

B.Tech(ICT) Semester VI: Computer Networks

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Title : TCP Congestion Control

- 1) AIMD - Additive Increase/ Multiplicative Decrease
- 2) Slow Start
- 3) Fast Retransmit

1 Introduction

1.1 Background

- TCP(Transmission Control Protocol) is a connection-oriented protocol, which means a connection is established so that application programs at each end can exchange messages. Transmission Control Protocol determines how to break application data into packets so that networks can deliver, send packets to and accept packets from the network layer. It manages flow control and provides error-free data transmission, handles retransmission of dropped packets as well as acknowledgement of all packets that arrive. TCP Congestion Control is meant for handling Congestion in Network. TCP Congestion Control Policy consists of three phases- Slow start phase, Congestion Avoidance Phase, Congestion Detection Phase. Congestion refers to a network state where the message traffic becomes so heavy that it slows down network response time.

1.2 Slow Start

In this phase after every RTT the congestion window size increments exponentially. The basic idea behind "slow start" is to send packets as much as the network can accept. It starts to transmit 1 packet and if that packet is transmitted successfully and receives an ACK, it increases its window size to 2, and after receiving 2 ACKs it increases its window size to 4, and then 8, and so on.. "slow start" increases its window size exponentially till ssthreshold value.

1.3 AIMD

- **Congestion Avoidance Phase(Additive Increase):-**

This phase starts after the congestion window reaches threshold value also denoted as ssthresh. The size of cwnd(congestion window) increases additive. After each RTT $cwnd = \text{congestion window} + 1$.

Initially congestion window = i

After 1 RTT, $cwnd = i+1$

2 RTT, $cwnd = i+2$

3 RTT, $cwnd = i+3$

Congestion Detection Phase(Multiplicative decrease) :-

If congestion occurs which is detected by packet loss, the congestion window size is decreased. A sender can guess that congestion has occurred is the need to retransmit a segment. Retransmission is needed to recover a missing packet which is assumed to have been dropped by a router due to congestion.

Retransmission due to 3 Acknowledgement Duplicates – In this case congestion possibility is less.

(a) ssthresh value reduces to half of the current window size.

(b) set $cwnd = 1$

(c) start with slow start

1.4 Fast Retransmit

Fast retransmit is a modification to the congestion avoidance algorithm. As in Jacobson's fast retransmit algorithm, when the sender receives 3rd duplicate ACK, it assumes that the packet is lost and retransmit that packet. After retransmission, the sender continues normal data transmission. When there is retransmission of packet, receiver sends commulative acknowledgement of all packets send till then.

2 Stimulation Analysis

- Congestion Window Vs Round trip Time

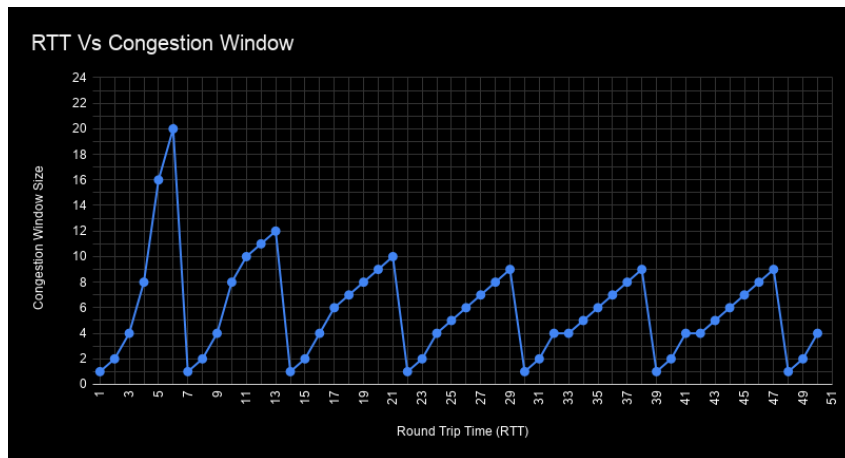


Figure 1:

- Acknowledge Received Vs Round trip Time

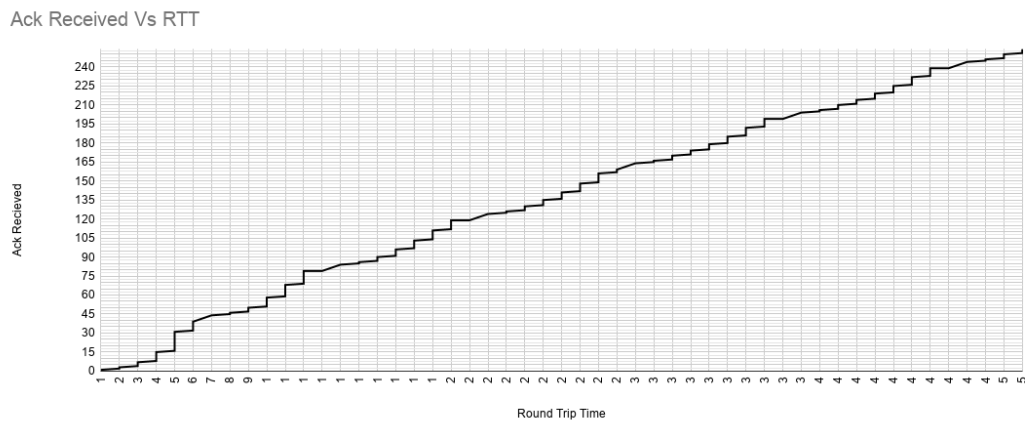


Figure 2:

3 Features

- This code stimulates the behaviour of TCP congestion control
- Untill the congestion window reaches ssthreshold, it increases exponentially.
- When it reaches ssthreshold it follows AIMD algorithm
- When there is packet loss which is detected by 3 duplicate acks, ssthreshold is set to half of current congestion window and congestion window is set to 1. We have assumed that every 40th packet results in packet loss
- This behavior of TCP is stimulated using a C program and plot CWND against time for 50 RTTs
- We have recorded ACK sequence numbers for the sent packets and plot them with time(RTT)

References

- [1] Computer Networks : A systems approach

<https://cseweb.ucsd.edu/~gmporter/classes/wi19/cse124/courseoverview/compnetworks.pdf>

- [2] Gate Vidyalay *<https://www.gatevidyalay.com/tcp-congestion-control-tcp-protocol-tcp/>*