CS 342 - Operating Systems
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Project 2
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Sample Input File used For FCFS vs SJF and Number of CPUS vs Average Waiting Time and Turnaround Time

PL 130
IAT 236
PL 176
IAT 237
PL 250
IAT 84
PL 34
IAT 13
PL 176
IAT 62
PL 176
IAT 17
PL 66
IAT 69
PL 188
IAT 236
PL 213
IAT 115
PL 179
IAT 18
PL 54
IAT 216
PL 144
IAT 24
PL 178
IAT 226
PL 67
IAT 186
PL 169
IAT 223
PL 241
IAT 183
PL 192
IAT 169
PL 180
IAT 248
PL 237
IAT 118
PL 215
IAT 226
PL 43
IAT 172
PL 49
IAT 92
PL 183
IAT 97
PL 166
IAT 194
PL 171
IAT 97

PL 123
IAT 67
PL 184
IAT 116
PL 233
IAT 169
PL 174
IAT 228
PL 248
IAT 110
PL 201
IAT 214
PL 79
IAT 63
PL 78
IAT 182
PL 60
IAT 206
PL 69
IAT 55
PL 72
IAT 237
PL 54
IAT 194
PL 137
IAT 41
PL 230
IAT 94
PL 206
IAT 66
PL 175
IAT 147
PL 186
IAT 146
PL 171
IAT 84
PL 57
IAT 171
PL 83
IAT 144
PL 207
IAT 48
PL 116
IAT 86
PL 80
IAT 239
PL 199
IAT 76
PL 47

FCFS vs SJF on Average Waiting Time and Average Turnaround Time

Output for FCFS using single queue approach, with 50 processes to be executed:

```
39   1    230      5577 6098   291         521
40   1    206      5672 6316   438         644
41   1    175      5738 6494   581         756
42   1    186      5886 6680   608         794
43   1    171      6032 6861   658         829
44   1    57       6121 6924   746         803
45   1    83       6298 7011   630         713
46   1    207      6445 7234   582         789
47   1    116      6494 7352   742         858
48   1    80       6581 7437   776         856
49   1    199      6820 7637   618         817
50   1    47       6903 7688   738         785
average turnaround time: 636.62 ms
average waiting time: 14.76 ms
```

Output for SJF using single queue approach, with the same 50 process to be executed:

```
39   1    230      5547 7644   1867        2097
40   1    206      5642 5907   59          265
41   1    175      5714 6083   194         369
42   1    186      5864 6900   850         1036
43   1    171      6013 6272   88          259
44   1    57       6102 6396   237         294
45   1    83       6275 6492   134         217
46   1    207      6421 7370   742         949
47   1    116      6492 6609   1           117
48   1    80       6579 6710   51          131
49   1    199      6823 7110   88          287
50   1    47       6900 7159   212         259
average turnaround time: 570.14 ms
average waiting time: 4.24 ms
```

Interpreting the results:
Prioritizing bursts with shorter lengths decreases the waiting time of those processes more than it increases the waiting time of longer length processes. This means that using SJF eliminates the convoying caused by FCFS, where shorter processes are waiting behind longer processes, therefore yielding lower waiting times and turnaround times. Our experiments show that this information is true for our system as well, SJF yielded better results compared to FCFS.

Number of CPUs vs Average Waiting Time and Average Turnaround time

- We fixed the algorithm to FCFS since we know how it performs against SJF and we are focusing on the impact of the number of CPUs on scheduling performance. Queue selection method is Round Robin for this experiment.

Number of CPUs	Average Turnaround Time	Average Waiting Time
1	636.62	14.76
2	166.14	0.08
4	155.02	0.04

8	152.02	0.03
16	148.14	0.03

Figure 1: Table Showing Comparisons Between Number of CPUs, Average Turnaround Time and Average Waiting Time

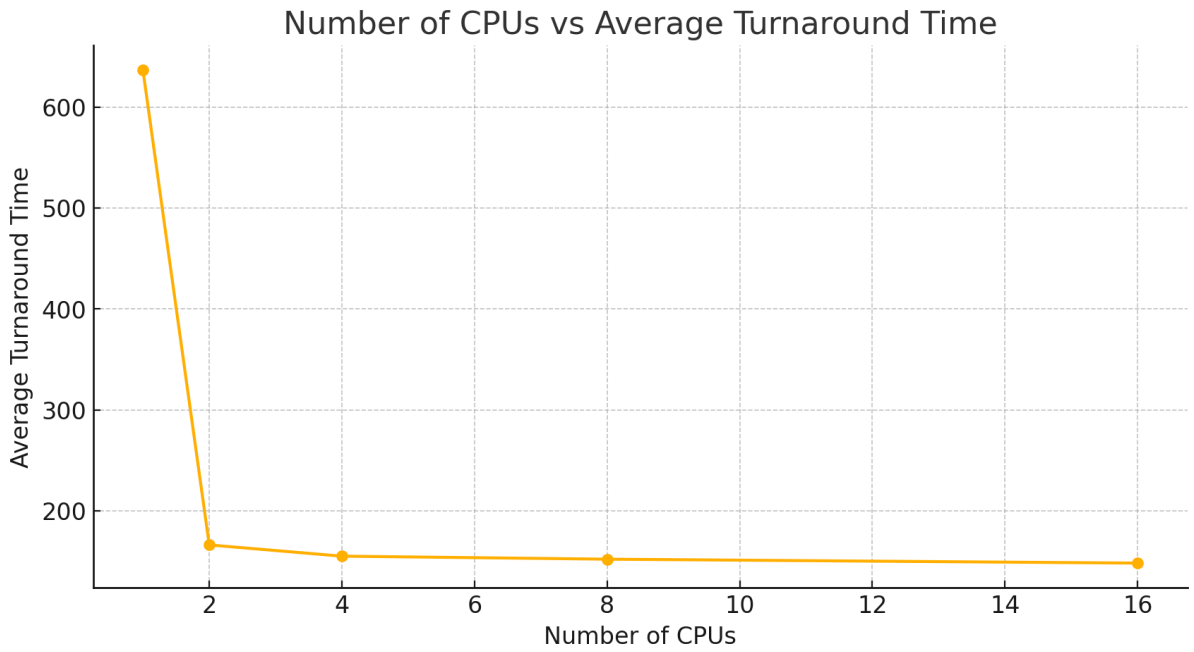

Figure 2: Number of CPUS vs Average Turnaround Time

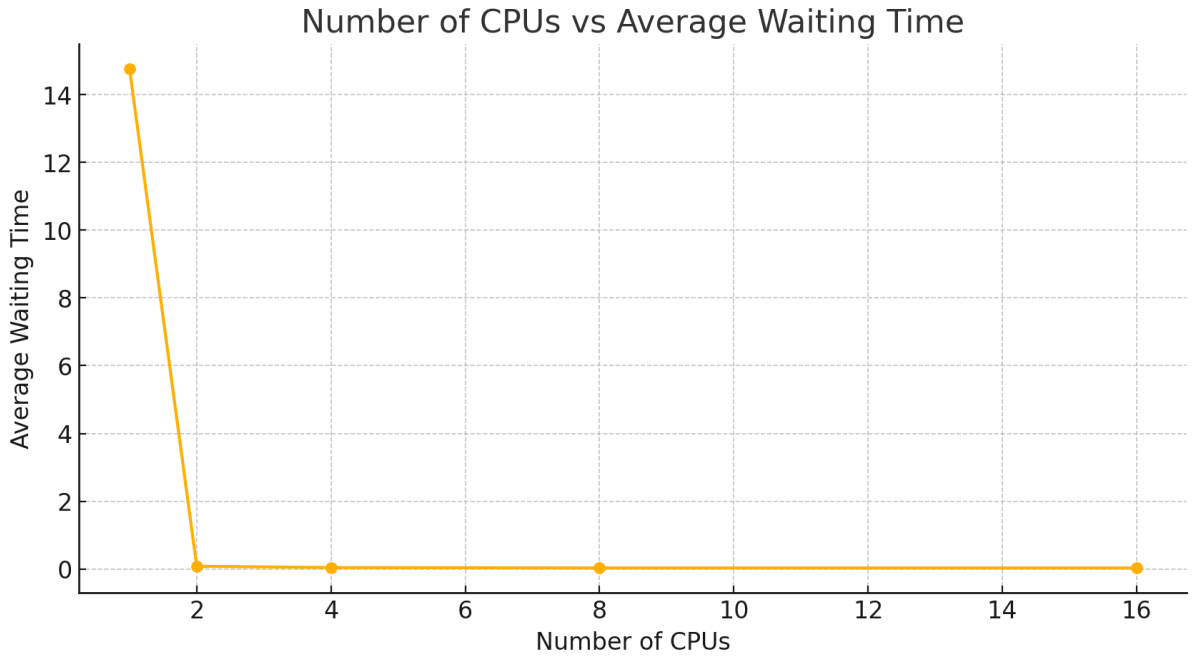

Figure 3: Number of CPUS vs Average Waiting Time

Interpreting the results: As the number of CPUs increases, the average turnaround time decreases significantly, showing that parallel processing causes great efficiency in process execution. This decrease is especially prominent from increasing the cpu's from 1 to 2. Same reasoning can be applied while interpreting how the number of CPUs affect the average waiting time. More CPUs mean that processes can start executing sooner when they arrive, resulting in less waiting time and turnaround time.

Round Robin vs Load Balancing on Average Waiting Time and Average Turnaround Time

- We fixed other parameters, used FCFS for scheduling algorithm, number of CPUs were 32 and number of processes were 100.

Input File Used:
PL 107
IAT 113
PL 113
IAT 91
PL 239
IAT 181
PL 32
IAT 31
PL 221
IAT 188
PL 147
IAT 106
PL 219
IAT 223
PL 86
IAT 40
PL 162
IAT 200
PL 57
IAT 101
PL 192
IAT 115
PL 106
IAT 133
PL 87
IAT 194
PL 173
IAT 69
PL 248

IAT 24
PL 146
IAT 50
PL 175
IAT 240
PL 221
IAT 183
PL 170
IAT 188
PL 193
IAT 98
PL 231
IAT 45
PL 34
IAT 168
PL 27
IAT 210
PL 178
IAT 82
PL 107
IAT 167
PL 220
IAT 157
PL 135
IAT 169
PL 98
IAT 141
PL 225
IAT 229
PL 44
IAT 119
PL 155
IAT 120
PL 211
IAT 208
PL 207
IAT 114
PL 196
IAT 218
PL 240
IAT 196
PL 72
IAT 86
PL 229

IAT 118
PL 242
IAT 170
PL 111
IAT 92
PL 25
IAT 178
PL 212
IAT 196
PL 58
IAT 91
PL 39
IAT 248
PL 202
IAT 49
PL 180
IAT 161
PL 180
IAT 216
PL 53
IAT 48
PL 76
IAT 64
PL 74
IAT 128
PL 164
IAT 209
PL 174
IAT 99
PL 250
IAT 53
PL 62
IAT 233
PL 82
IAT 119
PL 27
IAT 177
PL 141
IAT 199
PL 52
IAT 100
PL 172
IAT 146
PL 25

IAT 151
PL 221
IAT 112
PL 72
IAT 20
PL 121
IAT 232
PL 53
IAT 102
PL 187
IAT 180
PL 229
IAT 206
PL 225
IAT 90
PL 89
IAT 57
PL 82
IAT 229
PL 205
IAT 203
PL 176
IAT 23
PL 174
IAT 137
PL 31
IAT 212
PL 212
IAT 137
PL 120
IAT 153
PL 205
IAT 100
PL 67
IAT 77
PL 89
IAT 84
PL 238
IAT 234
PL 226
IAT 241
PL 87
IAT 218
PL 204

IAT 161
PL 53
IAT 194
PL 78
IAT 33
PL 102
IAT 93
PL 204
IAT 134
PL 178
IAT 34
PL 228
IAT 24
PL 188
IAT 27
PL 222
IAT 21
PL 104
IAT 119
PL 238
IAT 203
PL 175
IAT 223
PL 218
IAT 53
PL 92
IAT 56
PL 99
IAT 18
PL 106
IAT 92
PL 125
IAT 195
PL 71
IAT 117
PL 100
IAT 55
PL 57

Output for RM:

```
90   26   104      12629 12738  5           109
91   27   238      12751 13006  17          255
92   28   175      12971 13149  3           178
93   29   218      13194 13419  7           225
94   30   92       13248 13355  15          107
95   31   99       13309 13410  2           101
96   32   106      13355 13465  4           110
97   1    125      13455 13587  7           132
98   2    71       13651 13723  1           72
99   3    100      13769 13880  11          111
100  4    57       13825 13884  2           59
average turnaround time: 151.42 ms
average waiting time: 0.02 ms
```

Output for LM:

```
90   1    104      12549 12815  162         266
91   2    238      12671 13110  201         439
92   1    175      12878 13068  15          190
93   1    218      13117 13338  3           221
94   1    92       13189 13432  151         243
95   2    99       13246 13347  2           101
96   2    106      13286 13460  68          174
97   1    125      13384 13559  50          175
98   1    71       13595 13669  3           74
99   1    100      13716 13818  2           102
100  1    57       13772 13877  48          105
average turnaround time: 198.59 ms
average waiting time: 0.48 ms
```

Interpreting the results:
Normally we expect that LM should produce lower average turnaround times and waiting times since it properly distributes processes and causes more efficient parallel computing. In burst distributions with burst lengths with smaller standard deviations, we don't have many outliers so RM should produce similar results to LM. In our case, we do approximate load balancing by iteratively checking the ready queues of CPU's. This means that some ready queue closer to the start of the list of ready queues might be assigned many times before we utilize other CPU's, causing poorer performance. This is an explanation to our specific result, we also suspect that some faults in the experiment setup might've lead to RM performing better than LM