

Genie's Lamp

IoT Intelligent Streetlight Network

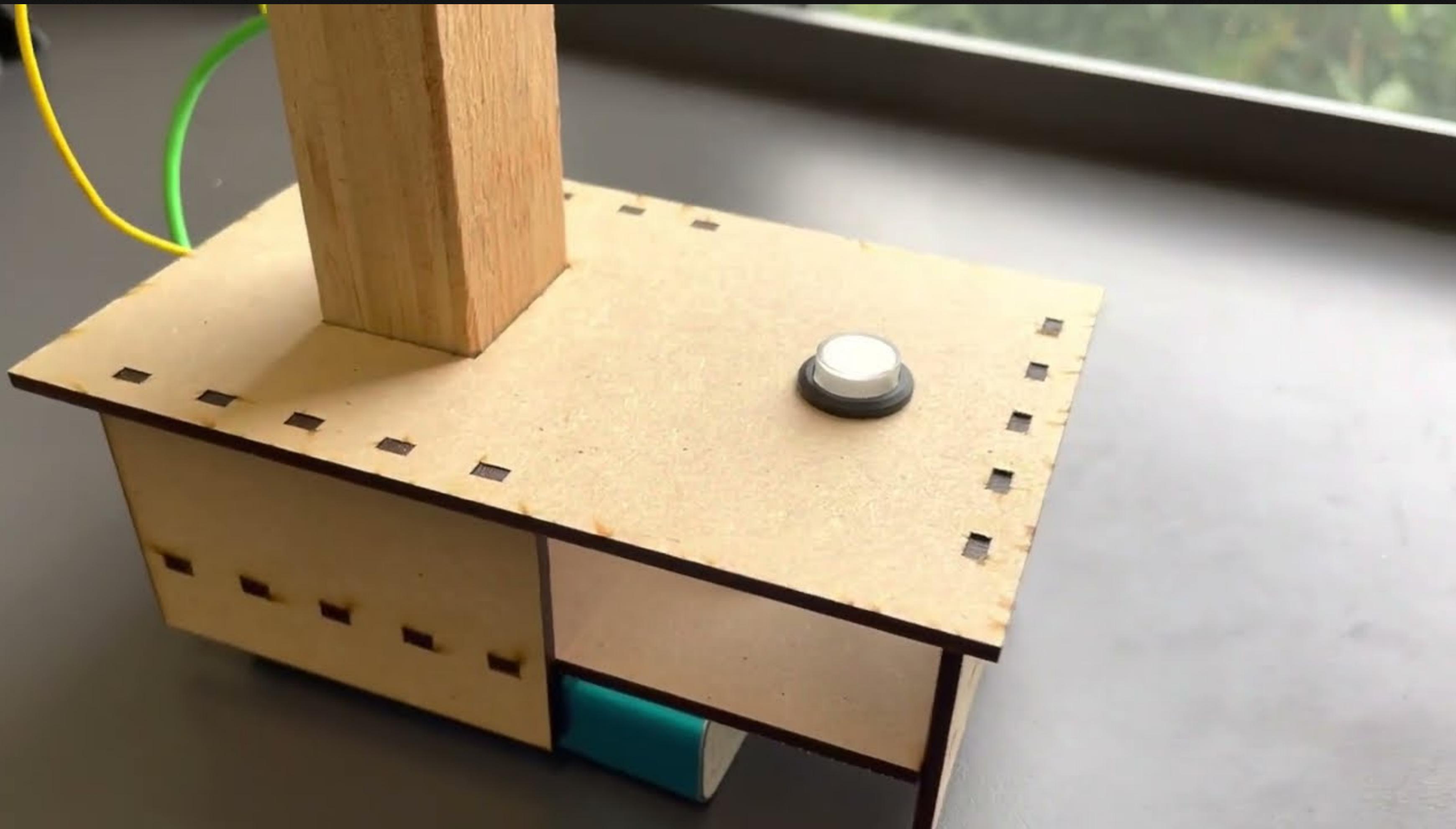
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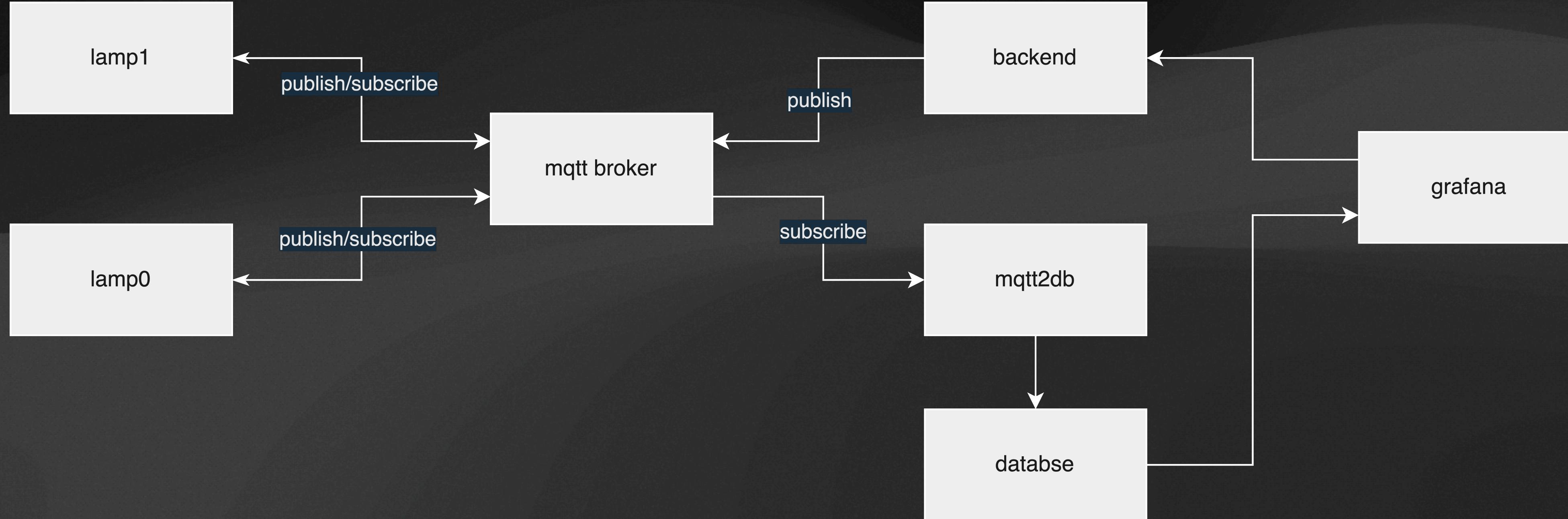
Motivation

- Streetlight is an essential element in modern city at night
- Reduce costs and conserve energy by brightness control and scheduling
- IoT node with weather observation and traffic monitoring function

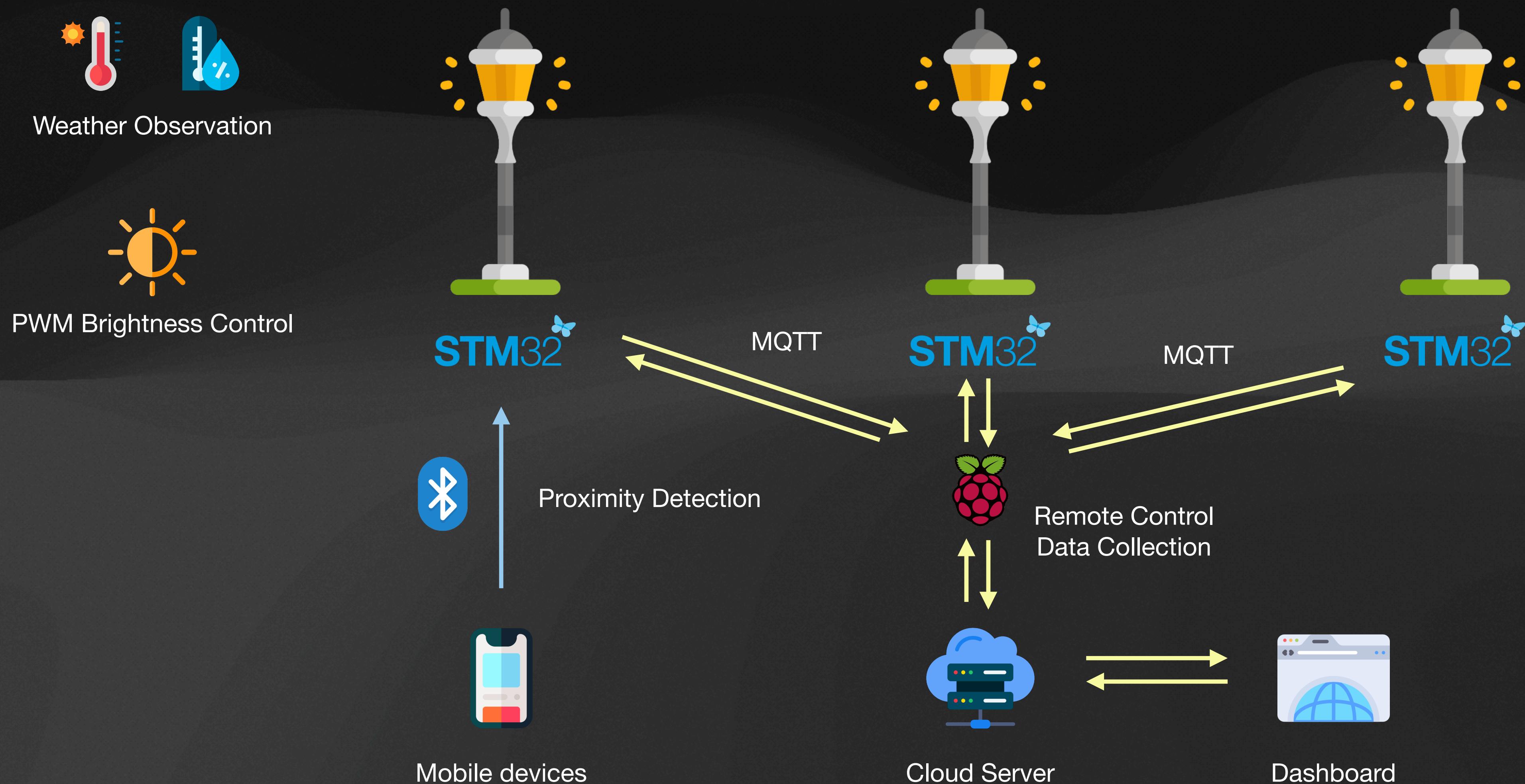
Our Lamp



System architecture



Framework



Implementation

Data Transmission

- Wifi node
 - MQTT
 - Auto reconnection
- Web dashboard
 - Grafana



Implementation

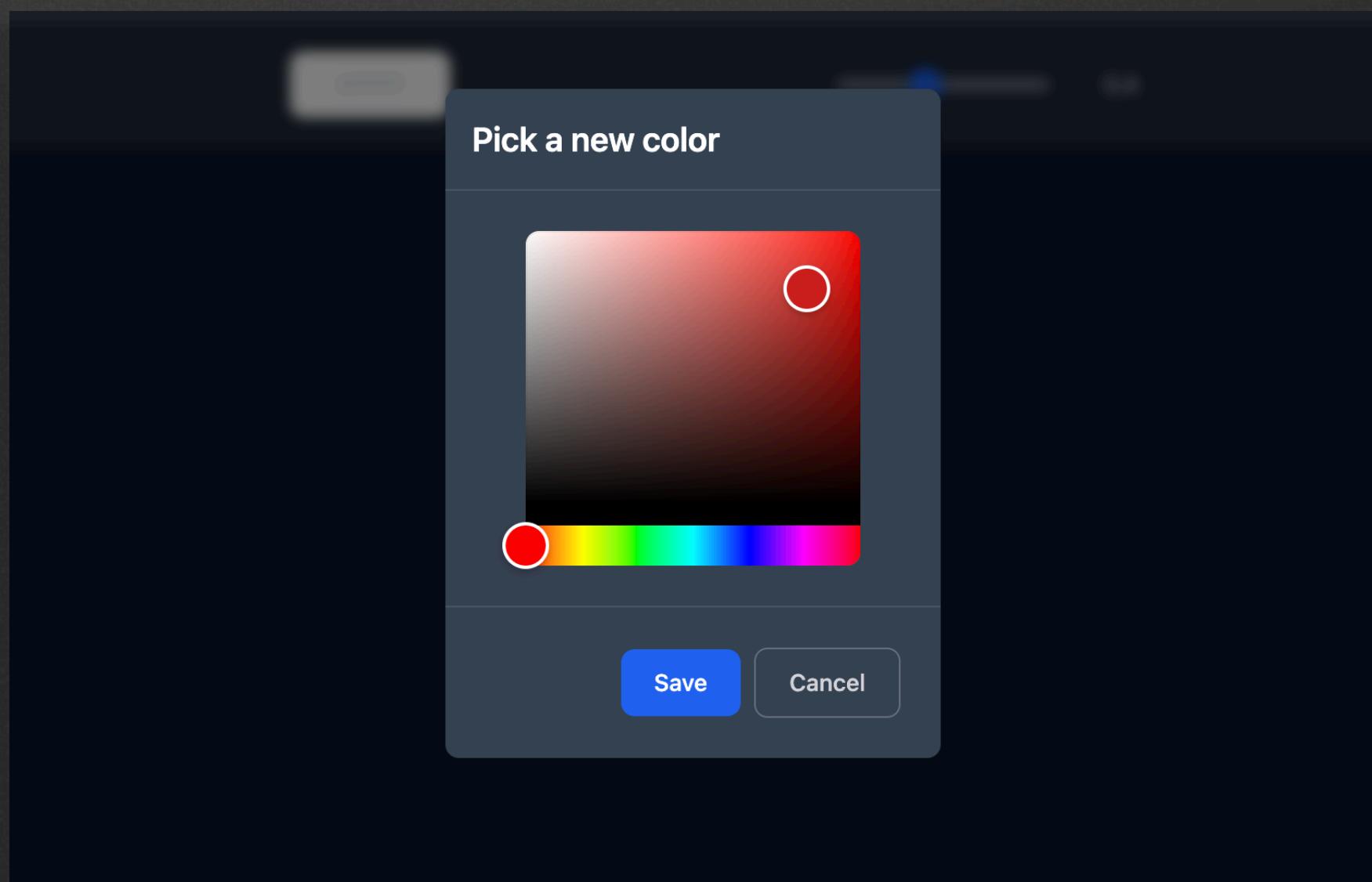
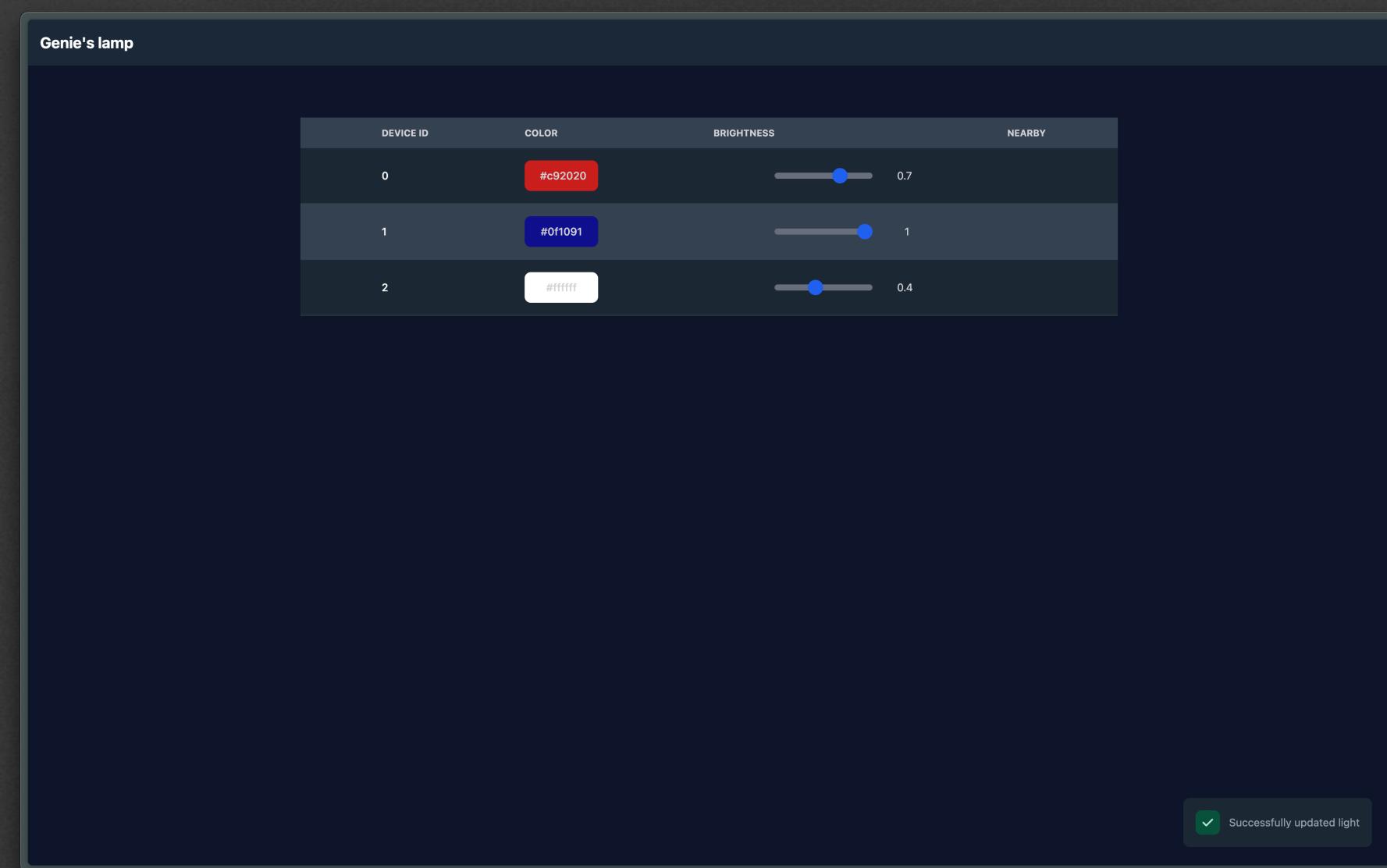
MQTT

- MQTT client communicating in QoS0
- Each device has a unique id to avoid
- Publish sensor data every 1000ms and emergency report
- Subscribe to brightness control according to their id

Implementation

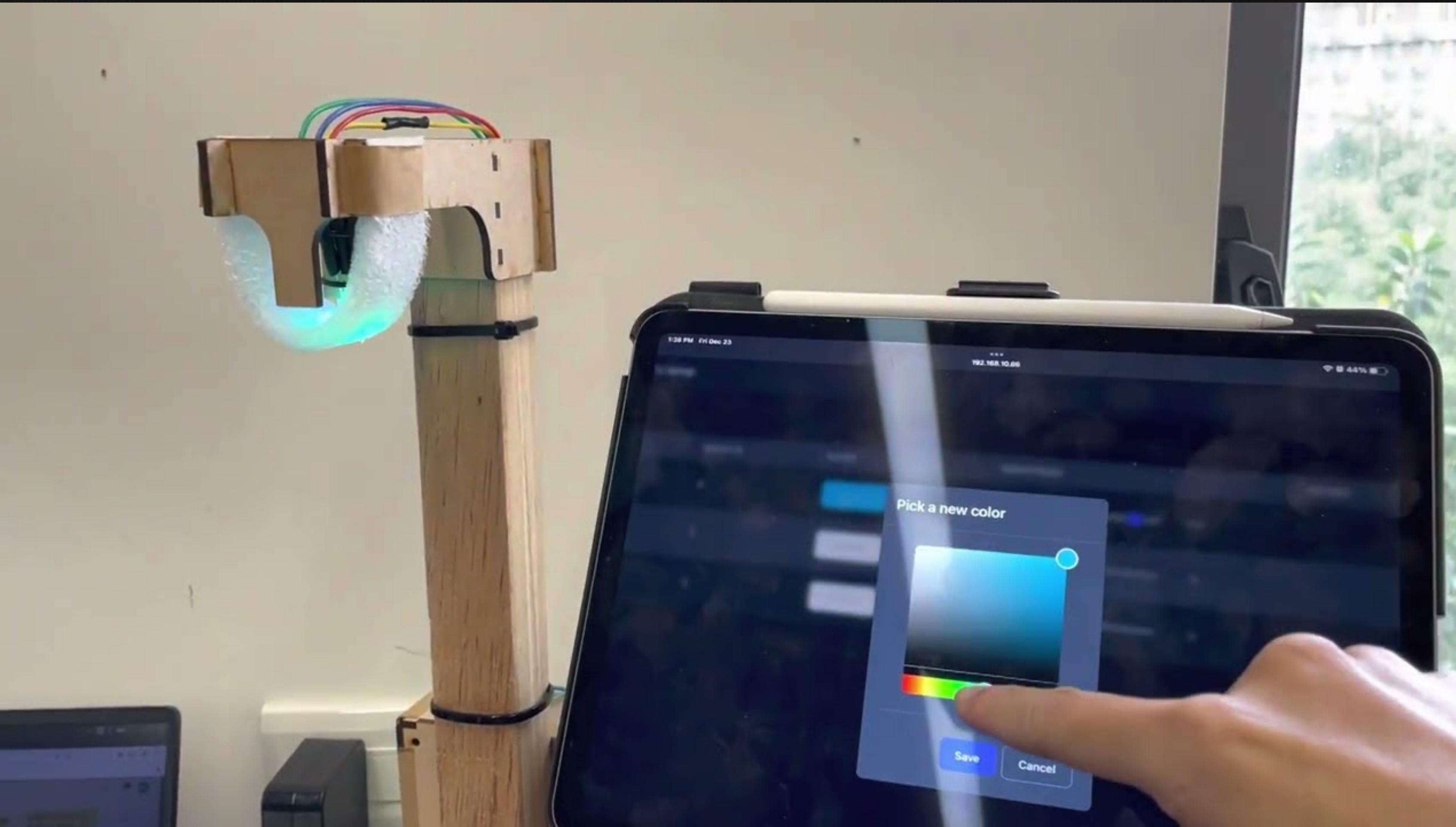
Color & Brightness Control

- Control brightness and color with three PWM input
- Turn on the light when people pass by
- Detect if people pass by via BLE signal strength



Implementation

Color & Brightness Control



Implementation

Proximity Detection

- Detect if people pass by via BLE signal strength
- Recognize service name to filter out unwanted advertisement



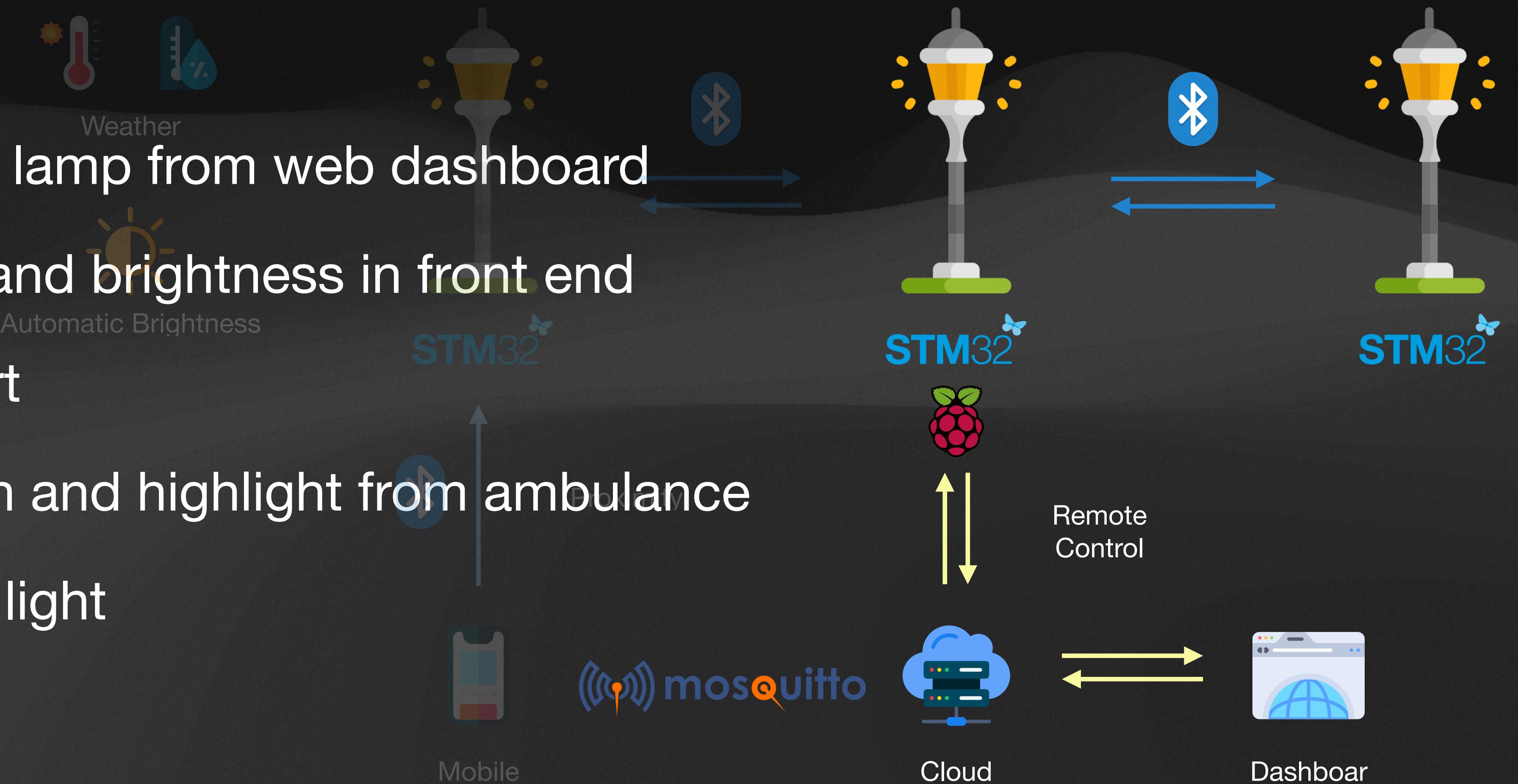
Implementation

Weather Observation

- Continuous weather observation with high time resolution (per second)
- Realtime weather observation
- Collect Temperature / Humidity / Pressure data and send to backend

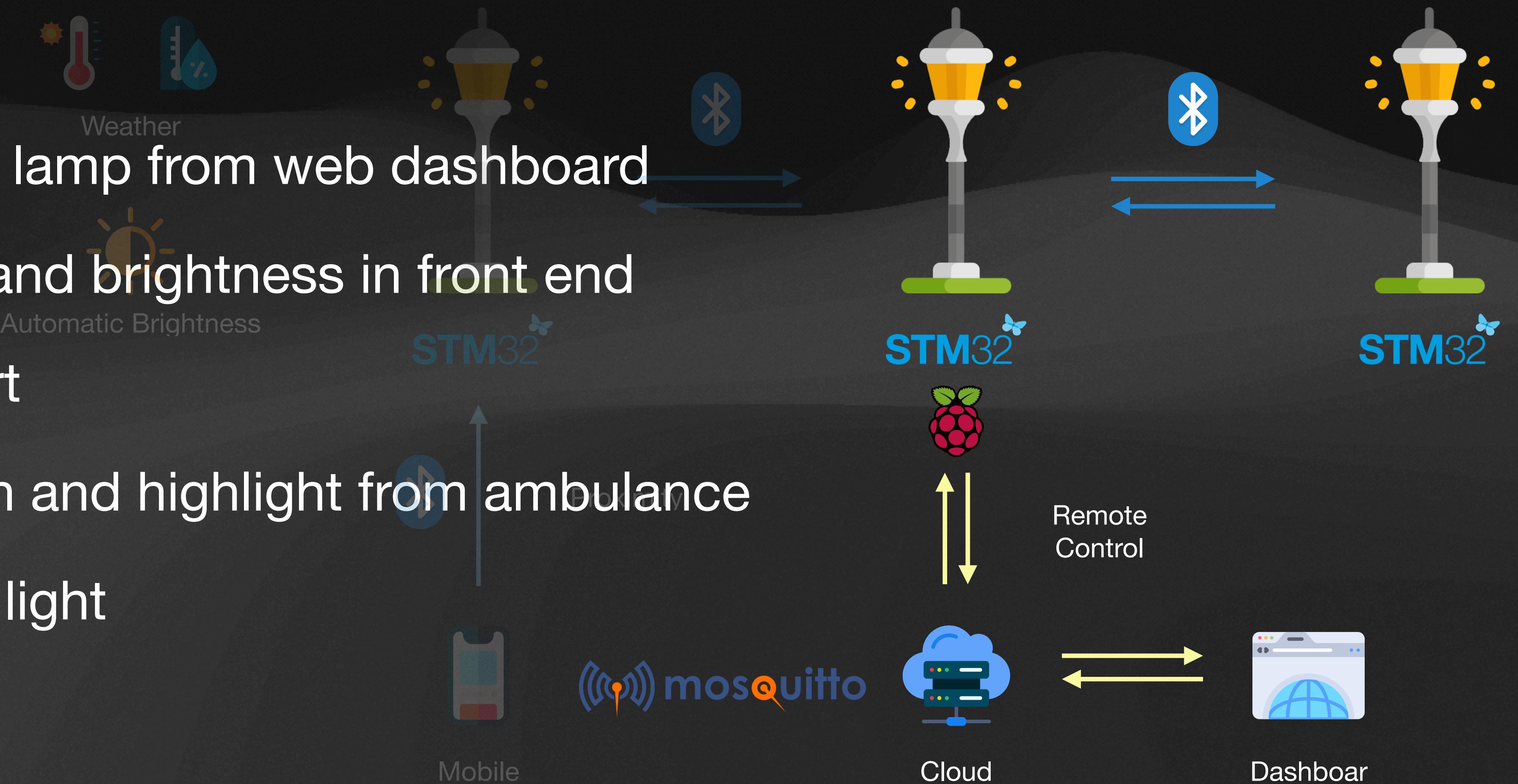
Features

- Remote access
 - Turn on/off the lamp from web dashboard
 - Change color and brightness in front end
- Emergency report
 - Report location and highlight from ambulance
 - Change to red light



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Features

- Brightness control
 - Use PWM to control the brightness
 - Remote Control and Scheduling
- Proximity detection
 - Bluetooth signal intensity
 - Report lost item or anomaly



Weather



Automatic Brightness



STM32



Proximity



Mobile



STM32



Cloud

Demo

Implementation Details

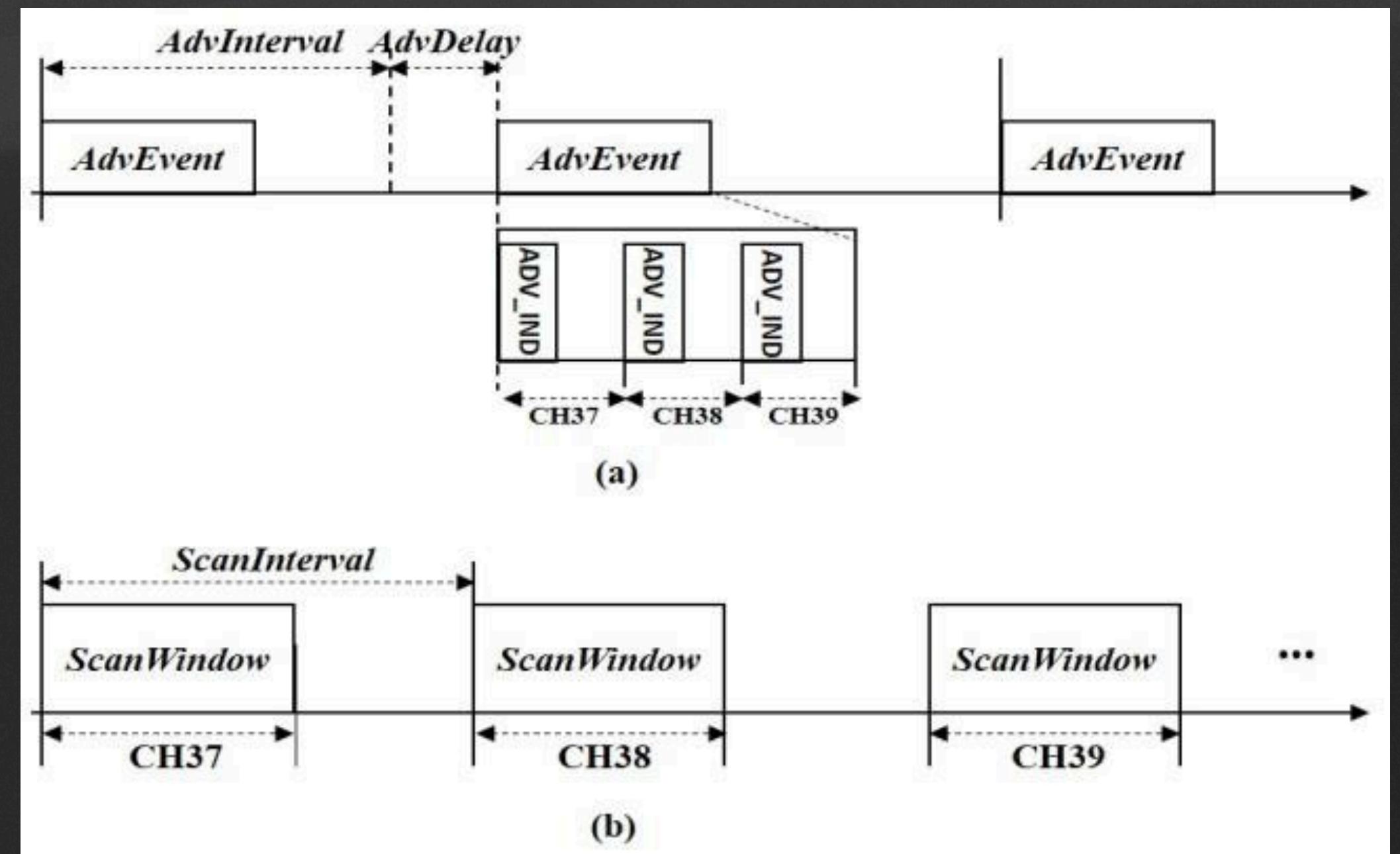
MQTT

- Host a MQTT broker on RPi
- Using library <https://github.com/kvaellning/mbed-mqtt>
- Subscribe color/brightness from server
- Publish status to server

Implementation Details

BLE Scan

- Using GAP to scan
- Use EventQueue to schedule event asynchronously
- Stack overflow
- Parameters hard to tune



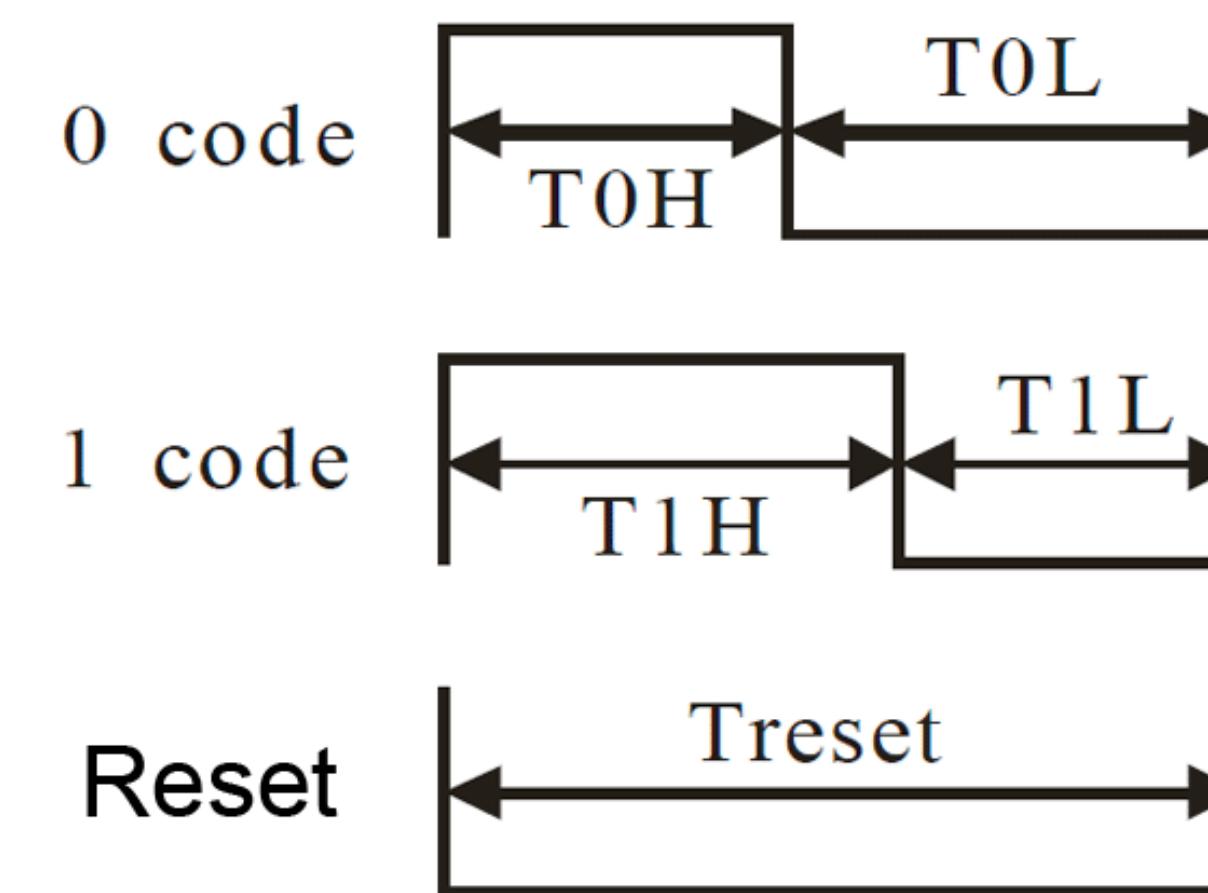
Implementation Details

PWM

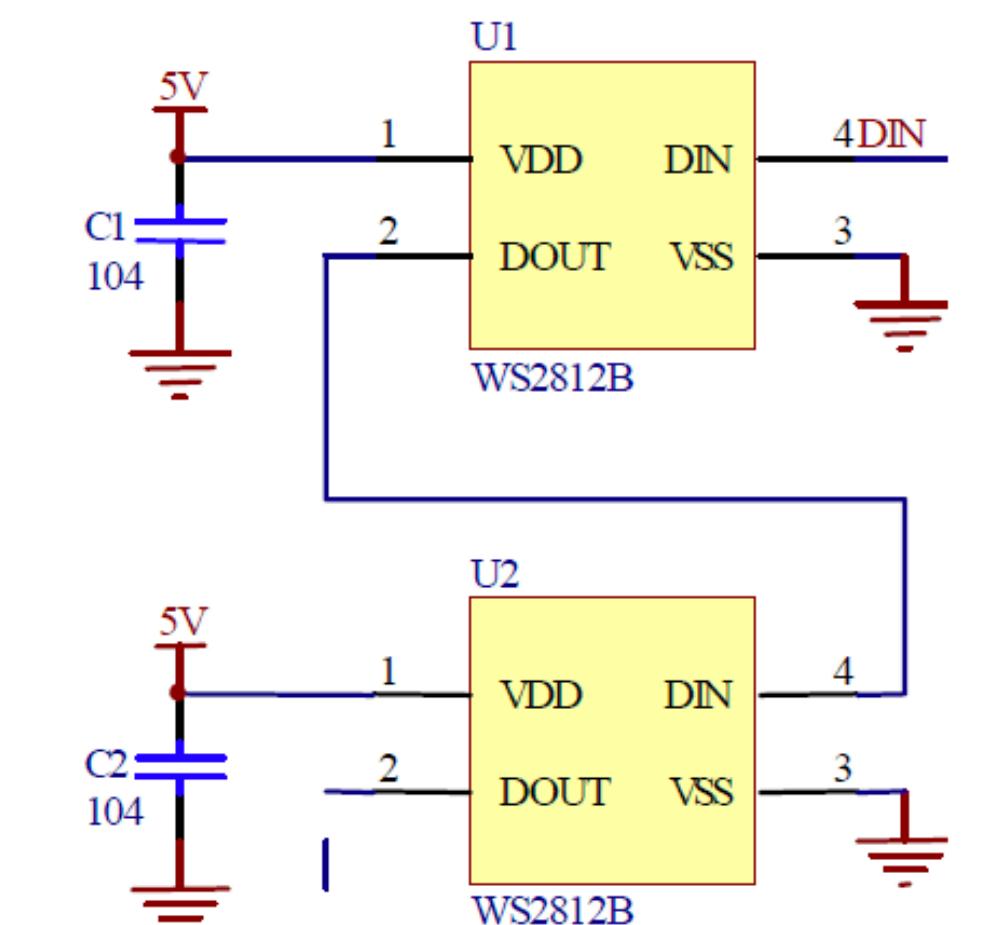
- Originally want to use WS2812 LED strip
- PWM-like signal
- Resolution not enough



WS2812 Protocol



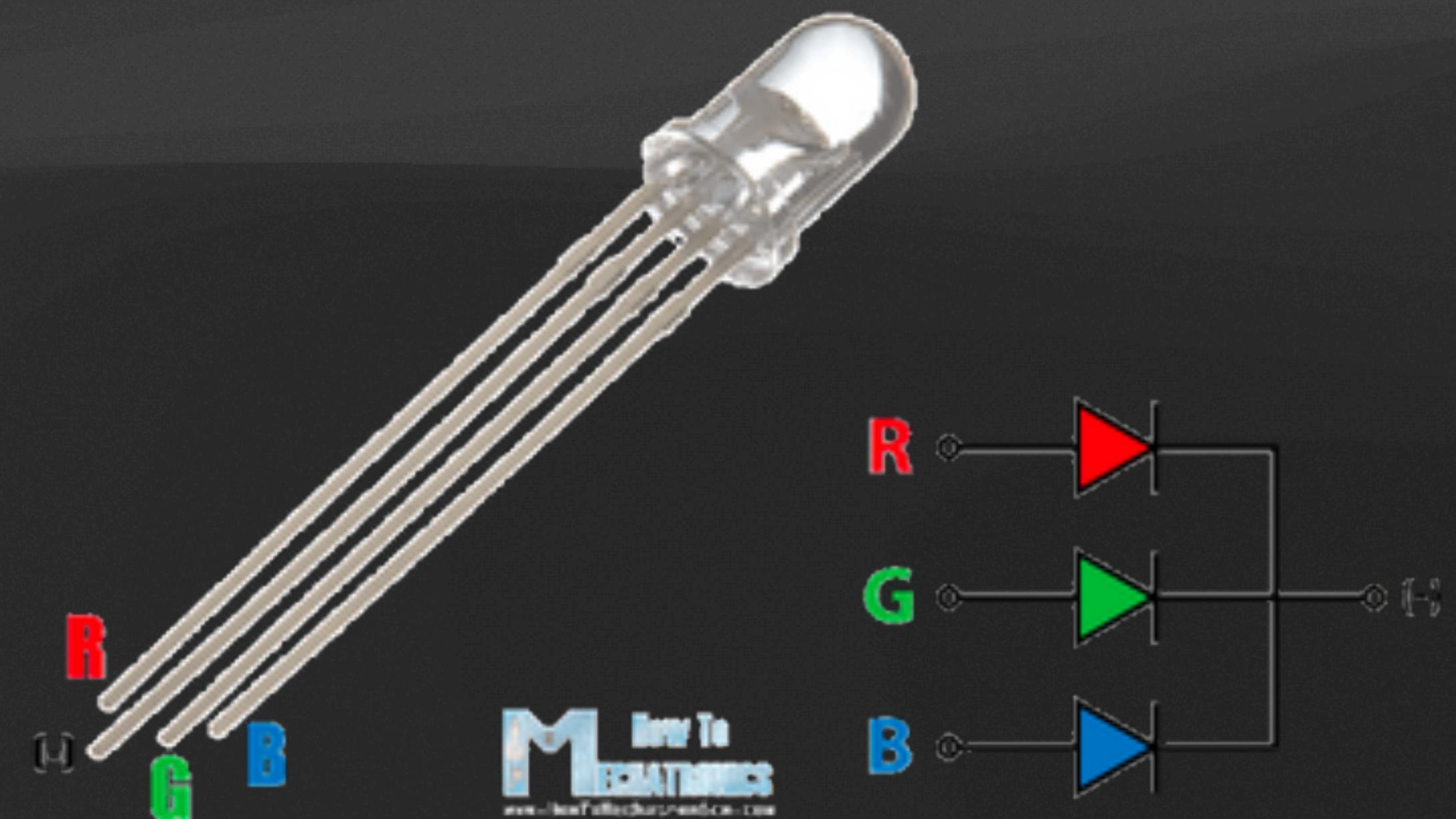
LED-Chain



Implementation Details

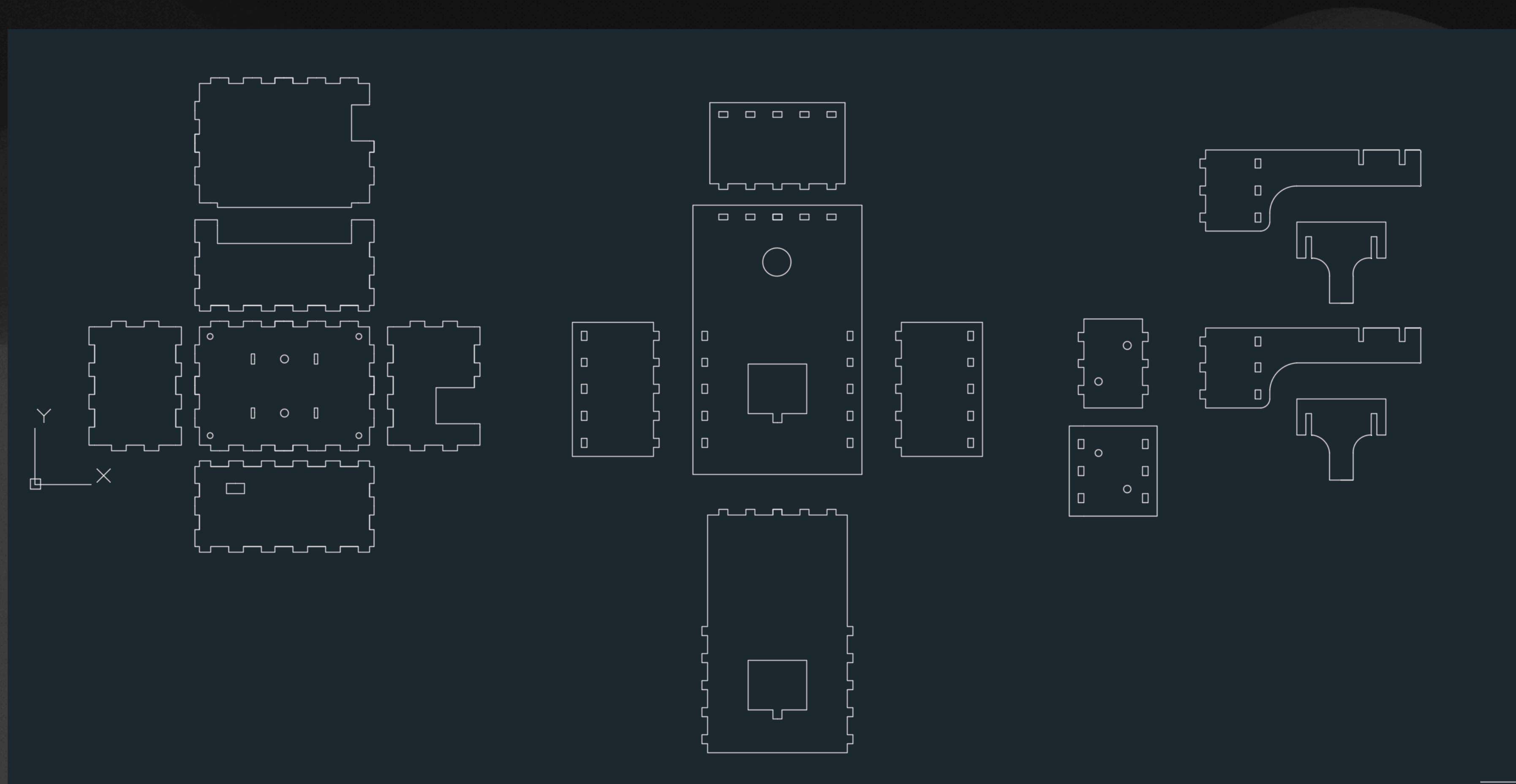
PWM

- RGB Led
- Use three channel PWM to control the color



Implementation Details

AutoCad & wire routing



Implementation Details

Button

- Pull-down resistor
- InterruptIn / DigitalIn

Project Links

GitHub & Demo Videos

- GitHub: <https://github.com/ESlab2022/genies-lamp.git>
- Demo Videos: <https://www.youtube.com/playlist?list=PLawsXeNez7n5Mb2bx2FjdouRDJQLOGS2z>

References

- STM32 BLE Mesh:
https://www.st.com/content/st_com/en/support/learning/stm32-education/stm32-moocs/STM32WB_Networking_BLE_MESH_MOOC.html
- Proximity Control:
<https://circuitdigest.com/microcontroller-projects/ble-based-proximity-control-using-esp32>
- Smart Streetlight:
<https://www.mokosmart.com/smart-street-lighting-using-iot/>
<https://pianalytix.com/street-light-monitoring-system-using-iot/>