Faculté des Sciences et Techniques

System Modelling

Smart building System

Authors: Chimezirim Victor EKEMAM CPS2
Arun Raveendran Nair Sheela CPS2
Ignas BARAKAUSKAS CPS2
Abdiwahab RABILEH CPS2
Sara Assefa ALEMAYEHU CPS2
Emmanuel Hinnougnon Hodonou CPS2
Randika Wishwani Rathwaththa RATHWATHTHAGE CPS2
Hanane CHRIF-El-ASRI ICM

Lecturer: Maxime LEFRANCOIS

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SMART BUILDING SOFTWARE DESIGN DESCRIPTION DOCUMENT

Version 1.0

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Revision History

Version No	Release Date	Author(s)	Approver	Remarks
1	21/10/2021	Chimezirim Victor EKEMAM Arun Raveendran Nair Sheela Ignas BARAKAUSKAS Abdiwahab RABILEH Sara Assefa ALEMAYEHU Emmanuel Hinnougnon HODONOU Randika RATHWATHTHAGE Hanane CHRIF-El-ASRI		

Introduction

PURPOSE

The purpose of this document is to present in detail the description of a Smart building project. The mode of operations of the smart building, its functional and non-functional requirements, dependencies, expectations and constraints are described in this document.

This document is to be used by the developers of the system as well as the stakeholders of the project and will be presented to the Board of Directors for approval.

SCOPE

This document details the workings of a smart building in general. The system is designed to make for an autonomous and optimal regulation of temperature and ventilation in rooms of a public building, considering room occupants preferences. The system is built with efficient energy consumption and user comfort in mind.

The Smart Building incorporates a window opener device, a user feedback device and a room management system. These devices enable the tracking of room status, configuring user preferences and a centralised management of multiple rooms.

PERSPECTIVE

The management of users' health (with respect to the COVID-19 pandemic and pollution), comfort and energy consumption necessitates the management of windows and heaters in a public building. It is important the rooms are well ventilated to curb the rate of spread of the virus while not neglecting comfort preferences of the occupants of rooms. The smart building aims at effectively and efficiently managing all these requirements without conflicts.

FUNCTIONS

With the window opener device, user feedback device and a room management system setup, the building thus has the following capabilities:
- Automatic opening and closing of windows
- Display of room information on a screen for occupants
- Setting of user preferences on via feedback device
- Autonomous toggling of heater status (ON and OFF)
- Forecast of room conditions and temperature based on room conditions history and forecast service.

Further details on these capabilities will be found in subsequent sections

USER CLASSES AND CHARACTERISTICS

Super Admin: This is an overall management user of the system. The super admin has full access rights to the system and has the ability to profile regular admins on the system.

Admins: These are managers of the system with lesser access rights in comparison with the super admin. An admin is involved in the day to day management of the system like tracking of room information, device configurations.

Regular users: These are the occupants of the rooms. They are the main focus of the system. They have the ability to set preferred comfort temperatures in the rooms by the use of the feedback devices.

ASSUMPTIONS AND DEPENDENCIES

The user feedback devices should be able to sense whether or not the rooms are occupied, the co2 levels as well as the room temperatures. They should have timers for periodic reading of these data. The devices should also be able to attempt to read data whenever a room door is opened and closed.

The accurate functioning of the room management system depends on access to a weather forecast service with an approximate 100 percent uptime.

ACRONYMS AND ABBREVIATIONS

WOP - Window Opener Device
UFD - User Feedback Device
RMS - Room Management System
SBS - Smart Building System
SRS - Software Requirement Specification
DB - Database

Design

STAKEHOLDER CONCERNS

For the SBS project, we have the Software/System Developers and the System Administrators as main stakeholders and have itemized their interest below

On the Software/System Developers hand, the following apply:
- Clarity of SRS in general
- Clearly defined use cases and their description

On the System Administrators end, the following apply:
- Scalability of system design and implementation
- Ease of configuration of devices
- System reliability and interrupted uptime

SELECTED VIEW POINTS

With respect to the identified stakeholder concerts, the following viewpoints:

Context Viewpoint - This describes the system in general. The components, interactions and dependencies.
Development Viewpoint - Addresses the software/system developers concerns.
Deployment Viewpoint - Addresses the software/system developers concerns and system administrators concerns on scalability.
Functional Viewpoint - Addresses system administrators concerns.

In the subsequent sections, the viewpoints generally stated above are highlighted in specifica details.

CONTEXT

The SBS ideally is proposed for efficient and non conflicting management of the ventilation in a building. It gives special attention to user preferences while taking into account the need for proper ventilation as necessitated by the COVID situation across the globe. It tries to make for optimal use of energy resources to avoid wastage.

The system comprises a window opener device, a user feedback device, a room management system with a centralised database and a web portal.

The window opener device can push and pull the two shafts of a window. It can display some information on a small screen, and has two buttons that enable simple user interaction of type (mode and select). Using the two buttons of the user feedback device, the users should be able to turn on the display and visualize the current temperature and CO2 levels, set the temperature comfort mode, and command the windows.

The user feedback device deployed next to the door, can sense the temperature, CO2 level, and detect if the room is occupied or not. It can display some information on a small screen, and has two buttons that enable simple user interaction of type (mode and select). Using the two buttons of the user feedback device, the users should be able to turn on the display and visualize the current temperature and CO2 levels, set the temperature comfort mode, and command the windows.

The room management system is a device connected to the same WiFi networks as the devices and centralizes the management for a couple of rooms. This device has access to a database that stores when rooms are theoretically occupied. It can command the heaters and change the temperature setpoints. It is also connected to the internet and can therefore access the weather forecast service. It has enough computational power to run simple simulations, and can therefore forecast the evolution of the temperature and CO2 levels in rooms.
The web portal is used by Authorised users. A super administrator profiles

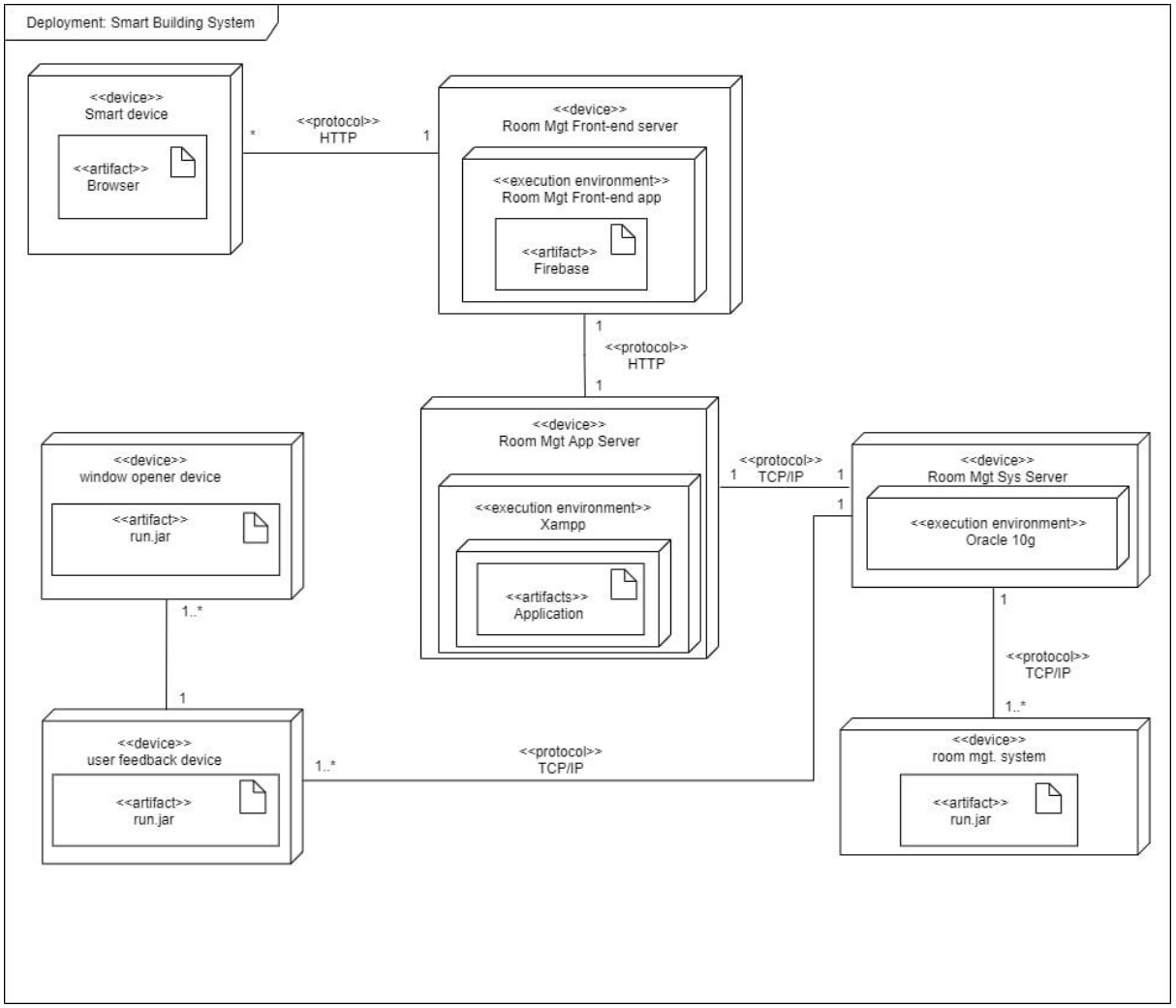
other system administrators on the portal, giving them necessary authorizations. On the other hand, authorized users should be able to access a web portal to visualize the history of the temperature, CO2 levels, and window open/close status. They are also able to configure new devices with necessary information.

COMPOSITION

For each room, a window opener device, a feedback device are installed. The feedback device should come with features to sense if a room is empty or occupied, likely via sensing of heat signatures of possible room occupants. The building in general will have a central room management system, with an SQL database, linked to the web portal and connected on same network as the devices in the room

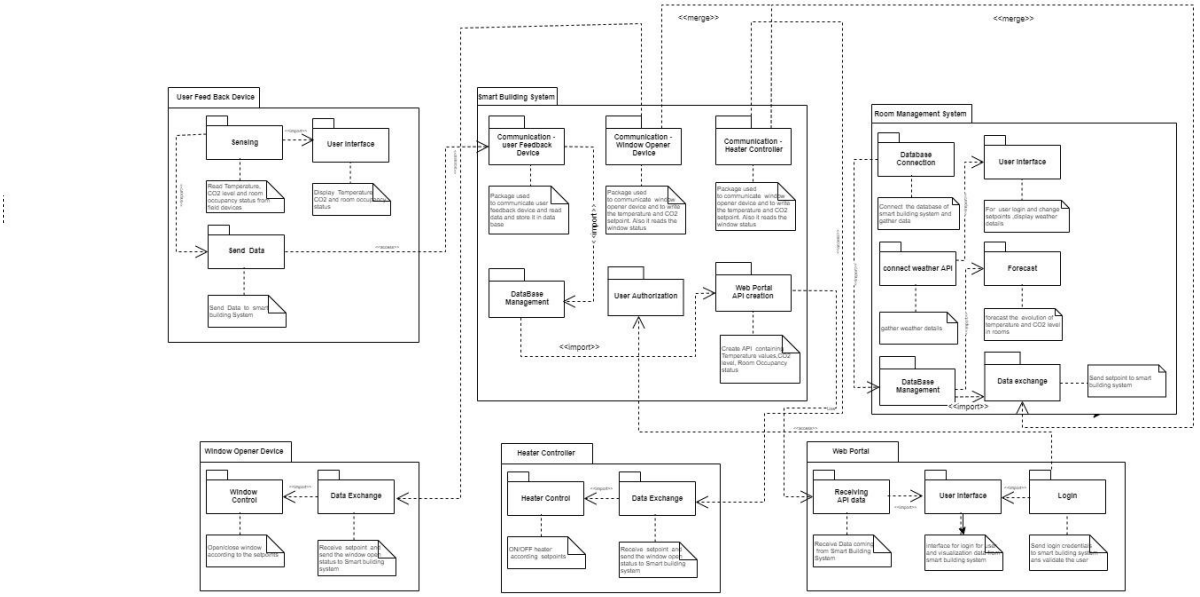
The deployment diagram below visualizes the deployment of the system

Deployment Diagram

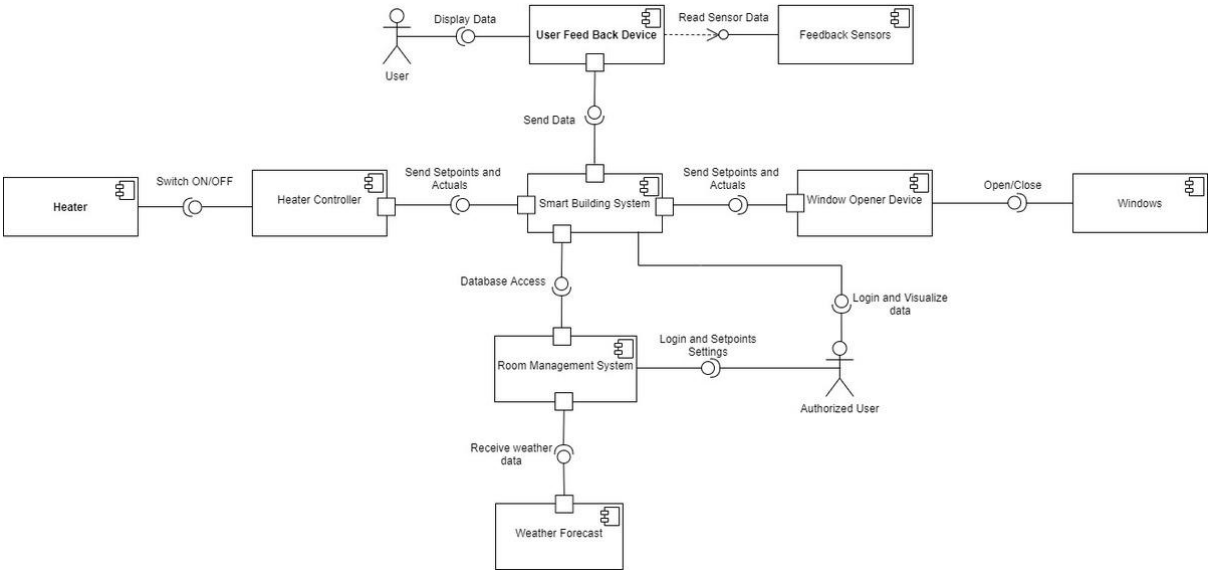


Next, we also have the Package Diagram

Package Diagram



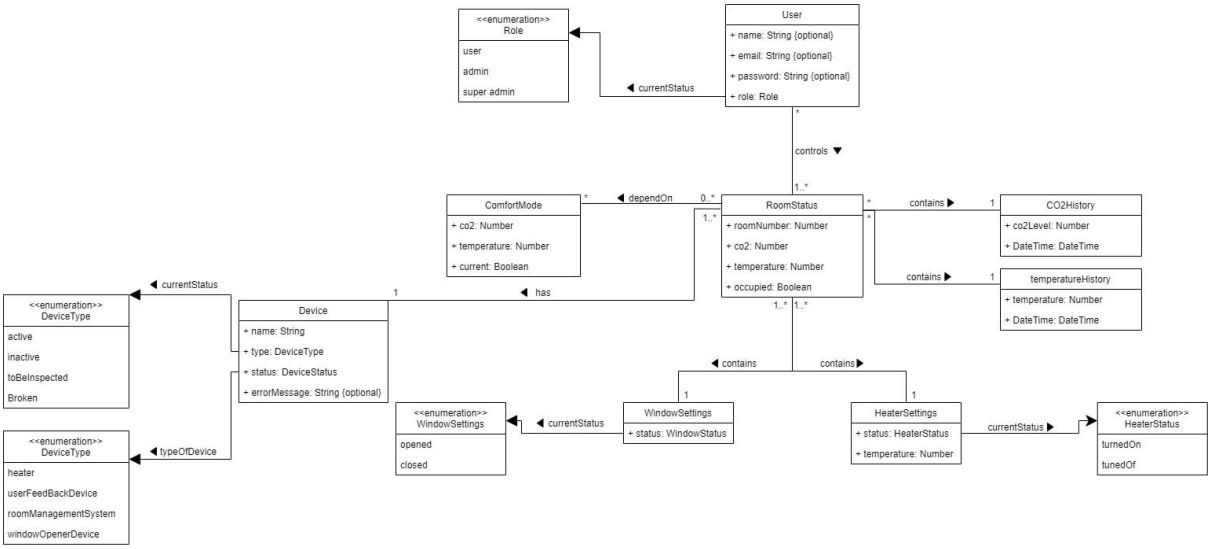
Component Diagram



LOGICAL

Below, the class diagrams highlight the classes (and their interactions) for the collection, processing and management of data in the SBS.

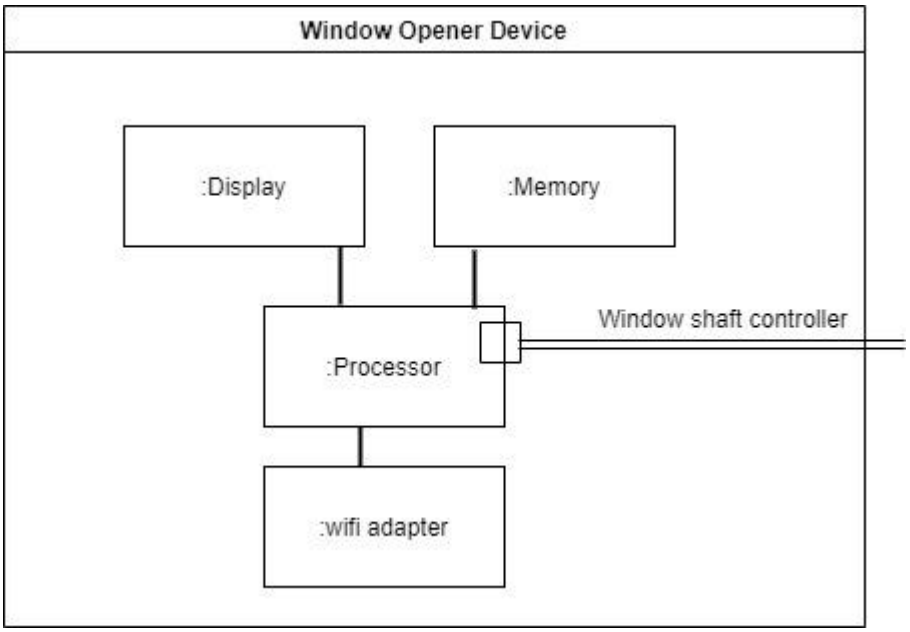
Class Diagram



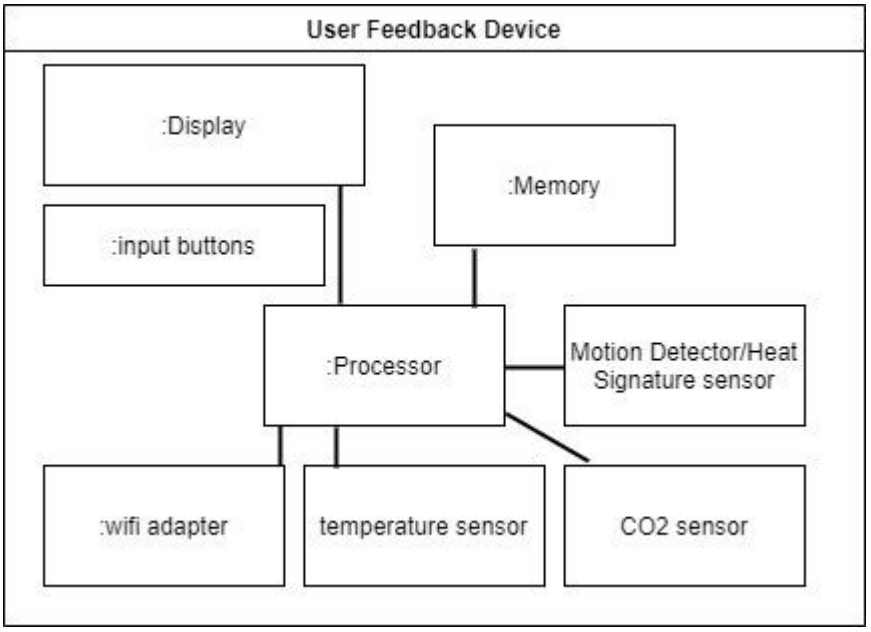
STRUCTURE

Below, the composite structure diagram describes the overall structure of the SBS, highlighting the different parts of the system and how they are interconnected

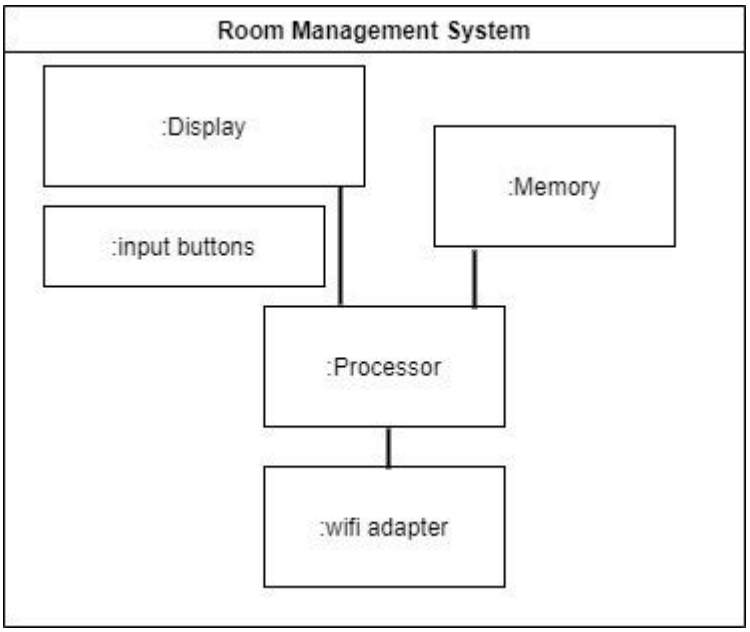
Window Opener Device



User Feedback Device



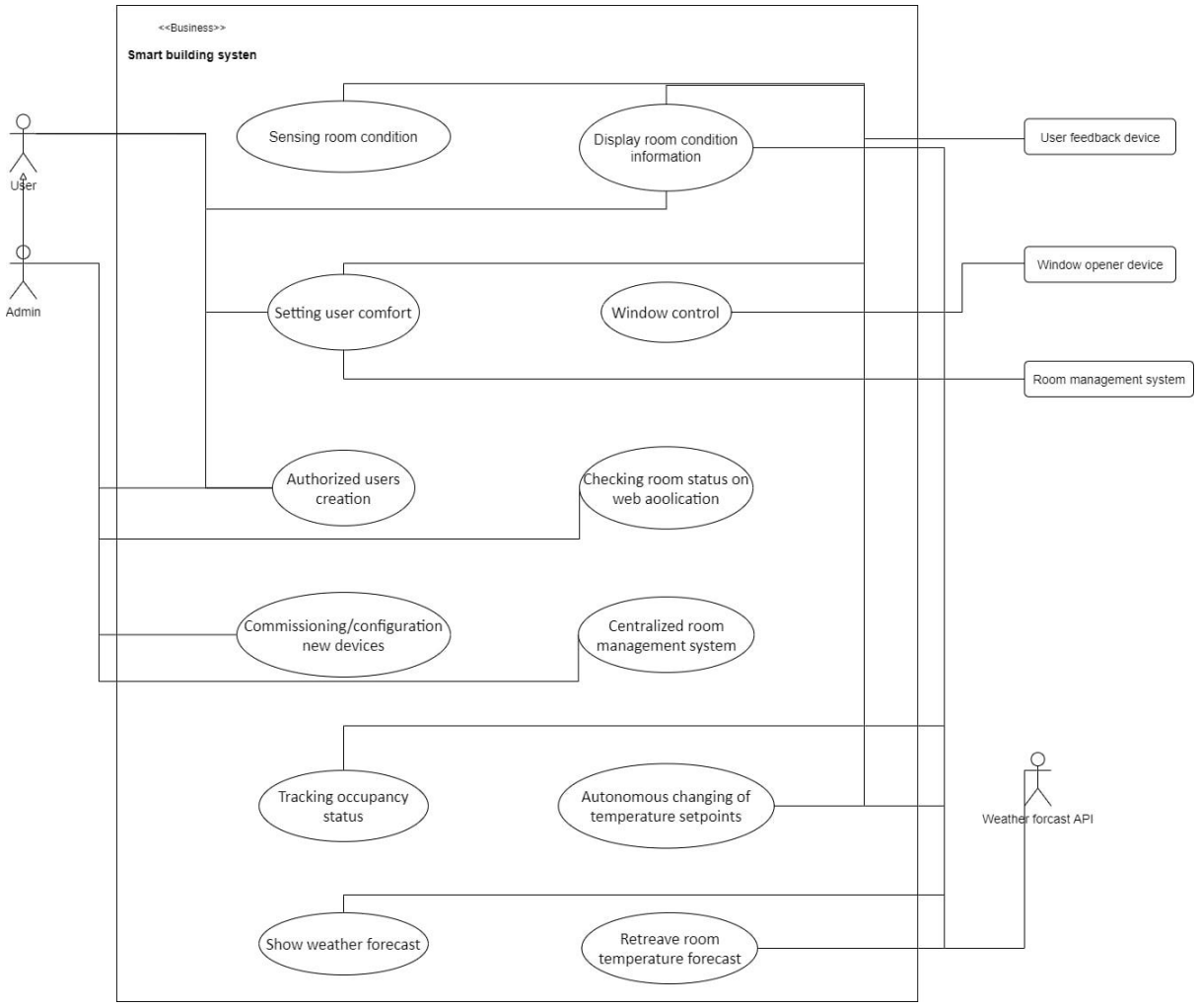
Room Management System



BEHAVIOURAL

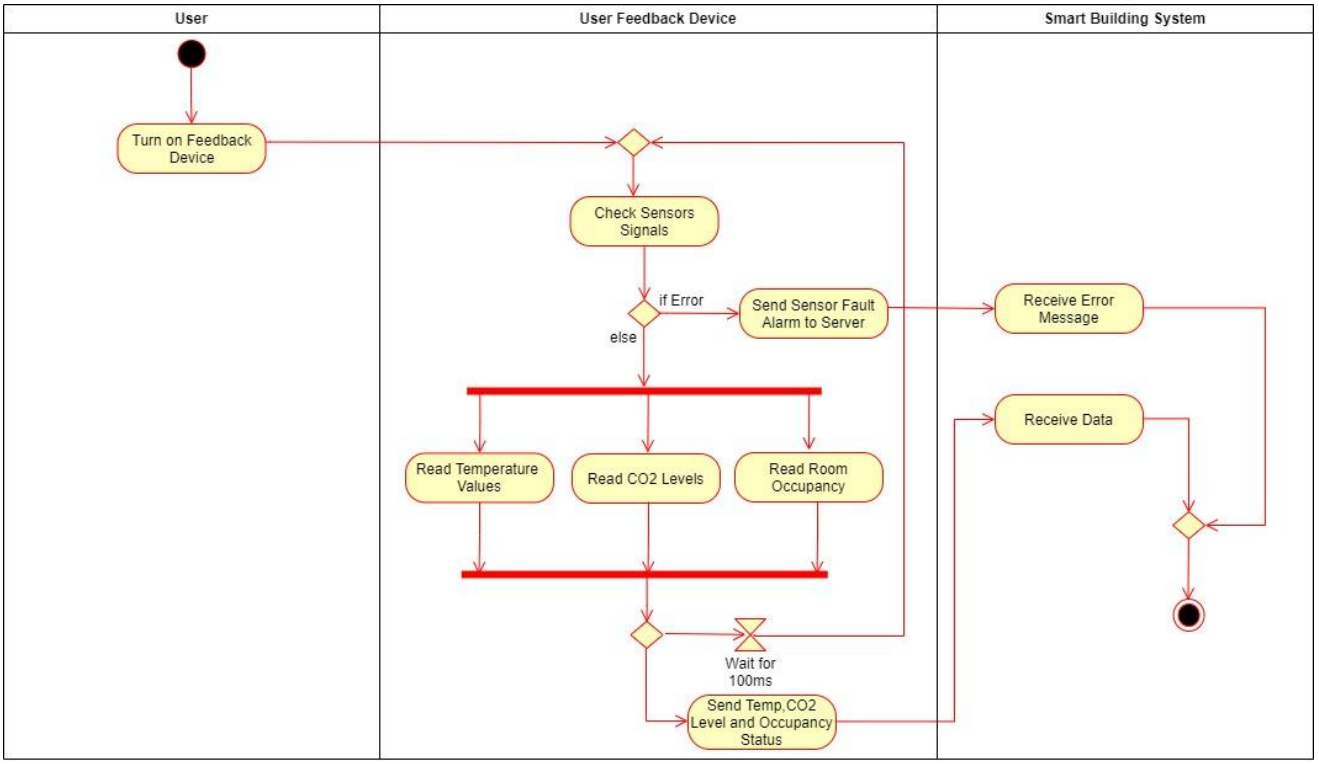
In this section, time dependency relationships and interactions between the components of the system are shown.

Usecase Diagram

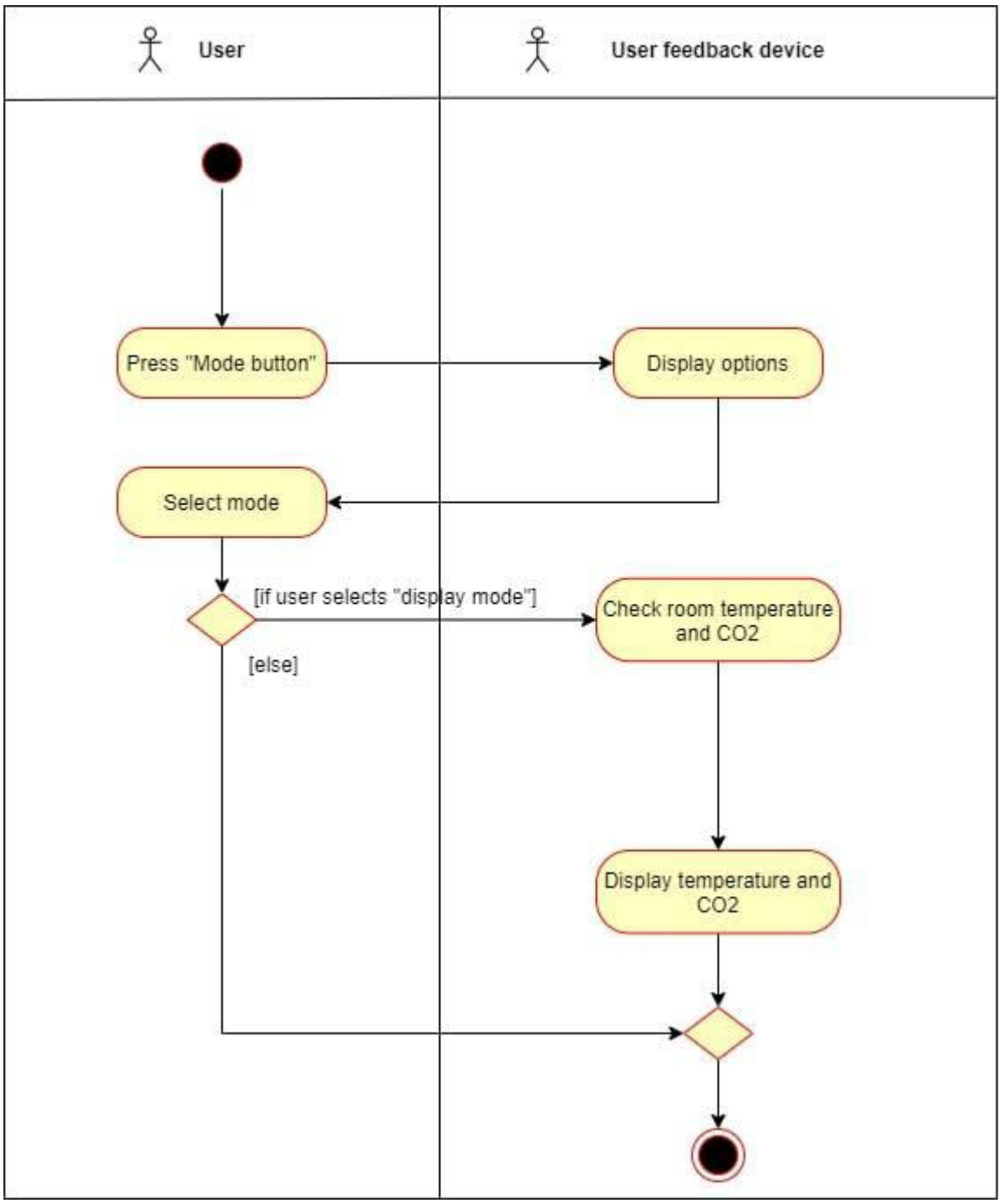


Activity Diagrams:

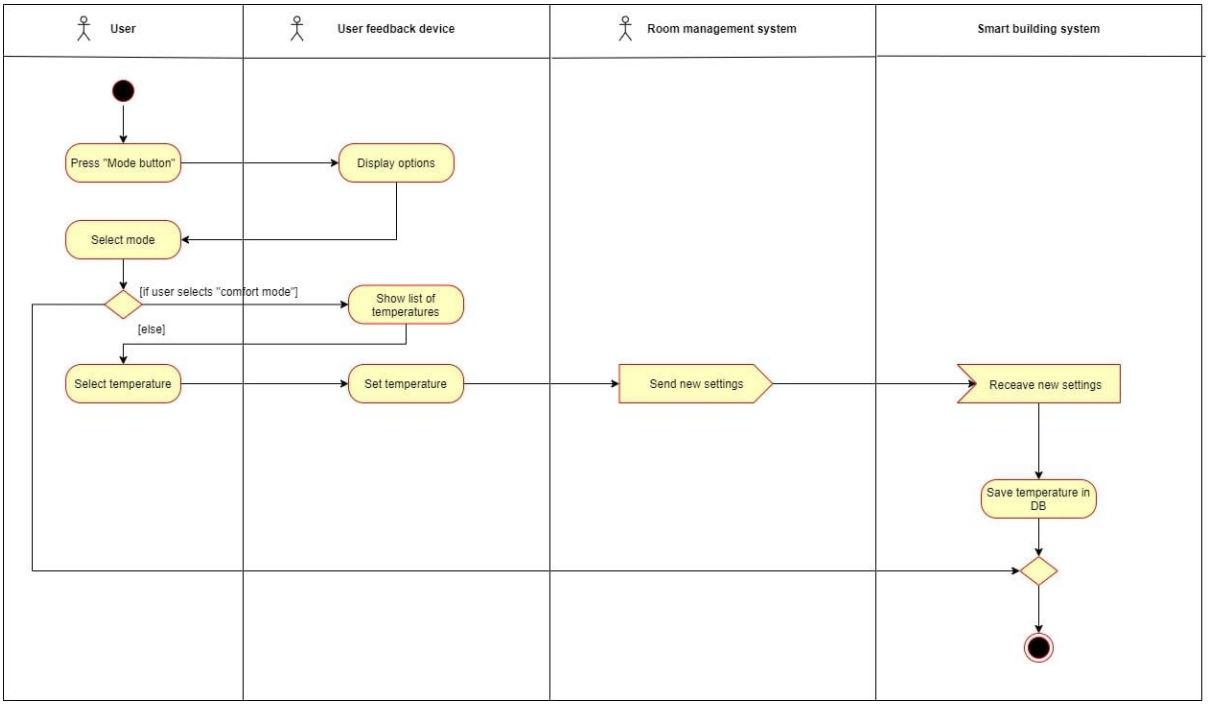
Sensing Room Conditions



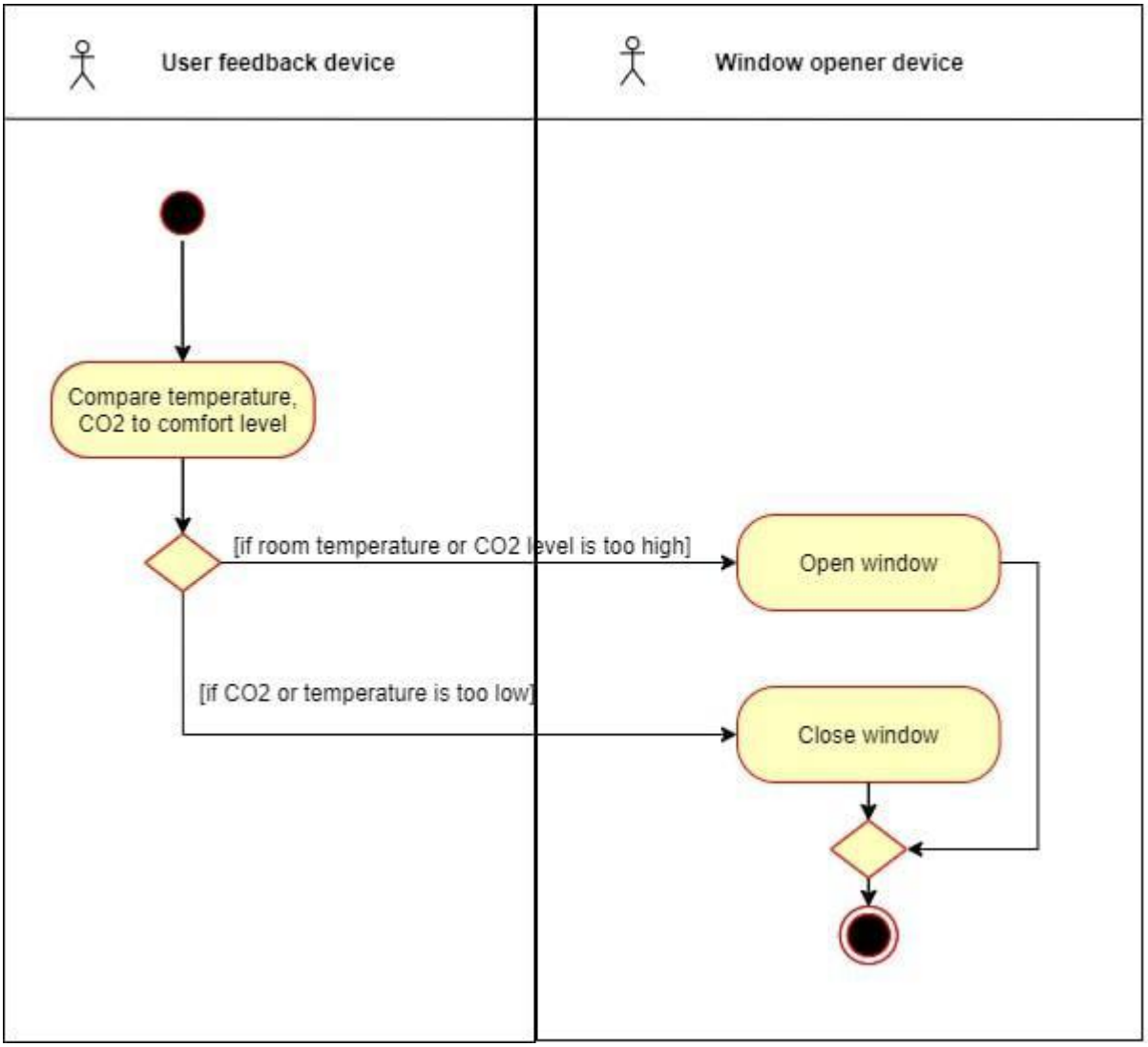
Display Room Conditions Graphic Information



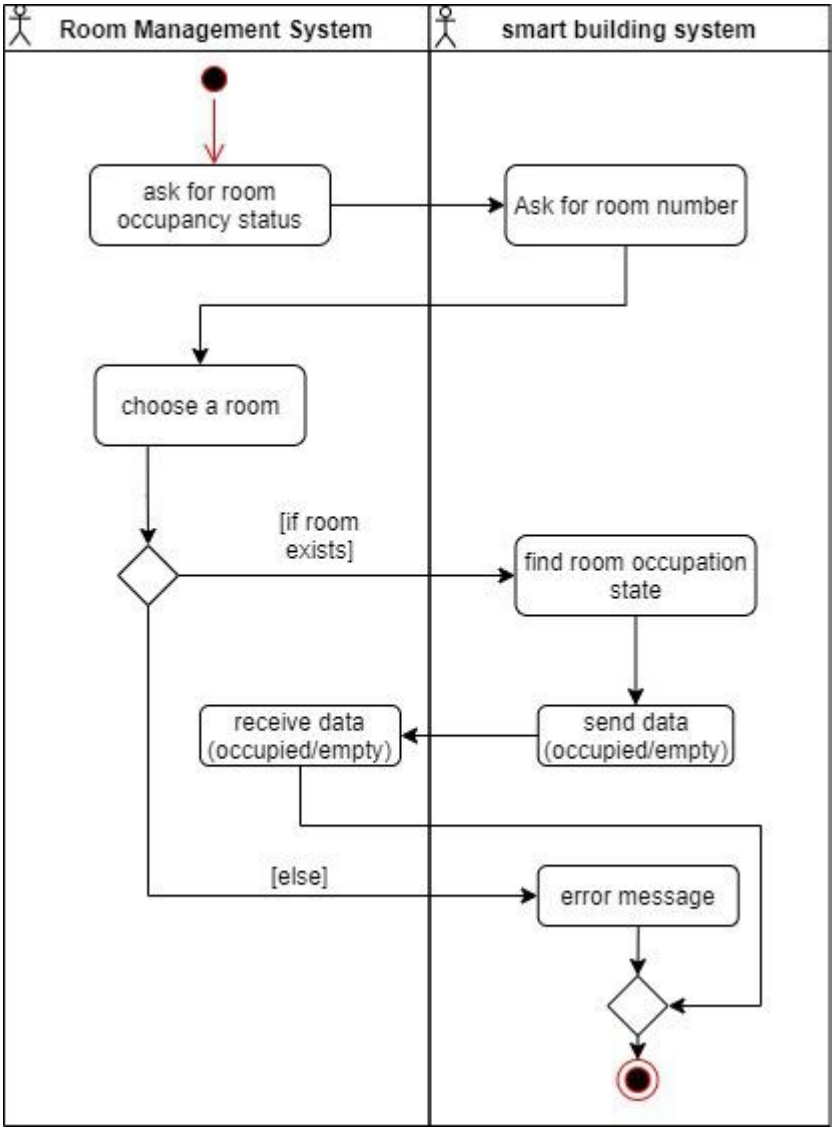
Setting User Comfort Temperature



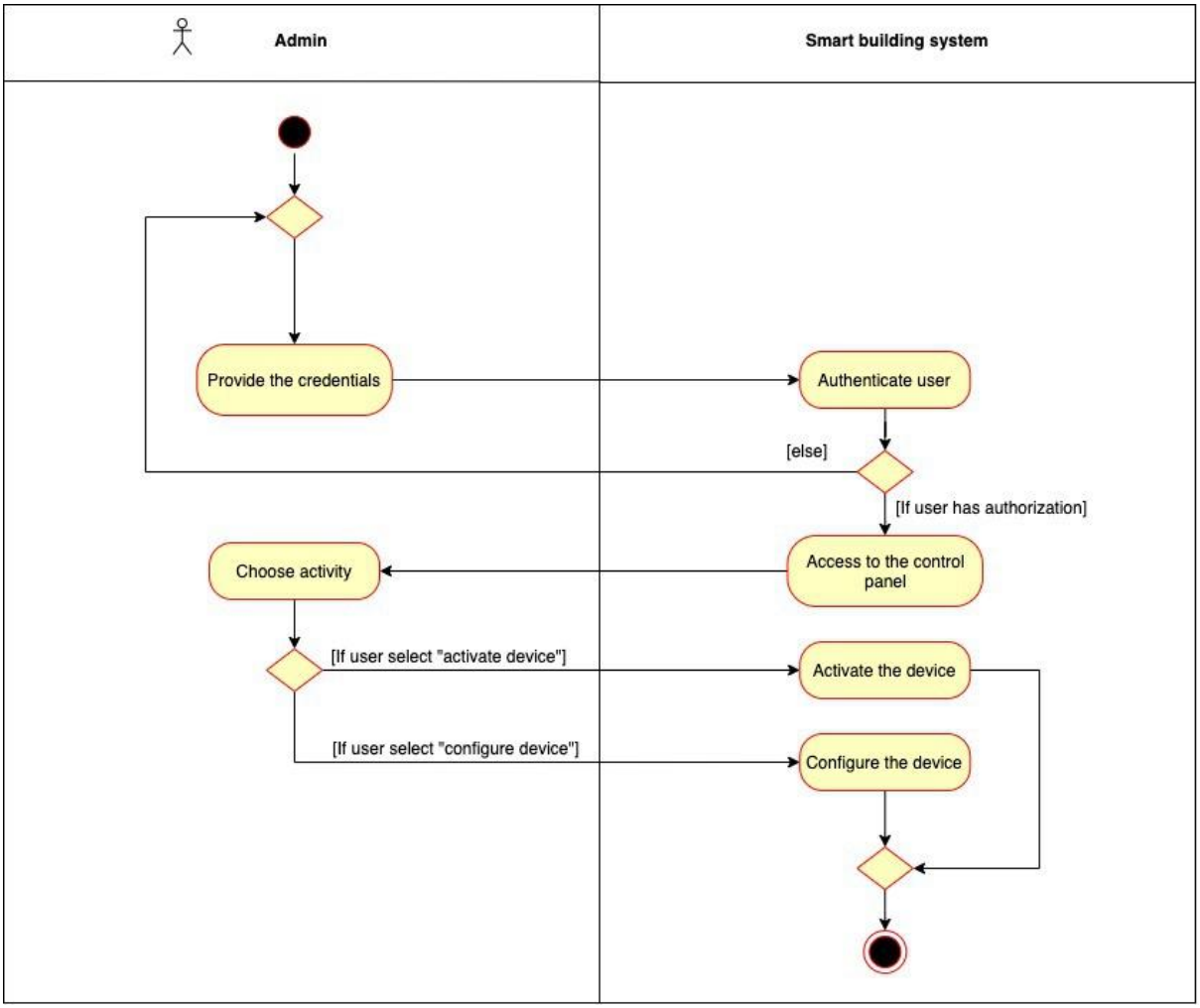
Window Control



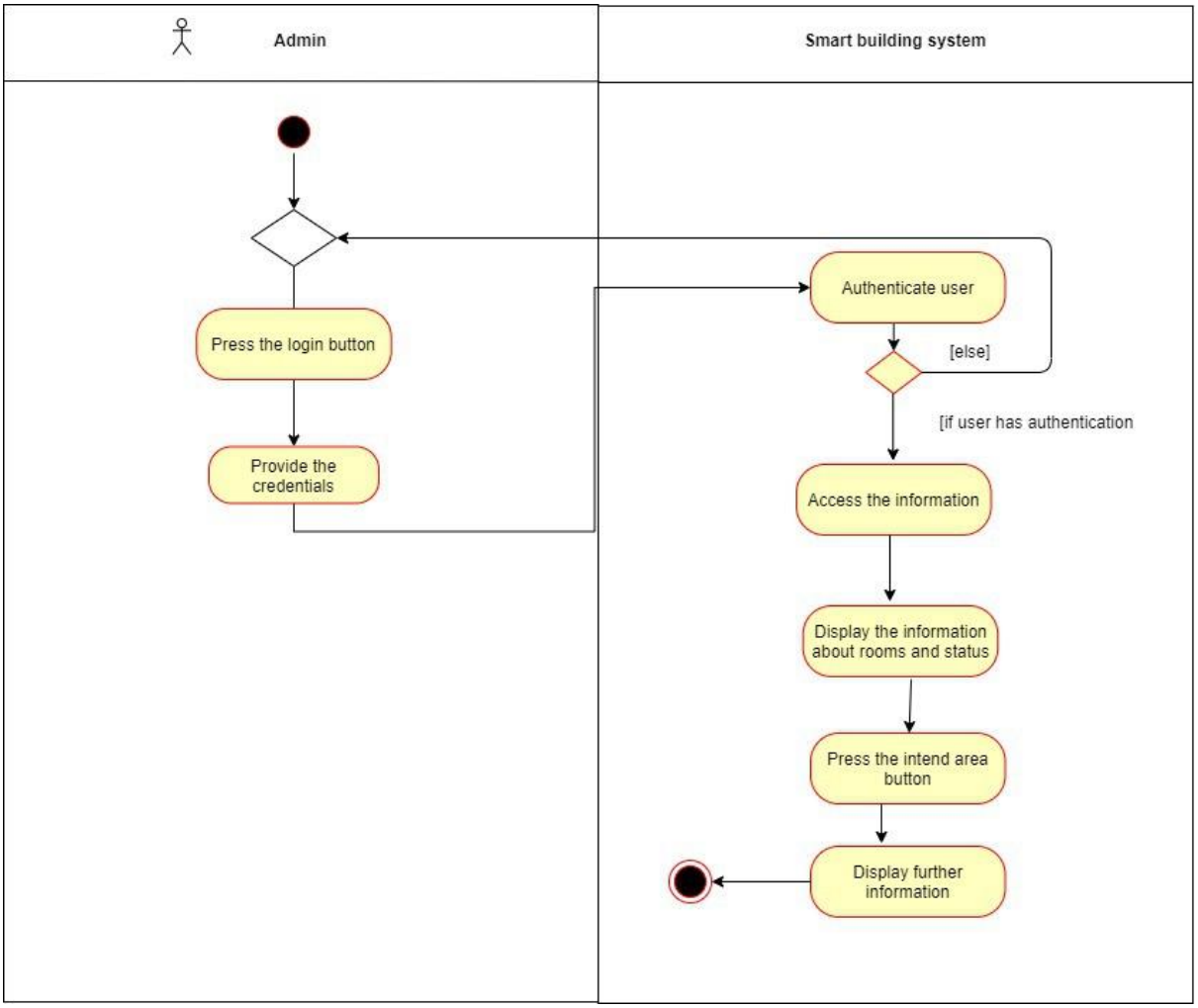
Tracking Room Occupancy Status



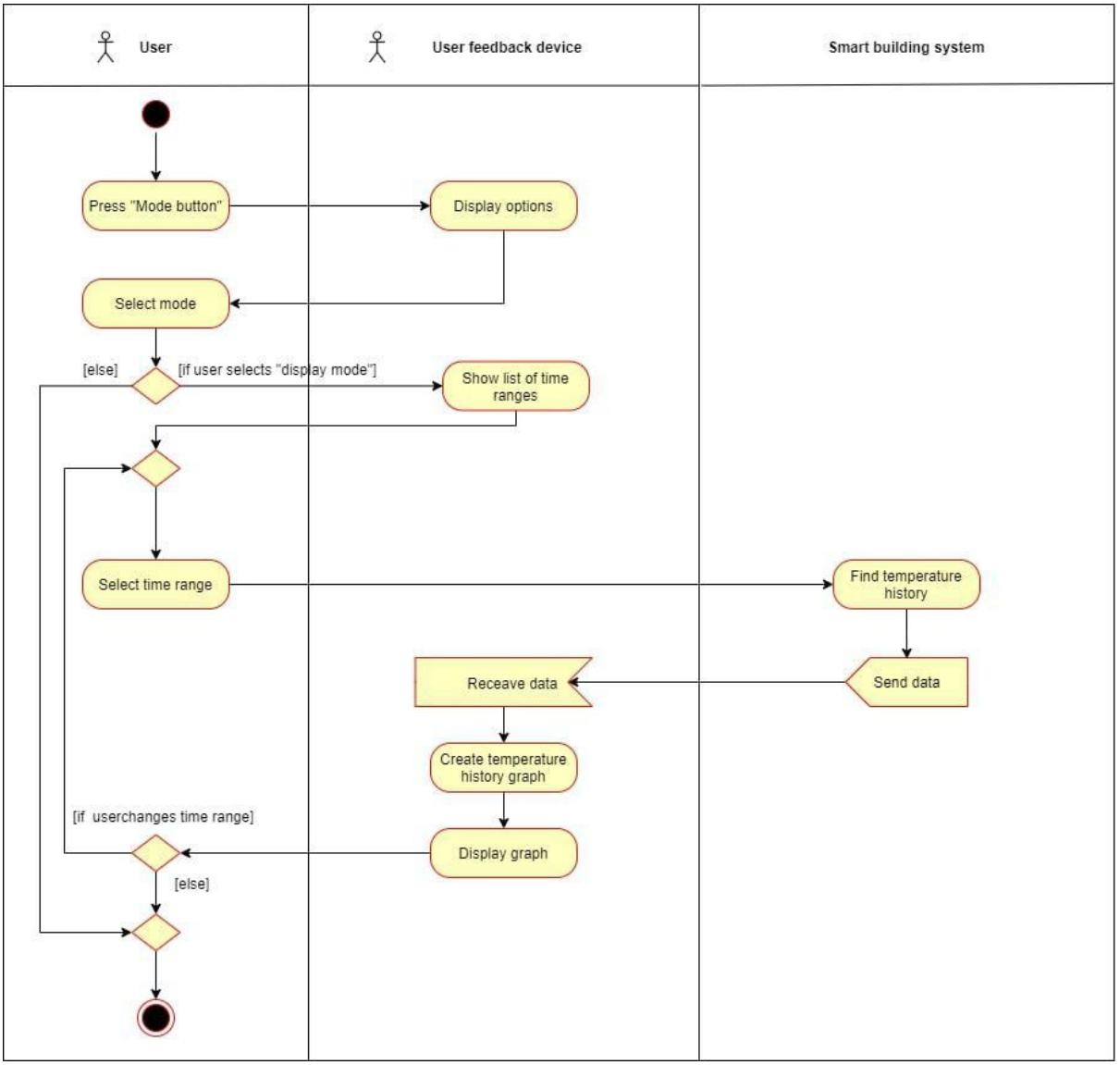
Commissioning/Configuration of New Device



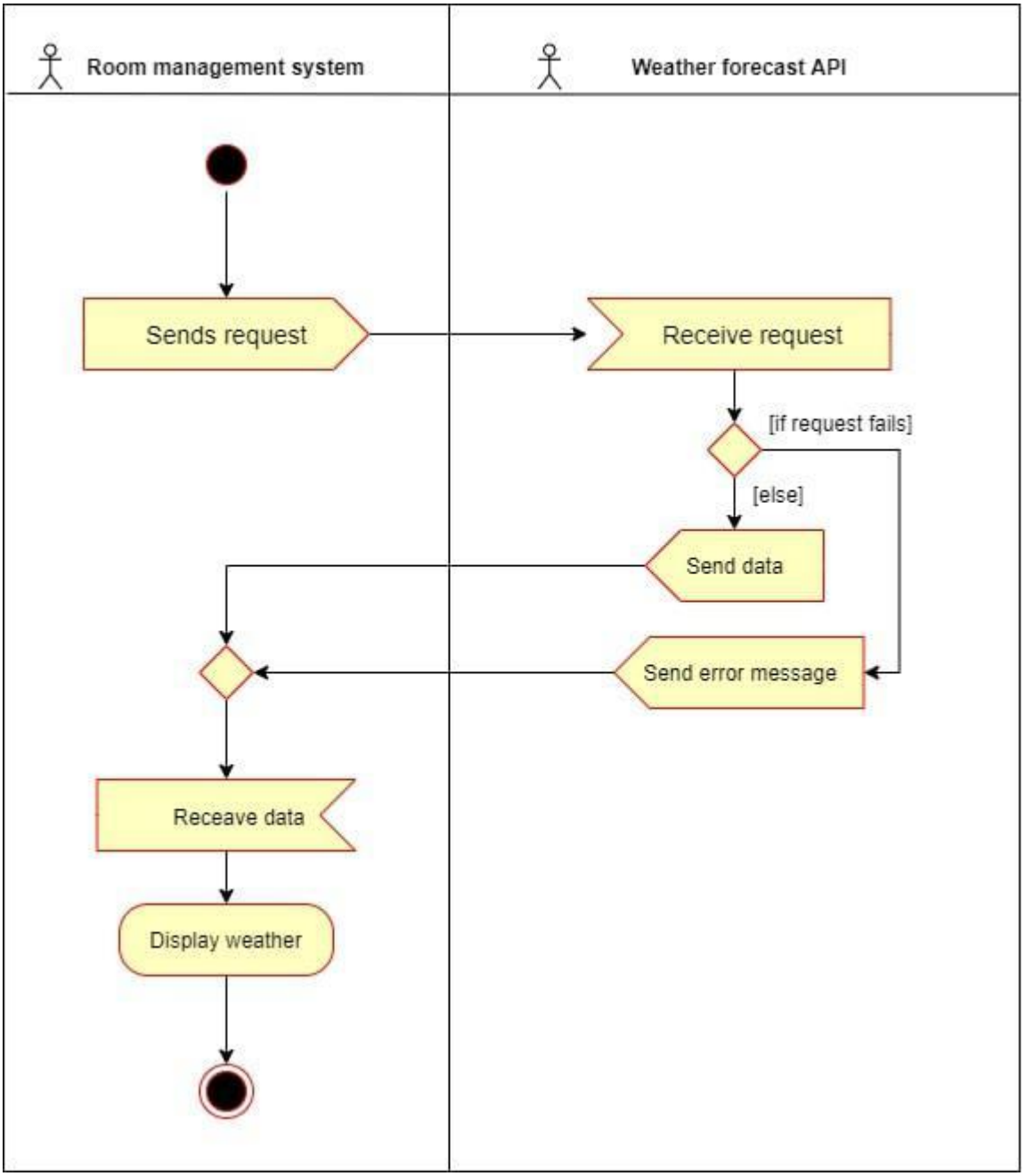
Centralized Room Management



Retrieve Room Temperature Evolution

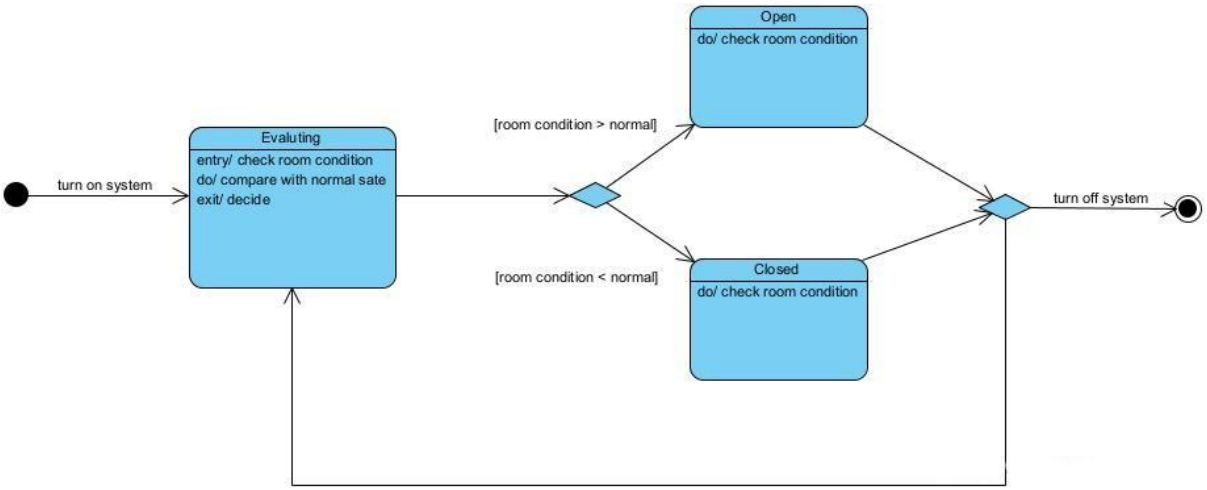


Weather Forecast

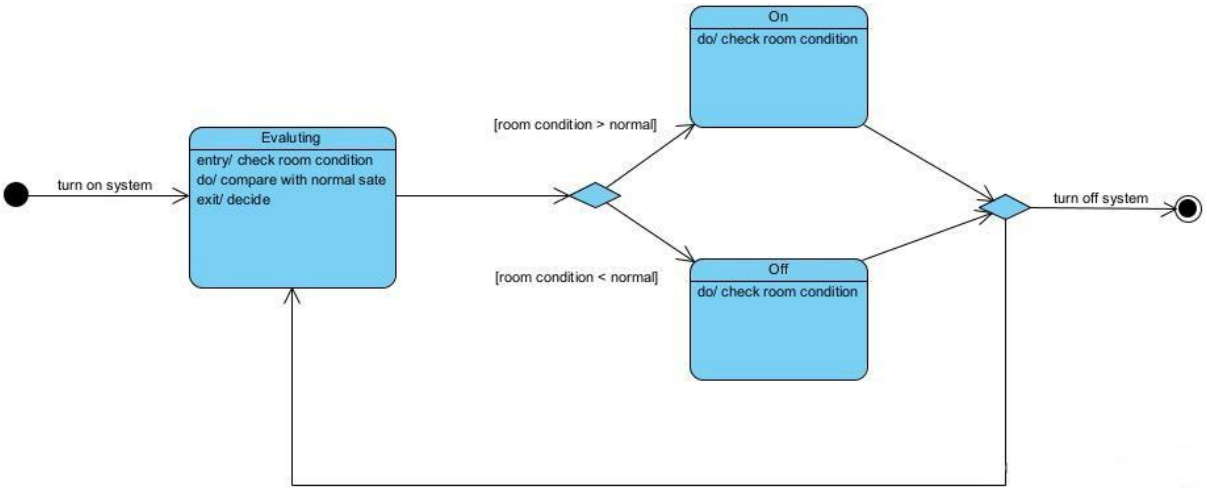


STATE DIAGRAMS

Window

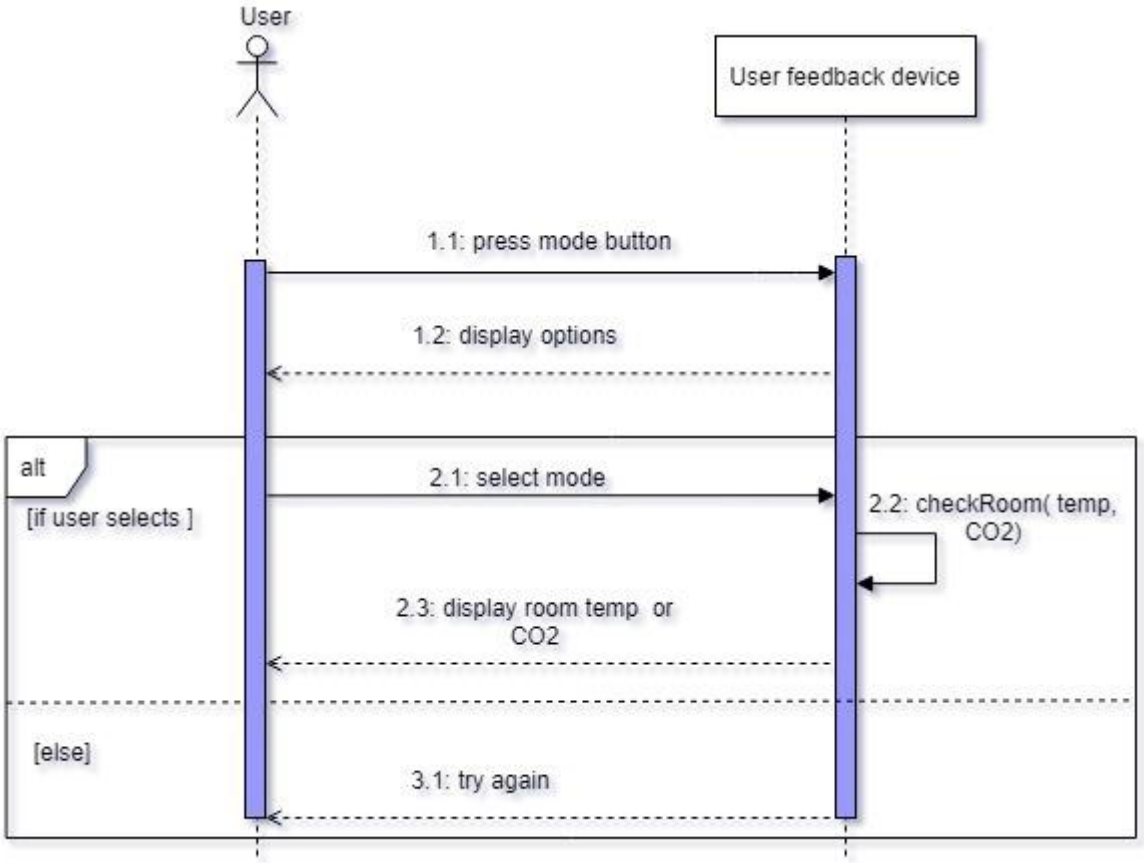


Heater

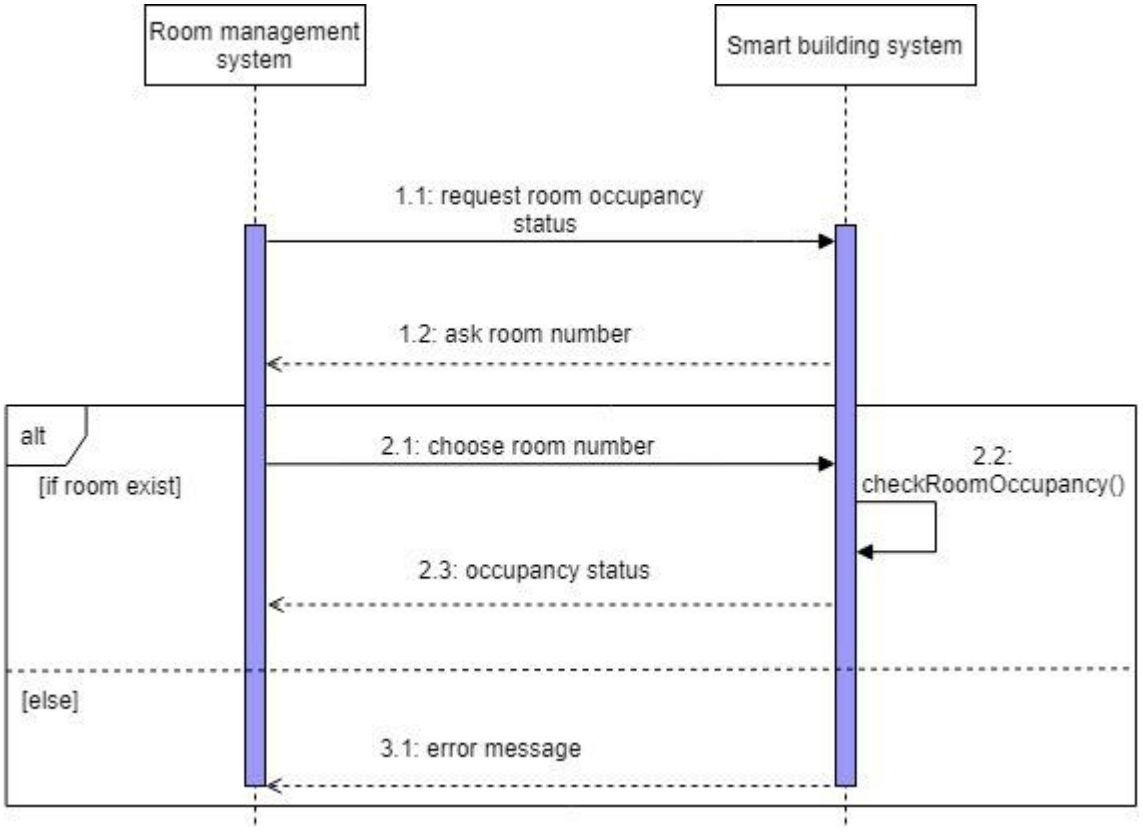


Sequence Diagrams

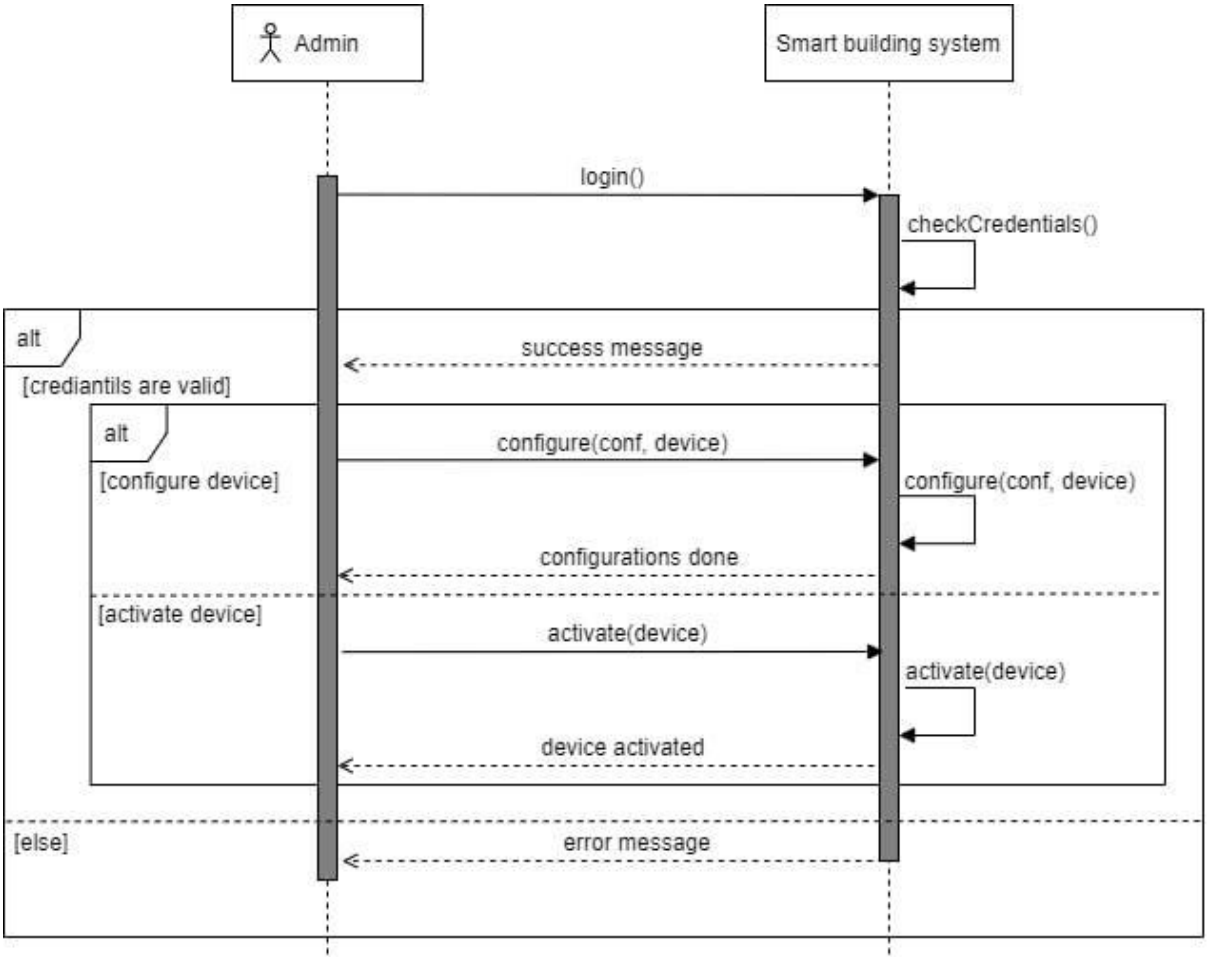
Display Room Conditions



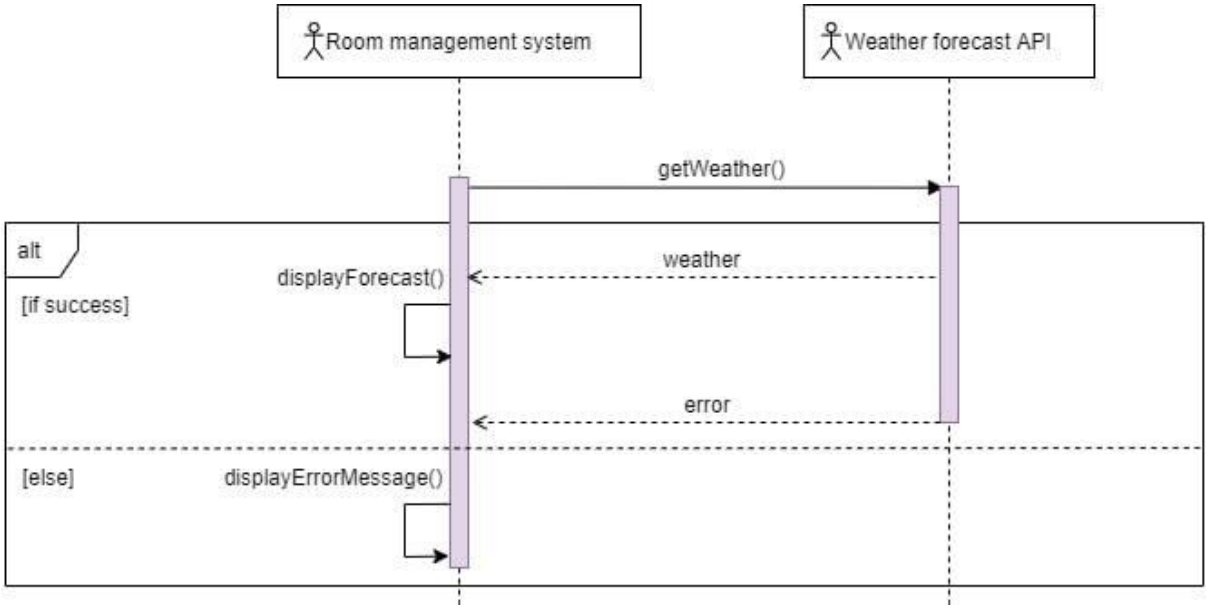
Tracking Room Occupancy Status



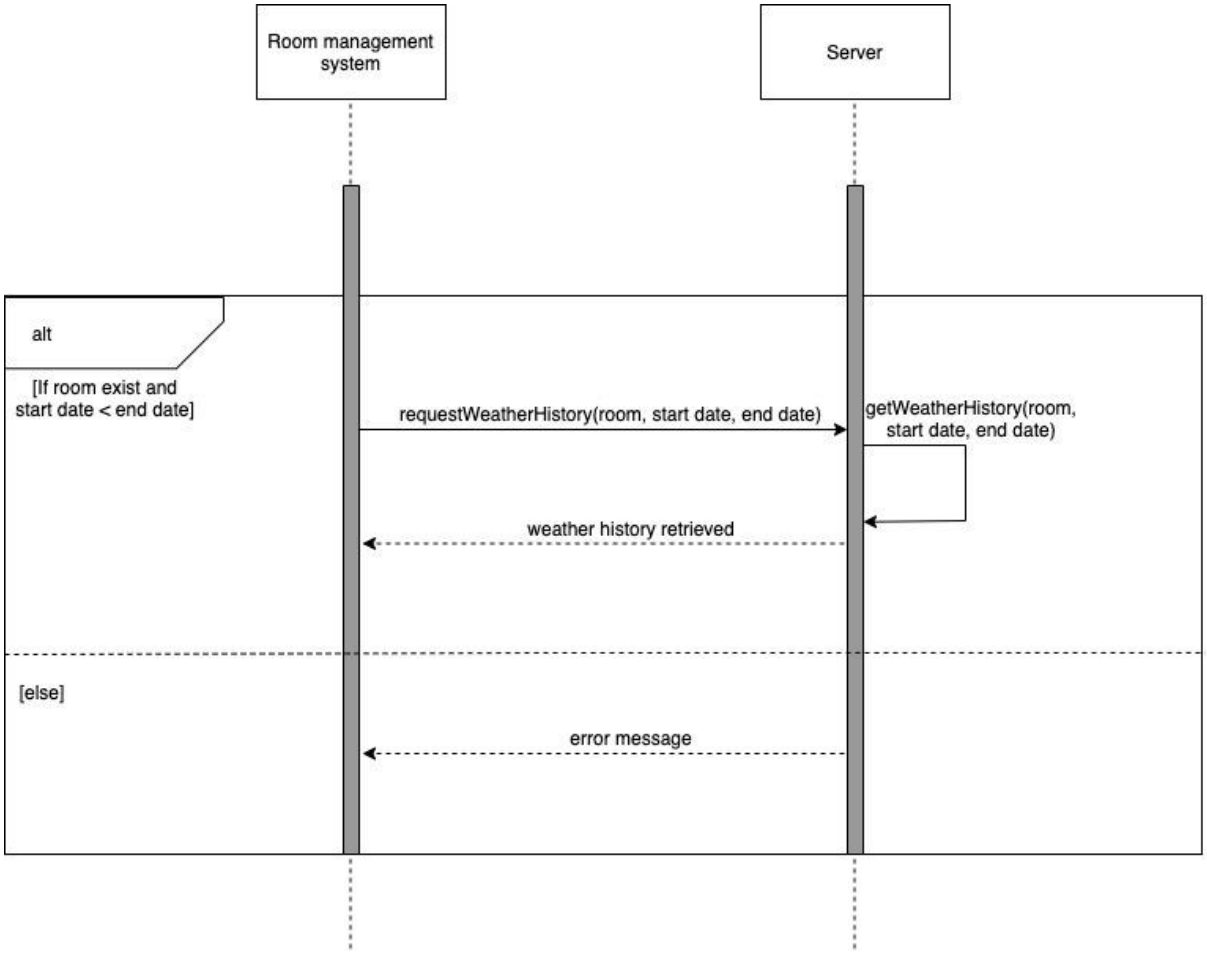
Configuration of New Devices



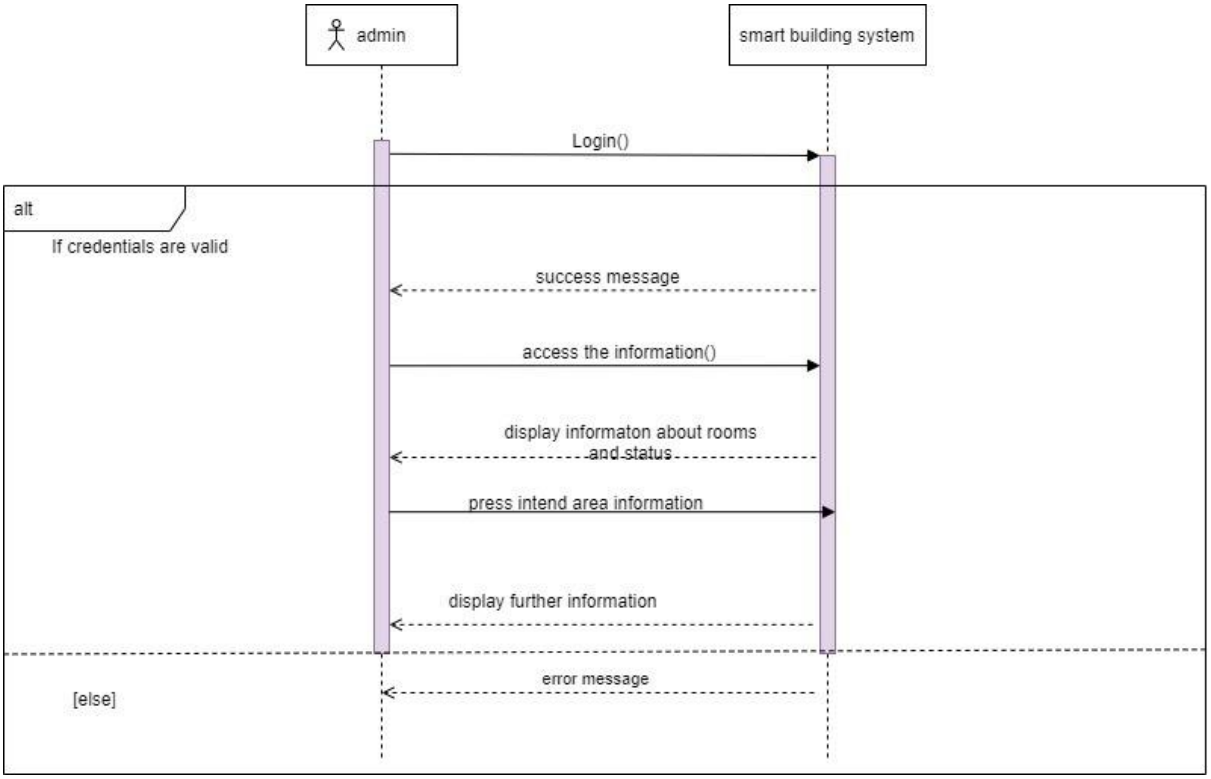
Weather Forecast



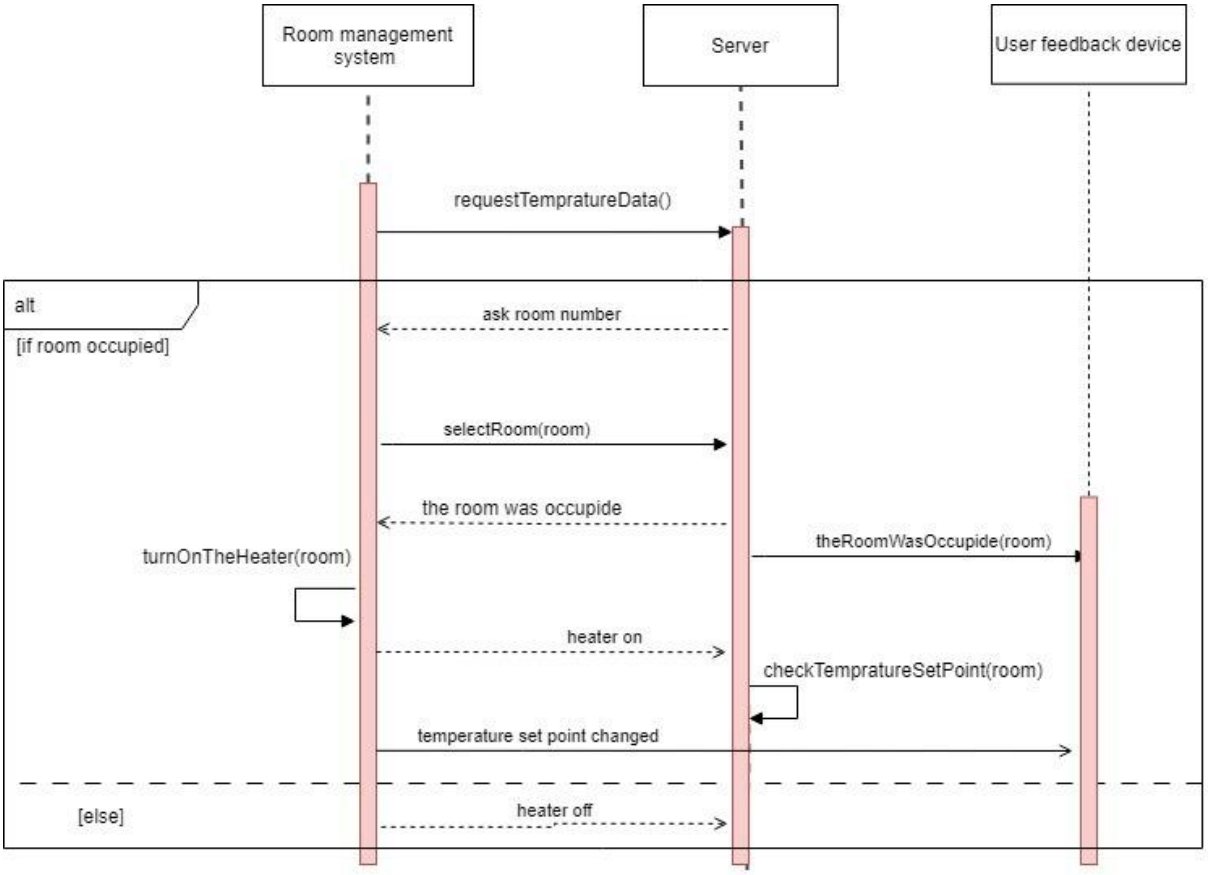
Room Temperature Evolution Forecast



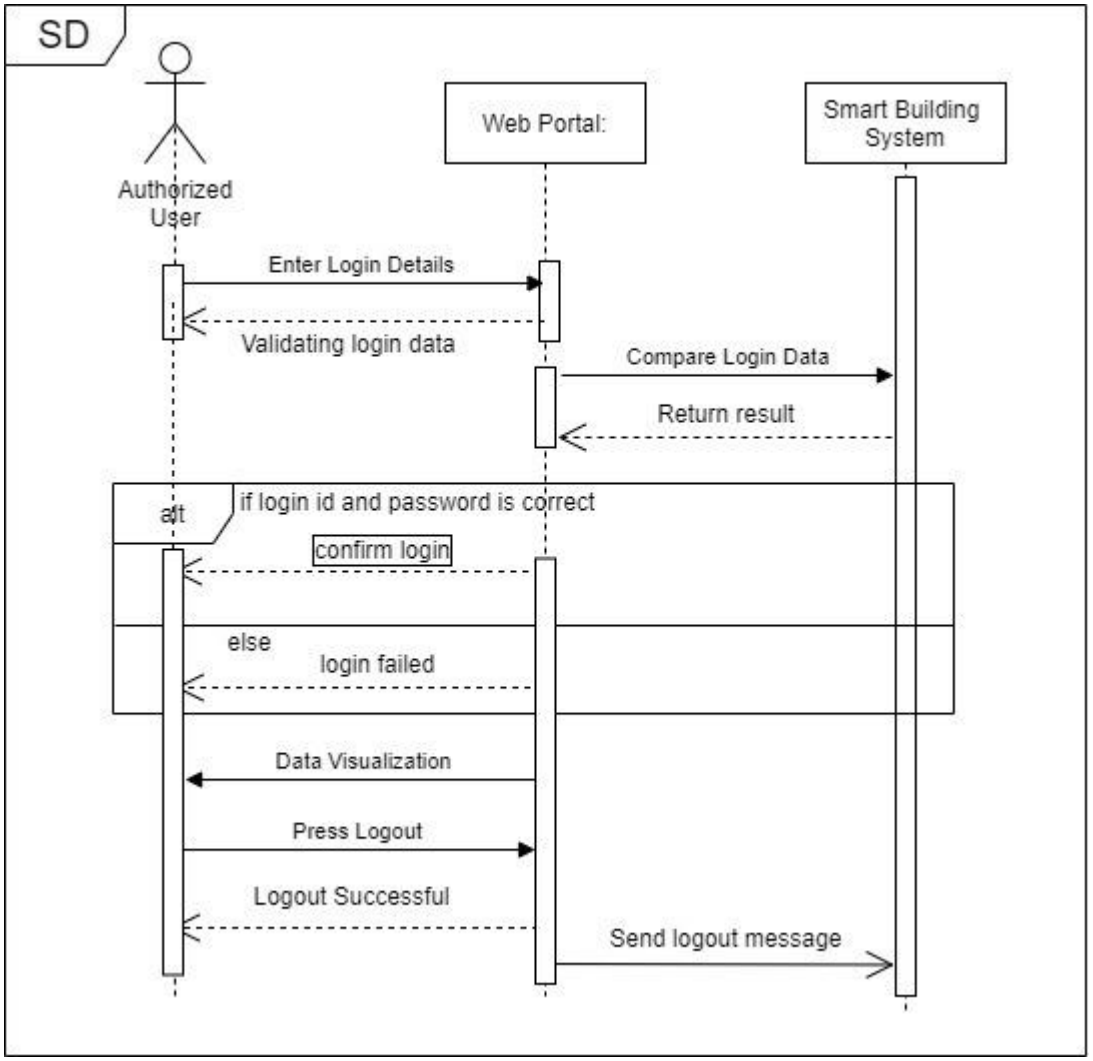
Centralised Room Management



Autonomous Changing of Temperature Setpoints

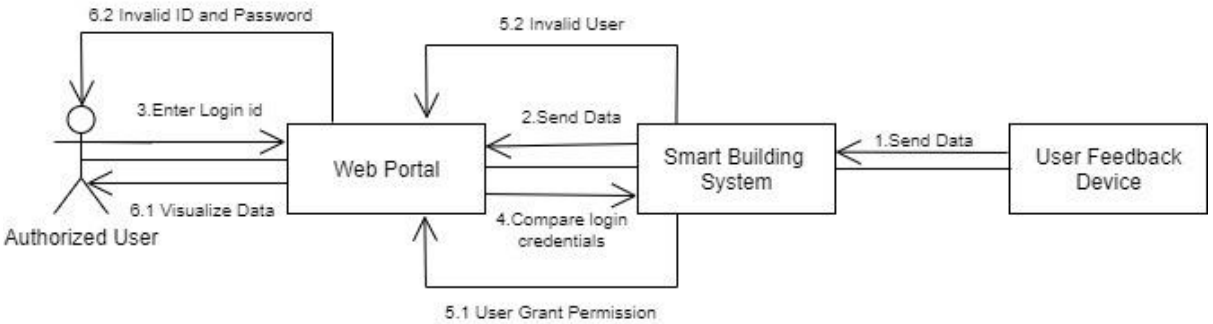


User Authentication

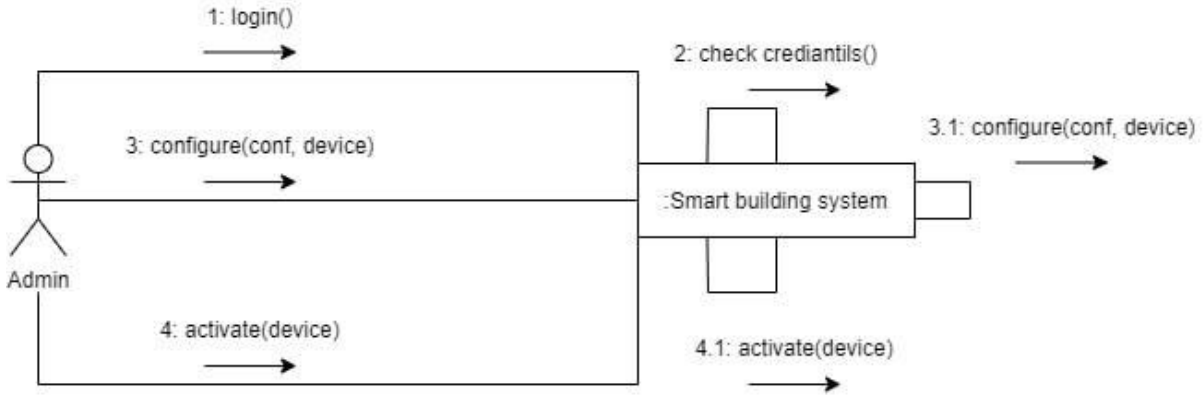


Communication Diagrams

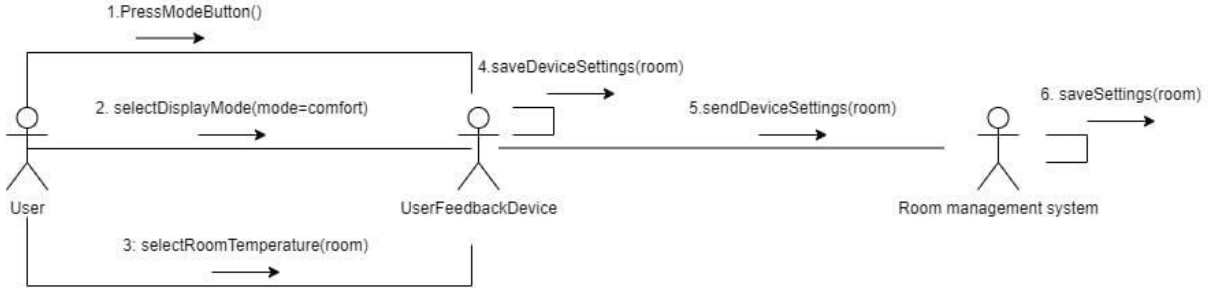
Login



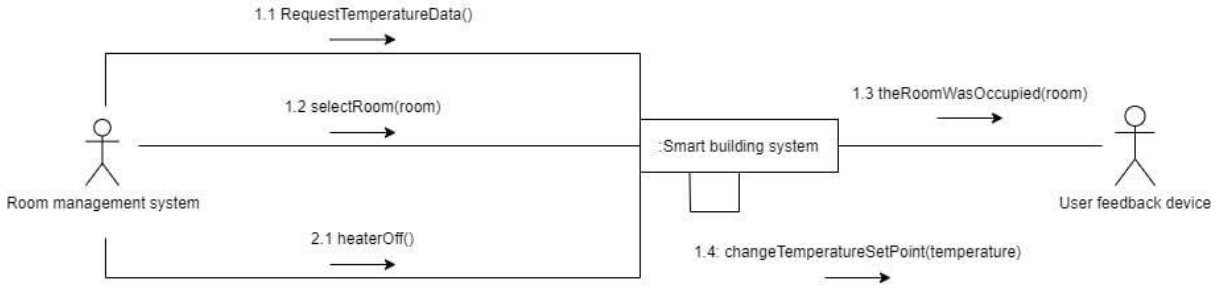
New Devices Configuration



Setting User Comfort



Autonomous Changing of Temperature Setpoints



ALGORITHM

Here the general algorithm/pseudocode for the expected flow and working of

the system is described

Room
-User enters a room
-User turns of feedback device (if it is switched off)
-At preconfigured intervals, feedback device checks for room occupancy status, CO_2 levels and room temperature and sends data to central database
-When necessary, User turns on display on window opener device
-If user selects a mode [display]
-Device displays room conditions; temperature, CO_2 levels
-If user selects mode [comfort]
-System displays list of temperatures
-User selects preferred option
-System sets users choice and sends users settings to central DB

on window control
-If CO_2 levels are high or temperature is higher (compared to user comfort settings) windows are opened else they are closed if open

Web Portal
On profiling users
-Superadmin logs into the system
-Navigates to create user section
-Inputs necessary details and authorizations and saves
On configuring devices
-System admin logs into the system
-fills in necessary device and room info and settings and saves

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