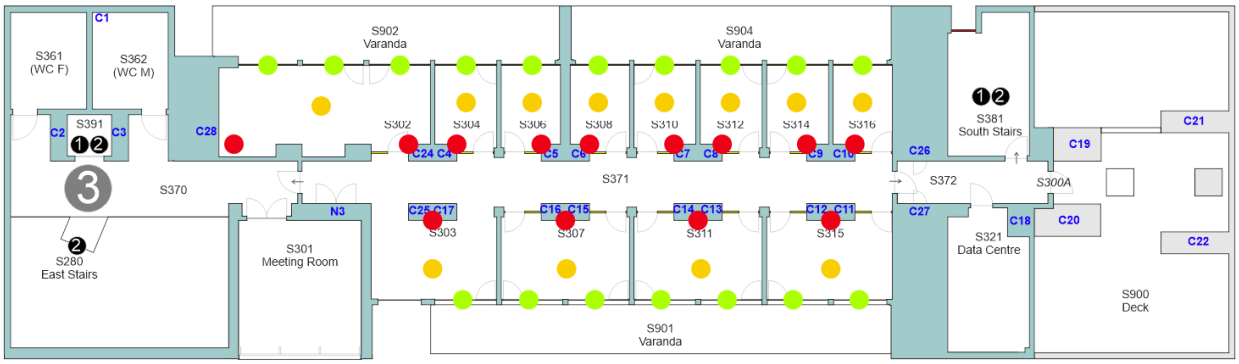
Automated Climate Control System

Context

In a large, modern building such as the one hosting the CISTER unit, the smart control of lighting and heating conditions is a key aspect to enable environment friendly usage of the building, reducing its running costs while simultaneously contributing to the wellbeing of the researchers.

The motivation of this project is the development of an automated climate control system that suits the specific properties of CISTER building, notably taking as inspiration its 3rd floor. The floor plan consists of seven individual offices with a single blind and a heater, 4 double occupancy offices with two independent blinds and heaters, and the director's office with three blinds and four heaters. The plant of the building is presented in the figure below.



Assume that in all the offices the **blinds (green)**, the **heaters (red)**, and the **lights (orange)** in the ceiling are smart, i.e., they can be inspected and controlled using WSN systems.

Objectives

A first approach towards having a full-featured automated climate control system with the characteristics of the 3rd floor of the CISTER building is to automate lighting conditions and temperature. Since the floor has different typologies of offices, this project will focus only on the individual offices.

The **first automation task** deals with controlling the lighting conditions of the office. Priority is given to sunlight, and thus blinds shall move into opening position that facilitates the entry of the required light. Whenever the natural light is not sufficient, it should be compensated for by the artificial light available in the office.

The **second automation task** is to control the heating with the help of the smart heater in the office.

The envisioned automated climate control system shall also provide a user interface that enables the occupant of the office to configure its preferences regarding lighting and temperature conditions, change the current status of blinds, lights, and heater. The system should also be

capable of warning its occupant that its preferences are not being met, which could point to a possible problem with the operation of the system.

The objective of this project is to design and implement a prototype system that complies of the requirements of what was described above. Due to limitations on the access to the building (given the current government's guidelines) and the high-risk that would represent physically interacting, e.g., with the real blinds in the offices of the CISTER building (which could lead to real damage and high repair costs, if not any consequence to the users) the system you will implement will mostly rely on simulated behavior. Nevertheless, the adoption of some physical sensors/actuators is highly motivated (e.g., movement of blinds represented by different led colors) and, if you plan to follow along, that must be made clear when an actuator is enabled/disabled.

Tasks

The goal of this project is to implement the above features. Furthermore, being a critical system, this WPS should be enriched with measures to prevent or mitigate failures. More concretely, the core tasks of this project are:

- **T1: Hazard analysis.** A list of potential hazards should be produced, indicating how each of these could be mitigated. This list could include hazards that are only identified but not addressed by your implementation. An initial list is included in the next subsection.
- **T2: Embedded components.** There should be embedded components to (1) read the sensor data, and (2) trigger the pump to start pumping (the component's software should use code written in assembly).
- **T3: WSN network.** WSNs should be used whenever possible.
- **T4: Hazard mitigations:** Extra components used to mitigate hazards, e.g., use redundant sensors and/or actuators, should be properly implemented and validated.

These 4 tasks may be carried in parallel, could have intersection points, and are not meant to be carried sequentially.

Initial Hazard Analysis

An initial list of hazards and mitigations can be found in the table below. All the listed hazards should be addressed in this project. You should complete this table and extend it with new hazards and mitigations, even if you do not plan to address these.

Hazards	Mitigations
One of the smart heater actuators is malfunctioning	Identify the failure, provide user with temporary fix (regulate by hand), and initiate long-term fix (send message to maintenance services)