Bilkent University

CS421 Programming Assignment 2

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This assignment investigated the effects of key network parameters such as loss rate, window size, and timeout values on file transfer performance. For this, a file consisting of 4,266,854 Bytes was used, and the Selective Repeat protocol over the User Datagram Protocol (UDP) was implemented.

The file transfer was performed 16 times by changing the loss rate, window size, and timeout parameters, respectively, and the time elapsed was measured. All the results obtained can be seen together in the table below.

Test no	Dmax	timeout	window size (N)	loss rate (p)	time elapsed (s)	Throughput (Mbps)
1	150	180	30	0.0	18.073	1.89
2	150	180	30	0.1	38.079	0.90
3	150	180	30	0.2	50.737	0.67
4	150	180	30	0.3	70.400	0.48
5	150	180	30	0.4	87.170	0.39
6	150	180	30	0.5	118.546	0.29
7	150	180	10	0.1	84.875	0.40
8	150	180	30	0.1	37.213	0.92
9	150	180	50	0.1	24.422	1.40
10	150	180	70	0.1	19.857	1.72
11	150	180	90	0.1	16.078	2.12
12	150	60	30	0.1	20.855	1.64
13	150	100	30	0.1	26.371	1.29
14	150	140	30	0.1	30.526	1.12
15	150	180	30	0.1	38.324	0.89
16	150	220	30	0.1	43.471	0.79

Figure 1: Test Results

In order to investigate the effect of each parameter on file transfer performance better, average throughput was calculated using the obtained time elapsed values and file size using the formula below.

$$Average\ Throughput = \frac{Total\ Data\ Transferred\ (File\ Size)}{Total\ Time\ Elapsed}$$

The following results were obtained by plotting the effect of each parameter on the average throughput.

a) Impact of Loss Rate

To observe the effect of the loss rate (p) value on the average throughput, the file transfer was repeated with six different values , and the following results were obtained.

When Dmax = 150, timeout = 180, and window size = 30:

- At a loss rate of **0.0**: Transfer time is **18.07 seconds**, and average throughput is **1.89 Mbps**.
- At a loss rate of **0.1**: Transfer time is **38.08 seconds**, and average throughput is **0.90 Mbps**.
- At a loss rate of **0.2**: Transfer time is **50.74 seconds**, and average throughput is **0.67 Mbps**.
- At a loss rate of **0.3**: Transfer time is **70.40 seconds**, and average throughput is **0.48 Mbps**.
- At a loss rate of **0.4**: Transfer time is **87.17 seconds**, and average throughput is **0.39 Mbps**.
- At a loss rate of **0.5**: Transfer time is **118.5 seconds**, and average throughput is **0.29 Mbps**.

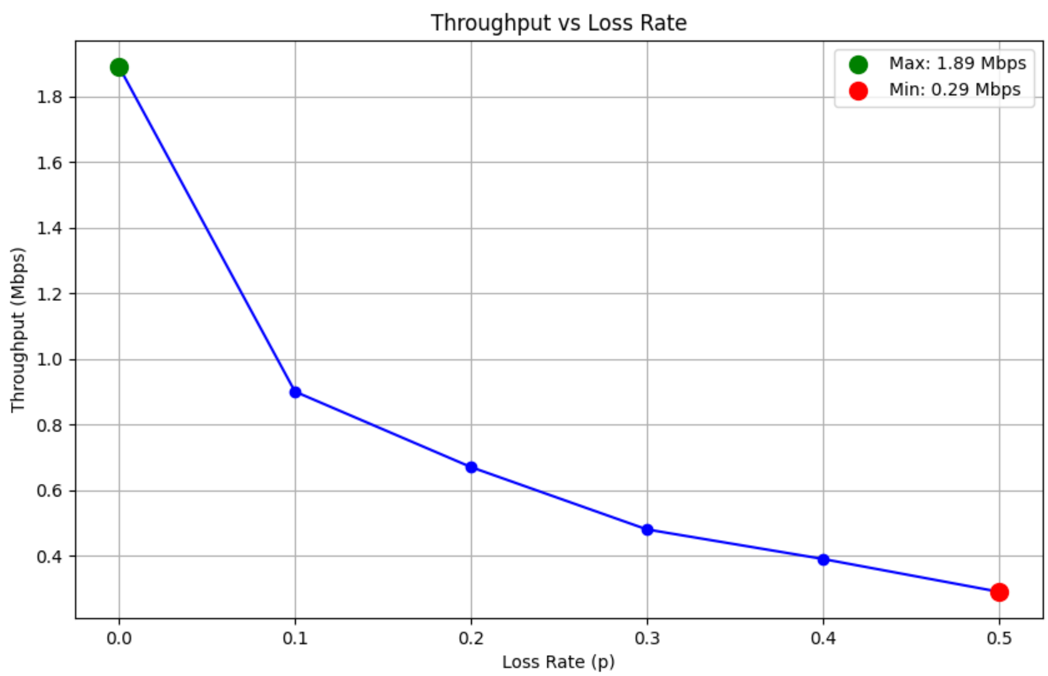

Figure 2: Average Throughput (in Mbps) vs. loss rate (p)

As can be seen from the above plot, as the loss rate (p) value increases, the average throughput value decreases. This is because as the loss rate values increase, more retransmission is required, and therefore the overall delay increases.

b) Impact of Window Size

The file transfer was repeated with five different values, and the following results were obtained to observe the effect of the window size (N) value on the average throughput.

When Dmax = 150, timeout = 180, and loss rate = 0.1:

- At a window size of **10**: Transfer time is **84.88 seconds**, and average throughput is **0.40 Mbps**.
- At a window size of **30**: Transfer time is **37.21 seconds**, and average throughput is **0.92 Mbps**.
- At a window size of **50**: Transfer time is **24.42 seconds**, and average throughput is **1.40 Mbps**.
- At a window size of **70**: Transfer time is **19.86 seconds**, and average throughput is **1.72 Mbps**.
- At a window size of **90**: Transfer time is **16.08 seconds**, and average throughput is **2.12 Mbps**.

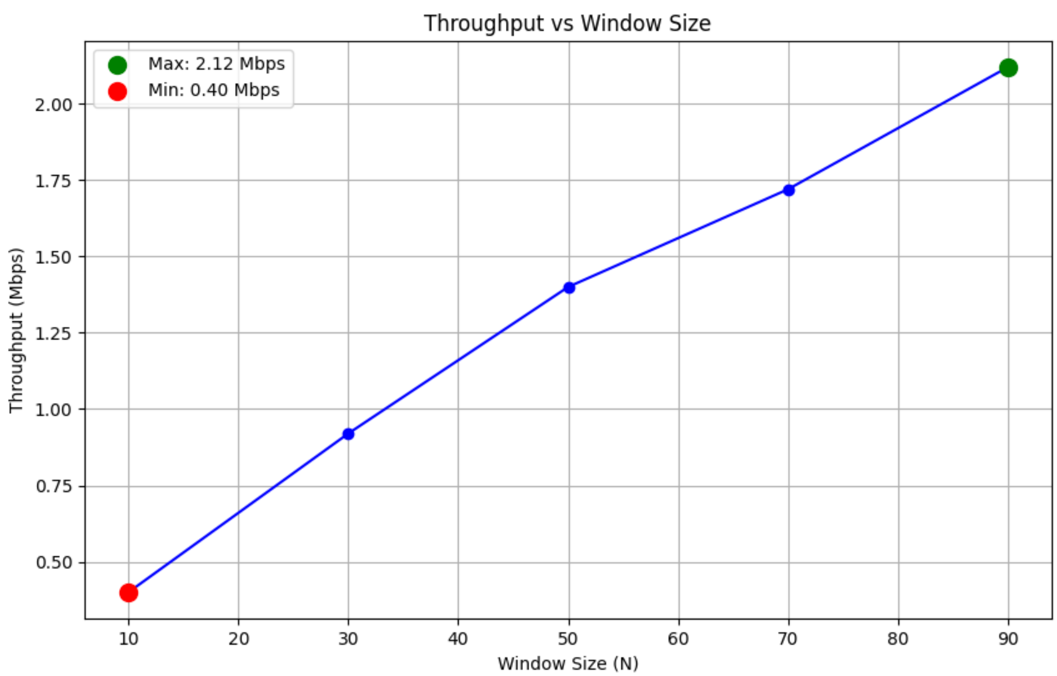

Figure 3: Average Throughput (in bps) vs. window size (N)

As can be seen from the plot above, as the window size (N) value increases, the average throughput value increases. Because as the window size value increases, the number of unacknowledged packets that can be sent before acknowledgment (ACK) increases. Thus, better bandwidth utilization is achieved. However, when the window size value becomes very large, the throughput value would decrease due to network congestion and buffer limitations.

c) Impact of Timeout

To observe the effect of the timeout value on the average throughput, the file transfer was repeated with five different values , and the following results were obtained.

When Dmax = 150, window size = 30, and loss rate = 0.1:

- At a timeout of **60**: Transfer time is **20.86 seconds**, and average throughput is **1.64 Mbps**.
- At a timeout of **100**: Transfer time is **26.37 seconds**, and average throughput is **1.29 Mbps**.
- At a timeout of **140**: Transfer time is **30.53 seconds**, and average throughput is **1.12 Mbps**.
- At a timeout of **180**: Transfer time is **38.32 seconds**, and average throughput is **0.89 Mbps**.
- At a timeout of **220**: Transfer time is **43.47 seconds**, and average throughput is **0.79 Mbps**.

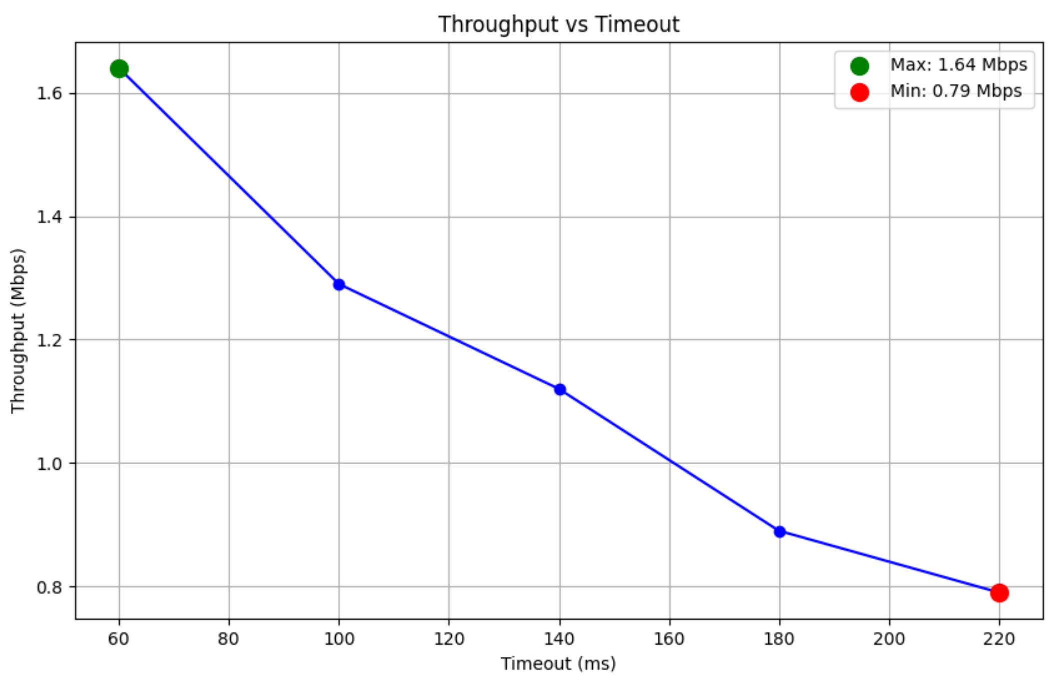

Figure 4: Average Throughput (in bps) vs timeout

As can be seen from the plot above, as the timeout value increases, the average throughput value decreases. Because increasing the timeout means increasing the idle time between the lost packet and retransmission, therefore the overall delay increases. However, when the timeout value drops below 60, after a while, the throughput value would decrease due to false retransmissions, meaning there would be premature timeouts.

As a result, increasing packet loss and timeout reduces throughput, while increasing window size increases throughput. However, exceeding a particular value in window size and decreasing timeout too much reduces throughput due to reasons such as network congestion and premature timeout.