Smart Jugs

IoT - Project

Authors

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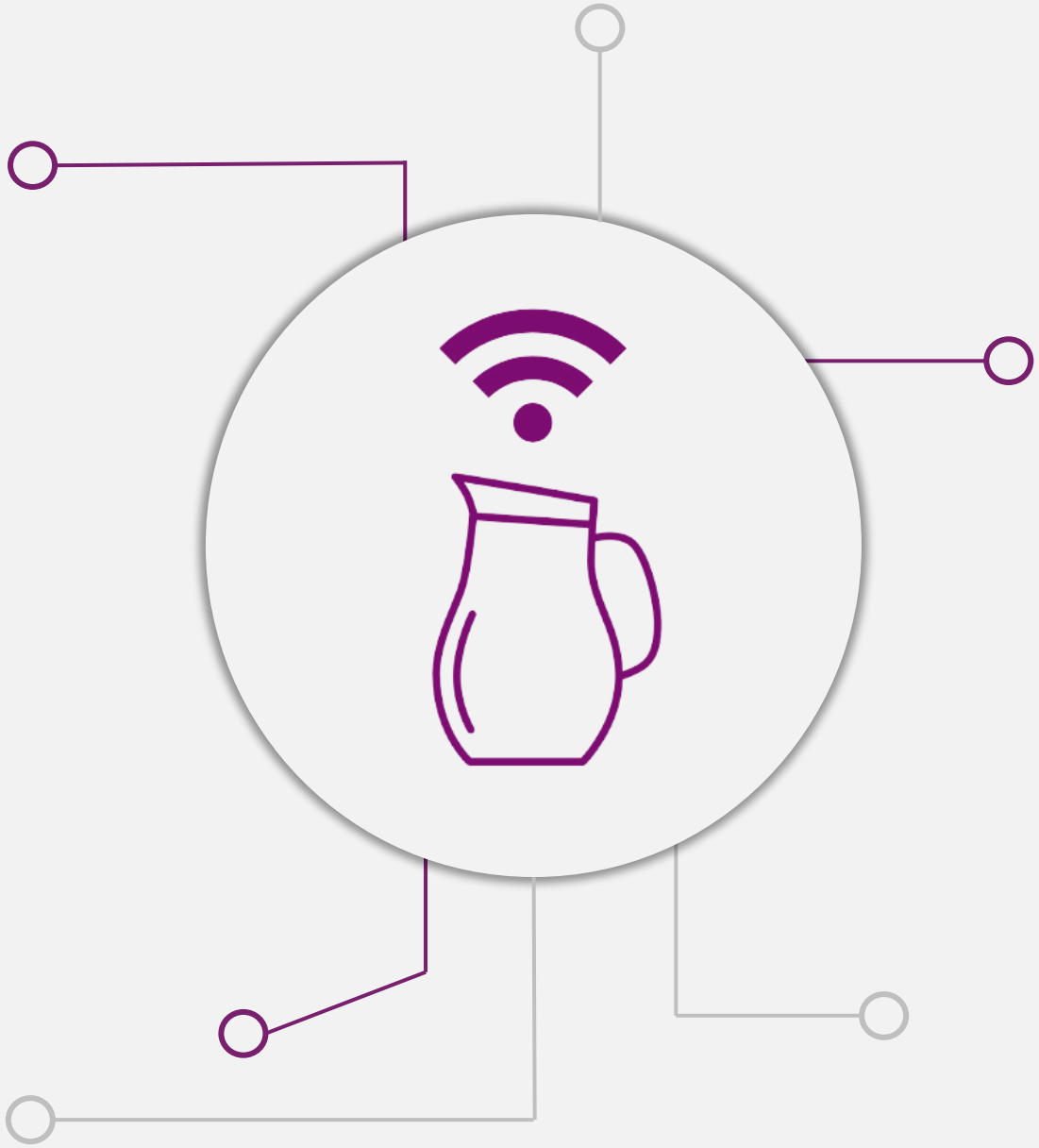
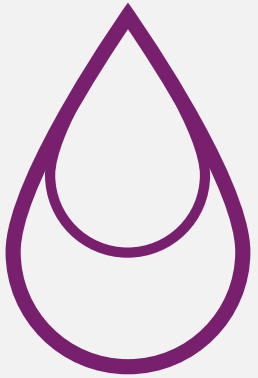


Overview

- Our project involves the connectivity of “Smart (Water) Jugs” and the tracking of the fluid filtered each second.

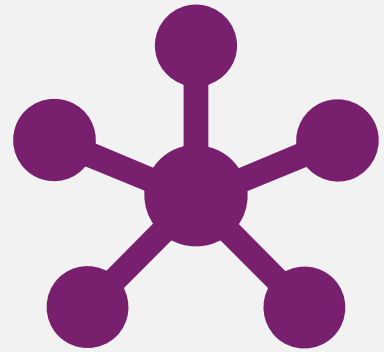
- We track:
  - The total number of liters filtered
  - The amount of water consumed each day
  - The filter usage
  - The kilograms of plastic saved
  - The location



- Coupled with an application developed in parallel with the Mobile Development course. The application part represent the user / client dashboard.

Technologies

- The technologies we adopted are the following ones:
  - **Arduino** – as hardware for emulating a sensor
  - **TypeScript** – to have a scalable simulated number of sensors
  - **Godot** – to have a gamificated version of the simulated sensor
  - **Node-RED** – representing the middleware between ThingWorx and the mobile devices, also used for dashboards
  - **ThingWorx** – used mainly as remote database to save things data persistently
  - **Redis** – cache service used to limit the traffic of requests to ThingWorx



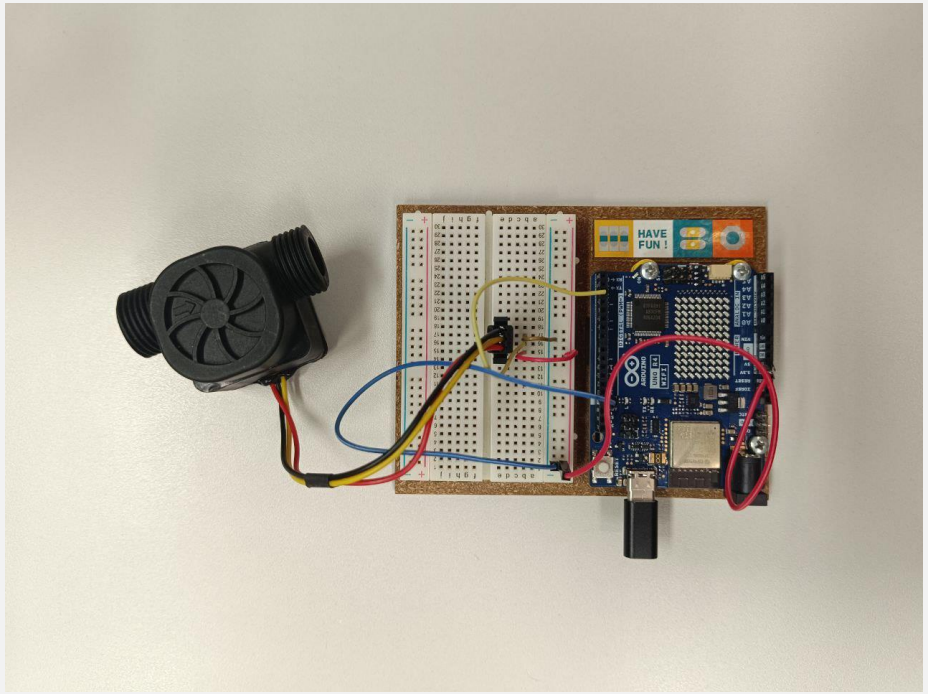
- We will discuss each one in the following sections.

Arduino

- Arduino represents the **hardware** version of the sensor and represents the **physical jug** itself or an “**adapter”** that can be put on the pouring part of the jug (with a smaller version of course).

- The script that executes allowed us to:
  - Pair the sensor with the mobile device and link itself to a user
  - After the first step, to send data via MQTT directly to ThingWorx

- The pairing is done via a self-hosted Wi-Fi from the Arduino itself, on which the client Wi-Fi credentials can be transmitted: in this way the Arduino connects to Internet and start publishing via MQTT

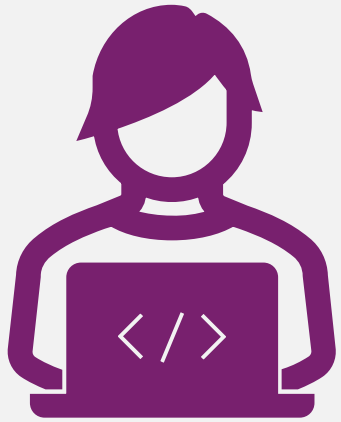


TypeScript

- TypeScript allowed us to write some APIs with which both the sensor and mobile device could interface

- The peculiarity of the code is the fact that allowed us to test our implementations on a **scalable number of sensors** (since, for example, owning 10 Arduino cards would be infeasible)

- This kind of simulator behaves exactly like it’s the hardware counterpart does

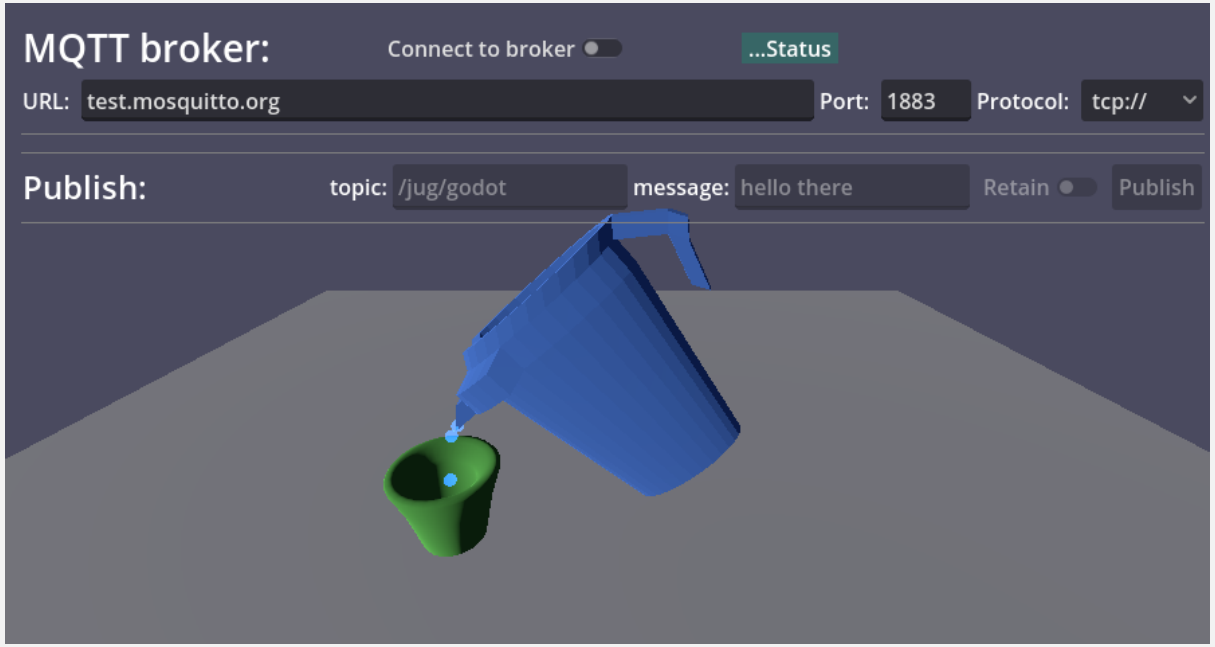


Godot

- We want also to try something extra, like the interiorization of the gamification process in these topics

- We delve into a 3D implementation of a jug and tried to simulate the behavior of the pouring of a jug

- Please note that while the entire scene has been made by us, the MQTT implementation of this part has been taken from GitHub, and adapted to our objectives, since knowing how Godot works with MQTT was not our primary focus. Thanks to: https://github.com/goatchurchprime/godot-mqtt?tab=readme-ov-file

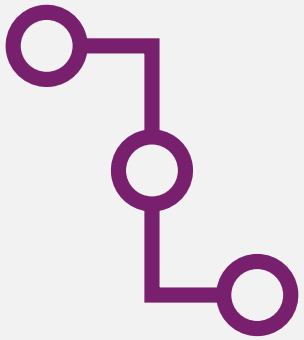


Note that this implementation doesn't send data to ThingWorx, we just implemented the Node-RED listener to MQTT.

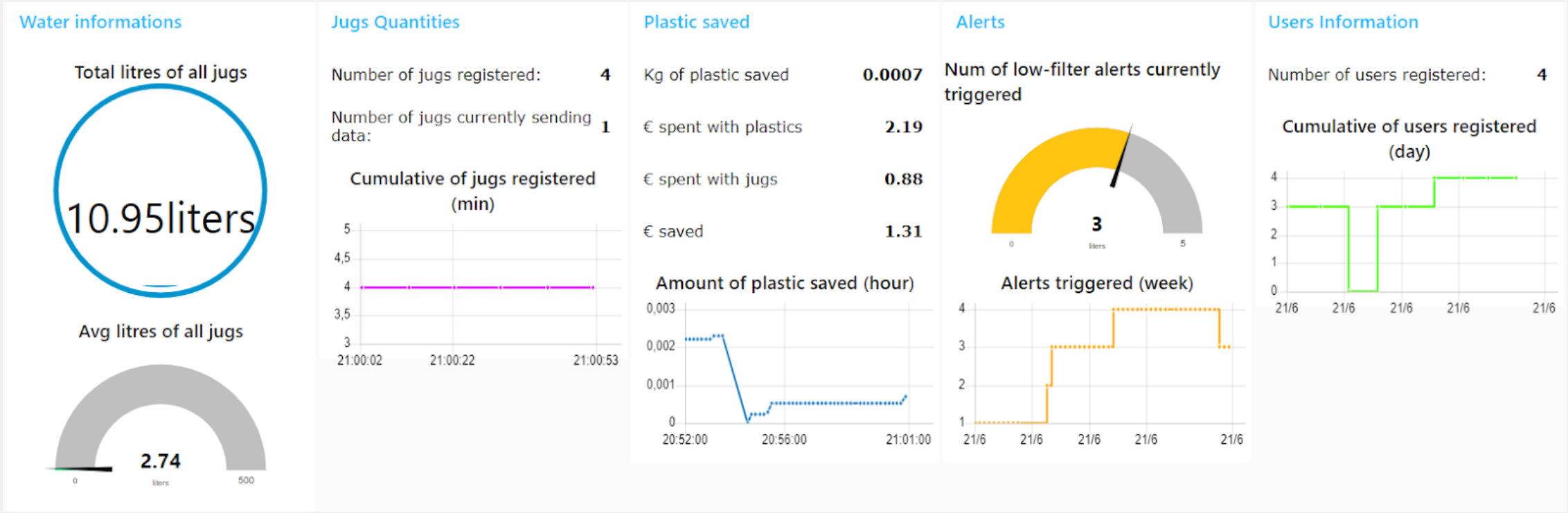
With the correct parameters, this could be also made work to send data to ThingWorx.

Node-RED

- Represents the middleware (“fog”) that implements all the APIs needed to make the mobile application works with the IoT system
- Contains also the APIs needed to the jug sensor to pair
- We also implemented the enterprise dashboard with it and split it in different categories.



Dashboard #1 - Overview



This is the main dashboard that the employee of SmartJugs can see and have an overview about the current registered jugs and the liters filtered **in real-time**

Dashboard #1 - Details

In this dashboard the following data are displayed:

- Water information: real-time information about the total and the avg liters poured until now from the jugs
- Jug Quantities: how many jugs have been paired by the users of SmartJugs
- Plastic saved: a metric to observe how much kilograms we saved instead of use plastic water bottles (see also next slide)
- Alerts: those alerts are implemented application-side and marks the number of mobile notification sent because the filter of a certain jug is about to expire
- User information: we track how many users registered and the curve in the current day

Plastic saving

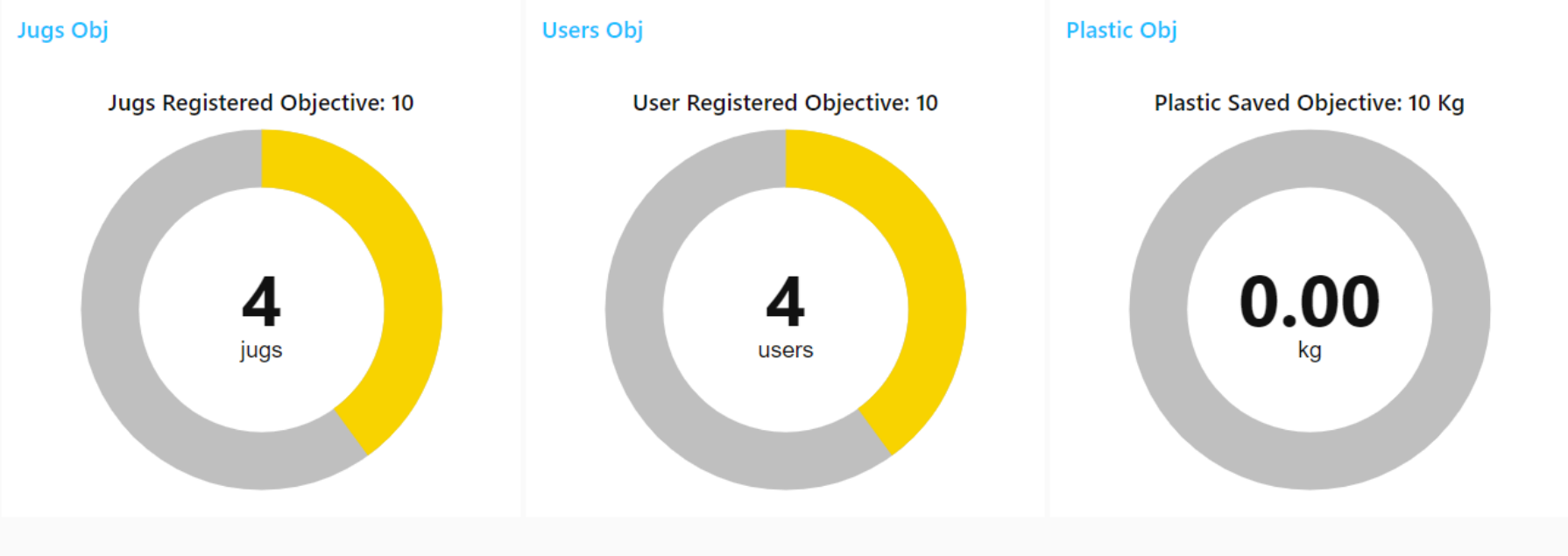
An ecological and financial parenthesis

Since we are talking of water and we know the problem of plastic in the modern days, we also felt the necessity to talk about plastic.

In our dashboard we provide two main categories of metrics for plastics, the first that weight the environment and the latter that weight the money topic:

- Kg of plastic saved: with this metric, we computed the equivalent of plastic water bottles weight in terms of water consumed
- € saved by using jugs: with this metric, we observe the difference into use jugs compared with buying the equivalent in plastic water bottles

Dashboard #2 - Objectives



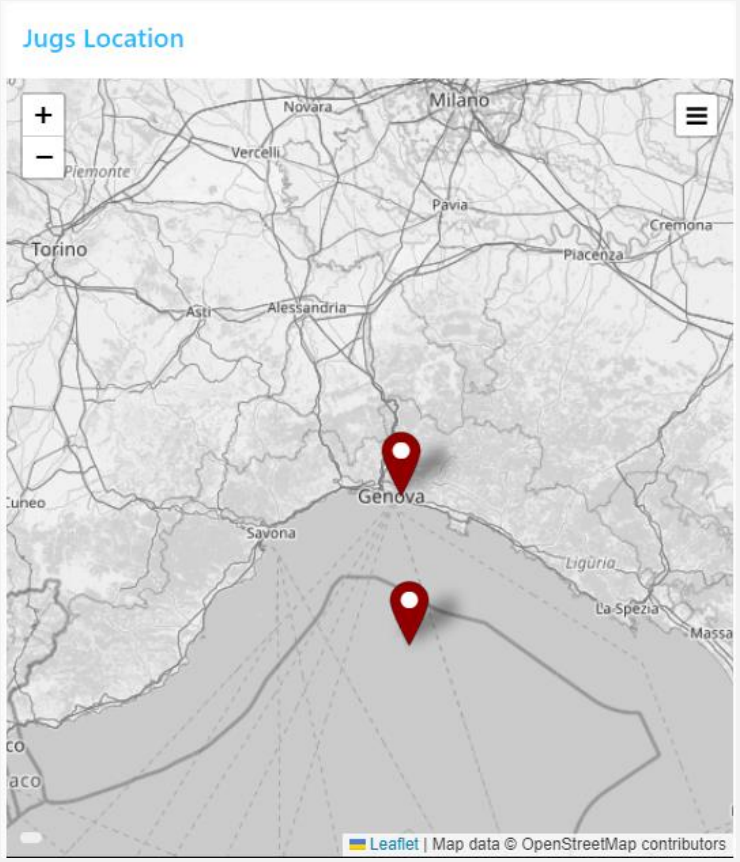
We also thought about the possibility to fix some objectives in the company and see how far we have got.

Dashboard #3 - Location

- We decided to track the jug position on pairing process, by taking the position from the mobile device and to show it on a map. We do not track the user. The user can choose if share the approximate, precise or no position at all.

- On the map provided as example, the jug was located at DIBRIS (University of Genova), we can see:
  - The approximate position, on the bottom
  - The precise position, on the Genova label

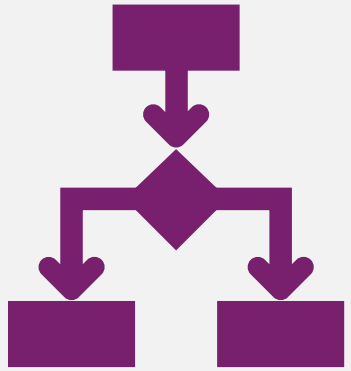
- Each mark holds the coordinates and the jug name



ThingWorx

- We use the ThingWorx platform to create the things and save persistently the data.

- In particular of ThingWorx we used:
  - Properties: to save things details (e.g. liters per second, total liters)
  - Shape: to represent the jug filter details
  - Template: to represent in a scalable and efficient way each thing, implements the interface above
  - Value Stream: to log the total liters filtered and retrieve it to achieve aggregation per day, per week etc. on Node-RED



Redis

- We implement a Redis cache service (as a separated server) to achieve for efficiency in our implementation

- The main objective was to limit the traffic to ThingWorx when getting the data stream, since we observed a certain fragility when we scale to a very big number of things

Thanks for your attention