

## Experiment results

In my experiment, the nEmulator program runs on ubuntu1804-002, while the receiver program runs on ubuntu1804 – 004 and the sender program runs on unbuntu1804 – 008.

I get my experiment results in the time.log, which is generated by then sender.py. And I run on the tiny.txt, small.txt, medium.txt, and large.txt each with three times for each of combined parameters described in the Assignment 2\_grading rubric.pdf. Then I get the average for each three times run to get the meaningful plot.

The plots shown below

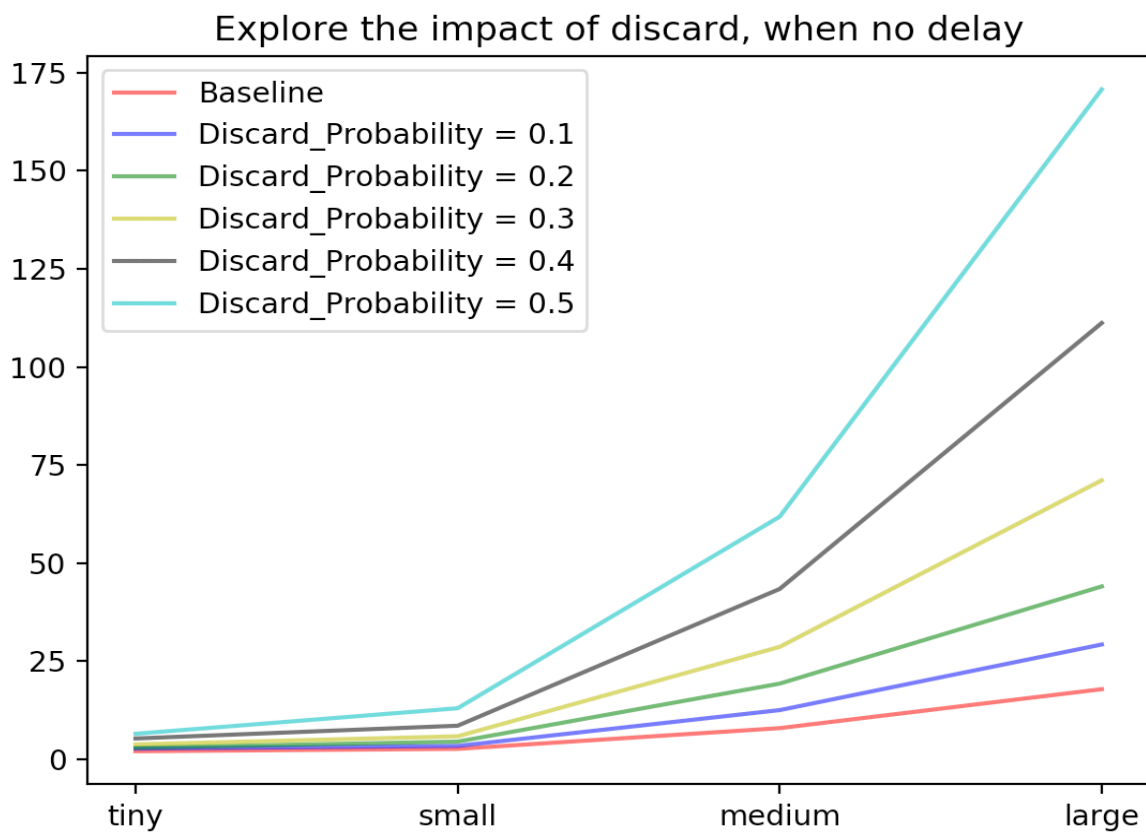
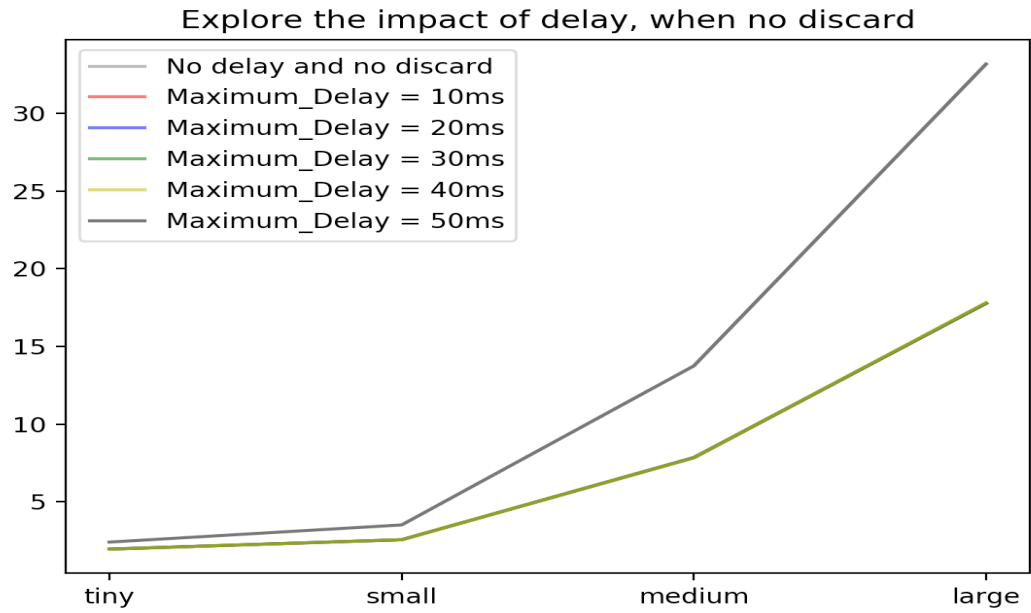


Figure 1: Explore the impact of discard, when no delay



No\_Discard\_1: [1.9542477130889893, 2.5568047761917114, 7.837615251541138, 17.78891134262085]  
 No\_Discard\_2: [1.95448899269104, 2.5570613145828247, 7.830549597740173, 17.778131127357483]  
 No\_Discard\_3: [1.9542609453201294, 2.5570911169052124, 7.852112412452698, 17.77486026287079]  
 No\_Discard\_4: [1.9546709060668945, 2.5570642948150635, 7.830698609352112, 17.824892282485962]  
 No\_Discard\_5: [2.4048980474472046, 3.508447527885437, 13.747154116630554, 33.17603087425232]

Figure 2: Explore the impact of delay, when no discard

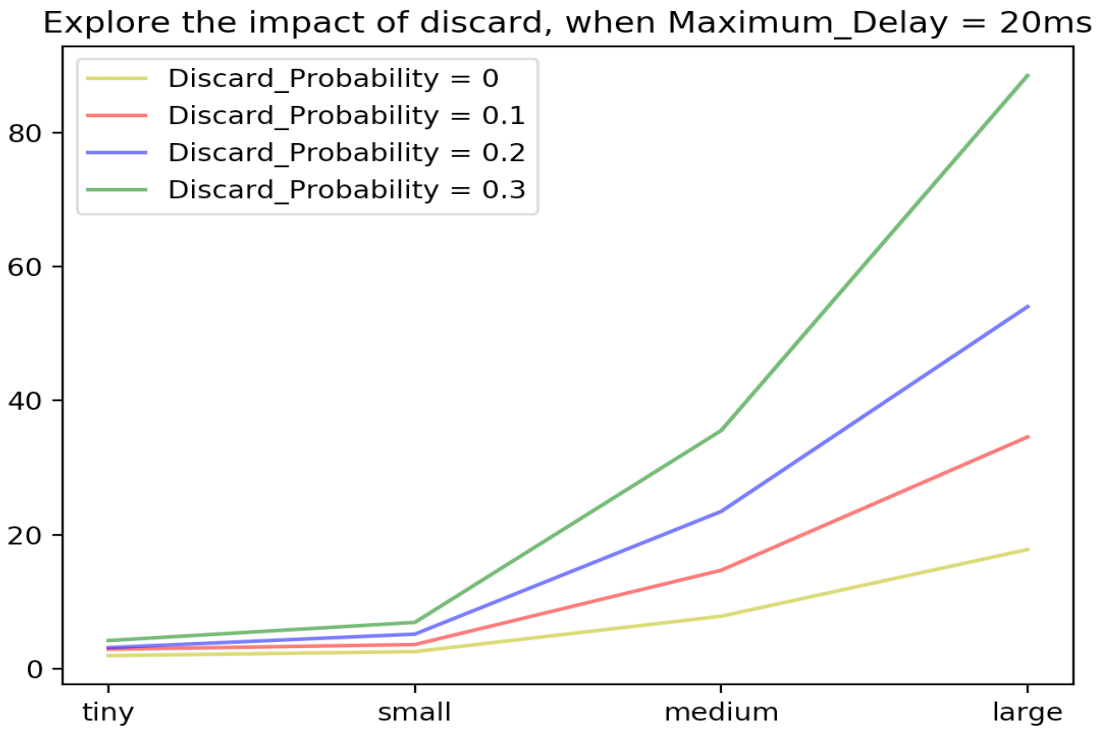


Figure 3: Explore the impact of discard, when Maximum\_Delay = 20ms

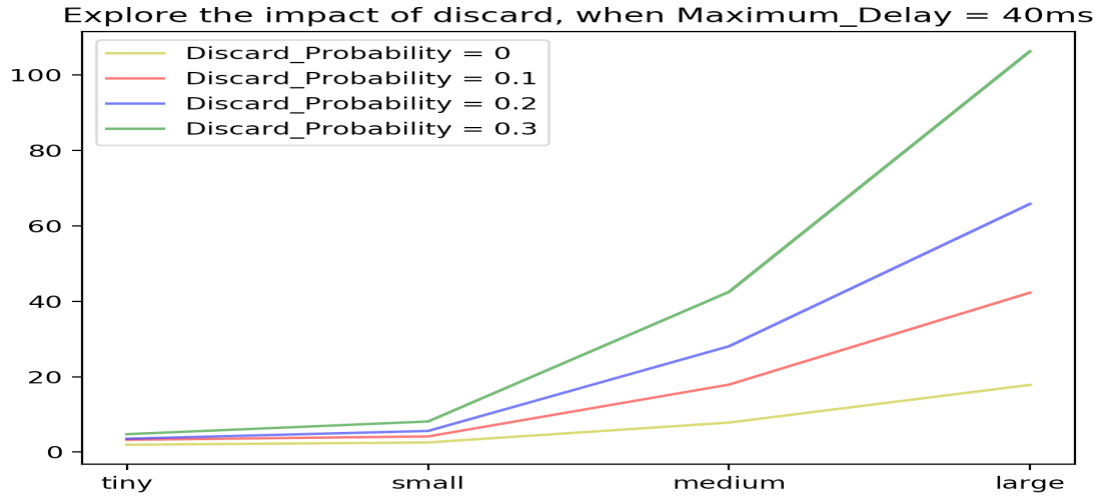


Figure 4: Explore the impact of discard, when Maximum\_Delay = 40ms

The time unit in the four figures is ms.

From Figure 1 – 4, we can get that no matter what combined parameter we choose, the time spent by the sender to send all the bytes of the source file increases with the increase of the source file size.

From Figure 1 – 4, we can also get that the discard probability has a larger impact on the sending time. For example, in Figure 1, we can get that when the discard probability is equal to 40% and 50 % with no delay, the time spent are the highest of all the situations, 111.19 ms and 170.77 ms respectively; Furthermore, seen from Figure 2, when the maximum delay is equal to 10, 20, 30, 40ms, the time spent is so close to the baseline situation that these five situation results in Figure 2 almost coincide. This is because that when the time delay is below 40 ms with no discard probability, the internet could not lead the packets to arrive at the receiver end out of order.

Seen from Figure1, 3 and 4, no matter the maximum time delay is equal to 0, 20ms or 40ms and no matter what source file we send, the time spent increases with the increase of discard probability. And with the source file size increase, the time spent increases more obviously with the increase of the discard probability. The impact of the discard probability is because of our GBN protocol, when one of the sent packets is dropped in the internet, the receiver will send back acknowledgement of the oldest received packet in order. Then this will occur our alarm in the sender program without receiving the expected packet acknowledgement in the timeout interval, which lead to resend all the packets that not acknowledged by the receiver, thus leading to the increase of the sending time spent. And because our GBN protocol use accumulative acknowledgement, the discard of the acknowledgement packet could have less impact.

Then we will discuss the reason why the maximum time delay causes the increase of the time spent. Seen from Figure 1 – 4, we can also get that when the maximum time delay increases,

the time spent increases. For example, in Figure1, 3, 4, when the discard probability is equal to 30 %, the time spent for large source file when time delay is equal to 0, 20ms, 40ms is 71.05ms, 88.45ms, and 106.28ms respectively. And also seen from Figure 2, we can get that when then maximum time delay is equal to 50ms, the time spent increases obviously compared with other situations in the Figure 2. The reason for the time spent increase is that when the maximum time delay increases, the packet sent from the sender program could not arrive in order at the receiver end because of the time delay in the internet. For example, when the sender sends packet 4 and packet 5, because of the time delay the packet 4 arrives after the packet 5. Then the receiver sends back acknowledgements packet 3 and packet 4, then this not acknowledgement of the packet 5 will lead the sender's alarm occur to resend the packet 5, which lead to the increase in the sending time; Furthermore, compared with the Figure 2, Figure 3, and Figure 4, we also can know that with the increases in the discard probability, the impact of the maximum time delay will be obviously increased because there are no obvious difference when the time delay is below 40ms without discard probability in Figure2.