Assignment 3: Elevator System Controller in Qt C++
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With Assignment 2 you have delivered your first version of design to Raven Elevators Inc. (REI) and the company is confident that you can implement a high quality elevator control system in Qt C++. REI asks you to proceed with the implementation and testing. Understanding that design is typically fine-tuned during implementation, REI also asked you to update the documentation. You will be delivering use cases, design documentation, source code, tests and traceability matrix.

Learning objectives:

- Exploring Qt architecture and functionality
- Implementing an elevator system controller using Qt C++ and updating your design as needed
- Implementing variability in elevator allocation strategy
- Building a requirements traceability matrix

Deliverables:

- Use cases (can borrow from A1 & grading feedback)
- Design documentation – structure and behavior – updated as needed (can borrow from A2 & grading feedback)
    - UML Class diagram
    - Sequence diagrams for these scenarios: 2 scenarios for the basic use cases for 2 of the strategies and 5 safety features scenarios (total of 7 sequence diagrams)
    - Activity or state diagram
    - Textual explanation of your design decisions
- Implementation
    - Source code of your Qt C++ project
    - Tests based on scenarios specified in design
    - Your implementation should have 1) a GUI that drives the program and 2) console output to display events such as floor button presses, elevator arrives, door opens, etc.
- Traceability matrix (can borrow from A2 & grading feedback)
    - Update the traceability matrix from A2 to include "implemented-by" and "tested-by" columns

Use CASE: Using an Elevator

       <u>Primary Actor</u>: Passenger

       <u>Scope</u>: The building

       <u>Level</u>: Summary

       <u>Stakeholders and Interests</u>:

Passenger – wants to move to destinated floor

Building Safety – helps in case of emergency

911 – helps in case building safety does not respond

<u>Precondition</u>: elevator working

<u>Minimal guarantees</u>:

<u>Success guarantees</u>: passengers move to destinated floor safely

<u>Trigger</u>: passenger takes the elevator

<u>Main success scenario</u>:

1. Elevator button gets pressed
2. Elevator arrives and passengers board
3. Passengers select destination floor(s)
4. Display shows the current floor, and the light is illuminated for destination floors
5. Doors close
6. Elevator takes off
7. Elevator arrives and notifies at the destinated floor, rings the bell

<u>Extensions</u>:

2a. Passengers overload

       2a1. An audio and text messages are presented to passengers asking for the load to be reduced before attempting to move again

       2a2. Elevator load needs to be reduced

3a. Fire alarm goes off

       3a1. An audio and text message are presented to passengersinforming them of an emergency and asking them to disembark once the safe floor is reached

       3a2. Elevator moves to safe floor

3b. Power goes out

       3b1. Audio and text messages are presented to passengers informing them of the power outage

       3b2. Elevator moves to safe floor

4a. Doors do not close

       4a1. Light sensor sees that an obstacle in the way

       4a2. Doors reopen to clear obstacle

5a. Open door is pressed

       5a1. Door reopens
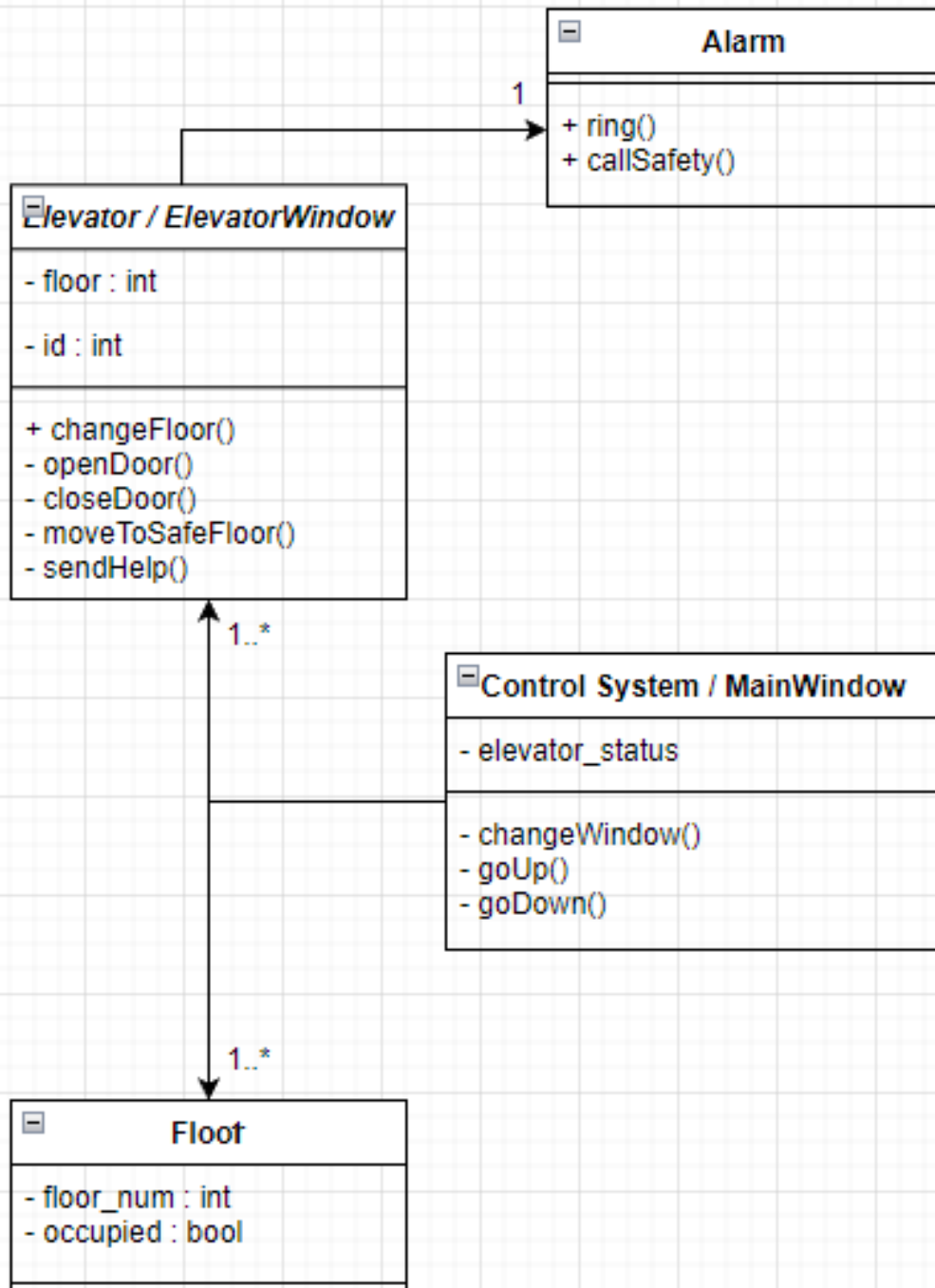
5b. Elevator does not take off

       5b1. Audio warning plays
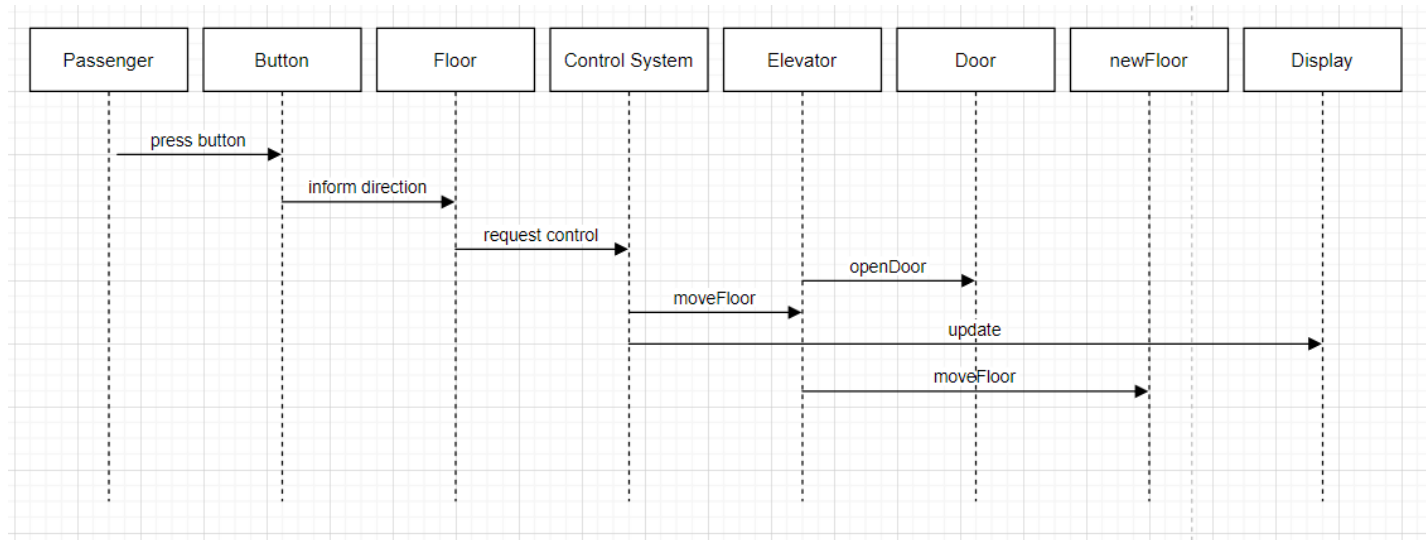
       5b2. Help button is pressed

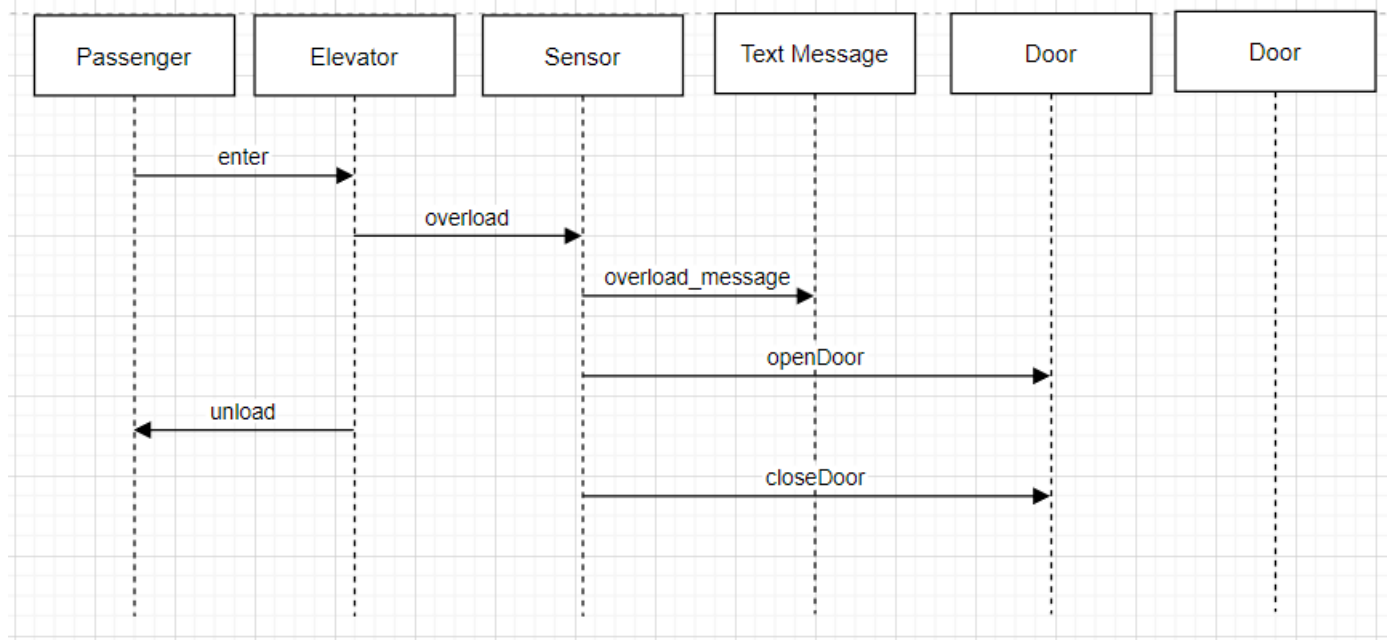   5b3. Building safety response?

       5b4. 911 call

UML Diagram

Alarm

+ ring()
+ callSafety()

1

Elevator / ElevatorWindow

- floor : int

- id : int

+ changeFloor()
- openDoor()
- closeDoor()
- moveToSafeFloor()
- sendHelp()

1..*

Control System / MainWindow

- elevator_status

- changeWindow()
- goUp()
- goDown()

1..*

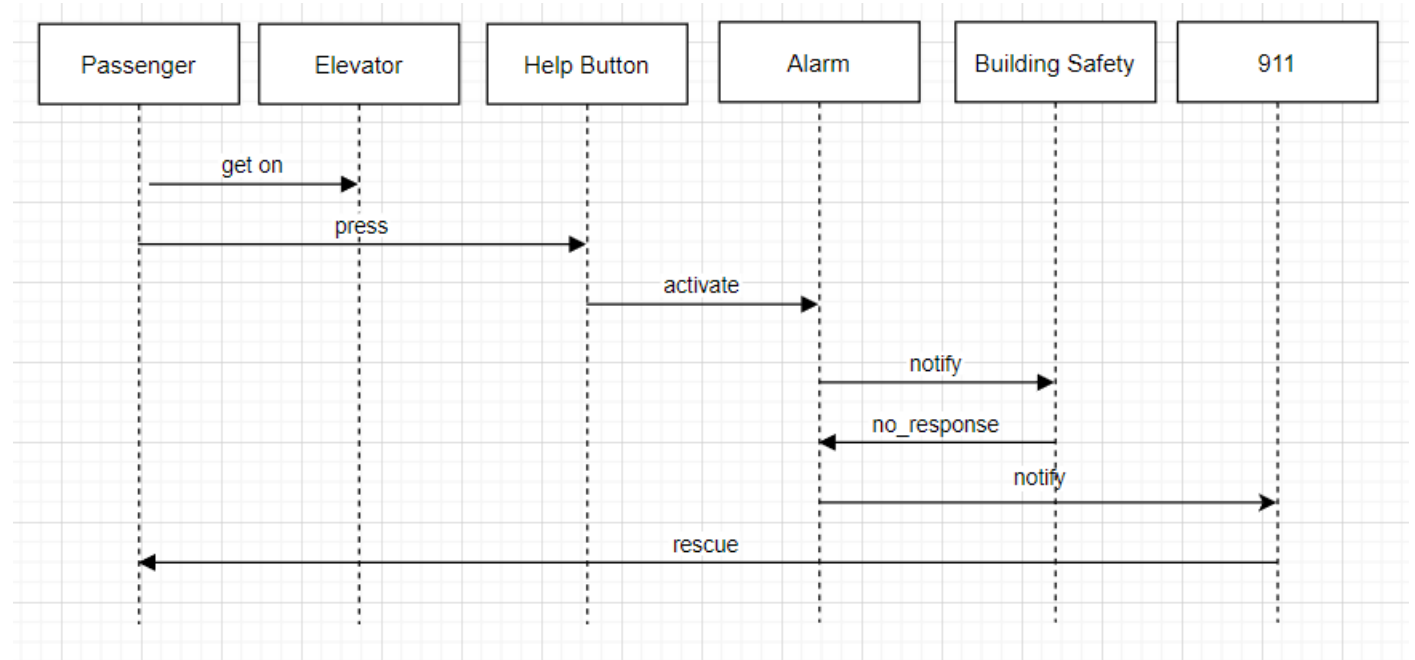## Floot

- floor_num : int
- occupied : bool

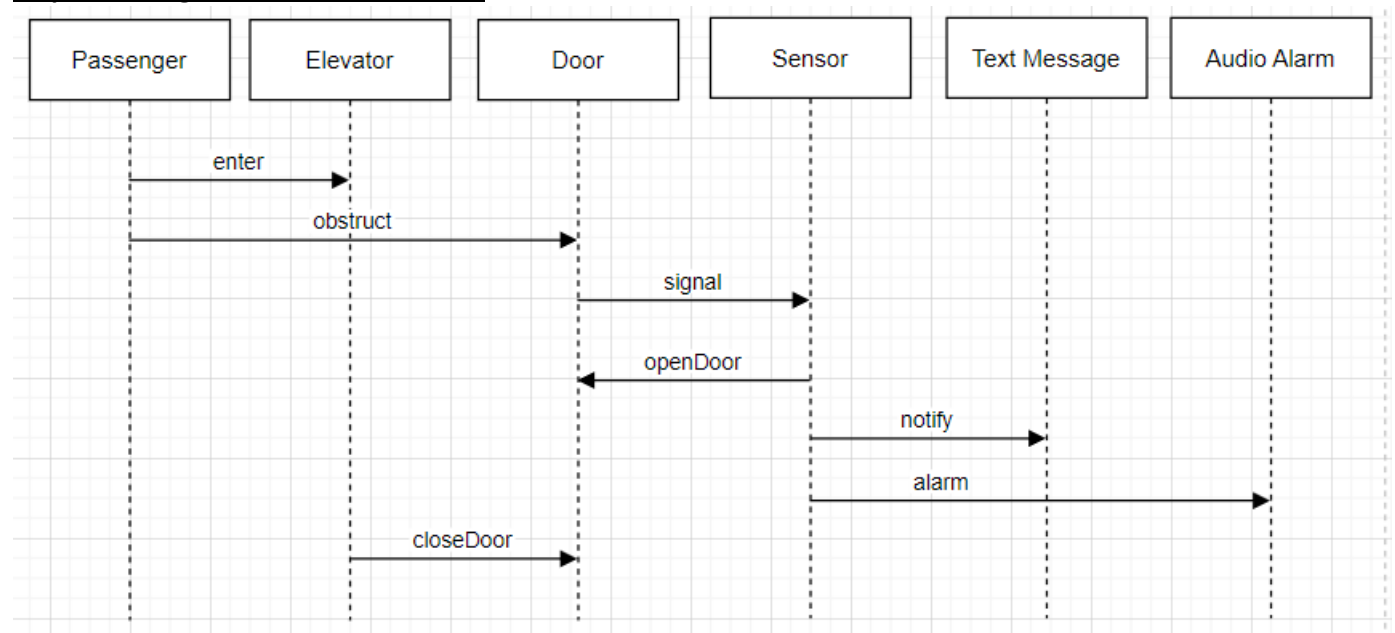## Sequence Diagram: Basic use case

Sequence Diagram: Overload case
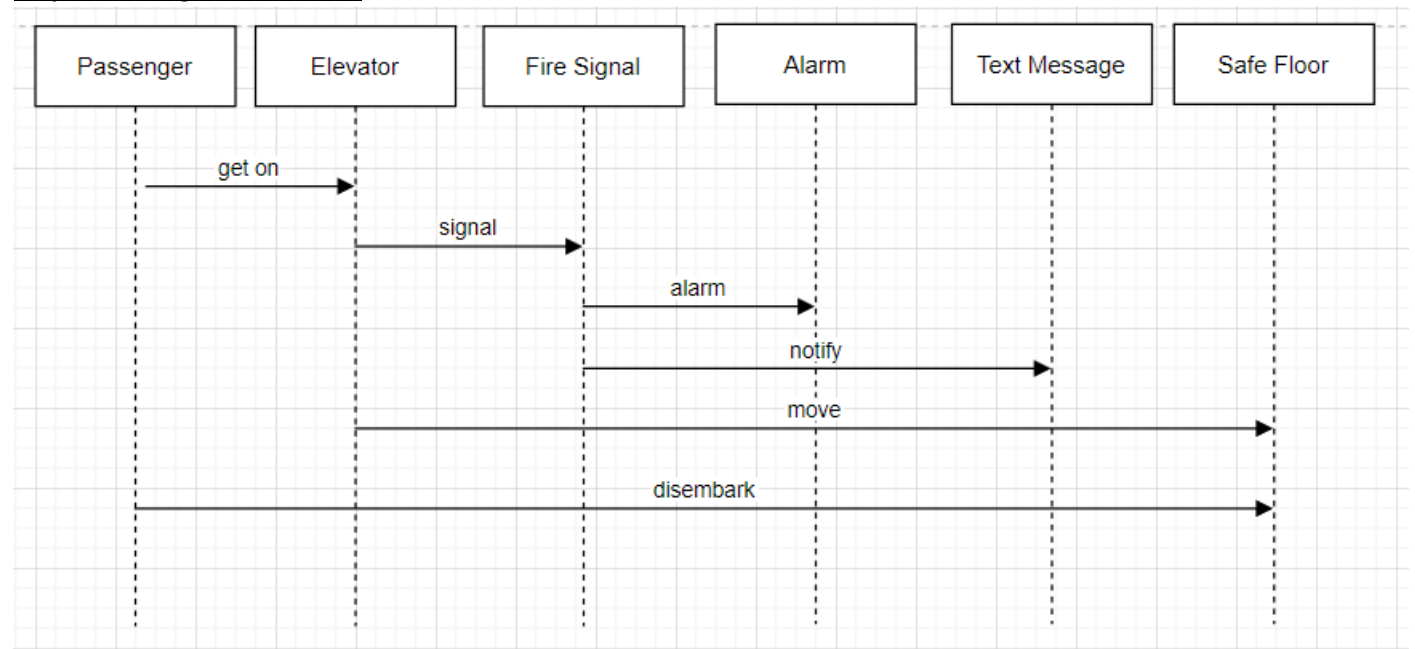
Sequence Diagram: Help button case

Sequence Diagram: Door obstruct case

Sequence Diagram: Fire case

Passenger	Elevator	Fire Signal	Alarm	Text Message	Safe Floor

get on →

signal →

alarm →

notify →

move →

disembark →

Sequence Diagram: Power outage case

Passenger	Elevator	Power Outage	Audio Alarm	Text Message	Safe Floor

get on →

signal →

alarm →

notify →

move →

disembark →
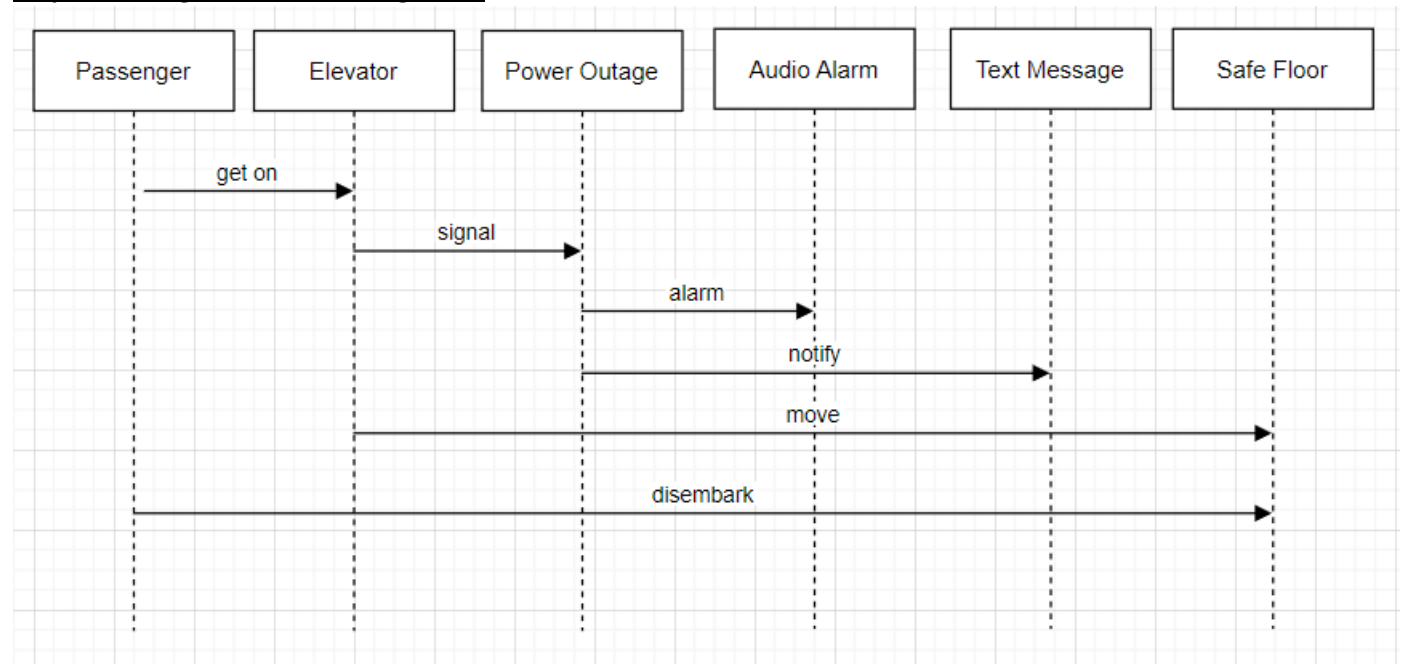
Activity Diagram
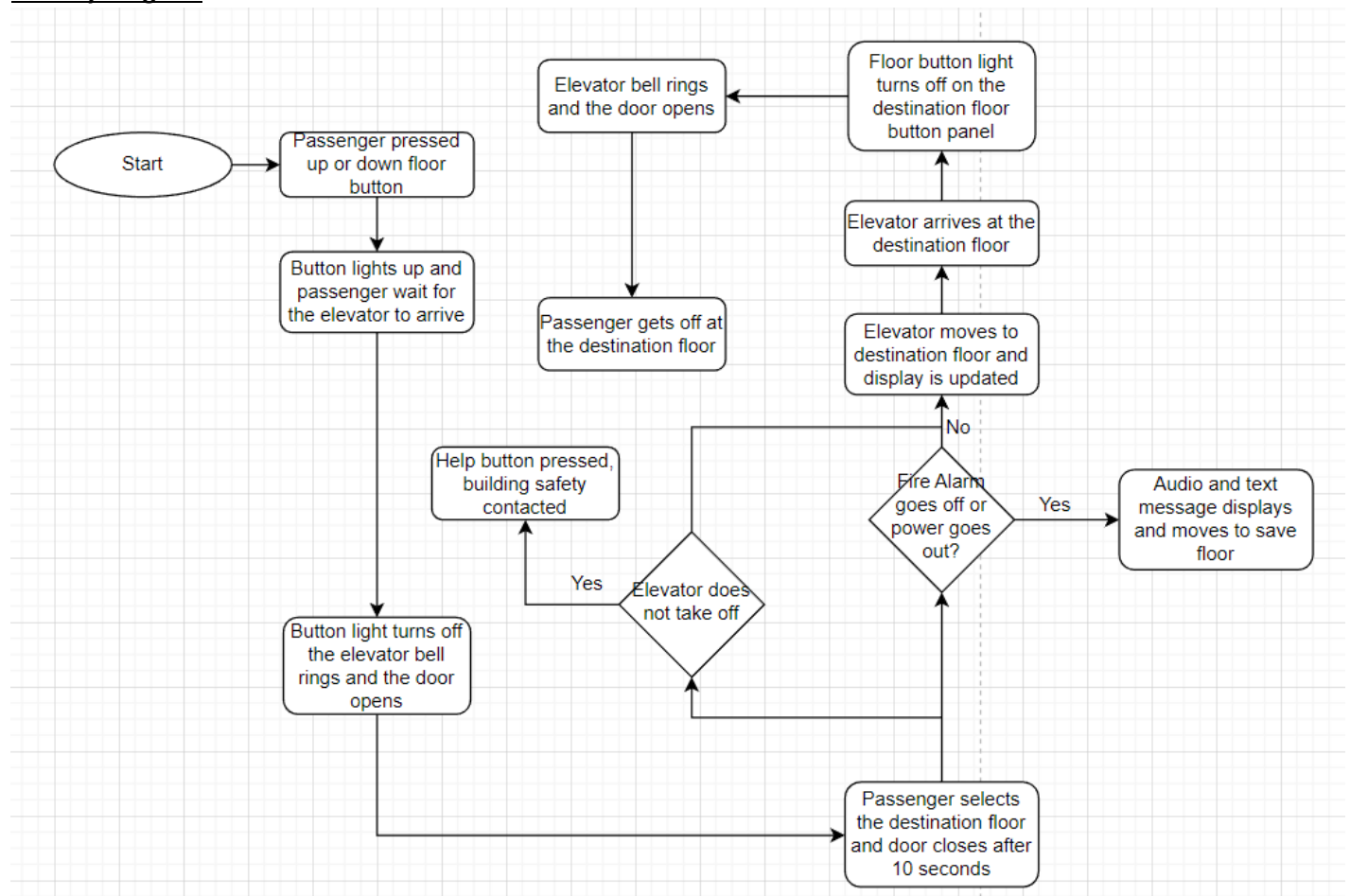
Textual explanation of your design decisions including use of design patterns, if any.
Went with the mediator design pattern. The pattern does not allow direct communication between objects but inside the communication is passed through a mediator object which in this case is the elevator control system. I'm going to be using the elevator control system to control how each object is going to interact with each other.

Traceability Matrix

ID	Requirement	Related Use Case	Fulfilled By	Test	Description
1	When a button is pressed it illuminates, and remains illuminated, until an elevator arrives to transport the customers who, at this floor, have requested an elevator going in a certain direction. When the elevator arrives, it rings a bell, opens its doors (the elevator and floor doors) for a fixed time (10 seconds) allowing people to exit or board, rings the bell again, closes its doors and proceeds to another floor. Once on-board passengers select one or more destination floors using a panel of buttons; there is one button for every floor. The elevator has a displaywhich shows passengers the current floor of the elevator. 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. The door will remain open beyond its default period if the "open door" button is held depressed; the doors can be closed prematurely by pressing the "door close"button. Inside the elevator there is also a help button linked to building safety service.	**Using an Elevator**	ECS, Passenger, Door, Elevator, Display, Buttons, Floors	Basic use	Basic use case of the elevator.
2	Each elevator has a sensor that notifies it when it arrives at a floor. The elevator controlsystem should ensure that the group of elevators services all (floor and on-board) requests expeditiously.	**Using an Elevator**	ECS, Elevator, Floor	Basic use	Basic control system for the elevator.
3	Each elevator has a display and an audio system. The display shows the current floornumber and warning messages that are synced with audio warnings.	**Using an Elevator**	Display, Bell, Floor, ECS	Basic use	Basic interface and display system for the elevator
4	Help: The control system receives a "Help" alarm signal from an elevator indicating that the "Help" button has been pressed. In that case, the passenger is connected to building safety service through a voice connection. If there is no response from building safety within 5 seconds or if there is no response from a passenger a 911 emergency call is placed.	**Using an Elevator**	Display, Bell, Buttons, Safety	Help button	Help button contacts the building safety and if no response then contact 911
5	Door obstacles: If the light sensor is interrupted when the door is closing, the control system stops the door from closing and opens it. If this occurs repeatedly over a short period of time, awarning is sounded over the audio system and a text message is displayed.	**Using an Elevator**	Door, Sensor, Display, Bell	Door obstacles	If something or someone is blocking the obstacle it will not close.

6	Fire: The control system receives a "Fire" alarm signal from the building and commands all elevators to move to a safe floor. Similarly, a "Fire" alarm signal from the elevator itself will cause that elevator to go to a safe floor. In both cases an audio and text message are presented to passengersinforming them of an emergency and asking them to disembark once the safe floor is reached.	**Using an Elevator**	Bell, Elevator, Floor, Display	Fire	If fire is to occur it will move to safe floor.
7	Overload: The control system receives an "Overload" alarm signal from an elevator if thesensors indicate that the passenger or cargo load exceeds the carrying capacity. In that case, the elevator does not move and an audio and a text messages are presented to passengers asking for the load to be reduced before attempting to move again.	**Using an Elevator**	Elevator, Sensor, ECS, Passenger	Passenger overload	If Passengers overload then it will ask to reduce load.
8	Power out: The control system receives a "Power Out" alarm signal. In that case, anaudio and a text messages are presented to passengers informing them of the power outage. Each elevator is then moved to a safe floor and passengers are asked to disembark via audio and text messages. The battery backup power is sufficient to do all of this.	**Using an Elevator**	Display, Passenger, Floor, Elevator	Power out	If power goes out then moves to safe floor.

Elevator system specification (same as Assignment 1)

<Paragraph 1> A building is serviced by a group of M elevators (also called cars). On each of the N floors is a pair of buttons marked "up" and "down". When a button is pressed it illuminates, and remains illuminated, until an elevator arrives to transport the customers who, at this floor, have requested an elevator going in a certain direction. When the elevator arrives, it rings a bell, opens its doors (the elevator and floor doors) for a fixed time (10 seconds) allowing people to exit or board, rings the bell again, closes its doors and proceeds to another floor. Once on-board passengers select one or more destination floors using a panel of buttons; there is one button for every floor. The elevator has a display which shows passengers the current floor of the elevator. 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. The door will remain open beyond its default period if the "open door" button is held depressed; the doors can be closed prematurely by pressing the "door close" button. Inside the elevator there is also a help button linked to building safety service.

<Paragraph 2> Each elevator has a sensor that notifies it when it arrives at a floor. The elevator control system should ensure that the group of elevators services all (floor and on-board) requests expeditiously.

<Paragraph 3> Each elevator has a display and an audio system. The display shows the current floor number and warning messages that are synced with audio warnings.

Safety features:

<Paragraph 4> Help: The control system receives a "Help" alarm signal from an elevator indicating that the "Help" button has been pressed. In that case, the passenger is connected to building safety service through a voice connection. If there is no response from building safety within 5 seconds or if there is no response from a passenger a 911 emergency call is placed.

<Paragraph 5> Door obstacles: If the light sensor is interrupted when the door is closing, the control system stops the door from closing and opens it. If this occurs repeatedly over a short period of time, a warning is sounded over the audio system and a text message is displayed.

<Paragraph 6> Fire: The control system receives a "Fire" alarm signal from the building and commands all elevators to move to a safe floor. Similarly, a "Fire" alarm signal from the elevator itself will cause that elevator to go to a safe floor. In both cases an audio and text message are presented to passengers informing them of an emergency and asking them to disembark once the safe floor is reached.

<Paragraph 7> Overload: The control system receives an "Overload" alarm signal from an elevator if the sensors indicate that the passenger or cargo load exceeds the carrying capacity. In that case, the elevator does not move and an audio and a text messages are presented to passengers asking for the load to be reduced before attempting to move again.

<Paragraph 8 > Power out: The control system receives a "Power Out" alarm signal. In that case, an audio and a text messages are presented to passengers informing them of the power outage. Each elevator is then moved to a safe floor and passengers are asked to disembark via audio and text messages. The battery backup power is sufficient to do all of this.