Internet Infrastructure and Protocols (COMP5311)

Assignment Two (due on 9 Nov. 2011)
Each question carries 8 marks, unless stated otherwise.

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1) Consider that an IP packet of 1500 bytes (with destination address as D and a 20-byte IP header) entering into a router R, and the packet will be tunneled before forwarding. The tunnel MTU is assumed to be 1480 bytes. Therefore, IP fragmentation is required for this packet. In this question, we explore a fragment-first-and-then-tunnel approach. Using this approach, the IP packet will be first fragmented in packets not exceeding the tunnel MTU, and then each fragment is tunneled by encapsulating the fragment with a 20-byte IP header.
   a) (3 marks) What is the size of the second fragment?
   b) (3 marks) If there is no further fragmentation, where will the fragments be reassembled? The exit tunnel endpoint or D?
   c) (2 marks) If the fragments are further fragmented in the path between the two tunnel endpoints, where will these fragments of fragments be reassembled? Assume that there is no other IP tunnel in the path.
2) When a TCP node receives a valid TCP data segment from the other side of a TCP connection, it has to check, among others, whether the data sent in the segment has been received before. If positive, it will discard the duplicate data. Let SEQ be the sequence number in the TCP data packet and LEN be the length of the TCP packet's payload.
   a) (2 marks) Give the condition in terms of the state variables kept by the receiver (e.g., `rcv_nxt` and `rcv_wnd`) that at least some data in the TCP packet are duplicate.
   b) (3 marks) Give the condition in terms of the state variables kept by the receiver (e.g., `rcv_nxt` and `rcv_wnd`) and LEN that the entire payload of the TCP packet is duplicate.
   c) (3 marks) If the entire payload is a duplicate, it is essential for the receiver to send an ACK to the sender before dropping the data. Explain why this is necessary.
3) Figure 1 shows a Wireshark trace of a web session: from a client with port 65416 to a server with port 80. Assume that both sides use an initial sequence number (SN) of 0. Therefore, the SN and the acknowledgment number (AN) in the SYN-ACK packet are 0 and 1, respectively. The SN and AN in the third hand-shaking packet are both 1.
   Answer the following questions concerning Figure 1 with succinct explanation.
   a) (2 marks) What is the server's `snd_nxt` just after sending the SYN-ACK packet at time 1.282?
   b) (2 marks) What is the client's `snd_nxt` just after sending the data packet at time 1.283 (i.e., the fourth packet in Figure 1)?
   c) (2 marks) What is the client's `rcv_nxt` just after receiving the data packet from the server at time 1.301 (i.e., the seventh packet in Figure 1)?
   d) (2 marks) What is the AN in the last packet in Figure 1?

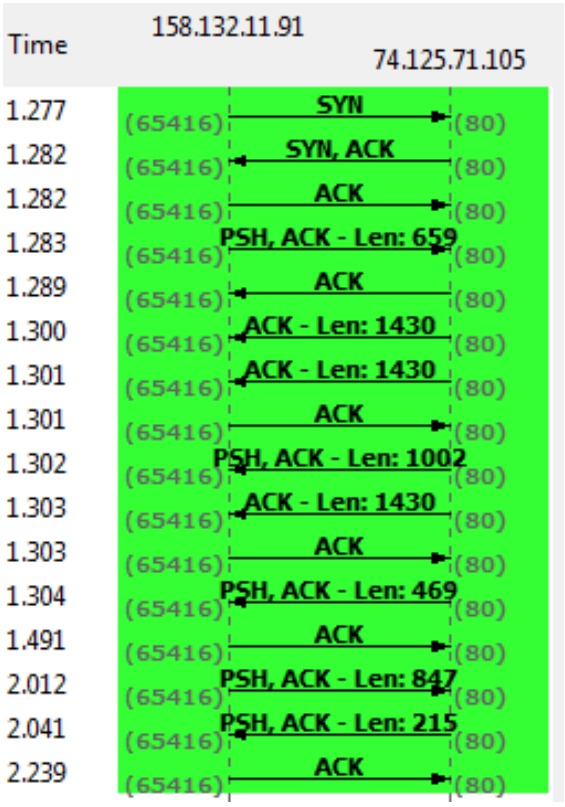

Fig. 1. TCP transmissions in a web session.

4) Figure 2 shows a similar plot (which was generated using a different simulator) as problem 1 of assignment 3. In this trace, we label the lost data segment (the one with a cross) to be segment 14, and other data segments are labeled consecutively. The only main difference as compared with the plot in the assignment is that the ACK values here refer to the next expected segment. Recall that ack-every-segment strategy is used, and assume that the `rwnd` value is always equivalent to 30 data segments.
   Answer the following questions concerning the trace in Figure 2 with succinct explanation. You do not need to know the `ssthresh` values to answer these questions.
   a) (2 marks) What is the value of `cwnd` by the time of transmitting data segment 14?
   b) (2 marks) Why is there an idle period between sending segment 14 and segment 15?
   c) (2 marks) What is the value of `cwnd` by the time of transmitting data segment 28?
   d) (2 marks) Why is there an idle period between sending segment 28 and segment 29?

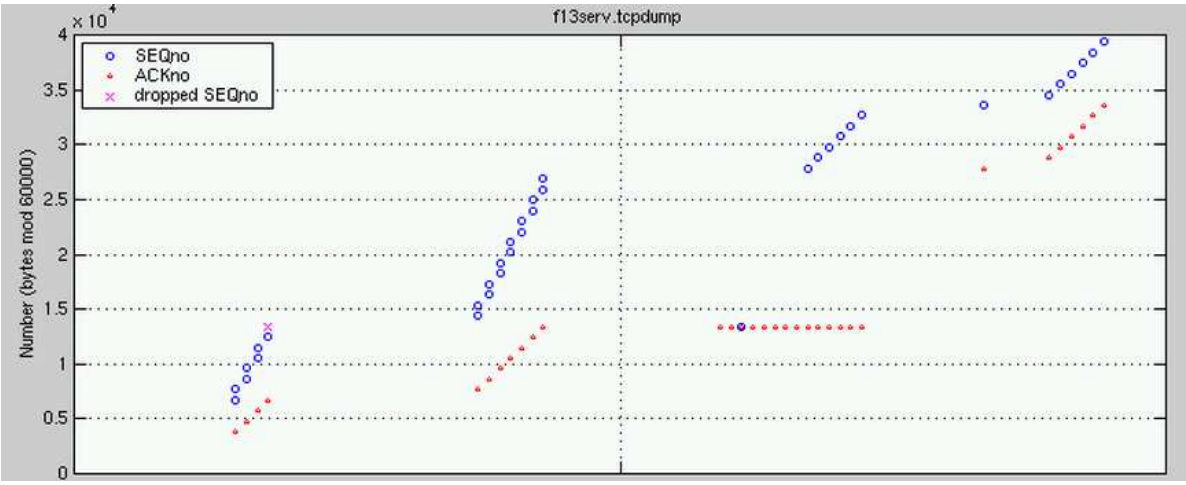

Fig. 2. TCP segment 14 is lost and is being fast retransmitted.

e) (2 marks) What is the value of `cwnd` by the time of transmitting data segment 29? Explain your answer *without* using `ssthresh`.
f) (2 marks) Why is there an idle period between sending segment 34 and segment 35?
g) (2 marks) What is the value of `cwnd` by the time of transmitting data segment 35? Explain your answer *without* using `ssthresh`.
h) (2 marks) Assume that just after sending data segment 28, `snd_una` $= n$, and the MSS is given by m bytes. What are the values of `snd_max` and `snd_nxt` in terms of m and n?
i) (2 marks) By the time of retransmitting segment 14, what are the values of `snd_max` and `snd_nxt` in terms of m and n?
j) (4 marks) If the `rwnd` value is changed to 15 segments, what would be different in the plot?