Report on AIMD Congestion Control Simulation

Objective: The objective of this project was to simulate two TCP flows implementing Additive Increase and Multiplicative Decrease (AIMD) congestion control while sharing a single queuing server. The study aimed to evaluate the fairness between the flows under varying Round Trip Times (RTTs) and to analyze the throughput and goodput under different conditions.

Simulation Setup: The simulation involved two TCP flows, A and B, with AIMD congestion control sharing a finite FIFO buffer queue. The primary metrics were throughput and goodput, recorded over the simulation time. Two scenarios were explored:

1. **Equal RTTs**: Both flows had the same RTT (50 units).
2. **Different RTTs**: Flow A retained the RTT of 50 units, while Flow B had an RTT of 100 units.

Packet losses were introduced probabilistically (15%), and Go-Back-N protocol was implemented to handle retransmissions.

Results and Analysis:

1. **Equal RTTs Scenario (Figures 1 and 2):**
    - Both flows started with the same RTT and were introduced sequentially, causing an initial disparity in performance as Flow A began first.
    - As the simulation progressed, throughput and goodput for both flows converged. This reflects the fairness property of AIMD under equal RTTs.
    - The periodic increase and decrease in throughput and goodput highlight the AIMD behavior, where the window size grows additively until congestion is detected (via packet loss) and is then halved multiplicatively.

    Observations:

    - Both flows eventually achieved similar throughput and goodput, indicating fairness.
    - Packet losses were evenly distributed, ensuring balanced performance between the flows.

2. **Different RTTs Scenario (Figures 3 and 4):**
    - When the RTTs were different, Flow A (with a shorter RTT) consistently achieved higher throughput and goodput than Flow B (with a longer RTT).
    - The imbalance arises due to the AIMD mechanism, where shorter RTTs allow faster acknowledgments and, consequently, quicker window growth.

Observations:

- Flow A outperformed Flow B in both throughput and goodput, demonstrating the RTT unfairness inherent in AIMD.
- The graphs reveal that while Flow B maintained a stable window size, its growth rate was constrained compared to Flow A.

Conclusion: The simulation effectively demonstrated the behavior of AIMD congestion control under varying RTT conditions. While AIMD ensures fairness in equal RTT scenarios, it introduces an inherent bias toward flows with shorter RTTs in differing RTT scenarios. These findings align with theoretical expectations and highlight the limitations of AIMD in heterogeneous network environments.

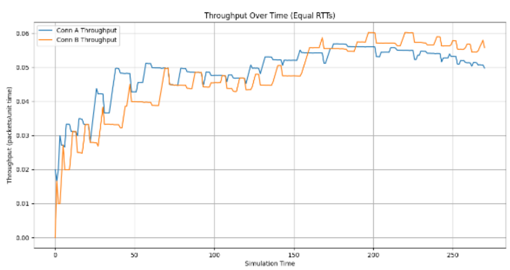

Figure 1

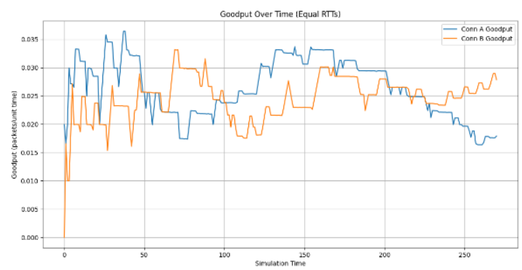

Figure 2

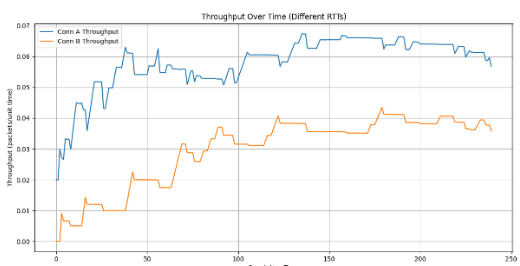

Figure 3

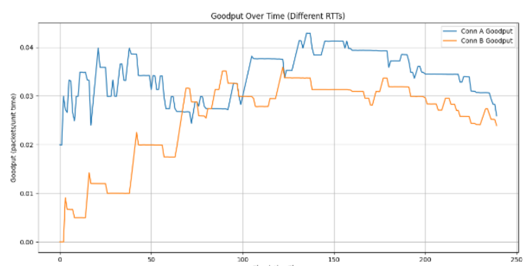

Figure 4