CSC5480 PROJECT
TCP Congestion Control, Active Queue Management and Differentiated Service

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In this project, you need to use NS-2 and stochstic differential equations to understand the interaction of TCP flows, active queue management (AQM) policies in the routers and differentiated service model.

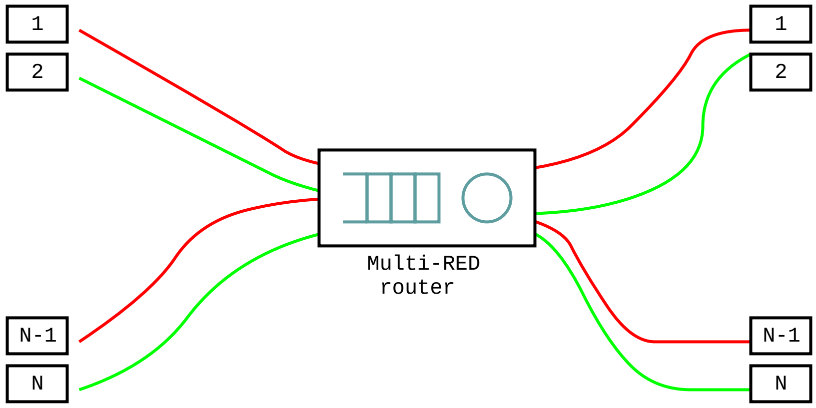

Figure 1: Single Multi-Red Router R supporting N TCP flows with two colors marking

Let us consider that we only have a single router R as illustrated in Figure 1. To realize the differentiated service, router R has a 2-colors active queue management policy. The goal is that the "green" IP packets should receive better service than the "red" IP packets. This is achieved by dropping "red" packets earlier than "green" packets. To realize this type of differentiated service, the AQM we use is two sets of random early detection (RED) thresholds. Let x denote the average queue length at router R, the probability functions of dropping a "green" and a "red" packet are described by:

$$p_g(x) = \begin{cases} 0 & 0 \leq x \leq t_g^{min} \\ \frac{x - t_g^{min}}{t_g^{max} - t_g^{min}} & t_g^{min} \leq x \leq t_g^{max} \\ 1 & t_g^{max} < x \end{cases} \tag{1}$$

$$p_r(x) = \begin{cases} 0 & 0 \leq x \leq t_r^{min} \\ \frac{x - t_r^{min}}{t_r^{max} - t_r^{min}} & t_r^{min} \leq x \leq t_r^{max} \\ 1 & t_r^{max} < x \end{cases} \tag{2}$$

We consider the case where

$$t_r^{min} < t_r^{max} < t_g^{min} < t_g^{max} \tag{3}$$

$$t_r^{max} - t_r^{min} = t_r^{max} - t_r^{min} \tag{4}$$

(of course, you should try to vary this to understand the physical implication.)

We have the following parameters in our system:

- C: the capacity of router R in Mbps.
- N_g: The number green TCP flows.
- N_r: The number red TCP flows.
- $a(i)$: The round trip time for TCP flow i, $1 \leq i \leq N_g + N_r$.

Use NS-2 and Matlab (using stochastic differential equations) to investigate the following performance measures:

- Congestion window size for all flows.
- Instantaneous queue length at router R.
- Average queue length at router R.
- Instantaneous throughput for all flows.

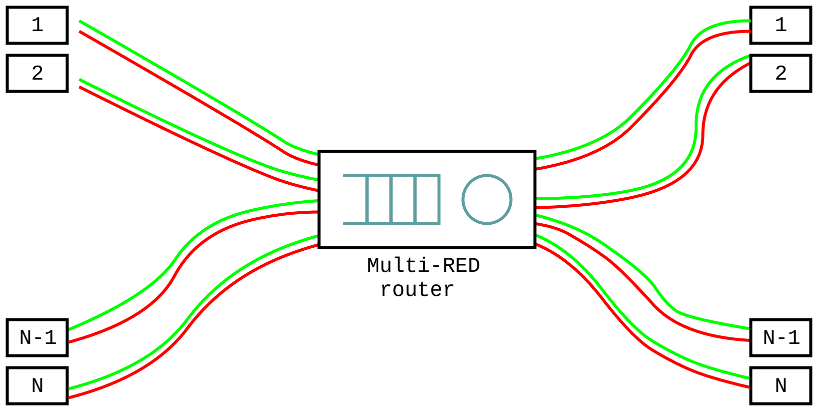

Figure 2: Single Multi-Red Router R supporting N TCP flows with two simultaneous colors marking

For part 2 of the project, consider the scheme as depicted in Figure 2. Let B_i^{min} be the minimum bandwidth for TCP flow i. Each TCP flow will mark its packet as green packet. If the current bandwidth exceeds B_i^{max}, it will mark the remaining packet as color red. The goal is to see *whether* we can achieve minimum bandwidth guarantee using this 2-colors marking scheme.

Present your result in a report (at most 20 pages) with tables and plots for various performance metrics under various scenarios. The grade you will receive depends on the *depth* of your analysis and investigation. For example, you may want to explore the stability condition, difference in throughput between the green and red TCP flows, transient behavior (e.g., at time t_1, all red flows will terminate and at time t_2, they will all come back up), and the behavior of flows if the system does not have the constraints in Equation (3) to (4).

Warning: In your simulation, be careful in choosing the values of the parameters (e.g., C). If you blindly choose some unreasonable parameter values, your simulation may not make sense. Choosing the *appropriate* values of the parameters requires some understanding of the system.