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Abstract	This annual report on collaboration activities performed under the umbrella of the OFERA project and in relation to the micro-ROS platform.

Table of Contents

1 Introduction

1.1 Summary

In the first year of the project, not much progress on collaboration could be done as the project was still on an early stage. Focused has been put in initiating collaboration activities:

- with other EU-funded projects in the Robotics area
- with the FIWARE Community
- with the ROS Community

However, very promising results have been achieved, overall with respect to collaboration with the FIWARE and ROS Communities. Actually, both communities have welcome the creation of the micro-ROS project and concrete tangible collaboration channels have been established in both communities:

- FIWARE Community: First results linked to micro-ROS (Micro XRCE-DDS) have been adopted as incubated FIWARE GE and consequently regular reporting and follow-up has been established at the level of the FIWARE Technical Steering Committee (TSC) where overall technical direction of the FIWARE Open Source Community is driven. Furthermore, involvement of eProsima, and of course the FIWARE Foundation, in the activities of the FIWARE Chapter linked to interfaces with IoT, Robotics and 3rd-party systems is facilitating potential collaboration in FIWARE Technical Roadmap activities.
- ROS Community: Creation of an Embedded Special Interest Group (SIG) under the umbrella of ROS 2 activities will help to establish a regular collaboration channel with relevant members of the ROS Community.

More details about collaboration initiated with the three referred target groups is provided along this document.

IMPORTANT Note: Reporting on collaboration activities within the first year of the project would be difficult because, as mentioned, the project was still on an early stage. Besides this had impeded to report on collaboration activities linked to the FIWARE Community where significant progress has been made early in 2019.

1.2 Partners involved

Following is a table listing partners involved in writing of this deliverable:

Short name	Full name	Contribution
FIWARE	FIWARE Foundation e.V.	Leading author
PIAP	Industrial Institute for Automation and Measurements	Contributor
Bosch	Robert Bosch GmbH	Contributor
ALR	Acutronic Link Robotics AG	Contributor
eProsima	Proyectos y Sistemas de Mantenimiento SL	Contributor

1.3 List of acronyms

Acronym	Meaning
API	Application Programming Interface
DDS	Data Distribution Service
GE	Generic Enabler
ROS	Robot Operating System
RTOS	Real Time Operating System
RTPS	Real Time Publish Subscribe
TSC	Technical Steering Committee
XRCE	eXtremely Resource Constrained Environments
WG	Working Group

2 Collaboration activities

2.1 Collaboration with other EU funded projects in the Robotics area

2.1.1 Luxembourg meeting

On the 21st of February, Jaime Martin Losa(eProsima) attended a synchronisation meeting in the European Commission. The purpose of this meeting was to find possible collaborations channels with other H2020 projects.

In this case, a meeting with ROS-Industrial Consortium Europe (hereafter RIC-EU), and RobMoSys took place. Regarding collaboration possibilities, this was an excellent opportunity as the three projects, ROSIN, RobMoSys and OFERA, play on the similar ground.

From this meeting, no new collaborations have been started. However, future collaborations could be possible, but there is still no steps in this regard. Also, the relation between ROSIN and OFERA Consortium has excellent health .An excellent example of this relationship is that OFERA partners are continuously invited to assist and participate in ROSIN Conferences (more details on this on D7.1) as happened in 2017 and 2018.

2.1.2 HRIM

Built around ROS, HRIM is an information model for robots that facilitates interoperability among modules from different vendors of robot hardware. Offering a common interface, it simplifies reconfigurability and flexibility, an innovation the robotics industry strongly demands. Although born as part of the H-ROS infrastructure, HRIM is independent and contains rules/specifications that standardize interactions between different robot components from different vendors. This project has received one-year lasting funding for its development. This funding comes from the the ROSin Focused Technical Projects, grant agreement number 732287, of the European Union. At the end of the project, a complete implementation of such an information model and its tools is expected.

As part of the consortium, ALR will contribute to integrate HRIM in micro-ROS project, establishing collaboration for integrating booth technologies. This is contemplated within Tasks 2.3 and 4.5. Specific bridges are going to be provided to micro-ROS, where the integration of micro-ROS in H-ROS is going to be facilitated using HRIM information model.

2.1.3 Outlook

A collaboration meeting involving several EU-funded projects in the area of robotics is planned for September 12th in Luxembourg. The consortium expects that concrete tangible actions regarding collaboration will be identified during the meeting.

2.2 Collaboration with the FIWARE Community

2.2.1 Integration of micro-ROS results in FIWARE

FIWARE brings a curated framework of open source software platform components (referred to as FIWARE Generic Enablers - GEs) which can be assembled together and with other third-party components to build platforms that support the development of Smart Solutions faster, easier and cheaper. A more detailed technical description of FIWARE can be found on the FIWARE website[1] or GitHub[2].

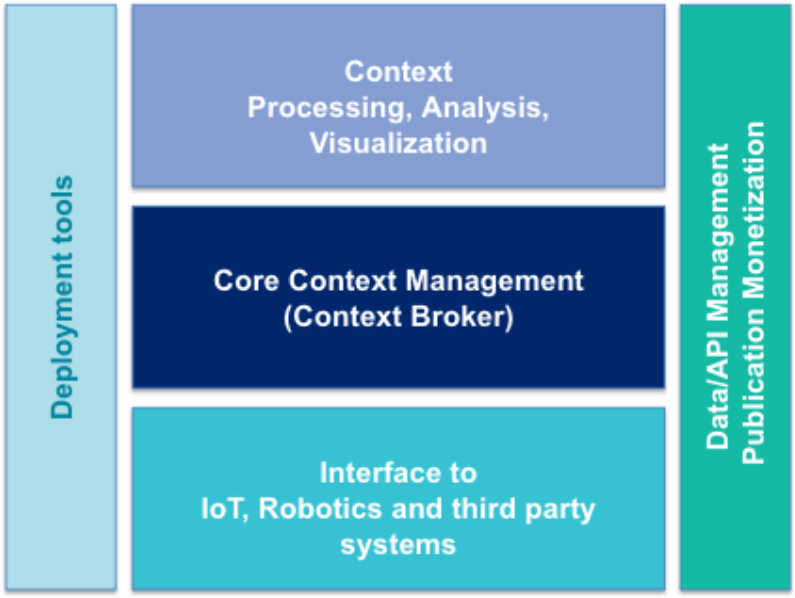
The FIWARE NGSI API provides a simple yet powerful API for solving a basic need in any smart solution: how to gather, manage and provide access to context information. The core Context Broker component of any "Powered by FIWARE" platform supports this API, which also enables the integration of the rest of platform components. The FIWARE NGSI API provides the basis for interoperability of smart solutions/services running on top of "Powered by FIWARE" platforms as well as their portability (replicability) across different "Powered by FIWARE" platforms.

Building around the FIWARE Context Broker, a rich suite of complementary FIWARE components can be integrated as part of a "Powered by FIWARE" platform. The complete set of FIWARE GEs are structured in several FIWARE chapters (see figure below):

- Core Context Management chapter, comprising the core FIWARE Context Broker component as well as components enabling integration with multiple alternative data sinks for storage and further processing of historic context data
- Chapter comprising FIWARE GEs helping to implement the interface with IoT devices, robots and third-party systems, capturing updates on context information and translating required actuations;
- Chapter comprising FIWARE GEs for advanced monitoring, using dashboard and analytical support tools, as well as processing and analyzing current and historic context data using event rules, advanced Big Data and AI algorithms, targeted to support smart decisions or the smart automation of processes;
- Chapter comprising FIWARE GEs dealing with management, publication and monetization of context data and services, preserving defined access and usage control policies.

An Incubated FIWARE GE is an open source software product whose owner has proposed for adoption as a new FIWARE Generic Enabler (i.e., component) of the FIWARE platform framework. Consideration as first-class FIWARE GE is achieved once well established requirements for FIWARE contribution are met[3].

[1] https://www.fiware.org/developers/
[2] https://github.com/FIWARE/catalogue
[3] https://github.com/FIWARE/contribution-requirements



One of the first results of micro-ROS, namely the Micro XRCE-DDS technology, has been contributed to FIWARE as Incubated FIWARE GE within the FIWARE chapter associated to the interface with IoT devices, robotics systems and 3rd party systems. Submission of the application for approval of Micro XRCE-DDS as Incubated FIWARE GE was issued on February 18th, 2019. A presentation of Micro XRCE-DDS was made in front of the FIWARE TSC on February 25th, 2019 where not only the adoption of the component as Incubated FIWARE GE was decided but also it was decided that Micro XRCE-DDS was going to be integrated into FIWARE Release 7.6 and properly communicated to the FIWARE Community (see minutes[4]). The component was presented at the FIWARE Summit celebrated in Genoa, May 21-22 where FIWARE Release 7.7 was published.

Regular Meetings

Once Micro XRCE-DDS was adopted as Incubated FIWARE GE, regular follow up presentations on progress of activities linked to the component are scheduled at FIWARE TSC meetings, at least every two months. This brings an excellent opportunity to get in permanent touch with relevant members of the FIWARE Community (FIWARE TSC meetings are open so anyone in the FIWARE Community can attend) as discuss potential collaborations derived from usage of micro-ROS results in "Powered by FIWARE" architectures.

[4] https://docs.google.com/document/d/1862-kz6Yq0O379i-g7yIOUXTXdSimGKI4jYwHUGY94A

Status by the end of June 2019

By end of June 2019, integration of Micro XRCE-DDS has not experienced any major issue and the experience has been quite positive.

Outlook

Integration of Micro XRCE-DDS into FIWARE has helped to make this component visible in projects (EU funded or not) where FIWARE is being applied in connection to robotics. This is the example of DIH^2[5], focused on the application of robotics technologies in agile production. Furthermore it has led to the incubation of project proposals where usage of the technology was foreseen (a project proposal was submitted to the EU Open Call DT-ICT-01-2019 targeted to foster adoption of results of micro-ROS through a network of Digital Innovation Hubs).

The successful incorporation of Micro XRCE-DDS into FIWARE paves the way for the contribution of other results from micro-ROS into FIWARE. It is worth noticing that FIWARE doesn't impose any exclusivity on technologies being contributed, therefore, components generated in micro-ROS can be contributed to other open source communities like ROS (this is actually the case with Fast RTPS, another component simultaneously adopted in FIWARE and ROS 2)

2.2.2 Participation in FIWARE Technical Roadmap activities

During the FIWARE Summit in Genoa, May 2019, the FIWARE TSC decided to create a number of Working Groups which are expected to accelerate roadmap activities in different areas. One of these areas is robotics. Activities of the Robotics FIWARE Tech Roadmap WG are led by eProsima, involving other members of the FIWARE Community and supported by the FIWARE Foundation. All FIWARE Tech Roadmap WG report to the FIWARE TSC on a regular basis (at least once every two months).

Outlook

Activities of the different FIWARE Tech Roadmap WGs had just started by end of June but prospects are good. One relevant aspect to highlight is that members of the FIWARE Community beyond Europe are involved in this WG. In particular, it is worth highlighting the involvement of TIS[6], which leads a flagship project funded by the Japan government targeted to the definition of a Cloud Robotics platform based on FIWARE. This may pave the way of promising collaboration with Japanese companies regarding usage of micro-ROS results.

[5] http://www.dih-squared.eu/
[6] http://www.tis.com/

2.3 Collaboration with the ROS Community

2.3.1 ROS 2 Embedded Special Interest Group

As a major venue for collaboration with other parties active in the embedded space, members of the project consortium initiated the formation of an *Embedded Special Interest Group* (SIG) for ROS 2 during ROSCon 2018. At the initial meeting, other parties included Amazon, Robotis, Renesas, eSOL, AIST Japan, and the OSRF.

The first concrete step was to publish the analysis and requirements from the project's first year as a Pull Request (PR), for inclusion in the ROS 2 design wiki. The Pull Request was discussed at https://github.com/ros2/design/pull/197. This turned into a lively discussion, with major participation by AIST Japan and the OSRF.

Nicely, the Embedded SIG turned into an official ROS 2 Working Group (WG) within ROS 2[7] in April 2019 after approval by the ROS 2 Technical Steering Committee (TSC).

Regular Meetings

After the initial discussion around the PR, and the SIG meetings, WG meetings are planned for the future, typically to be run on a monthly basis to follow-up ongoing work.

Status by the end of June of 2019

Right now the WG is in its infancy and, while the interest by other parties is promising, it is mainly driven by project members. The main reason is that use cases for embedded systems are quite diverse.

For example, Robotis is pursuing a solution based on the Arduino ecosystem, targeted at very small devices. They are currently using part of the project results (namely, the Micro-XRCE-DDS implementation by eProsima), but no higher layers. Similarly, Auterion, a Swiss drone-software company, is also using Micro-XRCE-DSS directly.

On the other side of the spectrum, eSOL is selling a safety-certified RTOS with POSIX compatibility that is primarily looking to replace Linux on similar-sized hardware. This is definitely of high interest for ROS on embedded but, firstly, does not scale down to the micro-controller platforms targeted here, and secondly, it is not an Open Source solution.

This diversity is both a problem and an opportunity: It is a problem because it makes agreement harder, but it is also an opportunity, because clear leadership towards a cohesive platform can be taken by the project consortium.

Outlook

The project will continue to engage the community within the ROS 2 embedded WG, particularly also trying to engage other European partners.

[7] https://index.ros.org/doc/ros2/Governance/

Project status updates, as well as interesting news, will be posted to the ROS Discourse embedded category.

We will also add a SIG page on the micro-ROS website, to enable fast, easily accessible communication and summarize ongoing activities.