NextRoom

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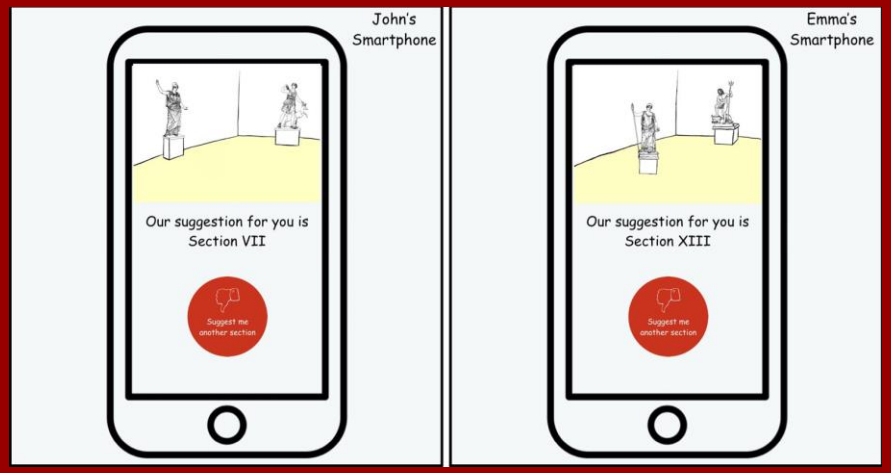
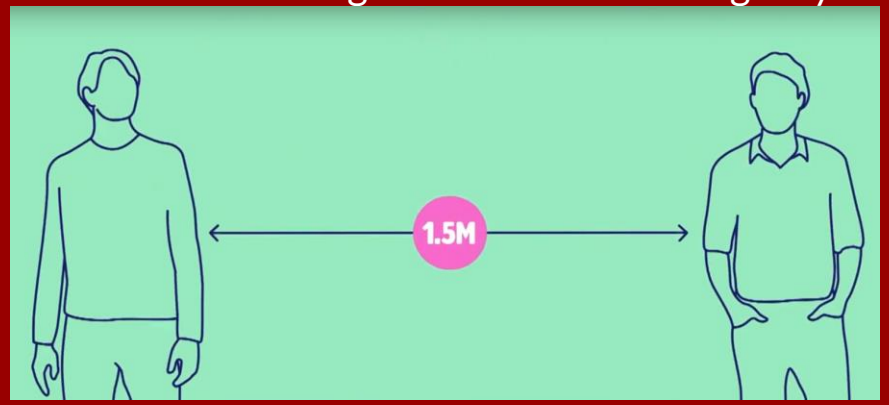
Repository
https://github.com/LuigiSigillo/NextRoom

The problems

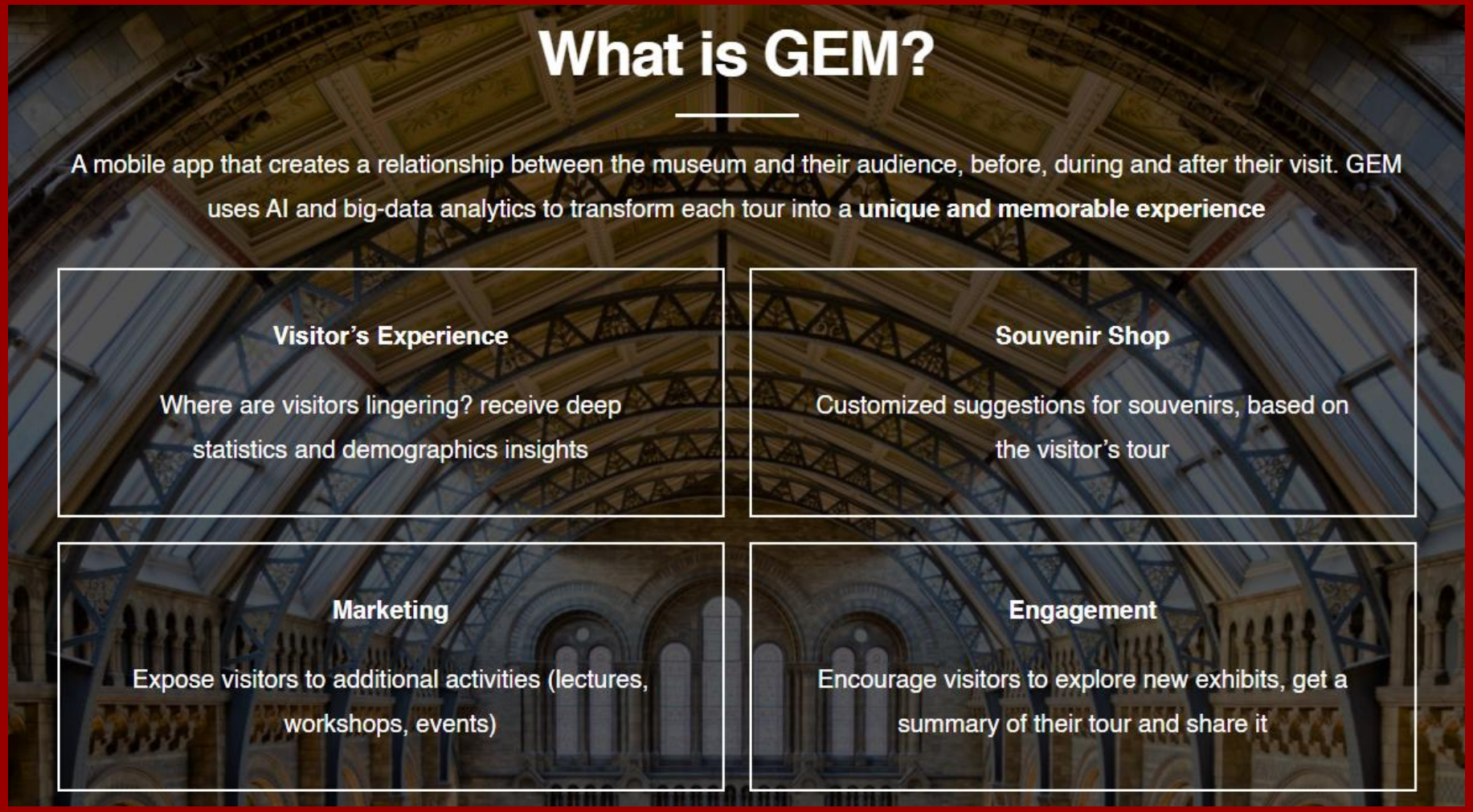
- Personalized tours in the museum



- Museum visits during the COVID-19 emergency

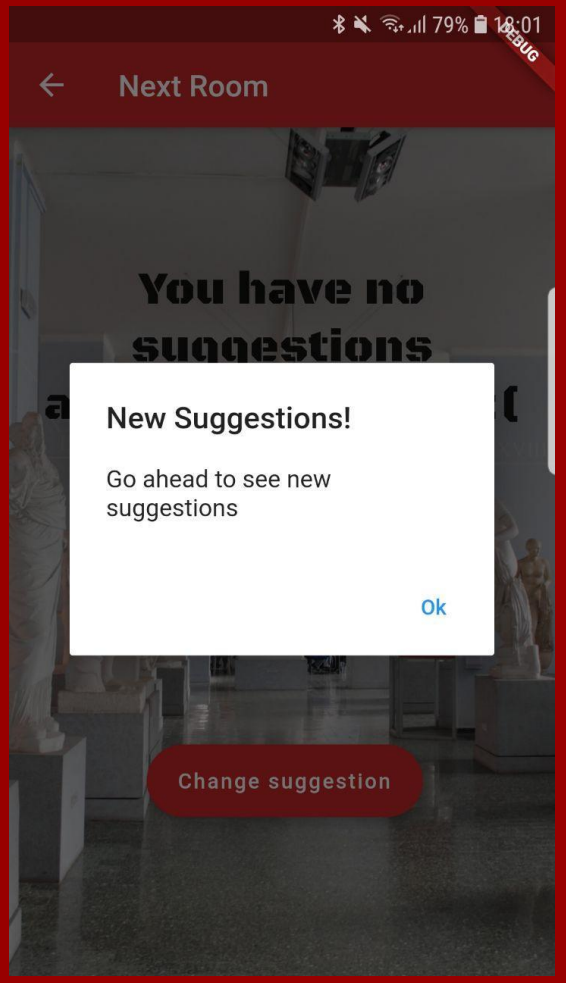


Existing approaches



Our solution for personalized tours

- Mobile application available for both iOS and Android
- 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



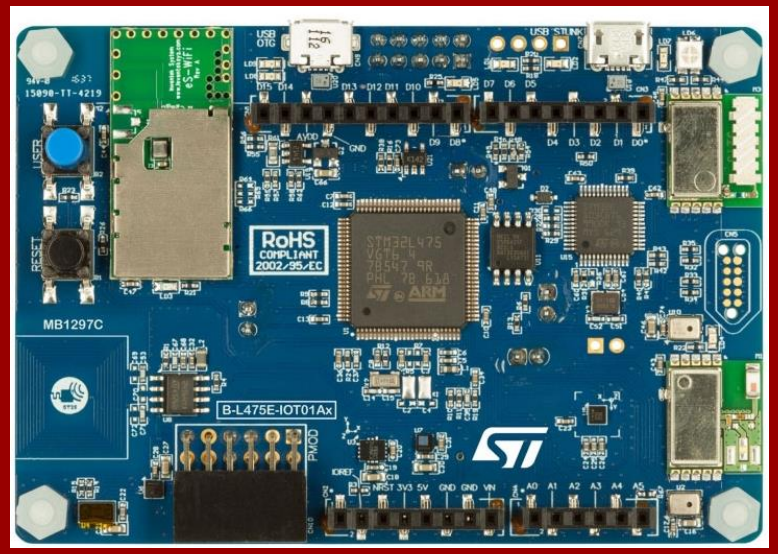
Our solution to avoid gatherings

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

- 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
- Estimating the proximity of two different visitor and check if they are respecting the security distance.

Hardware Components

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

Software services

IoT components

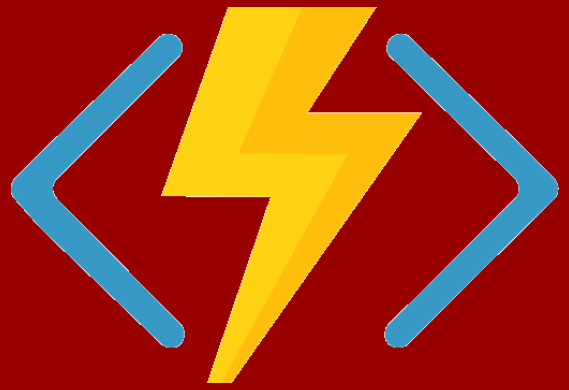
- Eclipse Mosquitto as MQTT broker

- Azure IoT Hub

Azure IoT Hub

Cloud components

- Azure Function to calculate the suggestion

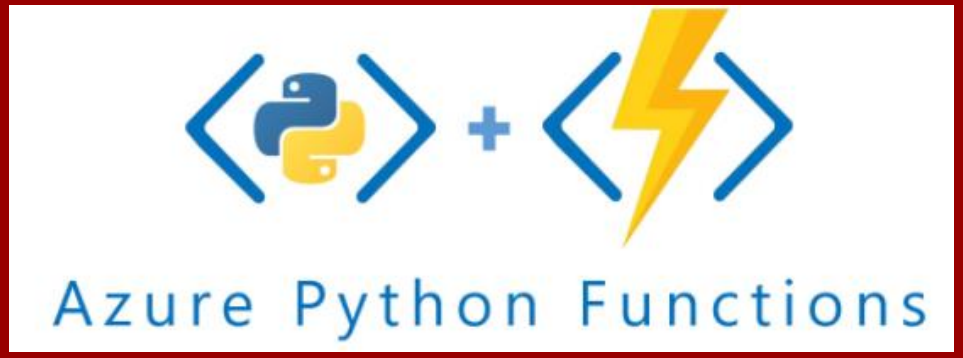


- Azure SQL DB to store the data

Programming languages used

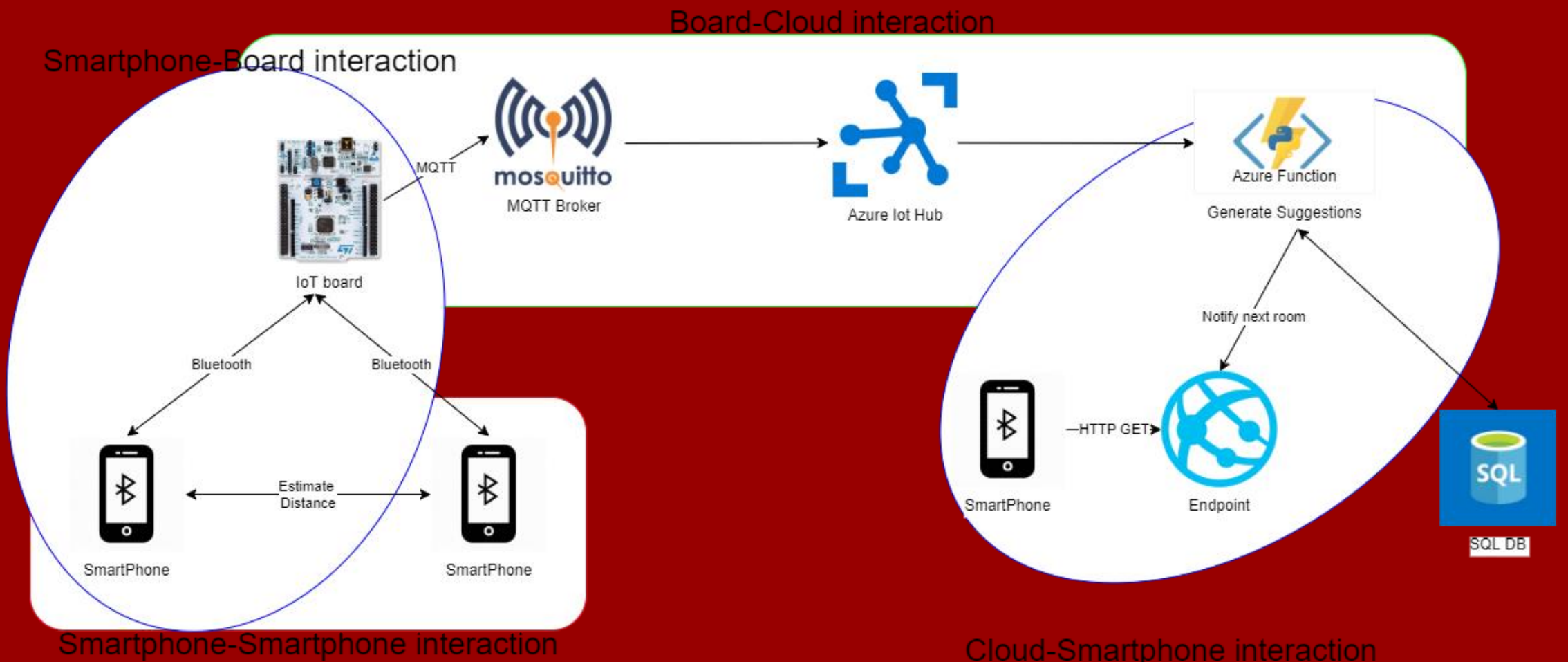
- c++ to write the code for the IoT board using Mbed OS

- Python for the suggestion algorithm and the data persistence



- Dart to write the code for the mobile application using Flutter

Network diagram



Evaluation

UX evaluation

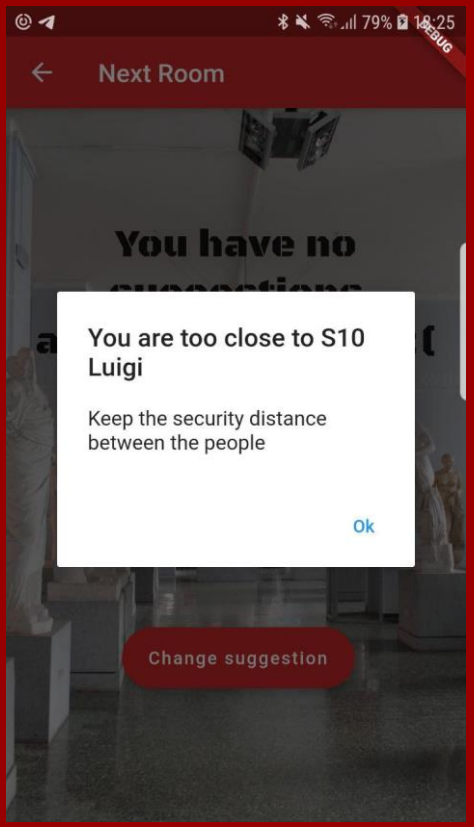
- We could not evaluate it giving a try in a museum to a user and asking him or her for feedback
- We evaluated our application and in particular, the user interface and its interactivity, giving people the application or videos of the application running on a smartphone.
- One feedback that we have collected was to create multiple suggestions and to let the user choose the suggestion he or she likes the most. This is a fix that we have already implemented, as we said above.
- The other main feedback that emerged from this kind of evaluation is that it could be cool if the application presents a map of the museum with the spot in which the user is, and the room he or she is suggested to visit. We did not yet implement this feature, although we believe this is a great idea. This feature will certainly be part of our future works.

Technical Evaluation

- We have done 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?
    - We conducted a simulation using the same device to connect to the board within a short period of time before it sends the list of devices to the cloud and empties the list. The results that we obtained were pretty good because the board could send an MQTT message with an average of 14 session IDs with the current parameters. But we found out that this is the bottleneck of our system.
  - **Cloud** IoT device-Cloud interaction: what is the message rate with which the device can send messages to Azure IoT hub?
    - We have performed a simulation, through a Python script, sending data to the cloud and analyzing the behaviour of our algorithm. We discovered that saving data to the DB, is an important bottleneck, so we have decided to collect the data from the board at least every 30 seconds after the previous data collection.

Technical Evaluation

- We have tested the feature that aims to calculate the distance between two visitor, as we expected is not too precise. This is since every vendor use different Bluetooth sensor on their smartphone, so the RSSI at one meter that is used to estimate the distance is not a unique value.
    - We decided to introduce a threshold, if we detect that two people are too near to each other for more than three times we would notice to them.
- Over 50 different measurements now **40 are correctly classified**



	Results
Smartphone-Smartphone interaction	Precision at 1-meter: 0,8
Smartphone-Board interaction	Average handled devices: 14
Board-Cloud interaction	Executions per minute (20 devices): 2

Pricing Evaluation

Board Pricing

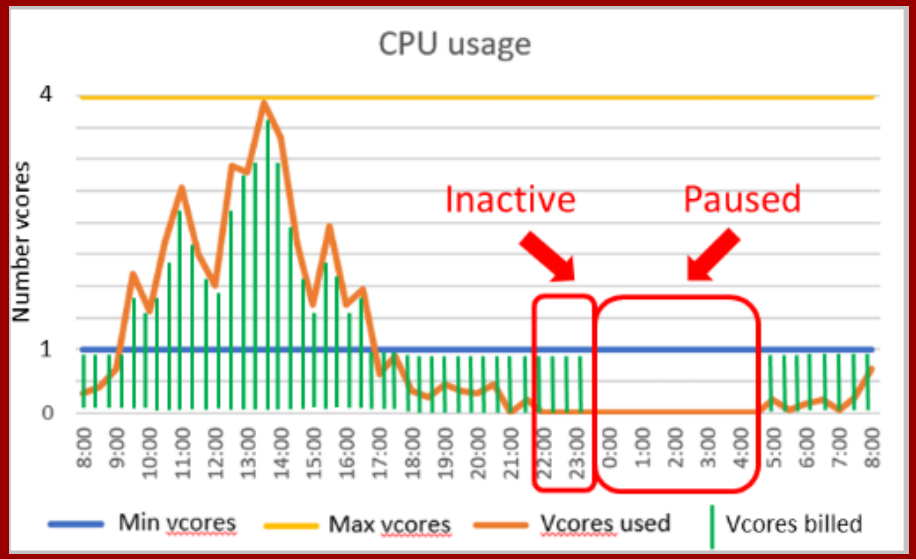
- The board used is the B-L475E-IOT01A Discovery kit that has a retail price of about 50€
- Considering at least two rooms per section, the estimated cost will be around 500€

Cloud Pricing

- Azure Function: the first 400,000 GB/s of execution and 1,000,000 executions are free. Then 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 maxi mum 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



Future developments

- Improve the user experience of our application adding a map that shows the users current position and the position of the section/room suggested by the system
- Implement a Curators Dashboard to monitor the amount of people in each section and to better handle the people flow in the museum
- Improve the accuracy of the estimated distance via Bluetooth adding other parameters than the RSSI

Thank you for listening