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Large-scale Integrated Project (IP)



D.32.3.2 Academia relationships report

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1 Introduction

1.1 Executive summary

This deliverable describes the relationships the FI-Core academic partners have with technologies and architectures developed in FIWARE. The first version included inputs from FI-Core academic partners, on how academia interacts and involves FIWARE in its processes. From that first report were to be derived educational sessions to be put in place with the support of the FIWARE technical teams in order to best support the FIWARE growing footprint within the academia.

Those educational sessions were to include many different activities: demos, practical labs, university lectures, FIWARE certifications, training courses to the FIWARE Academy and so on. Initial plans to have dedicated summer training, the FIWARE “summer school” leveraging on experts from the FIWARE technical chapters as teachers was explored with academic and technical partners in April/May 2015 – modeled on the FIWARE developers’ week event. Candidate locations were UPM and DFKI but, after a deeper analysis, unfortunately this project was abandoned (due to budget problems bit also to the Project review scheduled in July 2015 that captured time and energies to most partners, considering also the massive changes done to the DoW and future plans to many GEs).

This second version of the deliverable brings additional information describing what has been really done comparing to what was initially planned. In addition, this new version brings some views about the future plans.

Looking to what has been done during this second year, it seems that most academic partners implemented courses on FIWARE technologies but they are not really operational, and for sure one of the issues is the need to attract a sufficient number of students in order to setup a course.

On the same way, in order to have a training programme that could be attractive to students and, contemporary, could ensure results that students can exploit in the future and sell in some way to industries, courses should be organized taking into account two aspects:

- Theoretical courses were students learn the FIWARE architecture and technologies;
- Practical projects were students learn by using FIWARE Lab how to develop an application using FIWARE enablers.

1.2 Structure of this Document

Academic relationships at large are essential for FIWARE sustainability: It ensures the development of FIWARE platform through the FIWARE foundation, the collaboration with researchers and educators on one hand; and on the other hand it supports the growing adoption of new technologies, provides training for new users and developers of technologies in the FIWARE ecosystem in the broader community.

Educational processes involving academia concerned also new training content provided by Academic partners and published to the FIWARE Academy, based on new Future Internet technologies adopted by the FI-PPP Community in general. It is expected that students who will follow such new modules will spread the early adoption in the market of Future Internet challenging technologies such as Cloud, Big Data, Internet of Things, and Security, and then will support European Research for new challenges emerging from this market adoption.

In its first version this deliverable described how academia can interact and involve FIWARE in its process. Based on this report educational sessions were to be put in place with the support of the other FI-Core technical teams in order to best support the enlargement of the FIWARE footprint in academia. This second version of the deliverable describes the first educational programmes and courses that some academic partners actually put in place.

For the first version of the deliverable, input was collected from all FI-Core academic partners on: 1) what FIWARE technologies (GERis, architecture) they were mainly interested in; 2) what was their status and plans in terms of FIWARE education and training contribution on their behalf. Comments on FIWARE Academy were asked to have a technical point of view on the published content, and to know expectations for FIWARE Academy and what could be of interest for (each) academic partner.

In the second version of the deliverable, academic partners describe what was really done. For each academic partner, 2 paragraphs were added in order to report updates and progresses performed during year 2:

- Year one update;
- Future plans.

Other paragraphs, for each partner, report exactly the same content of the previous version of this deliverable.

1.3 Change History

Release	Major changes description	Date	Editor
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v0.1	Initial version	2016-06-15	Orange Labs based on the version 1
V0.2	Contributions from DFKI	2016-06-20	Orange
V0.3	Contributions from OKFN and Uni Roma	2016-06-30	Orange
V0.4	Contributions from Uni Surrey and ZHAW	2016-07-20	Orange
V0.5	Contributions from UPM and URJC	2016-07-30	Orange
V0.6	Integration + adds	2016-09-19	Orange
V0.7	Update of Exec summery and conclusion	2016-09-22	Orange
V0.8	First review	2016-09-26	ENG
V0.9	Final version	2016-10-21	Orange
V1.0	Final version after review	2016-11-11	ENG

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2 Education programmes on FIWARE by academic partners

2.1 DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH (DFKI)

The German Research Center for Artificial Intelligence (DFKI) is a non-profit, public-private partnership organization covering a range of activities from application-oriented basic research all the way to technology transfer directly to industry. It is located on the campus of Saarland University which is the top-ranked and by far the largest and Computer Science (CS) research campus in Germany. Besides the university the campus also includes the two only Max-Planck-Institutes in computer science, namely for Informatics (MPI-INF) and for Software Systems (MPI-SWS), the DFKI, the Intel Visual Computing Institute (IVCI), the Center for IT Security, Privacy, and Accountability (CISPA, one of three federal research institutes in this area), the joint German Excellence Cluster for Multi-modal Computing and Interaction (MMCI), and several other research organizations. DFKI itself is not a degree granting academic partner but it is closely collaborating with Saarland University. All its directors are also full professors at the university and many of its members teach courses there or pursue (PhD) degree at the university.

In the department of CS the university offers Bachelor and Master programs in CS, Visual Computing, Cybersecurity, Bioinformatics, and Computer and Communication Technology. Particularly interesting is also its international PhD program in CS, which currently hosts close to 400 PhD students in CS alone. The last year of the Bachelor and all Master and PhD courses are taught in English with about half of the students coming from abroad.

Besides the academic program at Saarland University, DFKI also offers continuous education activities in an increasing range of topics. They are typically targeting specific domains within industry and are more focused on practical skills in new and emerging areas. FIWARE technologies have been and will continue to be included in these activities.

2.1.1 GREis of interest

2.1.1.1 *Scope*

The focus of the teaching program on the Saarland Campus is clearly on fundamental knowledge including theoretical as well as practical aspects but less on skills related to specific technologies (such as FIWARE). Thus, it is unlikely that regular courses will ever be offered on FIWARE itself. However, this does not preclude the addressing of FIWARE technology scope as practical examples in some of the regular or in optional courses. In fact, several of the FIWARE GEs that originally come from DFKI have already been discussed in some of the courses taught by DFKI personnel.

2.1.1.2 *Technologies covered*

Thematically, DFKI will focus on the GEs developed within the WebUI chapter, the Advanced Middleware, and the media streaming GEs (all originally suggested by DFKI via the FI-PPP Architecture Board). Already in the past DFKI has augmented these GEs with SEs from the FI-Content as well as from the FITMAN projects.

Specifically these topics will be:

- 3D-UI/XML3D GE for real-time 3d visualization and interaction in the browser. DFKI has developed this technology, it is in active use in more than a dozen research projects as well as in a number of direct industry collaborations with commercial support from industry partners. XML3D is also the already basis for the Software-Integration Platform of the Cluster of Excellence in Saarbrücken and thus is offered as a platform for the research of our PhD students. XML3D includes many highly interesting technical aspects such as Xflow, shade.js, BLAST, and the renderer components that already have been and will be covered in courses as well as in other active PhD topics.
- The new Synchronization GE implementation FiVES is being developed at DFKI and offers many interesting aspects that will be relevant in various courses and is covered in several related PhD topics. It also makes use of the Advanced Middleware GE. We expect to begin to cover it in courses later this year.
- Cloud Rendering is an active area of research also at the DFKI with several recent papers. As a result this topic will be covered in advanced courses with pointers to the FIWARE GEis.
- Augmented Reality and its highly efficient implementation on current (mobile) hardware is an active research topic at DFKI and thus these topics will likely be covered in courses at some point also making use of FIWARE material where appropriate.
- Real-Virtual Interactions are active research topics. They have less fundamental aspects but might still be included in some courses as example use-cases based FIWARE material.
- The intelligent control of virtual characters in semantically annotated 3D environments is another research area at DFKI covering the aspects of motion synthesis and intelligent control and planning. Technology based on XML3D is already being used here and we plan to unify this with the FIWARE GEs in the future, also making this a relevant topic.
- DFKI is a partner in the development of the Advanced Middleware GE and sees this as a key development for some of its research. In particular, with the existing and future security modules it is becoming a key element in our distributed and service-oriented systems research.
- The Kurento streaming media GEi are relevant in many aspects of DFKI's work (e.g. streaming from the server-based renderer and is planned to be integrated in the future, likely resulting in some coverage also in courses.

Again, DFKI will likely not develop full courses on these topics but will cover them in selected lectures through suitable teaching material. Of course, any material developed will be made available also through FIWARE if appropriate.

2.1.2 FIWARE in education

2.1.2.1 *Content used*

DFKI has already developed teaching material for a number of its “FIWARE” technologies. They have been used at least three Startup-Weekends, one (upcoming) Developer Week, and various other events. Most of that material is also available via the FIWARE Web site.

Interestingly, as the core of the FIWARE technology of DFKI is Web-based, most of the material is developed also as Web-based material, which makes it even easier for general users to take advantage of.

2.1.2.2 *Content to be created*

DFKI is a core partner within the current FIC2-Lab activities that aim at creating a portal that allows to easily explore, change, and share FI-Content and FIWARE technology in a Web-based way. User will be able to start preconfigured machines with pre-existing solutions, edit them online via the Web while immediately seeing the results in their browsers, and finally share the results with their peers via social networks such as Facebook, Twitter, or so. Their friends can then start to collaborate online or start from the existing results to create their own new solutions that they can then share again.

DFKI sees this as a very novel and interesting approach to learning that has parallels to much of Open Source programming (e.g. Linux), except being tailored more towards the development of online and interactive Web applications. We will continue exploring this approach and will develop “teaching” material for that learning domain.

2.1.2.3 *Type and media*

As outlined above most of the DFKI is Web-based and we will likely shift more in that direction. This does, however, not preclude the use of traditional material.

2.1.3 Needs for training material

2.1.3.1 *From technical point of view*

DFKI is very interested in exploring the online, interactive, sharing model of creating content and “learning while doing” as enabled by the FIC2-Lab activities. Yet much work has to still be done here both on the technical infrastructure as well as on the content to be used here.

2.1.3.2 *From content point of view*

The existing training material in FIWARE is mostly prepackaged and it is difficult to repurpose it easily. This is contrary to how most courses materials are being taught at the Saarland campus where certain aspects are selected and are integrated with other (own) content. Creating a library of content that can easily be reused but is yet well organized and can be continuously be improved (like OSS software) would be highly useful. However, this may be beyond the scope of the project.

2.1.4 Year One Update

The Synchronization GE (FIVES) was introduced as a new GE during this period and teaching material is now being developed and will be added during the coming release of FIWARE.

2.1.4.1 *New content created*

With respect to XML3D, DFKI has developed an extensive specification document according to the official styles and rules of the W3C that carefully defines the technology (freely available via homepage at xml3d.org). This document is essential for teaching XML3D and for developing applications based on it. We have also significantly extended the set of example applications that show specific features of the technology (also freely available via the home page at xml3d.org). Finally, the Getting Started section of the web page has been updated and enhanced to offer newcomers and easier way to get started and produce their first application. This includes a dedicated set of tutorials (see <https://github.com/xml3d/xml3d.js/wiki>).

Similarly, we added extensive documentation for the new FIVES implementation of the Synchronization GE. This includes the usual FIWARE documentation but also a separate Getting Started section in the project specific pages on Github (<https://github.com/fives-team/FiVES>). Additional FIWARE Academy material is still missing for this relatively new GE and is scheduled for the next release.

2.1.4.2 *Teaching activities*

DFKI has demonstrated, explained, and taught about the technology of the entire WebUI chapter at a number of occasions during the last year. This was especially targeted to the accelerator program and the many SMEs and web entrepreneurs in the program. The full list of these events is documented

elsewhere in a FIWARE deliverable. Additionally, we have presented the technology and gave brief introductions during several events and visits by industry at the DFKI.

Unfortunately, as explained above the academic teaching activities at the local Saarland University Campus are structured in a way that courses on specific technologies are not appropriate in the curriculum (as opposed to teaching the fundamentals of the field in general). However, we have included material in individual lectures that gave an overview of the technology, its potential use, and the specific research challenges associated with it.

2.1.5 Future plans

Members of DFKI will continue to include selected technologies from FIWARE within the regular courses they offer at Saarland University as well as part of the continuous education activities. All training material developed in this context is generally open and freely available and will also be offered on FIWARE.

2.2 UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA (UniRoma1)

Sapienza University of Rome (UniRoma1), founded in 1303 by Pope Boniface VIII, is one of the oldest universities in the world and a high performer among the largest universities in international rankings. The Faculty of Information Engineering, Informatics, and Statistics was founded in November 2010 and is the result of the merger of the Faculty of Information Engineering, the Department of Computer Science and the Faculty of Statistics. The Faculty has a modern and interdisciplinary approach; the degree programmes offer students a wide range of subjects. The Faculty covers 10 undergraduate and 13 graduate programmes and hosts 11 professional master programmes and 14 doctoral programmes.

2.2.1 GREis of interest

2.2.1.1 *Scope*

The focus of the teaching program on the UniRoma1 is on courses including theoretical as well as practical aspects, but less related to specific technologies. These courses aren't full courses on FIWARE technologies, but intend to cover such FIWARE technologies in selected lectures with practical examples in some of the regular or in optional courses, for example with practical sessions involving the GERis. In particular UniRoma1 is interested in preparing training material and in giving courses dealing with a general overview on the FIWARE platform and the technologies that are been used in it.

From the GE point of view, UniRoma1 is mainly interested in the Advanced Middleware functionality and the Cloud Robotics GEs, and the links between the other GEs in FIWARE platform, in particular the Cloud chapter GERis.

For this purpose, the most involved GErI is the OFNIC GErI, developed by UniRoma1 itself, and other GErIs from Cloud Chapter.

2.2.1.2 *Technologies covered*

UniRoma1 is a partner in the development of the Advanced Middleware functionality and the Cloud Robotics GEs. UniRoma1 is explicitly focused on the open and standardized interface to the network infrastructure and devices, and more generally on the management of network resources, through software interfaces by the adoption of the Software Defined Network (SDN), OpenFlow-enabled.

2.2.2 FIWARE in education

2.2.2.1 *Content used*

UniRoma1 contributes to the dissemination of FIWARE technologies mainly through the creation of course's material that teach the technologies that are been used in the FIWARE platform. In particular, that material is used in:

- “Control and Management of Networks” course within the bachelor degree in Computer and Automation Engineering;
- “Process Automation and Control of Communication and Energy Networks” course within the master degree in Control Engineering;
- “Seminars held as part of the “PhD advanced courses” in Automatic Engineering and Operations Research.

Another interesting dissemination is done through the BSc and MSc thesis projects. UniRoma1 has personnel that supervises and supports students during the project in order to produce some materialized result such as thesis or interesting FIWARE technologies applications or extension.

Concerning the eLearning contents, UniRoma1 has already developed teaching material for of its developed FIWARE technologies. That training material consists in a Webinar Training course on our GErI OFNIC, already available on the eLearning platform.

2.2.3 Year One Update

UniRoma1, in the last year, continued to develop its owned GErI OFNIC under the I2ND chapter and to support the GErI with the aim to being part of the FIWARE community. Consequence of this is that now the OFNIC GErI is classified as incubated GErI in the FIWARE Catalogue. A new release was released during the last year on the github repository and as Docker image.

Along with the ongoing activities of software development, including new GErI features and bugs fixing, new documentation materials have been added and continually updated according with such new development. This include new materials on all the official FIWARE documentation channels (Catalogue, readthedocs.org, apiary.io, github.com), and represent the base for any training activity held in our courses.

As explained in the previous sections, the teaching's focus of the UniRoma1 courses is more theoretical so that the FIWARE concepts can be applied to a wider set of application scenarios. For such reason the FIWARE training activities were provided as 'FIWARE lectures' instead of full FIWARE courses.

During such FIWARE lectures, a wide overview on the overall FIWARE platform was presented, and, in addition, a deep focus on the GEs related with the topic of interest was provided. In particular, an overview of the GEs related to the smart network/energy resources management was introduced together with potential integrated use-cases. The focus was both on the research point of view and on possible use-cases of such technology.

Finally, UniRoma1 had the opportunity to invite SMEs that are in the INCENSE accelerator project in order to present their experience with such technology and demonstrate the FIWARE potentials.

2.2.4 Future plans

UniRoma1 plans are to continue to include selected topics from FIWARE within the courses and to improve and enhance all training material already developed, as well as to extend the content of the already available OFNIC GErI webinar. UniRoma1 also plans to create use cases to work with in practical environments.

2.3 UNIVERSIDAD POLITECNICA DE MADRID (UPM)

The Technical University of Madrid (UPM) was founded in 1971 through the integration of the Higher Technical Schools which up until then made up the Higher Technical Institutes. The University Schools joined the following year. UPM has 23 schools and faculties, 15 research and development centres, and hosts some 40000 students.

2.3.1 GREis of interest

Universidad Politécnica de Madrid (UPM) is interested in preparing training material and in giving courses and workshops dealing with a general overview of the FIWARE platform, and in depth knowledge of business framework, and apps and data visualization and mashup use cases. For that purpose the main GErIs involved in UPM training will be those of:

- Apps and Data Delivery Chapter, with special interest in the GERis owned by UPM: WStore, WMarket (including the Data Market), Revenue Settlement and Sharing System and Wirecloud.
- Identity and Security Chapter, with special interest in the GERis owned by UPM: KeyRock identity manager and Wilma proxy.
- Cloud Chapter, with special interest in the Cloud portal.

This material will be also tailored in order to enable other Universities to empower people to develop applications using the FIWARE platform. This material could teach the technologies that are been used in the FIWARE platform.

UPM will also act like a bridge with different open source communities relevant to FIWARE technology like, for example, OpenStack Community.

In order to provide realistic use cases, the courses will use the live demos developed in FI-Core Task WG11.1.2 to implement real scenarios in the lab sessions.

2.3.2 FIWARE in education and training

In particular, UPM will participate in creating the following training material and in giving the following courses and workshops.

2.3.2.1 ***Courses to be offered in the FIWARE Academy (eLearning) platform***

In the future UPM will extend the FIWARE academy resources with

- Revenue Settlement and Sharing (RSS) System
- Store (WStore), and usage of the Store portal
- Application Mashup (Wirecloud), and usage of the Mashup portal
- Marketplace (Marketplace RI and Data Market)
- The KeyRock identity manager and the Wilma proxy
- The usage of the cloud portal.

2.3.2.2 ***Dissemination in undergraduate and Master courses***

UPM implements a formal selection process of courses in the general curriculum, and the approval of a new course in undergraduate or master studies implies the approval of several University boards. In that context in the short time, UPM could contribute to the dissemination of FIWARE technologies through the creation of University workshops, summer training courses or online non curricular courses.

Another interesting dissemination could be done through the BSc and MSc projects. UPM has a frame to allow co-supervision of Master students between a University academic and an industry fellow. This collaboration could be especially interesting if one of the FIWARE partners or SMEs from the Accelerators Programme could be involved in this task, as the output of the Master project could derive in interesting applications or extension of FIWARE.

UPM may set up a learning and microlearning contents in an undergraduate level platform (<http://vishub.org>) in order to the teachers to reuse these resources for dissemination between their students. These contents may be used and remixed so that teachers can customize them for the educational level that they are teaching. This may give a great awareness about FIWARE and FIWARE technologies so that they can think about innovation stemming from the FIWARE applications ecosystem.

UPM may translate some of these contents to Spanish language in order to several Spanish communities to be able to learn about FIWARE.

FIWARE YouTube Channel

UPM will contribute to the FIWARE YouTube channel with tutorial videos and talks covering Wirecloud, the Business Framework GERis, the identity keyRock GE and the cloud portal.

2.3.2.3 *FIWARE Developers' Weeks*

UPM will focus on the training of the SMEs interested in using technologies emerging from the FIWARE ecosystem, such as those that will result from the Open Calls launched by the A16 Accelerator Projects (around 400 SMEs out of 3000 applications are expected from the 1st Open Call). The success of FIWARE will heavily depend on the success of these SMEs in using FIWARE technologies, which in turn will depend on the training and the support we will give them during the process.

As a consequence, the FIWARE consortium is designing a proper training programme in order to embark SMEs properly in the FIWARE ecosystem, to be launched early in March 2015. This programme will start with an initial series of workshops (called "FIWARE Developers' Weeks") where designated coaches will provide some initial high-level technical introduction to FIWARE, followed by a number of specific sessions focused on one or more interrelated GEs. These sessions will in turn be combined with hands-on labs that will help to make training much more efficient, enabling developers to try coding themselves. This programme is based on the experience and on the feedback collected from the bootcamps and other events targeted at developers (e.g. codemotion) which FIWARE successfully ran last year.

UPM has been involved in designing this programme from its very beginning, and has actively participated virtually all the bootcamps and other training events offered in 2014.

In particular, UPM will offer in the FIWARE Developers' Weeks the programme including following four sessions and their corresponding hands-on labs, focused on the Apps and Data Delivery, Identity and Security and Cloud Chapters:

- Data/Applications Visualization and Mashup
- Monetize your APIs and datasets or make them available as Open Data
- Secure your application and integrated into the FIWARE Platform.
- Use the Cloud computing infrastructure to deploy your application and services.

At the moment, there are planned three editions of the FIWARE Developers' Weeks for the March-April period, to be held in Spain, in Belgium and in Germany.

We foresee that the contents and the experiences developed here are key to be transferred to other universities so they can enrich their courses and curricula with this offering.

2.3.3 Year One Update

During the last year UPM, has made use on its involvement in the Apps and Data Delivery Chapter, Identity and Security Chapter and Cloud Chapter, related to the following academic type activities:

- Several Undergraduate Thesis projects related to Identity Management-Keyrock Ge-ri and Self Service Interfaces-Cloud Portal GE-ri.

One PhD degree related to GEDepOrch (FI-Toolkit).

2.3.3.1 ***New content created***

Also during the last year, UPM used its involvement in the referred FIWARE Chapters to produce academic type content oriented to Degree students in the areas of Identity Management Systems and GEDepOrch.

Besides students' learning material, laboratory practices related to Identity Management Systems and GEDepOrch were specified and performed.

2.3.3.2 ***Teaching activities***

In the last year, the following UPM teaching activities have made use of a variety of results and experiences of UPM participation in the FIWARE project:

- Degree in "Engineering of Telecommunication Technologies and Services": Subject on "Data Centers and Service Provision".

- University Master on “Engineering of Networks and Telematic Services”: Subject on “Foundations of Big Data Information Systems”.
- University Master on “Telecommunication Engineering”: Subject on “Infrastructure and Foundations of Big Data Information Systems”.

2.3.4 Future plans

Some of the main UPM academic type future plans, related to its participation in the FIWARE project, are the following:

- Preparation of academic papers related to GEDepOrch.
- Preparation of academic papers related to Identity Management Systems.
- Several new PhD degree students (one already working and 2 more to be added soon).
- Preparation of a MOOC related to Identity Management Systems and GEDepOrch (currently under feasibility analysis).

2.4 UNIVERSIDAD REY JUAN CARLOS (URJC)

The Universidad Rey Juan Carlos is the youngest public university in the Community of Madrid. The educational offering is distributed through the areas of Health Sciences, Experimental Sciences and Technology, Communication Sciences, and Law and Social Sciences. It has four campuses and seven faculties.

2.4.1 GREis of interest

2.4.1.1 *Scope*

In principle, URJC teaching interest on FIWARE is concentrated on the Stream Oriented GEri and on other GEri that may be integrated with it for the generation of novel IoT applications leveraging person-to-machine and machine-to-machine multimedia communication services. If after some initial teaching experiments basing on these GEri, the acceptance and results are reasonable, URJC might consider extending the scope of GEris and include others adapted to the teaching objectives of the Telecommunication School of Engineering.

2.4.1.2 **Technologies covered**

Technologies initially covered are the one devoted to real-time multimedia communications, in general, and WebRTC technologies in particular. These include many horizontal topics including Internet transport protocols (i.e. TCP, UDP), real-world Internet architectures (i.e. NATs, firewalls, IP addressing, etc.), multimedia transport and protocols (i.e. RTP, SRTP, RTCP, HTTP), multimedia signaling protocols (i.e. SIP, JSON-over-HTTP, JSON-over-WebSocket, REST, SOAP), multimedia information representation and compression (i.e. H.268, VP8, Opus) and multimedia client frameworks and APIs (RTCPeerConnection, RTCDataChannel, HTML5 video tag, etc.).

2.4.2 FIWARE in education

2.4.2.1 **Content used**

URJC has already in place a Master Degree (MSc) in Telecommunication Engineering, where one of the courses is specifically devoted to interoperable real-time multimedia communications and services. As part of this course, FIWARE has been introduced and some basic background on the Stream Oriented GErI (Kurento.org) has been presented during the lectures. Some initial material (slides and programming examples) have been presented.

2.4.2.2 **Content to be created**

The reinforcement of FIWARE curriculum in URJC courses would require the creation of additional content material. In particular, the following would be necessary:

- Audiovisual content introducing FIWARE technologies to students and making possible for them to access the FIWARE Lab in a simple and seamless manner.
- Background content devoted to explaining the low level involved technologies.
- Audiovisual content presenting in-depth information devoted to programming applications and services on top of FIWARE.
- Evaluation material including questionnaires and quizzes making possible self-evaluation as well as supervised evaluation.

2.4.2.3 **Type and media**

URJC current teaching activities take place in the physical classroom, although it is enabled for students to follow lectures in a blended mode through the use of the URJC virtual e-learning portal (campusonline.urjc.es).

2.4.3 Year One Update

During the last year URJC continued to develop the Stream Oriented GEri (aka Kurento) and has invested a relevant maintaining it up-to-date in relation to the protocol standards specified at the IETF (Internet Engineering Task Force) and to the API standards specified by the W3C (World Wide Web Consortium). Thanks to this, the GEri has maintained interoperability with the WebRTC implementations of the Chrome and Firefox browsers and with most mobile SDKs implementations including Bowser and Google webrtcclib. Thanks to this, the GEri has been a very useful tool from the teaching perspective, particularly for lab activities, as students can freely create Web and mobile applications involving WebRTC capabilities that interoperate seamlessly with the GEri.

2.4.3.1 ***New content created***

With the objective of reinforcing the teaching activities, during last year a relevant effort has been invested in improving the understandability, completeness and tutorial nature of the Kurento official documentation that is present at <http://www.kurento.org/documentation>. As part of these efforts, the following additional content has been created:

- Full documentation of the Kurento Room API and framework
- Full documentation of the Kurento stats and monitoring system
- Full documentation of Kurento DataChannel capabilities
- New tutorials and videos available at the Kurento Youtube channel

2.4.3.2 ***Teaching activities***

URJC has used the Stream Oriented GE, its GEri and the documentation and content generated among them for the following teaching activities:

- Integration of Heterogeneous Communication Systems Course. This course is part of the Official Master Degree on Telecommunications Engineering at URJC. The course provides an introduction to real-time communication systems and presents WebRTC technologies as a paradigmatic implementation of an interoperable communication technology. The FIWARE Stream Oriented GE is introduced as a WebRTC media server and detailed information on its interfaces, capabilities and architecture is introduced for the course. The advanced capabilities of the GE (e.g. Augmented Reality, Computer Vision) are also presented to illustrate current trends on multimedia communication systems. Specific slides and presentations have been created for the course. In addition, the course makes extended use of the Kurento documentation that is available at <http://www.kurento.org/documentation>.
- Development of audio-visual applications and services in the Internet. This course is part of the Official Degree on Multimedia Communications. The course reviews current state-of-the-art on multimedia communications on the Internet paying special attention to Web technologies.

The FIWARE Stream Oriented GEri is introduced as paradigmatic implementation of a real-time multimedia infrastructure. For this, specific presentations have been created and the Kurento documentation available at <http://www.kurento.org/documentation> has been extensively used.

- Use of the Stream Oriented GEri on Final Degree Projects. Before getting their Degree, students need to perform a final project demonstrating the development skills. The Stream Oriented GEri has been used, during the last year, on 3 Final Degree Projects. In particular, 1 of them have produced useful software that has been made available through open source licenses. The software can be obtained at the following GitHub repo: <https://github.com/sergiobanegas/perseus>

2.4.4 Future plans

URJC plans to continue to use the Stream Oriented GE and GEri on its teaching activities on its Degree and Master courses. The main improvement area we have detected is in relation to the availability of more and more detailed tutorials providing code snippets and better explanations for supporting students on their laboratory environments and on the creation of applications.

2.5 University of Surrey

The roots of the University of Surrey (UniS) date back to 1891. The University Professional Training has been an integral part of undergraduate degrees, with well defined learning and assessment outcomes, for over forty years. The University of Surrey celebrated in 2015 great achievement:

- Surrey rose two places to fourth position in The Guardian League Table 2016;
- Surrey achieved ninth place ranking in The Times Higher Education Table of Tables 2015;
- Figures from HESA reveal that the University is ranked first for graduate employability when compared with chartered universities in England;
- The University incubator has been ranked by the University Business Incubator Index (UBI) as number one Incubator in Europe and second in the World 2014;
- A consortium of key global players has pledged support of £58m for our 5G Innovation Centre in addition to the £11.6m awarded by HEFCE.

2.5.1 GERis of interest

University of Surrey is mainly interested in the IoT GEs and the links between the IoT GEs and other GEs in the FIWARE platform.

2.5.1.1 *Scope*

University of Surrey is interested in courses dealing with a general overview of the FIWARE platform, and in depth knowledge of IoT use cases. For that purpose the main GEs involved in UniS courses will be those of the IoT chapter, with special interest in the GEi owned by UniS, IoT Discovery. In order to provide realistic use cases, the courses will also cover GEs of the data management chapter that can be used to developed use-case scenarios in the practical sessions.

2.5.1.2 *Technologies covered*

The technologies covered in the courses will be those directly involved in the implementation of FIWARE applications, especially in IoT applications. In this context, the most used technologies would be technologies of wireless interfaces (such as Bluetooth, WIFI), middleware (such as CoAP, MQTT), semantics and web services (such as XML, XSD, JSON, RDF, SPARQL), and the internal FIWARE technologies such as NGSi-9 and NGSi-10.

2.5.2 FIWARE in education

2.5.2.1 *Content used*

University of Surrey in November 2014 organised a workshop as a part of the MSc module on the IoT. Among the recent trends in the IoT, FIWARE was also discussed during the workshop. The semantic technologies that UniS has used in FIWARE were also discussed in the MSc module.

2.5.2.2 *Content to be created*

UniS has extended the FIWARE academy resources towards to enable the FIWARE academy as a complete course platform complying with quality definitions for online courses such as the sloan consortium quality parameters (Moore, 2005) that could be measured by LORI (Learning Object Review Instrument) (Vargo, Nesbit, Belfer and Archambault, 2003; Nesbit and Leacock, 2005; Leacock and Nesbit, 2007). UniS will continue to add more content using the learning platform resources, such as the use of assignments, use cases, quizzes, forums, chats, etc. The course will be self-contained, although it will have links to already existing learning resources (such as GEs). The course will have a home page with links to the content and description of the curriculum, evaluation, teacher, etc. This webpage will be similar to the courses taught in popular MOOC (Massive Open Online Courses) providers, such as coursera (<https://www.coursera.org/>), edX(<https://www.edx.org/>), Alison (<http://alison.com/>) or UDACITY (<https://www.udacity.com/>). Coursera and edX provide courses from leading Universities, such as University of California at Berkeley, Stanford, or Massachusetts Institute of Technology (MIT). UDACITY and Alison provide courses from leading Silicon Valley firms such as ATT or Google.

2.5.2.3 *Type and media*

UniS has a strict selection process for courses officially offered as a part of the undergraduate and postgraduate curricula and the approval of a new course in undergraduate or MSc programmes requires an approval from the department's and University's teaching boards. In this context and in the short-term UniS has contributed to the dissemination of FIWARE technologies through the creation of academic workshops, summer training courses and online non-curricular courses. Another interesting dissemination will be explored through offering new MSc projects based on FIWARE technologies. Since the initial report was prepared after the MSc projects has been assigned, this activity is planned to be introduced in the next academic year. UniS allows joint supervision of MSc students between a University academic supervisor and an industry co-supervisor. This collaboration would be especially interesting if any of the industry FIWARE partners could be involved in this task. The outcome of the MSc project could provide interesting applications or extensions to FIWARE technologies and applications.

2.5.3 Needs for training material

2.5.3.1 *From technical point of view*

UniS had previously faced difficulties using the SCORM package and the voice was at times difficult to sync. It was previously recommended that text-to-speech tools are used as an audio source, but feedback from external evaluators and users noted that the machine generated voice is difficult to understand, and preferred a natural voice. Steps were taken initially to use alternatives to this package could to ease the creation of online content. This included recorded videos of step-by-step tutorials, and preparation can be much quicker than a SCORM package. The loading of a SCORM package had proven to be quite inconsistent and occasionally parts of the UI do not appear. But the SCORM package has been replaced by the Course Builder web application which was released after the initial report and has improved the process quite considerably.

The addition of stand-alone slides has proven to be useful for blended courses. In that content the teacher could make a flexible use of the slides on in-class sessions, taking into account the feedback of the students. Some partners have already slides on slideshow and hence can point to them as resources.

We encourage the possibility to issue course certifications by FIWARE which will attract potential students as a form of getting a certification for attending and learning a new platform/technology.

2.5.3.2 *From content point of view*

An academic course will cover several GEs, and it is good to have a uniform content. Guidelines on how to publish courses in the FIWARE academy, such as elements to publish and format should help to have common basic elements in each GE course (i.e. a 5 minutes introductory video, a demo-video, etc.).

A general course on an overview of FIWARE, easily accessible at the top of the FIWARE Academy courses could be very useful. This course could cover the general overview, followed by more detailed videos on

the FIWARE technologies, specially the protocols NGSI-9 NGSI-10 and now with the recent emergence of NGSI v2.

The creation of content showing how to implement a general application which makes use of several GEs should be important for the lab sessions of the course. As well, as some general descriptions of each GE, specifying the purpose of each GE.

2.5.4 Year One Update

2.5.4.1 *New content created*

UNIS has continued to add resources to the FIWARE Academy with regards to the aspects that the IoT Discovery GE covers. This relates to:

- Background content for learning about core technologies and annotations being used.
- Video tutorials on how to install the GE and its dependencies
- Slide tutorials on how utilize the API exposed by the GE.

The SCORM package has been replaced by the Course Builder web application which was released after the initial report and has improved the process quite considerably. This was used to create a newer version of the SCORM tutorial.

We have also provided support for other research students on how to adopt the FIWARE technology; from the use of the cloud platform, to the deployment and interaction with other GE, such as the context broker. This was done locally and also for students from other countries outside the UK

2.5.4.2 *Teaching activities*

Since the initial report was prepared after the MSc projects has been assigned, this activity is planned to be introduced in the next academic year. Since the content for the related taught module had already been set for the previous academic year, FIWARE has been provided through supplementary information about the state-of-the-art in IoT Frameworks.

2.5.5 Future plans

University of Surrey is extending the content of IoT discovery GEi with the creation of use cases, showing examples of addition of datasets to the GE, queries, etc. UniS is also creating use cases to work with in practical environments. We are planning to host some visiting PhD students to see if they can integrate/extend our GE in their work. For the next academic year, we will use some of the concepts and models that we have developed in the project in the IoT module that we offer to our undergraduate and MSc students.

2.6 ZÜRCHER HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFTEN (ZHAW)

The ZHAW is one of the leading universities of applied sciences in Switzerland. 30 institutes at the ZHAW network their resources to provide business and industry with customised services, and host some 11000 students enrolled at the ZHAW in a total of 26 Bachelor's degree programmes and 13 consecutive Master's programmes. The university also offers a broad range of continuing education courses, including over 40 Master's of Advanced Studies programmes.

2.6.1 GREIs of interest

2.6.1.1 *Scope*

ZHAW has two main areas of interest in FIWARE: security and cloud computing.

The course curriculum is something a research project cannot really influence. The concepts and the structure of the teaching program at ZHAW focuses on fundamental knowledge and concepts. Therefore, it is not possible to have a course fully devoted to FIWARE, but we try to use FIWARE technologies on an exemplary level within in the syllabus of specific existing courses.

In cloud computing for example the main technologies of interest are the enablers from the Cloud Hosting and Apps Chapter. In our Cloud Computing (CCP1 & CCP2), Service Engineering (SEG) and Internet Service Prototyping (IS-PROT) classes we are covering FIWARE technologies on different levels from multiple chapters.

In security, ZHAW is interested mainly in the Privacy GE. The Privacy GE allows providers of services to use credentials that are anonymous and yet allow the verification of attributes. This allows the service provider to verify only those attributes that are absolutely needed for it to provide the service. For example, a provider of a virtual city tour might allow anonymous comments, but only to those people who can prove that they are citizens. Another example is the verification of voting age where credential holders can prove that they are above a certain age without having to reveal their date of birth. Our scheme knows three roles:

- The ISSUER issues privacy-preserving credentials.
- The VERIFIER controls access to a source by taking privacy-preserving credentials and checking them for correctness.
- The USER obtains credentials from an ISSUER and uses them with a VERIFIER. With these credentials, USERS automatically create different pseudonyms for every interaction with a

VERIFIER, and VERIFIERS will not be able to detect from those pseudonyms that these interactions are from the same USER. In fact, this is true even if the VERIFIER and the ISSUER collude. When verifying a credential with a VERIFIER that VERIFIER will say to the USER things like, "I need you to reveal attributes 'citizenship' and 'gender' to me, issued by 'City of Helsinki'". This is known as a presentation policy. The USER then reveals the gender and citizenship attributes, but not, for example, the name or other personally identifying information.

Beside lecturing, we are offering to bring in FIWARE technologies into student, bachelor and master project proposals.

2.6.1.2 *Technologies covered*

In cloud computing we are basically covering the main technologies used in the GEs of the Cloud Hosting chapter. Starting from the IaaS GE, Object Storage GE up to the newly added GEs like Docker. In addition, we are covering the topic of Cloud Orchestration, which uses the same technologies as the PaaS Manager and Software Deployment and Configuration GEs. In the advanced course we are covering topic like Cloud Native Application Design, which covers important know-how for architects and developers to develop systems on top of Infrastructure and Platforms like, but not exclusively for FIWARE. In 2016 we also started to cover new vertical topics like Cloud Robotics, based on the technologies used in the Robotics GEs in FIWARE.

In Service Engineering (SEG) classes we are covering FIWARE on a higher level. FIWARE was used in a lab to design and provision a simple prototypical service based on the Application Mashup GE Wirecloud and the Marketplace.

In security, the main technology used is privacy-preserving credentials and privacy-preserving data sharing. Privacy-preserving data sharing works by homomorphic encryption and secret sharing. In homomorphic encryption, it is possible to do operations on ciphertext without knowing the corresponding plaintext. It would thus be possible to compute the sum of two encrypted integers without knowing the integers themselves. The use case for this is when three or more service providers want to get a view of the total number of attacks their networks suffered during the last 24 hours (for example), but where none of them is comfortable in providing its competitors with the provider's raw data. In the secret-sharing scheme to be implemented in FIWARE, the provider uses not the raw data, but an encrypted version of that data. The total is then computed through homomorphic encryption, and the plaintext of that total can then be decrypted by the provider. The provider thus knows its own contribution to the total, and knows the total itself, but does not know the contributions of the other providers.

Secret sharing is a Shamir threshold scheme. In such schemes, a secret x is used as the constant in a polynomial P of large degree n ; i.e., it is $P(0)$. Shares are points on the polynomial, e.g., $P(1)$, $P(2)$, ... To compute $P(0)$, one needs at least $n + 1$ such shares. By choosing n and the number of shares distributed to each participant, one can control how many participants must work together to reassemble the secret $P(0)$ and how many dishonest participants the scheme can tolerate.

Privacy-preserving authentication is used in products like Idemix (IBM) or UProve (Microsoft); its technology works as described in the documents on http://www.zurich.ibm.com/idemix/publ_full.html

We have described these technologies in slightly more detail than we would normally do in order to underscore the fact that these are very advanced technologies and not suited for undergraduate education. We will elaborate below why this is important.

2.6.2 FIWARE in education

ZHAW's main educational vehicle is the Bachelor degree, i.e., teaching undergraduates.

In cloud computing, ZHAW did the first rudimentary test in including FIWARE examples in their cloud computing course in the 2014 semester.

Unfortunately, the technologies used for privacy-preserving authentication and privacy-preserving data sharing are too advanced for presentation and teaching in undergraduate courses: they use advanced mathematics and concepts that have been the subject of PhDs and are entirely unsuitable even at the Master's degree level. These technologies will therefore have no impact on ZHAW's security curriculum.

In security, we use FIWARE in postgraduate education: the scientific assistants we employ are usually former students, and FIWARE is no exception. But this is not course-level education, but rather learning on the job.

In cloud computing, ZHAW did the first rudimentary test in including FIWARE examples in their cloud computing course in the 2014 semester. The course curriculum is something a research project can not influence. ZHAW proposes FIWARE education to be implemented within the KIC ICT (i.e. EIT ICT Labs Professional Education).

2.6.2.1 *Types and media*

Most ZHAW current teaching activities are based on a blended learning concept which consists of physical presence lecturing and labs, supported by self-paced learning based on additional reading material or online tutorials.

2.6.3 Needs for training material

2.6.3.1 *From technical point of view*

The trend in many courses at ZHAW is going towards reverse classroom and self-paced learning concepts. This requires much more guidance and flexibility within the course material. The existing training material in FIWARE is difficult to tailor for a specific setting because it is in a prepackaged form. Smaller modules, which can be reordered, skipped, replaced or extended would help to adopt for different kind and levels of courses.

2.6.3.2 *From a content point of view*

The current learning content is mainly addressing the requirements of the user on how to install, manage and access the GE and not the engineer which need to understand how the technology works. Because our courses are focusing on concepts and base technologies we need content which cover more the fundamental technologies and concepts of the GEs. This may be a special requirement of our courses and may go beyond the scope of the project.

2.6.4 Year One Update

In our cloud computing courses we added additional technologies like Docker and Cloud Orchestration and extended the content to Cloud Native Application design as well as new vertical topics like Cloud Robotics covering the technology from the Robotics GE.

In addition, we addressed FIWARE in this year's Cloud Computing Summer School (<https://blog.zhaw.ch/icclab/cloud-computing-summer-school-2016-highlights>) organized in collaboration with Grand Valley State University (GVSU) from Allendale (MI, USA). The two-week program in Winterthur covered all the fundamental cloud concepts and technologies like Infrastructure and Platform services, Orchestration, Monitoring, Kubernetes, Docker and Cloud Robotics. The half day presentation and lab session on FIWARE was very well received by the Swiss and American students.

2.6.5 Future plans

ZHAW will continue to extend the coverage and details of the technologies used in FIWARE in our courses. For example, for the coming autumn semester 2016/2017 we are offering a new elective course about "Internet Service Prototyping" (ISPROT), where we plan to more extensively include some of the FIWARE technologies to provide or consume service APIs, i.e. the Mashup GE rapidly build prototypical service offerings.

ZHAW proposes FIWARE education to be implemented within the KIC ICT (i.e. EIT ICT Labs Professional Education).

2.7 Open Knowledge International (OKFN)

Open Knowledge International is a worldwide non-profit network of people passionate about openness, using advocacy, technology and training to unlock information and enable people to work with it to create and share knowledge. We are not an institution offering formal educational qualifications. However, trainings do constitute part of our work, both in the ideas and tooling used to move towards a more open worlds. It is also the case that community building and maintenance is a big part of what we do and maintenance and growth of these communities has a large educational component, even if this

is may be informal and take many forms. Because of the nature of the development of the project it is important that education materials are up to date and are regular and numerous.

2.7.1 GREis of interest

The relevant GREis here is CKAN. Other GREis may become relevant when they are interacting with CKAN. For example, in the creation of extensions to allow for integration. However, the overwhelming focus of this report concerns CKAN.

2.7.1.1 *Scope*

For an open source project such as CKAN the scope of the work here is concentrated on supporting, maintaining, educating and inspiring this community of developers and users. There are many forms this takes from regular meetings with the dev team and steering committee, bug fixes and answering questions from general users. As the organisation who built CKAN and continue to lead in it's development it is essential that OKI take a lead role in this task. FIWARE has made a major contribution to the continued growth and success of the CKAN project. After building CKAN and continuing to have a major role and interest in the development and future of CKAN, it is the role of OKI as FIWARE GREis maintainer to ensure that the work done as part of the FIWARE project is communicated to ensure uptake, continued use and further development. This include making sure the developer community are updated on how things are built, and also on communicating innovations to both developers and new and existing end users.

2.7.1.2 *Technologies covered*

The Technologies covered are CKAN and the associated updates and extensions made as part of the FIWARE project. Key areas of development which has constituted a key need for education material and effort include: Platform updates - support has been a key part of FIWARE, Improvements in usability and service integrations which support better interoperability with the rest of FIWARE Generic Enablers.

2.7.2 FIWARE in education

- The FIWARE Academy course includes a video tutorial which was especially produced to assist new users in uploading and managing their data with CKAN. The course was created specifically for the FIWARE Academy. As well as use in the Academy, the content will generally contribute to webinars and general introduction sessions to CKAN. This is already evident in the work of OKI, but due to the lack of similar resources elsewhere, the exposure of the Academy course, and so FIWARE in general, should be promoted.

- Open Knowledge Labs is Open Knowledge International's collaborative platform which helps our community of developers discuss ideas and contribute to projects and learn from each other. The community is used to update the community on FIWARE through channels such as the mailing list, forum

posts. Most importantly the monthly community calls have been used to focus on specific updates to the CKAN platform.

- The Flask migration is a key deliverable for FIWARE and a great step forward for the CKAN project and community. It is a priority to update the tech team on progress on this FIWARE item and this happens on a weekly basis.

- OKI Labs is also responsible for running real-life events such as hack days and meetups, bringing the whole OKFN community closer together. Material has been prepared to update the community on FIWARE work to ensure dissemination of knowledge and awareness in the CKAN open source community. This is particularly the case for the Flask Migration work. The slides will be made available and continued to be used for training purposes by OKI and the wider developer community who have, and will increasingly have a need to learn and pass this knowledge on.

- A stack overflow tag for FIWARE is identified which allow members of the OKI team to concentrate their community support responsibilities on FIWARE items. This will live on after the project is over so maintenance and support will continue and the FIWARE work will be known about and maintained. The IRC channel also exists for a similar purpose.

2.7.3 Year One Update

OKFN contribution was not mentioned in the initial version of this deliverable

2.7.4 Future plans

CKAN is an ongoing open source project with an active community of developers working both for OKI and independently. OKI continues to have a major leadership role within the CKAN association. The Work done as part of FIWARE has made a huge contribution to the CKAN project and this work has become integral to the overall project. This work will continue after the FIWARE project ends. OKI have a continued interest in promoting the work done as part of the FIWARE project and in their role within the CKAN association will continue to inform and educate people of the progress made. All materials created will live on and continue to be edited and built upon.

3 Conclusions

All the FIWARE academic partners reported that education activities have been conducted during this second period of the FI-Core project, which is showing the interest for such an initiative.

At this stage there are a number of aspects that Academia could improve, further analyze and implement in order to support and contribute to the growth of FIWARE, such as, for example, the conception of a FIWARE diploma that could even be recognized by the industry, the pan European diploma (European Master course ?) with the need to align education procedure between universities.

Regarding this last aspect, it seems that a good education on FIWARE would need a course with 2 different and complementary parts:

- A Theoretical course to teach students the FIWARE architecture, the NGSI APIs, the data models, the enablers, ...
- A practical course that allows students to create an account on a FIWARE Lab and to develop an application using the data set available or using open data / data from IoT Networks. In this phase they could also participate to hackathons in order to compete among Universities, for example.

With such an education model, students should be able to create their own FIWARE application when joining Industry and/or when creating their own startup. With such knowledge of FIWARE, they can easily apply to future calls for proposals open by the EC, Regions, cities, Industries.