



**Carleton**  
UNIVERSITY

Faculty of  
**Engineering**  
and Design

# Elevator Simulator

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[SYSC 3303] L1

Github: [ElevatorSimulator](#)

## Group 4

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# Task Breakdown

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## *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

# **Setup**

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## *Running*

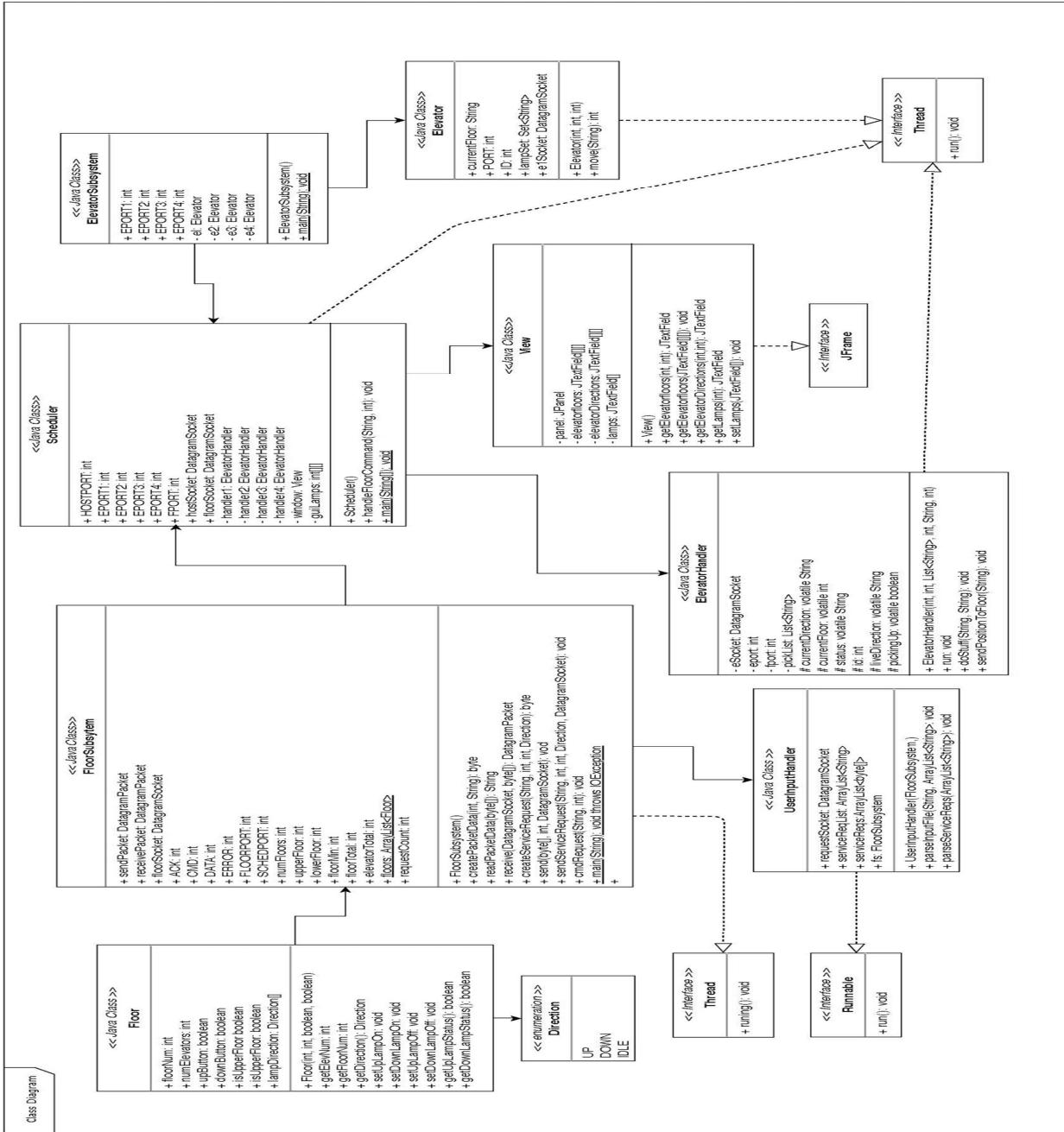
- extract the L1G4\_i5.zip file
- in Eclipse navigate to File>Open Projects from File System
- click 'Directory'
- find the L1G4\_i5/ElevatorSimulator/ directory and click 'Finish'
- the main files for the system are ElevatorSubsystem.java, Scheduler.java, FloorSubsystem.java
- run the Scheduler and ElevatorSubsystem before running the FloorSubsystem

## *Testing*

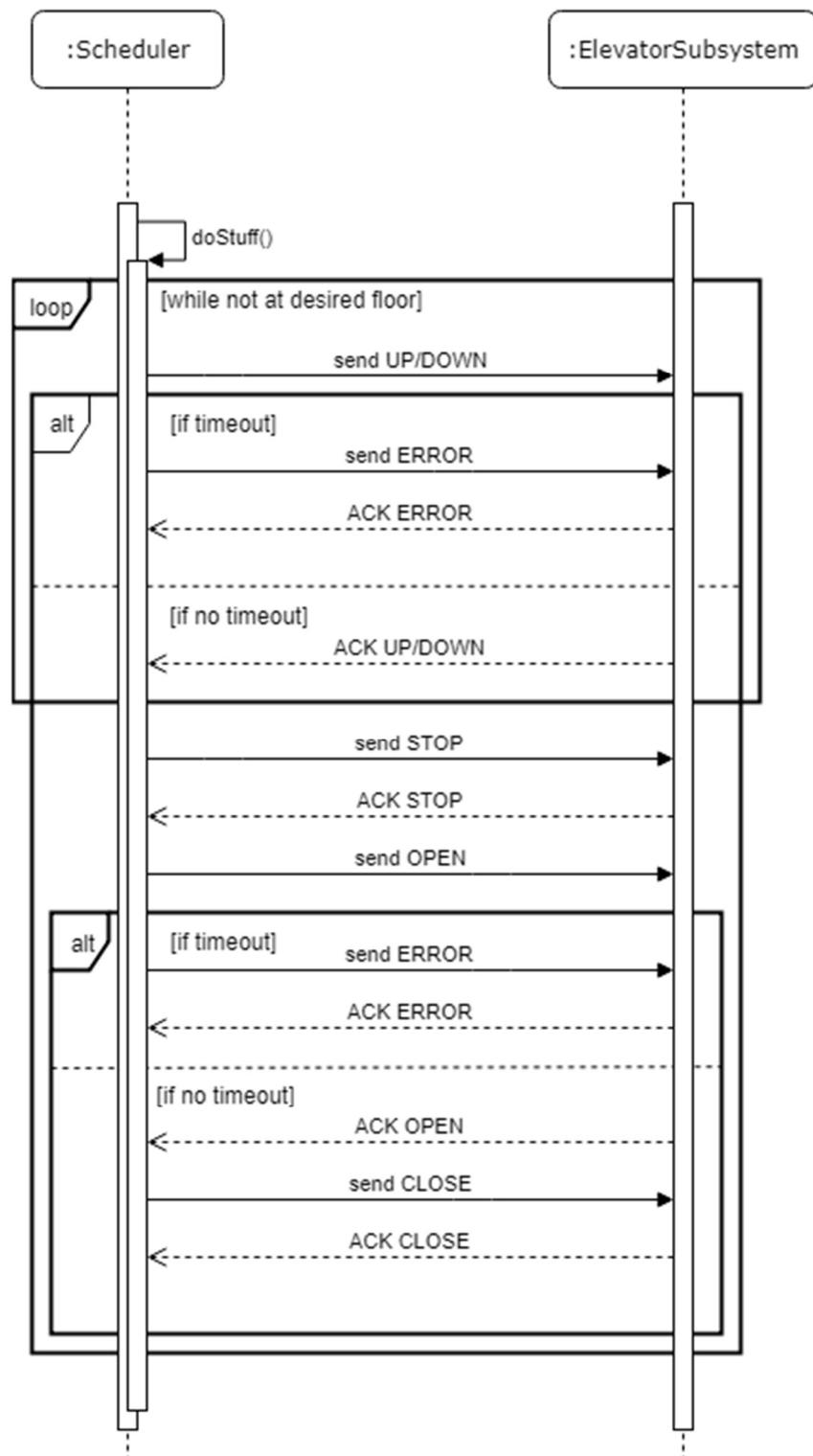
- AllTest.java has all the Junit test classes
- Run the AllTest.java class and observe the tests being done
- All tests being done are from return type methods from all classes within L1G4\_i5.zip file
- If all shows green and all tests are satisfied using the Junit framework and the assert commands, then the project is fully tested

# Documentation

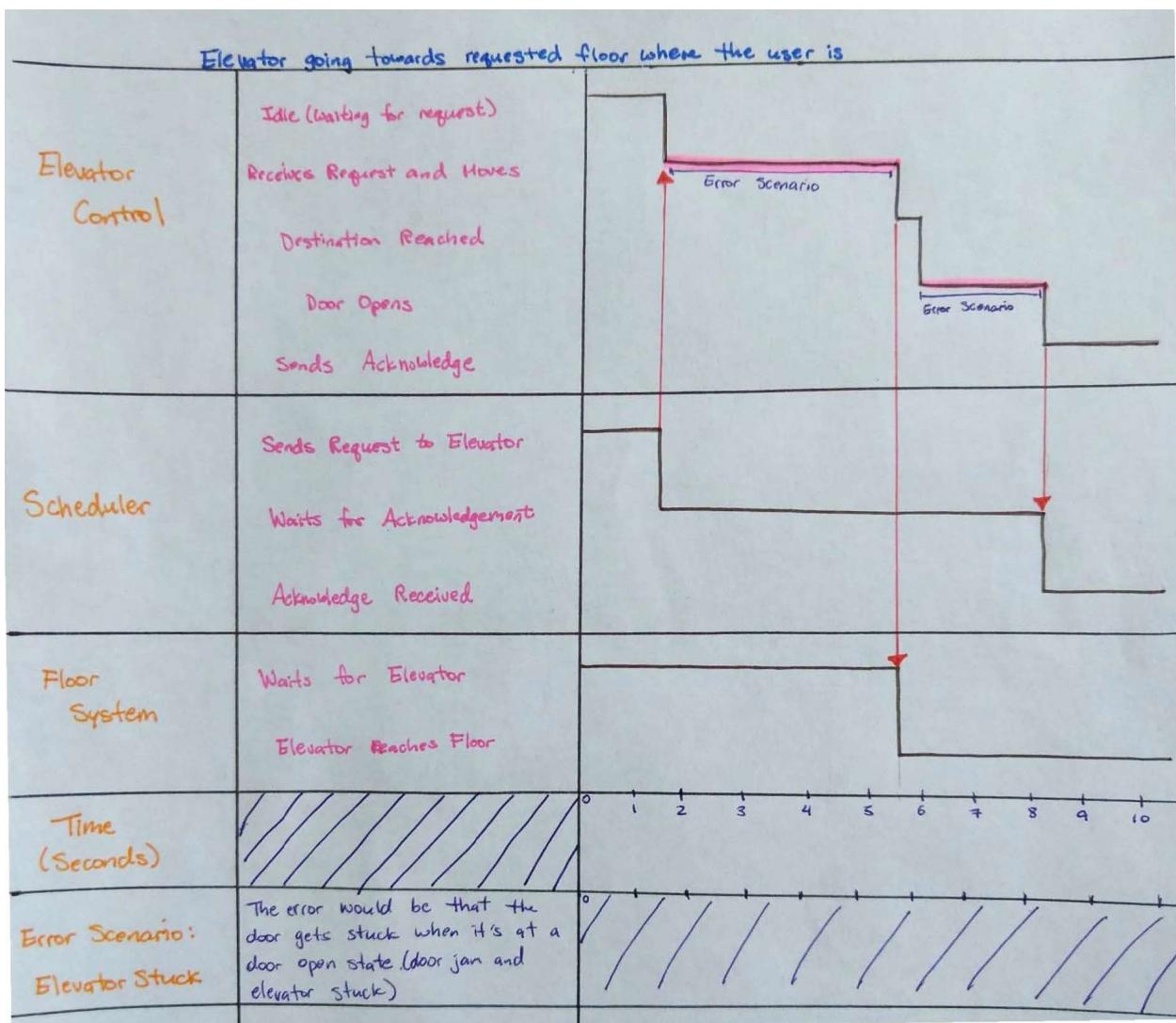
## *Class Diagrams*



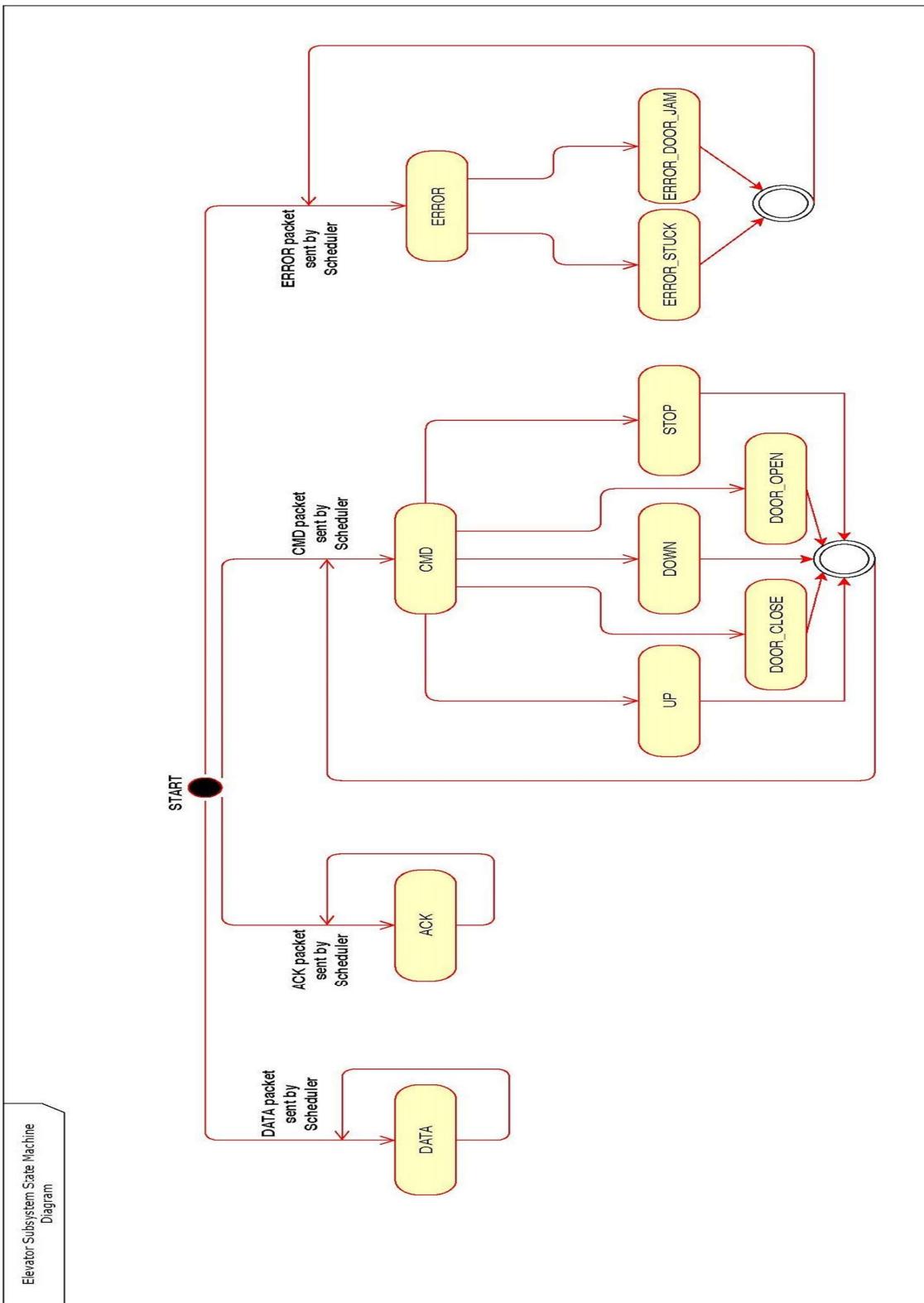
## Sequence Diagram for Error Scenarios



## Timing Diagram for Error Scenarios

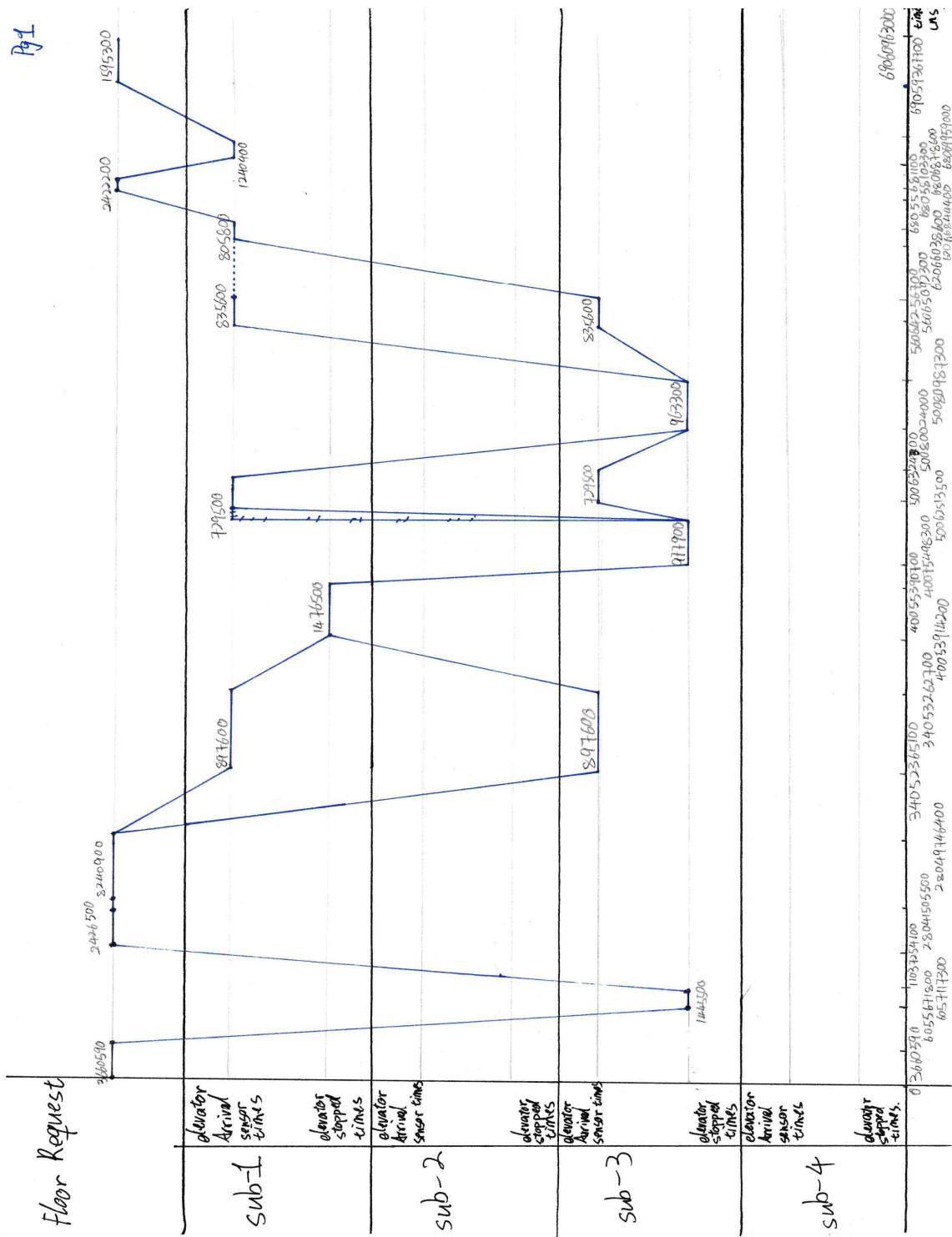


## Elevator Subsystem State Machine Diagram

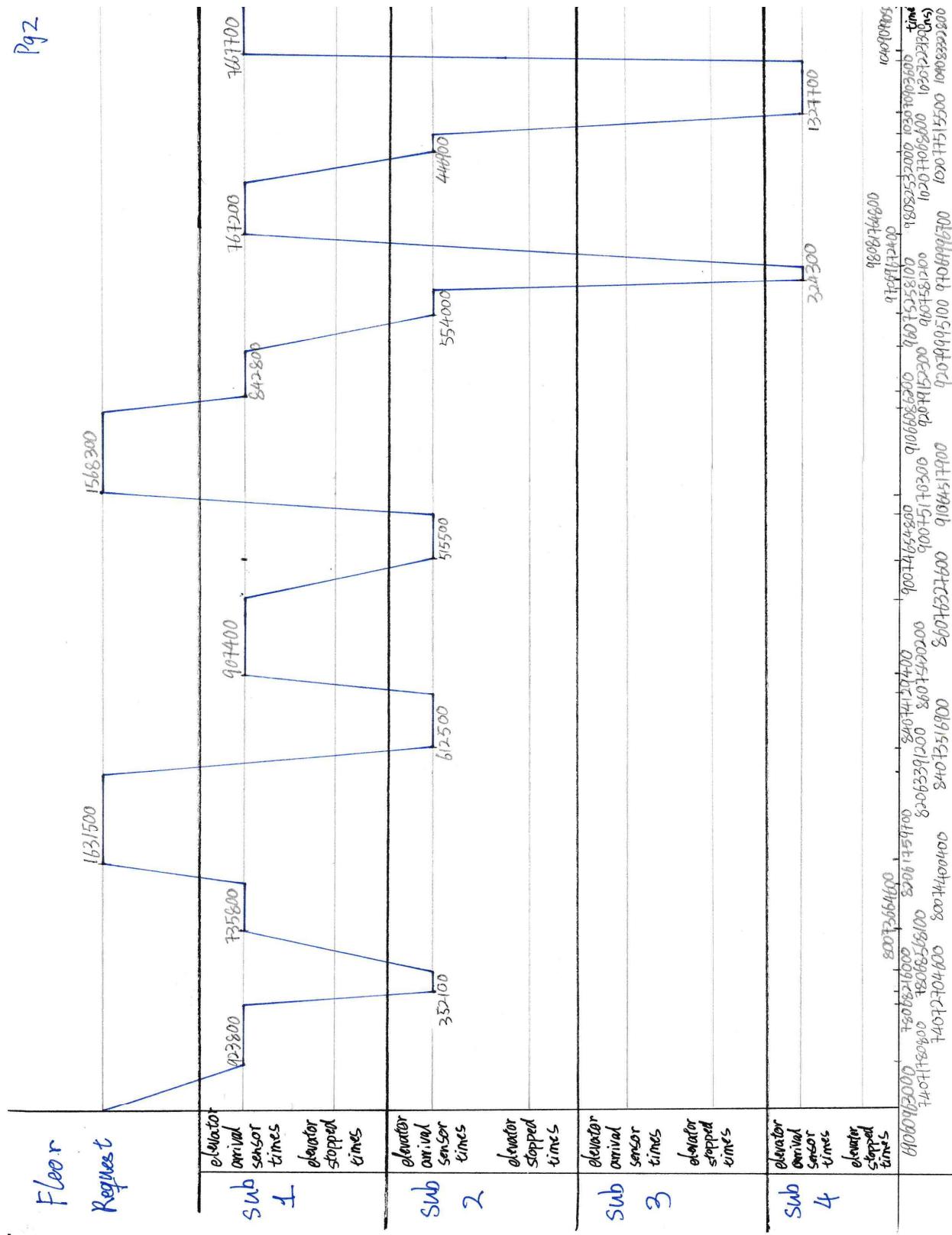


# Performance

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

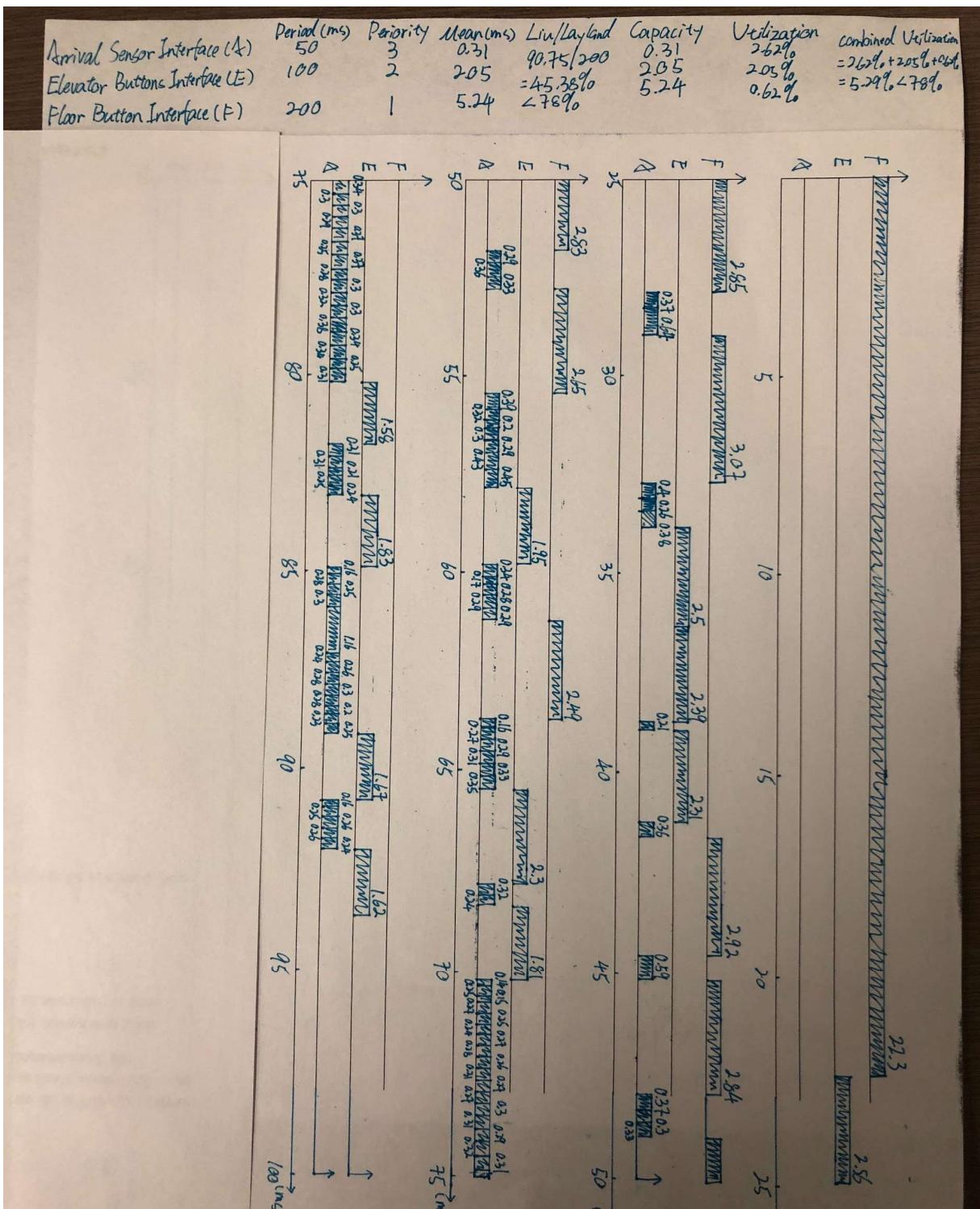
```
sub-2: elevatorArrivalSensorTimes:  
Elapsed time: 346116 Start timestamp: 1296604292711937  
Elapsed time: 292231 Start timestamp: 1296804360509741  
Elapsed time: 308481 Start timestamp: 1296598290735603  
Elapsed time: 286529 Start timestamp: 1296668319383333  
Elapsed time: 295937 Start timestamp: 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.