Use Case: Elevator System Simulation

Primary Actor(s):

System Administrator
Passenger

Stakeholders:

System Administrator - Wants to manage and observe the system's behaviour.
Passenger - Wants to use the elevator to get to their destination
Building Owner - Wants the elevator to operate properly for the end user's satisfaction

Pre-conditions: The elevator system is fully operational. The simulation is up and running, and ready to be used.

Success Guarantees: The System Administrator can set up the simulation as desired and the simulation runs all requests and displays logs for everything that is happening. Simulation can be paused, continued, or stopped by the system administrator at any point if desired.

Main Success Scenario:

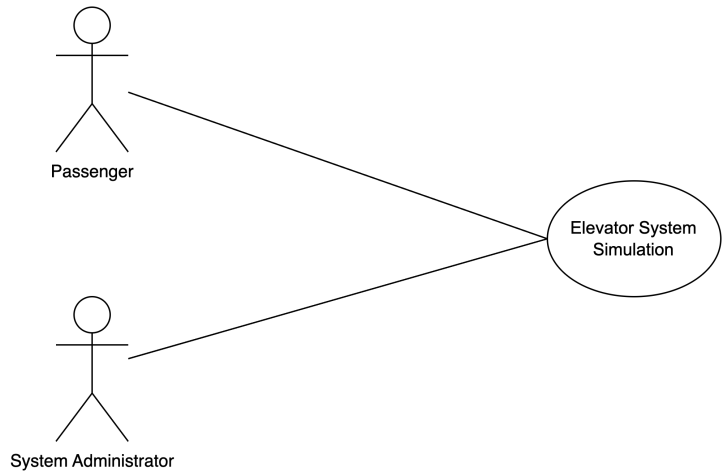
1. The System Administrator sets up the simulation.
    1.1. Set the number of floors, elevators, and passengers.
    1.2. Define passenger behaviours.
    1.3. Define safety events with their time step.
2. The simulation begins
    2.1. As the simulation goes on, processes will be logged and elevators will be monitored
    2.2. The simulation can be stopped, paused, continued, or left running until idle by the administrator
3. Passengers call for an elevator with floor buttons.
    3.1. They press the direction button (Up or Down).
    3.2. The button Illuminates until the elevator arrives.
4. The elevator arrives, the doors open, and the elevator bell rings.
5. Passengers board and deboard the elevator.
6. After 10 seconds the elevator bell will ring and the doors will close.
7. Passengers select their desired floor by pressing the button on the panel.
8. The elevator will move between floors
    8.1. The display panel will show the current floor.

Extensions:

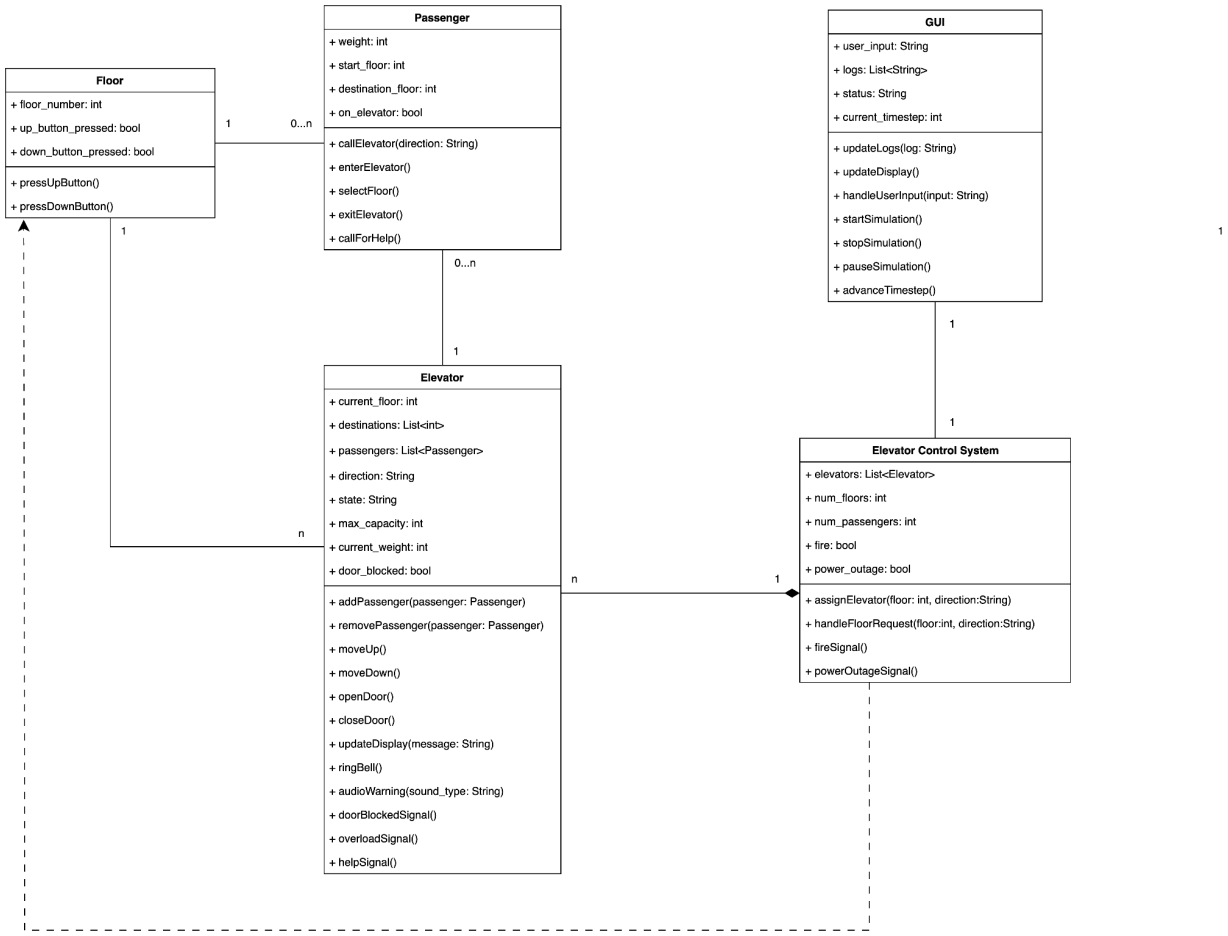
5a. The control system receives an “overload” signal and the elevator does not move.
    5a1. There is a visual and audio warning.
    5a2. The passenger exits the car and waits for the next available car.
6a. The open or close door button is pressed.
    6a1. The doors will stay open longer than 10 seconds or close prematurely.

6b. There is an obstacle preventing the doors from closing.
    6b1. The elevator opens the doors and issues a visual and audio warning if it happens repeatedly.
7a. The “Help” button on the panel is pressed.
    7a1. Connects the passenger to building safety services or if there’s no response from either end within 5 seconds, a call to 911 will be placed.
8a. There is a fire
    8a1. There is a visual and audio warning.
    8a2. The elevator moves to a safe floor and passengers are asked to disembark.
8b. There is a power outage.
    8b1. There is a visual and audio warning.
    8b2. Passengers are informed of the power outage and the elevator is moved to a safe floor. Passengers are asked to disembark.

Use Case Diagram:

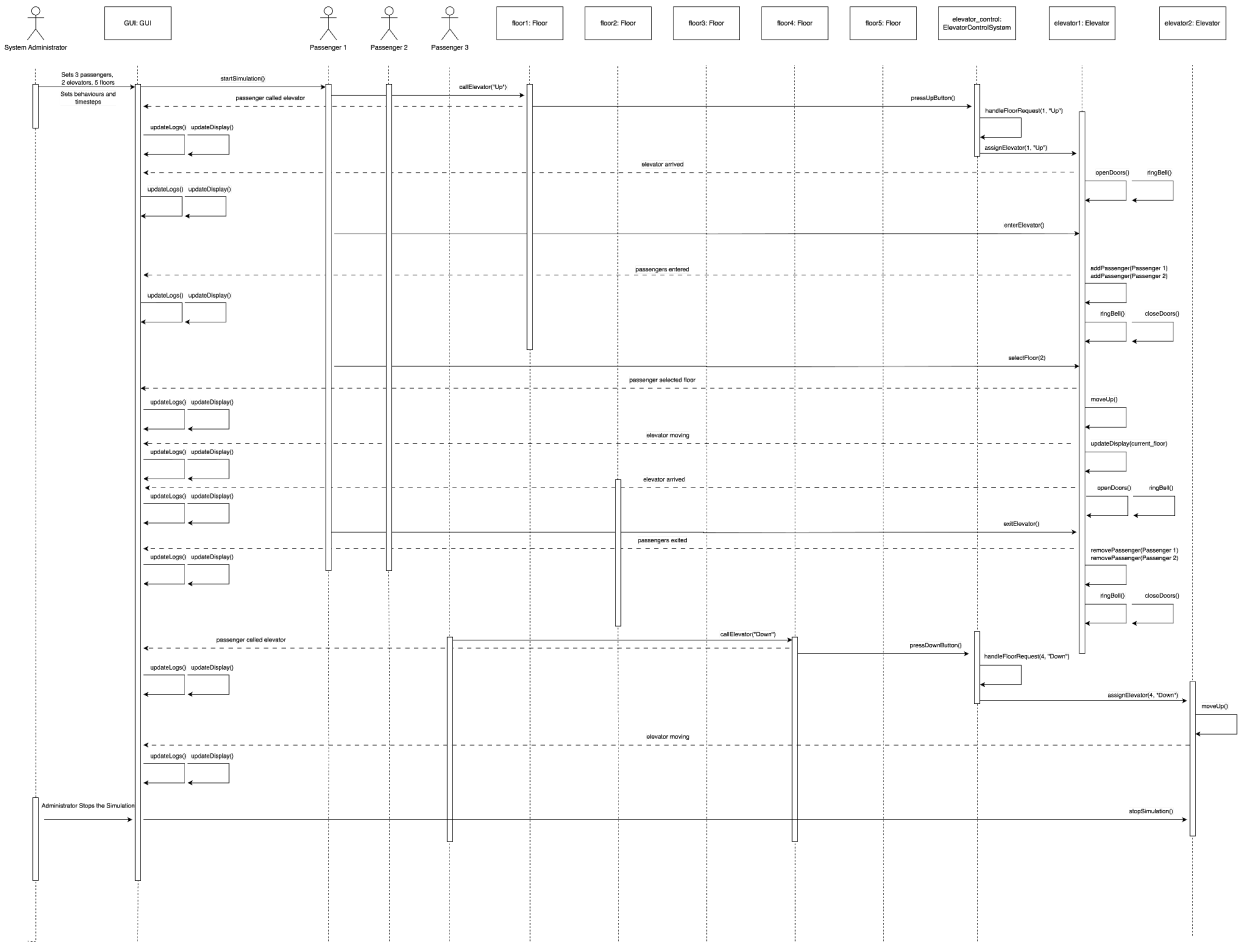


UML Class Diagram:



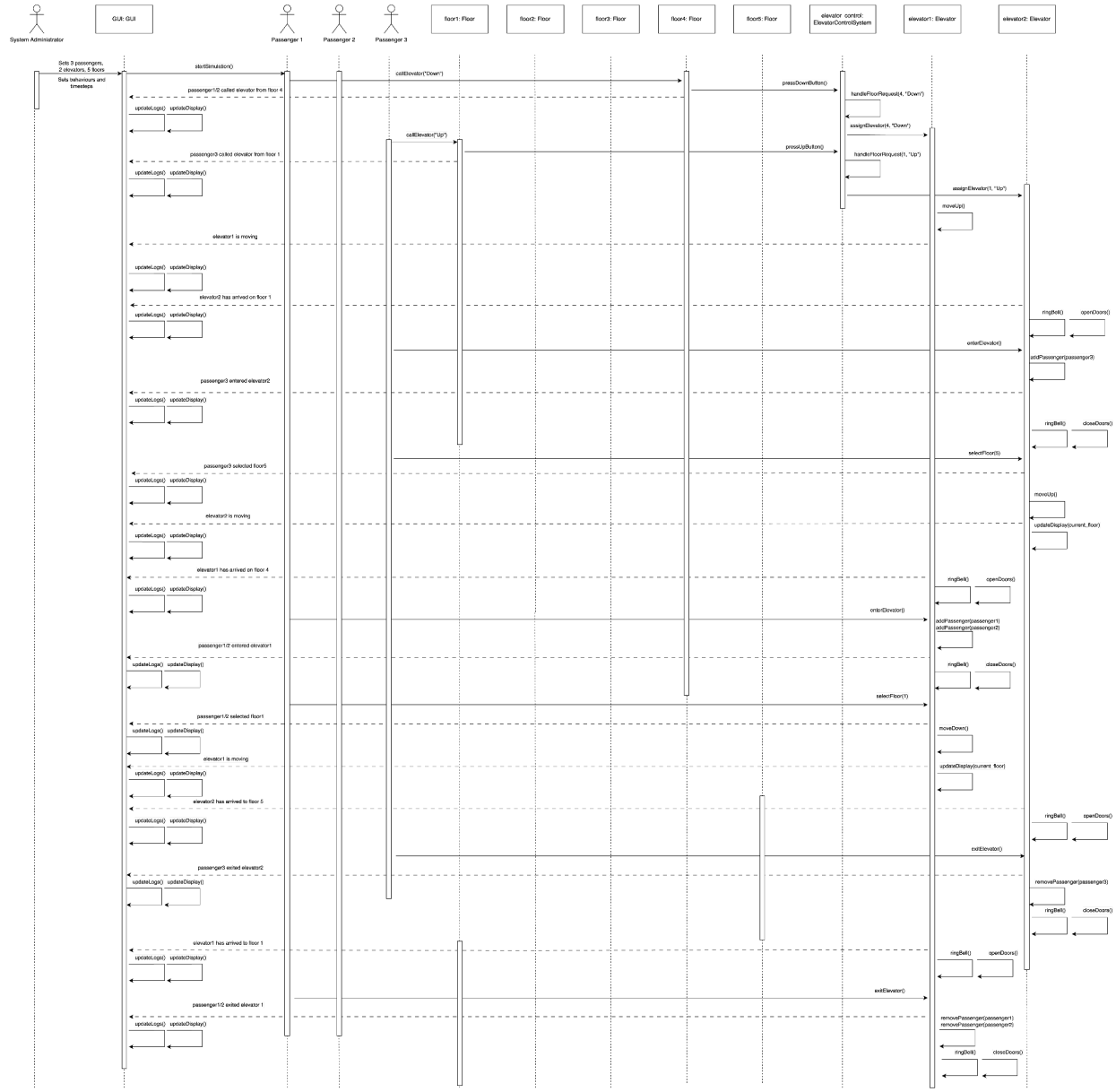
UML Sequence Diagram Sucess Scenario 1:

In this scenario, there are two passengers wanting to get from floor 1 to 2 and another passenger who wants to get from floor 4 to floor 2. These events happen one after another. After the third passenger requests the elevator, the system administrator stops the simulation. This is an example of a success scenario, you can see which methods are invoked and how the system works behind the scenes to cover the requirements.



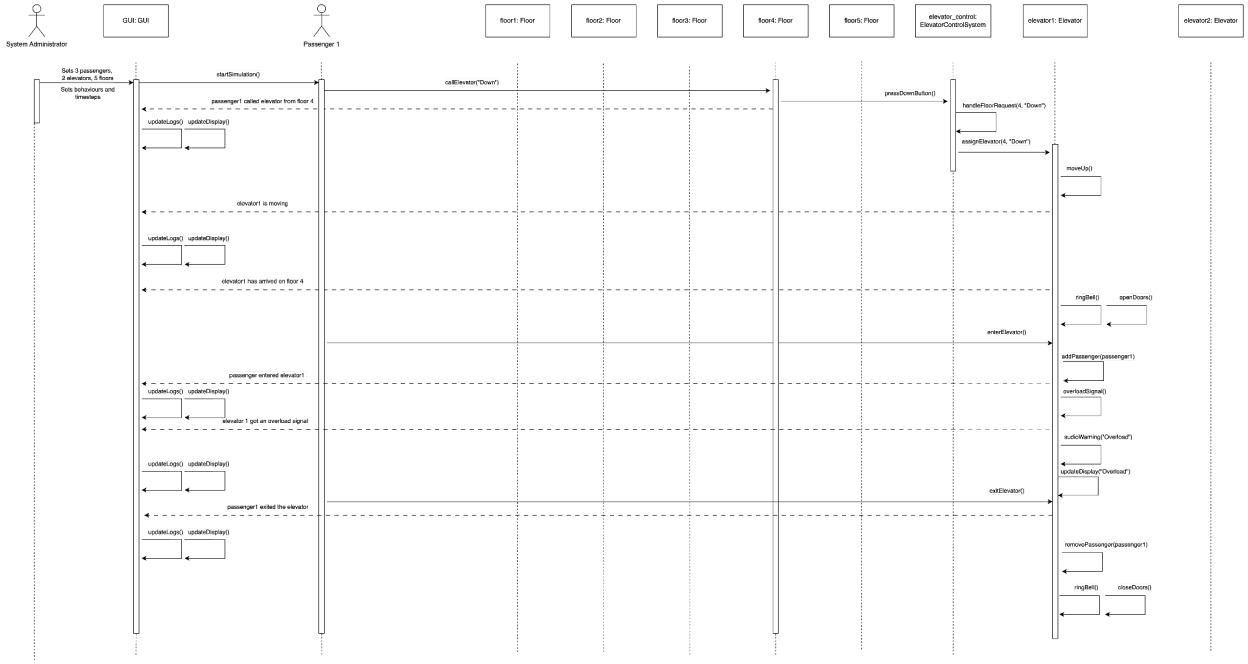
UML Sequence Diagram Sucess Scenario 2:

In this scenario, two passengers want to get from floor 4 to 1 and another passenger wants to get from floor 1 to floor 5. These events happen approximately at the same time. You can see how the ECS dispatches the two elevators to the different passengers since they're going in different directions and you can see how the events happen side by side. This is an example of a success scenario.



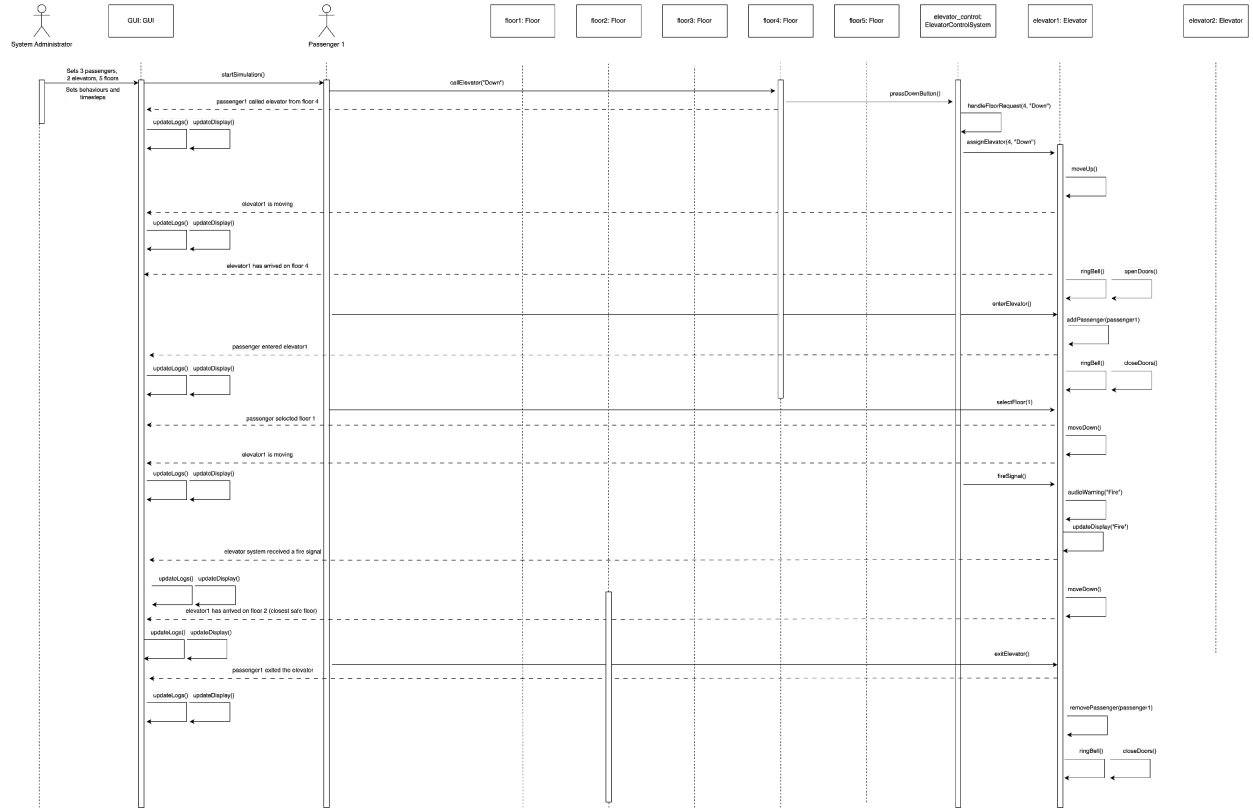
UML Sequence Diagram Safety Scenario 1:

In this scenario, there is one passenger who is trying to get from floor 4 to floor 2. However, after they request the elevator and it arrives and they enter, the elevator gets an overload signal and displays a visual and audio warning. The passenger then gets out and the issue is solved. This is an example of a safety scenario.



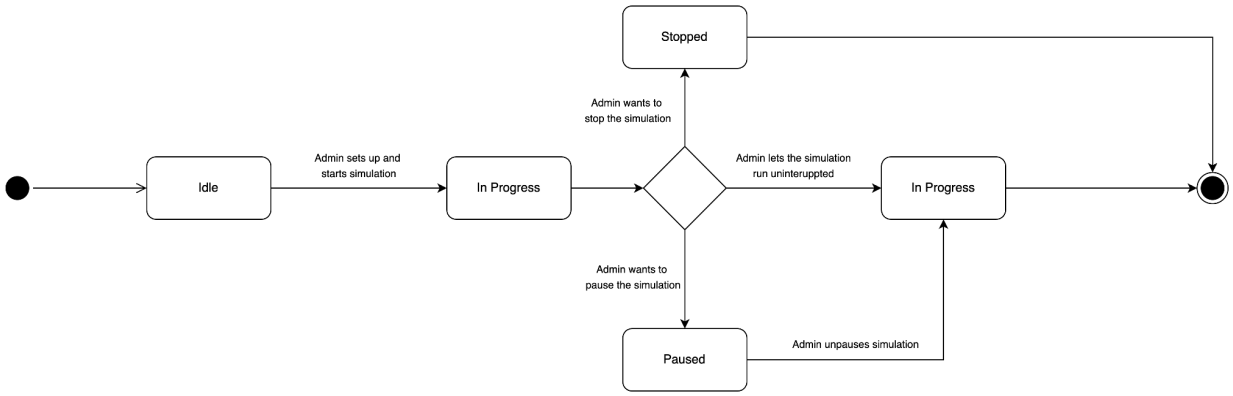
UML Sequence Diagram Safety Scenario 2:

In this scenario, there is one passenger who is trying to get from floor 4 to floor 1. However, after they request the elevator, it arrives, they enter, and it starts moving, the elevator gets a fire signal and displays a visual and audio warning. It then moves to the nearest, safest floor, in this case, floor 2 and the passenger disembarks. This is an example of a safety scenario.



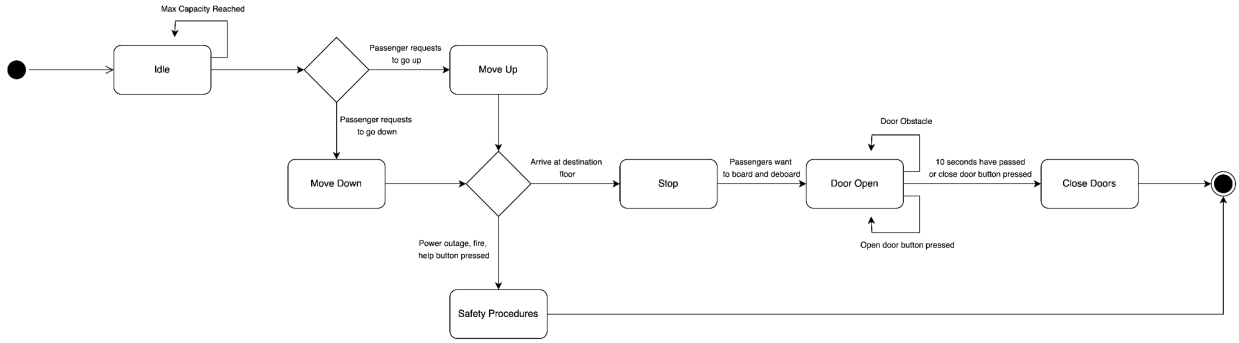
UML State Machine Diagram for Controller:

This state machine diagram shows the transitions of states in my elevator simulation for the system admin. In this case, it starts idle until the system admin sets up the simulation, then it begins running at which point the admin can pause and unpause it, they can completely stop it, or they can let it run until it is idle again.

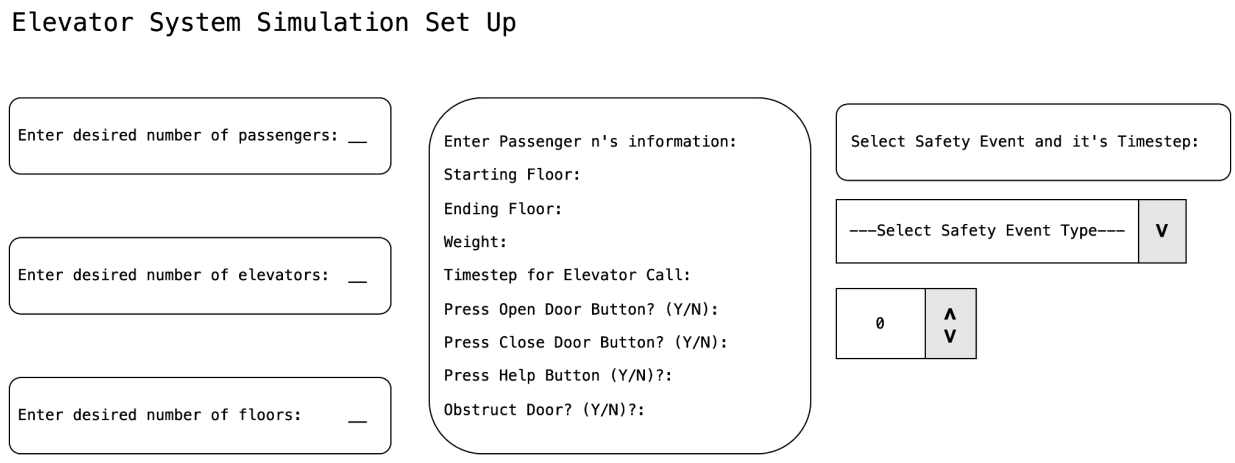


UML State Machine Diagram for Elevator:

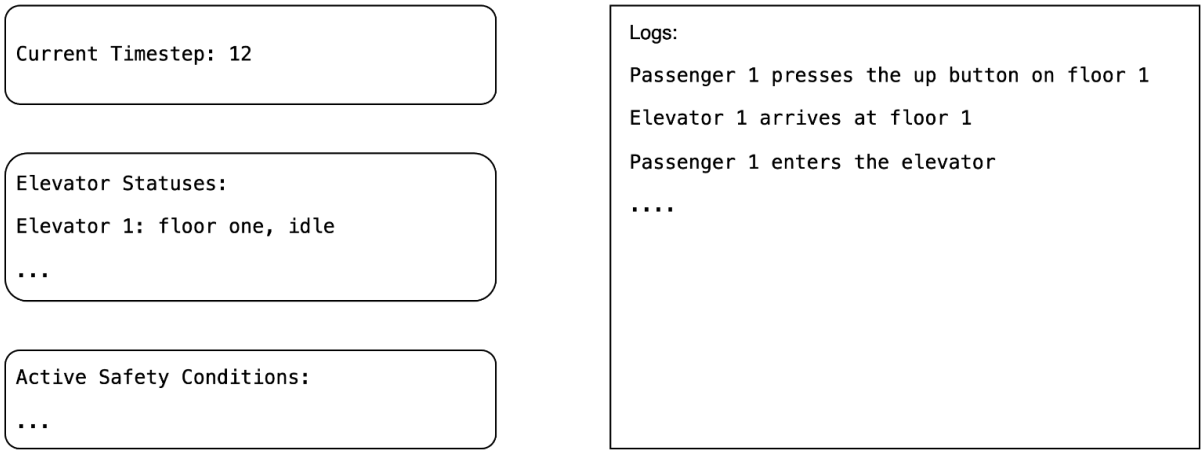
The state machine diagram shows the transitions of states in my elevator simulation for the elevator. In this case, it starts idle until the passenger selects which direction they would like to go, then it begins moving but it would go either up or down depending on the passenger input. While it's moving, it will either move to its destination, or there will be a safety condition which stops the process. If there is a safety condition, the safety procedures will be executed. If there are no issues, then the elevator will eventually stop at the destination and open its doors. The doors will stay open if there is an obstacle or if someone is pressing the open door button. After this, the doors will close and the elevator will be idle again.



Sketch of GUI:



Elevator System Simulation:



Design Discussion:

When designing the elevator system simulator I tried to keep two things in mind, modularity and scalability. Especially because we wouldn't know exactly how many passengers, elevators, or floors there would be, since the admin decides those. I wanted to make sure not to overcomplicate things as there is a big set of functionalities and requirements. That's why, for example, during the design process, I decided to treat the Elevator Control System and the GUI as what controls the simulation. This is because the Elevator Control System already does the things that a simulation would do and the GUI just handles input and displays what is happening.

See respective sections for other design discussions.

Traceability Matrix:

ID	Requirement	Related Use Case	Fulfilled By
1	The administrator must be able to select number of floors, elevators, and passengers in the building	Elevator System Simulation Step 1 substep 1.1	GUI
2	The administrator must be able to set the passenger's behaviour	Elevator System Simulation Step 1 substep 1.2	GUI
3	The administrator must be able to set safety events and their timesteps	Elevator System Simulation Step 1 substep 1.3	GUI

4	During the simulation, the log console displays the passenger actions and system responses.	Elevator System Simulation Step 2 substep 2.1	GUI
5	The administrator can pause, continue, and stop the simulation, as well as let it run until all the events are handled and all elevators are idle.	Elevator System Simulation Step 2 substep 2.2	GUI
6	As the simulation runs, the current time step is displayed	Elevator System Simulation Step 2 substep 2.1	GUI
7	As the simulation runs, the location of each elevator in the building and its state (moving or idle) will be displayed	Elevator System Simulation Step 2 substep 2.1	GUI
8	As the simulation runs, active safety conditions will be displayed	Elevator System Simulation Step 2 substep 2.1	GUI
9	On each of the floors is a pair of buttons marked “up” and “down.	Elevator System Simulation Step 3 substep 3.1	Floor
10	When the elevator arrives, it rings a bell and opens its doors for a fixed time (10 seconds) allowing people to exit or board, rings the bell again, closes its doors.	Elevator System Simulation Step 4,5,6	Elevator, Passenger
11	Once onboard passengers select one or more destination floors using a panel of buttons.	Elevator System Simulation Step 7	Elevator, Passenger
12	The elevator has a display which shows passengers the current floor of the elevator	Elevator System Simulation Step 8, substep 8.1	Elevator
13	There is also a pair of buttons on the elevator control panel marked “open door” and “close door”. These buttons can be used by a passenger to override the default timing of the doors.	Elevator System Simulation Extensions 6a	Elevator
14	Each elevator has a display and an audio system.	Elevator System Simulation Step 8, in multiple extensions ex. 5a	Elevator

15	“Help” alarm signal connects you to safety services	Elevator System Simulation Extension 7a	Elevator, Passenger
16	Door obstacles will not allow doors to close. If it repeatedly happens a warning will go off.	Elevator System Simulation Extension 6b	Elevator
17	Fire will make elevators move to nearest safe floor and generate warnings.	Elevator System Simulation Extension 8a	Elevator Control System, Elevator
18	Power Outage will make elevators move to nearest safe floor and generate warnings.	Elevator System Simulation Extension 8b	Elevator Control System, Elevator
19	Overload will not allow the elevator to move until load is reduced. Warnings are displayed.	Elevator System Simulation Extension 5a	Elevator