the host-B receives at a rate of 75 Mbps. What is the maximum throughput of the system?	**[1 Mark]**
	b. How do we detect the TCP congestion?	**[1.5 Mark]**
	c. Explain the working principle of connectionless demultiplexing with a suitable example.	**[2.5 Marks]**
2.	The maximum window size for data transmission using the selective repeat protocol with n-bit sequence numbers is 2^(n-1)	**[2 Marks]**
3.	Consider sending a large file from a host to another over a TCP connection that has no loss. a. Suppose TCP uses AIMD for its congestion control without slow start. Assuming cwnd increases by 1 MSS every time a batch of ACKs is received and assuming approximately constant round-trip times, how long does it take for cwnd increase from 6 MSS to 12 MSS (assuming no loss events)? b. What is the average throughput (in terms of MSS and RTT) for this connection up through time = 6 RTT? a) It takes 1 RTT to increase CongWin to 7 MSS; 2 RTTs to increase to 8 MSS; 3 RTTs to increase to 9 MSS; 4 RTTs to increase to 10 MSS; 5 RTTs to increase to 11 MSS; 6 RTTs to increase to 12 MSS. b) In the first RTT 6 MSS was sent; in the second RTT 7 MSS was sent; in the third RTT 8 MSS was sent; in the fourth RTT 9 MSS was sent; in the fifth RTT, 10 MSS was sent; and in the sixth RTT, 11 MSS was sent. Thus, up to time 6 RTT, 6+7+8+9+10+11 = 51 MSS were sent. Thus, we can say that the average throughput up to time 6 RTT was (51 MSS)/(6 RTT) = 8.5 MSS/RTT.	**[2 Marks]**

<table>
<tr><td>4</td><td>a. Consider the figure below, in which a TCP sender and receiver communicate over a connection, and the sender->receiver segments may be lost. The TCP sender sends an initial window of 3 segments. Suppose the initial value of the sender->receiver sequence number is 20, and the first three segments each contain 191 bytes. The delay between the sender and receiver is 7-time units, so the first segment arrives at the receiver at t=8. As shown in the figure below, one of the three-segment (s) is lost between the segment and the receiver. What will be the sequence number of the three segments transmitted?


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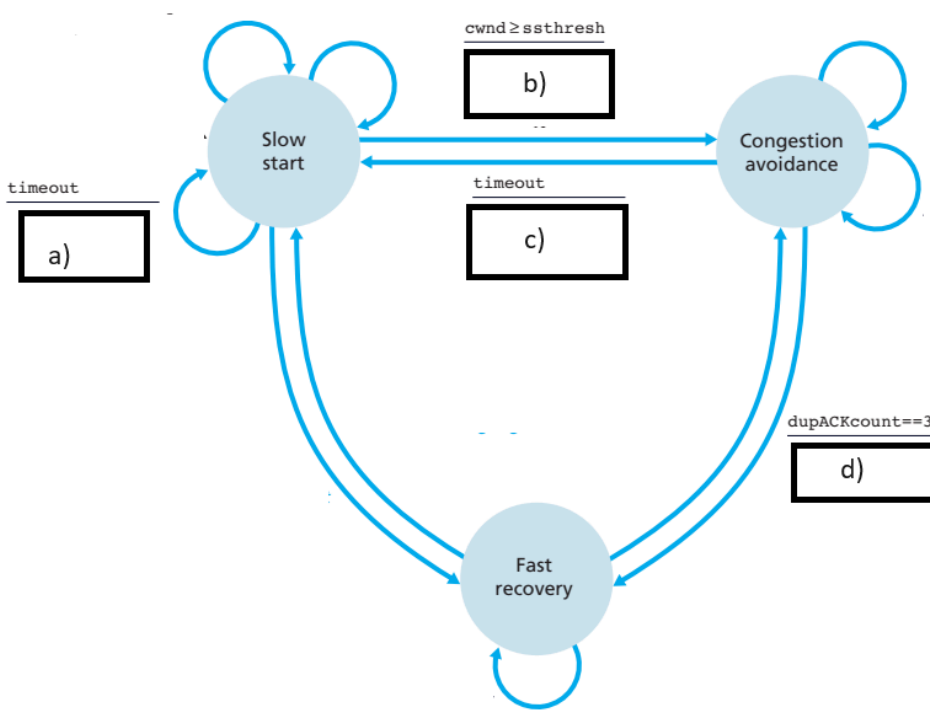
b. In part b, give the ACK numbers the receiver sends in response to each of the three segment. If a segment never arrives, use 'x' to denote it.
i. Segment 1: X
ii. Segment 2: 20
iii. Segment 3: 20</td><td>[2 + 2 Marks]</td></tr>
<tr><td>5</td><td>i. Match the following and fill in the details accordingly
(Note: Answers for (i) must be written in the space provided in the Table)</td><td>[3 Marks]</td></tr>
</table>

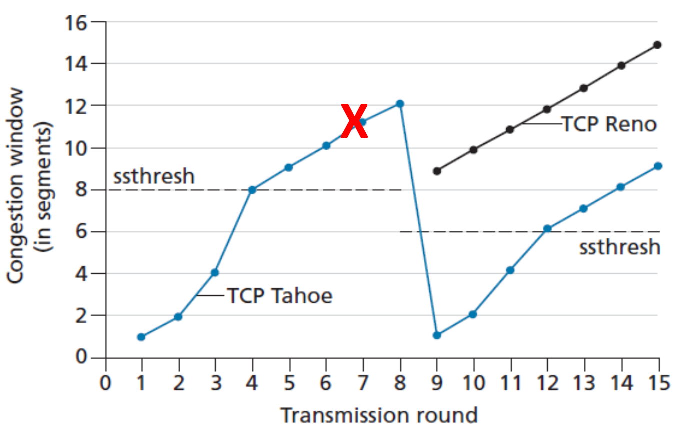
Protocol	Description	Answer (Mention the SNO matching the description)	Field added to RDT-1.0 for protocol Implementation (Ex: Sequence numbers etc.)
1. RDT-2.1	Protocol to consider lossy channel and bit errors in packets and acks		
2. RDT-3.0	Protocol to consider bit errors in packets		
3. RDT-2.0	Protocol to consider bit errors in packets and acks		

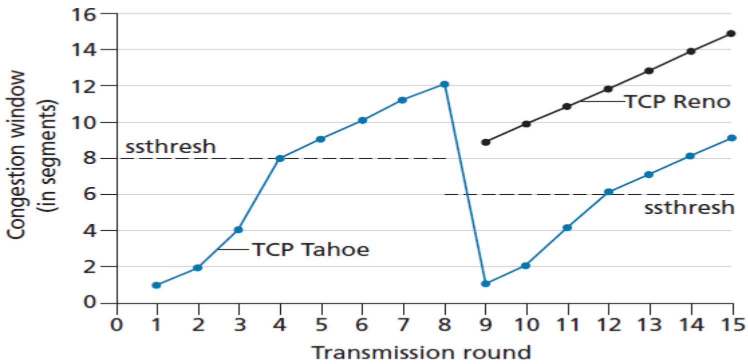
ii. Fill in the actions taken in a), b), c) and d) because of the events above the horizontal line in the FSM given below for the TCP Congestion Control (Note: No need to redraw the diagram in the answer booklet. Mention 4(ii) and directly write (a), (b), (c) and (d)

[4 Marks]



Q1 Answer:

Q. No		Description of Questions	Marks
1.	a)	We consider a congestion control system with infinite buffer size, where capacity of the input link and the output link is 100 Mbps. The host-A transmits data to host-B with rate 90 Mbps, and the host-B receives with rate 75 Mbps. What is the maximum throughput of the system? **Answer**: ● The size of buffer is infinite. Thus, transmission rate depend on capacity of the input and output link, host-A transmission rate and host-B reception rate. ● Here, capacity of the input and output link is greater than the host-A transmission rate and host-B reception rate. ● Hence, maximum throughput of the system = minimum (host-A transmission rate, host-B reception rate) = minimum (90 Mbps, 75 Mbps) = 75 Mbps.	1
	b)	How do we detect the TCP congestion? **Answer**: TCP reacts in different ways based on how the packet loss is detected. Case-1: Detection on Time Out ☐ Time Out occurs before the sender receives the acknowledgment for a segment. ☐ Reaction: ✔ Setting the ssthresh to half of the current cwnd. ✔ Decreasing the cwnd to 1 MSS. ✔ Resuming the slow start phase.  	1.5

<table>
<tr><td></td><td></td><td>
Case-02: Detection on receiving 3 Duplicate Acknowledgments
- Sender receives 3 duplicate acknowledgments for a segment.
- This case suggests the weaker possibility of congestion in the network.
- A segment has been dropped but few segments sent later may have reached.
- Reaction:
✔ Setting the ssthresh to half of the current cwnd. Retransmit the missing segment (Fast retransmit)
✔ Decreasing the cwnd to:
o 1 MSS and resume the slow start phase (TCP Tahoe).
o ssthresh and resume the congestion avoidance phase: additive increase (TCP Reno).
- Fast recovery (if the cwnd is decreased to ssthresh instead of 1).


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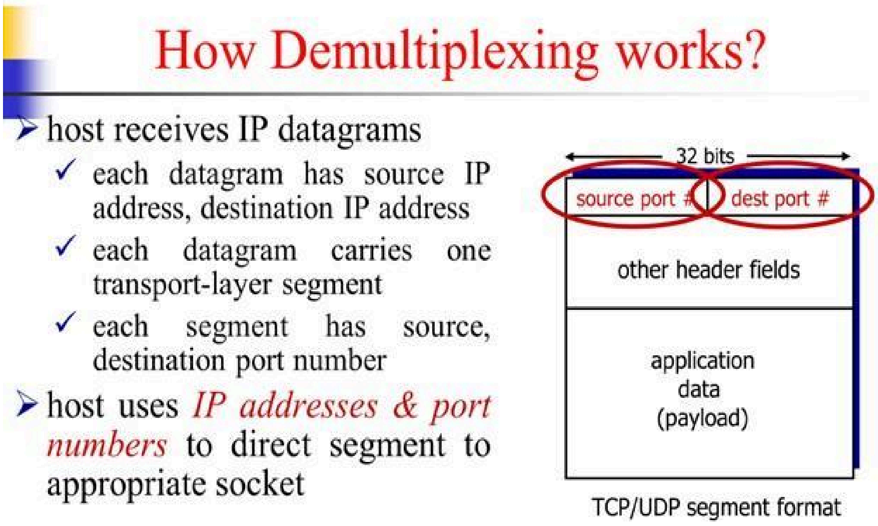
<tr><td></td><td>c)</td><td>
Explain the working principle of the connectionless demultiplexing with a suitable example?
Answer:


</td><td>2.5</td></tr>
</table>

Connectionless Demultiplexing

Recall:

- when creating socket, must specify *host-local* port #:

```
DatagramSocket mySocket1
 = new
 DatagramSocket(12534);
```

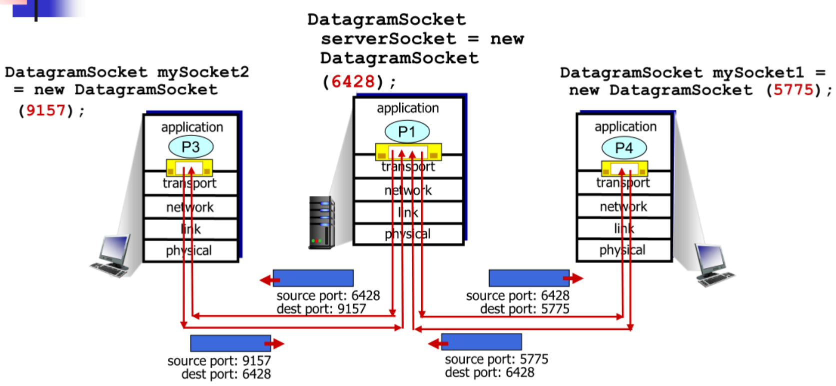
- when creating datagram to send into UDP socket, must specify
  - destination IP address
  - destination port #

when receiving host receives *UDP* segment:

- checks destination port # in segment
- directs UDP segment to socket with that port #

Segments with *same dest. port #*, but different source IP addresses and/or source port numbers will be directed to *same socket* at receiving host

Connectionless Demultiplexing: an example



Q5 Answer:

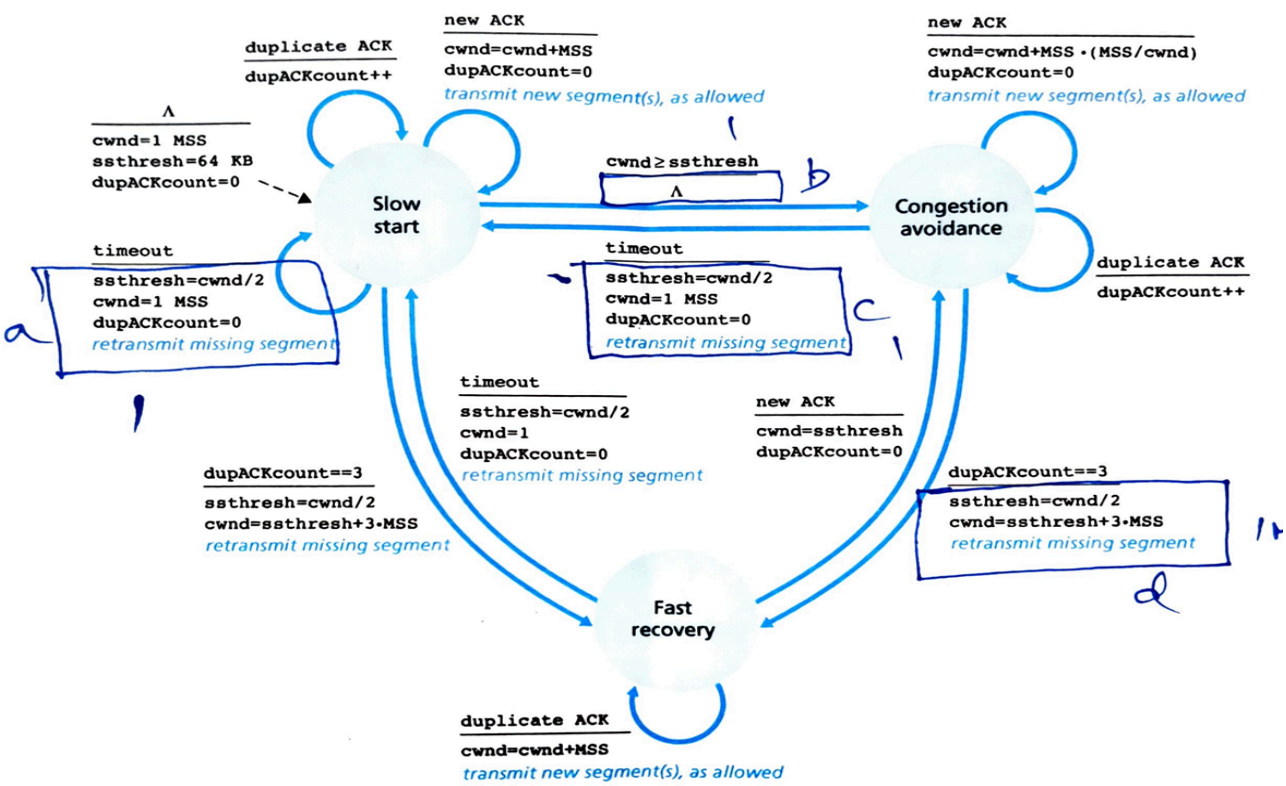


Figure 3.52 ♦ FSM description of TCP congestion control

MSS, and thus, the value of the congestion window will have increased by one MSS after ACKs when all 10 segments have been received.

But when should congestion avoidance's linear increase (of 1 MSS per RTT) end? TCP's congestion-avoidance algorithm behaves the same when a timeout occurs. As in the case of slow start: The value of cwnd is set to 1 MSS, and the value of ssthresh is updated to half the value of cwnd when the loss event occurred. Recall, however, that a loss event also can be triggered by a triple duplicate ACK event. In this case, the network is continuing to deliver segments from sender to receiver (as indicated by the receipt of duplicate ACKs). So TCP's behavior to this type of loss event should be less drastic than with a timeout-indicated loss: TCP halves the value of cwnd (adding in 3 MSS for good measure to account for

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2. RDT-3.0	Protocol to consider bit errors in packets RDT 2.0	3	Checksum, Seq/Num, Timer
3. RDT-2.0	Protocol to consider bit errors in packets and acks RDT 2.1	1	Checksum,

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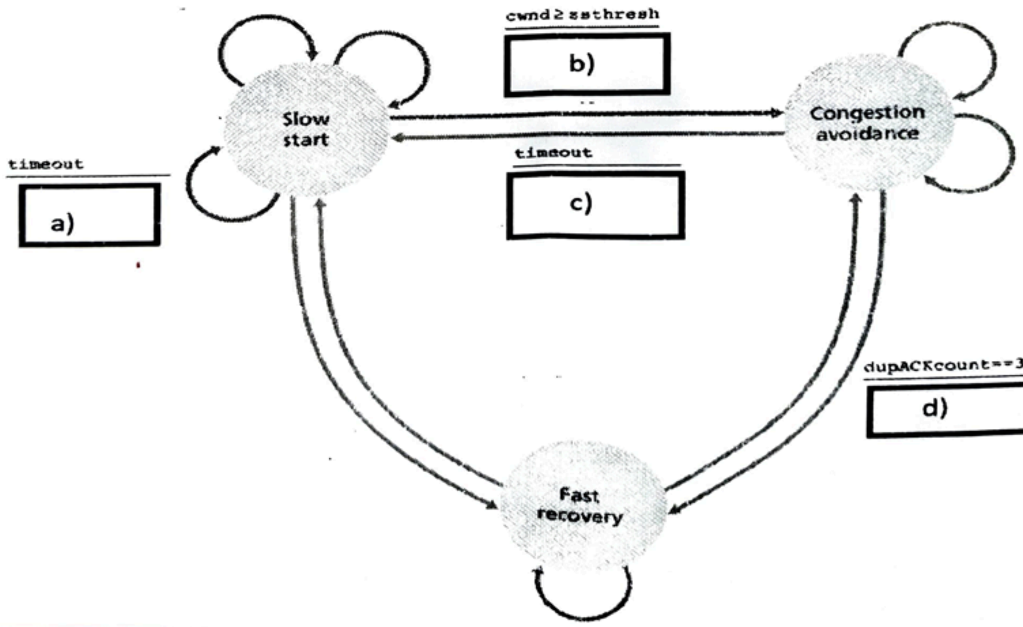

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