



**UNIVERSITÉ  
DE GENÈVE**

**CENTRE UNIVERSITAIRE  
D'INFORMATIQUE**

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**Internship - Description  
(Works to be done within an enterprise)**

Title : Software Development Intern

Student : Nicolas BOECKH

Enterprise : Association Citoyenne de Mesure Environnementale - LogAir

Overseer within the enterprise : Emmanuel KELLNER

Academic overseer :

ECTS Credits : ☐ 3 ☐ 6 ☐ 9 ☐ 12 Period : Autumn 2019

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## **Description**

LogAir is an emerging association that aims to empower citizens to crowdmap air quality in cities, to help them adapt their behaviour, reduce the impact on their health, and advocate for more sustainable policy-making.

As part of this mission, one key component of LogAir is the development of a mobile particulate matter sensor that generates a pool of open data. Another key aspect implies the analysis and modelling of this data, used to suggest ways of avoiding exposure to air pollution for the users.

The objective of this internship is to provide assistance to the LogAir project in:

- The development of a functional Android application that handles the incoming data from the mobile monitoring device
- The implementation of the server infrastructure to receive and store this data.
- The creation of a web-based API to open the data to interested parties and improve how their services interact.
- The liaison with other developers working on the project.

## **Expected results and projects**

This internship revolves around 3 different projects of varying scopes and sizes, that should all require analysis of objectives, conception, implementation and testing.

The first of these tasks is the prototyping of an Android application.

Its main objective is to ferry data from the hardware (which broadcasts updates via Bluetooth Low Energy) to the server, but should also be simple enough so that a generic individual is able to use it. On top of that, he should be able to visualize what data is collected by the sensor tethered to his phone.

The second task is the design and implementation of a DataBase Management System (DBMS) and the databases collecting the data within. These databases should be designed with respect to atomicity and integrity clauses, which enables services and API's to exploit them optimally.

The third task is to develop a reactive web-API that would allow LogAir's services to be able to get and post data to and from the database, as well as to allow the same for third-parties. This project also relates to notions such as privacy and developing a shared data system and interfacing with collaborators.

## **Detailed description**

### **I - LogAir: Mission statement, Objectives and Philosophy**

The internship is at an emerging association named LogAir, whose aim is to propose a service which would monitor the amount of aerial pollution in real time, through the use of open-source hardware, firmware and software. LogAir's areas of activity are related to Health and sustainable development, as well as citizen science. The fields which directly relate to completing its objectives are data science, software, database and web development.

Aerial pollution, as defined by the World Health Organization, is comprised of particulate matter, nitrogen dioxide, sulphur dioxide and ozone. LogAir focuses on particulate matter, specifically on PM values, such as PM1, PM2.5, PM4 and PM10, all of which are particles of 1, 2.5, 4 and 10 microns or less, all of which can penetrate and lodge deep inside the lungs, causing health issues after a certain amount of time.

Analysis of the acquired data should enable the creation of a second service, concentrated around predicting the evolution of micro particulates in the air, and thus enabling users to avoid the more polluted areas.

To this end, LogAir has multiple objectives, of which the first is to acquire live data from all of the deployed sensors and integrate it to a database. Since LogAir works in collaboration with some enterprises such as GenèveRoule and the Service Industriels Genevois (SIG), this can be achieved by deploying sensors on GenèveRoule's bike fleet.

This would allow having a sample size of approx. 300 devices on first deployment, as well as deploying devices for individual use, leading to a collaborative citizen effort.

Advancing with this project grants LogAir the ability to advance on other objectives that are to map the pollution density in real time and to create a service for users to be able to find a path between two points, with the added constraint of getting a minimum amount of exposure to aerial pollution as possible.

Integrating LogAir in these early stages means that I have to assist LogAir to attain these objectives, be it by way of software development, designing a database and developing mechanisms and subsequently optimizing how they work and thus how the data flows from point to point, be it between LogAir's services or to and from third parties.

Since LogAir promotes an open-ended philosophy, the assembled hardware needs to be open-source, enabling any interested person to build their own device and flash the firmware onto it and transmit the collected data to LogAir's servers using their phone or do something different with it.

## II - Task 1 : Android Application

My first task within LogAir would be to develop a connector-type mobile application that would bridge the Bluetooth LE variant of LogAir's devices with the servers.

Bluetooth LE is a variant of Bluetooth developed in 2009 designed for small use cases such as heart rate monitors, proximity sensors or other devices supporting a Generic Attribute Profile (GATT) such as advert displays or LogAir's devices, with the added advantage of being a low power-consumption alternative to Bluetooth, even if throughput is slightly reduced.

The Bluetooth LE chip broadcasts a CSV like string containing the collected data once per second. The mobile application should constantly listen for this data packet, and, once received, integrate it, possibly provide feedback for the user, and eventually ferry it to the server.

To attain this objective for Android mobile devices, it is to be developed in the native Android development ecosystem, which is comprised of :

- Java (Java for Android) for the sources ;
- AndroidXML for the resources ;
- Gradle for the package management and app deployment.

The mobile application is developed with an emphasis on functionality, with UX/UI being implemented in a way that leaves it open to change.

The application is destined for mobile phones running Android 4.3 and higher, as that is when Android devices started to support Bluetooth LE.

The deployment of the application is as a standard .apk file, available on the project's website and probably on some distribution sites.

The testing of this application should be a mix of stress testing, bug hunting and user feedback.

## III - Task 2 : Database

My second task within LogAir is to setup a database which will be used to store all of the collected data. This database will follow the standard table format for easy interaction with other services, mostly through the use of a web API.

It's conception should respect conventional database design rules, such as validating the ACID model, not containing redundant or repetitive information, and respecting a standard naming convention.

The objective will be completed using MySQL in the InnoDB engine, via the PHPMyAdmin interface.

The deployment of this objective is to be live during the test phase of LogAir's devices, with a previous version backed up. At a later time there will be migration and parallel modifications during transitions, of which there should be few.

The tests to be implemented here are mostly theoretical in design, such as testing that the implemented solution respects the conventional database design rules, but will also be subjected to various stress tests to test the performance of the service under heavy load.

#### IV - Task 3 : Web API

My third task is to develop a web API which will allow LogAir's services and devices to insert data into the database and enable these and other services to acquire data from LogAir's servers.

Conceptually, this API should enable basic GET, POST, UPDATE and DELETE operations by focusing on a REST architecture, though a stronger emphasis will be set on the first two. But seeing as it is possible that many users request a specific time-related dataset (such as entries for the last 30 minutes or such) for interactive use, an approach that entails keeping a local copy of the data set within the confines of the API instead of querying the exact same data many consecutive times could be seen as more optimal.

An initial version of this API would be made in PHP 7.2, for quick deployment. A second and more thoughtful approach would see the rewriting of the API with another framework such as Node.js+Express, or Django or React.js.

The testing of the API would be done by batch testing edge cases with an API testing service such as available on [apitester.com](https://apitester.com).

#### V - Task 4 : Liaison with participants

LogAir participates in an educational program for students to work on practical projects during their university studies. One of the tasks is to support students working to the benefit of the LogAir project by providing technical assistance, including but not limited to providing and managing access to databases, code, and other resources necessary to their work.

## **Completion Criteria**

Task 1 : Design, production and testing of a fully functional prototype, with basic UX/UI and possible service integration.

Task 2 : Design, production, testing and maintenance of a consistently designed and intuitive database.

Task 3 & 4 : Design, production and testing of a RESTful web-API, enabling the processing of incoming data and the provisioning of data to interested parties.

Task 4 : Integration of feedback and requested use-cases into the API's functionality.

## **Contribution to the project**

As mentioned in the introduction of this document, LogAir is an emerging association working in a mobile solution for generating useful data to tackle the air pollution problem while engaging citizens in the process.

The founder of LogAir, Emmanuel Kellner, has a background in microengineering and innovation for sustainable development. Julieta Arancio, who later joined Emmanuel, has a background in environmental sciences and experience working and facilitating open science projects with communities.

Nicolas' contribution to the project is therefore essential in terms of expertise that is currently vacant in the team, and helps to shape the roadmap ahead. On the other hand, the dynamics of social innovation imply interacting with multiple and diverse stakeholders, their demands and deadlines, besides providing and evaluating technical alternatives with the rest of the team. We consider this to be a good opportunity to complement formal education with first-hand experience.