

Design and Implementation of an Environmental Monitoring System

Felipe A. Moreno

Advisor: Prof. Manuel Castillo



**UNIVERSIDAD
NACIONAL DE
INGENIERÍA**

**VICERRECTORADO
DE
INVESTIGACIÓN**

PRONABEC

CTIC 

About me



B.Sc. Felipe A. Moreno
www.fmorenovr.com



Content

- Motivation
- Related Works
- Methodology
 - Technologies
 - System Analysis
- Application
 - Web Dashboard
 - Rest API
- Conclusions
 - Main Contributions

Motivation

Motivation

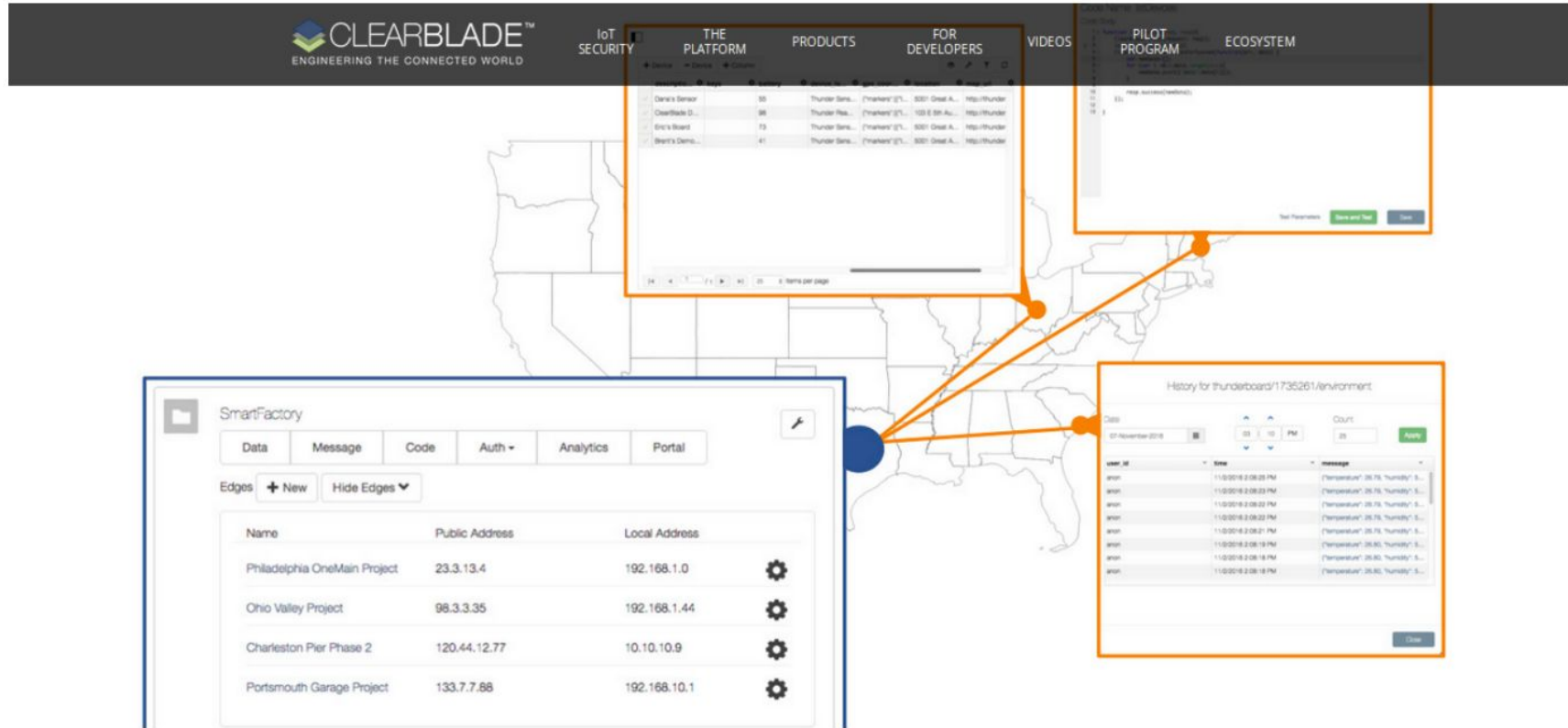
The motivation for which this theme was decided is due to the huge amount of software, libraries and frameworks that carry out this work using other technologies to obtain and update in a certain time (it could be time real), in addition to the great need for software that provides information in a friendly and easy-to-use manner.

Related Works

ClearBlade

It is a web platform software which provides services on IoT, that is, you can create connectivity with devices any, which provide any information that you you want and the ClearBlade, using the MQTT protocol and SDK of development, it will notify you about changes (on off, data, connectivity) in the associated devices, that is, ClearBlade works as a Socket MQTT web broker.

ClearBlade



The image displays the ClearBlade IoT Security Platform interface, which is centered around a map of the United States. The interface is divided into several sections:

- Header:** Features the ClearBlade logo with the tagline "ENGINEERING THE CONNECTED WORLD" and navigation links for IoT SECURITY, THE PLATFORM, PRODUCTS, FOR DEVELOPERS, VIDEOS, PILOT PROGRAM, and ECOSYSTEM.
- THE PLATFORM:** A table listing various sensors and their associated data. The table has columns for Name, Value, and Location. The data is as follows:

Name	Value	Location
Dan's Sensor	30	Thunder Sens... (Franklin) (E)... 5001 Great A...
ClearBlade D...	98	Thunder Sens... (Franklin) (E)... 100 E 5th Ave...
Eric's Board	73	Thunder Sens... (Franklin) (E)... 5001 Great A...
Brent's Demo...	41	Thunder Sens... (Franklin) (E)... 5001 Great A...
- PILOT PROGRAM:** A section for testing the platform, featuring a "Test Program" button and a "Test" button.
- SmartFactory:** A section for managing data and analytics, featuring a "Data" tab and a "Message" tab. It includes a table of edges with columns for Name, Public Address, and Local Address. The data is as follows:

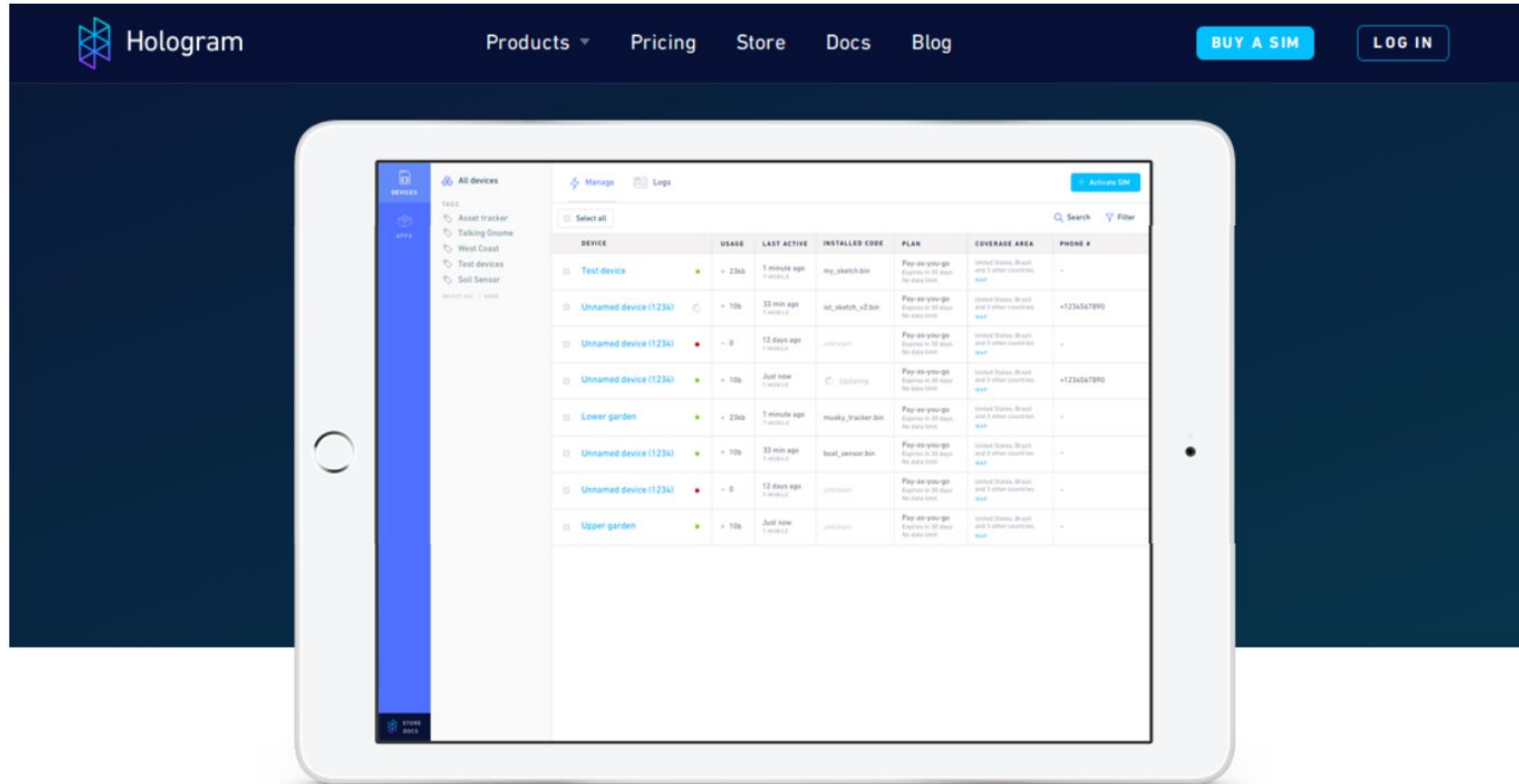
Name	Public Address	Local Address
Philadelphia OneMain Project	23.3.13.4	192.168.1.0
Ohio Valley Project	98.3.3.35	192.168.1.44
Charleston Pier Phase 2	120.44.12.77	10.10.10.9
Portsmouth Garage Project	133.7.7.88	192.168.10.1
- History for thunderboard/1735261/environment:** A section for viewing the history of data, featuring a "Count" dropdown and a "Filter" button. The data is as follows:

user_id	time	message
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...
anon	11/02/16 2:08:25 PM	Temperature: 26.75, Humidity: 5...

Hologram

It is a web platform software which provides services storage for any affiliated device that has Internet connectivity for storage, the protocols that uses Hologram for shipping are bluetooth, wifi and GSM, which they send it to their web platform, storing it for subsequently display the information obtained in your dashboard.

Hologram



Methodology

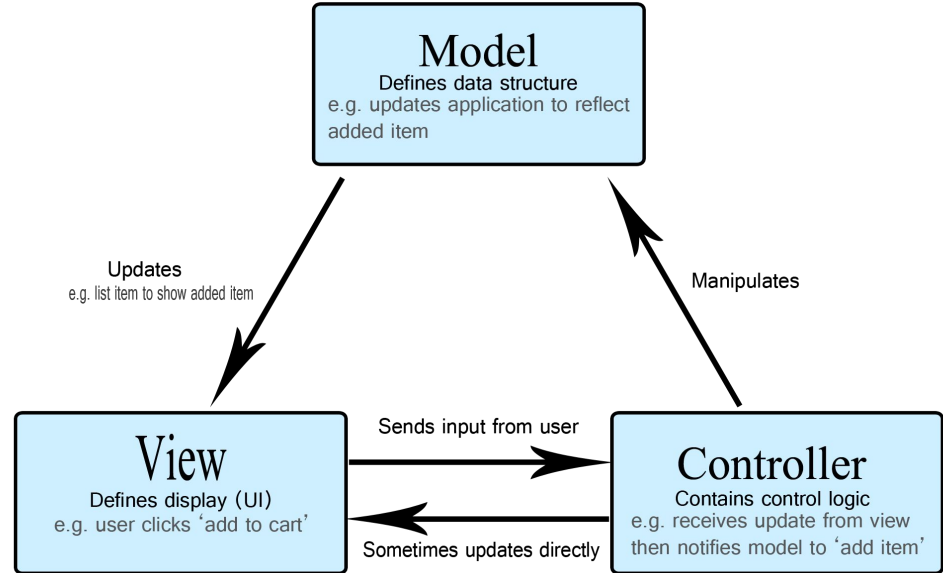
Technologies

Description

- The pattern of development on which the design of the implementation of the web platform is MVC (model-view-controller).
- For the development of a platform, a library, a package or a project in general, it is best to save the modifications or corrections of errors as they appear during the implementation stage.
- For the implementation of the database, the size of information and development of a platform, a library, a package or a project in general, it is best to save the modifications or corrections of errors according to appear during the implementation stage.
- It is an object-oriented design pattern, where objects to a class instead of the class itself instantiating the object, used for web application implementation making calls to various components necessary for the functioning.

Model View Controller (MVC)

- MongoDB: NoSQL
- AngularJS
- Golang (Backend)
- github



HTTP: Routing in MVC - Rest API

Controller *Action method*

Id parameter value

`http://localhost:1234/home/index/100`

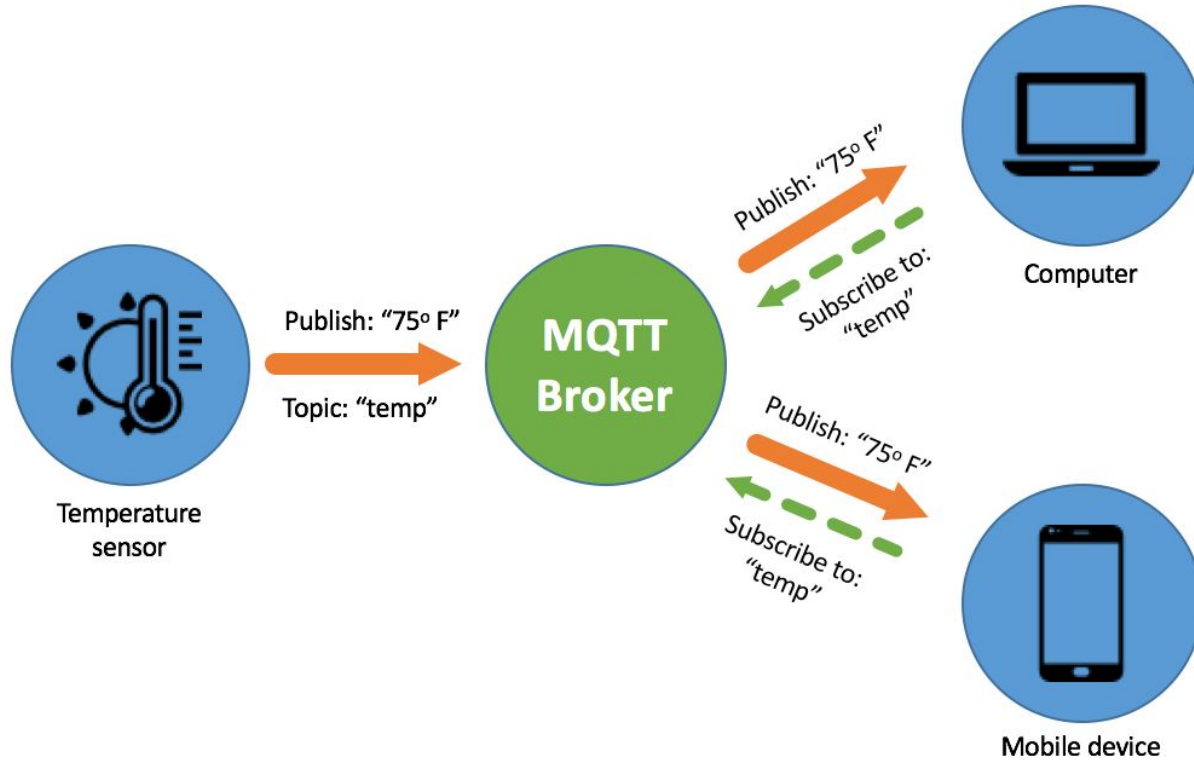


Controller *Action method*

`http://localhost:1234/home/index`

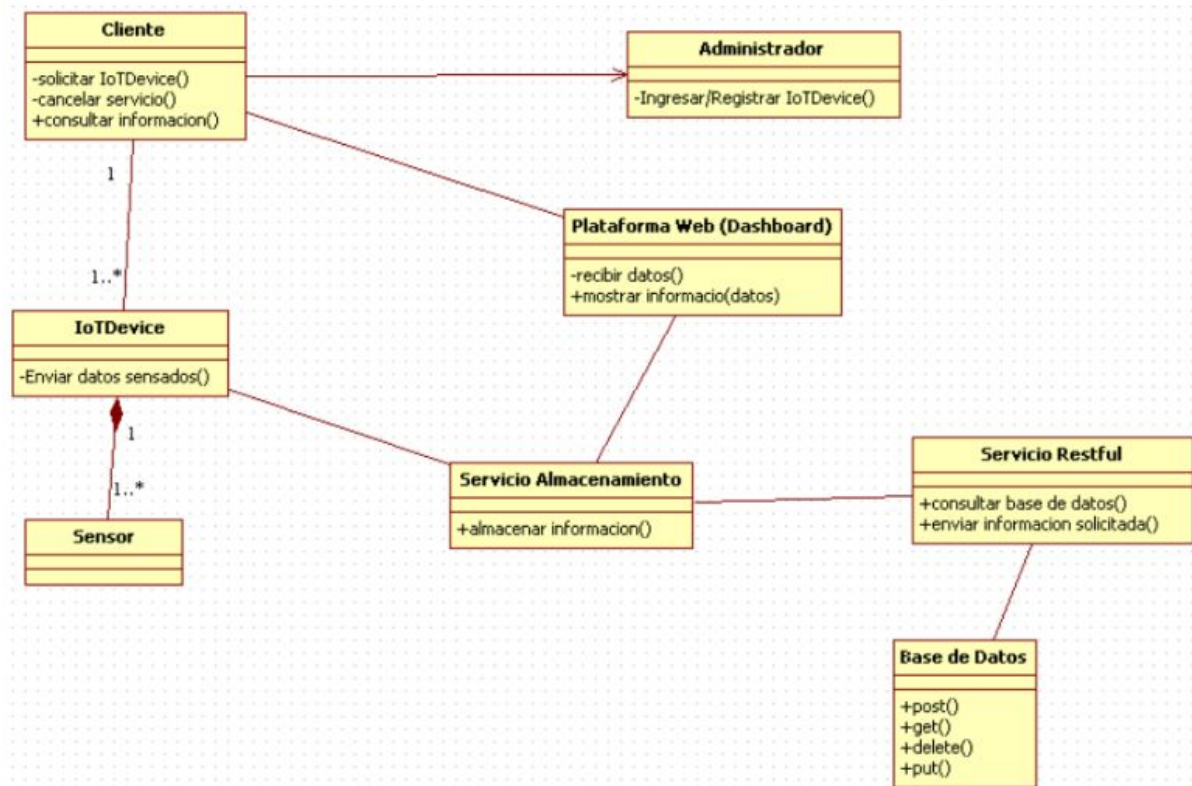


MQTT: Message Passing



System Analysis

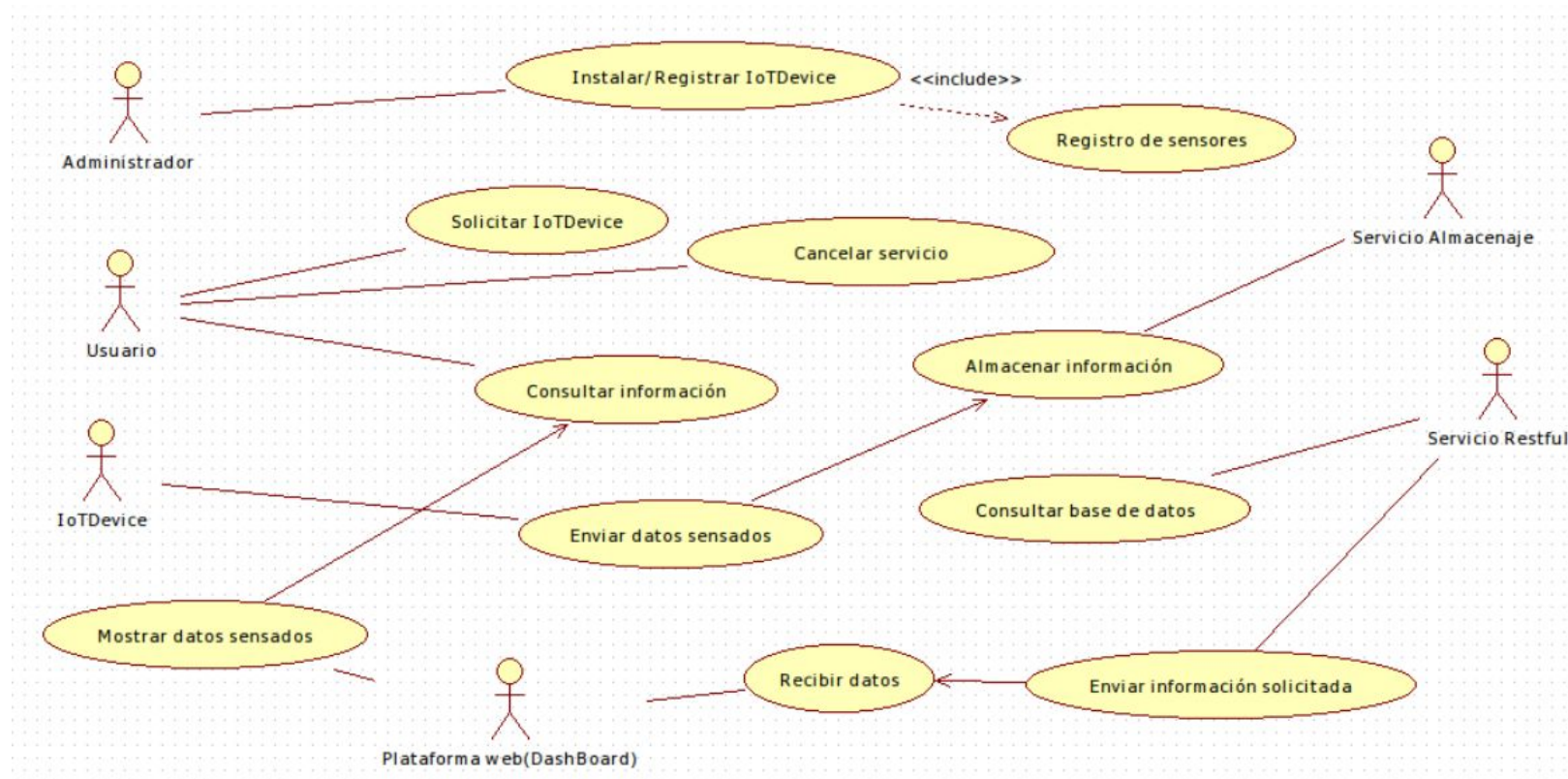
Classes Diagram



Classes Diagram

- **Administrator** It is the actor in charge of the administration of the users. He is the only user who does not have IoT-Device registered.
- **User** It is the actor that has requested a service to the system, it is that is, it is aware of the sensed information displayed by the system depending on the devices that the same user have requested.
- **IoTDevice** It is the actor that sends the information that it captures from the sensors and sends them to the storage actor.
- **Dashboard** It is the actor in charge of displaying the information sensed and stored.
- **Restful** It is the actor that is in charge of performing and returning answers according to the requests of the actor dashboard, as well as also check the storage.
- **Storage** It is the actor in charge of storing the information

Case Study Diagram



Application

Web Dashboard

Dashboard: Device information

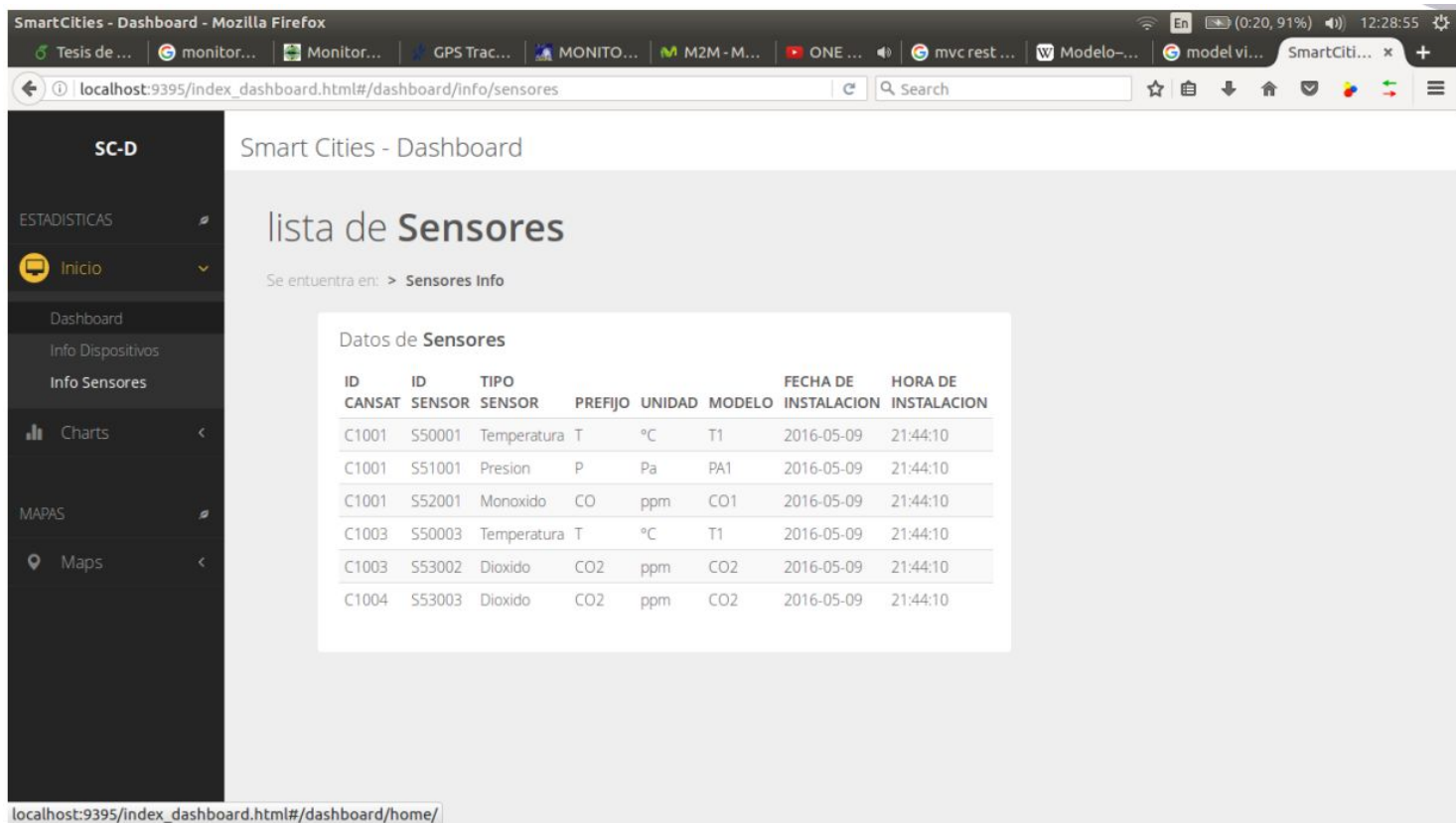
The screenshot shows a web browser window with the address bar displaying `localhost:9395/index_dashboard.html#/dashboard/info/cansats`. The browser's tab bar shows several open tabs, including 'Tesis de ...', 'monitor...', 'Monitor...', 'GPS Trac...', 'MONITO...', 'M2M - M...', 'ONE ...', 'mvc rest ...', 'Modelo-', 'model vi...', and 'SmartCiti...'. The browser's status bar at the bottom shows the time as 12:20:27 and the battery level as 86%.

The dashboard itself has a dark sidebar on the left with the following menu items: 'SC-D', 'ESTADISTICAS', 'Inicio' (with a yellow bus icon), 'Dashboard', 'Info Dispositivos' (highlighted), 'Info Sensores', 'Charts' (with a bar chart icon), 'MAPAS', and 'Maps' (with a location pin icon). The main content area is titled 'Smart Cities - Dashboard' and 'lista de Dispositivos'. Below the title, it says 'Se encuentra en: > Dispositivos Info'. A white box titled 'Datos de Dispositivos' contains a table with the following data:

ID	CANSAT	MODELO	UBICACION	LONGITUD	LATITUD	FECHA DE INSTALACION	HORA DE INSTALACION
C1001	verl	Zona 1	-77.0499641	-12.0166427	2016-05-09	21:44:10	
C1003	verl	Zona 1	-77.0495435	-12.0173944	2016-09-20	13:44:10	
C1004	verl	Zona 1	-77.0503843	-12.0157352	2016-05-09	21:44:10	

The browser's address bar at the bottom shows `localhost:9395/index_dashboard.html#/dashboard/home/`.

Dashboard: Device-Sensors information



SmartCities - Dashboard - Mozilla Firefox

localhost:9395/index_dashboard.html#/dashboard/info/sensores

Smart Cities - Dashboard

lista de Sensores

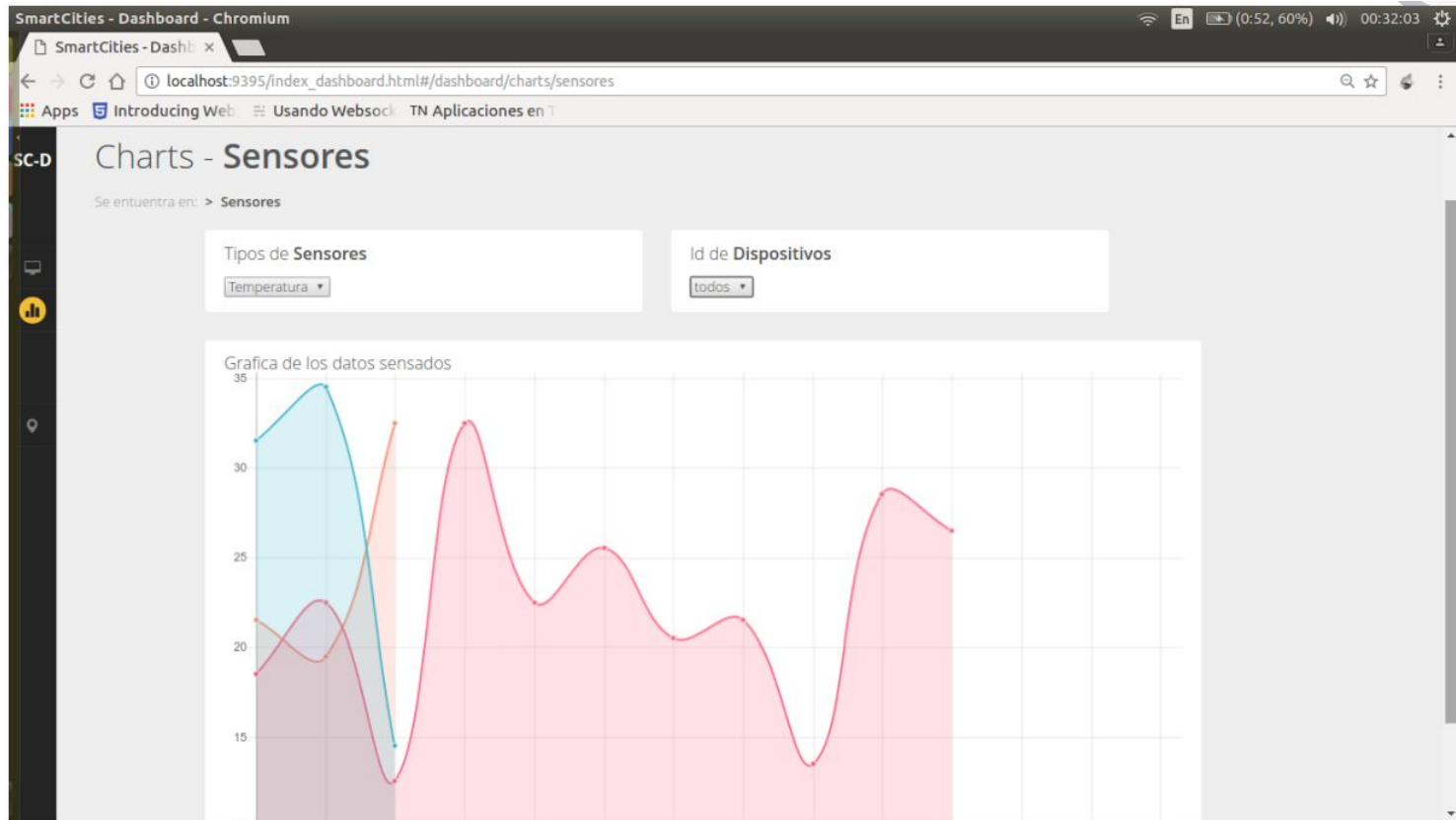
Se encuentra en: > Sensores Info

Datos de Sensores

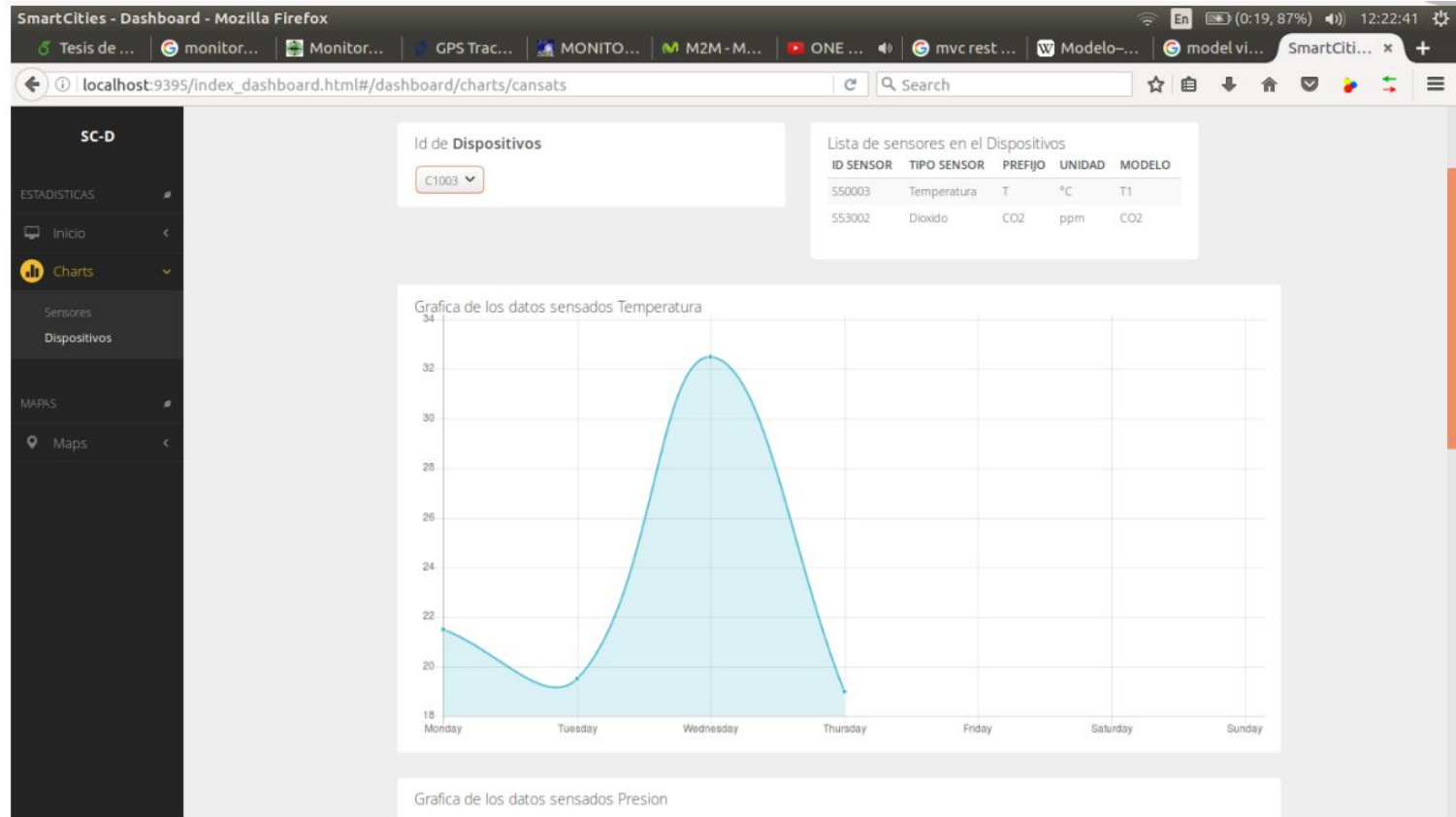
ID CANSAT	ID SENSOR	TIPO SENSOR	PREFIJO	UNIDAD	MODELO	FECHA DE INSTALACION	HORA DE INSTALACION
C1001	S50001	Temperatura	T	°C	T1	2016-05-09	21:44:10
C1001	S51001	Presion	P	Pa	PA1	2016-05-09	21:44:10
C1001	S52001	Monoxido	CO	ppm	CO1	2016-05-09	21:44:10
C1003	S50003	Temperatura	T	°C	T1	2016-05-09	21:44:10
C1003	S53002	Dioxido	CO2	ppm	CO2	2016-05-09	21:44:10
C1004	S53003	Dioxido	CO2	ppm	CO2	2016-05-09	21:44:10

localhost:9395/index_dashboard.html#/dashboard/home/

Dashboard: Device-Sensors Types information



Dashboard: sensor data



Dashboard: sensor location

SmartCities - Dashboard - Mozilla Firefox

localhost:9395/index_dashboard.html#/dashboard/maps/cansats

Smart Cities - Dashboard

Ubicación de los Dispositivos

Se encuentra en: > Dispositivos Maps

Map Satellite

Google

Map data ©2016 Google Terms of Use Report a map error

SC-D

ESTADISTICAS

Inicio

Charts

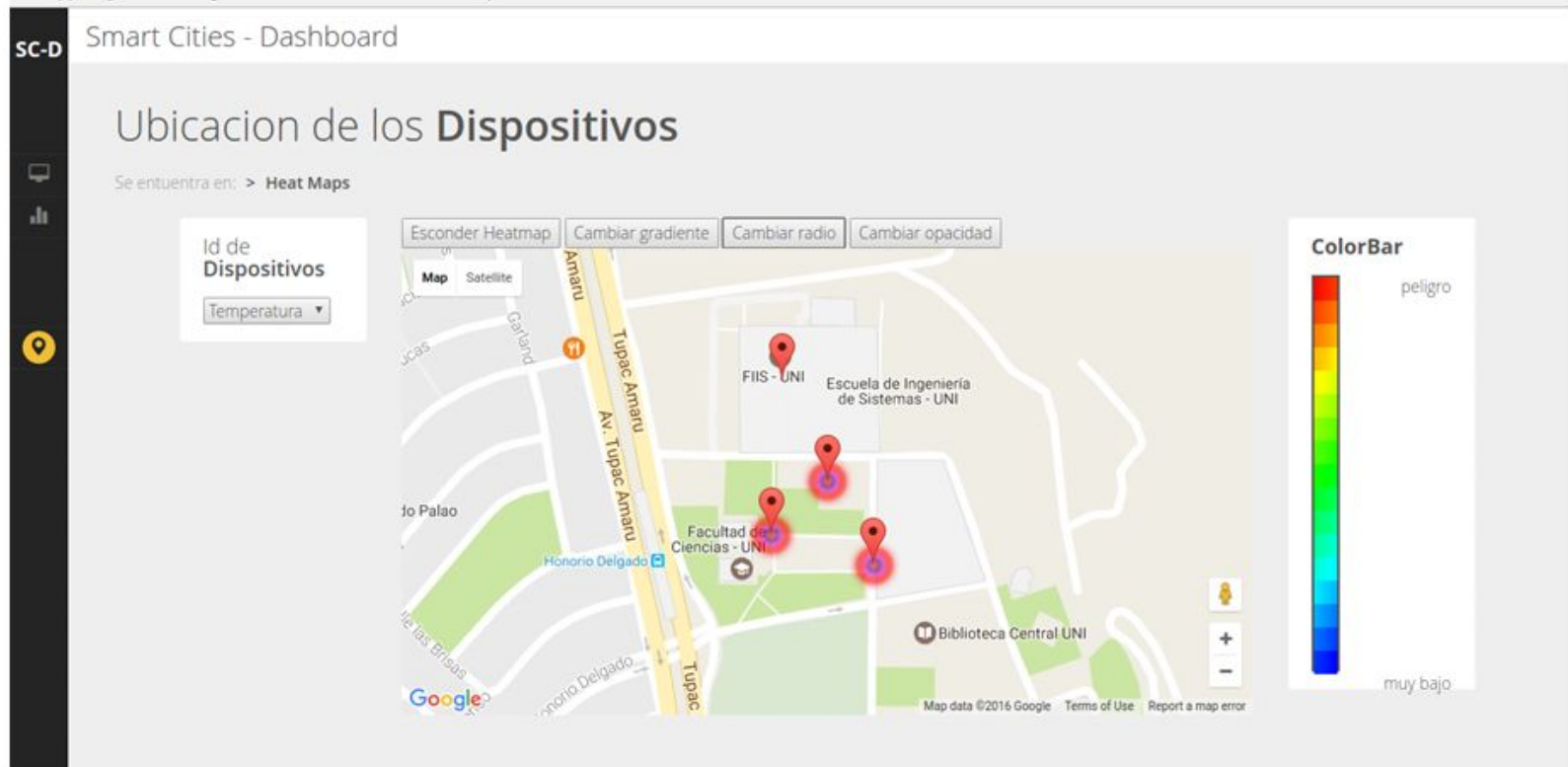
MAPAS

Maps

Dispositivos Maps

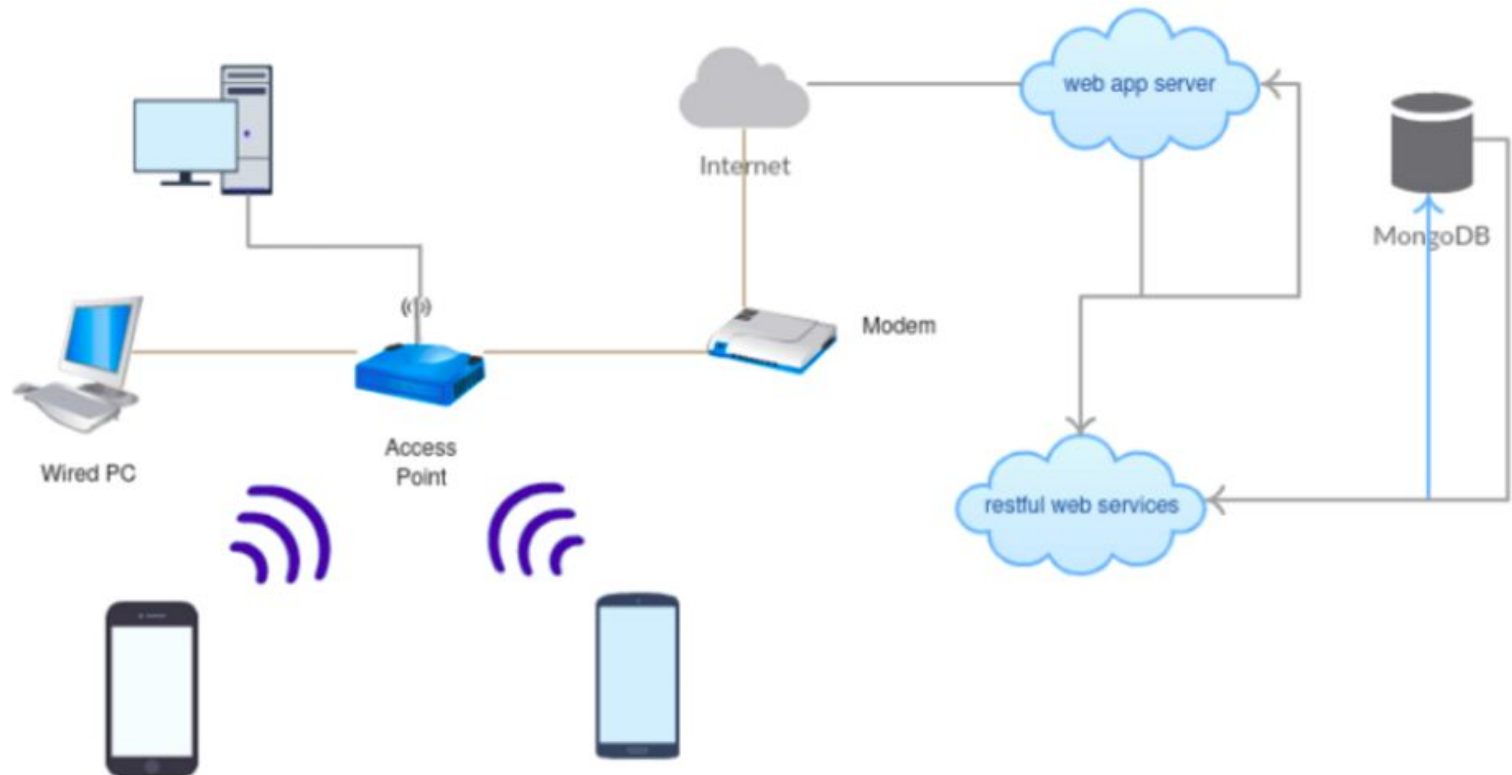
Heat Maps

Dashboard: sensor heatmap



Rest API

REST: System architecture



Conclusions

Main Contributions

- We propose a methodology to analyze income data from remote sensors.
- We implement a Fullstack application to process, clean, and show information sensed
- We develop a dashboard to show information in real-time.
- We build an Fog-based architecture to sensing, process, and track sensors data from different locations in real-time.

Questions?