CSE123 Fall 2016 Homework #4
Instructor: Stefan Savage

Due Friday 12/2 at the beginning of class

1. TCP performance

a) Consider a standard TCP implementation using flow control, slow start and AIMD-style congestion control. A TCP-based application wishes to send 100KB to a receiver. The bottleneck link between the sender and receiver is 10Mbps and there is no competing traffic. The round-trip time is 100ms and the packet size is 1KB. The receiving application reads 10KB of data every second and has 100KB of buffer. Will this transfer saturate the bottleneck link? If so, explain why. If not, explain why not.

No. There is no flow control problem because there is enough buffer to accept the whole 100KB. However, to max out the link would require a window equal to the bandwidth*delay product (BDP), 10Mbps*100ms. Since there is no flow control limitation we need cwnd=125KB. Due to slow start, the sender will send 1KB, then 2KB, 4KB, 8KB, 16KB, 32KB then 37KB. Cwnd will never reach 125KB and hence the sender will never send fast enough to saturate the 10Mbps link.

b) What if the receiver buffer were set to 200KB?
No. this won't matter because there is no flow control limitations in this example.

c) What if the round-trip time was 1ms?
Yes. In this case, the BDP would be 1250bytes, barely more than one packet and we will reach this quickly (after one RTT). At this point we'll be injecting data into the network at a rate of at least 2000bytes per 1ms (or 16Mbps) which will exceed the capacity of the link.

2. Transport behavior

Consider a TCP session for which the current window size is 10,000 bytes and the MSS (the number of maximum bytes in a packet) is 1,000 bytes. Suppose the sender sends 5,000 bytes. In return it receives several acknowledgements (assume for this example that sequence numbers start at 1). It receives an ACK for byte 1001, then another for byte 2001, then another for byte 2001, then another for byte 2001… and that's it (four acks)

a) Describe two possible explanations for this sequence of packets (i.e., what could have happened in terms of which packets were delivered, in what order and which packets were lost)

i) the third packet was lost (from bytes 2001-3000), but the fourth and fifth packets were delivered. All ACKs were delivered.
ii) the fourth and fifth packets were delivered before the third packet AND the acknowledgement for the third packet (which would have been for byte 5001) was lost.

b) Suppose you send another 1000 byte packet (i.e., for bytes 5001-6000) and receive an acknowledgement in response. How would the contents of that acknowledgement let you distinguish between the two cases above?

If the ack was for byte 6001 then you could conclude that the third packet really was delivered. If the ack was still for byte 2001 then you know that the third packet was not delivered.

3. Flow control

Consider a TCP connection with a 1ms round-trip time in which the sender has 50,000 bytes of data to send and there are no losses and no congestion. The receiver has an initial advertised window of 10,000 bytes and reads 2,000 bytes of data once every two seconds. Answer the following questions with a number and a sentence explaining why.

i) What is the advertised window after one second?

0, because 10000 bytes are buffered and the receiver has not yet read.

ii) What is the advertised window after two seconds?

2000 because the receiver just read 2000 bytes and so the sender can send another 2000.

iii) What is the advertised window after fifty seconds?
10000 because after fifty seconds all 50KB will have been transferred AND consumed and thus the receiver's buffer will be empty.