# SYSC 3303 A1 Final Project Report

**Elevator Control System & Simulator**

Group 2

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SYSC 3303A RealTime Concurrent Systems Winter 2023

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## Breakdown of Responsibilities

### Iteration 1 - Establish Connections between the three subsystems

| | |
|---|---|
| **Anthony Massaad** | Floor Subsystem, Parser, Logger, JavaDocs, UML Class Diagram, JUnit Testing |
| **Dorothy Tran** | Scheduler Subsystem, Message System, JavaDocs |
| **Max Curkovic** | Scheduler Subsystem, Message System, JavaDocs, UML Sequence Diagram |
| **Elisha Catherasoo** | Elevator Subsystem, JavaDocs |
| **Cassidy Pacada** | JUnit Testing, Elevator Subsystem, ReadMe |

### Iteration 2 - Adding the Scheduler and Elevator Subsystem

| | |
|---|---|
| **Anthony Massaad** | ElevatorSubSystem, Scheduler, Floor, MessageQueue, Message, ElevatorSubSystemMessageQueue, FloorMessageQueue, ArrivalMessage, MoveToMessage, ElevatorRequestMessage, Log, UML Class Diagram, Scheduler State Diagram |
| **Dorothy Tran** | ElevatorSubSystem, Scheduler, Floor, MessageQueue, Message, ElevatorSubSystemMessageQueue, FloorMessageQueue, ArrivalMessage, MoveToMessage, ElevatorRequestMessage, JUnit Testing |
| **Max Curkovic** | ElevatorSubSystem, Scheduler, Floor, MessageQueue, Message, ElevatorSubSystemMessageQueue, FloorMessageQueue, ArrivalMessage, MoveToMessage, ElevatorRequestMessage, Sequence Diagram, JUnit Testing |
| **Elisha Catherasoo** | ElevatorSubSystem, Scheduler, Floor, MessageQueue, Message, ElevatorSubSystemMessageQueue, FloorMessageQueue, ArrivalMessage, MoveToMessage, ElevatorRequestMessage, JUnit Testing |
| **Cassidy Pacada** | ElevatorSubSystem, Scheduler, Floor, MessageQueue, Message, ElevatorSubSystemMessageQueue, FloorMessageQueue, ArrivalMessage, MoveToMessage, ElevatorRequestMessage, Elevator State Diagram |

## Iteration 3 - Multiple Cars and System Distribution

| | |
|---|---|
| **Anthony Massaad** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, Log, UML Class Diagram, Scheduler State Diagram |
| **Dorothy Tran** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, JUnit Testing |
| **Max Curkovic** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, Sequence Diagram, JUnit Testing |
| **Elisha Catherasoo** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, JUnit Testing |
| **Cassidy Pacada** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, Elevator State Diagram |

## Iteration 4 - Adding Error Detection and Correction

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|---|---|
| **Anthony Massaad** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, Log, Timing, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Uml Class Diagram, Scheduler State Diagram |
| **Dorothy Tran** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, JUnit Testing |
| **Max Curkovic** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Sequence Diagram, JUnit Testing |
| **Elisha Catherasoo** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, |

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| | SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, JUnit Testing |
| **Cassidy Pacada** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Elevator State Diagram |

## Iteration 5 - Measuring the Scheduler and Predicting the Performance

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|---|---|
| **Anthony Massaad** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, Log, Timing, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Uml Class Diagram, Scheduler State Diagram, MainGui, MessageCollections, ElevatorComponent, FloorComponent, FloorInfo, ElevatorInfo, NextDestField, FloorInputTest |
| **Dorothy Tran** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, |

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|---|---|
| | SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, JUnit Testing, MainGui, MessageCollections, ElevatorComponent, FloorInfo, ElevatorInfo, NextDestField, FloorInputTest |
| **Max Curkovic** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Sequence Diagram, JUnit Testing, MainGui, MessageCollections, ElevatorComponent, FloorInfo, ElevatorInfo, NextDestField, FloorInputTest |
| **Elisha Catherasoo** | ElevatorSubSystem, Scheduler, Floor, Message, UpdatePositionMesesage, ArrivalMessage, MoveToMessage, RequestElevatorMessage, FloorRequestElevator, ElevatorComReceiver, Elevator, ElevatorStatus, SchedulerMidTask, UDPReceive, UDPBoth, UDPSend, UDPImpl, Clock, FloorManager, FloorScheduler, SchedulerIdleState, SchedulerMidTaskIdleState, SchedueIrProcessElevatorState, SchedulerProcessFloorState, State, ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, JUnit Testing, MainGui, MessageCollections, ElevatorComponent, FloorInfo, ElevatorInfo, NextDestField, FloorInputTest |
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| | ElevatorBrokenState, ElevatorCloseDoorState, ElevatorDoorFaultState, ElelvatorIdleState, ElevatorMovingState, ElevatorOpenDoorState, ElevatorRequestProcessState, Elevator State Diagram, MainGui, MessageCollections, ElevatorComponent, FloorInfo, ElevatorInfo, NextDestField, FloorInputTest |

# Diagrams Representing the Elevator System

## UML Class Diagram

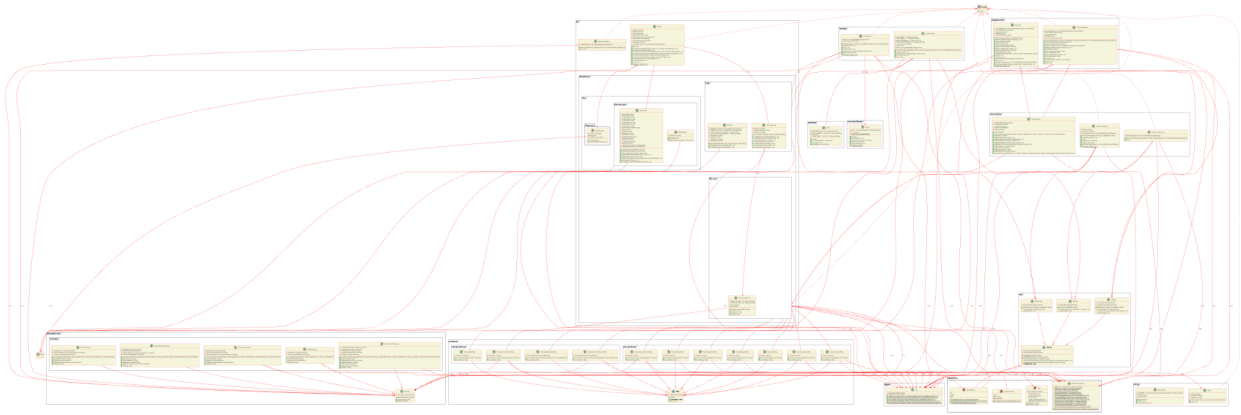

Figure 1: UML Class Diagram for the Elevator Control System

## State Machine Diagram

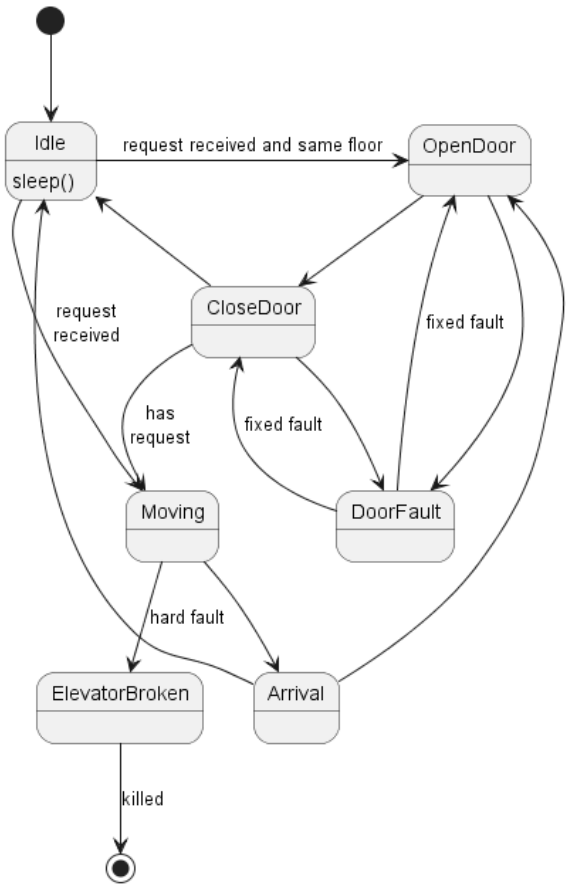


Figure 2: State Machine Diagram for Elevator

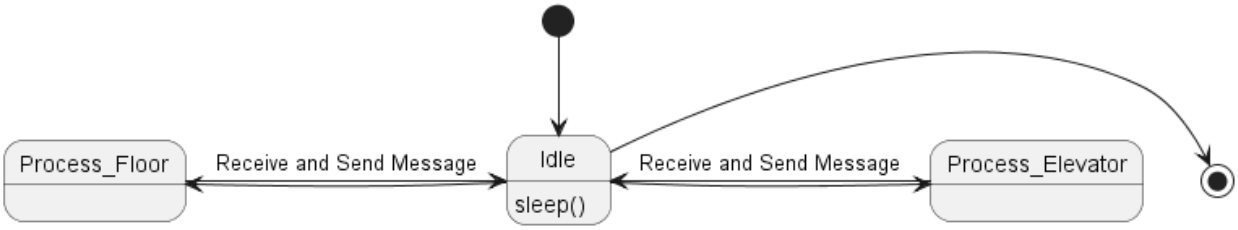


Figure 3: State Machine Diagram for Scheduler

## Sequence Diagram

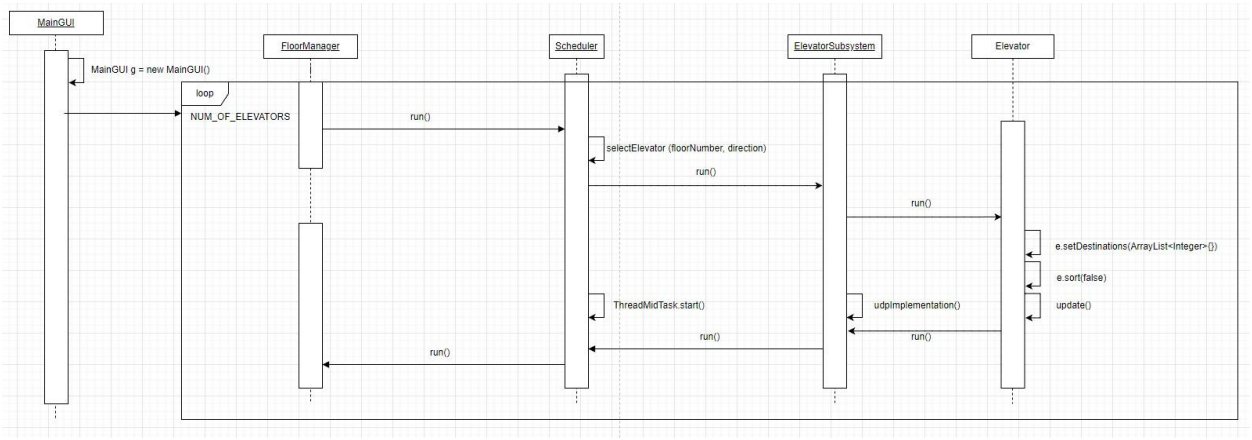


Figure 4: Sequence Diagram for the Elevator Subsystem

## Timing Diagram

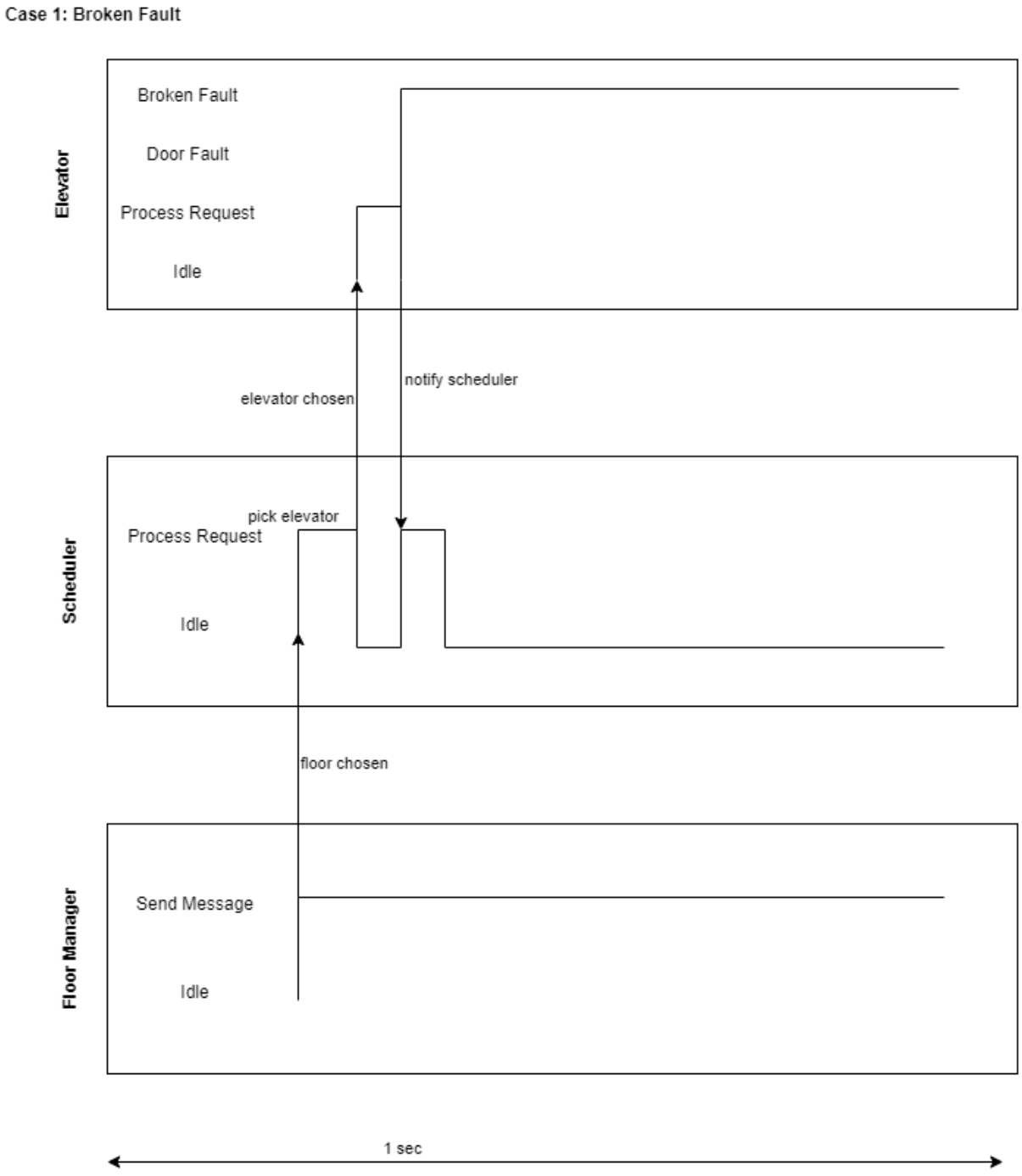


Figure 5: Timing Diagram for Broken Fault

Case 1: Door Fault

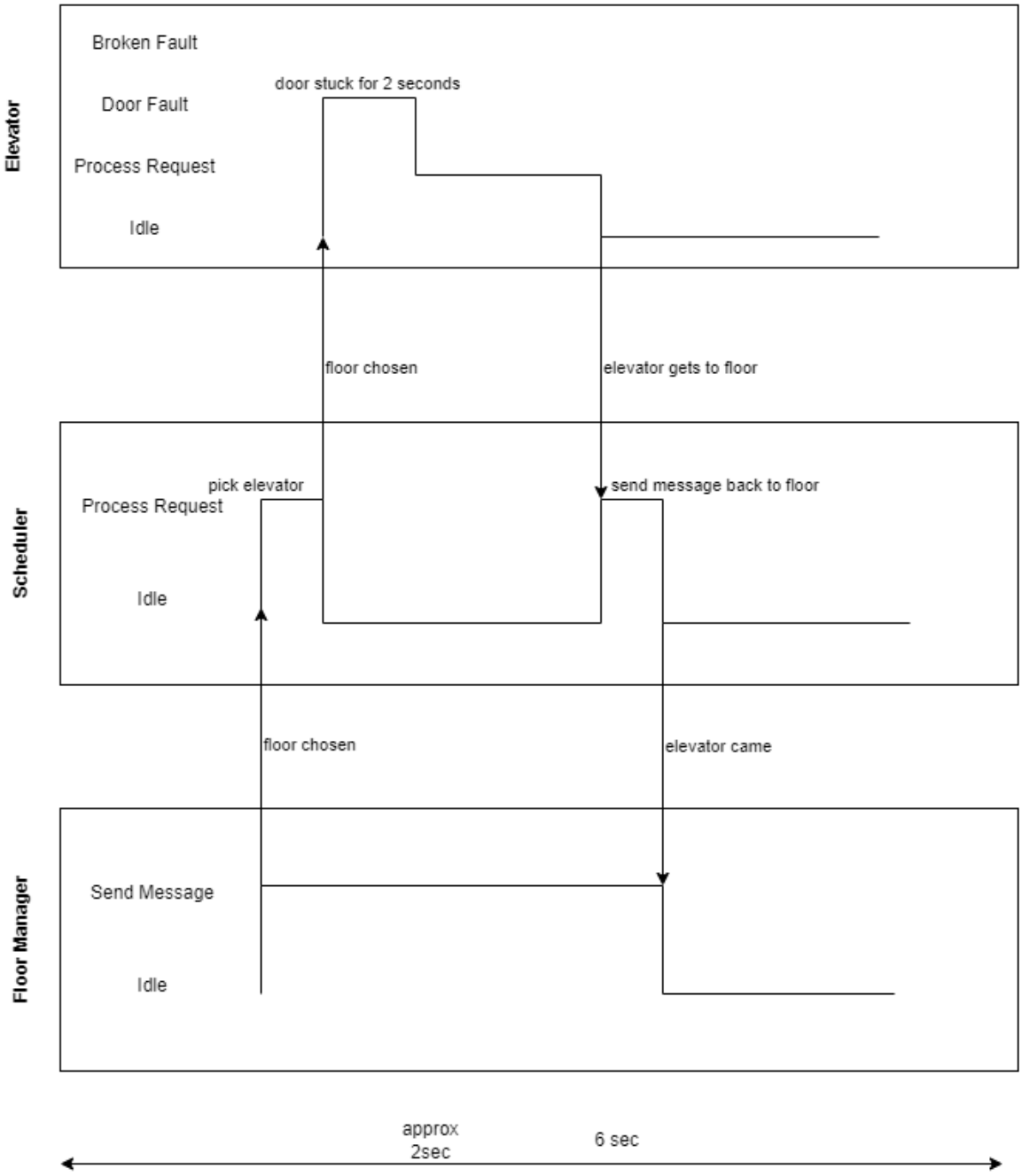


Figure 6: Timing Diagram For Door Fault

## Set Up and Test Instructions

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1. Open Eclipse IDE and import the project by going to *File → Import → Projects from Folder or Archive* and select the submitted archive file.
2. To run the program, the order in which the files are run is important. First open MainGui.java and navigate to the toolbar. Find the green run button and select the down arrow next to it. A dropdown menu will appear, hover over the *Run As* option and select *1 Java Application*. This will launch a window in which the floors, elevators, and elevator statuses can be seen.
3. Next, open Scheduler.java and run it in the same way that MainGui.java was run. This will not produce output.
4. Next, open ElevatorSubSystem.java and run it in the same ways as outlined in the step above.
5. Finally, open FloorManager.java and run it as per the steps above. This will start the elevators in the GUI and the four elevators can be seen progressing through the floors.
6. To run the tests, make sure JUnit is added to the build path. For all of the tests (TestElevator.java, TestElevator.SubSystem.java, TestFloor.java, TestMeasureSystem.java, TestParser.java, TestScheduler.java, and TestFloorManager.java) run each file the same way as the project files were in the previous steps. JUnit will display whether the tests pass or fail.

## Measurement Results

There were four overall things that were measured in the Elevator system, each having three separate measurements for accuracy. We measured the time for the elevator door to open, the time for the elevator door to close, the time to move one floor, and the time to move from the first floor to the 21st floor.

| | **Measurement 1** | **Measurement 2** | **Measurement 3** | **Average** |
|---|---|---|---|---|
| **Elevator Open Door** | 2209 ms | 2212 ms | 2217 ms | 2213 ms |
| **Moving From Floor 1 to 21** | 20160 ms | 20178 ms | 20119 ms | 20152 ms |
| **Moving One Floor** | 1014 ms | 1020 ms | 1006 ms | 1013 ms |
| **Elevator Close Door** | 1205 ms | 1205 ms | 1213 ms | 1208ms |

Table 1: Measurements Taken from the Elevator System

## Design Reflection

After several months of putting crucial hours into this project, it is finally in a fully completed state. There are several things that we, as a group, have learned throughout completing each milestone. We also reflect that, while the majority of the implementation of our project was done well, there are some changes that we could have made to make life easier on ourselves.

Our team has learned a lot from completing this project. Concept-wise, we learned a ton about networking protocols (UDP especially) and how to implement network communication in Java. UDP communication was added in Iteration 3 to coordinate the Scheduler, the Floor Manager, and the Elevator subsystem. The team also learned a substantial amount of information related to implementing states and using the State Pattern. In Iteration 4, we switched to using the State Pattern by using one abstract State class and having all Scheduler and Elevator states extend from that class. This made any new states that needed to be implemented a lot easier and more straightforward. In terms of working as a group, we learned a lot about dividing up work equally, and overall collaboration in general with each other.

We believe that the overall design and implementation of the project requirements was done very well. Our user interface runs very smoothly, allowing the end user to see the elevators respond to events (moving up and down), as well as showing both hard and transient faults with the elevators. We also did a great job of keeping everything (mostly!) decoupled - for example, keeping the Elevator and the Elevator subsystem two separate classes, as well as having a separate class for the Floor Scheduler rather than including its functionality in the Scheduler class.

There are a couple of things that we would have liked to have implemented prior to the submission deadline, but they are mostly minor. Firstly, having a section in the GUI for showing the measurements would have been a nice bonus, but they are mostly for the technical side and only show in the console for testing purposes. Another thing that we could have implemented were states for the Elevator when they are loading passengers and unloading passengers, rather than having one idle state, in order to take measurements of these two events. However, we like our current implementation and this would only have been a minor change to better serve the requirements of the project.

Overall, our team created a project that very much demonstrates the knowledge that we have gained on thread synchronization, network protocols, and state machines. We are very proud of the work that has been accomplished, and hope that this project serves as a learning experience for future courses or the workforce.