Assignment 4 - Part 2: Congestion Control Implementation and Analysis

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1 Fixed Bandwidth Experiment

Observation: From the plot, we observe that the Jain's Fairness Index (JFI) remains constant and equal to 1 across all link capacities, indicating perfect fairness among flows. However, the link utilization decreases sharply as link capacity increases.

Reason: The constant JFI = 1, shows the CCA correctly maintains the fairness of in the given topology. Howver the dropping link utilisation is an effect of the having a fixed queue size on the switches, which limits the max throughput with which files may be transferred from the server to the client. Hence, as bandwidth increases, the link utilisation decreases. Also, since we have put an upper limit to the cwnd, therefore sending rate does not scale with increasing bandwidth, again leading to decreased throughput.
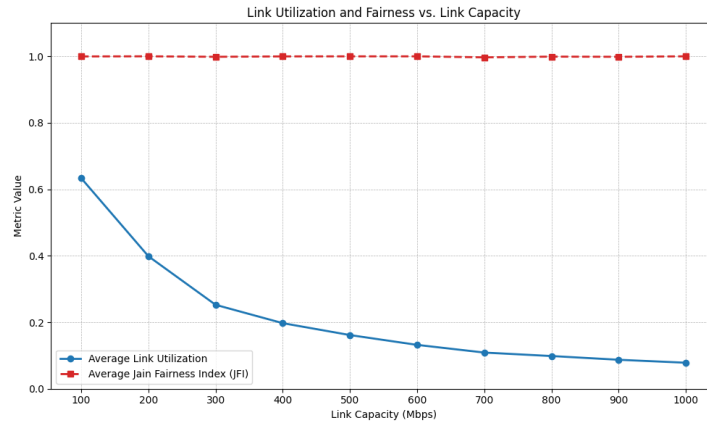

Figure 1: Link utilization and JFI vs link capacity

2 Varying Loss Experiment

Observation: Link utilization decreases significantly with increasing packet loss rate. The curve shows a steep decline as loss increases from 0% to 2%.

Reason: As the loss rate increases, the reliability algorithm resends packets, hence taking larger time to deliver the a single packet. This leads to reduced throughput and hence reduced link utilisation. Also, CUBIC responds less aggresivly to losses, since the β is 0.7, therefore leading to only 30% reduction in cwnd.
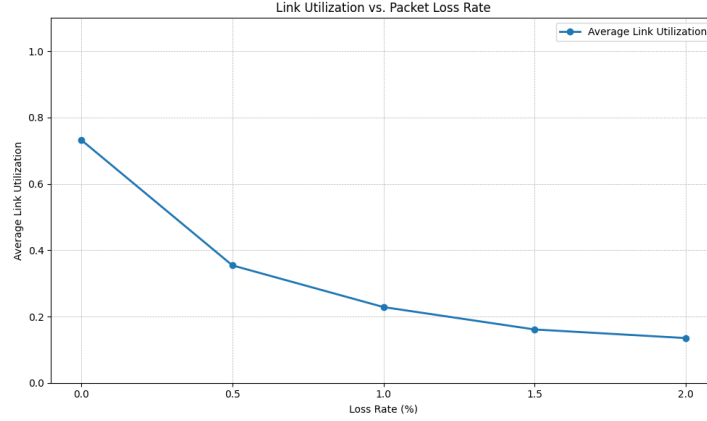
Figure 2: Effect of loss on link utilization

3 Asymmetric Flows Experiment

Observation: The JFI remains constant and equal to 1 even when one flow experiences increasing RTT delay. This shows that the system maintains fairness regardless of delay asymmetry.

Reason: Since TCP Cubic ideas are implemented, it is made RTT independent and hence does not produce a bias towards smaller RTT connections. Hence JFI is close to 1.
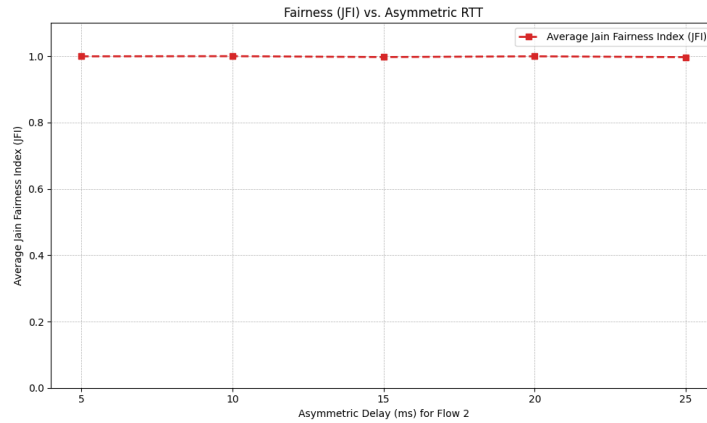

Figure 3: Fairness (JFI) vs RTT difference

4 Background UDP Traffic

Observation: As the background UDP load increases (from Light to Heavy), link utilization decreases slightly, while JFI remains nearly 1. This indicates fairness is preserved even under heavy interference.

Reason: Since the queue size on the switches are fixed, therefore when another bursty flow is introduced it keeps the high percentage of the queue occupied. This causes the loss of packets sent based on reliability, which leads to retransmission, hence decrease in throughput and link utilisation. The other reason includes the fact that UDP flows do not react to congestion. When the TCP-like flows reduce their congestion window to decrease their flow rates, the UPD flows still sends out data at the same rate. This increases losses due to queuing up.
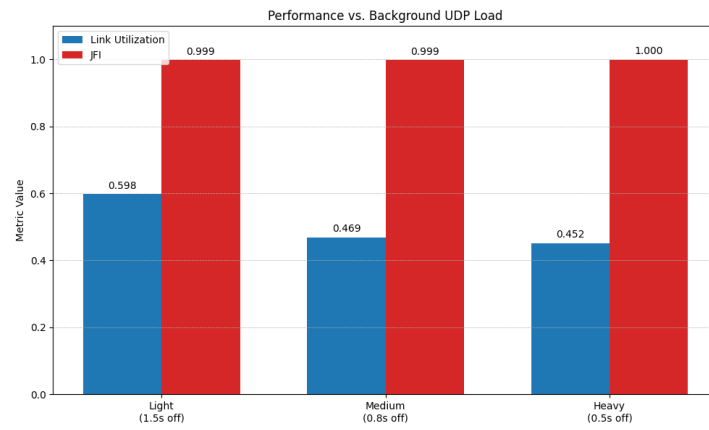
Figure 4: Impact of background UDP traffic on utilization and fairness