CSCI203 Assignment 2

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This is an analysis of the Single Queue vs. Multi Queue strategy, based on the outputs of the simulations run. The analysis will be made for 3 input files - sample_input, longer_queues and much_longer

The primary focus would be the waiting times when determining the best strategy.

Analysis 1

Output - Sample_Input File

```
Simulation Type: Single Queue

---Simulation Results---
Number of people served:       1000
Total simulation time:         30558.4
Average service time:          159.108
Average time spent in queue:   0.207763
Maximum time spent in queue:   57.9131
Average length of queue:       0.611111
Maximum length of queue:       2

Total idle time for servers:
Server 1: 4745.79
Server 2: 6403
Server 3: 7165.6
Server 4: 9052.99
Server 5: 11746.3
Server 6: 15012.6
Server 7: 18564.8
Server 8: 20965.3
Server 9: 26030.4
Server 10: 27622

---Simulation complete---
```

```
Simulation Type: Multi Queue

---Simulation Results---
Number of people served:     1000
Total simulation time:       30558.4
Average service time:        159.108
Average time spent in queue: 0.612584
Maximum time spent in queue: 270.43

Average length of queue:
Server 1: 1
Server 2: 1
Server 3: 0
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0

Maximum length of queue:
Server 1: 1
Server 2: 1
Server 3: 0
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0


Total idle time for servers:
Server 1: 4819.98
Server 2: 6259.3
Server 3: 7490.4
Server 4: 8712.39
Server 5: 11605.6
Server 6: 14883.8
Server 7: 18299
Server 8: 20995.8
Server 9: 25787.4
Server 10: 27622

---Simulation complete---
```

Analysis - sample_input

Stat	Single Queue	Multi Queue	Comment
People Served	1000	1000	Same
Total time	30558.4	30558.4	Same
Average service time	159.108	159.108	Same
Avg time in queue	0.207763	0.612584	Single performs better
Max time in queue	57.9131	270.43	Single performs better
Average length of queue	0.611	Server 1: 1 Server 2: 1 Server 3: 0 Server 4: 0 Server 5: 0 Server 6: 0 Server 7: 0 Server 8: 0 Server 9: 0 Server 10: 0	Multiple performs better, as most queues will be free on arrival
Max length of queue	2	Server 1: 1 Server 2: 1 Server 3: 0 Server 4: 0 Server 5: 0 Server 6: 0 Server 7: 0 Server 8: 0 Server 9: 0 Server 10: 0	Even though multiple has a smaller max length, the single queue would move much faster because it has 10 servers, compared to the 1 in multiple. Single will effectively perform better
Total idle time	Server 1: 4745.79 Server 2: 6403 Server 3: 7165.6 Server 4: 9052.99 Server 5: 11746.3 Server 6: 15012.6 Server 7: 18564.8 Server 8: 20965.3 Server 9: 26030.4 Server 10: 27622	Server 1: 4819.98 Server 2: 6259.3 Server 3: 7490.4 Server 4: 8712.39 Server 5: 11605.6 Server 6: 14883.8 Server 7: 18299 Server 8: 20995.8 Server 9: 25787.4 Server 10: 27622	Single has slightly better utilisation of servers

Verdict: Single Queue would be the more preferable strategy as the overall wait times are smaller, resulting in faster service.

Analysis 2

Output - longer_queues

```
Simulation Type: Single Queue

---Simulation Results---
Number of people served:     1000
Total simulation time:       30438
Average service time:        190.597
Average time spent in queue: 2.05647
Maximum time spent in queue: 128.566
Average length of queue:     0.734848
Maximum length of queue:     3

Total idle time for servers:
Server 1: 4214.78
Server 2: 4828.87
Server 3: 6867.07
Server 4: 7646.17
Server 5: 9189.28
Server 6: 11672.8
Server 7: 14476.2
Server 8: 16420.5
Server 9: 18535.4
Server 10: 23655.5

---Simulation complete---

Simulation Type: Multi Queue

---Simulation Results---
Number of people served:     1000
Total simulation time:       30438
Average service time:        190.597
Average time spent in queue: 5.46744
Maximum time spent in queue: 462.156
Average length of queue:
Server 1: 1
Server 2: 1
```

```
Server 3: 1
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0

Maximum length of queue:
Server 1: 1
Server 2: 1
Server 3: 1
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0


Total idle time for servers:
Server 1: 3641.17
Server 2: 3780.58
Server 3: 6155.58
Server 4: 7119.77
Server 5: 9217.37
Server 6: 11271.1
Server 7: 14078.9
Server 8: 16603.1
Server 9: 18190.5
Server 10: 23724.5

---Simulation complete---
```

Analysis - longer_queues

Stat	Single Queue	Multi Queue	Comment
People Served	1000	1000	Same
Total time	30438	30438	Same
Average service time	190.597	190.597	Same
Avg time in queue	2.05647	5.46744	Single performs better
Max time in queue	128.566	462.156	Single performs better
Average length of queue	0.734848	Server 1: 1 Server 2: 1 Server 3: 1 Server 4: 0 Server 5: 0 Server 6: 0 Server 7: 0 Server 8: 0 Server 9: 0 Server 10: 0	Multi performs better, as most queues will be free on arrival
Max length of queue	3	Server 1: 1 Server 2: 1 Server 3: 1 Server 4: 0 Server 5: 0 Server 6: 0 Server 7: 0 Server 8: 0 Server 9: 0 Server 10: 0	Single would effectively perform better as there's 10 servers, compared to the 1 server per queue in the multi.
Total idle time	Server 1: 4214.78 Server 2: 4828.87 Server 3: 6867.07 Server 4: 7646.17 Server 5: 9189.28 Server 6: 11672.8 Server 7: 14476.2 Server 8: 16420.5 Server 9: 18535.4 Server 10: 23655.5	Server 1: 3641.17 Server 2: 3780.58 Server 3: 6155.58 Server 4: 7119.77 Server 5: 9217.37 Server 6: 11271.1 Server 7: 14078.9 Server 8: 16603.1 Server 9: 18190.5 Server 10: 23724.5	Slightly better distribution of load on single

Verdict: Single would still be the more preferable strategy as overall wait times are lower than the multiple, with better performance on most stats.

Analysis 3

Output - much_longer

```
Simulation Type: Single Queue

---Simulation Results---
Number of people served:     1000
Total simulation time:       35299.7
Average service time:        234.874
Average time spent in queue: 7446.67
Maximum time spent in queue: 23727
Average length of queue:     29.8047
Maximum length of queue:     132

Total idle time for servers:
Server 1: 3448.63
Server 2: 3435.84
Server 3: 3862.93
Server 4: 4249.74
Server 5: 4728.23
Server 6: 5042.44
Server 7: 5707.04
Server 8: 6507.43
Server 9: 8227.74
Server 10: 8859.23

---Simulation complete---


Simulation Type: Multi Queue

---Simulation Results---
Number of people served:     1000
Total simulation time:       30457.6
Average service time:        234.874
Average time spent in queue: 23.6015
Maximum time spent in queue: 441.699
Average length of queue:
Server 1: 1
Server 2: 1
Server 3: 1
Server 4: 1
```

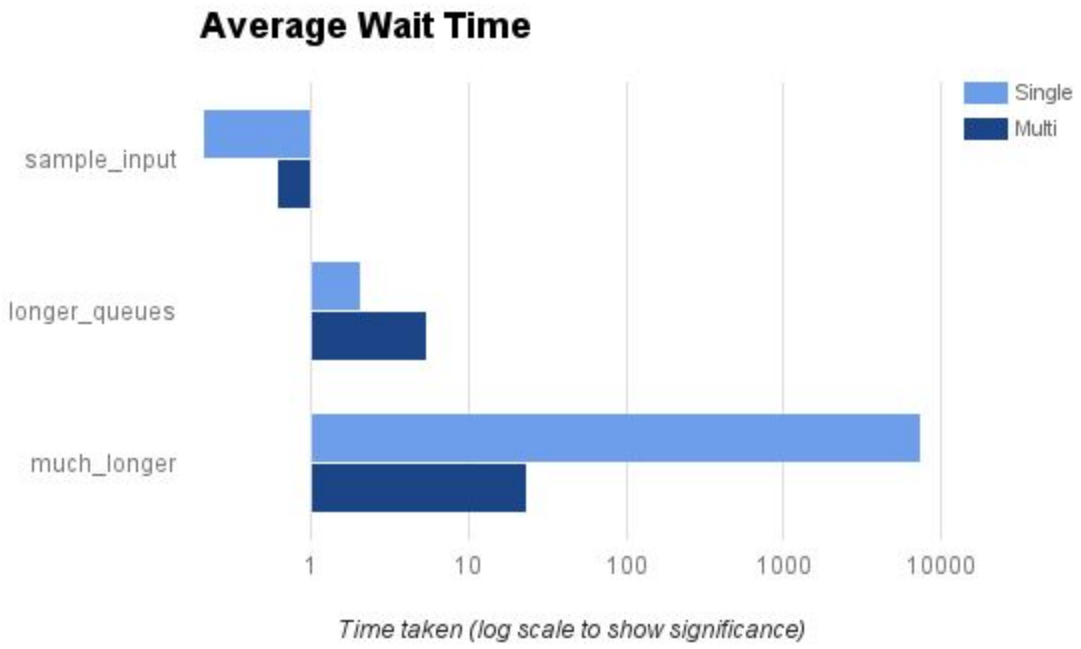
```
Server 5: 1
Server 6: 1
Server 7: 1
Server 8: 1
Server 9: 0
Server 10: 0

Maximum length of queue:
Server 1: 1
Server 2: 1
Server 3: 1
Server 4: 1
Server 5: 1
Server 6: 1
Server 7: 1
Server 8: 1
Server 9: 0
Server 10: 0


Total idle time for servers:
Server 1: 1638.29
Server 2: 2645.69
Server 3: 3964.69
Server 4: 4287.69
Server 5: 5227.99
Server 6: 7210.88
Server 7: 8028.39
Server 8: 9431.39
Server 9: 12612.4
Server 10: 14654

---Simulation complete---
```

Analysis - much_longer

Stat	Single Queue	Multi Queue	Comment
People Served	1000	1000	Same
Total time	35299.7	30457.6	Multi performs better
Average service time	234.874	234.874	Same
Avg time in queue	7446.67	23.6015	Multi performs better
Max time in queue	23727	441.699	Multi performs better
Average length of queue	29.8047	Server 1: 1 Server 2: 1 Server 3: 1 Server 4: 1 Server 5: 1 Server 6: 1 Server 7: 1 Server 8: 1 Server 9: 0 Server 10: 0	Multi performs better, as most queues will have only 1, compared to the 28.8 amongst 10 servers (which would result in higher wait times compared to multi).
Max length of queue	132	Server 1: 1 Server 2: 1 Server 3: 1 Server 4: 1 Server 5: 1 Server 6: 1 Server 7: 1 Server 8: 1 Server 9: 0 Server 10: 0	Multi performs better, as it has a max queue length of 1 overall
Total idle time	Server 1: 3448.63 Server 2: 3435.84 Server 3: 3862.93 Server 4: 4249.74 Server 5: 4728.23 Server 6: 5042.44 Server 7: 5707.04 Server 8: 6507.43 Server 9: 8227.74 Server 10: 8859.23	Server 1: 1638.29 Server 2: 2645.69 Server 3: 3964.69 Server 4: 4287.69 Server 5: 5227.99 Server 6: 7210.88 Server 7: 8028.39 Server 8: 9431.39 Server 9: 12612.4 Server 10: 14654	Single has more uniform utilisation of server resources

Verdict: Multi queue strategy works drastically better in “much longer queue” scenarios, with less wait times and overall better performance.

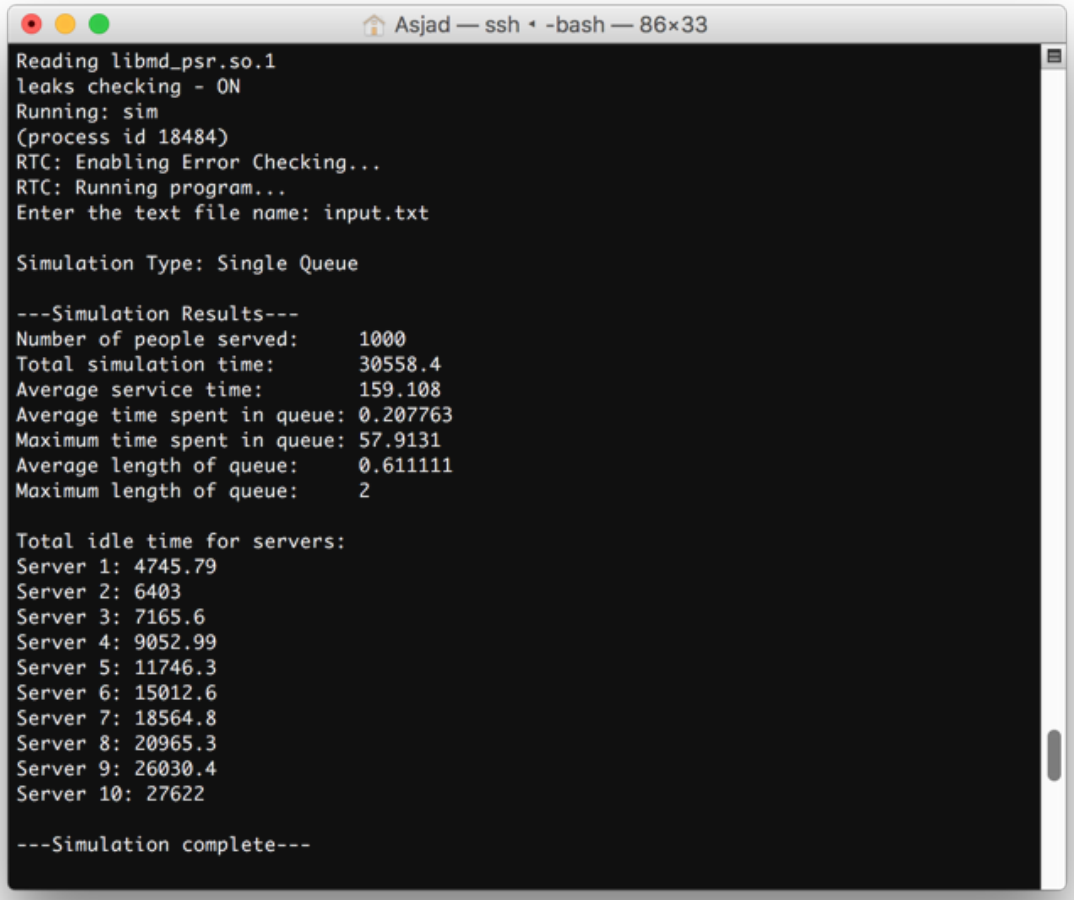
Summary of Average Wait Times

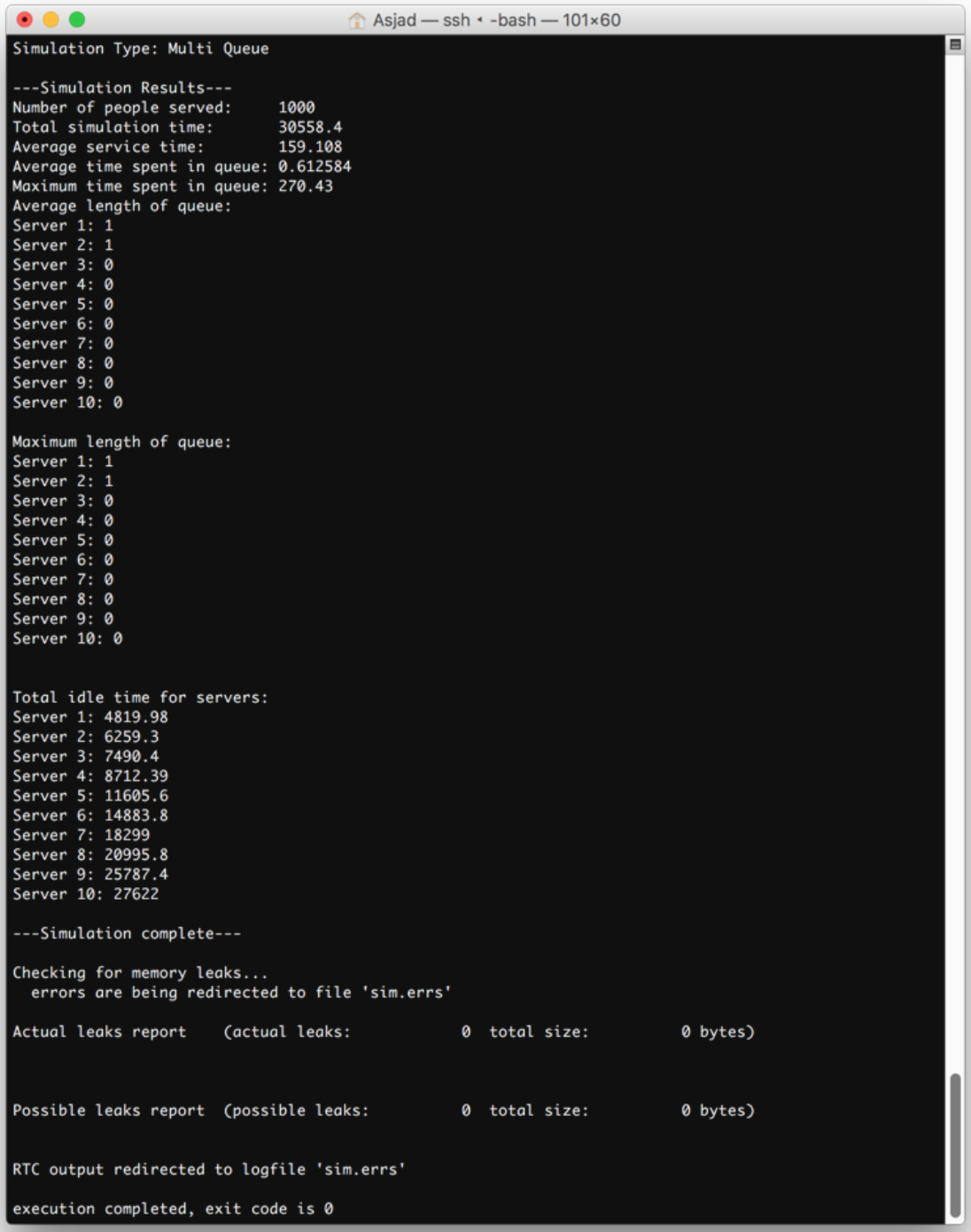


Conclusion

The single queue strategy works very well for small queue sizes, but when queue sizes increase drastically, the single queue strategy fails to cope. The multi queue strategy handles the surge in queue length very well, while maintaining reasonably low wait times compared to the single queue.

Screenshot of program output:




Asjad — ssh • -bash — 101×60
Simulation Type: Multi Queue
---Simulation Results---
Number of people served: 1000
Total simulation time: 30558.4
Average service time: 159.108
Average time spent in queue: 0.612584
Maximum time spent in queue: 270.43
Average length of queue:
Server 1: 1
Server 2: 1
Server 3: 0
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0
Maximum length of queue:
Server 1: 1
Server 2: 1
Server 3: 0
Server 4: 0
Server 5: 0
Server 6: 0
Server 7: 0
Server 8: 0
Server 9: 0
Server 10: 0
Total idle time for servers:
Server 1: 4819.98
Server 2: 6259.3
Server 3: 7490.4
Server 4: 8712.39
Server 5: 11605.6
Server 6: 14883.8
Server 7: 18299
Server 8: 20995.8
Server 9: 25787.4
Server 10: 27622
---Simulation complete---
Checking for memory leaks...
errors are being redirected to file 'sim.errs'
Actual leaks report (actual leaks: 0 total size: 0 bytes)
Possible leaks report (possible leaks: 0 total size: 0 bytes)
RTC output redirected to logfile 'sim.errs'
execution completed, exit code is 0

END