CS3205 Assignment 3

Amogh Prabhunanda Patil ee19b134

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1 Introduction

The objective of this project is to simulate the TCP congestion control algorithm. Congestion Window is a TCP state variable that limits the amount of data the TCP can send into the network before receiving an ACK.

- Initial congestion window (CW):

$$CW_{new} = K_i * \text{MSS} \tag{1}$$

- The exponential phase

$$CW_{new} = min(CW_{old} + K_m * \text{MSS}, \text{RWS}) \tag{2}$$

Also called slow start phase.

- The Linear phase, when the congestion window has crossed the threshold value:

$$CW_{new} = min(CW_{old} + K_n * \frac{\text{MSS} * \text{MSS}}{CW_{old}}, \text{RWS}) \tag{3}$$

- When timeout has occured due to undelivered packets or when the acknowledgement has not reached the sender:

$$CW_{new} = max(1, K_f * CW_{old}) \tag{4}$$

Certain Points to note:

- Receiver Window Size (RWS) is set to 1MB.
- Sender's MSS is 1KB.
- Go-back-N is used.
- The congestion threshold is always set to 50% of the current CW value. Assume the initial threshold to be RWS/2.

2 Observations

2.1 Initial Congestion Window $\mathbf{k}_i$

Two cases of
$K_i = 1$ and 4 are chosen,
keeping all other parameters constant.
$K_m = 1.0$, $K_n = 1.0$, $K_f = 0.1$, $P_s = 0.99$, T = 1000.

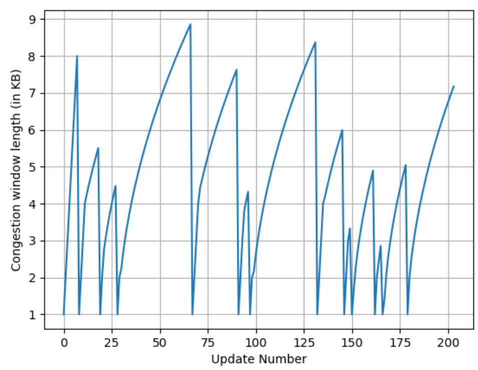

Figure 1: ki=1, km=1, kn=1, kf=0.1, ps=0.99

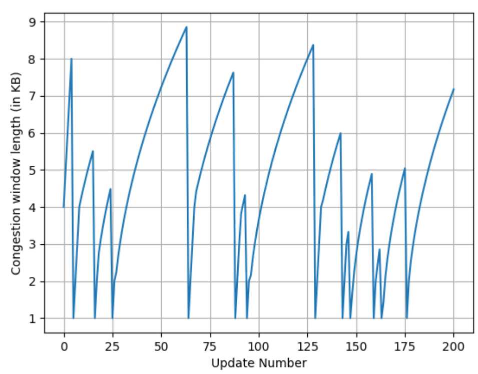

Figure 2: ki=4, km=1, kn=1, kf=0.1, ps=0.99

It can be observed that $K_i = 4$ ends earlier as the congestion window is larger initially, which allows a higher number of bytes to be sent out initially.

2.2 Congestion Window Multiplier(Exponential Phase) K_m

Two cases of
$K_m = 1$ and 1.5 are chosen,
keeping all other parameters constant.
$K_i = 1.0$, $K_n = 1.0$, $K_f = 0.1$, $P_s = 0.99$, T = 1000.

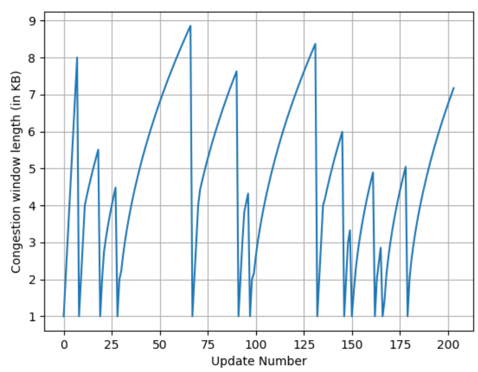

Figure 3: ki=1, km=1, kn=1, kf=0.1, ps=0.99

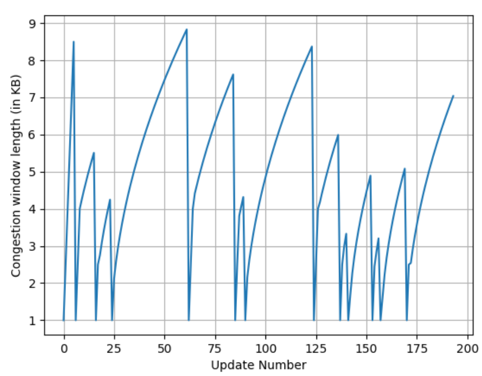

Figure 4: ki=1, km=1.5, kn=1, kf=0.1, ps=0.99

The congestion window increases at a faster rate for $K_m = 1.5$, Hence the peaks are higher and the transmission ends faster as more bytes are sent out for a given time slot due to the larger congestion window.
The Equation for this stage is infact linear and the slope is K_m, Therefore $K_m = 1.5$ has steeper lines.

2.3 Congestion Window Multiplier(Linear Phase) K_n

Two cases of
K_n = 0.5 and 1 are chosen,
keeping all other parameters constant.
K_i = 1.0, K_m = 1.0, K_f = 0.1, P_s = 0.99, T = 1000.

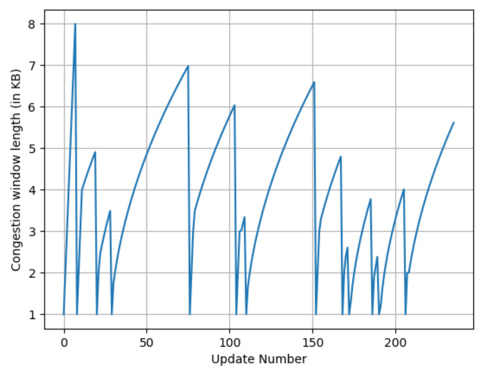

Figure 5: ki=1, km=1, kn=0.5, kf=0.1, ps=0.99

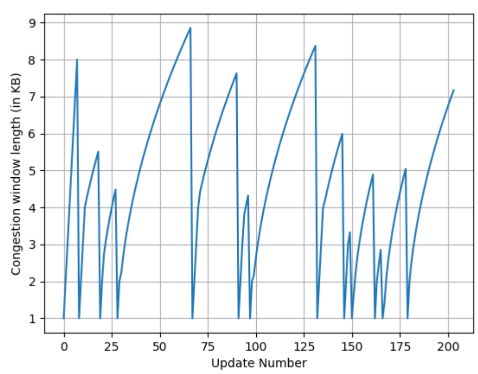

Figure 6: ki=1, km=1, kn=1, kf=0.1, ps=0.99

The congestion window increases at a faster rate for K_n = 1, Hence the peaks are higher and the transmission ends faster as more bytes are sent out for a given time slot due to the larger congestion window.

2.4 Congestion window multiplier (Timeout) K_f

Two cases of
$K_f = 0.1$ and 0.3 are chosen,
keeping all other parameters constant.
$K_i = 1.0$, $K_m = 1.0$, $K_n = 1$, $P_s = 0.99$, T = 1000.

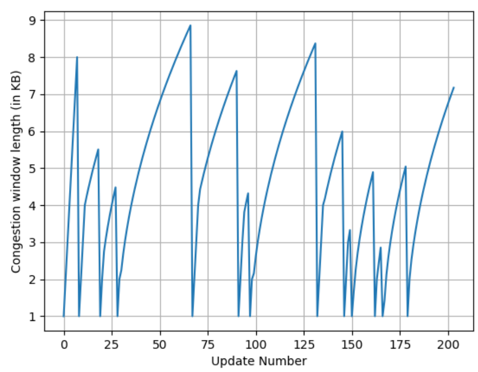

Figure 7: ki=1, km=1, kn=1, kf=0.1, ps=0.99

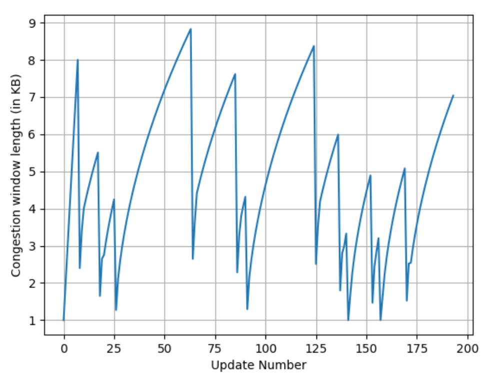

Figure 8: ki=1, km=1, kn=1, kf=0.3, ps=0.99

During timeout, The decrease in congestion window is greater for smaller values of K_f (= 0.1), therefore the transmission of entire data takes longer for smaller values of K_f.

2.5 Probability of receiving Acknowledgments P_s

Two cases of
$P_s = 0.99$ and 0.9999 are chosen,
keeping all other parameters constant.
$K_i = 1.0$, $K_m = 1.0$, $K_n = 1$, $K_f = 0.3$, T = 1000.

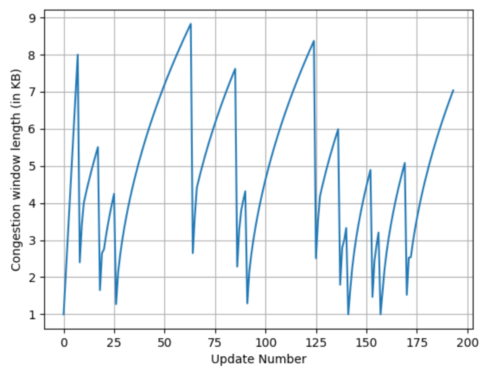

Figure 9: ki=1, km=1, kn=1, kf=0.3, ps=0.99

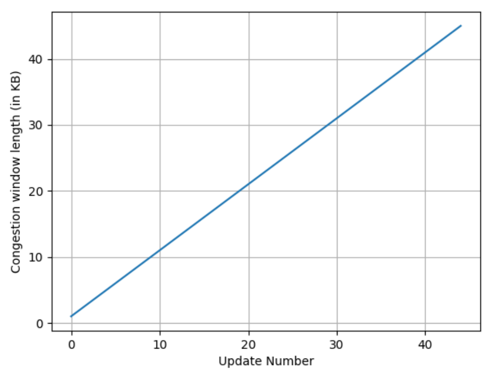

Figure 10: ki=1, km=1, kn=1, kf=0.3, ps=0.9999

For higher P_s, the lower probability of packet loss(transmitted packet or acknowledgment packet), Hence less likely the event of a retransmission and therefore the transmission process takes l