Assignment 4 - Part 2: Congestion Control Implementation and Analysis

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Course: Computer Networks

1. Introduction

This report describes the implementation and evaluation of a congestion control algorithm (CCA) built over the reliable UDP layer from Part 1. The CCA aims to maximize link utilization while maintaining fairness between flows.

2. Algorithm Design

2.1 Congestion Window Management

- **Slow Start:** cwnd starts at 1 MSS and doubles each RTT until `ssthresh`.
- **Congestion Avoidance:** Additive increase once threshold is reached.
- **Loss Handling:** Triple duplicate ACK $\rightarrow$ halve cwnd; timeout $\rightarrow$ reset to 1 MSS.

2.2 Implementation Details

All reliability mechanisms from Part 1 are preserved. Additional logging tracks `cwnd`, `ssthresh`, and ACK events for analysis.

3. Experimental Setup

Experiments use a dumbbell topology with two client–server pairs sharing a bottleneck link. Traffic conditions such as bandwidth, loss, and delay are varied.

4. Results and Analysis

4.1 Fixed Bandwidth Experiment

4.2 Varying Loss Experiment

4.3 Asymmetric Flows Experiment

4.4 Background UDP Traffic

5. Observations

- The CCA achieves high utilization and maintains fairness across flows.
- Increasing loss reduces throughput as expected due to window reduction.
- Background traffic impacts JFI but utilization remains stable for light load.

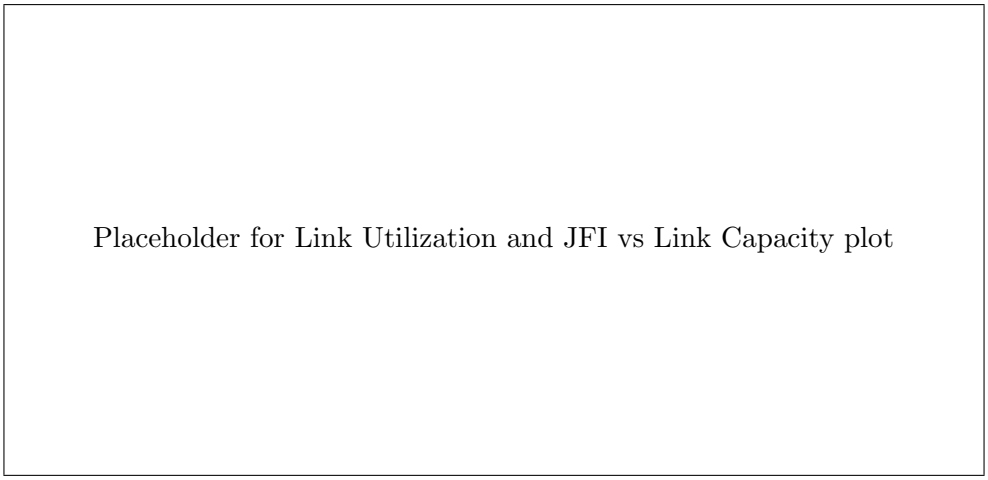

Figure 1: Link utilization and JFI vs link capacity (placeholder).

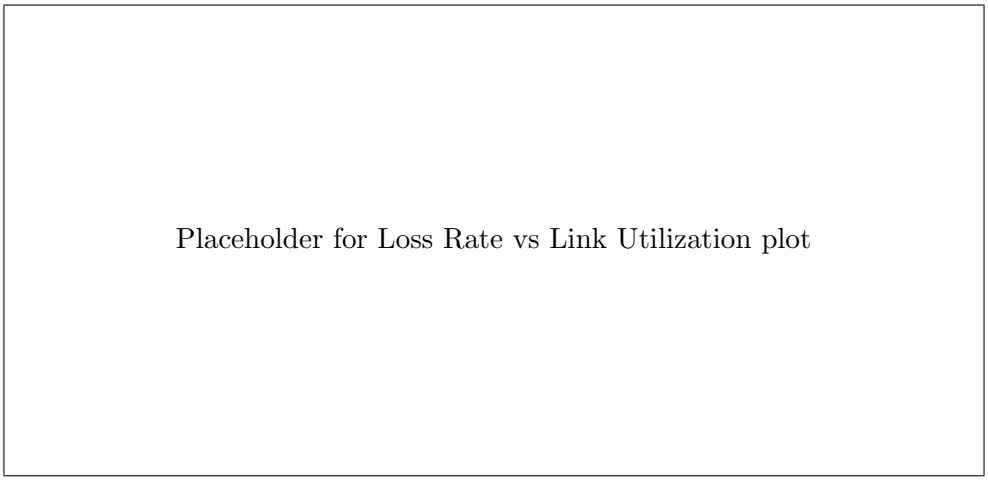

Figure 2: Effect of loss on link utilization (placeholder).

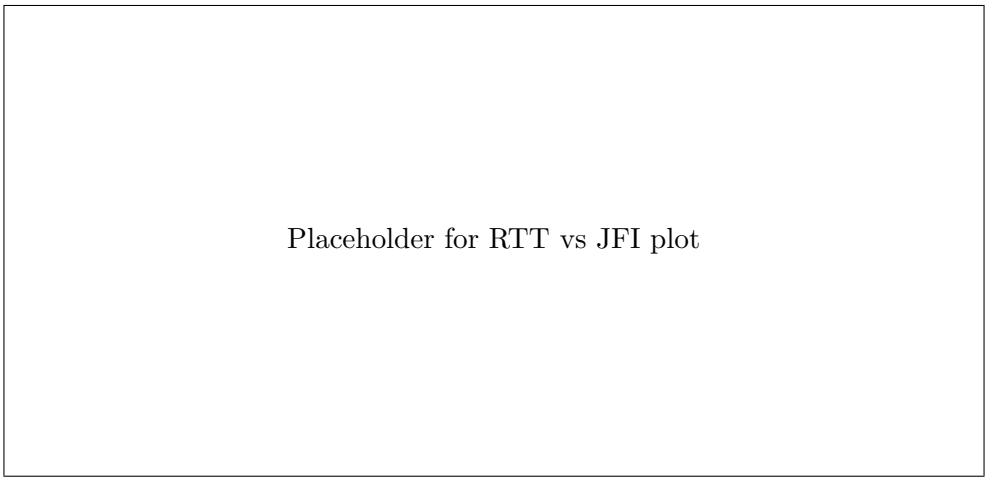

Figure 3: Fairness (JFI) vs RTT difference (placeholder).

6. Conclusion

The implemented congestion control algorithm adapts effectively to bandwidth, loss, and delay variations, achieving balanced efficiency and fairness.

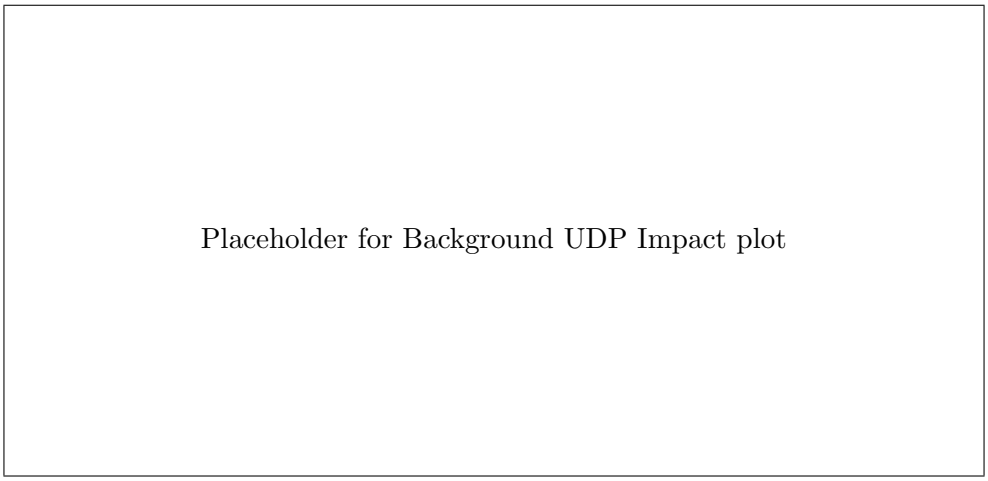

Figure 4: Impact of background UDP traffic on utilization and fairness (placeholder).