

CNT5106C Computer Networks, Fall 2014

Instructor: Prof. Ahmed Helmy

Homework #2

On the Transport Layer, Congestion Control and TCP & Wireshark Exp.

[Date Assigned: Oct 12th, 2014. Due Date: Oct 24th, 2014]

[Please submit your homework through the on-line Sakai system.]

Q1. (8 points: 4 points each)

- I. Consider a reliable data transfer protocol that uses only negative acknowledgements. Suppose the sender sends data only infrequently. Would a NAK-only protocol be preferable to a protocol that uses ACKs? Why?
- II. Now suppose the sender has a lot of data to send and the end-to-end connection experiences few losses. In this second case, would a NAK-only protocol be preferable to a protocol that uses ACKs? Why?

Q2. (12 points: 4 points each case) Consider a transport protocol that uses connection-oriented network service. Suppose that the transport protocol uses a credit allocation flow control scheme (such as TCP), and the network protocol uses a sliding-window scheme. What relationship should there exist between the dynamic window of the transport protocol and the fixed window of the network protocol, such that the transport protocol is effective? Consider the following cases: I. There is one-to-one relationship between a transport layer connection and network layer connection. II. A transport layer connection may be split among multiple network layer connections. III. Multiple transport layer connections may be multiplexed in one network layer connection.

Q3. (14 points: 6 + 8)

- I. Describe (with the aid of a graph) the different phases of network load/overload outlining the degrees of congestion with increase of load. Indicate the point of congestion collapse and explain why it occurs. (6 points)
- II. Where does TCP operate on that graph? Explain for the various phases of TCP; slow start, congestion avoidance (due to timeout), fast retransmit-fast recovery triggered by duplicate ACKs. (8 points)

Q4. (20 points: 4 points each)

Let's take a closer look at the reasoning behind TCP Reno's window adjustment algorithm. The algorithm is as follows (from the lecture slides):

- Initially we use Slow start:
$$CongWin = CongWin + 1 \text{ with every ack}$$
- When timeout occurs we enter congestion avoidance:
$$ssthresh = CongWin/2, CongWin = 1$$

slow start until $ssthresh$, then increase linearly
$$CongWin = CongWin + 1 \text{ with every } RTT, \text{ or}$$

$$CongWin = CongWin + 1 / CongWin \text{ for every ack}$$
- Fast recovery: when 3rd dup ack arrives
$$ssthresh = CongWin/2$$

retransmit segment, set $CongWin = ssthresh + 3$
 for every duplicate ack $CongWin = CongWin + 1$
 after receiver gets cumulative ack: $CongWin = ssthresh$

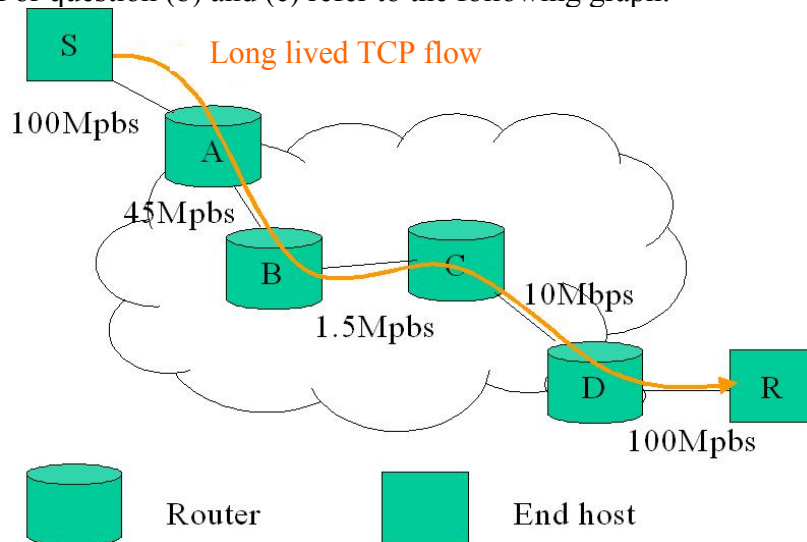
Answer the following questions based on your understanding about this algorithm.

- Why do we set $ssthresh = CongWin/2$ upon entering congestion avoidance? Why not set $ssthresh = CongWin/3$ or $ssthresh = CongWin - 20$? Is there any particular reason, or this is an arbitrary decision?
- Why do we set $CongWin = 1$ upon entering congestion avoidance in the basic TCP algorithm (the one WITHOUT fast recovery)?
- Why do we set $CongWin = ssthresh + 3$ when we receive the 3rd dup ack in the fast recovery algorithm?
- In the fast recovery algorithm, for every dup ack $CongWin = CongWin + 1$, is this equivalent to exponential increase?
- What is the feature in the fast recovery algorithm that makes it possible to set $CongWin = ssthresh$ instead of $CongWin = 1$ when TCP exits fast recovery?

Q5. (9 points (a), (b) + 8 points part (c)) Interaction between TCP and other flows:

- (4 points) In a scenario where long lived TCP flows share several links with UDP flows, explain what happens in cases of congestion? [i.e., who gets more share of the bandwidth, and who experiences more packet loss, etc.]

For question (b) and (c) refer to the following graph:



- (5 points) If someone were to inject UDP traffic into the network to attempt to harm the long lived TCP flows the most using the least amount of traffic/bytes, where in the network would they inject such UDP traffic? Please specify the location (at which router) and the direction (toward S or D) you would inject the UDP flow and clarify.
- (8 points) Consider a scenario in which the network is protected against excessive UDP flows (using UDP filtering gateways/firewalls) and TCP Syn flood attacks (So if you attack by generating a lot of new TCP flows you will also get caught). If someone were to inject traffic into the network to attempt to harm the long lived TCP

flows the most, where in the network would they inject such traffic? Note that now you are limited to using small number of 'short' TCP flows. Clarify your strategy as compared to (b) above, would you attack the same link(s)? Please specify the location (at which router) and the direction (toward S or D) you would inject the short TCP flow and clarify.

[Hint: note that short TCP flows spend most of their lifetime in the slow start phase, and they need to get acks to open their window size (i.e., they cannot increase their rate arbitrarily)]

Q6. (12 points) Based on your understanding of explicit and implicit congestion signaling discuss why TCP's performance in general degrades over wireless links? If the network provides explicit congestion signaling discuss modifications you would propose to TCP such that its performance improves over wireless networks. Discuss possible drawbacks and improvement of your initial solution above considering both wireless and wired links.

Q7. (14 points) ATM ABR rate-controlled flow, starts with initial cell rate (ICR) of 16k cells/sec. The peak cell rate (PCR)=32k cells/sec, the minimum cell rate (MCR)=1k cells/sec, the maximum burst size (MBS) is 100k cells, and the RM cell rate is 1cell/sec (these RM cells were received by the sender). The rate increase factor (RIF)=1/4, and the rate decrease factor (RDF)=1/4. The no increase (NI) bit was always '0' in the RM cells, while the setting of the congestion indication (CI) bit in the consecutive RM cells was as follows: 0,0,0,0,1,1,1,1. Draw a graph showing the cell rate of the source against time with intervals of 1 sec, starting at time $t=0$ when the sender started with ICR, up to $t=8$ secs.

Q8. (8 points) In ATM ABR congestion control the equation to increase the rate is given by:

$Rate_{new} = Rate_{old} - Rate_{old} * RDF$, where RDF is the rate decrease factor,

- discuss how fast/slow does the sender respond to congestion for the various value of RDF .
- If the equation was changed to $Rate_{new} = Rate_{old} * \beta$, do you think the response will be better or worse and why.

Q9. (8 points) Argue for or against this statement (reason using examples as necessary): "Packets are lost only when network failures occur (e.g., a link goes down). But when the network heals (e.g., the failed link comes back up again), packets do not get lost."

Q10. (10 points) The delay performance of a particular ATM network is dominated by one critical physical link, which is shared by three flows (referred to in ATM as virtual paths or VPs). Each time slot, the probability of a cell arriving on the first, second, and third VP is 0.1, 0.2, and 0.3, respectively, and cell arrivals are independent in time. Assume that the statistical multiplexer at the head end of every VP can store an arbitrarily large number of cells.

- Find the allocation of link bandwidth among the three VPs such that the average cell delay is the same for all VPs

- b. Repeat part a if the probability of a cell arriving on the first, second, and third VP is 0.05, 0.05, and 0.5, respectively.

Q11-Q15. Perform the HTTP experiment (Lab II) using Wireshark in the following link:
http://www.cise.ufl.edu/~helmy/F14/Wireshark_HTTP_v6.1.pdf

Including the following parts: (12 points each)

Q11. The Basic HTTP GET/response interaction

Q12. The HTTP CONDITIONAL GET/response interaction

Q13. Retrieving Long Documents

Q14. HTML Documents with Embedded Objects

Q15. HTTP Authentication

[Note: You should start with the introductory experiment to Wireshark (Lab I) if you are not familiar with it. You can also submit Lab I for extra credit (15 points) but that is optional.

Lab I is at: http://www.cise.ufl.edu/~helmy/F14/Wireshark_Intro_v6.0.pdf]