

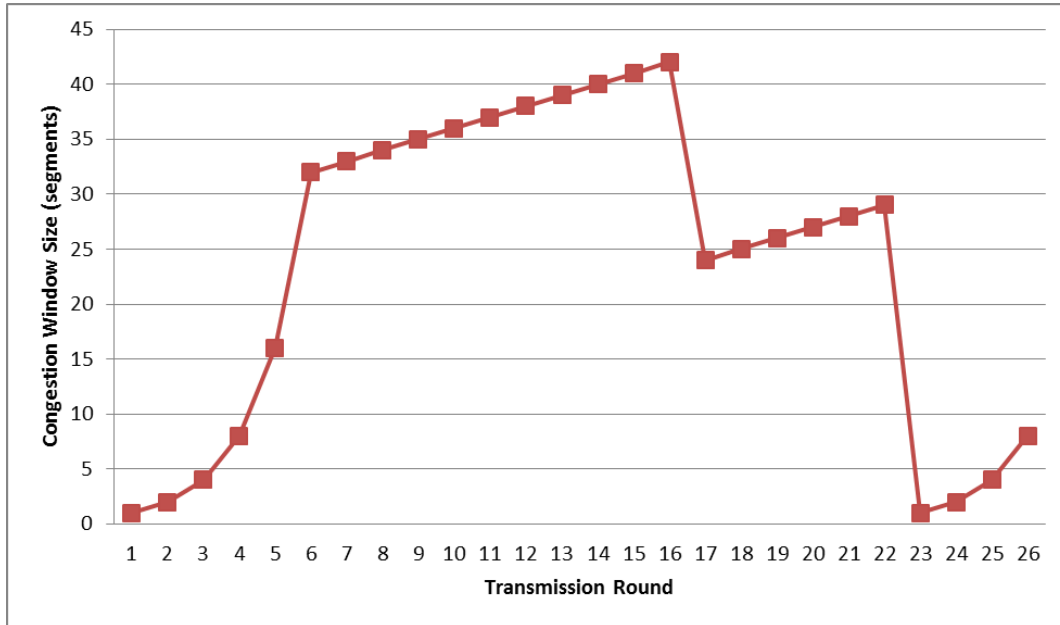
IK1203

Networks and Communication

Recitation 2 – Transport layer

1. TCP uses delayed ACKs instead of sending an 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).
- Mark the intervals when TCP is in slow start and congestion avoidance respectively.
 - During the 16th transmission round, a packet loss occurs. How is it detected? Is detected through a timeout or through the reception of three duplicate ACKs?



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.

