Assignment-3 CS3205.

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1 Insights for Stop-and-Wait (SW), built on top of an unreliable UDP transport

Latency is like the delay or lag between when you request the file and when you actually start receiving it. **Packet loss** is when some of the data packets carrying the file get lost or don't reach you.

Interaction of Latency and Packet Loss: Higher latency tends to exacerbate the impact of packet loss on download time.
if there's a little bit of packet loss (low levels), it might not affect your download time too much if the latency is low. But if the latency is high (meaning you're waiting longer for each packet), even a small amount of packet loss can make a big difference in how long it takes to download the file. So, high latency makes packet loss have a bigger impact on your download time.

Below is the heat map that we obtained for Stop-and-wait

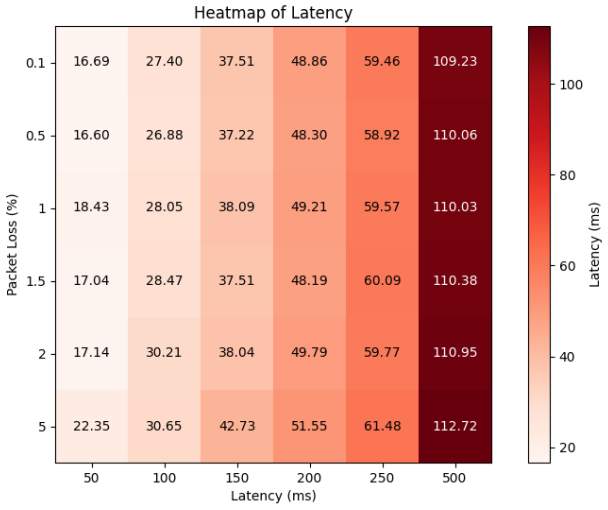

Figure 1: SW Heatmap

2 Insights for Go-Back-N(GBN), built on top of an unreliable UDP transport

Interaction of Latency and Packet Loss:Higher latency tends to exacerbate the impact of packet loss on download time.GBN generally exhibits lower download times than SAW across various latency values, showcasing its efficiency in utilizing network bandwidth.
The variability and unpredictability in GBN's performance under dynamic network conditions highlight the trade-offs between efficiency and reliability, while SAW's more predictable but potentially slower

performance emphasizes its focus on reliability and simplicity.
Below is the heat map that we obtained for GBN,

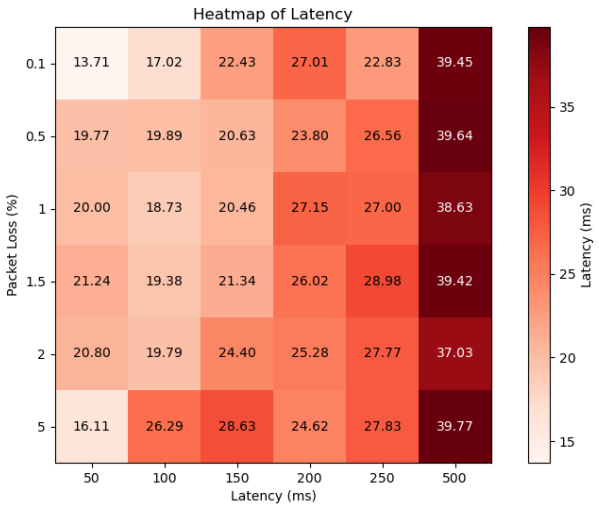

Figure 2: GBN Heatmap

3 Insights for Selective-Repeat(SR), built on top of an unreliable UDP transport

Interaction of Latency and Packet Loss: The variability in download times increases as packet loss percentages increase across different latency values. This indicates that SR's performance is sensitive to packet loss, with higher loss rates leading to longer and more variable download times. Notably, some rows may exhibit a zig-zag pattern in download times as packet loss percentages increase, indicating fluctuations in performance under varying network conditions.

Below is the heat map that we obtained for SR,

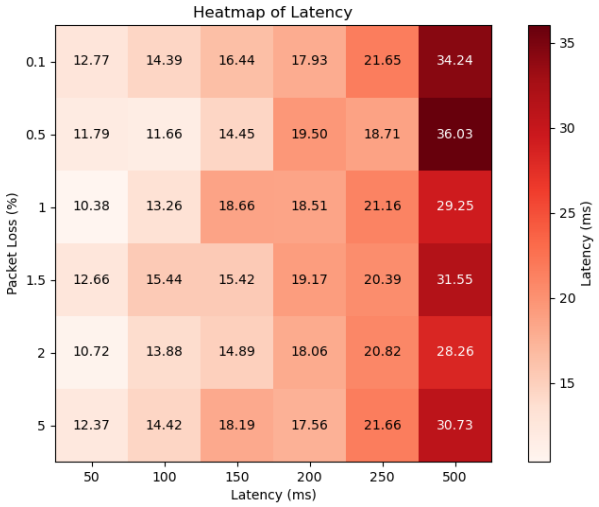

Figure 3: SR Heatmap

4 Some Conclusion that we got observing the heat maps of SW,GBN and SR

4.1 Impact of Congestion control and Flow control and reasons for some zig-zag patterns in heatmaps:

1. Congestion Control: Congestion control mechanisms aim to manage network congestion by regulating the rate of data transmission. When packet loss occurs, it can be an indicator of network congestion, prompting congestion control algorithms to react.
In some cases, congestion control mechanisms may lead to variations in data transmission rates. For example, the protocol may reduce its sending rate in response to detected congestion, causing download times to decrease temporarily before increasing again as congestion eases or as the protocol adjusts its sending rate.

2. Flow control:In situations where flow control mechanisms kick in due to receiver buffer limitations or processing capabilities, the data flow may fluctuate, resulting in zig-zag patterns in performance metrics like download times.

3. Window Size Adjustments: In protocols like SR, the window size determines the number of packets that can be sent before receiving acknowledgments. Changes in window size due to congestion control or flow control algorithms can lead to zig-zag patterns in performance.
For example, if congestion is detected and the protocol reduces its window size, there may be a decrease in download times initially. However, as the window size adjusts again or congestion eases, download times may increase once more.

4.2 Reliability vs Efficiency Trade-off:

1. Stop-and-wait: SAW prioritizes reliability and simplicity over efficiency, making it suitable for applications where consistent performance is critical but potentially slower transfer speeds are acceptable.

2. Go-Back-N: GBN offers higher efficiency by allowing multiple packets to be in transit simultaneously, leading to faster data transfer rates in optimal network conditions.However, GBN's performance may become less predictable in less favorable network conditions, requiring a trade-off between efficiency and reliability.

3. Selective Repeat (SR):SR strikes a balance between reliability and efficiency by retransmitting only necessary packets, making it more efficient than SAW while maintaining good adaptability to network conditions.

4.3 Optimization

Download times tend to follow a consistent pattern, with gradual increases as both latency and packet loss levels rise. This predictability allows for targeted optimization strategies.

1.Optimization Strategies: To improve download performance, we can focus on reducing latency and mitigating packet loss.This could involve optimizing network routing, or using error correction techniques.
Identify critical thresholds where increases in latency or packet loss lead to disproportionately higher download times. Targeting these thresholds for optimization efforts can yield significant performance improvements.