



Carleton
UNIVERSITY

Faculty of
Engineering
and Design

Elevator Simulator

[SYSC 3303] L1

Github: [ElevatorSimulator](#)

Group 4

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Table of Contents

Task Breakdown.....	2
<i>Summary of Iterations.....</i>	2
<i>Team Member Roles.....</i>	3
Setup.....	4
<i>Running</i>	4
<i>Testing.....</i>	4
Documentation	5
<i>Class Diagrams.....</i>	5
<i>Sequence Diagram for Error Scenarios</i>	6
<i>Timing Diagram for Error Scenarios</i>	7
<i>Elevator Subsystem State Machine Diagram</i>	8
Performance.....	9
<i>Scheduler Timing Diagram.....</i>	9
<i>Measurement Results.....</i>	11
<i>Schedulability.....</i>	15

Task Breakdown

Summary of Iterations

- **(Iteration 1)** Implemented the beginnings of the Scheduler, ElevatorSubsystem, FloorSubsystem.
 - ◆ Communication was established between the three subsystems.
 - ◆ A single elevator was controlled and serviced requests on a first come first serve basis through 10 floors.
- **(Iteration 2)** Multiple elevators added and number of floors increased to 22.
 - ◆ A Scheduling algorithm was made to determine the most suitable elevator to service a request.
- **(Iteration 3)** Added error handling.
 - ◆ Implemented handling of errors: dropped packets, elevator movement faults.
 - ◆ Hardcoded errors into the system to simulate what would happen in those scenarios.
- **(Iteration 4)** Measured the performance of the Scheduler subsystem.
 - ◆ The performance of the Scheduler subsystem was measured by running it on a separate machine than the Floor Subsystem and Elevator Subsystem.
 - ◆ The measurement data was analyzed using Rate Monotonic Analysis and schedulability was determined from that.
- **(Iteration 5)** Added a GUI. Scheduler enhancements.
 - ◆ A GUI showing the elevator movements was added over the Scheduler.
 - ◆ The Scheduler was refactored to provide better elevator scheduling and improve the overall performance of the system.

Team Member Roles

- Sunjay Panesar
 - ◆ Floor Subsystem
 - ◆ Performance Analysis
- Arianna Shi
 - ◆ Elevator Subsystem
 - ◆ Performance Analysis
 - ◆ Documentation
- Tashfiq Akhand
 - ◆ Unit testing modules
 - ◆ GUI
 - ◆ Performance Analysis
- Martin Klamrowski
 - ◆ Scheduler, Elevator Subsystem
 - ◆ Documentation
 - ◆ GUI
- Angie Byun
 - ◆ Scheduler, Elevator Subsystem
 - ◆ Documentation
 - ◆ Diagrams

Reflections

Possible improvements to the system would include better elevator scheduling and an algorithm that takes into account more scenarios while the elevator is operating. Additional error checking should also be implemented as real world operation is far from ideal. A more comprehensive GUI for a potential concierge.

Setup

Running

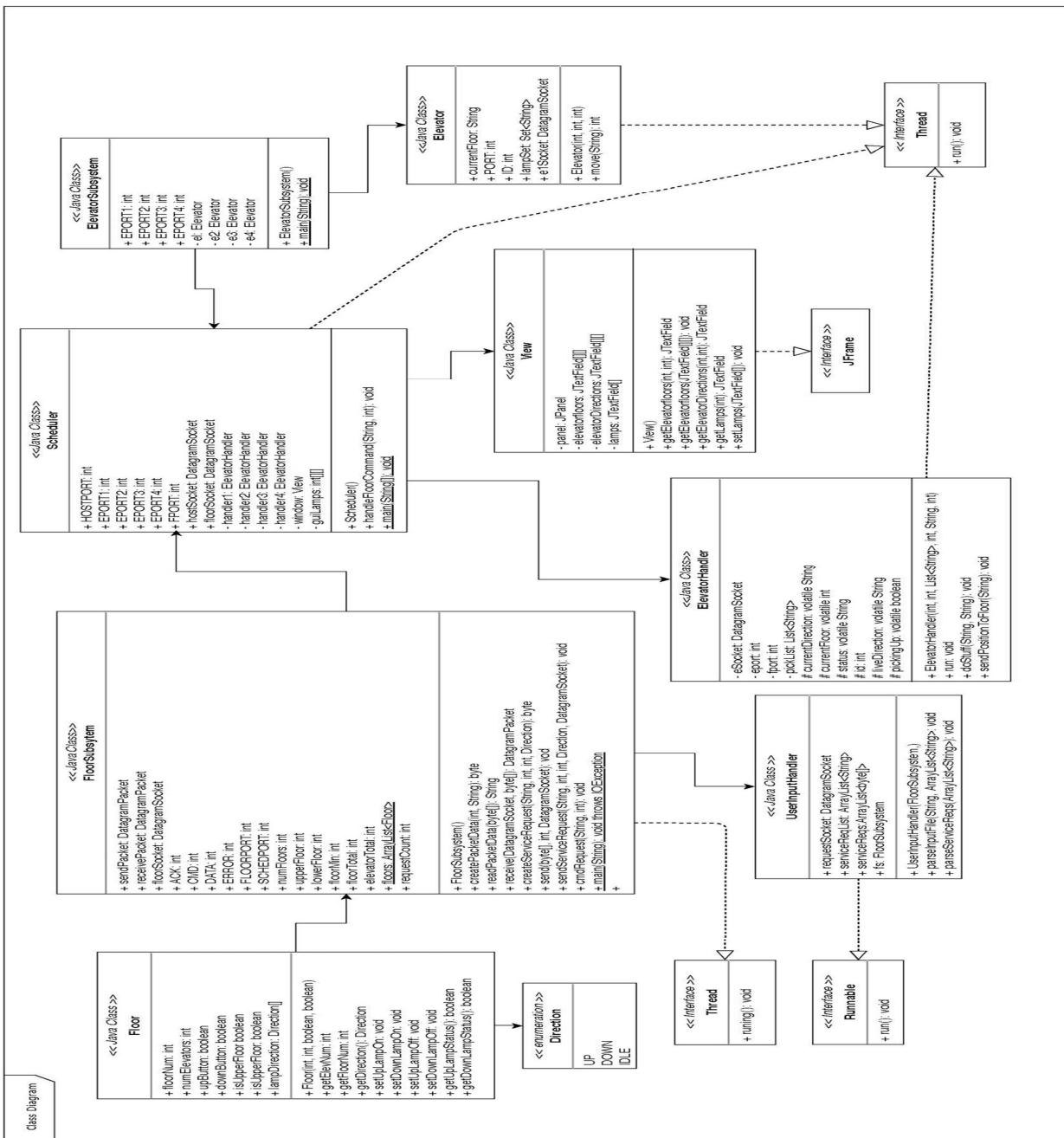
- extract the L1G4_i5.zip file
- in Eclipse navigate to File>Open Projects from File System
- click 'Directory'
- find the L1G4_i5/ElevatorSimulator/ directory and click 'Finish'
- the main files for the system are ElevatorSubsystem.java, Scheduler.java, FloorSubsystem.java
- run the Scheduler and ElevatorSubsystem before running the FloorSubsystem

Testing

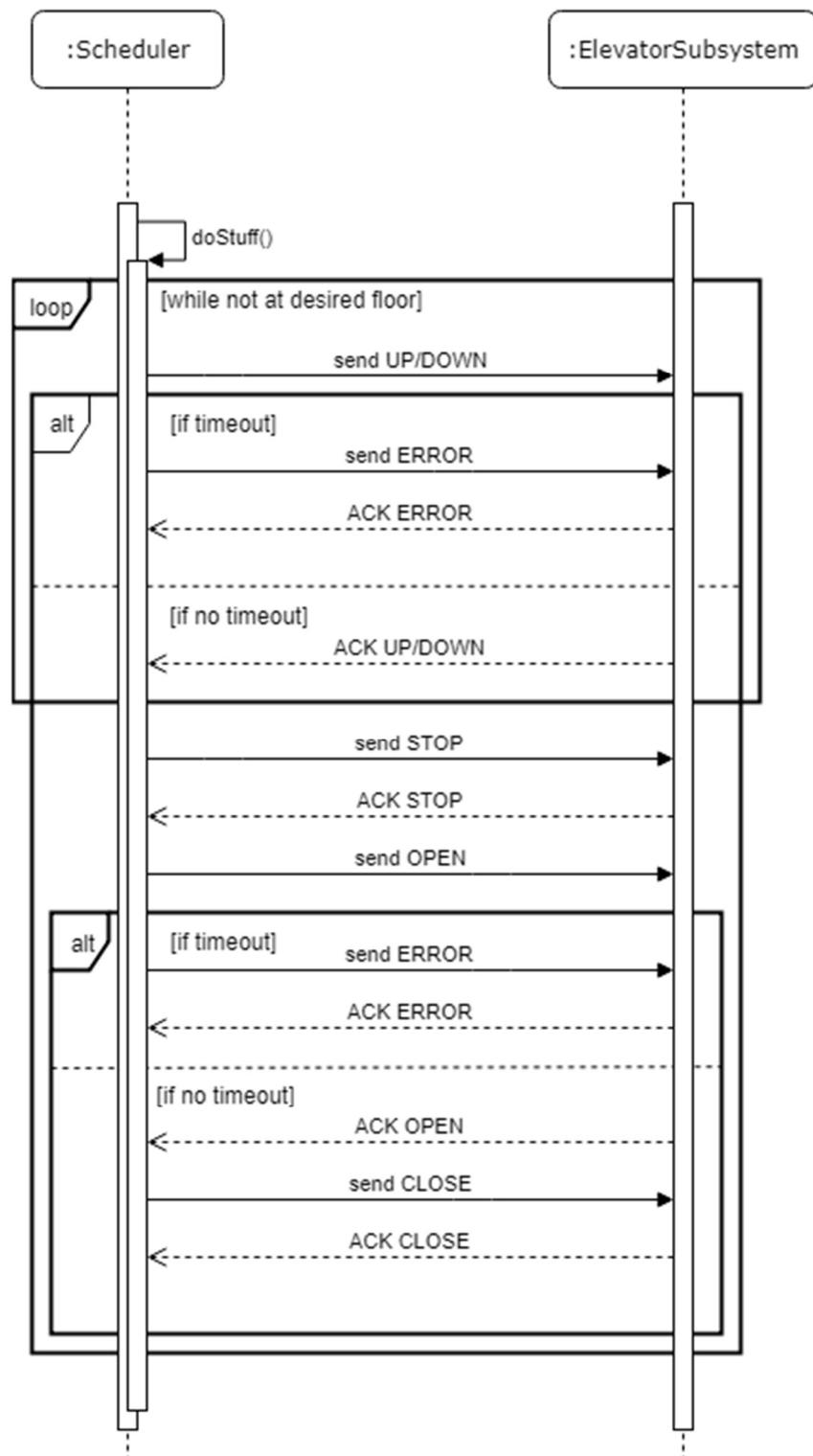
- AllTest.java has all the Junit test classes
- Run the AllTest.java class and observe the tests being done
- All tests being done are from return type methods from all classes within L1G4_i5.zip file
- If all shows green and all tests are satisfied using the Junit framework and the assert commands, then the project is fully tested

Documentation

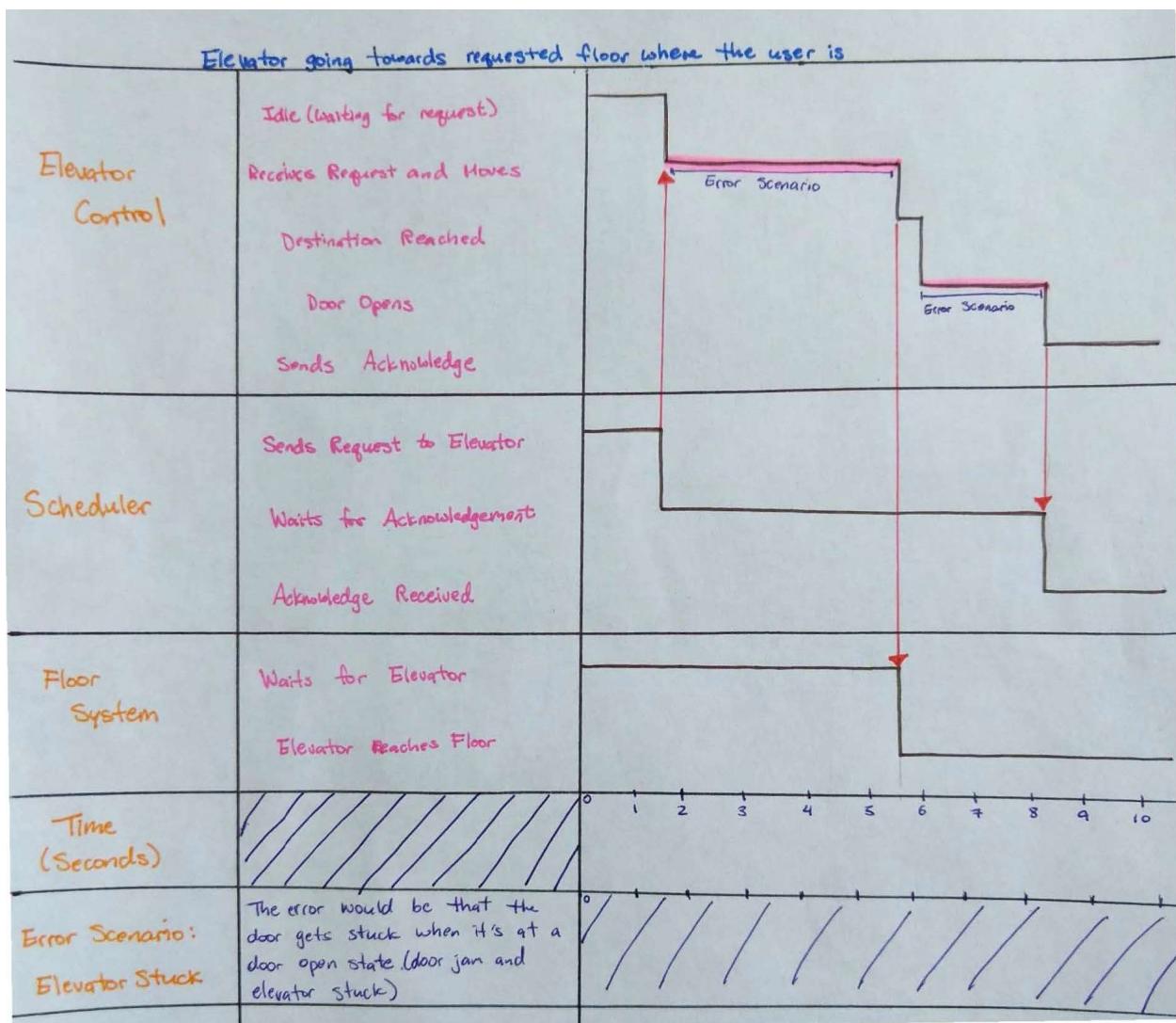
Class Diagrams



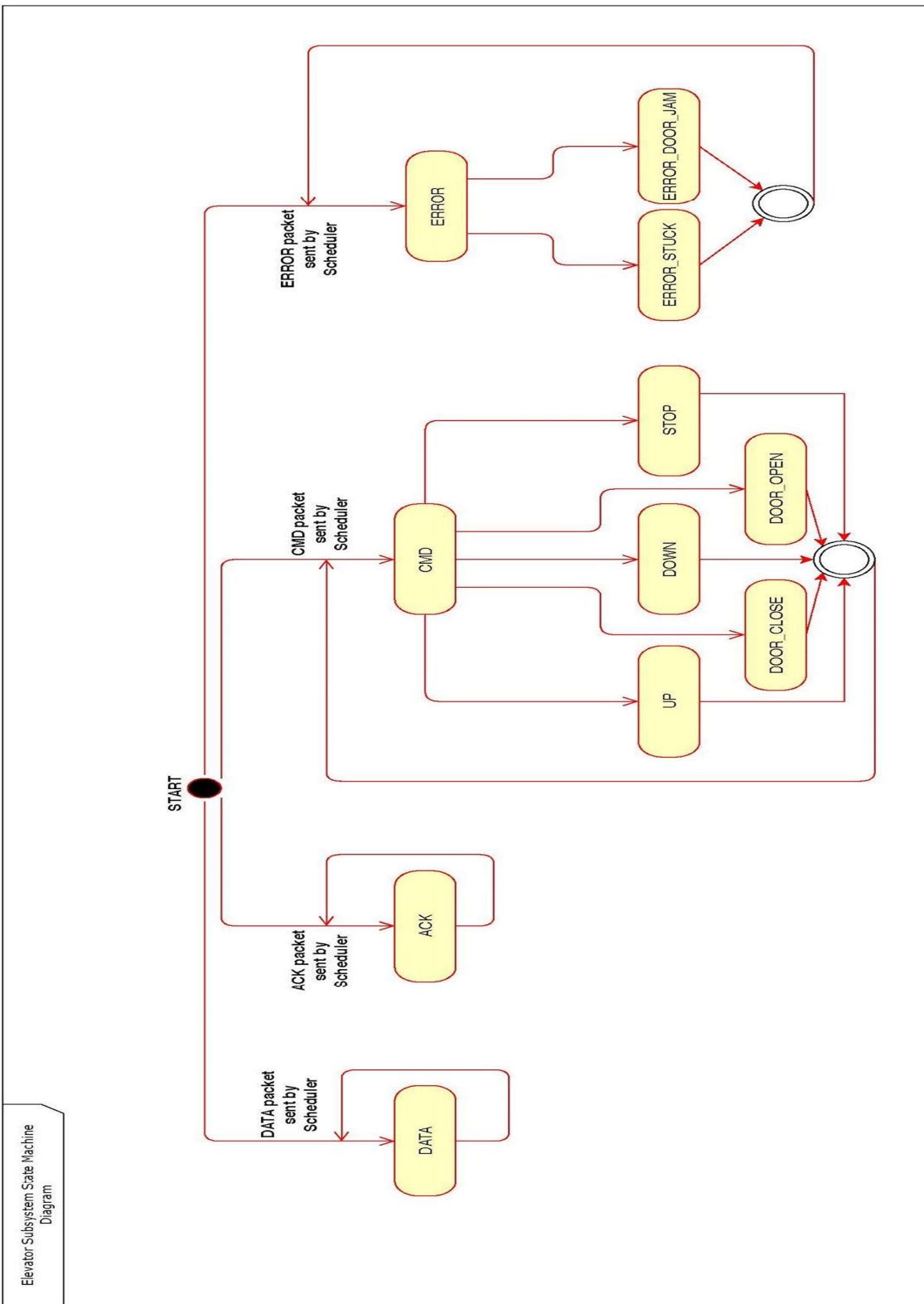
Sequence Diagram for Error Scenarios



Timing Diagram for Error Scenarios

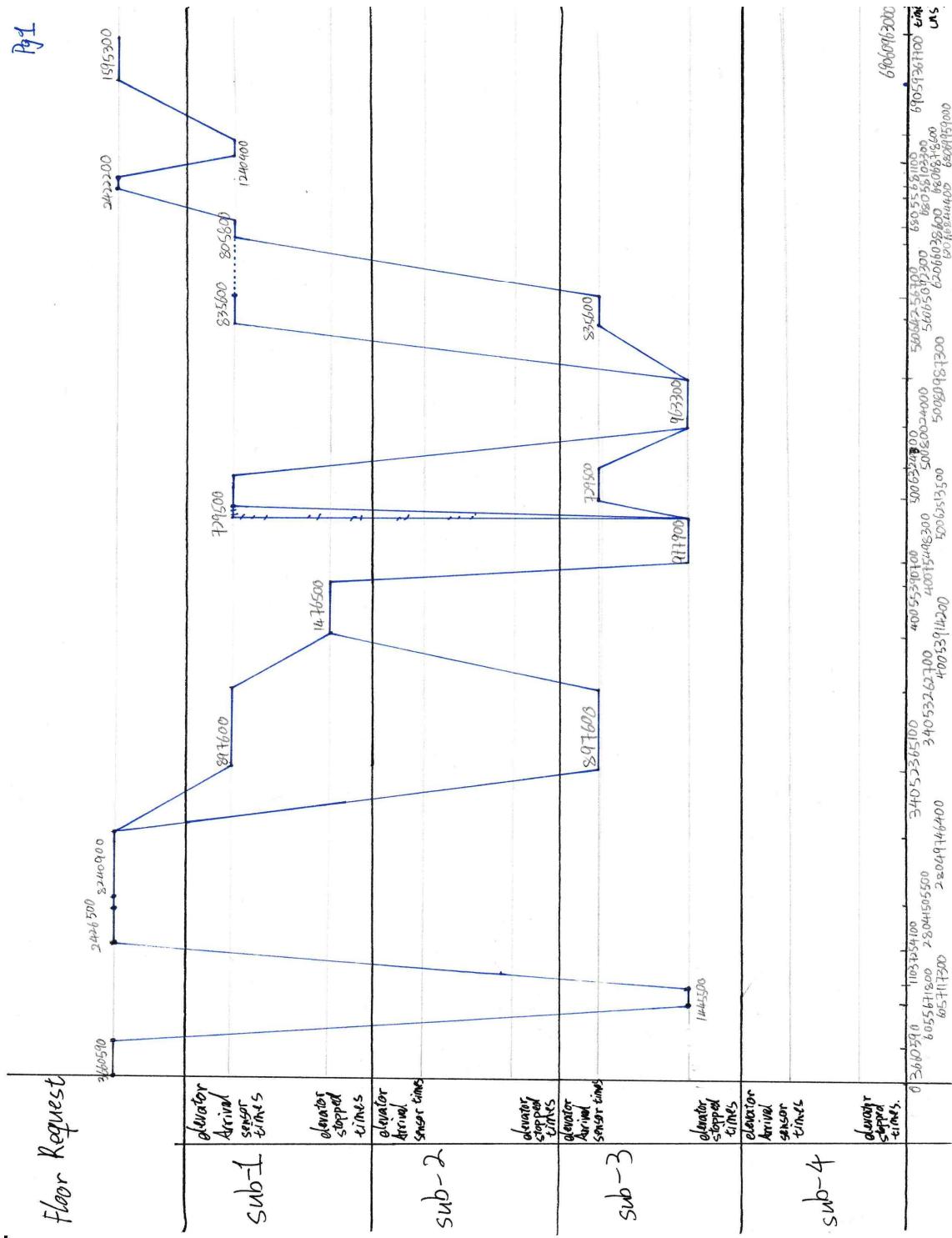


Elevator Subsystem State Machine Diagram

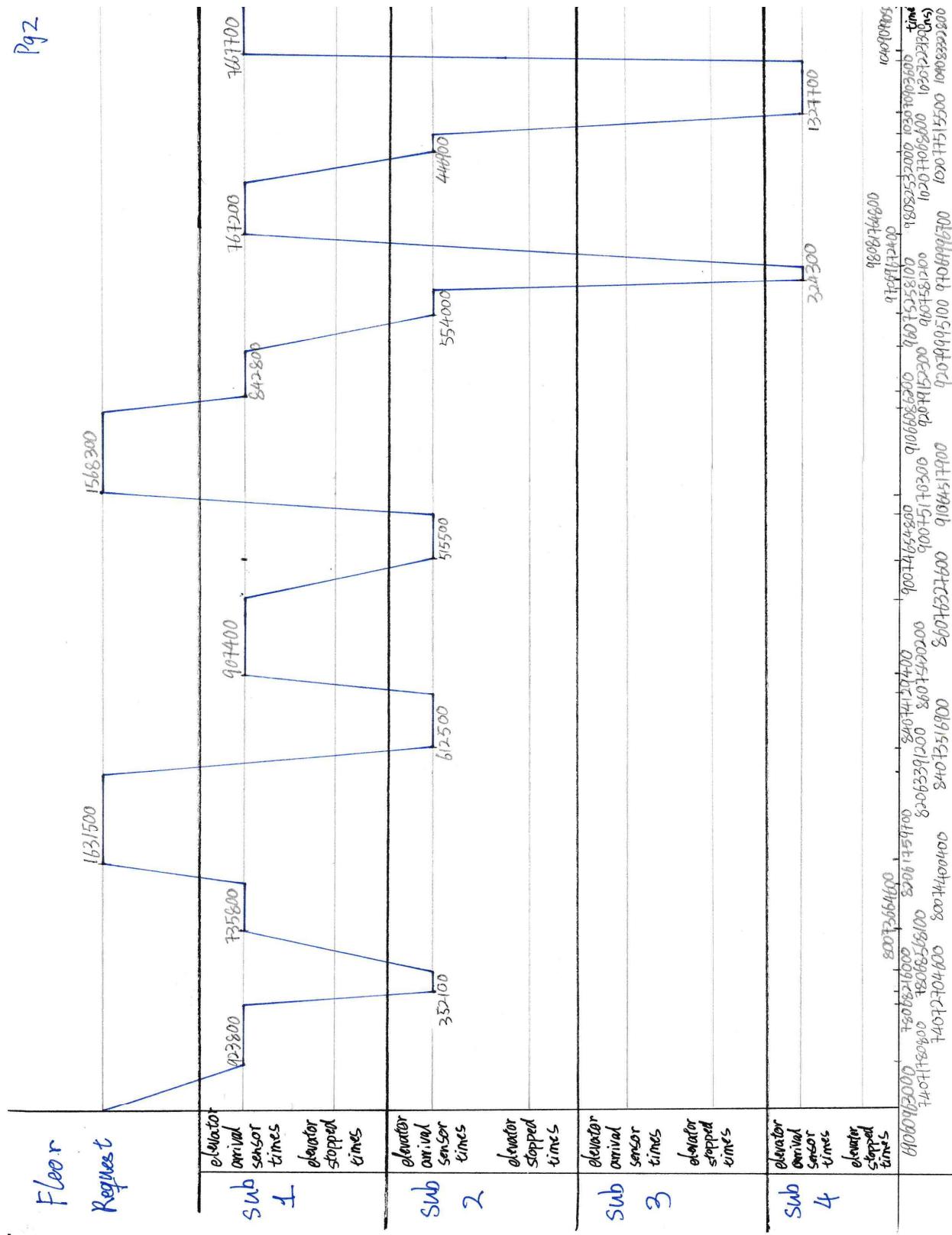


Performance

Scheduler Timing Diagram



Pg72



Measurement Results

```
main: floorRequestTimes: (floor button)
Elapsed time: 22382020 Start timestamp: 1296474219377716
Elapsed time: 3077403 Start timestamp: 1296502246926374
Elapsed time: 2650319 Start timestamp: 1296565265139616
Elapsed time: 2494652 Start timestamp: 1296591269436975
Elapsed time: 2856448 Start timestamp: 1296485242657811
Elapsed time: 2832784 Start timestamp: 1296556260299706
Elapsed time: 2840197 Start timestamp: 1296543255857229
Elapsed time: 2922307 Start timestamp: 1296542251765429

sub-1: elevatorArrivalSensorTimes:
Elapsed time: 166785 Start timestamp: 1296584290671455
Elapsed time: 276551 Start timestamp: 1296694336763503
Elapsed time: 308481 Start timestamp: 1296652327401573
Elapsed time: 352387 Start timestamp: 1296688335728009
Elapsed time: 323592 Start timestamp: 1296700338902347
Elapsed time: 356949 Start timestamp: 1296530273944740
Elapsed time: 366357 Start timestamp: 1296548280112376
Elapsed time: 334996 Start timestamp: 1296602297055768
Elapsed time: 287954 Start timestamp: 1296590292320776
Elapsed time: 269138 Start timestamp: 1296634324085253
Elapsed time: 387740 Start timestamp: 1296566285570105
Elapsed time: 139416 Start timestamp: 1296622320360951
Elapsed time: 583891 Start timestamp: 1296542278000047
Elapsed time: 447897 Start timestamp: 1296578288729332
Elapsed time: 249180 Start timestamp: 1296628322545697
Elapsed time: 337562 Start timestamp: 1296676332440200
Elapsed time: 320741 Start timestamp: 1296554282004035
Elapsed time: 264290 Start timestamp: 1296508254846254
Elapsed time: 270563 Start timestamp: 1296658328646618
Elapsed time: 285673 Start timestamp: 1296596294933746
Elapsed time: 212402 Start timestamp: 1296524272315376
Elapsed time: 306486 Start timestamp: 1296664330224379
Elapsed time: 294512 Start timestamp: 1296682333778759
Elapsed time: 315325 Start timestamp: 1296670331357663
Elapsed time: 362367 Start timestamp: 1296560283968680
Elapsed time: 252601 Start timestamp: 1296712341832922
Elapsed time: 242623 Start timestamp: 1296640325054604
Elapsed time: 375481 Start timestamp: 1296706340349815
Elapsed time: 283962 Start timestamp: 1296646326403427
Elapsed time: 296507 Start timestamp: 1296572287622562

sub-1: elevatorStoppedTimes: (elevator button)
Elapsed time: 2304203 Start timestamp: 1296608299121626
Elapsed time: 2491231 Start timestamp: 1296514256428576
Elapsed time: 1576050 Start timestamp: 1296718343529570
```

Time values are in nanoseconds

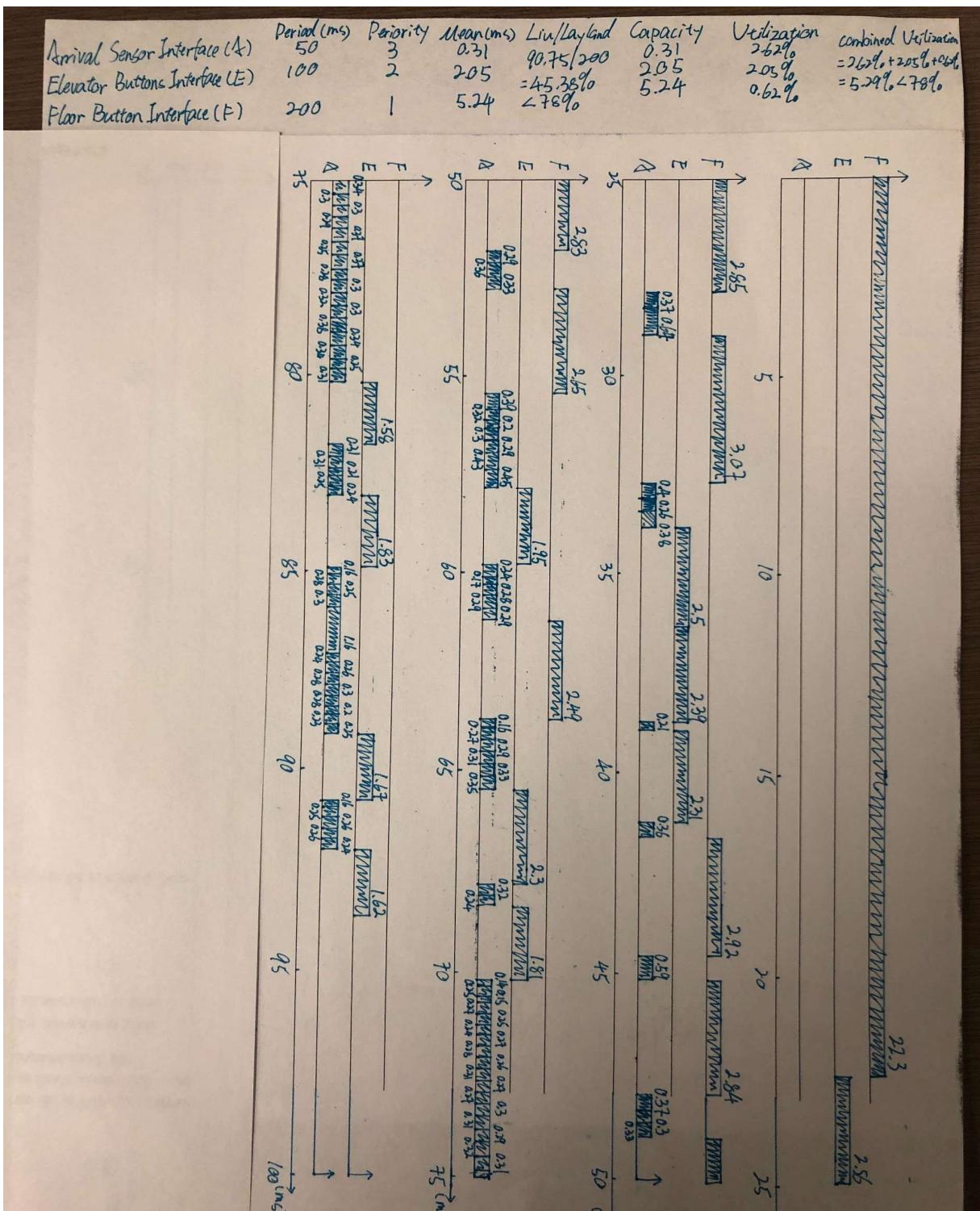
```
sub-2: elevatorArrivalSensorTimes:  
Elapsed time: 346116 Start timestamp: 1296604292711937  
Elapsed time: 292231 Start timestamp: 1296804360509741  
Elapsed time: 308481 Start timestamp: 1296598290735603  
Elapsed time: 286529 Start timestamp: 1296668319383333  
Elapsed time: 295937 Start timestamp: 1296698326714474  
Elapsed time: 159943 Start timestamp: 1296844376920561  
Elapsed time: 336707 Start timestamp: 1296692325240776  
Elapsed time: 260869 Start timestamp: 1296856379749354  
Elapsed time: 242052 Start timestamp: 1296740336194723  
Elapsed time: 226372 Start timestamp: 1296822363799546  
Elapsed time: 254027 Start timestamp: 1296638310851052  
Elapsed time: 254026 Start timestamp: 1296828364766331  
Elapsed time: 153100 Start timestamp: 1296632309069443  
Elapsed time: 331860 Start timestamp: 1296564274427135  
Elapsed time: 262294 Start timestamp: 1296644312859319  
Elapsed time: 237776 Start timestamp: 1296616295447502  
Elapsed time: 1164932 Start timestamp: 1296780352607253  
Elapsed time: 284818 Start timestamp: 1296810361583439  
Elapsed time: 296222 Start timestamp: 1296662318266584  
Elapsed time: 308767 Start timestamp: 1296716330325020  
Elapsed time: 281112 Start timestamp: 1296798359047732  
Elapsed time: 321882 Start timestamp: 1296570275493135  
Elapsed time: 246044 Start timestamp: 1296850377874516  
Elapsed time: 292516 Start timestamp: 1296558272420294  
Elapsed time: 314468 Start timestamp: 1296674320131159  
Elapsed time: 298788 Start timestamp: 1296704327782185  
Elapsed time: 239202 Start timestamp: 1296786355526709  
Elapsed time: 236065 Start timestamp: 1296868383078218  
Elapsed time: 204134 Start timestamp: 1296816362737537  
Elapsed time: 160228 Start timestamp: 1296756347201698  
Elapsed time: 286243 Start timestamp: 1296576277521929  
Elapsed time: 374626 Start timestamp: 1296686322644057  
Elapsed time: 335852 Start timestamp: 1296710328794301  
Elapsed time: 266286 Start timestamp: 1296656315968653  
Elapsed time: 263151 Start timestamp: 1296862381201669  
Elapsed time: 162223 Start timestamp: 1296592288924343  
Elapsed time: 320170 Start timestamp: 1296610294235814  
Elapsed time: 256877 Start timestamp: 1296792357560065  
Elapsed time: 300213 Start timestamp: 1296552270632983  
Elapsed time: 303350 Start timestamp: 1296680321329447  
Elapsed time: 309622 Start timestamp: 1296722331766501  
Elapsed time: 293942 Start timestamp: 1296774351407254  
Elapsed time: 214967 Start timestamp: 1296728333904775  
Elapsed time: 256308 Start timestamp: 1296650314898661  
Elapsed time: 250036 Start timestamp: 1296734335084246  
Elapsed time: 248895 Start timestamp: 1296768349802124  
Elapsed time: 280827 Start timestamp: 1296762348813386  
  
sub-2: elevatorStoppedTimes:  
Elapsed time: 1830362 Start timestamp: 1296746338176760  
Elapsed time: 1619386 Start timestamp: 1296874384962179  
Elapsed time: 1665002 Start timestamp: 1296834365804391  
Elapsed time: 1953241 Start timestamp: 1296582279431835  
Elapsed time: 1811260 Start timestamp: 1296622297331463
```

```
sub-3: elevatorArrivalSensorTimes:  
Elapsed time: 640057 Start timestamp: 1296496265266772  
Elapsed time: 368068 Start timestamp: 1296490262692291  
Elapsed time: 382608 Start timestamp: 1296508269345457  
Elapsed time: 399144 Start timestamp: 1296502267315238  
  
sub-3: elevatorStoppedTimes:  
Elapsed time: 2555094 Start timestamp: 1296480246264365  
Elapsed time: 2313326 Start timestamp: 1296524282785503  
Elapsed time: 2392586 Start timestamp: 1296514271871185  
  
sub-4: elevatorArrivalSensorTimes:  
Elapsed time: 201282 Start timestamp: 1296571272676032  
Elapsed time: 336707 Start timestamp: 1296583277720076  
Elapsed time: 429935 Start timestamp: 1296577275118510  
Elapsed time: 283677 Start timestamp: 1296589279641386  
Elapsed time: 269993 Start timestamp: 1296595281576380
```

Floor Buttons Interface (ms)	Arrival Sensors Interface (ms)	Elevator Buttons Interface (ms)
22.38202	0.166785	0.226372
3.077403	0.276551	0.254027
2.650319	0.308481	0.254026
2.494652	0.352387	0.1531
2.856448	0.323592	0.33186
2.832784	0.356949	0.262294
2.840197	0.366357	0.237776
2.922307	0.334996	1.164932
	0.287954	0.284818
	0.269138	0.296222
	0.38774	0.308767
	0.139416	0.281112
	0.583891	0.321882
	0.447897	0.246044
	0.24918	0.292516
	0.337562	0.314468
	0.320741	0.298788
	0.26429	0.239202
	0.270563	0.236065
	0.285673	0.204134
	0.212402	0.160228
	0.306486	0.286243
	0.294512	0.374626
	0.315325	0.335852
	0.362367	0.266286
	0.252601	0.263151
	0.242623	0.162223
	0.375481	0.32017
	0.283962	0.256877
	0.296507	0.300213
	0.346116	0.30335
	0.292231	0.309622
	0.308481	0.293942
	0.286529	0.214967
	0.295937	0.256308
	0.159943	0.250036
	0.336707	0.248895
	0.260869	0.280827
	0.242052	

	Mean (ms)	Variance (ms^2)
Floor Buttons Interface	5.25701625	47.91050095
Arrival Sensors Interface	0.302596769	0.014441127
Elevator Buttons Interface	2.046521909	0.137387701

Schedulability



From the timing diagram and Rate Monotonic Analysis of the Scheduler subsystem, the combined utilization has a result of 5.29%, which is smaller than 78%. Thus, it can be concluded that the Scheduler subsystem is schedulable.