COMPENG 4DK4 Lab 2 Report

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Random Number Generator Seeds

For the experiments in this lab, we used the same set of 18 random number seeds for all experiments. Experiment 2 instructs us to include runs with our *McMaster Student ID numbers* as our seeds. We used our *McMaster IDs* and shifted them by one digit at a time to create 9 different seeds from each our IDs, for a total of 18 different seeds. All the random number generator seeds can be seen in Table 1. In the C code used for the experiments, leading zeroes are removed.

400188200	400190637
001882004	001906374
018820040	019063740
188200400	190637400
882004001	906374001
820040018	063740019
200400188	637400190
004001882	374001906
040018820	740019063

Table 1: Random Number Generator Seeds

Experiment 2

A plot of the mean delay vs. packet arrival rate is shown in Figure 1. At low packet arrival rate values, we see the mean delay approaches 0.5 msec. The mean delay axis intercept at these low packet arrival rates equal to the packet length divided by the link bit rate, in this experiment this is 500 bits divided by 1000 bits per msec, or 0.5 msec. Similar to Lab 1, we can observe that the mean delay begins to increase exponentially from this mean delay axis intercept value as we begin to increase the packet arrival rate.

Experiment 3

The code was modified to add a check to see if the delay for any packet is greater than 20 msec. The function used to check this is shown in Listing 1. The modified code was run with different values of `PACKET_ARRIVAL_RATE` λ to determine the maximum value of λ where the average probability was less than 2%. The maximum value determined as 402 packets per second, with the probability of a packet's delay exceeds 20 msec beginning to exceed 2% at 403 packets per second.

Listing 1: Modifications to Experiment 3 Code

```
1    void check_delay(Simulation_Run_Ptr simulation_run, double arr
         []) {
2        Simulation_Run_Data_Ptr data;
3
```

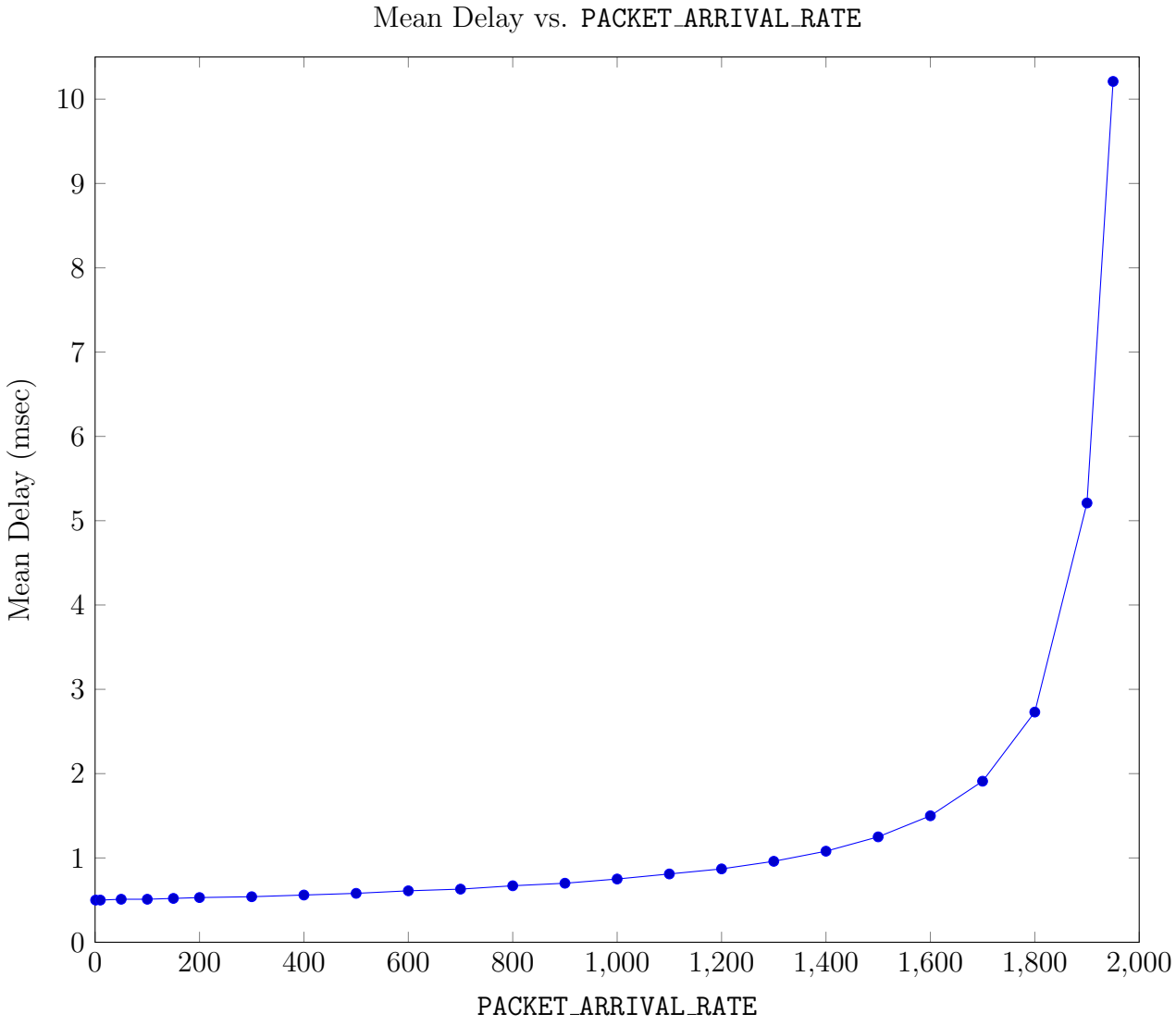

Figure 1: Experiment 2: Mean Delay vs. Packet Arrival Rate

```
4           data = (Simulation_Run_Data_Ptr) simulation_run_data(
                simulation_run);
5
6           // Get current packet and time
7           double a = 1e3 * data->accumulated_delay;
8           int b = data->number_of_packets_processed;
9
10          // Check if num packets has changed
11          if (arr[1] + 1 == b) {
12              // Check if change in time is greater than 20 (packet
                    delay > 20 msec)
13              if (a > arr[2] + 20) {
14                  arr[0]++;
15              }
16
17              // Update with new packet and time
18              arr[1] = b;
19              arr[2] = a;
20          }
21      }
```

Experiment 4

To achieve this M/D/2 queueing system, the `packet_arrival_event` in `packet_arrival.c` was modified with the changes in Listing 2 which adds an additional link. A plot of the mean delay vs. packet arrival rate is shown in Figure 2. At low packet arrival rate values, we see the mean delay approaches 1.0 msec. The mean delay axis intercept at these low packet arrival rates equal to the packet length divided by the link bit rate, in this experiment this is 500 bits divided by 500 bits per msec, or 1.0 msec. If we compare it to experiment 2, we can see that adding the 2nd link decreases the rate of mean delay growth as the packet arrival rate values increase. Although, similar to Lab 1, we can observe that the mean delay growth is still exponential as we begin to increase the packet arrival rate.

Listing 2: Modifications to Experiment 4 Code

```
22      if (server_state(data->link1) == BUSY) {
23          if (server_state(data->link2) == BUSY) {
24              fifoqueue_put(data->buffer, (void *) new_packet);
25          } else {
26              start_transmission_on_link(simulation_run, new_packet,
                    data->link2);
27          }
28      } else {
29          start_transmission_on_link(simulation_run, new_packet,
                data->link1);
```

```
30      }
```

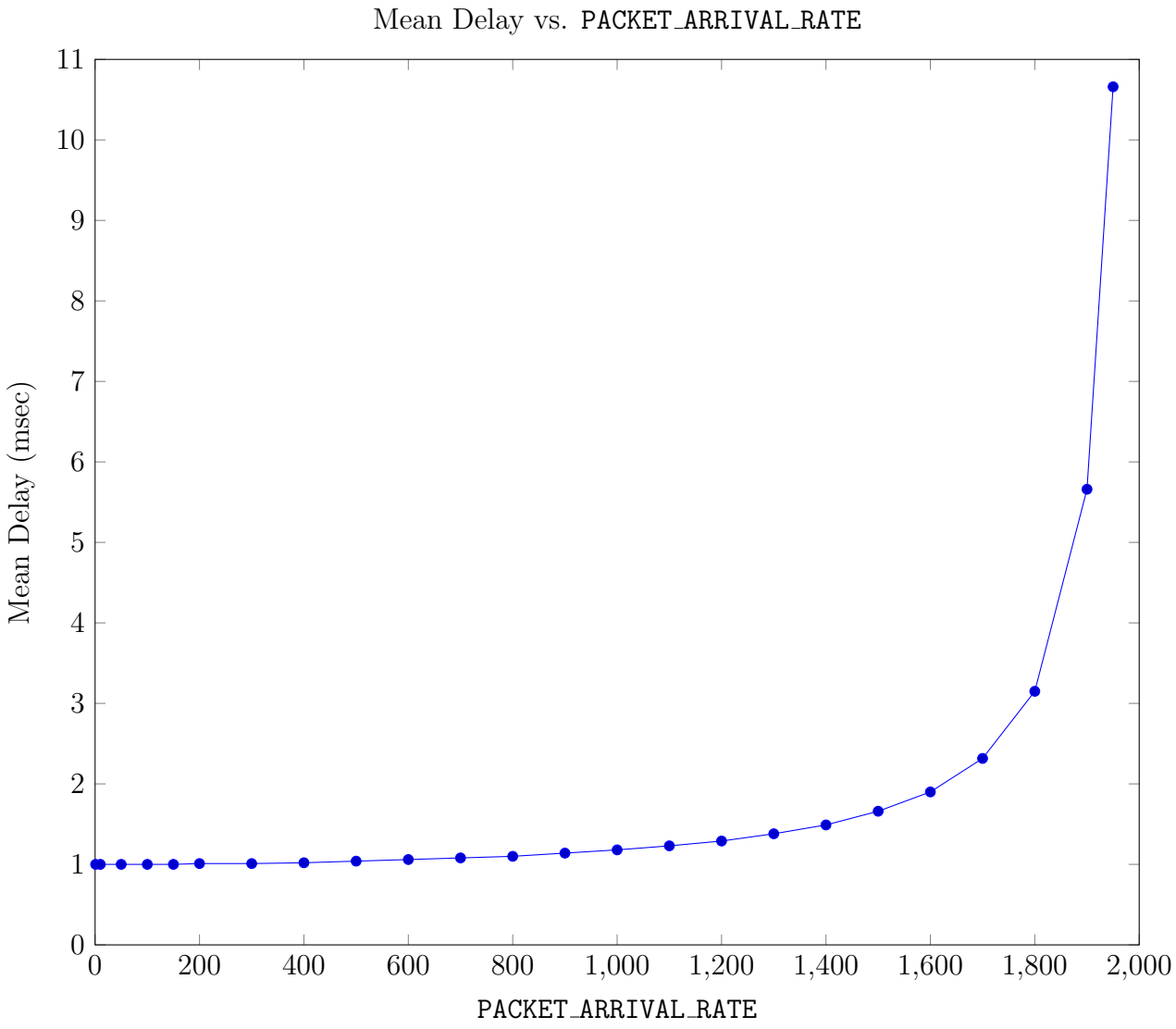

Figure 2: Experiment 4: Mean Delay vs. Packet Arrival Rate

Experiment 5

Experiment 6

Experiment 7