A Hybrid Application For Real-Time Air Quality Monitoring

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***Abstract*—With the raising concerns for the environment, interest in monitoring air quality is likely to increase in the near future. However, most data comes from a limited number of government-owned sensors, which can only capture a small fraction of reality. Improving data coverage thus involves reducing the cost of sensors and make data widely available. For this, we will use a very high number of low-cost sensors as the basis for an air quality monitoring platform, capable of collecting, aggregating, storing and displaying data. This platform will use stream-based technologies capable of scaling for large numbers of sensors and users. The resulting NanoSen-AQM platform will provide vast amounts of air quality data to the public, with the aim of improving public health.**

I. Introduction

Air in large cities and industrial complexes is often far from good, despite the seemingly growing interest of the public on health quality. The World Health Organization claims that one in eight deaths can be linked to the poor quality of the air [3]. It is therefore important to enable public regulators and citizens to take informed decisions regarding air quality. However, this is often difficult to attain, for reasons ranging from the price and number of available sensors to the dispersion of data sources.

We propose to improve the situation, by creating an end-to-end system that will use low-cost nano-sensors, data streaming mechanisms and a hybrid web site and mobile application, to cover all the steps of the air quality control process. In this document, we briefly describe our initial steps in the creation of an air quality monitoring platform, in the context NanoSen-AQM project [1]. This platform aims to bring together data from many nano-sensors, to improve the coverage of air quality data and make this data available to the general public.

These steps include the analysis of requirements, architecture and technologies that better suite our project. In this last step, there was a wide range of technologies that could meet the needs of the project, especially the scope of the various platforms. We decided to use Ionic, a platform which presents the advantages of hybrid development as well as the advantage of delivering the project to the web platform, which not all hybrid development technologies have.

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II. Architecture

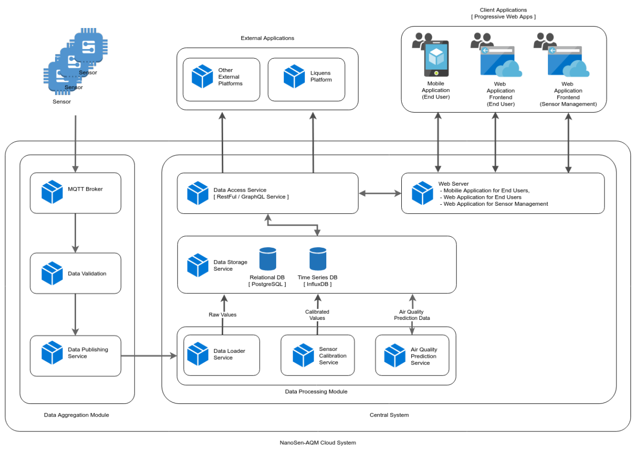

Fig. 1. Architecture overview of NanoSen-AQM system[4]

As shown in Fig. 1, the system comprises a front-end and a back-end. The former part will deal with different types of actors that define the main requirements of the system: sensor owners, administrators and general public. The back-end involves the entire process from collecting the data, to making it available to the front-end. Alongside this, the system will have access to external nano-sensors, through a Data Aggregation Module. This module consists of an Message Queuing Telemetry Transport Broker, which will receive data from the sensors; a Data Validation, in charge of all data validation coming from sensors; and a Data Publishing Service, which publishes validated sensor data. The validated data will be sent to a central server, where 4 modules will be available: the Data

Processing Module; the Data Storage Service; the Data Access Service and the Web Server. The Data Processing Module will handle data calibration, value predictions and data forwarding to the system database. Calibrating data refers to adjusting the output values of the low-cost nano-sensors, according to (previous) comparisons against calibrated reference sensors. The Data Storage Service module will keep sensors data. The Data Access Service will provide the means to let other platforms access data available in the system. Finally the Web Server provides access for client applications.

III. The Front-End Prototype

The front-end has two branches: the mobile application and the web application, allowing the project to be available on different types of devices. The web application will be accessible by any browser, while the mobile application will be available for mobile phones after installation from the Play-Store and the AppStore. All the initial information presented on both platforms will be transferred via Hypertext Transfer Protocol GET methods on the main page of the platform. To support all the logic that provides the Hypertext Markup Language pages and the Cascading Style Sheets styles, the project will use TypeScript [2], a technology that has been gaining increasing interest in the web development community due to its capabilities.

A. Ionic

Based on the previous considerations and on the analysis of the application requirements, we concluded that our best option to develop the front-end application would be through an hybrid application. One of the most important points for this decision was the importance of making the platform available not only as a website, but also as an application in mobile stores. Another decisive point was that the application does not require a great interaction with specific characteristics of mobile devices or high graphics renderings, as would be the case with a video game. This made as opt for the Ionic technology, which makes it possible to develop a web site and a mobile application within the same application. Using Cordova, PhoneGap, or other similar solutions, it is possible, and very easily, to wrap the Hypertext Markup Language code to native code, and thus make it possible to deploy the application in the mobile application stores in an accessible way. These solutions also allow bridging applications with the specific features of devices (Camera, Bluetooth, Global Positioning System, etc).

B. Layouts

To demonstrate the work that will be developed and to better understand how to present the functionalities and data, the layouts of a prototype developed in Ionic are presented.

In Fig. 2 we display air quality data for a particular cluster of sensors on mobile devices (Android and iOS). These clusters aggregate measurements from co-located sensors. The prototype presents the recorded data through plots that will have the aid of filters for improved visualization of data. An option to download data in csv format is also available.

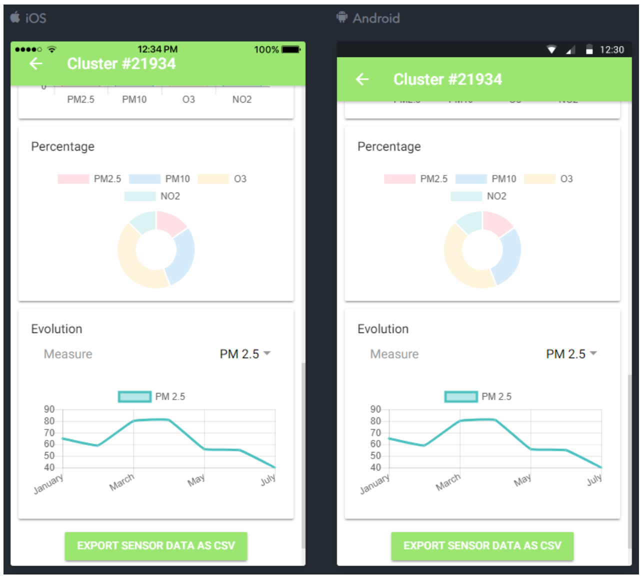

Fig. 2. Layout of the mobile application for the feature of listing air quality data.

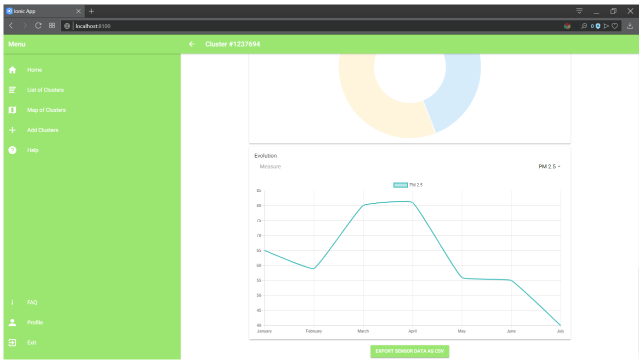

Fig. 3. Website layout for the feature of listing air quality data.

Fig. 3 shows the layout of the application, but for the web. Despite the different layout, it presents the same features, with the particularity of being adapted to the additional space available in the web platform.

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