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Data as an asset: EMT open platform for transport data in Madrid

Sergio Fernández Balaguer^{1*}, Mario González Fernández², Andrés Recio Martín³

1. *Communication and Consultancy Department, EMT Madrid, C/Cerro de la Plata 4, 28007 Madrid, Spain*
2. *Tenchnology Department, EMT Madrid, C/Cerro de la Plata 4, 28007 Madrid, Spain*
3. *Tenchnology Department, EMT Madrid, C/Cerro de la Plata 4, 28007 Madrid, Spain*

Abstract

EMT Madrid (Empresa Municipal de Transportes de Madrid S.A.) is at the forefront of Intelligent Transport Systems and Customer Information Systems use. On this regard, EMT adopted an active open data policy back in 2006, and developed also a new open data portal in 2011, which has allowed us to innovate and improve user's information, letting third parties to develop apps and services specifically oriented to users.

Furthermore, at EMT we have developed an open and standard platform (framework) with the purpose of building applications and developing services, that allows the subscription and events exchange system for mobility data in the context of Smart Cities, including Internet of Things and MAAS.

The main achievement has been to allow the unification under one single infrastructure of the different elements that handle the information on traffic and transport in the city. It has been developed in a quite innovative way as well, as a mobility lab has been created in order to work on this topic.

Keywords: ICT Technology Applications (e.g. Block Chain / Internet of Things / Big Data / ...); Sensors / Data Acquisition and Management; Big Data / Cybersecurity

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* Tel.: +34 914068831 fax:+34 914068801
E-mail address: sergio.fernandez@emtmadrid.es

1. Introduction

Empresa Municipal de Transportes de Madrid S.A. (hereinafter, EMT Madrid) is a public company created in 1947 and 100% owned by Madrid City Council. It manages the bus transport service in the municipality of Madrid, being the only bus operator of the City, and the largest company in Spain in its sector. EMT Madrid also manages 18 underground parking facilities of the city, as well as the tow trucks service and the public bike sharing system (BiciMAD, with 2,028 pedelecs). EMT also provides technical assistance to Madrid City Council on sustainable urban mobility matters.

Nowadays, EMT employs nearly 8500 workers. Its fleet accounts 2,000 buses (with 3,725 km network), 10,024 bus stops and are available to travel in 203 routes across Madrid. Its fleet includes a wide variety of alternative fuels (including fully electric, CNG-hybrid and diesel-hybrid, and one of the biggest CNG fleet in Europe).

Yearly, the EMT's buses are travelling more than 90 million kilometers and carrying 430 million passengers, 365 days a year, and 24 hours a day, becoming a critical infrastructure of the urban ecosystem and therefore, playing an important role on the normal functioning of the city and of course, having an impact on urban environment of the city.

Mobility in a "Smart City" flags up also the vital importance of the improvement of energy efficiency and the optimization of services, producing qualitative improvements in services affecting the environment and of course, generating an immense exchange of information related to goods, services and people's trips. In this sense, mobility should not be interpreted as an isolated element in which ecosystems such as Public Transport, Traffic or any other related element, become islands that operate autonomously. The objective of the Open Lab Mobility initiative is precisely the construction of a dynamic and adaptive model based on Big Data that provides diverse elements of the city under a standardized and georeferenced approach, facilitating the work of data scientists and other consumers of information, and offering it in a free and open way.

In this regard, and beyond the open data concept, EMT has developed an open and standard platform (framework) with the purpose of building applications and developing services, that allows the subscription and events exchange system for mobility data in the context of Smart Cities, including Internet of Things and MAAS.

The open platform is available to citizens and businesses under a completely new and innovative model, containing three essential novel components:

- Allows observation of events related to the real need of the applicant without searching if there is any data available and where this is. The system automatically provides a data when it occurs.
- Allows easy integration of existing sensors and elements in the city (for example, buses) creating inter-related information.
- Defines a common open protocol for the exchange of information between citizens/companies and public bodies. Moreover, data datagrams (messages) have been standardized under a JSON data structure model that favors public exchange and knowledge of the information that is exchanged between all connected clients. The ultimate goal is to promote exchange between systems connected in real time to a common data bus of the city using a single and unique data protocol

2. Open platform architecture and components

The platform is an open and event oriented platform that has been developed with the aim of providing to the mobility environment of the city of Madrid an exchange system of information in real time.

It allows the entry of data from multiple stakeholders (institutions, citizens...), making multiple and unlimited exchanges we must point out that the system allows multiple customers to subscribe to the kind of information they need and the platform automatically provides them with such information; Hence, it would be transferable to any city/transport authority/Transport operator.

The platform also enables the integration of events or sensor data from citizens and other corporations, institutions, administrations, etc. building new data layers that can be exchanged again with third parties. The infrastructure

contains a semantic website, a "wikipedia" and a dissemination of information website, along with a set of APIs that allow the exchange of information throughout the system.

To help setting it, first version of a mobility lab for the city was created in May 2015 (<https://mobilitylabs.emtmadrid.es>). The aim of this "Madrid Open Mobility Lab" is to become a testing site for any system or application, either public or private that likes to observe mobility events and generate useful data (intelligent knowledge or services) to others.

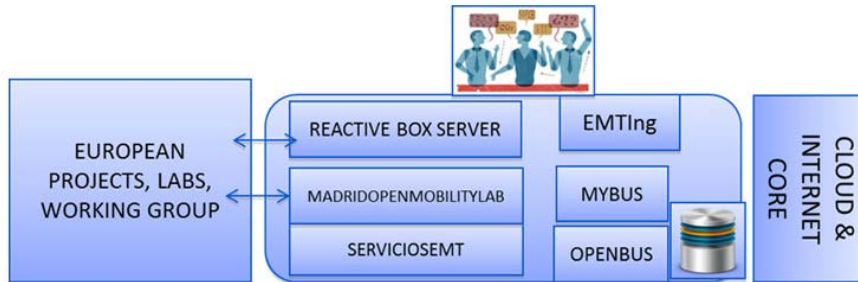


Fig. 1 General overview of MobilityLabs platform, including Gamification

It is formed by an internet platform that allows getting connected virtually to a bus and moving around with it, and a platform to watch events, the "Reactive Box". It's open to anyone and access can be applied by our open data portal <http://opendata.emtmadrid.es/>

The system information model is based on NoSQL² databases and subscription and exchange events and sensor readings is built under a Meteor³ platform powered by Node.js, allowing observation models in real time with thousands of simultaneous clients.

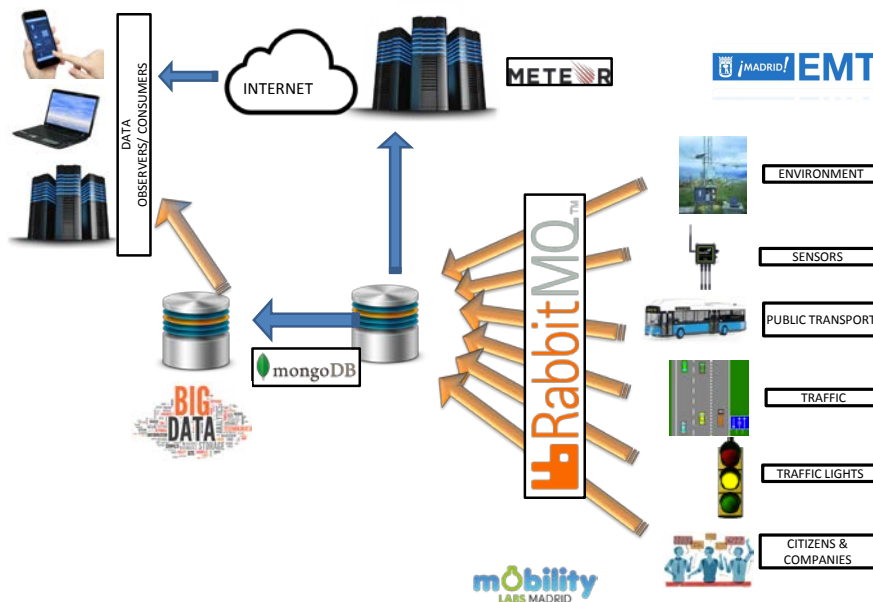


Fig. 2 Open platform architecture

² Not Only Structured Query Language database (originally referring to "non SQL" or "non relational"). It provides a mechanism for storage and retrieval of data that is modeled in means other than the tabular relations used in relational databases.

³ Meteor is a free and open-source isomorphic JavaScript web framework written using Node.js. Meteor allows for rapid prototyping and produces cross-platform (Android, iOS, Web) code. It integrates with MongoDB and uses the Distributed Data Protocol (DDP) and a publish-subscribe pattern to automatically propagate data changes to clients without requiring the developer to write any synchronization code

In the previous figure we can observe the reactive mechanisms of the system, based on Meteor, as well as the historical model of massive storage (bigdata) that supports it. When an external system provides data to the platform, this information is transferred through AMPQ⁴ to an informer that elaborates the information in NoSQL databases. This information is automatically published and can be observed or consumed through APIs containing Reaction based subscription / observation models, thus allowing reacting to the creation, change or deletion of a data. These observers and the data they post are open and can be used by any developer.

The design of the platform, called “rbmobility” is simple. The client, once authenticated, can insert, update or delete data using a queue server.

Any authorized client looking at a certain type of information to which is subscribed will get in real time all changes produced in the different layers it is looking at.

One of the most important issues of the architecture put in place by third parties in Opendata mode is that it is an architecture based on events and not classic services. For this, it has the possibility of sending information to the platform by integrators using a Rabbit messaging queue. Through this message queue an integrator can send standardized messages.

Regarding the data model, the Madrid entities basic model has been defined based on the following aims: being shared and open, adaptable, scalable and standard. This data model contains the semantic definition of objects, and both real time data and Big Data collections. It is also public and open, and it is published in <https://github.com/madridopenlabmobility/MOBILITY-MADRID-virtual-entities>

Currently, the platform has enough information to perform multiple analyzes. Among the most relevant events that can be cited is the position in Real Time of all EMT buses, estimated arrival time at each stop, updated information of all pollutants and particles of the sensors of the City of Madrid, data and readings from the Airborne Pollen network of the Regional Government of Madrid and the status of Madrid traffic in Real Time.

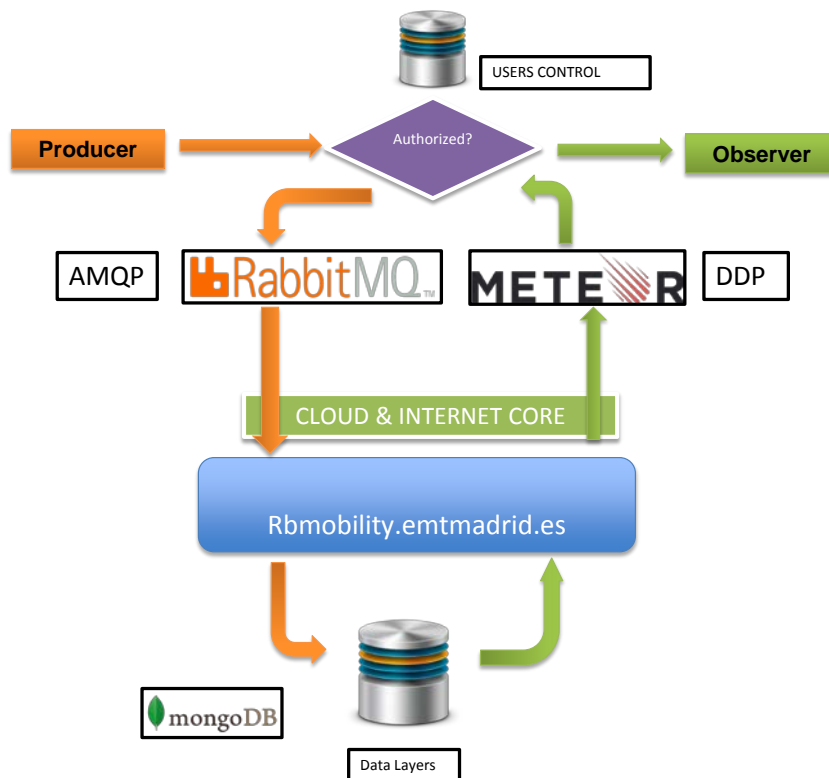


Fig. 3 Open platform architecture. Input/output dataflow process.

⁴ Advanced Message Queuing Protocol

Among other facilities available to integrators is a geographic portal, in which the data of the system activity can be visualized in real time along with its contents. This portal is available on the Internet and uses the same event-based architecture to connect by Meteor.js

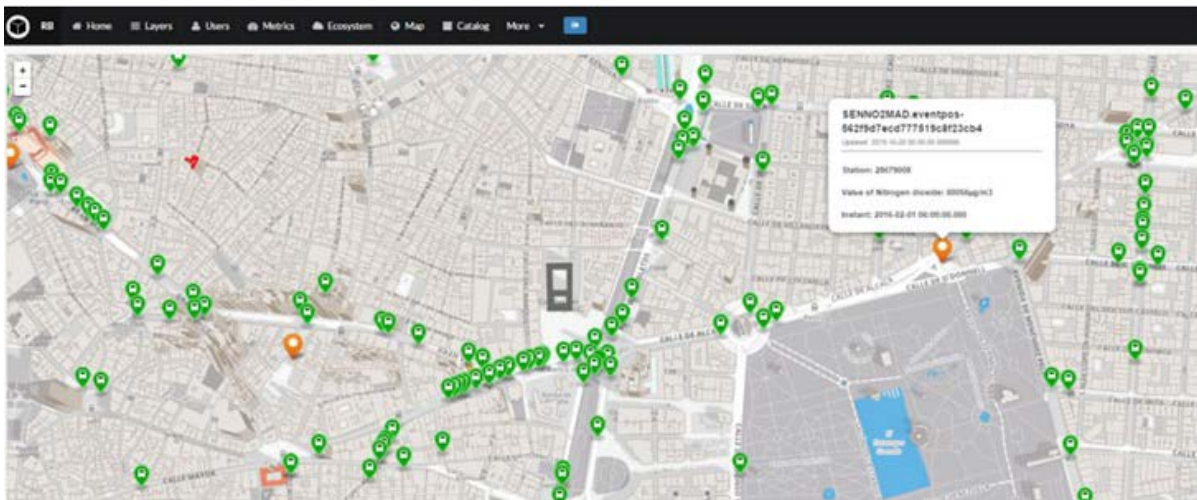


Fig. 4 MobilityLabs Events Query Portal

As for the bus emulator, it allows to connect to any vehicle that is in service in the line and obtain information of real time. The information includes the GPS coordinate of the bus, the online position and the data related to the line and the trip, including the expected time of arrival at every bus stop, among others. This information is available through an API REST for any developer.

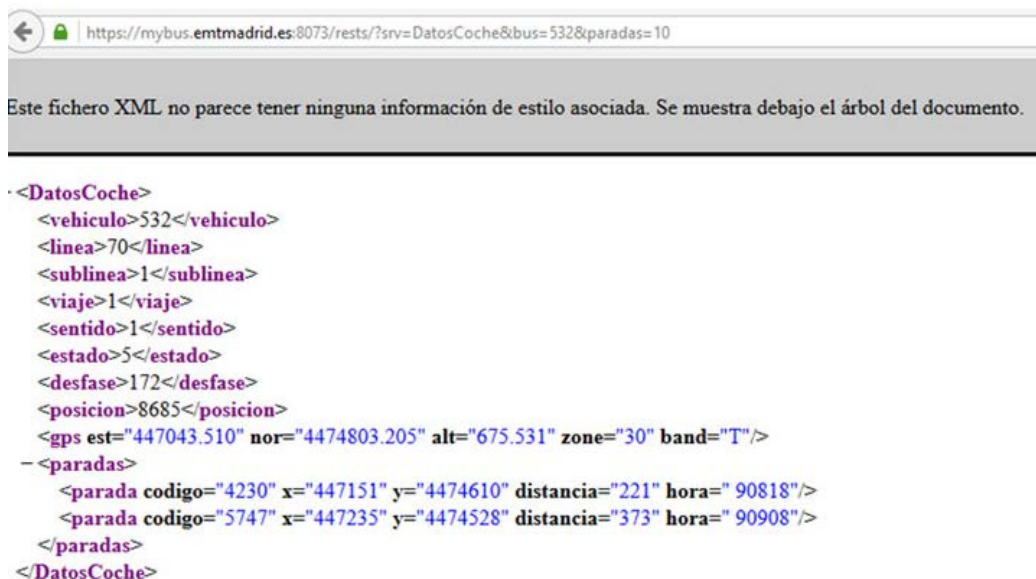


Fig. 5 Information provided by EMT Madrid's Opendata myBus service

The same information can be obtained through the Wi-Fi access point of the bus allowing developers to develop real-time services with information contextualized and associated with the territory in motion.

3. The laboratory for mobility and research projects

Currently, the Laboratory for Mobility in Madrid is committed to various development and research projects and involves multidisciplinary integrators. Among the most important projects in which it is collaborating are several European FP7 (recently ended) and ongoing H2020 projects: MOVEUS, COSMOS, iKaaS and INLIFE, cooperating in its promotion, construction or diffusion with many partners around Europe and beyond: ATOS,

ESRI, Solusoft, Media Lab Prado, Localidata, the National Technical University of Athens or ETRA R&D, among others.

4. Conclusions

The main achievement has been to allow the unification under one single infrastructure of the different elements that handle the information on traffic and transport in the city, which allows to develop interesting projects such as models of traffic light prioritization, smart management of traffic lights environments, etc. simultaneously providing real-time information to allow third parties to develop other integration solutions. It has been developed in a quite innovative way as well, as a mobility lab has been created in order to work on this topic.

EMT is currently developing the second version of MobilityLabs. That new version includes, among other characteristics, a management portal through which a developer can register, define data structures and publish them for others to be used, and all of this, on an autonomous way. The following resources will be also shortly available for the whole developers' community: APIs, mobile platform SDKs and everything needed to make the platform a model for data sharing by a community.

5. References

EMT open data portal: <http://opendata.emtmadrid.es/>

EMT partial data model: <https://github.com/madridopenlabmobility/MOBILITY-MADRID-virtual-entities>

Reactive Box: `rbmobility.emtmadrid.es:4444`

Mobilitylabs: <https://emting.emtmadrid.es> (currently is <https://mobilitylabs.emtmadrid.es>)

Website IKAAS (Intelligent Knowledge as a Service) project: <http://ikaas.com/>

Web site COSMOS (Cultivate resilient smart Objects for Sustainable city applicatiOnS) project: <http://iot-cosmos.eu/>