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Performance Analysis  
of Single and Multi-Queue,  
Multi-Server Queueing Systems

CSE 4550

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# Description

In this report, we present a comparison of the results of the output statistics derived from our Single-Queue and Multi-Queue, Multi-Server Queueing System simulations. The output statistics that were considered are:

* Average waiting delay, i.e. Queuing Delay
* Average number of jobs in the system, i.e. System Size
* Average server utilization

These values were calculated based on randomly generated arrival and departure times for 100 customers. The mean arrival time was assumed to be exponentially distributed at 10 time-units. The mean departure time (for the system) was assumed to be exponentially distributed and was varied between 0.5 to 9 time-units.

The mean departure time was calculated as follows:

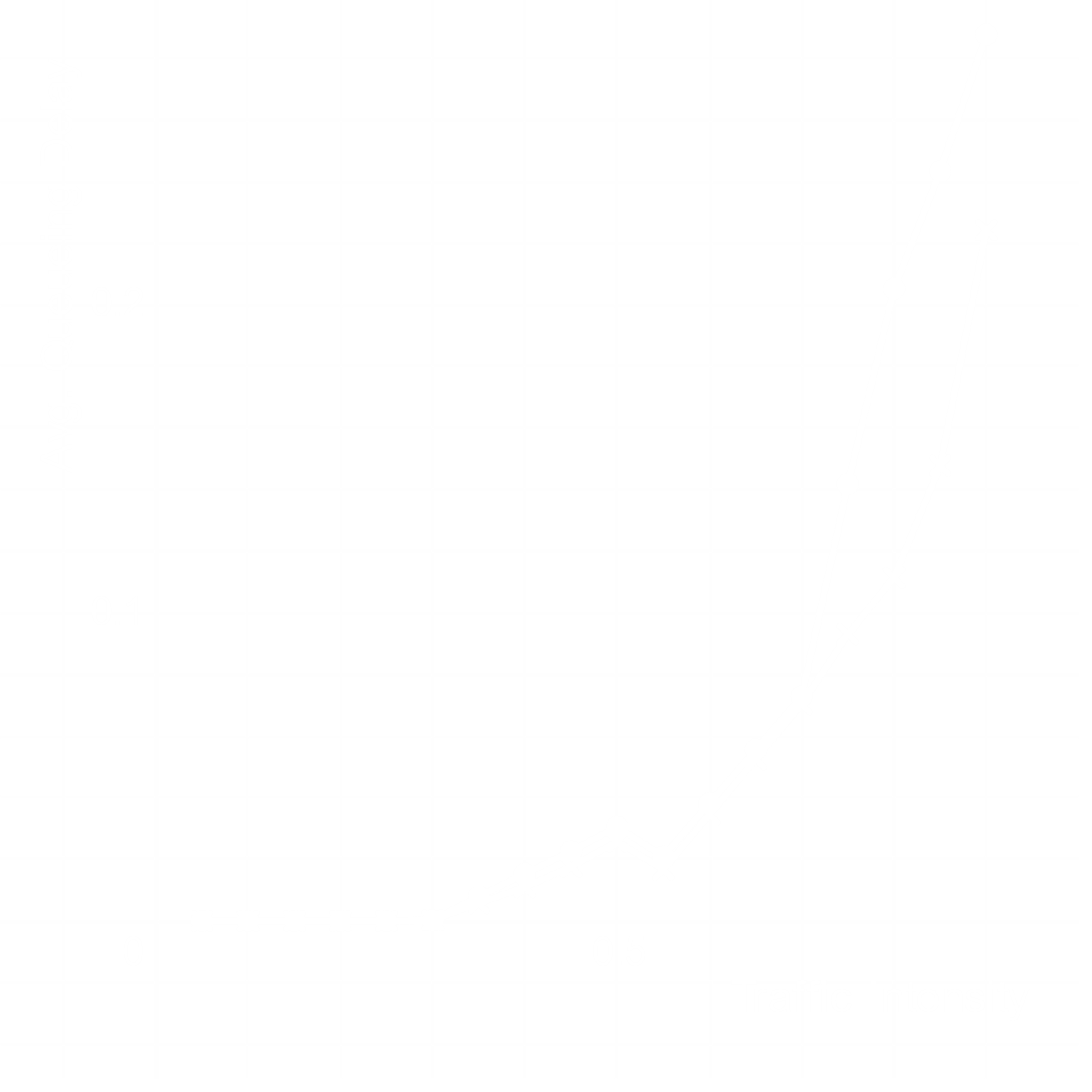
For simplicity, the mean departure time for both servers have been considered to be equal.

# Simulation Results

## Collected Data

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Arrival Mean** | **Departure Mean (Server 1)** | **Departure Mean (Server 2)** | **Departure Mean (Overall)** | **Traffic Intensity** | **2-Queue System** | | | **1-Queue System** | | |
| **Average Queueing Delay** | **Average System Size** | **Average Server Utilization** | **Average Queueing Delay** | **Average System Size** | **Average Server Utilization** |
| 10 | 0.25 | 0.25 | 0.5 | 0.05 | 0 | 0.0131948 | 0.0131948 | 0 | 0.0131948 | 0.0131948 |
| 10 | 0.5 | 0.5 | 1 | 0.1 | 0 | 0.0263815 | 0.0263815 | 0 | 0.0263815 | 0.0263815 |
| 10 | 0.75 | 0.75 | 1.5 | 0.15 | 0 | 0.0395604 | 0.0395604 | 0 | 0.0395604 | 0.0395604 |
| 10 | 1 | 1 | 2 | 0.2 | 0 | 0.0523278 | 0.0523278 | 0 | 0.0523278 | 0.0523278 |
| 10 | 1.25 | 1.25 | 2.5 | 0.25 | 0 | 0.0656012 | 0.0656012 | 0 | 0.0656012 | 0.0656012 |
| 10 | 1.5 | 1.5 | 3 | 0.3 | 0.00021 | 0.0798319 | 0.0798217 | 0.00021 | 0.0798319 | 0.0798217 |
| 10 | 1.75 | 1.75 | 3.5 | 0.35 | 0.007961 | 0.0961512 | 0.0957533 | 0.005834 | 0.0989677 | 0.095674 |
| 10 | 2 | 2 | 4 | 0.4 | 0.015286 | 0.110482 | 0.109711 | 0.010964 | 0.111896 | 0.10962 |
| 10 | 2.25 | 2.25 | 4.5 | 0.45 | 0.022612 | 0.121797 | 0.120667 | 0.017566 | 0.123271 | 0.120667 |
| 10 | 2.5 | 2.5 | 5 | 0.5 | 0.030558 | 0.136521 | 0.135022 | 0.025753 | 0.139408 | 0.135017 |
| 10 | 2.75 | 2.75 | 5.5 | 0.55 | 0.020923 | 0.145218 | 0.144206 | 0.016689 | 0.146682 | 0.144201 |
| 10 | 3 | 3 | 6 | 0.6 | 0.038254 | 0.159104 | 0.157255 | 0.03459 | 0.160595 | 0.157249 |
| 10 | 3.25 | 3.25 | 6.5 | 0.65 | 0.055584 | 0.172798 | 0.170119 | 0.052491 | 0.174334 | 0.170124 |
| 10 | 3.5 | 3.5 | 7 | 0.7 | 0.072915 | 0.18666 | 0.183145 | 0.070393 | 0.188223 | 0.183151 |
| 10 | 3.75 | 3.75 | 7.5 | 0.75 | 0.141823 | 0.210343 | 0.203381 | 0.093066 | 0.216414 | 0.203402 |
| 10 | 4 | 4 | 8 | 0.8 | 0.205251 | 0.221705 | 0.211755 | 0.11147 | 0.233306 | 0.211778 |
| 10 | 4.25 | 4.25 | 8.5 | 0.85 | 0.243398 | 0.236714 | 0.224919 | 0.147737 | 0.24972 | 0.224945 |
| 10 | 4.5 | 4.5 | 9 | 0.9 | 0.287734 | 0.259062 | 0.244915 | 0.224248 | 0.266224 | 0.24492 |

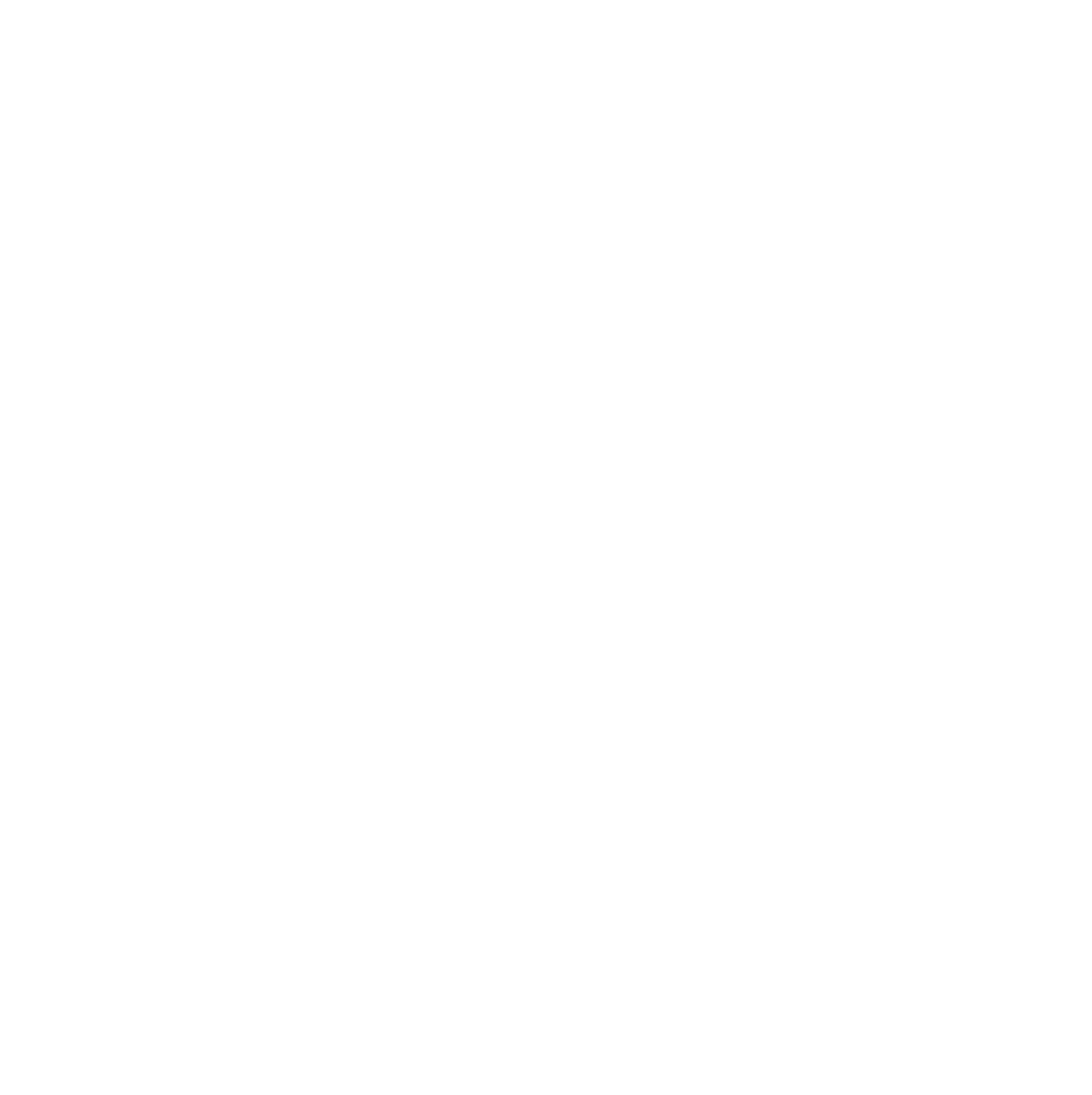
## Average Queuing Delay



For the graph above, the represent data points for the simulation results of the 2-Queue, 2-Server Queueing System and the represent data points for the simulation results of the 1-Queue, 2-Server Queuing System. The same is true for the rest of the graphs.

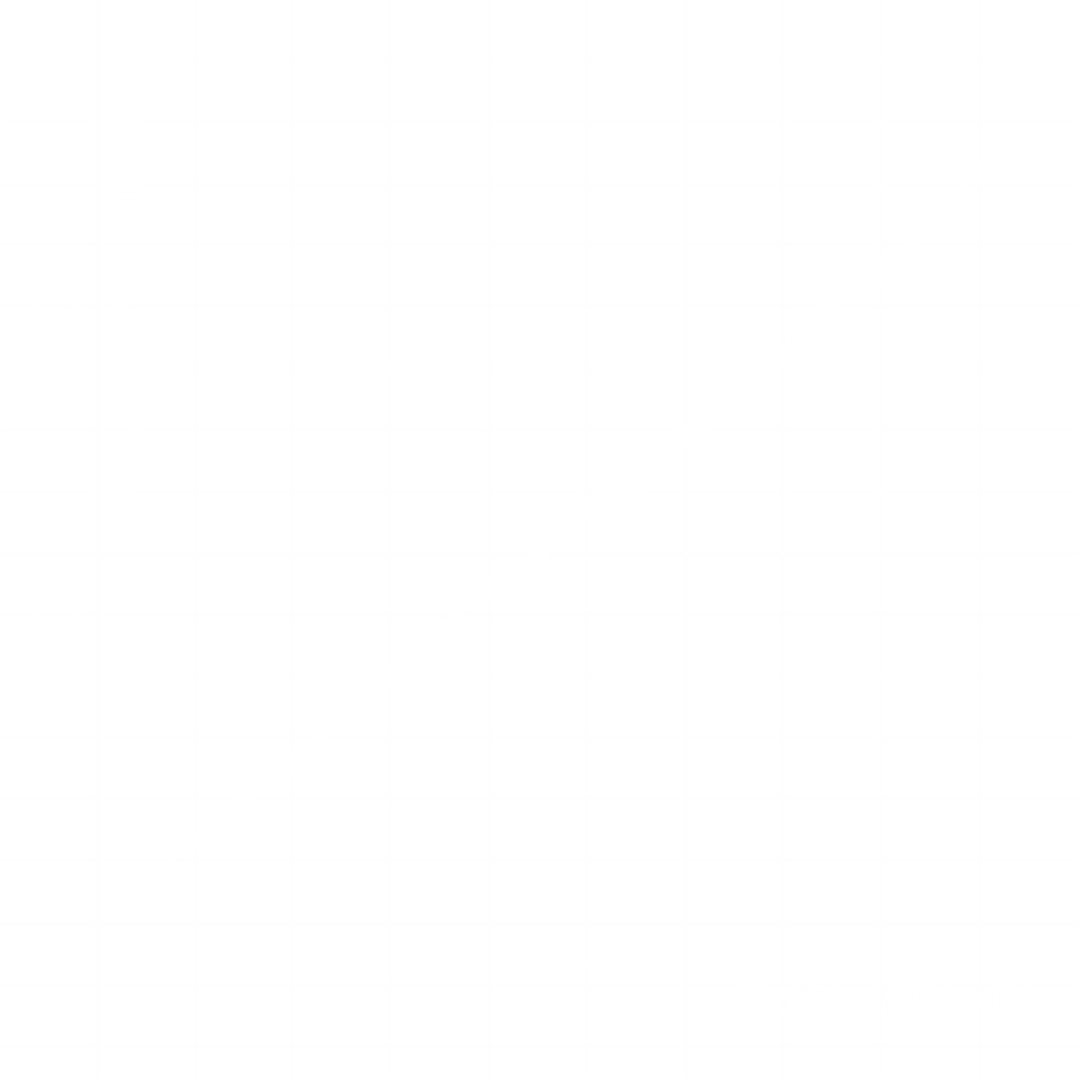
As can be seen, the queueing delay is nearly identical for lower traffic intensities. However, for higher traffic intensities, the 2-Queue system performs comparatively poorly.

## Average System Size



The system size for both systems are identical

## Average Server Utilization



The average server utilization for both systems are completely identical. The nature of the queues do not make a difference here.