LAB 5: TCP Congestion Window

The goal of this lab is to observe the variation of the congestion window size with time. Coincidentally, you'll also be introduced to the tracing subsystem of ns-3.

Description

Consider the simple topology where you have two nodes (A & B) that are connected by a single ethernet link. Further assume that A is sending data to B using TCP. We would like to observe how the TCP congestion window of A changes with time.

The official ns-3 tutorial has a code walkthrough that explains how we can implement the above. We recommend that you go through the aforementioned tutorial section closely. Once you have read and understood the code, answer the following questions.

1. TCP comes in many flavors. Which flavor does ns-3 use in its tutorial? What are the differences among the different versions? Compare and contrast.
2. Now that you know how to run the given code and generate the plot given in the tutorial, we shall tweak it a little to make this lab more interesting. Fix the link rate of A --- B to be 25 Mbps. We would like to see how TCP behaves on links with different delays and loss rates. Specifically, consider two different delays d_{low} and d_{high}. Similarly, we have three link error rates given by l_{low}, l_{med} and l_{high}. You are free to pick the actual values for the above parameters. You may pick any value that you like as long as the values satisfy the following constraints:
    a. $d_{low} \in [5ms,\ 15ms]$
    b. $d_{high} \in [200ms,\ 300ms]$
    c. $l_{low} = 0$
    d. $l_{high} \in [0.006,\ 0.01]$
    e. $l_{med} \in [0.00001,\ 0.0001]$
3. Plot the variation of congestion window with respect to time for all delay-link error rate combinations. Given that you have two possible delays and three possible losses, you'll need to generate six plots in total.
4. In question 1, you identified the version of TCP that you are working with. In your plots, can you identify the salient features of the TCP flavor that you used? For instance, do you see slow-start? What else can you identify? Note that not all features may appear in a single plot. You also may need to play around with the start and stop times for your code.
5. For each link error rate, you have two plots each corresponding to a different delay value. Explain the differences introduced by the change in delay values. Do the plots conform to your expectations?

6. For each delay value, you have three plots each corresponding to a different link error rate. Your friend (who has already taken EE 450 earlier!) only views the plots and immediately identifies which error rate (low, medium or high) a plot belongs to. How did your friend classify the plots? (Of course, assume that the deduction was done using the features of the plot itself as opposed to trivial explanations such as "The title/labels said so!").
7. In the plot corresponding to (d_{low}, l_{med}) identify the points corresponding to a loss event. Be sure to mark the relevant time points on the plot explicitly.