NextRoom

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Repository
https://github.com/LuigiSigillo/IotBigProject

Changes from 1° delivery

The main changes from the first delivery are:

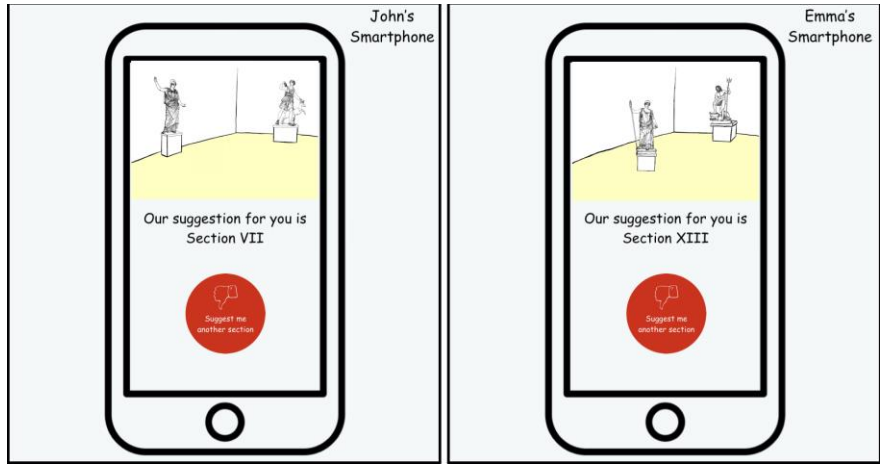
- We faced the problem of the COVID-19 and limited accesses to the museum in our system and redefined our solution taking into account this factor.

- After some tests we decided to discard the option to implement the communication between each board and Azure IoT Hub using LoRaWAN. The test we have done to make this decision will be later described.

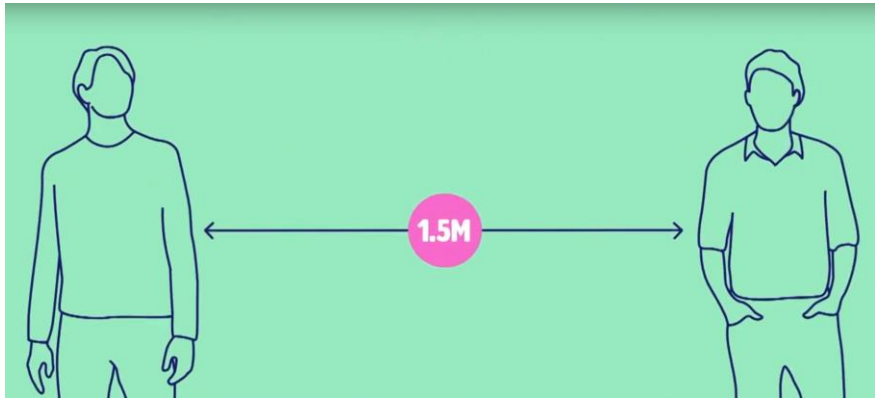
- Since we have the possibility to test on a physical board we have changed our plans to evaluate our system. Indeed now we can do better evaluation tests, and discarded the possibility to use Fit IoT Lab mobile robots.

The problems

- Personalized tours in the museum



- Museum visits during the COVID-19 emergency



Our solution for personalized tours

- Web application that runs on a smartphone
- During a tour suggests the next section you could visit based on the time you have spent in the previous sections
- The application will display a preview of the suggested section
  - The user could choose to follow it or to jump to another suggestion.
- The suggestions are sent every time a user is leaving a section

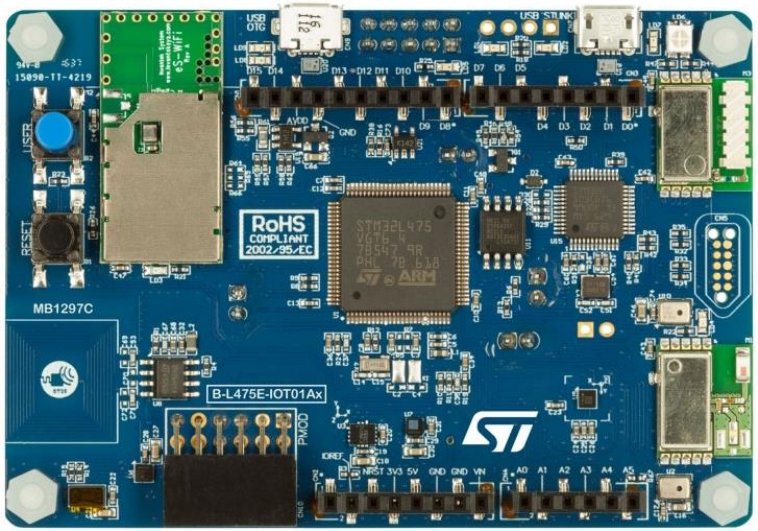
Our solution to avoid gatherings

Solve the crowd problem of our personalized tour in these times in which sections cannot be overcrowded:

- Dashboard for the curators of the museum to monitor the number of people in the different sections of the museum.
- Added features to try to equalize the number of people in each section.
  - Suggest the most interesting section for the visitor and, at the same time, try to avoid the formation of gatherings

Architecture

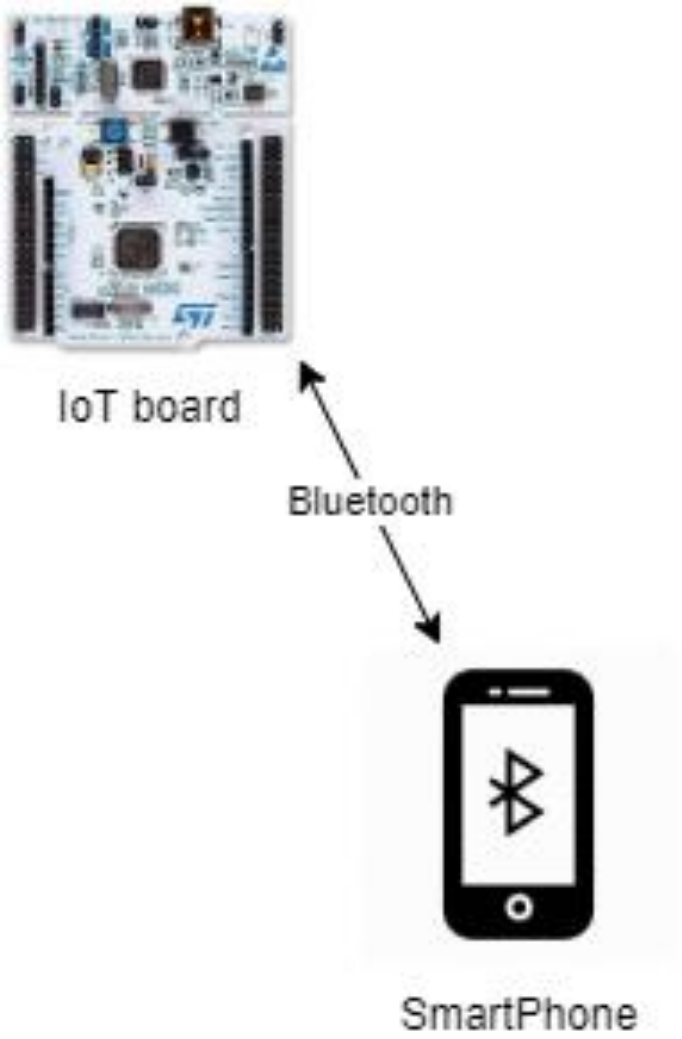
B-L475E-IOT01A Discovery kit



- Ultra-low-power STM32L4 Series MCUs based on Arm® Cortex®-M4 core with 1 Mbyte of Flash memory and 128 Kbytes of SRAM
- Bluetooth® V4.1 module (BLE technology)
- 802.11 b/g/n compliant Wi-Fi® module from Inventek

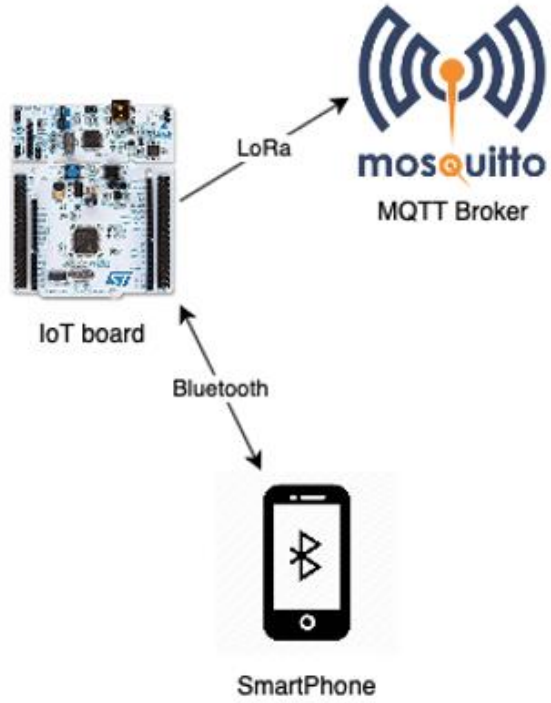
arm MBED OS

Typical scenario



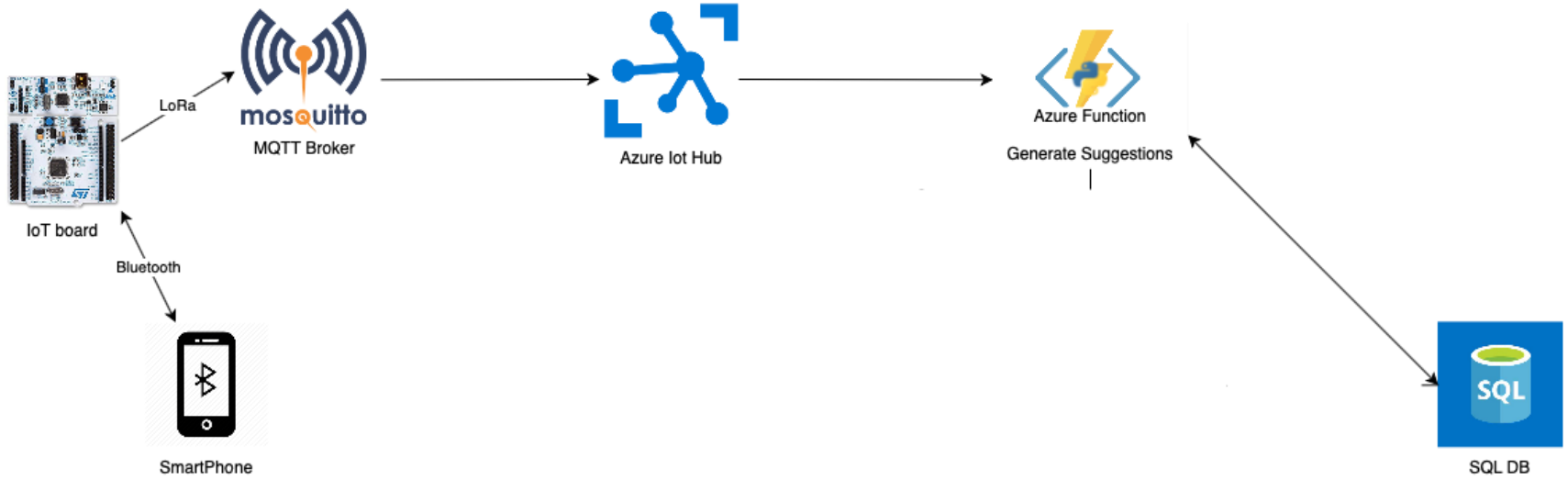
- BLE technology
- Bluetooth beacon functionality

MQTT Protocol



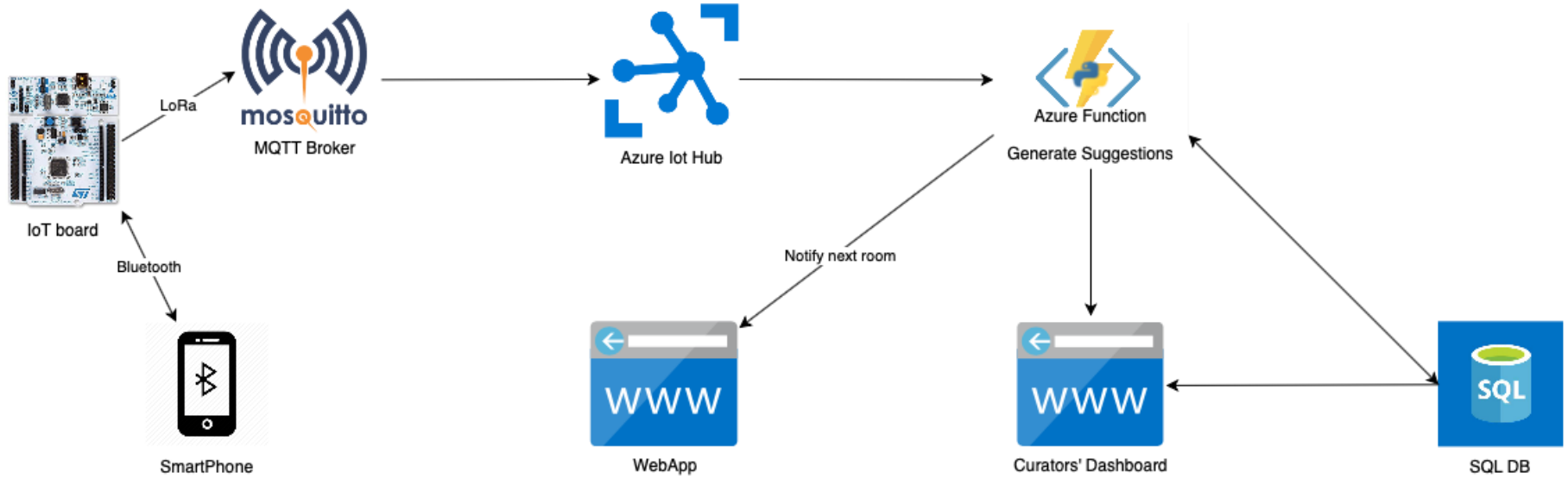
- MQTT protocol
- Eclipse Mosquitto MQTT Broker

Cloud Services



- Azure Cloud services
  - Azure Function
  - Azure IoT Hub
  - Azure SQL DB

The complete flow



- Azure App service will host the Web Application

Technical work done so far

Our work, from a technical point of view up to now is:

1. We have implemented the cloud infrastructure to make the system work:
    i. An SQL database with all the necessary tables to maintain useful data to be processed by our system.
    ii. We implemented a scoring algorithm that takes into account the similarity between recent visits and t he current visit, and the number of people that is currently in each section.
2. We have a starting version of the web application that gives suggestion about the next room t o visit, taking into account the taste of the visitor and the crowding situation in each section.

Technical work for the last delivery

1. The boards in our future plans
   have to communicate to reach a consensus about the final list of devices in each section, moreover they have to send this list to the cloud.
2. We do not know if the
   board can handle this load. Otherwise the computation will be done using the computati onal power of the cloud as we do now.
3. The curators dashboard

Evaluation

Technical Evaluation

- LoRaWAN and TTN not used anymore.
  - 60% of message loss with TTN.
- MQTT with Eclipse Mosquitto broker

Pricing Evaluation

Board Pricing

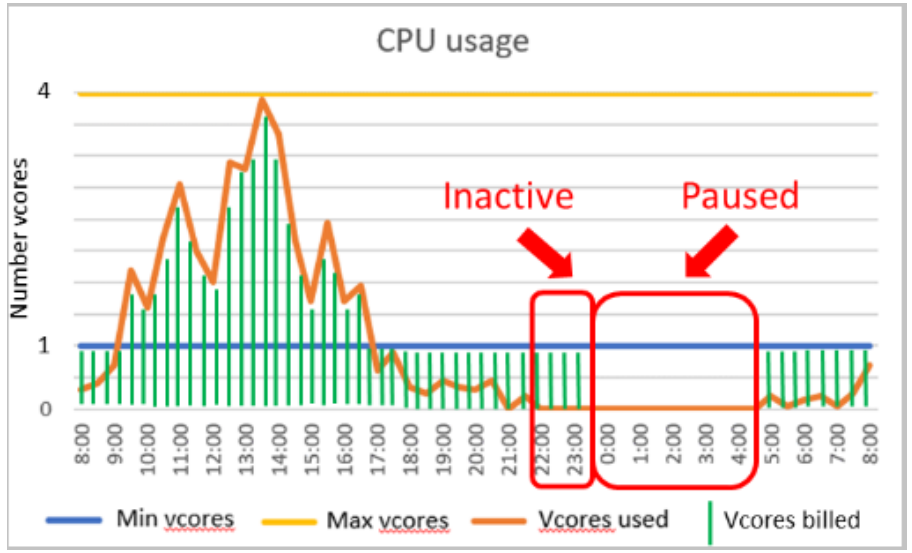
- The board used is the B-L475E-IOT01A Discovery kit that has a retail price of about 50€
- Considering at least two rooms per section, the estimated cost will be around 500€

Cloud Pricing

- Azure Function: the first 400,000 GB/s of execution and 1,000,000 executions are free. T hen you pay what you consume (serverless)
- App service: The basic plan cost around 60€, for testing purpose we will use the free one.
- Azure SQL Database: We choose to use the serverless option also in the DB, we use the m aximum size of 15GB but it is possible to use more space.

Pricing Evaluation

Microsoft Azure Estimate					
Your Estimate					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Azure Functions		France Central	Consumption tier, 128 MB memory, 100 milliseconds execution time, 0 executions/mo	€0,00	€0,00
App Service		France Central	Basic Tier; 1 B1 (1 Core(s), 1.75 GB RAM, 10 GB Storage) x 730 Hours; Windows OS	€57,87	€0,00
Azure SQL Database		France Central	Single Database, vCore Purchase Model, General Purpose Tier, Serverless, Gen 5, 1 Billed vCores, 16 GB Storage, 0 GB Backup Storage	€2,49	€0,00
Support			Support	€0,00	€0,00
			Licensing Program	Microsoft Online Services Agreement	
			Total	€60,36	€0,00



Evaluation for the last delivery

1. We have to test whether our cloud architecture is efficient enough for our purposes, our target remains to manage 20 devices per room.
    1. So we will perform a simulation, through a Python script, sending data to the cloud and analyzing the behavior of our algorithm, taking into account that saving data to the DB, from what we have experienced so far, is an important bottleneck
2. Evaluation of MQTT (we have to repeat a similar experiment using MQTT)

Technical Evaluation

- We will do a technical evaluation performing load tests on all parts of our system:
  - **BLE** IoT device-Smartphone interaction: how many smartphones a single device can handle?
  - **Cloud** IoT device-Cloud interaction: what is the message rate with which the device can send messages to Azure IoT hub?
  - **Responsiveness** Cloud-Smartphone interaction: how fast the smartphone receives the advice on where to go, does it depend from the number of connected devices?

Thank you for listening