

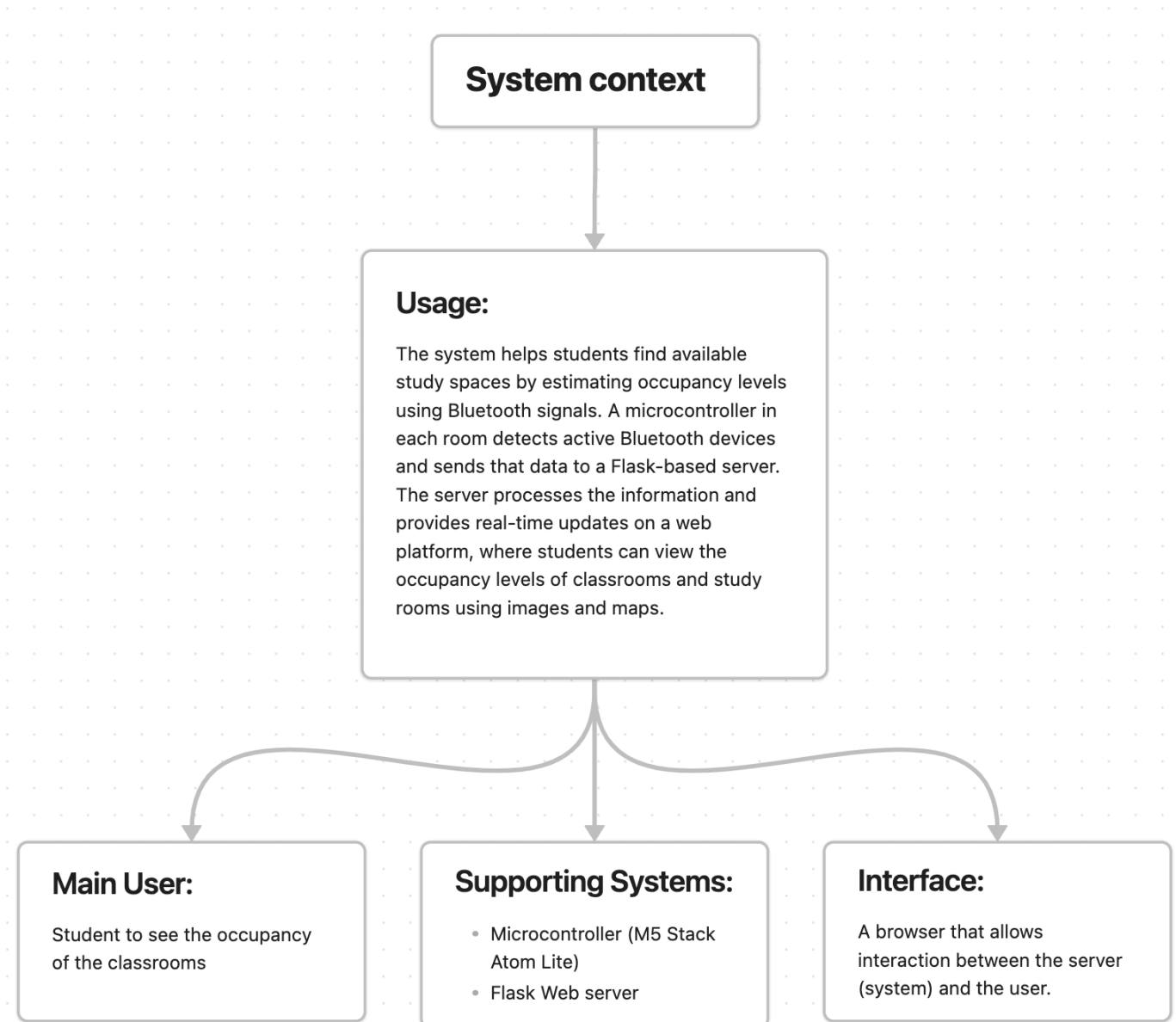
Report

Introduction

This project was developed as part of the *System Oriented Programming* course, with the goal of creating a system that estimates the number of people in specific university classrooms or study areas. The system uses Bluetooth technology to detect nearby devices, which acts as a proxy to estimate occupancy levels in real time.

Each room is equipped with a microcontroller (M5Stack Atom Lite) that periodically scans for Bluetooth-enabled devices within its range. The data collected is then used to estimate the amount of people and is sent to a central server, which processes the information and displays it on a web platform. This allows students to easily check which rooms are more or less crowded, helping them choose quieter places to study.

The main aim of the project is to simplify the process of finding available study spaces, using lightweight hardware and an accessible web interface that works in real time.



Project structure

The system architecture follows the C4 model to describe the various levels of the application, from general context to internal components. It is divided into three main parts:

Microcontroller

The microcontroller (M5Stack Atom Lite) is installed in each classroom. It is responsible for:

- Scanning the room for nearby Bluetooth devices using BLE.
- Estimating the number of people present based on detected devices.
- Sending this data in JSON format to the server via HTTP POST requests.
- Managing Wi-Fi connection configuration and communication logic.

Flask Server

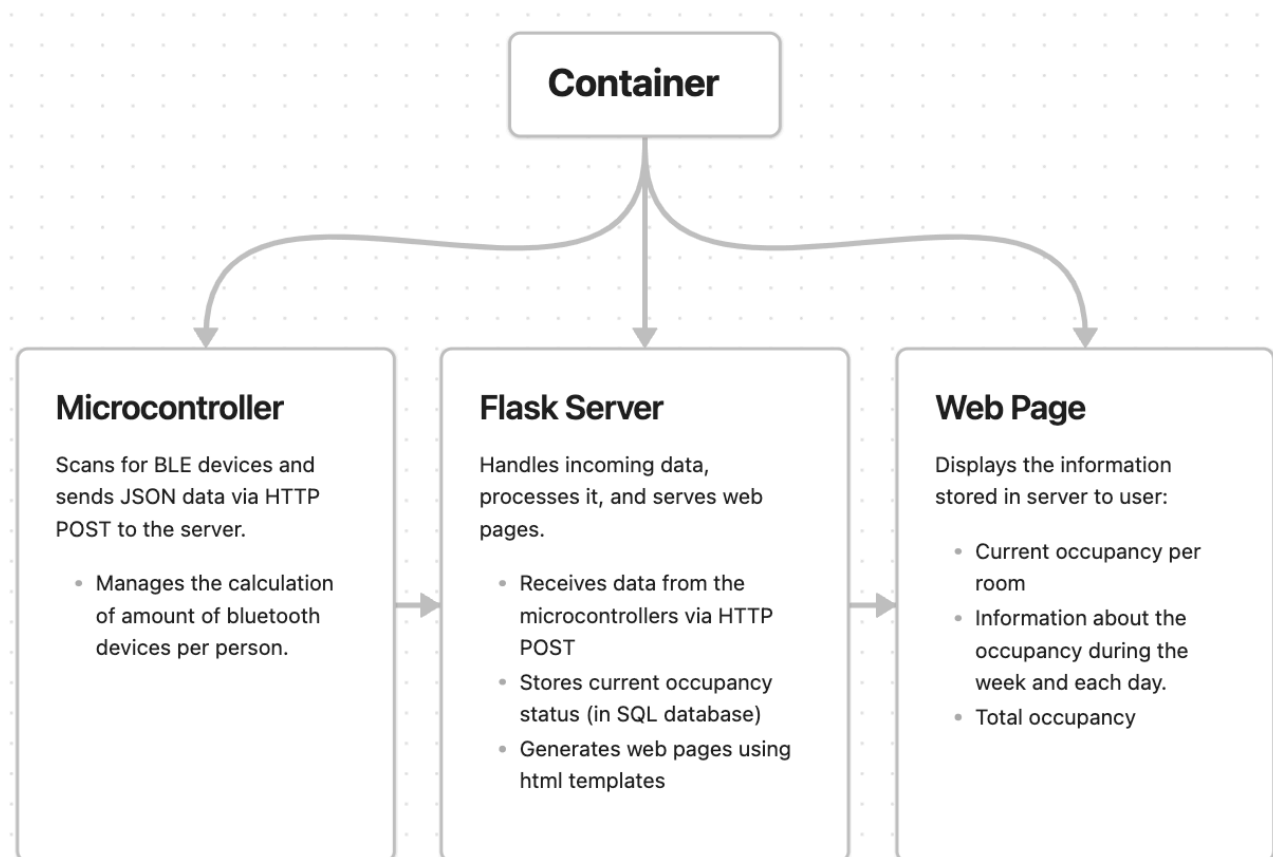
The central Flask server acts as the brain of the system. It handles:

- Receiving occupancy data from multiple microcontrollers.
- Storing and updating the current room occupancy in a SQL database.
- Rendering and serving dynamic web pages using HTML templates, filled with real-time occupancy data.

Web Page (Frontend Interface)

The web page is what the student sees in their browser. It provides:

- A user-friendly view of occupancy data per room.
- A visual layout (such as maps or room diagrams).
- Information such as current occupancy, daily summaries, or weekly trends (planned for future implementation).



The user interacts only with the web page, while all background processing (Bluetooth scanning, data handling, rendering) is managed by the microcontroller and server.