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Smart Jugs Project - Documentation

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Overview

Our mobile application involves a dashboard that shows data sent by sensor in water jugs with filters. Those data are sent from sensors in the jugs, following guidelines explained, and with which we merge the project, by the Internet of Things (IoT) master course.

Sensor data

The sensor we use is a fluxometer.

The data we retrieve and show is specified for each jug owned by the user in the dashboard represent the following parameters:

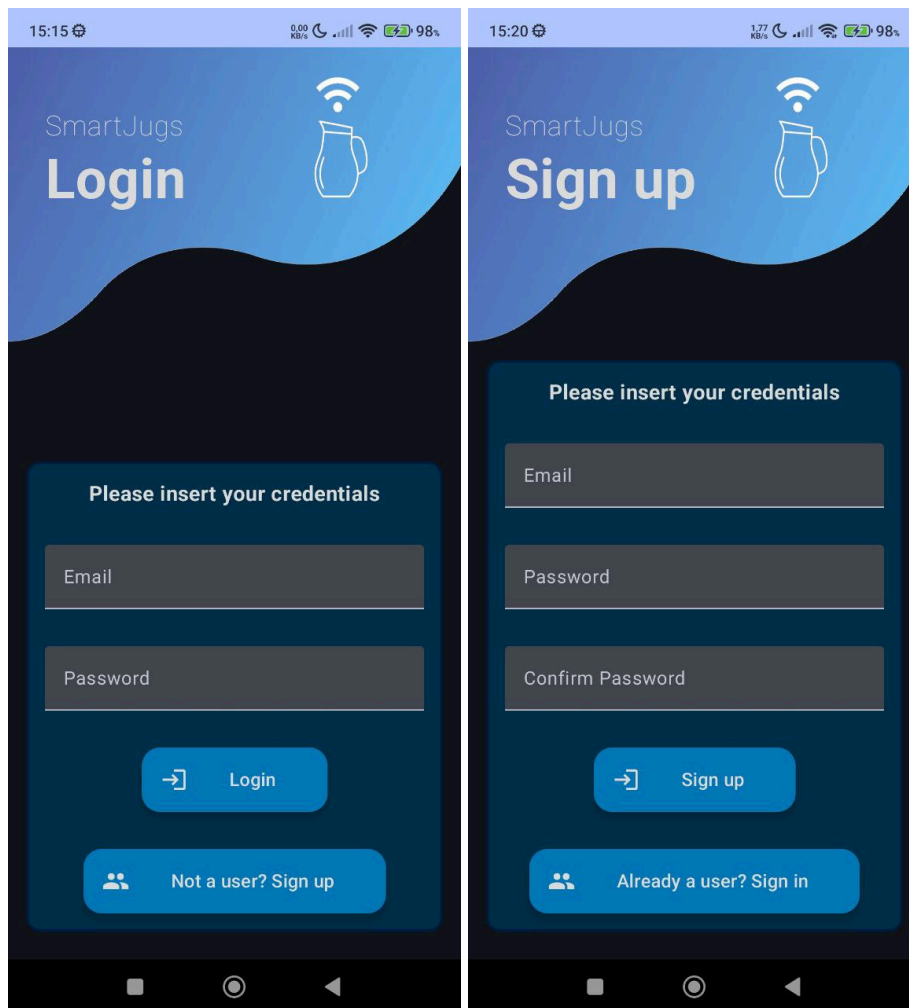
- Total consumption of water
- Daily consumption
- Filter capacity
- Quantity of plastic saved (by using a jug)
- Filter time remaining
- Percentage of usage of filter
- Approximate Location of the device

Functionalities and flows

This section will present the functionalities with the flows that contain them that are implemented in the application.

Main views

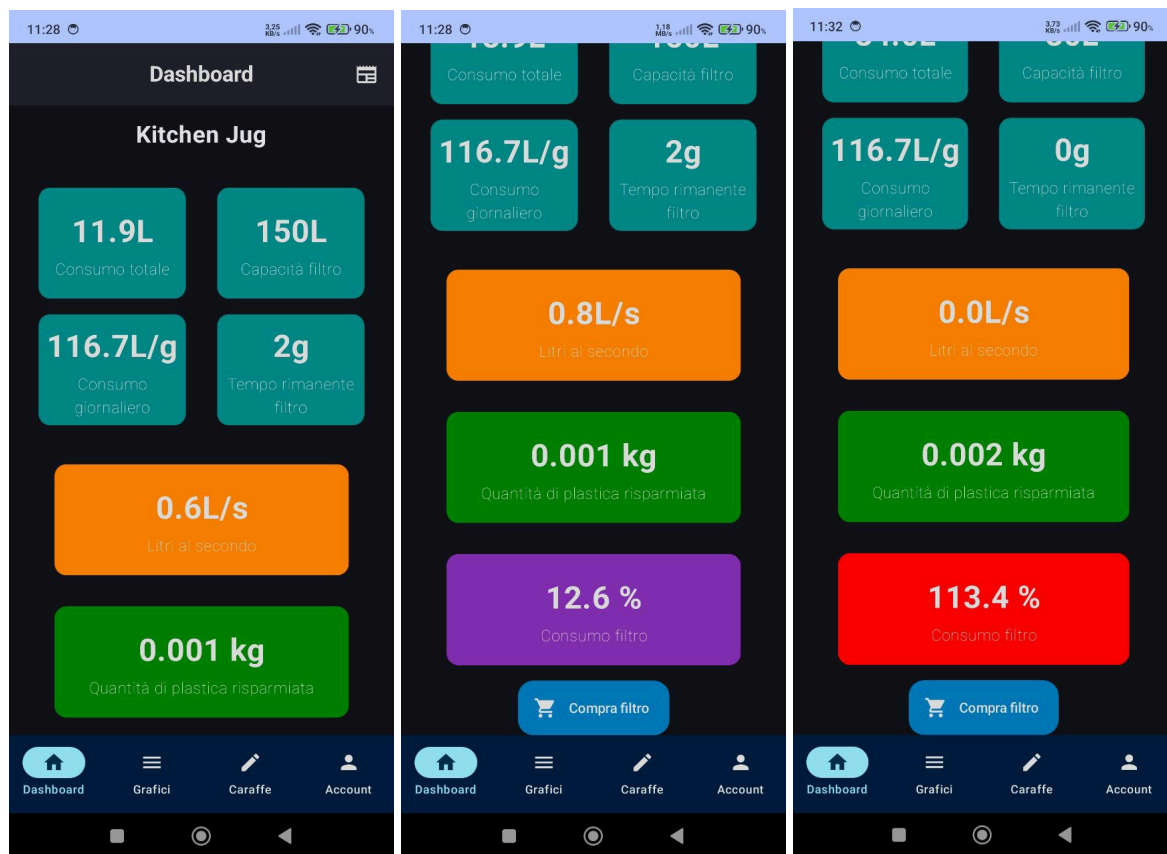
Login and Registration



The one on the left (Login page) will be the first page shown when the app opens (if not already logged), to continue in the app the user must provide their credentials. If an account has not been already created, the user is needed to create an account with the register box.

To make the application work, a network connection is needed to connect to the remote server with the database that contains the login information.

Dashboard



This page is provided as first if the user has already logged in and has a paired jug; otherwise the dashboard will show Not Available status (N/A) for each label. Moreover this page shows all the information sent by the jug sensor.

To know which jug has been selected, we show its name on the very top, under the navigation bar.

The dashboard shows also, in the bottom part, a percentage of the filter usage, alerting with a red color if the filter is exhausted (over 80%, we accept over usage).

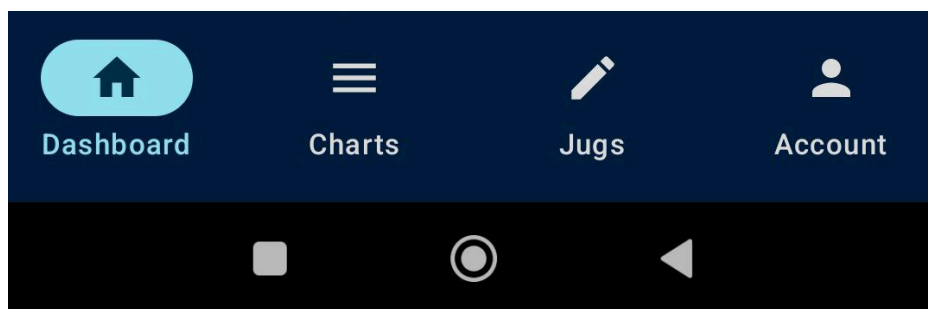
The user can also click on the bottom button to buy a filter, this will redirect him to an online web search.

Top navigation bar



We provide a top navigation bar with which the user can navigate to the previous page (that we consider the “main”, e.g. the Change Password page is a child of the Account Details page) through the arrow-back icon. Also the user can reach the news feed from the app and see other sections from jugs information / list to account management.

Bottom navigation bar



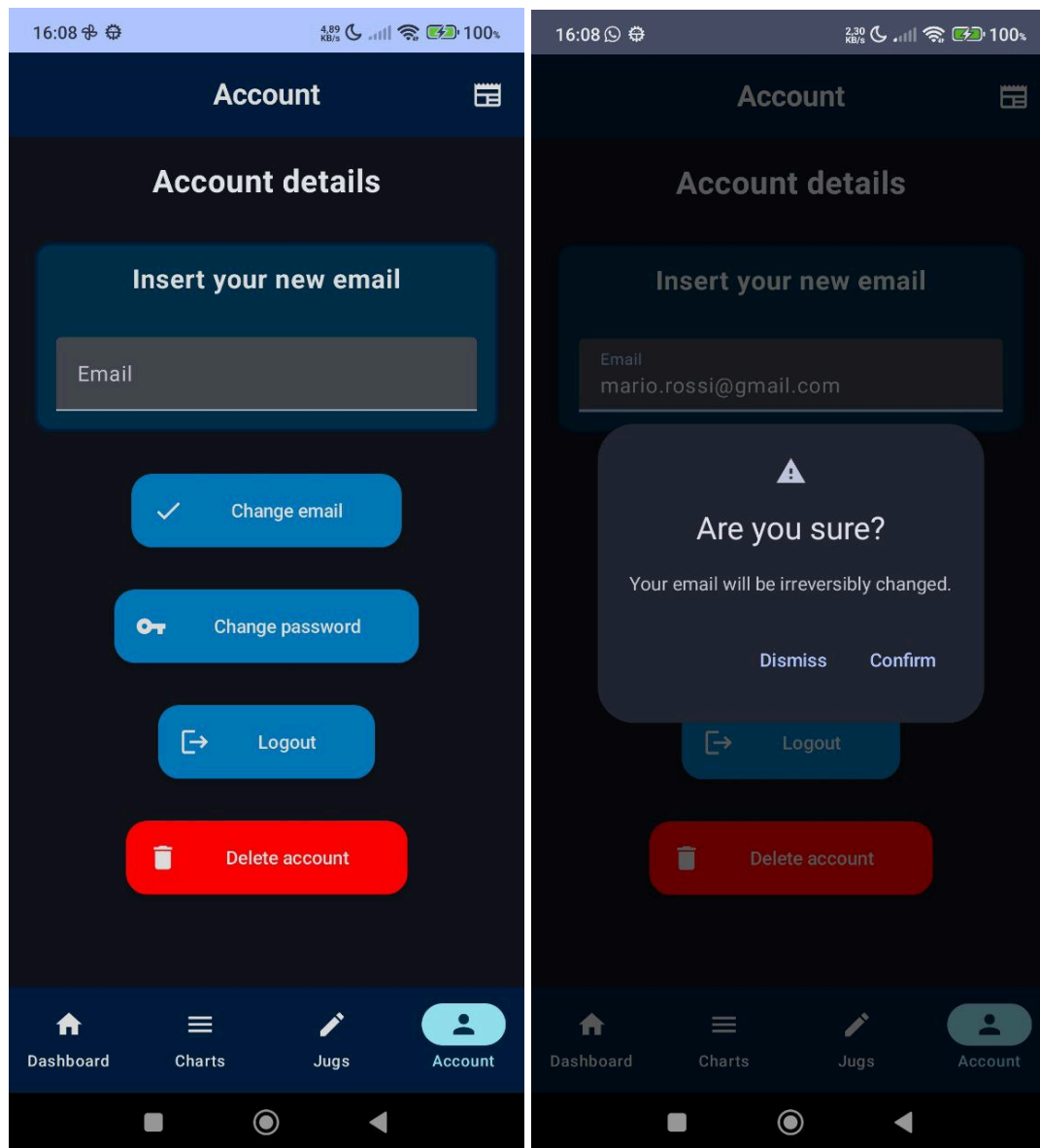
We provide a bottom navigation bar with which the user can navigate through the app and see other sections from jugs information and pairing to account management.

Charts view



This view shows two graphs about the water consumption respectively in the last hour, so each minute the information is retrieved (excluding the current minute) and in the last week (including the current day).

Account management

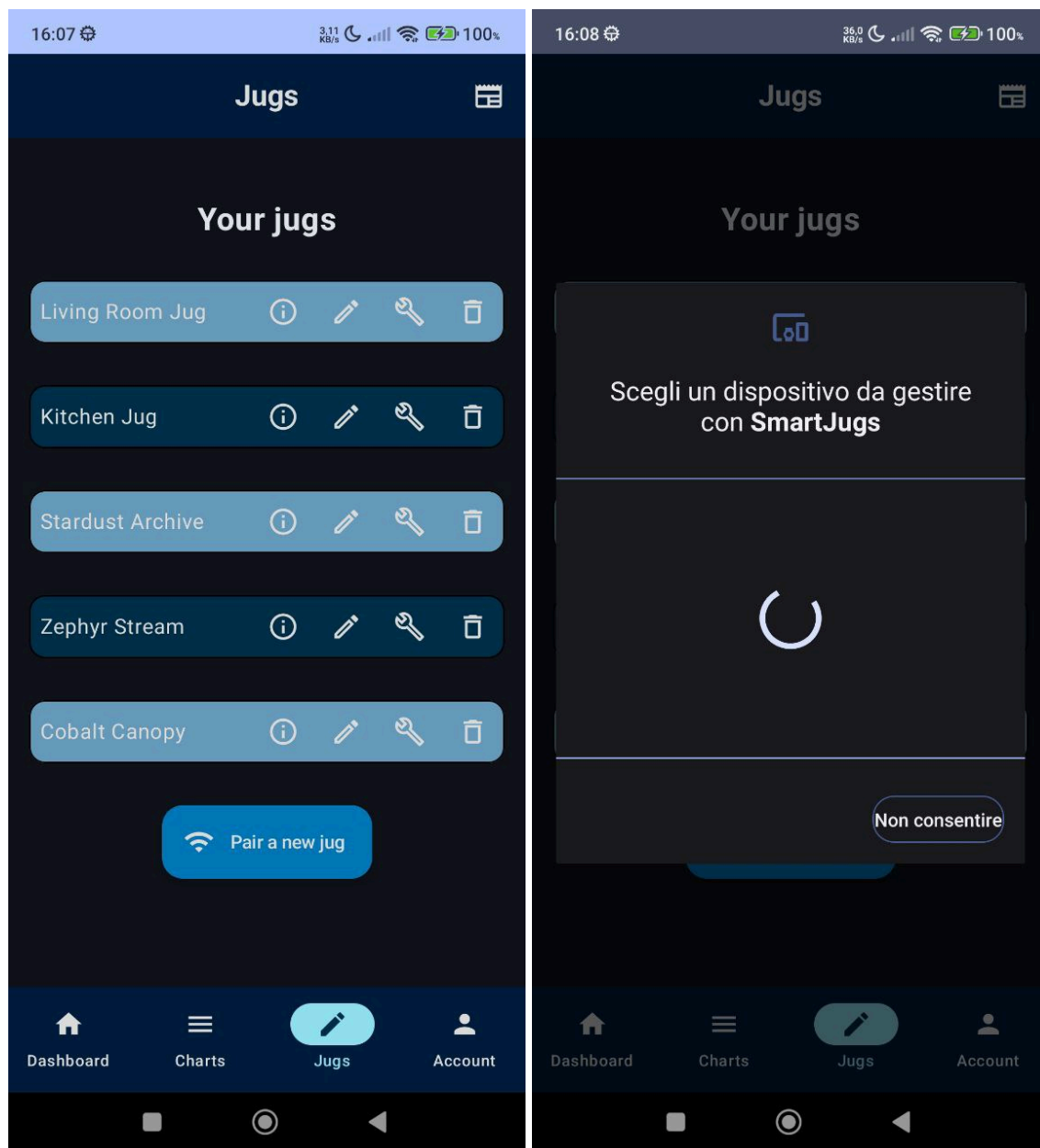


In this page the user can review their email and by editing the field and clicking the “Change Email” button an alert dialog pops up requesting a confirmation; by confirming this, the dialog closes and the email is updated. By clicking on the “Change password” button the user will be redirected to the “Change Password” page, discussed in the next section. By clicking the “Disconnect” button the user will be disconnected and the app will navigate to the Login page. By clicking the “Delete account” button the user will be disconnected, their credentials and their jugs information deleted and the app will navigate to the Login Page.

Change password

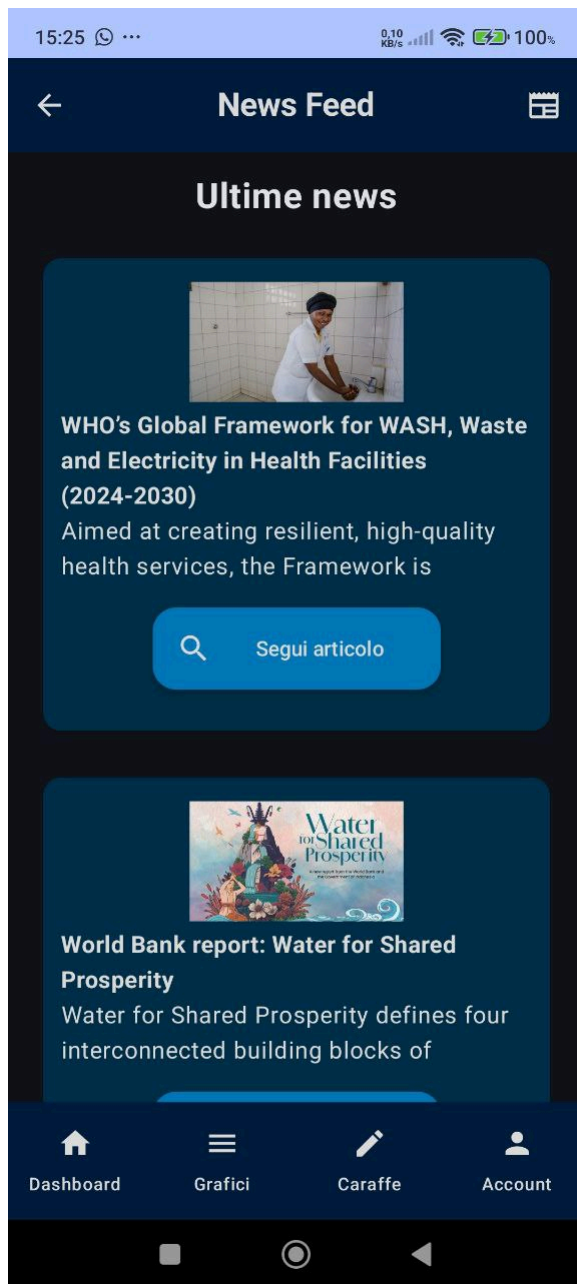
In this page the user can edit the password fields to change their password. By clicking the “Change password” button an alert dialog pops up requesting a confirmation; by confirming this, the dialog closes and the password is updated if the old password is verified.

Jugs management



In this page the user can review the owned jugs or pair new ones via WiFi. This WiFi will be hosted by the jug devices themselves and the process of searching can be started by clicking the button “Pair a new jug”, this will interface directly with the Android System. By clicking on the Information icon, the user will be redirected to the Dashboard, displaying the information about the selected jug. By clicking on the Edit icon (pencil), the user will be prompted with a dialog in which they have to provide a new name for the jug. By clicking on the Settings icon, the user will be prompted with a dialog in which they have to provide a new filter value for the jug, this emulates the fact that the user is changing the filter of the jug. The new correct value of filter capacity will be displayed in the Dashboard page. Any error in these phases is properly handled.

News feed



In this page the user can review the latest notice world-wide about the water, to stay connected. The website we refer to is <https://www.unwater.org/news>. Clicking the upper arrow-back, will bring the application to the previous page viewed.

Other functionalities details

Pairing process

The pairing process after clicking the “Pair a new jug” in the Jugs page proceed as follows:

- The application search for jugs and the user is needed to select a jug that is in a pairing state (sensor view).
- After the jug is connected to the device, the app prompt a list of available WiFi in the nearby, to whom the jug will connect (usually the same WiFi of the application, e.g. an house WiFi); after having selected the WiFi network, a prompt with a password request is given, asking the user to enter the chosen network password.
- If everything is successful, the pairing of the jug is completed and prompted with a success dialog.

Buy filter online

By clicking on the bottom button of the Dashboard view, the application will redirect to the browser to search for a new jug filter. Any action performed by the user from this point will not involve or influence in any way the application behavior.

Disconnection

Any moment the disconnection term is cited, the application will redirect the user to the Login page. No information of the user is deleted, so when the user logs in a second time, all the jug associations will be kept.

Input Field empty

Any moment the user is requested to insert values into fields, if those fields are left empty, they enlight themselves in a red color and any further button click to send data is disabled.

Warning filter usage

If the usage of the current inspected jugs is over 80%, the card relative to the Filter usage becomes colored in red. Note that we allow the percentage to go over the 100%, showing that the filter is overused.

Single login

If the user has already logged in one time, even between sessions the application performs an auto-login and brings the user directly to the Dashboard page. This process is not done if the user has performed a logout.

Translations

Depending on the user's system language, the application currently supports English (Default) and Italian languages.

Dark/Light mode

The application supports both dark and light modes of the user system device preference, the colors have been fixed to be in a sufficient contrast for both modes.

Permissions and location

When the app is started for the first time, two permission pop-ups are displayed asking for two kind of permissions:

- The first one is about the location. We make the user choose if they want to share their coarse position that is sent in an aggregated form to the company to analyze where the jugs are distributed and paired geographically. The effective sharing is performed on pairing. The user can choose both to share the approximate location or not to share at all.
- The second one is about notifications: the user can choose if they want to receive notifications. Those notifications involve just the alert if a filter is almost exhausted (about 80%).

Push notifications (Firebase)

When the filter usage reaches a percentage of filter usage above the 80%, the application will send a notification suggesting to buy a new filter. This notification is just sent once per jug to the user and refreshes only when a new filter capacity is provided, that is the change of a filter. If the user clicks on the push notification, they will be redirected to jug who has the filter almost exhausted.

The system of notification is implemented through Google Firebase, where each device is associated with a token.

Error handling

If for some reason (e.g. the server is not reachable) an error from the server occurs, we notify it via Toast on the bottom of the screen. A personalized Toast appears also if the user tries to register with an email that already exists or if the user tries to change password providing a different old password from the current one and so invalid.

Technologies

- The application needs the network connection to work. Indeed it is used to pair, to retrieve sensor data, perform login/registration, to manage account information and to collect data for aggregated data analysis by vendors. We do not use any other sensor from the mobile device.
- The application is implemented in Kotlin via Android Studio.
- The layout and design graphics are implemented in Jetpack Compose, using Kotlin Flows and ViewModels.
- For handling HTTP requests and responses we used the Retrofit library.
- Any operation that needs to check the owning of a jug is done by a JWT token verification server-side, that is given upon a successful login.

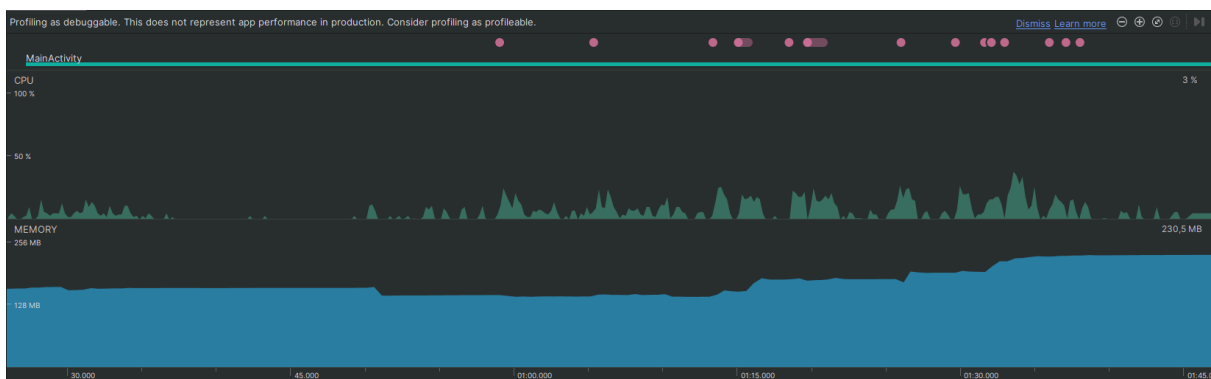
Privacy of the user

The jugs sensor data will be sent via Wi-Fi to the vendor server, in an aggregated way. The only user data that will be saved on the vendor servers are their credentials and their associations with their jugs in order to properly display the dashboard for each owned jug. No other mobile device information is gathered and transmitted except for user app credentials (to handle login and information) and the coarse location that can be chosen if to be shared or not.

Performances

We also decided to measure the performance of our application (debug mode) while performing main tasks in the application, in particular in the following order:

- Registration/Login
- Pairing of a new jug
- Rename jug
- Edit filter capacity
- Navigation to the dashboard
- Navigation to the chart view
- Navigation to the news feed



We observed that the most CPU intensive tasks involve the navigation through the section of the app: Dashboard, Chart View, News Feed. The peak we reached is about 38% of the CPU, while remaining usually between 15%-20%. Talking about memory, on average we use 160MB (Dashboard), reaching 228MB in the Chart and News section.

Please take note that these tests have been done in debug mode, and we observed that the debug mode with respect to the release mode slows down the animations and the overall smoothness of the application.

Differences w.r.t the proposal

In this section we will analyze the main changes done into the application that differs with the project proposal.

- The user registration and login have been separated in two different pages, in order to have a cleaner interface.
- Improved the graphical view of the Dashboard page, substituting the idea of the cylinder as status with a cleaner view: the percentage is put into a card that changes color into red if the usage of the filter is above a certain amount.
- The idea of sidebar navigation has been replaced with a bottom bar navigation.
- We slightly changed the idea of the charts, by using both line and bar plots.
- A cleaner look has been put into the Account and Password management page, giving the user a better visualization, with icons, of which button do what.
- The management of the jugs has changed in the number of actions that can be performed on each jug: inspect, rename, change filter, delete with a clearer look accompanied by intuitive icons.
- Since a new functionality was suggested to be added, we decided to introduce a news feed about information world-wide on the water topics.