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Large-scale Integrated Project (IP)

D.11.6.2: Report on FIWARE Success Stories in selected Application Domains

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Executive Summary

This report is a summary of selected, FIWARE Success Stories on different application domains:

- ***CityGo***, smart mobility solution part of a wider pilot project developed in Málaga (Spain). *CityGO* aims at providing recommendations about the best route to get usual destinations within a city, depending on diverse real-time conditions, promoting healthy and environmental care behaviours. It calculates the usual daily paths or itineraries, providing also valuable information to the municipality to take decisions about transport regulation. This application has been successfully presented during the *Smart City Expo World Congress 2016*.
- ***Smarter Water*** for healthier urban living, developed in the cities of Seville and Las Palmas de Gran Canaria (Spain). This project uses FIWARE technologies to monitor the salubrity and other parameters of water masses, including sea waters, rivers and public drinking water distribution networks, contributing to the sustainability and efficiency of municipal facilities and improving overall citizens life. It was presented during the *IoT Solutions World Congress 2016* and the *Smart City Expo World Congress 2016*.
- ***Portable City Dashboards***, demonstrating how to build portable smart city dashboards using FIWARE Harmonized Data Models. Focusing on municipalities that do not manage the public services by themselves but need reliable mechanisms to check if the service actually provided performs as expected and if the public resources are properly used. The showcase demonstrates, among others, a tool used to track waste management resources and utility performance, with real-time information from the city of Guadalajara (Spain). This showcase was presented during the *Smart City Expo World Congress 2016*.
- ***Robotics Warehouse showcase***. A warehouse automation demonstration using FIWARE. It uses several robots working together to pick up and deliver goods, and it has been presented at the *IoT Solutions World Congress 2016*. A robotic arm is able to serve requests for materials in a warehouse. At the same time, it shows the

potential that lies in the creation and implementation of middleware standards to inter-connecting systems and to solve interoperability issues with FIWARE.

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1 Introduction

1.1 Introduction

This document describes several *FIWARE Success Stories* that were used for dissemination events as showcases, and which demonstrate the FIWARE potential to various stakeholders (FIWARE community members, interested customers, cities, industry associations, etc.). Nonetheless the most relevant FIWARE Success Stories are those supported by the *FIWARE Acceleration Program*. Such stories are already well described on the FIWARE Web site.

This is the second and last issue of this document that provides an account of new showcases developed in several FIWARE application domains. All of them were presented at relevant industry fairs during the year 2016 .

1.2 Target audience

The target audience of the present document is anyone who wants to know more about the potential of FIWARE to catalyze the advent of innovative solutions to problems in different domains. In addition any member of the FIWARE Community will benefit from reading it, as it can serve as a point of inspiration for further work.

1.3 Related readings

To know more about the FIWARE Acceleration Program, please visit https://www.fiware.org/fiware-accelerator-programme/

To know more about success stories funded by the FIWARE Acceleration Program, please visit http://myfiwarestory.fiware.org/

2 CityGo

2.1 Success story summary

Name:

CityGO - A Smart City application for Malaga.

Developed by:

ATOS.

Collaborators:

City of Malaga - Spain (as data provider).

2.2 Functionality

CityGo is the implementation of the use case scenario for the transportation diversity in Malaga City. The application is composed of two main frontends: the mobile application and the administrative dashboard.

2.2.1 Mobile Application

The mobile application is utilized by the user to get the best route and transportation option to reach his usual places.

Figure 1.- Map navigation through the mobile application

This is done through the “CityGO” application, which analyzes the usual daily paths or itineraries and frequency (weekdays, hours, timing) for every user and provides predictive information on this regular transportation habits based on the open data taken from different open datasets.

CityGO mobile application has 3 main sections:

- Settings: Users can store their own settings (transportation type, enable/disable sending user information to the server etc.).
- Main screen: For the optimum path calculation based on user inputs.
- Points of Interest screen: To help users save their favourite locations so that they can be easily used for the next transportation calculation.

Figure 2.- Points of interest screen

2.2.2 Administration Dashboard

The administration dashboard provides detailed information on how the different transportation methods are used by the citizens of Málaga. The data about the citizens’ movements and transportation habits are fed to the *CityGo* servers by the mobile application. The app also monitors the GPS signals and sends anonymous information about the user’s routines to the servers.

In the dashboard, users can find statistics on the use of different bus routes at various times of the day, such as the morning and evening rush hours, the non-peak hours, etc., together with data on the movements of the app users around the city.

The screenshots below show some of the different views on this dashboard: a heatmap of the citizen locations, and a view on the use of bus routes by citizens.

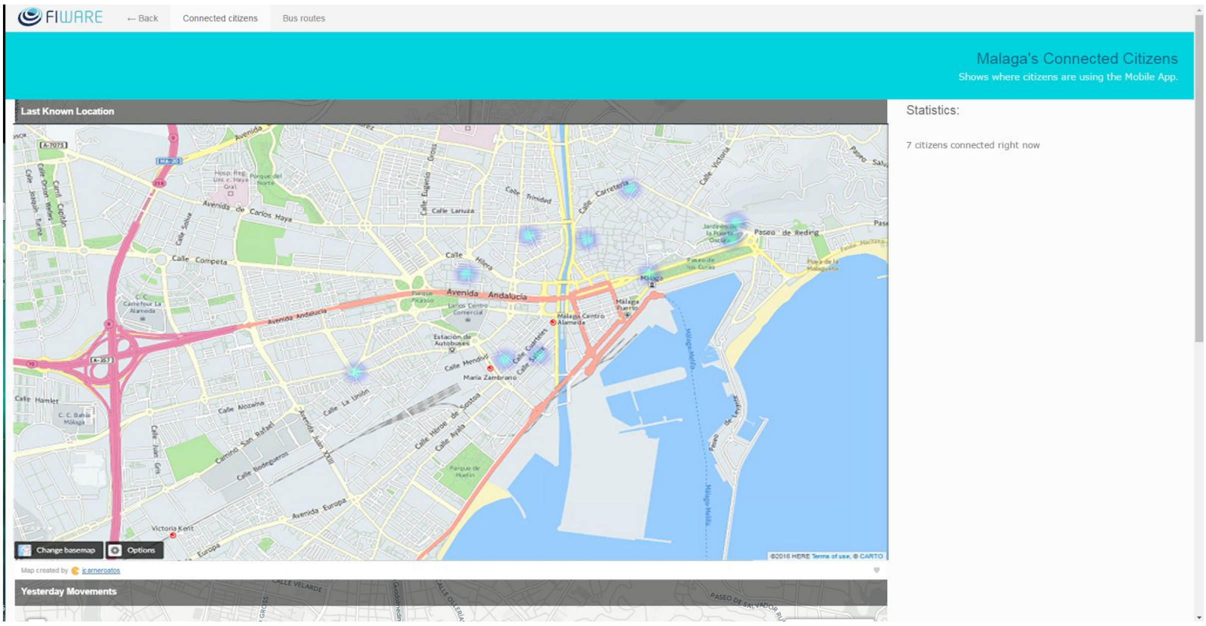

Figure 3.- Heatmap of citizen location

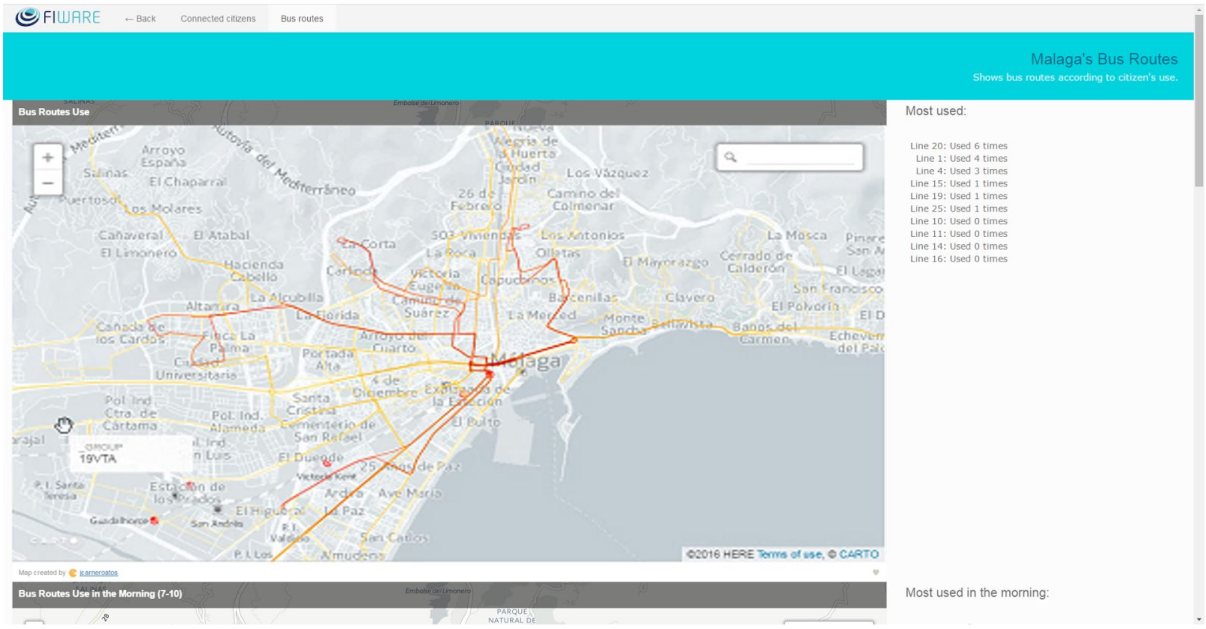

Figure 4.- Use of bus routes by citizens

This data can then be viewed by citizens, local governments, third party service providers, plus everyone who may find this information useful. In particular, local governments could provide better public services, knowing more accurately the needs of the city and optimizing its resources.

2.3 Architecture

For Malaga City, the data about parking places, transportation routes or buses is presented via services provided by the Malaga Municipality. Such data is provided in a format that can be used by developers. In fact, sensors, parking, bicycle and bus routes information is retrieved from the official Malaga city web services.

These datasets are published by these actors:

- EMT Malaga and SMASSA
- Portal Datos Abiertos (http://datosabiertos.malaga.eu/) - A CKAN instance

All the dynamic datasets are exposed in these two platforms and get updated at specific time intervals. The following is the list of datasets that are available to the 3rd party application users:

- Parking places: Provide the free, occupied and total capacity of a parking place.
- Bus routes: Provide bus routes, number, address and the line number of a bus for a specific station.
- Bicycles: Provide the free, occupied and total capacity of a specific bicycle station.
- Weather forecasts: Display the daily weather forecasts.

CityGO application keeps the user itineraries anonymously for better recommendations and provides, in the end, a big dataset which is entirely open. Application developers or City Hall officials can analyze this kind of data and come up with practical solutions, alternatives for the transportation case in Malaga.

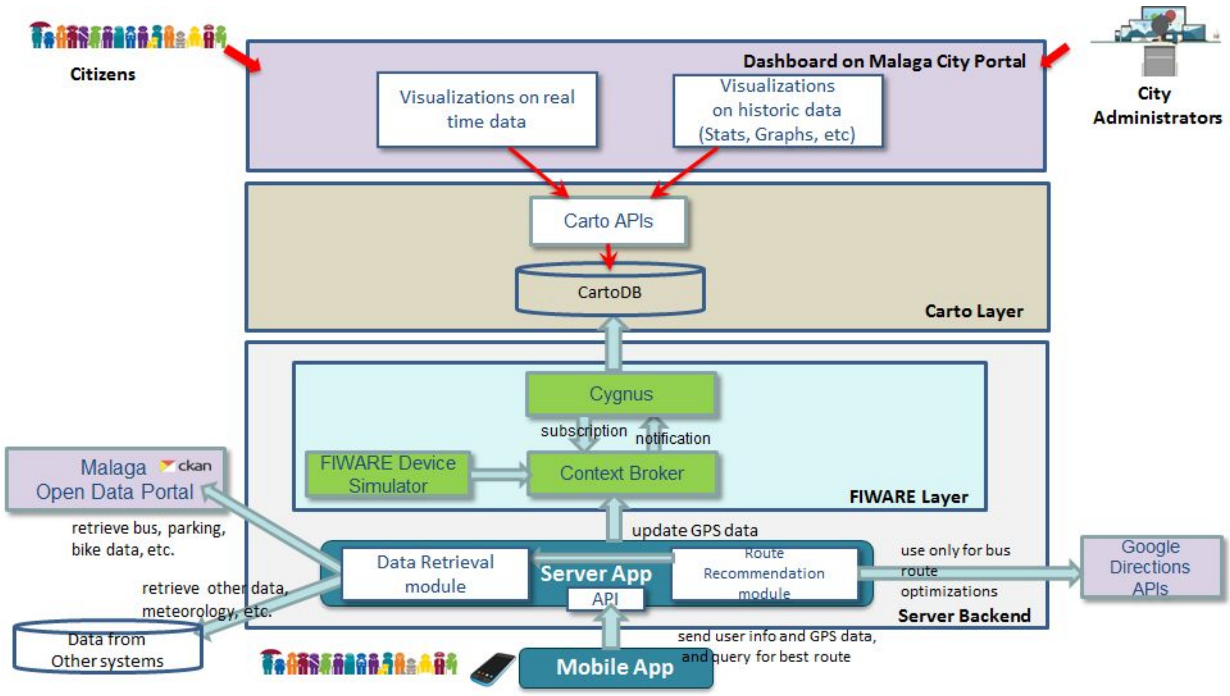

Figure 5.- City Go High Level Architecture

Our pilot city application architecture is composed of several layers as shown above:

- **Mobile application**: An Android application for the end users to provide the best routes for their points of interest based on the transportation types (vehicle, bus or bicycle).
- **Server application:** A Django/Python based web server application composed of two parts. The first one is the *"backend"*, which consumes the data coming from different sources like the mobile app users or the Malaga City open datasets, and send it to the Carto component through the FIWARE platform (see below). The second part is the *"portal"*, a public website which aims to provide statistical data referred to citizens, such as where the app is most used and which bus routes are being used most, etc. It runs on a FIWARE Virtual Machine in the FIWARE Lab node in Tenerife (Spain) operated by Atos.
- **FIWARE layer:** Orion Context Broker, Cygnus and the FIWARE Device Simulator compose the FIWARE layer. The first one, Orion, is in charge of the context data, and Cygnus acts as a gateway between backend components and visualization or storage components. The last one has been used to simulate the data sent by the CityGO app during the development stage. The three components run on the same virtual machine as the Server application.
- **Carto application:** It is in charge of receiving the data sent by the backend in the server application. This data includes anonymous GPS locations and bus routes used by citizens. Carto stores and analyzes it, plotting then this data into meaningful maps to be used by the *"portal"* component. The Carto application runs on the servers provided by the Carto company.

2.4 The role of FIWARE

FIWARE acts as the middle layer providing all the APIs for this application which provides the abstraction layer between, the end users who populate the GPS data and the CartoDB application that deals with the historical records.

These are the list of the Generic Enablers used in the implementation cycles:

- **Orion Context Broker**: For managing user GPS data as Context data.
- **Fiware Device Simulator**: for simulating context data to be able to demonstrate more meaningful analysis on the City dashboard.
- **Cygnus**: For flowing the data from Orion Context Broker to CartoDB.

Last but not least, the FIWARE Device Simulator and the FIWARE Harmonized Data Models were also used.

2.5 Achievements

CityGO application beta version is already available in the Google Play Store. Beta testers of Malaga citizens are able to use the application for their daily transportation activities. It has been presented in the Smart City Expo World Congress Barcelona 2016 event and has received wide interest among participants and visitors.

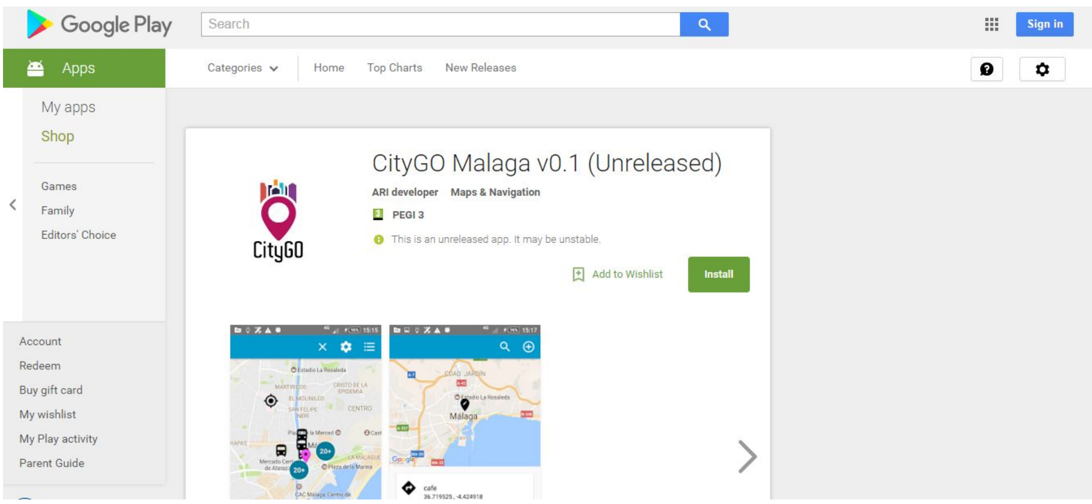

Figure 6.- Google Play entry for the CityGo application

2.6 Conclusions and outlook

Even in its current beta version, *CityGO* is a solid example of how a smart city application can be implemented easily with FIWARE technologies.

The next iteration of *CityGo* will also make use of the city's weather information to offer users better suggestions about commuting and route planning. Another planned feature that is worth mentioning are personalized suggestions. Travel behavior and application usage habits of the user will be collected and analyzed by *CityGo* in order to provide further refined warnings or suggestions to the user via push notifications. Finally, several more views may be added to the dashboard, to show some information on the usage of bike paths or stations and parking lots by citizens, similar to the statistics provided on the usage of bus routes.

2.7 References

- https://catalogue.fiware.org/enablers/publishsubscribe-context-broker-orion-context-broker
- https://github.com/telefonicaid/fiware-cygnus
- http://fiware-device-simulator.readthedocs.io/en/latest/
- http://www.smartcityexpo.com/en/
- http://datosabiertos.malaga.eu/

3 Smarter Water for healthier urban living

3.1 Success story summary

Name:

Smarter Water for healthier urban living

Developed by:

aDevice (Spain), University of Las Palmas de Gran Canaria (Spain), Telefónica I+D.

Collaborators:

Puerto de Sevilla - Tecnoport 2020,

EMALSA (Municipal water services operator in Las Palmas de Gran Canaria),

Hanna Instruments (water sensor provider).

3.2 Functionality

The showcase demonstrates how FIWARE technologies can be used for monitoring and controlling the quality of water masses at different locations (sea, river, public fountain, public distribution network, etc.). The full water lifecycle is covered enabling more efficient and effective water management systems. Besides, it enables the improvement of the environment surrounding city's rivers or seas.

IoT FIWARE Ready sensors are installed on a river, water distribution pipes, public fountains or marine outfalls. These sensors are able to report, real time, different water quality parameters (pH, chlorine, temperature, etc.) and conditions of related appliances (pipes, fountains, etc.). Then, they publish such data using NGSI and the FIWARE OASC harmonized data models. The final aim is to provide a Decision Support System (DSS) thanks to the monitoring of the differents values given by sensors, helping operators to control watering systems and related water ecosystems.

Last but not least, 3D visualizations are used so that operators can gain a better understanding of of what is happening when, where and why. Additionally thematic layers, like the wastewater network of the city of Las Palmas de Gran Canaria, can be loaded.

Figure 7.- View of the web application with the wastewater network loaded displaying sensor data.

The context data provided by a sensor can be obtained by selecting its 3D model using the mouse. Such data is obtained in real time from different context brokers. Data provided by sensors located in the city of Seville comes directly from the field. However, for demo purposes and to respect the restrictions imposed by EMALSA, the sensor data which origin is Las Palmas de Gran Canaria is generated using the FIWARE Device Simulator.

In addition to displaying sensor locations and retrieving its data in real time, the application also allows users to create alerts that will be raised when a certain condition is met. An alert can be defined using any numerical attribute of a sensor and a condition value that could be:

- Sensor attribute value lower than a specified reference value.
- Sensor attribute value equal to a specified reference value.
- Sensor attribute value greater than a specified reference value.

Figure 8.- Alert registration view .

3.3 Architecture

The figure below shows the main components of the system architecture. Yellow modules generate the information stored in Context Brokers, while the other modules display the information and manage the alert system and the application behaviour.

The differents elements involved are:

- *Seville sensors*: Real sensors placed in the city of Seville in a fountain and the Guadalquivir river. They collect field data every 15 minutes.
- *IoT Device Manager & NGSI IoT Adapter*: IDAS GE with IoT Agent using UL2.0 (Ultralight) protocol. This component receives raw data from sensors and harmonizes it as per the FIWARE Data Models.
- *FIWARE Device Simulator*: This component is used to reproduce the data provision behavior of the sensor located in the city of Las Palmas de Gran Canaria.
- *Context Brokers*: They store context data coming from sensors that will be queried by the application in real time and also send notifications to the alert managers every time a value related to an alert is modified.
- *Alert management*: This component creates the alerts storing them when they are raised. This component subscribes, via NGSI, to attributes involved in the created alerts.

- *Web app*: This component is the front end of the application. It retrieves in real time all the sensor data and represent them in a 3D map. It also interacts with the alert management subsystem in order to get the raised alerts and allow users to add or remove alerts. Finally, the component interacts with OGC WMS servers to get extra map layers.
- WMS server: This component provides extra map layers, using OGC standards, to be used from the web app.

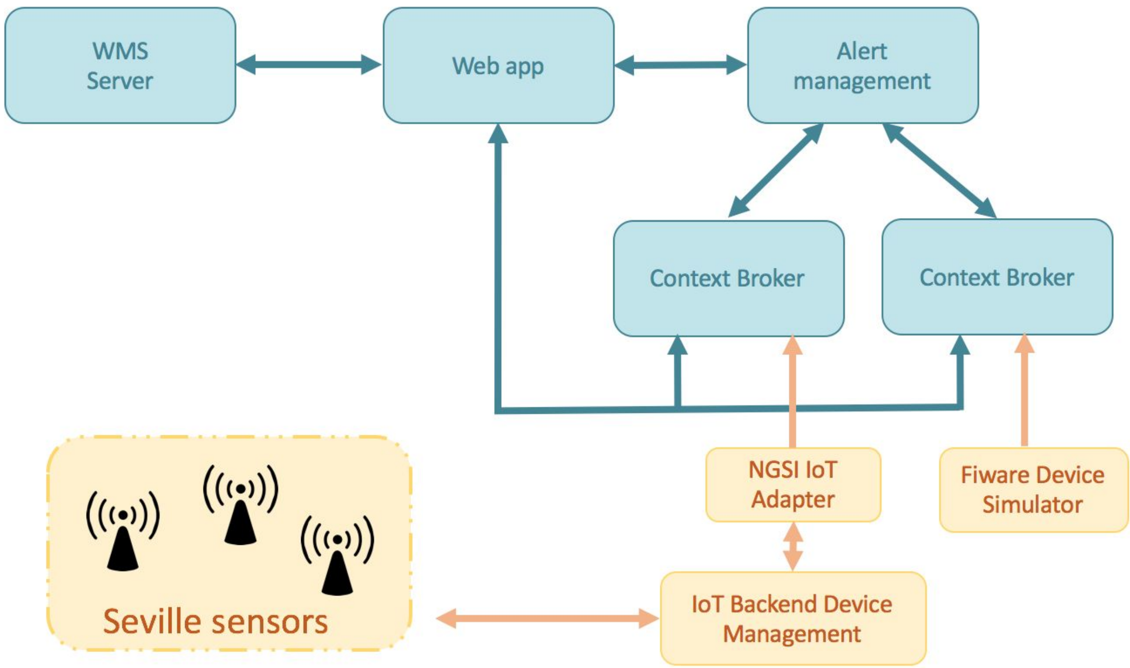

Figure 9.- Architecture of the Smarter Water showcase

3.4 The role of FIWARE

FIWARE has been a key element in the development of this showcase. All the components used for the data generation area based on open source FIWARE GEs, namely:

- **Orion Context Broker** (Context Broker GEri)
- **IoT Agent Ultralight 2.0** (IoT Backend Device Management GEri)

In addition other elements of the FIWARE technology stack have been used:

- **FIWARE Device Simulator** (utility for context data provision, simulating real life data patterns adapted to each use case).

- **FIWARE Data Models** (harmonized schemas for different verticals).

The Context Broker GE has played a central role in the alert system, providing a very convenient subscription and notification mechanism. Besides, the use of the FIWARE Data Models has allowed developers to focus in the application logic instead of spending many resources consolidating a model. This advantage is magnified with the FIWARE stack, because all the communications between components are clearly defined and different developer teams can work together with minimum interaction. In terms of scalability, this showcase has demonstrated how simple is to add more sensors of different type and from different sources if the FIWARE platform is used.

3.5 Achievements

The application has been developed successfully only in a few days by two developer teams placed in differents locations with minor interaction between them. This demonstrates the benefits that the FIWARE platform offers to developers, thanks to the availability of GEs 'out of the box', together with well defined workflows and harmonized data models. Another important feature is that developers can choose to just use the components that they need. They can even use a module that replaces the functionality of a GE. In this showcase, developers decided not to use the CEP GE and they implemented a custom alert system.

This showcase was exposed during the Barcelona **Smart City Expo World Congress 2016** under the FIWARE stand. In addition it was also part of the testbed area of the **IoT Solutions World Congress 2016**.

Figure 10.- Showcasing at SCEWC 2016 Barcelona

Figure 11.- Testbed at IoT Solutions World Congress showing the IoT device infrastructure

3.6 Conclusions and Outlook

This application is an excellent showcase of the benefits of the FIWARE proposal for IoT and Smart cities. FIWARE provides a full stack of technologies for smart applications which is really simple to integrate with other systems. Giving the high potential demonstrated, this showcase is planned to be evolved by transforming it into a real commercial product to be offered to the cities of Seville, Las Palmas de Gran Canaria and water distribution companies. A commercial product will be improved by incorporating other functionalities such as metering and related predictions about consumption. This can be enabled by the Big Data Analysis GE which can be seamlessly incorporated to any FIWARE Data architecture.

3.7 References

A list of the most relevant references to this success story is shown below:

- https://www.fiware.org/2014/11/24/fiware-transforms-cities-into-engines-of-innovation-scewc-2014/
- https://www.fiware.org/2014/08/07/adevice-fresh-projects-on-clean-water/
- https://www.fiware.org/2016/11/25/scewc-2016-fiware-at-the-center-of-the-smart-city-innovation/
- http://www.iotsworldcongress.com/testbeds/the-testbed-area/

4 Portable City Dashboards

4.1 Success story summary

Name:

Portable City Dashboards enabled by FIWARE Harmonized Data Models

Developed by:

Telefónica I+D, Geographica

Collaborators:

Ayuntamiento de Guadalajara (Spain).

4.2 Functionality

This showcase demonstrates the potential of the FIWARE Harmonized Data Models in enabling a new generation of enhanced portable city dashboards that can combine seamlessly real time data, together with advanced aggregation, analytics and correlation capabilities. In addition, these portable city dashboards can be enriched by means of the usage of advanced visualization tools, which can represent individual or aggregated geospatial features by means of rich web maps and charts.

The Portable City Dashboard is a powerful, multi-tenant tool which can encompass multiple smart city verticals helping city administrators to make informed decisions. As a result, the efficiency and effectiveness of city daily operations is improved dramatically. A demonstrator of the capabilities of this dashboard technology has been provided for the verticals of waste management and parking.

The figure below shows a screen capture of the landing page of a typical portable city dashboard configuration. A dashboard can manage multiple scopes. Application users can be assigned different roles and scopes, so that the environment is secure and auditable. In the figure below only one scope is present (named “Distrito Telefónica”).

Figure 12.- Landing page which allows to select scopes

Each scope can encompass a number of different verticals (see figure below). One of the aims of this new kind of application is to have common UI patterns for managing the different verticals found in a city. As a result designs can be reused and efforts can be concentrated, going towards the creation of global, holistic smart city solutions, avoiding the usual fragmentation between the different departments in a municipality.

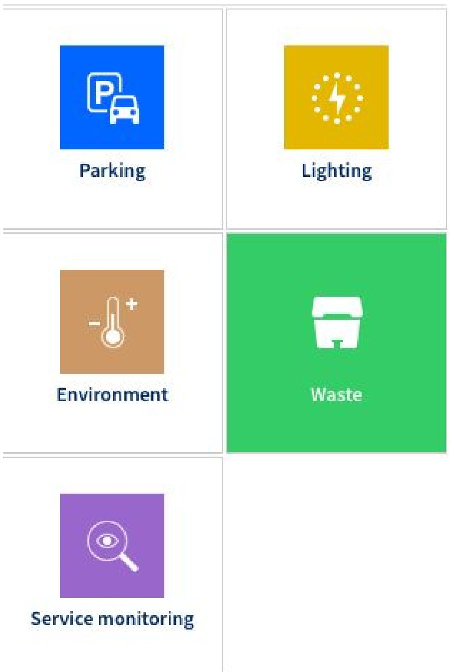

Figure 13.- Multi-vertical support for a scope

Once the user get access to a specific vertical all the information from the assets belonging to such vertical is displayed. The information is shown using web map technologies (CartoDB) and, for aggregated data, web charts are used as well. Using the referred Web Maps users can know the asset status in context with their spatial situation. For instance, in waste management end users can easily get access to the real time status data (filling level, weight, etc.) of each waste container. Such data is shown in a web map conveniently as illustrated in the figure below. The graphical power of web map technologies is exploited, so that different graphical conventions are given to alert the operator about abnormalities (a container is full or the container's lid has been open) or to encode the kind of waste container considered. Besides, the dashboard provides access to the time series data of each asset.

The application combines seamlessly individual asset views with aggregated data views, such as the one shown below. Such view displays different aggregated data using the powerfulness of web charts, allowing city administrators to have a higher level view of the status and helping them to make the right decisions. One important feature is that the aggregated view can be filtered spatially, so that only the assets covered by a bounding box are considered when building the aggregated figures. Other remarkable features are data correlation and analytics, and the capability of generating key performance indicators, so that municipalities can evaluate the performance of the service and establish service level agreements with contractors.

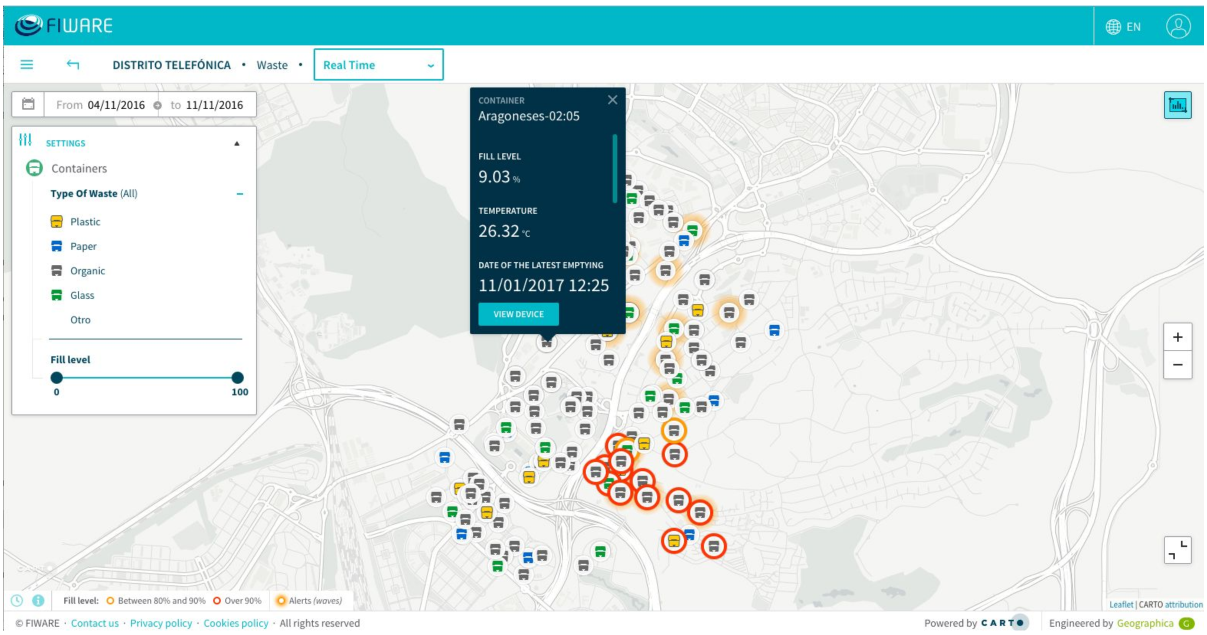

Figure 14.- Web map displaying asset location (waste containers) and their real time status

Figure 15.- Real time data aggregated views

4.3 Architecture

Figure below shows a high level architecture of a portable city dashboard deployed using the solution described here. It is in fact a typical FIWARE IoT architectural stack. On the southbound side IoT devices or other context data sources, including the FIWARE Device Simulator. These elements publish data to Orion Context Broker (northbound side) using FIWARE NGSI. IoT devices do it through the IoT Agent layer which speaks both IoT device protocols (to the south) and NGSI (to the north).

Once real time data arrives to Orion, it is automatically populated to CartoDB. For doing so, the FIWARE Cygnus connector is used, which is capable of generating historical series as CartoDB geo-located entities. Every time a data change happens in the context data layer Cygnus is notified through NGSI, and as a result, the CartoDB instance is updated properly. Actually, CartoDB makes extensive use of PostGIS capabilities in order to support geospatial queries and the calculations involved with the analytics offered. It is important to note that all the data arriving to the context broker should be harmonized as per the FIWARE Data Models. This is the key aspect to enable data portability. If data is harmonized this dashboard can work with multiple data providers and cities without changing any line of code.

Finally, the Web front-end makes extensive use of the Web mapping capabilities of the CartoDB front-end libraries to display real time data about the different assets. In addition it makes use of chart libraries, namely D3.js, to display all the analytical data as compelling graphics.

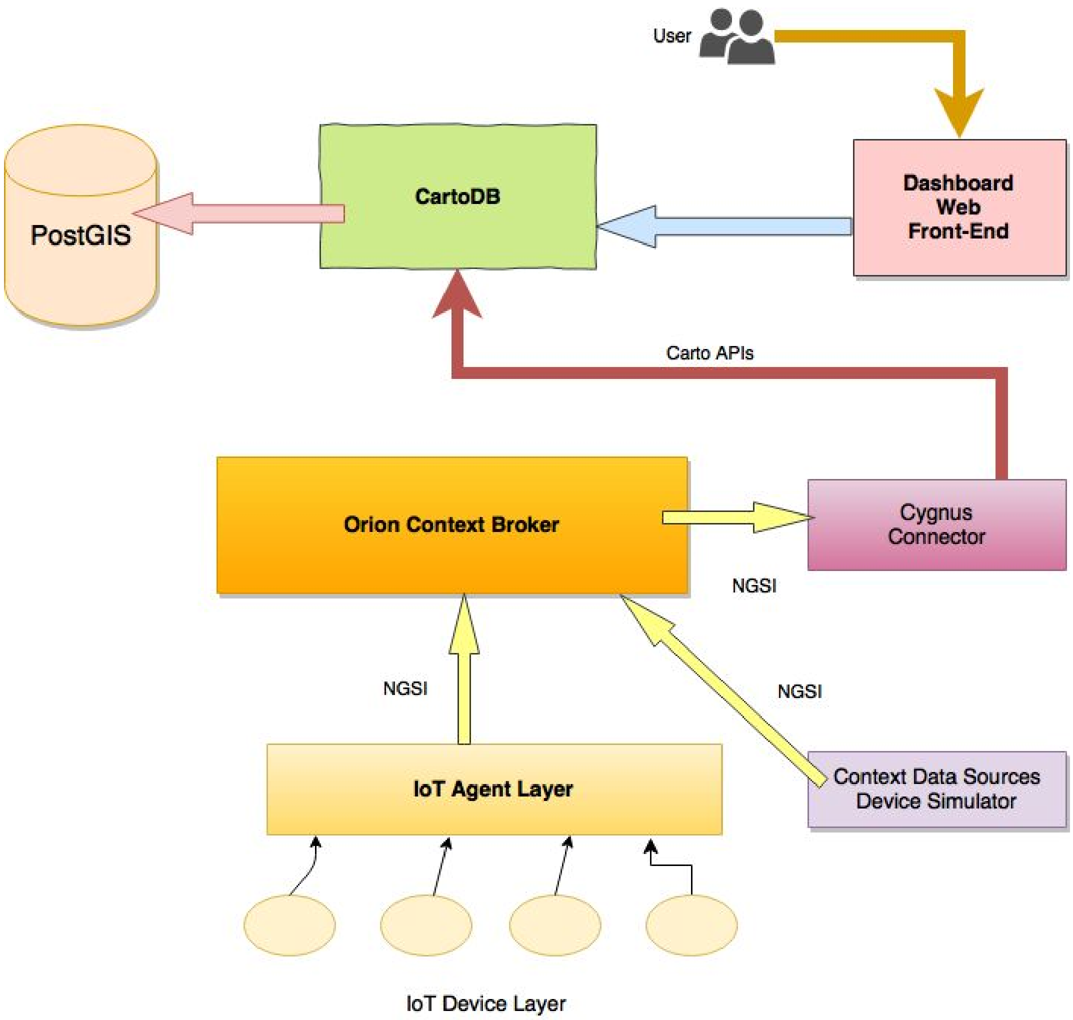

Figure 16.- Architecture of portable city dashboards

4.4 The role of FIWARE

The following FIWARE GEs have been used to develop this application:

- **IoT Agent suite** (IoT Backend Device Management GEri) to incorporate all the real time data coming from IoT devices.
- **Orion Context Broker** (Context Broker GEri) to store and offer all the harmonized data to be consumed by the dashboard.
- **Cygnus connector** to allow a fluid and robust interconnection between the Context Broker and the CartoDB analysis and visualization tool.

In addition other tools offered by FIWARE have been used:

- **FIWARE Device Simulator**, a tool intended to simulate real life data patterns avoiding helping to speed up development processes before
- **FIWARE Harmonized Data models**, harmonized schemas developed by FIWARE that enable the development of the portable city dashboard concept. In particular the showcase has focused on the parking and waste management schemas.

The most important asset provided by FIWARE in this case have been the FIWARE Harmonized Data Models. The open source project behind data models started in mid 2016 and offers different schemas (data models), which cover the typical modelization needs of the most used smart city verticals (parking, street lighting, transport, waste management, etc.). The combination of FIWARE IoT Ready devices and the harmonized data models turns FIWARE into a champion in terms of data portability, openness and multi-vendor support, making this offer very attractive for cities.

On the other hand, FIWARE provides the infrastructure for the data layer of the application, offering a robust backend which has accelerated the implementation. The horizontal approach offered by FIWARE makes it easier to integrate this application into any smart city suite. FIWARE and its open architecture guarantee the scalability of the product and its sustainability over time, together with a seamless evolution.

4.5 Achievements

The portable city dashboard concept is now in process of becoming a commercial solution offered by Telefónica and Geographica. The first city that will count with an instance of this technology is Guadalajara (Spain). This technology will replace an existing legacy dashboard and will enhance the overall functionality available to city administrators. The advantage of the migration is that the portable city dashboard concept enables a seamless evolution and allows the city to incorporate new data providers compatible with FIWARE.

From a functional point of view, Guadalajara will be able to monitor the performance of city contractors by evaluating real time key performance indicators (KPIs). All these actions will contribute to the efficiency, effectiveness and sustainability of the daily city operations.

It is noteworthy, that the pilot described here was presented with great success during the Smart City Expo 2016 (Barcelona). This dissemination action raise the level of awareness of portable dashboards between cities and other technology providers.

4.6 Conclusions and outlook

This portable city dashboards project is an excellent example of the innovation brought by FIWARE, Smart Cities and the Internet of Things. This project is quickly reaching the commercial phase and currently is being added to the smart city portfolio of Telefónica. At the time of writing this document, Telefónica and Geographica are working hard on extending the functionalities by incorporating new verticals (public transport, tourism, traffic flows, etc.) and by creating more sophisticated data analysis. For instance, by correlating different variables, such as air quality and traffic or waste management and citizen's civic issue tracking.

This is an outstanding and credible proof of the exploitation opportunities which FIWARE offers.

4.7 References

Below there is a list to the most notable references to this project.

- https://www.fiware.org/event/smart-city-expo-world-congress-2/
- https://www.fiware.org/2016/11/25/scewc-2016-fiware-at-the-center-of-the-smart-city-innovation/

5 Robotics Warehouse

5.1 Success story summary

Name:

Warehouse automation using robots

Developed by:

eProsima (SME, Spain)

Collaborators:

Telefónica I+D

Universidad Politécnica de Madrid (Spain)

5.2 Functionality

This showcase demonstrates how to automate a warehouse through autonomous robots. Robotic arms pick and place the goods from the warehouse shelves to autonomous mobile bases to transport them to the delivery area. This is done with the help of a camera and a depth sensor and it is able to react to obstacles and changes in the environment.

Figure 17 .- Candies warehouse demonstration.

To show the concept we built a small circuit representing the corridors of a warehouse and a shelve with a robotic arm and candies (see photo above). The "customer" can ask for several candies through a web application and the autonomous base drives to the pick up area in front of the shelve, then the robotic arm picks the desired candies and place them on the base, afterwards the base will drive back to the delivery area (as it is shown in the figure below). A complete video demonstration is available at https://youtu.be/M2dx1oyiKpk.

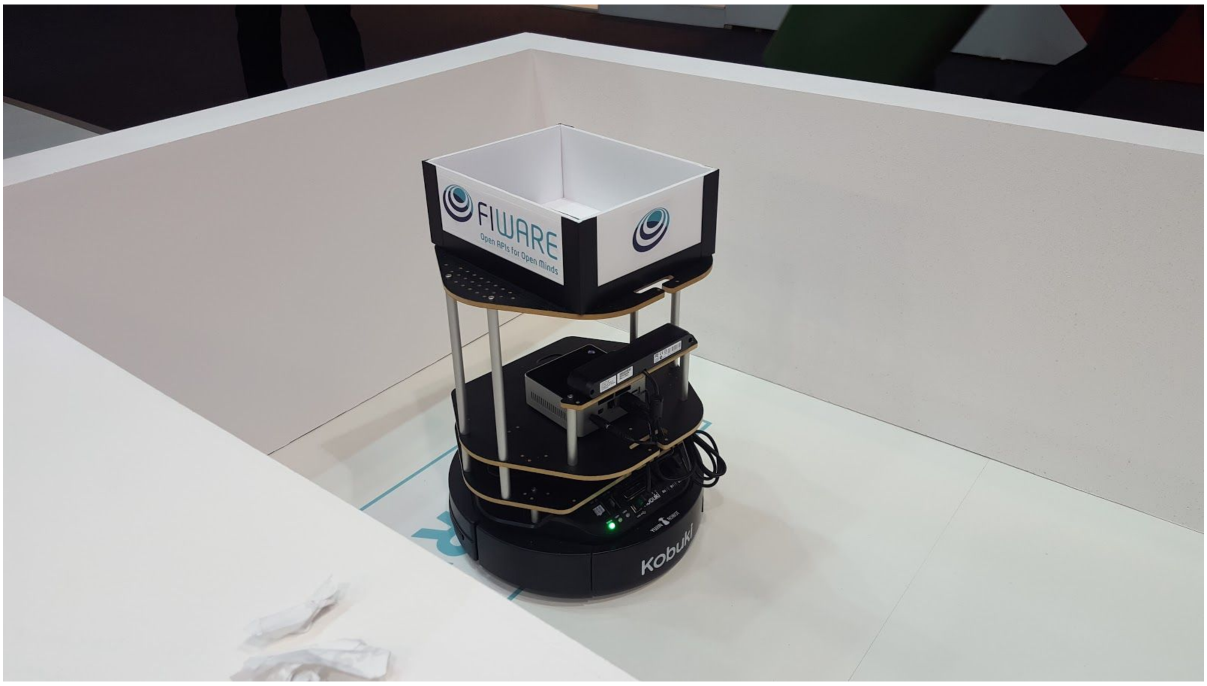

Figure 18.- Autonomous Base transporting candies

5.3 Architecture

The figure below shows the architecture used for the demonstration:

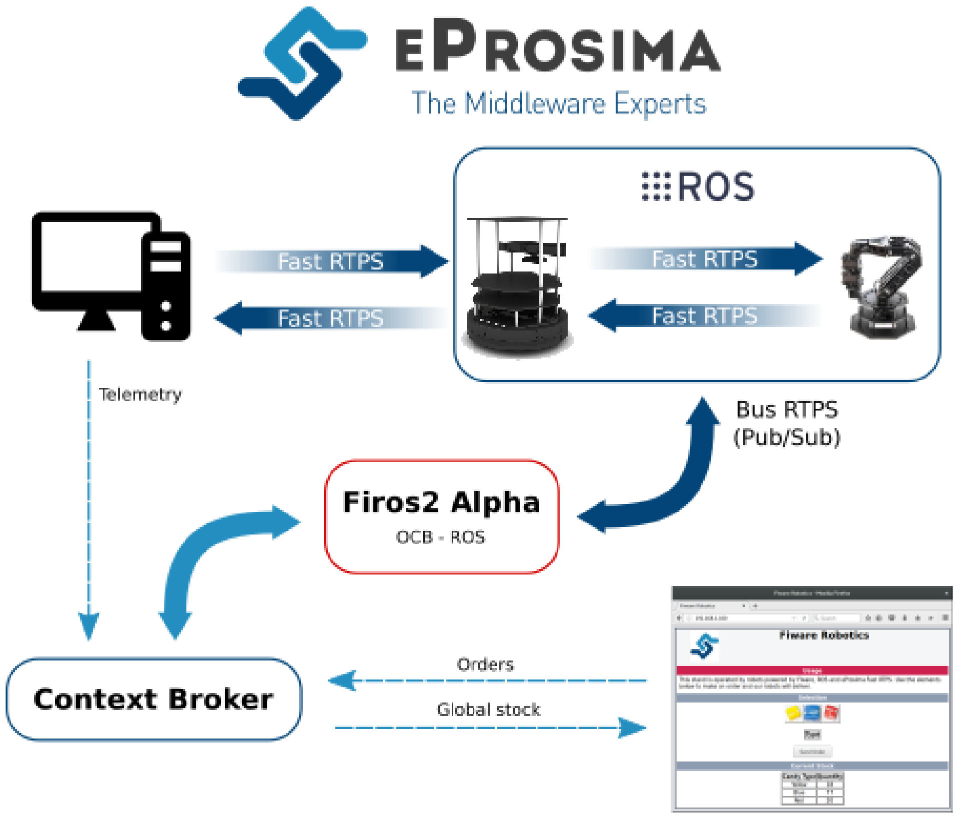

Figure 19.- Architecture of the robotic showcase

Fast RTPS is used for the real-time communication between robots and to post the robots' telemetry and state to Orion Context Broker. Fast RTPS is a new FIWARE incubated GE, a middleware designed for real-time communications used by many critical applications, and the middleware powering the upcoming release of ROS (Robot Operating System), a de facto standard framework for Robotics. All the robots of the demonstration are using ROS components to operate, and Fast RTPS underneath for the communications.

To implement the business logic of the application, Orion Context Broker is used, storing the candies stock, the orders, and the state and telemetry of the robots. When an order is posted to the context broker, a control application orchestrate the demonstration sending commands to the robots, while watching their telemetry parameters. The bridge between the *Context Broker* and *Fast RTPS* and ROS, called *FIROS2*, routes the messages between the different protocols.

5.4 The role of FIWARE

This showcase has demonstrated how to connect FIWARE with robots by using the the following GEs within a ROS (Robot Operating System):

- **Orion Context Broker** used to share context information which enables the implementation of the robotics business logic.
- **Fast RTPS** (incubated GE) a middleware which supports real-time communication between robots and to post the robots' telemetry and state to Orion Context Broker. Fast RTPS is a new "FIWARE Incubated GE".

The adoption of Fast RTPS by both the ROS Framework and FIWARE makes this new incubated GE a perfect middleware to connect the different FIWARE GEs to real Robots. There are many robots implementing ROS, and therefore ready to be connected to FIWARE. Furthermore, in this application it is used a routing service between Orion Context Broker, Fast RTPS and ROS. This routing service is a prototype of the upcoming **FIROS2**, a future incubated GE, which will make even easier connecting FIWARE to Robots.

5.5 Achievements

When this demo was developed (October 2016) the upcoming release of ROS, known as ROS2 was in an alpha state and there was no prior experience using this new software in real robots, such as the "turtlebot" used as autonomous base or the robotic arm. At the time of writing this document ROS2 is in beta state and about to being released. Therefore this showcase is a sneak peek of the future of many robotic applications using this new release of the Framework and also will be a reference example for the community, demonstrating how to connect FIWARE GEs with the state of the art in Robotic Frameworks.

Also the demo is a good real example of robotics and automation, and it can be implemented in real cases, with industrial grade robots. We also showed at the IoT Congress a bigger industrial base using the same software, the Robonik RB-1 Base. Last but not least, this showcase was a complete success at the *IoT World Congress 2016* and it was run **561** times in three days with no issues, bringing a lot of attention about FIWARE.

5.6 Conclusions and outlook

Our case of study shows how to connect FIWARE GEs to industrial and research robots in real world applications such as warehouse automation. Robotics is the future. In 2015, industrial robot sales increased by 15% to 253,748 units, again by far the highest level ever recorded for one year, and for professional service robots the numbers are even higher, rising by a 25% the units sold, to 41.060 (data from *International Federation of Robotics*). This pilot is the first demonstration of the potential of the FIWARE ecosystem in the robotics field and has the potential to outreach thousands of emerging robotic projects.

In the future we plan to improve this showcase by updating the software components with the general access release of ROS2 and FIROS2 (Alpha releases of these software components were used for the demo), and adding security to the communications, avoiding potential malicious attacks to the robot operations. This evolution will make our pilot an excellent reference material for the community using ROS2, while at the same time keeping the momentum of FIWARE within the robotics area.

5.7 References

A list of the most relevant references to this success story is shown below:

- http://www.eprosima.com/index.php/company-all/news/65-fast-rtps-at-iot-congress-2016-oct-25-27
- http://www.eprosima.com/index.php/company-all/news/67-fast-rtps-is-adopted-by-ros
- http://www.eprosima.com/index.php/company-all/news/66-fiware-to-use-fast-rtps

6 Conclusions and further work

This document has provided an overview of some of the most remarkable success stories which demonstrate that FIWARE is nowadays a reality. Undoubtedly, FIWARE is a robust platform which facilitates the creation of new products and businesses across Europe and in different domains. The present document has elaborated on applications which exhibit a context-aware, smart behaviour to make people's lives easier, contributing to a more sustainable, efficient and effective lifestyle.

FIWARE provides a software substrate that enables entrepreneurs to create pilot products in record time and to analyze its viability in a few weeks. But FIWARE is going further and further everyday. FIWARE is currently being exploited successfully. In fact, it is expected that in the upcoming months these success stories will multiply across the globe. To make that a reality, the FIWARE team will continue monitoring the most salient initiatives so that support and help is given to those which believe in FIWARE and in the power of open technologies.