# Telematics

Winter Semester 2010/11



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| Number: | 11. Assignment |
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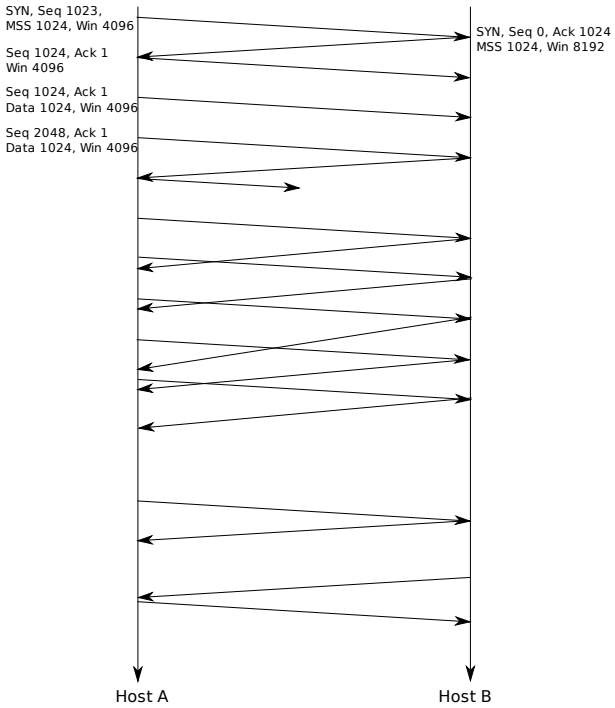
## Exercise 1, TCP Connection:

Consider the following message sequence chart of a TCP connection. The horizontal arrows represent the transmission of segments between two hosts while the vertical arrows represent the time. The labels show an excerpt of the header fields (values and flags) of the TCP segments.




1. Discuss the exchange of the the first three segments and the values of the header fields.
2. Host A transmits 7 segments with a payload size of 1024 Byte to host B and closes the connection afterwards. The first two segments carrying payload are already annotated in the message sequence chart. Label the remaining segments with the values of the headers header fields considering the following information:
   - One of the segments is lost in the network (indicated by an arrow that does not reach the right side).
   - Assume that host A supports fast retransmit and no timeouts due to the lost segment occur in A's TCP implementation.

## Exercise 2, Basic TCP Features:

The TCP protocol as defined in RFC 793 specifies several features besides to provision of a reliable end-to-end connection. Explain the following features / properties:

1. Push function
2. Urgent data transport
3. TCP Options
4. Connection reset

## Exercise 3, The History of TCP:

The Transmission Control Protocol has gotten many modifications/improvements over time. Discuss when the following got added, list the relevant RFCs (if any), and briefly explain the extension/algorithm/feature:

1. Fast Retransmit
2. Fast Recovery
3. Congestion Control
4. Flow Control
5. Karn's Algorithm
6. Nagle' Algorithm
7. Selective Acknowledgements
8. TCP for networks with high bandwidth-delay product

List TCP variants that implement these features.

## Exercise 4, Compatibility:

There are many TCP implementations/variants available and used in today's operating systems. Discuss if and why these variants are (not) fully compatible.

## Exercise 5, Operating System Support:

Which TCP variants and features are supported by modern operating systems? Give examples.
How can you configure your TCP implementation?

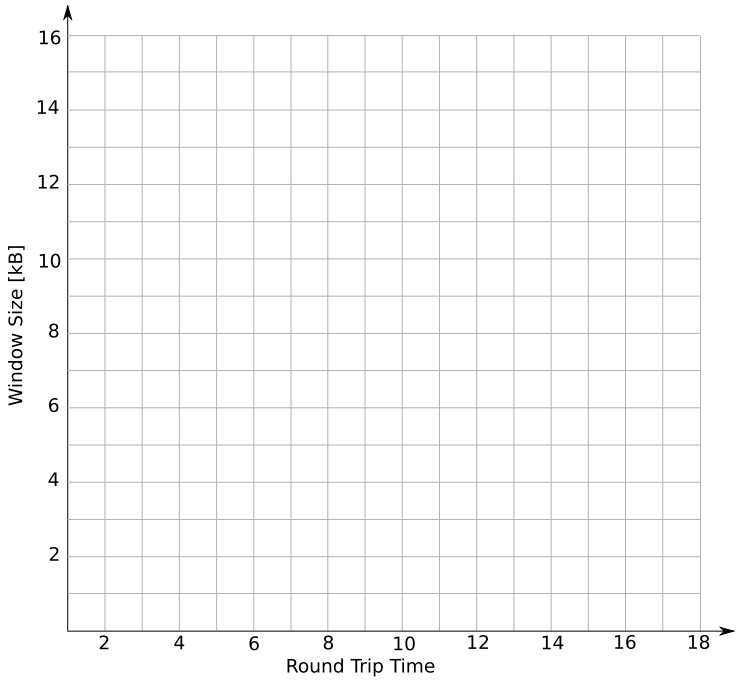
## Exercise 6, Basic and Advanced Congestion Avoidance:

Sketch a diagram depicting the behavior of a TCP implementation that detects congestion in the network (no ACKs are received for some segments). Assume three cases:

1. The TCP implementation does not support congestion avoidance.
2. The TCP implementation supports slow start and congestion avoidance.
3. The TCP implementation supports fast retransmit and fast recovery (implies slow start and congestion avoidance support).

## Exercise 7, TCP Slowstart and Congestion Avoidance:

Consider a TCP implementation that uses an initial slow start threshold of 8 kB and a maximum segment size of 1 kB. A connection between hosts A and B is established and (unlimited) data sent from A to B while B only acknowledges received segments and has no data to sent. Assume that the receiver window of host B is always at 16 kB[a]. Timeouts occur due to congestion after the 8th, the 11th, and the 17th *round trip time*, respectively after A has sent the i-th round of TCP segments. For simplicity, assume that host A will always sent as many segments as possible, that B acknowledges all received segments at the same time, and that all segments experience the same delay in the network.
Sketch the size of the congestion window and the slow start threshold in the following figure. Assume that the TCP implementation of host A does not support fast retransmit and fast recovery (or other improvements).




[a]Normally, the receiver window changes during the connection depending on the amount of data in the receive buffer.

## Exercise 8, TCP Limitations:

TCP is a reliable transport protocol but reliability can decrease throughput and increase delay.

1. The maximum payload size of a TCP segment is limited to 65495 Byte. Explain this value.
2. Consider a communication channel with a data rate of 1 GBit/s and a delay of 10 ms. What is the maximum throughput a TCP connection can achieve? How efficient is the TCP connection?

## Exercise 9, TCP Security:

Discuss attacks on the TCP protocol and how these can be detected or prevented.
Hint: Watch the following conference talk. TCP DoS Vulnerabilities