IK1203
Networks and Communication

Recitation 2 – Transport layer

1. TCP uses delayed ACKs instead of sending and ACK directly after a correctly received packet. Answer the two following questions related to delayed ACKs in TCP.
   a) An ACK must not be delayed more than 500 ms. Why?
   b) Assume that a TCP segment arrives with the expected sequence number. The previous segment arrived in correct order and it has not been ACKed yet. What will the receiver do now?

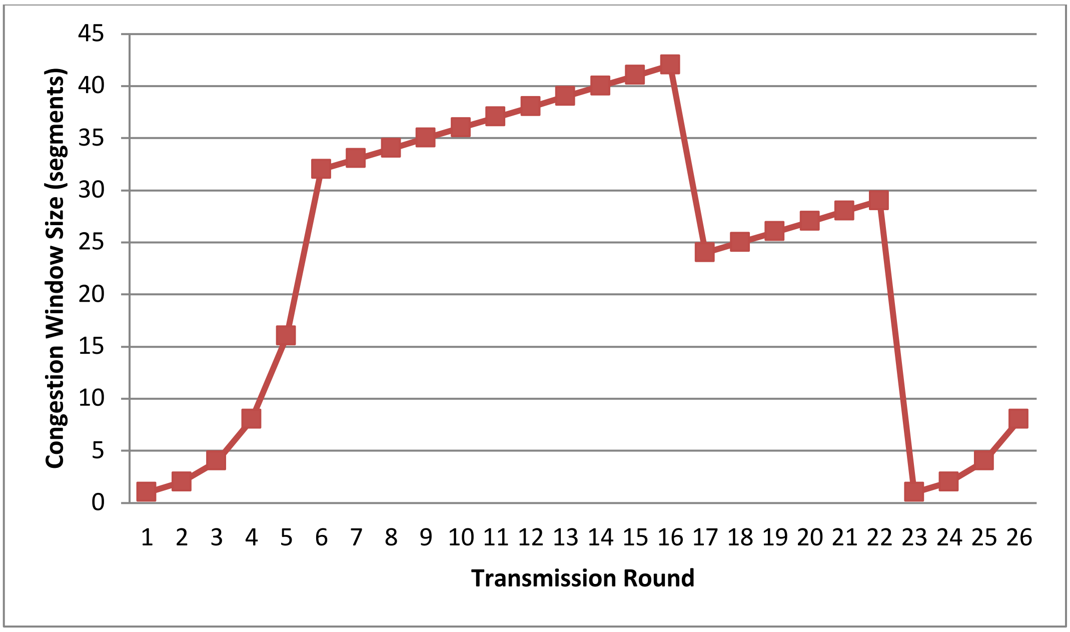
2. TCP uses both flow control and congestion control. Explain the overall difference between these. What do they mean? What are their purposes?

3. An application uses TCP and sends data in full size windows (65 535 bytes) over a 1 Gbps channel having a one-way delay of 10 ms. The transmission time can be neglected.
   a) What is the maximum throughput that can be achieved?
   b) What channel utilization can be achieved, i.e., how large part of the available bandwidth can be used?

4. A client application establishes a TCP connection to a server application to transfer 15 kB of data. The (one-way) delay is 5 ms, RTT (round-trip time) is 10 ms, and the receive window (rwnd) is 24 kB. Assume that the initial congestion window is 2 kB. There is no congestion in the network, the transmission time can be neglected, and the connection establishment phase can be neglected. Calculate the total transfer time.

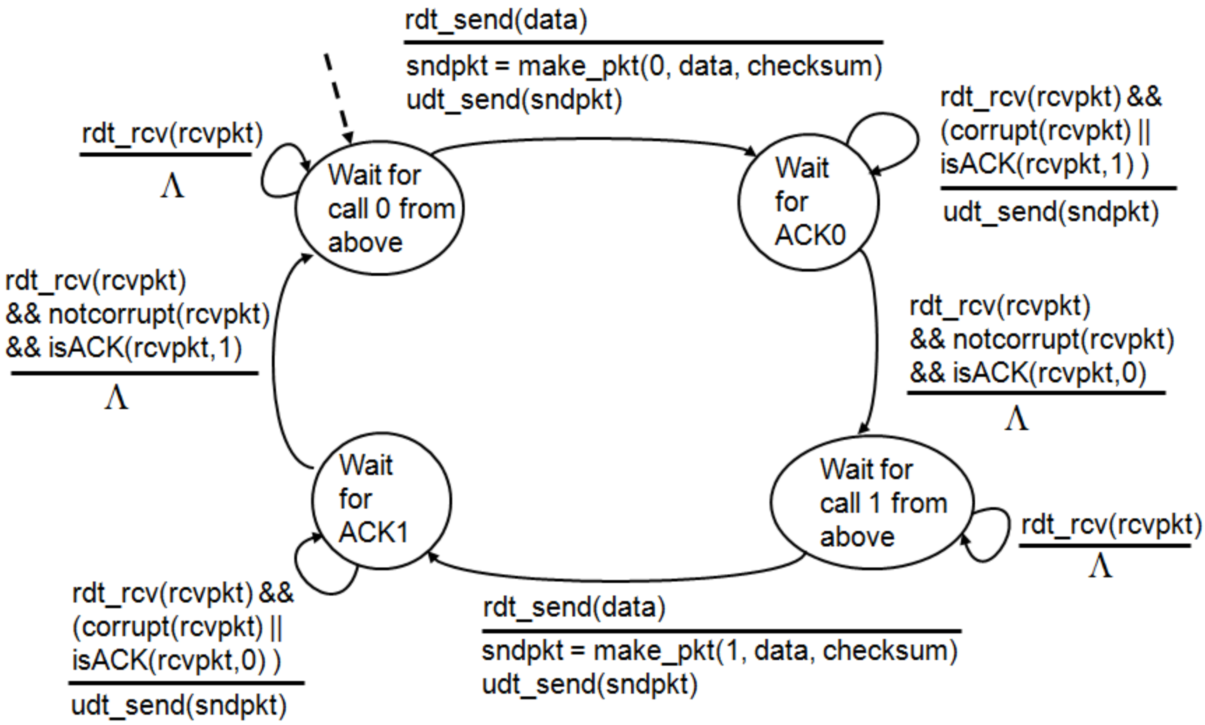
5. The figure below shows how the congestion window (CWND) varies in TCP Reno (i.e., with fast retransmit and recovery).

a) Mark the intervals when TCP is in slow start.
b) Mark the intervals when TCP is in congestion avoidance.
c) During the 16^{th} transmission round, a packet loss occurs. How is it detected? Is detected through a timeout or through the reception of three duplicate ACKs?
d) During the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
e) What is the initial window of `ssthresh` at the first transmission round?
f) What is the value of `ssthresh` at the 18th transmission round?
g) What is the value of `ssthresh` at the 24th transmission round?
h) During what transmission round is the 70th segment sent?
i) Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of `ssthresh`?
j) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the `ssthresh` and the congestion window size at the 19th round?
k) Again suppose TCP Tahoe is used, and there is a timeout event at 22nd round. How many packets have been sent out from 17th round till 22nd round, inclusive?

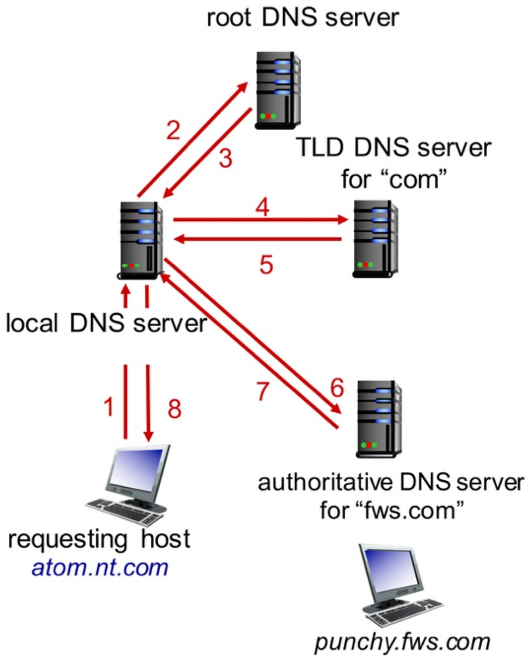


6. The figure below illustrates the finite state machine (FSM) on the sender side of a reliable stop-and-wait transport protocol, which can handle corrupted packets but it cannot handle lost packets. The notation in the FSM is the same as the one used in the course book.

Complete the FSM with a timer-based retransmission mechanism so that the transport protocol can handle also packet losses. We assume that the functions `start_timer` and `stop_timer` are there to start and stop a timer, and that a `timeout` event occurs when a timer expires.



7. The figure below illustrates what happens when a host computer “atom.nt.com” at the fictive company Newton Technologies (“nt.com”) does a DNS lookup of the domain name of a computer “punchy.fws.com” at the (also fictive) company Future Web Services (“fws.com”). The numbers on the arrows in the figure indicate the order in which the operations are done.



a) Based on the figure, explain what happens during the DNS lookup. From the description, the different types of DNS servers should be clear.
b) There are two different kinds of lookup schemes procedures: recursive and iterative. Which of the DNS queries are recursive, and which are iterative?
c) Suppose that Newton Technologies has a web server with the domain name “www.nt.com”. The company does now want the web server to have a second name in the ”.biz”-domain, “www.nt.biz”. Is this possible? Can a web server have domain names in different top level domains?

8. DNS is used for translating host names to IP addresses. But DNS is really more general: it is a distributed database for storing Resource Records. IP addresses represent one type of resource records.

A DNS query has two parts, a name and a type, and the response contains one or more resource records. Which of the entries in the table below describes valid queries that are support by DNS? For the valid queries, write the corresponding query type. (The textbook may not be sufficient to answer this question; you may need to consult the web.)

Query description	Query type
IP version 4 address for “www.kth.se”	
IP version 6 address for “www.kth.se”	
TCP port number for HTTP server at “www.kth.se”	
Incoming mail server for “kth.se”	
Outgoing mail server for “kth.se”	
Authoritative name server for “kth.se”	
Web server for “kth.se”	
Main (canonical) name for alias “www.kth.se”	
Host name with address “130.237.28.40”	

Problems from course book (Kurose and Ross, 7th ed)

P45.
Recall the macroscopic description of TCP throughput. In the period of time from when the connection’s rate varies from W/(2 · RTT) to W/RTT, only one packet is lost (at the very end of the period).
a) Show that the loss rate (fraction of packets lost) is equal to

$$L = loss\ rate = \frac{1}{\frac{3}{8}W^2 + \frac{3}{4}W}$$

b) Use the result above to show that if a connection has loss rate L, then its average rate is approximately given by

$$\approx \frac{1.22 \times MSS}{RTT\sqrt{L}}$$

P46.

Consider that only a single TCP (Reno) connection uses one 10 Mbps link which does not buffer any data. Suppose that this link is the only congested link between the sending and receiving hosts. Assume that the TCP sender has a huge file to send to the receiver, and the receiver's receive buffer is much larger than the congestion window. We also make the following assumptions: each TCP segment size is 1,500 bytes; the two-way propagation delay of this connection is 150 ms; and this TCP connection is always in congestion avoidance phase, that is, ignore slow start.

a) What is the maximum window size (in segments) that this TCP connection can achieve?
b) What is the average window size (in segments) and average throughput (in bps) of this TCP connection?
c) How long would it take for this TCP connection to reach its maximum window again after recovering from a packet loss?