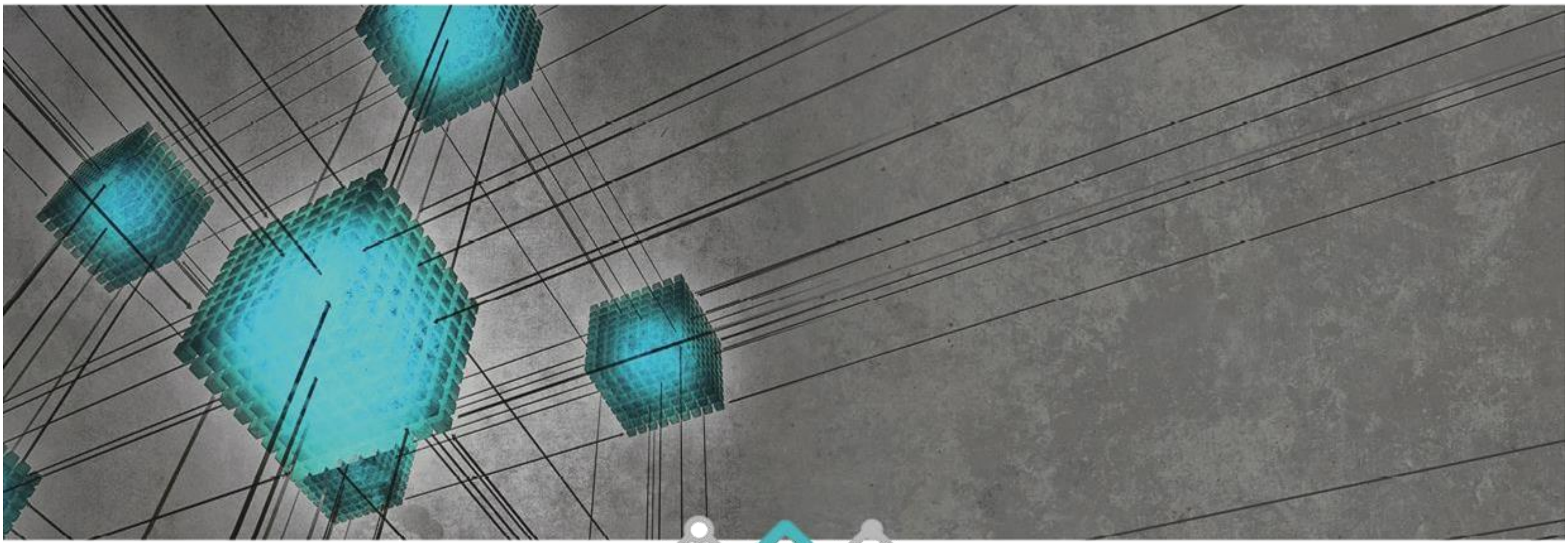

interiot

INTEROPERABILITY
OF HETEREOGENEUS
IOT PLATFORMS.

Periodic Technical Report

Part B

Project Number: 687283

Project Acronym: INTER-IoT

Project Title: Interoperability of Heterogeneous IoT Platforms

Period Covered: from 1st January 2016 to 30th June 2017

Periodic Report: 1st

INTER-IoT

INTER-IoT aim is to design, implement and test interoperability tools, a framework and a methodology that will allow interoperability among different Internet of Things (IoT) platforms.

Most current existing IoT developments are based on “closed-loop” concepts, focusing on a specific purpose and being isolated from the rest of the world. Integration between heterogeneous elements is usually done at device or network level, and is just limited to data gathering. Our belief is that a multi-layer approach to the integration of different IoT devices, networks, platforms, services and applications will allow a global continuum of data, infrastructures and services. Additionally, a reuse and integration of existing and future IoT systems will be facilitated, enabling the creation of a de facto global ecosystem of interoperable IoT platforms.

In the absence of global IoT standards, INTER-IoT results will allow any company to design and develop new IoT devices or services, leveraging on the existing ecosystem, and bringing them to market quickly.

INTER-IoT has been financed by the Horizon 2020 initiative of the European Commission, contract 687283.

INTER-IoT

Periodic Technical Report Part B.

Version:1.1

Security: Confidential

August 29th, 2017

The INTER-IoT project has been financed by the Horizon 2020 initiative of the European Commission, contract 687283

Disclaimer

Executive Summary

The present document provides the Project Progress Report (PPR) for the first review to be held on 26th September 2017 in Athens. The review will assess the progress of the project from M1 to M18. In October 2016 a technical review to assess technical and management aspects of the project was already held. The different recommendations suggested by the expert reviewers were incorporated to the project and corrective actions were applied. Additionally, an ethics review was performed as suggested by the expert reviewers, it was received in January 2017, and corrections were applied to the project activity and documentation (e.g. PPR Ethics section).

The document provides an overview of the work done and the actions performed to achieve the goals proposed and included in the GA during the first 18 months of the project. The document includes use of resources section in addition to the technical and impact aspects.

The document is structured in four blocks, starting with a brief introduction about the project and its main challenges. The four blocks provide the description of the work performed by the members of the consortium during the period under review. First block analyses the actions taken to accomplish the specific objectives listed in the DoA. Second block describes with more detail the main results and achievements per WP (providing additional details to the information provided in part A of the PPR); including the responses to the technical and ethic recommendations issued by the reviewers. The third block provides an overview of the impact achieved so far, including the different actions at industrial, scientific, academic and communication levels. Ending the report with an overview of an explanation of the use of resources, clarifying the efforts done by the entities to achieve the objectives.

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Change control datasheet

Version	Changes	Chapters	Pages
0.1	ToC build up responsible assignation	All	25
0.2	Preliminary draft	All	56
0.3	Second draft	All	122
0.4	Formatting and Use of Resources Explanation	All	134
1.0	Final version for review	All	132
1.1	Final version	All	140

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Acronyms

AIOTI	Alliance for Internet of Things Innovation
BIP	Best Ideas and Projects
EC	European Commission
IERC	European Research Cluster on the Internet of Things
INTER-LAYER	INTER-IoT Layer integration tools
INTER-FW	INTER-IoT Interoperable IoT Framework
INTER-METH	INTER-IoT Engineering Methodology
INTER-LogP	INTER-IoT Platform for Transport and Logistics
INTER-Health	INTER-IoT Platform for Health monitoring
INTER-META-ARCH	INTER-IoT Architectural meta-model for IoT interoperable platforms
INTER-META-DATA	INTER-IoT Metadata-model for IoT interoperable semantics
INTER-API	INTER-IoT Programming library
INTER-CASE	INTER-IoT Computer Aided Software Engineering tool for integration
IoT	Internet of Things
ITU	International Communications Union
PCS	Port Community Service
SEAMS	Smart Energy-efficient and Adaptive Management System
API	Application Programming Interface
HMI	Human Machine Interface
IDE	Integrated Development Environment
ACL	Access Control List
GSM	Global System for Mobile communications
Port CDM	Port Collaborative Decision Making
MVC	Model, View, Controller
IoS	Internet of Services
QoS	Quality of Service
QoE	Quality of Experience
SDN	Software Defined Network
API	Application Programming Interface
CRUD	Create, Read, Update and Delete
SDO	Standards Developing Organization

W3C	World Wide Web Consortium
SSN	Semantic Sensor Network
SAREF	Smart Appliances REFerence
OGC	Open Geospatial Consortium
LTE	Long-Term Evolution networks
DSL	Digital Subscriber Lines
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
M2M	Machine to machine
RFID	Radio Frequency IDentification
MAC	Media Access Control address
HTTP	Hyper Text Transfer Protocol
IP	Internet Protocol

1 Introduction

1.1 Overview of INTER-IoT project

INTER-IoT project is a Research and Innovation Action under H2020 EC Framework Programme. The project aims at the design, implementation and experimentation of an open cross-layer framework, an associated methodology and tools to enable voluntary interoperability among heterogeneous Internet of Things (IoT) platforms. The proposal allows effective and efficient development of adaptive, smart IoT applications and services, atop different heterogeneous IoT platforms, spanning single and/or multiple application domains. The project will be tested in two application domains: transport and logistics in a port environment and mobile health, additionally it will be validated in a cross-domain use case supported by the integration in the project of twelve third parties. The INTER-IoT approach is general-purpose and may be applied to any application domain and across domains, in which there is a need to interconnect IoT systems already deployed or add new ones. Additionally, INTER-IoT is one of the seven RIAs and two CSA composing IoT-EPI, supporting the creation of a European common space for IoT interoperability.

INTER-IoT is based on three main building blocks: (i) Methods and tools for providing interoperability among and across each layers of IoT platforms (INTER-LAYER); (ii) Global framework (INTER-FW) for programming and managing interoperable IoT platforms; and (iii) Engineering Methodology (INTER-METH) based on CASE tool for IoT platforms integration/interconnection. This three main building blocks are represented in figure 1. The three main building blocks and the subcomponents have been identified and classified in different exploitable products adequate to the needs of the different stakeholders involved in the project and also addressing the main needs of the potential customers of the entities participating in INTER-IoT.

INTER-IoT provides an interoperable mediation component (i.e INTER-LAYER to enable the discovery and sharing of connected devices across existing and future IoT platforms for rapid development of cross-platform IoT applications. INTER-IoT allows flexible and voluntary interoperability at different layers. This layered approach can be achieved by introducing an incremental deployment of INTER-IoT functionality across the platform's space, which will in effect influence the level of platform collaboration and cooperation with other platforms. INTER-IoT does not pretend to create a new IoT platform but an interoperability structure to interconnect different IoT platforms, devices, applications and other IoT artifacts.

Syntactic and semantic interoperability represent the essential interoperability mechanisms in the future INTER-IoT ecosystem, while organizational/enterprise interoperability has different structures/layers to enable platform providers to choose an adequate interoperability model for their business needs. It will be supported by INTER-FW that may allow the development of new applications and services atop INTER-LAYER and INTER-METH, to provide a methodology in order to coordinate interoperability supported by the definition of different interoperability patterns and a CASE tool.

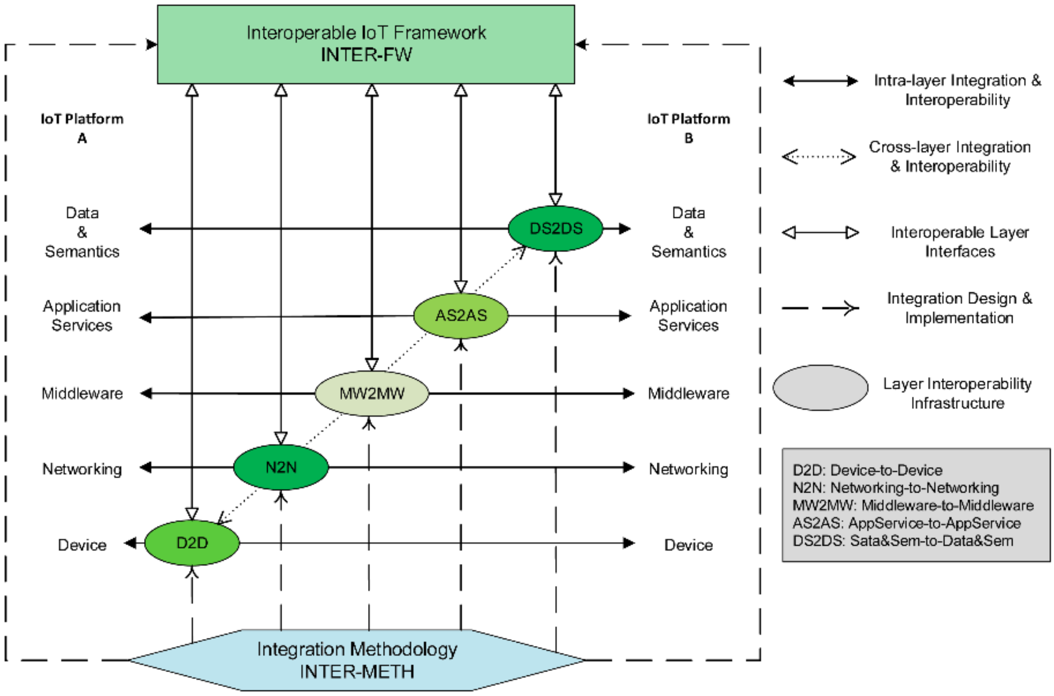

Figure 1. INTER-IoT concept and vision

INTER-LAYER is composed by five layers, supported by cross-layer components as needed for the interaction of the different layers:

- At the Device level: the seamless inclusion of new IoT devices and their interoperation with already existing heterogeneous ones, allowing a fast growth of smart objects ecosystems.
- At the Networking level: seamless support for smart objects mobility (roaming) and information routing. This will allow the design and implementation of fully connected ecosystems.
- At the Middleware level: a seamless resource discovery and management system for smart objects and their basic services, to allow the global exploitation of smart objects in large scale IoT systems.
- At the Application and Services level: the discovery, use, import, export and combination of heterogeneous services between different IoT platforms.
- At the Data and Semantics level: a common interpretation of data and information from different platforms and heterogeneous data sources, providing semantic interoperability.

And INTER-FW which provides the wrapping environment for INTER-LAYER component coordination and new services development using INTER-API.

Open interoperability delivers on the promise of enabling vendors and developers to interact and interoperate, without interfering with anyone's ability to compete by delivering a superior product and experience. In the absence of global IoT standards, the INTER-IoT project will support and make it easy for any company to design IoT devices, smart objects, or services and get them to market quickly, and create new IoT interoperable ecosystems. INTER-IoT may provide a solution to any potential interoperability problem within the IoT landscape. Figure 2 represents the potential environment of INTER-IoT use.

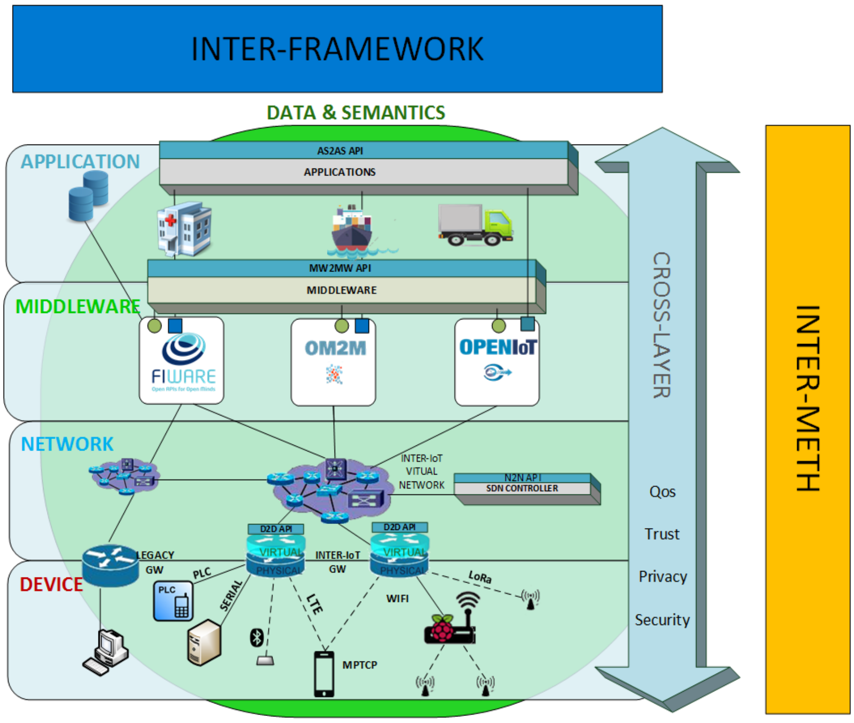

Figure 2. INTER-IoT layered approach

The INTER-IoT approach is use case-driven, implemented and tested in three realistic large-scale pilots: (i) Port of Valencia transportation and logistics involving heterogeneous platforms with ~400 smart objects; (ii) an Italian National Health Center for m-health involving ~200 patients, equipped with body sensor networks with wearable sensors and mobile smart devices and (iii) a cross domain pilot involving IoT platforms from different application domains and enlarged by the collaboration of the solutions associated to the different layers and sublayers from the third parties that have attended the open call. The use cases are:

- INTER-LogP: The use of IoT platforms in the ports of the future will enable locating, monitoring, and handling different transport and cargo equipment and storage areas. This use case will address the need to seamlessly handle IoT platforms interoperation within port premises: container terminal, transportation companies, warehouses, road hauliers, port authorities, customs, and outside the port.
- INTER-Health: The Decentralized and Mobile Monitoring of Assisted Livings' Lifestyle use case, aims to develop an integrated IoT system for monitoring humans' lifestyle in a decentralized mobile way to prevent chronic diseases. The aforementioned monitoring process can be decentralized from the healthcare center to the monitored subjects' homes, and supported in mobility by using on-body physical activity monitors.
- INTER-DOMAIN, composed by IoT platforms from the two application domain oriented pilots and the IoT platforms and the specific layer-oriented solutions from different application domains selected in the open call. SENSINACT and OM2M platforms with Smart Cities orientation have been selected, and contributions from the different layers may complement INTER-IoT.

The project has analyzed requirements provided by the stakeholders of the project and usability of the provided solutions from the perspective of IoT platform creators, IoT platform owners, IoT application programmers and users investigating business perspectives and creating new business models. These results may allow to start INTER-IoT ecosystem and the most important benefits expected for third parties are related with the new features and components that will be released by the consortium: methodologies, tools, protocols and API. That will be released as open items available to develop new applications and services. The variety and cross availability of the results could be used to build and integrate services and platforms at different layers according to the needs of the stakeholders and developers. The availability of more and new data will stimulate the creation of new opportunities and products.

2 Explanation of the work carried out by the beneficiaries and Overview of the progress

2.1 Objectives

The overall goal of the INTER-IoT project is: "*to provide an interoperable open IoT framework (with associated engineering tools and methodology) for seamless integration of heterogeneous IoT platforms functioning in the same or different application domains. INTER-IoT uses a layer-oriented approach. The two application domains and use cases addressed in the project and in which the IoT framework will be applied are (a) port transportation and logistics and (b) m-Health. Achievement of interoperability will optimize different strategic operations in the two use cases: (a) increasing efficiency in transportation time, reducing CO2 emission, improving access control and safety; (b) improving remote subject monitoring; increasing the number of people that medical units can assist using the same resources. The INTER-IoT approach is indeed general and may be applied to any application domain and across domains, in which there is a need to interconnect diversified IoT systems already deployed or add new ones. This will enable bottom-up formation of interoperable IoT ecosystems.*"

In order to accomplish our overall interoperability goal, INTER-IoT will not be another IoT-Platform but the mean to abstract the complexity of the interconnection between different IoT elements (devices, gateways, platforms, etc.). The collaboration with other ICT30 projects and the creation of a community to support our interoperability objective are also considered as main goals, since this will be the way to extend our work once the project has ended.

All the efforts done during the reporting period are in the line of accomplishing these objective. At this point, the consortium has achieved all the proposed milestones as they were described in the DoA and has delivered all the promised deliverables timely and with an excellent level of quality. Technical activity is advancing and several developments are ongoing and dissemination and communication activities have been performed to maximize impact.

2.1.1 Research and Innovation objectives

INTER-IoT project will focus on the following set of specific research and innovation objectives. Below is the list of objectives with the detailed actions that have been taken in order to accomplish them:

Obj1. Design and Implementation of an Open Cross-Layer Framework for Interoperability of IoT Platforms.

The interoperability framework (INTER-FW) will fully address interoperability issues that do not allow heterogeneous IoT platforms to be interconnected and interoperate. By using the INTER-FW, any IoT platform can be made interoperable with respect to its fundamental layers: device, networking, middleware, application service, and data/semantics. Starting from heterogeneous IoT platforms, the INTER-FW will facilitate creation of an ecosystem of interoperable and open IoT platforms. Thus, novel IoT services and applications will be more rapidly developed and provided atop interoperable IoT platforms. From a business perspective, interoperability will result in decreased costs, reduced inefficiencies, lower customer frustration, and therefore speed-up adoption of the IoT.

The actions taken to accomplish the first objective have been:

- Analysis and research of the state of the art and feature comparison of interoperability solutions for network, gateways, message brokers, IoT, platforms and IoT Cloud Platform providers.
- Analysis and research of the state of the art on techniques and styles in frameworks generation.
- Technical requirements elicitation, that have been released in D2.3v2 (M12) following the recommendations of the reviewers after the technical review and have been used to start the activity in WP3, WP4 and WP5.
- Ongoing work for the reference model and architecture based in IoT-A, adapting the concepts to the interoperability if platforms realm, and in developments form AIOTI and the HLA proposal from WG3. First version of the architecture and reference model were released in D4.1
- Ongoing work for the metadata model coordinated with the developments of IPSM and GOIoTP, whose corresponding results may be contained in D4.3 and D3.2 (M21)
- Selection of the IoT platforms to be used in the pilots and controlled demos, recommendations obtained from the stakeholders, market analysis. The platforms have been complemented through the open call.
- Definition of a set of tools included in INTER-FW to manage the interoperability components of each layer.
- Ongoing development of a web framework to manage multi-layer interoperability of existing systems.
- Ongoing development of security mechanisms to ensure the privacy of data and secure communications in the INTER-IoT interoperability scenario.
- Evaluation of security techniques and solutions suitable for IoT data protection.
- Instantiation of the meta-architecture developed. Definition and use of deployment technologies (Docker, Vagrant, …), plug-in facilitators (OSGi), and other languages and technologies, etc.
- Systematic Analysis and testing of different IoT platforms relevant for the project, including the installation and operation in order to obtain the pros and cons and how INTER-IoT may interact with them.
- Set-up of a lab testbed infrastructure with clients for the different IoT platforms, considering interfaces and APIs
- Setup of a development environment for INTER FW and INTER API (git, maven, …)
- Setup of the Azure cloud infrastructure for the deployment of INTER FW and INTER API demonstrators
- Preparation of detailed software development plans for INTER FW and INTER API, including a definition of functionalities for each release. The plan foresees three internal software releases.
- Design and development of the INTER-FW web app. The design phase consisted of requirements analysis, design of the user interface and creation of sequence diagrams that represent user's interaction with the GUI. Furthermore, analysis of web development frameworks was performed and the most suitable for INER FW was selected.
- In the context of INTER API development different API standards were examined. This analysis included technical and organizational (community, business viability) advantages of different solutions. The result of this exploration phase is the decision to expose INTER FW through REST API using the WSO2 API Manager server and describe the APIs using the Swagger (OpenAPI) description language. Detailed reasoning behind the selected solution is provided in D4.3.
- In order to expose a unified set of INTER API functionalities, D2D, Middleware, AS2AS and IPSM INTER-LAYER components exposed their functionalities as REST API documented in

the OpenAPI format. Single layer APIs where further analyzed and exposed under the umbrella INTER API (through the WSO2 API manager)

- Implementation of access to INTER-LAYER from the INTER-FW webapp using the INTER API is in progress (beta version expected in M20)
- Development of guidelines and software structures to enable extensions of the layers (software development framework)

Obj2. Definition of Techniques and Tools for interoperability at the different IoT Platform Layers.

Layer (and cross-layer) interoperability is fundamental to provide global interoperability between IoT platforms. To fully address layer interoperability, the following activities will be carried out: (i) design of device-to-device interaction based on multiprotocol/access mechanisms; (ii) design of software defined interoperable modules for mobility and routing; (iii) development of an open service discovery and management framework for smart objects; (iv) design and implementation of smart IoT application service gateway and virtualization; (v) definition of a common ontology which will facilitate access to the heterogeneous data, which will be collected and managed by integrated IoT platforms.

The actions taken to accomplish the second objective have been:

- State of the art of interoperability mechanisms associated with different interoperability layers (included in D3.1)
- Test and selection of technologies for the different interoperability layers, including the deployment and study of the current common IoT platforms (FIWARE, OM2M, WSO2, universAAL).
- Definition and specification of INTER-LAYER and its different components to provide the infrastructure required for interoperability, using as input the requirements (D2.3), use cases and scenarios (D2.4) and inputs from the stakeholders and AB.
- Specification and development of the first version of INTER-IoT gateway considering the physical part and the virtual part.
- Definition and development of a virtual software defined network, with virtual switches and controllers based in RYU, including QoS components
- Definition and development of the MW2MW structure for interconnection of platforms and their applications considering the platforms specified by the stakeholders.
- Definition and development of the AS2AS component based in NodeRED to achieve interoperability between services from different IoT platform deployments.
- Definition and development of the IPSM (Interoperability Platform Semantic Mediator) and conceptualization of GOIoTP as the core INTER-IoT ontology
- Development of the required cross layer components required for the execution of INTER-LAYER, including the security and privacy components
- Scientific publication of papers of different components defined and developed within the project.
- Definition of the different connection interfaces in each layer to communicate with INTER-FW, and allow the access to the interoperability mechanisms.
- Setup the development infrastructure and environment (virtual servers, repositories, continuous integration, etc.…)
- Definition of marketable products in close work with WP8 exploitation and business models.
- Preparation of demonstrators for INTER-MW (eHealth and homecare) and AS2AS (port operations) components for the Geneva IoT Week 2017.

Obj3. Definition of a CASE-driven Engineering Methodology Driving the Application of the IoT Platform Interoperability Framework.

INTER-IoT will define a special-purpose, systematic methodology (INTER-METH) that will enable (semi)automation of application of the INTER-FW framework for making heterogeneous IoT platforms interoperate, and guide the process. To support application of INTER-METH, a CASE (Computer Aided Software Engineering) tool will be implemented. It will help automate each phase (analysis, design, implementation, deployment, test, maintenance) of the integration process, using the INTER-METH, providing guidelines, graphical facilities, engineering patterns, and project data repositories.

The actions taken to accomplish the third objective have been:

- Plan definition and organization of the Deliverable D5.1 document.
- State-of-the-art Analysis (SotA) about design patterns for integration in the IoT domain.
- Elicitation of micro (general-purpose and domain-specific) design patterns for IoT systems integration.
- Definition of INTER-Layer-oriented Design Patterns, which include design patterns supporting integration at each layer: device, networking, middleware, application services, data and semantics.
- Plan definition and organization of the Deliverable D5.2 document.
- SotA about general-purpose and IoT-specific methodologies for systems integration.
- Definition of the INTER-METH methodology and correlated process, which is organized in phases (Analysis, Design, Implementation, Deployment, Testing and Maintenance) and activities per phase. Specifically, this activity has been further split into: (a) Definition of the abstract methodology for IoT systems integration; (b) Instantiation of the abstract methodology specifically for INTER-IoT (which is an on-going activity): analysis, design, implementation and deployment phases are being defined.
- Plan definition and organization of the Deliverable D5.3 document.
- SotA about general-purpose and IoT-specific CASE tool for systems integration.
- Development of the CASE Tool supporting INTER-METH. Specifically, detailed design specifications of the CASE tool are being finalized.

Obj4. Design and Implementation of an Integrated Interoperable Open Platform for Transport and Logistics in Port Environments (INTER-LogP).

By using the INTER-FW framework (and the related tools and methodology), we will demonstrate the need for a system that allows the exchange of data and messages among the different actors of the port community. There are three main actors that have heterogeneous IoT platforms: the IoT platform deployed in the port premises for daily activity management, including operational and environmental monitoring; the SEAMS, an IoT platform at NOATUM container terminal based on WSO2; and the IoT platform of a haulier company, deployed in Azure cloud. INTER-LogP will be the result of using INTER-IoT in a specific application domain providing support among others to containers, trucks, environmental platforms, with the main goal to improve different indicators through a fully working interoperable platform.

The actions taken to accomplish the fourth objective have been:

- Interviews with stakeholders involved in port activities and systems in order to know their needs associated with IoT platforms and interoperability, the results have been included in D2.1.

- Gathering of the associated requirements from stakeholders, partners' expertise and IoT projects and associations (included in D2.3 v2) and a thorough review of the market watch (included in D2.1). Requirement were prioritized using the MOSCOW methodology.
- Definition of the scenarios in which test INTER-IoT and the use cases to develop it included in D2.4.
- Analysis of the laws and regulations in port domain that have to be considered included in D2.5.
- Analysis of the existing IoT platforms at Valencia Port and Noatum that will be used in INTER-LogP in WP6 pilot, and its potential adaptation to existing platforms, considering the different improvements performed by these entities since the project started.
- Adaptation and preparation of the required means and permissions to start deploying the pilot, already accomplished before M16.
- Pre-pilot testing of the software and submodules to minimize integration effort and rule out architectural errors.

Obj5. Design and Implementation of an Integrated Interoperable Open Platform for Mobile Health Monitoring (INTER-Health)

INTER-IoT will use the INTER-FW framework (and the related methodology and tools), in order to make interoperate two representative and heterogeneous IoT platforms: one developed for static remote health-care (health-care center-to-home) and one specifically focused on health monitoring in mobility (everywhere, anytime). The integrated open platform (INTER-Health), will support health monitoring at health-care center through the center facilities, at home through a set of medical consumer devices, and in mobility based on body sensor networks. In order to evaluate the integration from functional and non-functional perspectives, atop the interoperable platform, we will develop and deploy in a controlled medical testbed, a fully-working application use case, related to the lifestyle monitoring. The application use case will therefore have its own specific objectives to improve and overcome the currently available methods, instruments and protocols.

The actions taken to accomplish the fifth objective have been:

- Interviews with stakeholders involved in m-health environment in order to know their needs associated with IoT platforms and interoperability, the results have been included in D2.1-
- Gathering of the associated requirements from stakeholders, partners' expertise and IoT projects and associations (included in D2.3 v3) and a thorough review of the market watch (included in D2.1).
- Definition of the scenarios and use cases, analyzing different health status scenarios we could image possibilities in the implementation of technologies in the health care services in the public and in the private area, included in D2.4-
- Analysis of legal issues, definition of a research protocol for scientific and technical data, including preparation of informed consent and project information sheet. All previous material has been approved by the Bioethics Committee according with the national directive in Italy on Privacy Guarantee (DL 196/2003) and the European law for data protection and management of online data (REG. UE 2016/679) included in D2.5.
- Establishing links with potential end users and stakeholders, e.g. working closely with consultants in Acute Medicine and Elderly care in Doncaster UK covering remote review and triage of patients in residential, nursing homes, and prison environments.
- Management of the substitution of the eCare platform by UniversAAL open platform and analysis of the implications.

- Interaction with the Bioethics committee of ASLTO5 in order to get all the approvals for start deploying and executing the pilot.

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Obj6. Successful completion of field trials

The INTER-IoT developed pilots (Objectives 4 and 5) will be further evaluated in the two proposed application domains in: Nichelino (Turin) (IT) for m-health and Valencia (ES) for port transportation. Additionally, a cross-domain use case and associated field trial will be performed (see section 1.3.3.3) in order to proof extendibility and interoperability of platforms from different application domains. Moreover, the project will analyse the provided solutions from the perspective of relevant stakeholders by considering their specific benefits, requirements, and constrains, and involving stakeholders from other application domains in order to evaluate the extendibility of the results.

This objective is directly linked to the development of the pilots, explicitly WP6 and WP7. Although these two WP have not started yet, the consortium has been developing some actions in order to prepare the accomplishment of this sixth objective:

- The first steps have been taken to setup a test-system that will allow different scenario's to be tested. This test-system will be used to train with, and validate the implementation of the architecture before the actual INTER-LogP pilot of WP6. Several scenarios will be tested in advance to rule out bugs and architectural errors.
- Related to the INTER-LogP pilot, meetings have been continuous with Port Authority of Valencia, Noatum Container Terminal Valencia and hauliers companies, in order to confirm the ability of the integration and to analyze the existing sensor data to be used in the pilot. Adaptation to the evolution of systems and corresponding permissions in order to start working have been achieved.
- Different meetings have taken place in order to specify the use cases for the INTER-Health pilot, one in Turin (January 2017) and another one in Valencia during the 4th plenary meeting, some teleconferences and a lot of exchange of emails.
- Different equipment have been tested in order to be used in the trials, checking compatibility with the communications and components. Because of incompatible previous software by TI, Bluetooth drivers had to be adapted to the new hardware models.
- Also we have been working on the definition of the pilot plan with regarding to security and ethical issues, deployment, and training needs.
- Substitution of TI by SABIEN was seamless and UniversAAL is now part of the pilot architecture, substituting completely the work provided by TI.
- M19 has started with the definition of the integration plan.
- Open Call was successful and the third parties have started to develop their activity towards INTER-DOMAIN use case.

Obj7. Establishment of a New Cooperation and Business Framework

This objective aims at defining a cooperation and business framework among project partners to bring to market the results of the project, creating new and innovative business opportunities. The role of each partner will be defined, considering its capabilities. Cooperation will be defined in a common framework comprising technical and research aspects. A business and exploitation strategy will also be defined attending to market features and a framework for extending the technology to third parties and assuring long-term sustainability of project results.

The actions taken to accomplish the seventh objective have been:

- Stakeholders' analysis and Market watch included D2.1, and creation of a community of stakeholders that will be informed of the advances and results.
- Definition of individual business models following CANVAS model approach included in D2.2.
- Preliminary joint business model of the three first products INTER-LAYER, INTER-FW and INTER-METH (D2.2).
- Results from D2.2 have been reviewed and enlarged using the LLAVA matrix in D8.7a, a preliminary version of D8.7 suggested by the technical reviewers.
- Exploitation plan was updated in D8.3 v2 in M12, templates were updated and a clear exploitation strategy has been proposed and drafted in D8.5 and D8.7.
- Joint and individual exploitation templates provided and analysed by the different partners in the consortium.
- Definition of the different products that may come out as results from INTER-IoT and start of exploitation activities within the consortium.
- Cooperation in the framework of the different IoT-EPI task forces, especially TF4, and with other projects within the cluster.
- Analysis of Open Source strategy for the results of the project and the management of a potential developing community.
- Preliminary marketing strategy has been proposed in D8.7
- Interaction with open call selected third parties in terms of individual and joint exploitation activities.

8. Impact creation

Beside typical project dissemination activities in presenting and promoting the project approach and achieved results at various occasions (conferences, website, exhibitions, and workshops), the INTER-IoT project will perform several showcases including small demonstrations, to widely present the main project outcomes and to show concrete advantages of using INTER-IoT framework and methodology to stakeholders and potential clients. Furthermore, the project will establish an Advisory Board with key people from industry and academia. Exploitation and Business models are also means to strengthen impact and they will be goals of INTER-IoT.

The actions taken to accomplish the eighth objective have been:

- Scientific publications, more than 30 papers published or accepted in journals, magazine, book chapters and books.
- Organization of scientific events (i.e. workshops and conferences)
- Non-academic talks made in different fora related with IoT or the different application domains addressed in the proposal.
- Start of industrial dissemination activities (e.g. TRON 2016, SIDO 2017, IoT Week 2017) and some events already planned for the following period.
- Development of demos to be showcased in different events, already presented in IoT Week 2017.
- Web site set up and periodic update (D8.1)
- Leaflet and poster designed and available. (D8.2)
- Presence in social networks (LinkedIn, Facebook and Twitter), active distribution of information that will be enhanced through the gathering of target audiences.
- Organization of first IoT-EPI event in Valencia (June 2016) with more than 150 attendants.
- Supervision of different MSc and PhD Thesis, same already presented and other under development.

- Master and PhD courses, and lectures associated with INTER-IoT content and basics.
- Links with other projects: with members of the consortium (TT, ACTIVAGE or IoF2020) and without members of the consortium (OpenIoT and FIWARE)
- Advisory Board appointed with seven members European and non-European, IoT oriented and Application domain oriented, business oriented. Covering what was specified by the consortium.
- Preliminary business models and exploitation plans have been developed at individual and joint levels.
- D8.5 contains a review of all the activities performed to achieve impact.

Specific details about impact actions are available in section 3.

2.2 Follow-up of recommendations and comments from previous review(s)

2.2.1 Technical Review

R1. In light of the SW engineering challenges of the project, it should be considered to appoint an experienced Chief/Senior SW Architect, ideally to be recruited from an Industry partner.

Recommendation was addressed after the technical review. The consortium analyzed potential candidates from different non-academic entities within the consortium, and from the available expertise, experience and nature of the business Miguel Angel Llorente from P4-PRODEVELOP was considered the most adequate candidate to carry out the activity of Chief/Senior SW Architect. Hence he was appointed to this task after being selected in a poll by the partners in PMC telco of 29th November 2016.

R2. Risk management shall be strengthened. In particular, for next periodic report, precise mitigation actions shall be defined, with dates/responsibilities, and their implementation should be tracked, together with the trend of each risk. New risks shall be identified as necessary; as an example risk on exploitation with respect to open source strategy shall be addressed, with licensing policy to be put in place as a mitigation action, and a risk related to SW integration shall be added.

Risk management has been revisited and reoriented following the feedback provided by the technical experts at the technical review of the project held in Vienna (Austria) in October 2016, from the submitted version in June 2016. The criteria to classify and prioritize the risks have been updated and more practical risks have been introduced, following the principles recommended by the Project Management Body Of Knowledge (PMBOK®) of the Project Management Institute (PMI).

Frequent risk management meetings (1-month periodicity combined with PMC or standalone teleconferences) have been held in order to ensure tight control over the execution of the project. Each Work Package leader has been identifying and gathering risks for the specific Work Package, analyzing and measuring the impact, establishing management actions, assigning responsible managers, monitoring them, logging changes and closing them when they appear or disappear. Issues related to risk management have been held in the different plenary meetings: Valencia (January 2016), Cosenza (May 2016), Lancaster (September 2016), Ljubljana (February 2016) and Valencia (April 2016).

D1.3 was resubmitted on 31st January 2017 with a complete revision of the preliminary detected risks. D1.4 submitted on 30th June 2017 continued the analysis of the risks following the proposed methodology. The risk management document is a living document, managed online and it is updated in the worklog.

D1.4 was improved with the addition of a section of Ethical Risks as recommended by the Ethical Review received in January 2017. Most of the risks, which may appear during the execution of the project, are related with INTER-Health pilot, however can be extended for INTER-LogP and INTER-DOMAIN. As recommended we formed within the consortium an Ethical Advisory Board and appointed an External Ethical Advisor. All activities performed to achieve the pilot's objectives (e.g. health care related) are characterized by ethical behavior and the protection of the subject's privacy. Our goals for the pilots are the protection of the physical health and the improvement of people life quality, in accordance to the good clinical practice and the respect of human subjects (including assessment and management to ensure the safety of the participants, psychological burden, and stigmatization). For those reason the operator's behavior is aimed to respect the person dignity and privacy. Consequently the overall protection of subject's health data is a priority of that has been applied follow the European, Italian law (country where the INTER-Health pilot will be executed) and

Spanish law (country where INTER-LogP and INTER-DOMAIN pilots will be executed) on all matters related to Privacy. Our goal is concerned to manage properly the protection of individuals and communities, the collection, recording, organization, storage, consulting, development, modification, selection, extraction, comparison, use, interconnection, blocking, communication, dissemination, deletion and destruction of data, in a word, the treatment of the data, defining general procedures and special instructions for the operators. Criteria and methods used are also applied to activities carried out for the project INTER-IoT and they have been analyzed and specifically for INTER-Health have approved by the Bioethic Committee after the Request for authorization to the Health Director of Presidio Ospedaliero of Moncalieri (TO) to conduct the spontaneous observational study of cohort prospective called "Decentralized and Mobile Monitoring of Assisted Livings' Lifestyle" - M-Health Pilot in the European Project "Interoperability of Heterogeneous Platforms IoT- INTER-IoT " and the request for an opinion from the Ethics Committee for a spontaneous observational study of cohort prospective.

R3. Next time, detailed information is expected to be given on the volume of efforts assigned to OSSW community/ecosystem building and maintenance and to standardisation.

The PPR contains detailed information and effort devoted to OSSW and ecosystem building with regard to aspects such as standardization. During this first period the ecosystem building has been fostered by the open call and collaboration with IoT-EPI and Be-IoT CSA. Additionally participation of consortium members in IoT1 LSPs ACTIVAGE and IoF2020 has allowed to cross-disseminate and enlarge the INTER-IoT ecosystem.

Regarding standardization, the activity during the first half of the project has been devoted to track different initiatives, and in M19 INTER-IoT has participated in the IETF meeting in Prague[1] and in the ETSI meeting of a new working group Industry Specification Group on cross-sector Context Information Management (ISG CIM)[2], group that was created in March 2017. Additionally, preliminary contacts are on-going with the W3C Web of Things working group regarding semantics.

And with regard to OSSW, initial activity was internal in order to define the OSSW policy to be applied to the results. Outcomes have been reflected in D8.5 and D8.7a. INTER-IoT attended ECLIPSECON Europe and started preliminary contacts with the ECLIPSE Foundation. Additionally one of the open call winners (SENSINACT) has become an ECLIPSE project, so the visibility of INTER-IoT in this area will be substantially increased. On the other hand, activity in WSO2 community is ongoing.

Additionally ABC has been involved in a group related with the definition of an Open IoT Certification Mark[3]. The group has just started activity and in the area of interoperability it will be providing contributions in the second half of the project.

R4. For the foreseen larger OC call partner budgets, it should be tried to recruit more application experiments and thus to solicit additional end users for the project (even replication of the current application areas would be seen beneficial here).

The Open Call had been launched by the time of the technical review. The Grant Agreement specified the nature of the entities that could attend to it. The main goal was the validation of the INTER-IoT results. Stakeholders could attend the Open Call if they were SME, universities or

[1] https://www.ietf.org/meeting/99/
[2] https://portal.etsi.org/CIM
[3] https://iotmark.wordpress.com

research centers as indicated in the GA. This point was discussed with the Project Officer upon the reception of the review consolidated report.

Several of the open call third parties have provided new experiments that may allow the replication of INTER-IoT products, e.g. NEMERGENT proposes the use of INTER-IoT in emergency management scenarios.

A summary of the results of the Open Call is provided in the analysis of the WP1 outcomes during the project.

R5. Requirements engineering has to be quickly concluded by refining and prioritizing the gathered requirements mainly along the needs of the demonstrators to be deployed in the project's two application experiments' areas.

Requirements were reviewed in accordance with the recommendation from the experts. Stakeholders within the project, and actual responsible of the demonstrators supervised the process. A new prioritization component was included following the MOSCOW methodology and a new version of D2.3 was released (31st December 2016) with the corresponding changes.

R6. The requirements should also be made more concrete. It is therefore requested to deliver an updated version of D2.3 within 2 months.

Requirements were reviewed and made more concrete, following the recommendation. The raw information already gathered during the requirements analysis was re-processed, and the results were analyzed again by the consortium providing a more concrete orientation, with special contribution from the stakeholders. Individual meetings with some of the Advisory Board members helped to refine the requirements. As a result a new version of D2.3 was released on 31st December 2016.

Each technical work package (WP3, WP4 and WP5) made a review of its requirements at the beginning of the WP, currently in M19 WP6 related with integration has started its activity with a review of the requirements analyzed during WP2 activity. Description of the activity carried out during WP2 execution is provided in the detailed description of WP2.

R7. For the D2D gateway, information on its baseline and the envisaged delta/innovation ("what and who") should be provided (as for other arbitrary artefacts of the project's technology baseline).

Detailed information about the different developments and participating entities in the project and the delta regarding the existing components has been gathered, as requested, and is provided in this PPR (WP3 description activity and contribution of the different partners to every software artifact) and, upon request, will be clarified to the necessary extent, during the review meeting.

R8. Final versions of the project's architectural considerations need to be devised from the consolidated and prioritized list of requirements.

Preliminary version of the architecture and of the reference model has been provided in D4.1. The submission of the deliverable was delayed 15 days after agreement from the PO in order to accommodate this recommendation to the deliverable. The consortium decided that although the reviewers indicated that the final version of the architecture needs to be devised from the consolidated and prioritized list of requirements, to provide the relationship with them already in the intermediate architecture version. The delay was needed in order to complete the new version of D2.3 including the reviewed version of requirements considering prioritization.

The final version of the architecture will be consolidated in D4.2 in M24 of the project (as planned in the project schedule), and will be devised from the continuously checked requirements of the project.

By that time, initial input from the development of the pilots (WP6) will be used to reevaluate the requirements and this (updated/refined) list of requirements will be used in the final architecture.

The architecture is not only related with activity in WP4 but in WP3, and deliverable D3.1 (M12) and D3.2 (M21) have been refined with the new consolidated and prioritized list of requirements done in D2.3.

R9. Since so far the technical deliverables do not stick to a classical engineering documents plan (i.e., requirements specification, design, interfaces' control documents, integration/validation plan/procedure/ report, etc.) allowing to keep developments under control, it is strongly recommended to introduce a more rigorous SW& System engineering process for the project.

Several actions have been carried out in order to follow a systematic software engineering approach applicable to the whole project and the different modules being developed. The technical coordination of the project (lead by the STPM and the newly appointed Chief Software Architect) has made compatible a degree of flexibility in the specification and coordination of the development of each submodule (in particular, each interoperability layer, the three main components of INTER-FW and the CASE tool), with a solid methodology to document and plan the different developments, reducing risks and allowing an appropriate control of the intermediate milestones of each development. To make this possible, the following list of measures and actions have been performed:

- Unification and reinterpretation of user requirements, according to R6.
- Elaboration of a single space for developers in the project Intranet. Including style guides, common resources, quality standards, etc. Accordingly, a set of software development support tools were deployed and made available to all the development modules: git for version control and documentation, Jenkins for integration, SonarQube for software quality assessment, Dockerhub for containers management, Maven for modules and dependencies management.
- Transformation of requirements and scenarios in a list of use cases for each software module. (D2.3, D2.4, D3.1, D4.3, D5.3)
- Analysis of the interaction with INTER-IoT users, including, at least the analysis of the front-end and UX for the main GUI of the project (Webapp for the INTER-FW).
- Design phase, including at least:
    - Design of sequence diagrams for the use cases, considering normal and failing scenarios. (D3.1, D4.3, D3.2, D5.3).
    - Design of interfaces and APIs for each interoperability layer and for the INTER-API to be used as the interface point with INTER-IoT integrators.
    - Design of Graphical User Interface (GUI) of the Web application to be used by INTER-IoT users, through the INTER-FW.
    - Specification of backend of the systems including UML Class diagrams and modular architecture for all the systems. (D3.1, D4.3, D3.2).
    - Design of Graphical User Interface (GUI) of the Web application to be used by INTER-IoT integrators, through the INTER-CASE (according to the INTER-METH methodology).
- Setting up a methodology for the parallel development of the layers, based on an Agile approach, where each iteration aims at complete sets of features related to the identified use cases.
- Elaboration of the integration, validation and test plans. (D6.1)

The combination of Agile approaches -to manage intra-tasks development- and plan-and-document for the general documentation and overall alignment of the different modules present advantages such as the independence of the development teams to address the different challenges and, at the same time, being coordinated with the milestones of the project and common goals.

R10. Apart from the related scientific communities the project should address with the same degree the corresponding industrial realm

Since the start of the project, the consortium planned to address industrial communities, in three different axes:

- Port related entities and stakeholders through VPF, NPV, AFT and PRO.
- Health related environments through ASLTO5, RINI and TI (UPV-SABIEN after TI withdrawal)[4].
- IoT related entities, mainly through industry partners TI, PRO, RINI, X-LAB and ABC, but also through universities and research centers.

During the first half of the project we have addressed the industrial realm in different events, mainly with stakeholders (e.g. Port Authorities meetings in Spain) or existing customers but also in industry oriented events like SIDO 2017[5] and in E-World at Essen[6]. Although the technical results were not complete to be properly shown, the feedback gathered in these events helped us to fine-tune adequately the different products and innovations coming out from the project.

Regarding the m-Health application domain we have defined several potential scenarios, for impact creation and next pilot development according to the real Health stakeholder requirements and support. Through local event and scientific dissemination we are involving all citizens, cultural and sportive associations, municipalities and even family doctors, so we are reaching the Public Health System to demonstrate the effectiveness of the experimental introduction of IoT such as instrument of prevention. The introduction of new technologies in the Public Health Service can be also an example for use by other public or private-state actors to improve and enhance the health of the populations about territory reference.

As Industry is obviously more interested in working modules than concepts to be developed, presentations to the industrial realm will be more product oriented during the second half of the project as soon as different prototypes will be available. First presentation of running prototypes was performed in June 2017 at Geneva during the IoT Week, and was well-received by the visitors.

To have a better reach of our target customer base, we did run a survey among different stakeholders involved in the market watch of D2.1 in order to understand the most adequate venues to participate and disseminate the results. The venues and industrial communities have already been selected and different events like TOC Amsterdam[7], TRA 2018[8], SIL2018[9] or IoT World Congress[10] will have the participation of INTER-IoT in order to present the results.

Our work in this domain has been complemented by the suggestions from the Advisory Board members, coming mainly from industry. The AB provided feedback that was highly adequate to identify the main INTER-IoT products and different exploitation aspects.

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[4] TI promoted INTER-IoT until they withdrawn from the project on 31st December 2016.
[5] http://www.sido-event.com
[6] https://www.e-world-essen.com
[7] https://www.tocevents-europe.com/
[8] http://www.traconference.eu/
[9] http://www.silbcn.com/
[10] http://www.iotsworldcongress.com/

R11. As no further delivery of D2.2 is planned to address the business and exploitation aspects, this latter being addressed only by D8.7 from Task T8.4, coming very late (at M30), the reviewers perceive a risk about an insufficient exploitation planning of the project results. It is therefore recommended to deliver an intermediate version of D8.7 at some point at M18, as these common and individual exploitation plans are planned to be available in a preliminary version at this date. Additionally, the corresponding templates given in D8.3 should be revised within a month.

D2.2 provided the initial business plans of the consortium partners, and D8.7 contains the exploitation and marketing strategy of the consortium. As requested by the reviewers, the INTER-IoT consortium delivered an intermediate version of D8.7, named D8.7a on 30th June 2016, in which aspects regarding identification of products, exploitation strategy, preliminary marketing strategy and competitors' analysis. All of these have been following the LLAVA methodology that completed the CANVAS model provided in D2.2 and adding information regarding exploitation of results.

Templates for individual and global exploitation plans were reviewed following comments and recommendations from the technical experts and added to D8.3 corresponding annex and exploitation plan on 30th April 2016 and a revised version on 31st December 2016. The filled templates were added to the analysis of D8.7a. Additionally, open call third parties that had their initial review in May 2017 provided the templates filled in order to contribute with their individual and joint exploitation plans.

R12. The limitations of the business Canvas should be addressed while leaving the more theoretical character of the current business modelling/planning considerations and turning them into concrete and pragmatic ones in the next phases of the project, based on concrete (technical) project results to emerge in future; [recommendation to be implemented within D8.7 intermediate version above].

To address the recommendation from the reviewers, we followed a complementary approach to the CANVAS business model, named the LLAVA matrix. The use of this methodology that will be completed in the final version of the deliverable contemplates the different drawbacks and missing components of the CANVAS business model (e.g. competitors' analysis).

Additionally, interaction with stakeholders, has allowed the consortium to identify more specific commercialization products. The Advisory Board members have also collaborated in this area of the project has produced different demonstrable results that have already been presented in different environments (e.g. three demos in IoT Week).

R13. Exploitation planning in the project's m-health sector need to take account of the certification issues relevant for commercializing IT artefacts in the medical area.

Certification issues are key for the medical sector. RINICOM and the new partner that has substituted TI after its withdrawal (UPV-SABIEN) have expertise in the medical sector and in aspects related with certification. Regarding this, D8.7a preliminary addresses certification in the medical area and it will be considered in the final products.

Likewise, the INTER-Health pilot has been subjected to an ethical board examination in Italy, according to the article 6 of Legislative Decree 24 June 2003, no. 211 to carry out clinical trials is mandatory to request authorization to the Ethics Committee. ASLTO5 on 9th July had the favorable opinion to perform the study by the Ethical Committee of the A. O. U. San Luigi Gonzaga of Orbassano (TO). To have the opinion the Bioethics Committee needs all the information regards: Privacy and Security management, sensitive data, Data Controller, Data Processor, Eternal Data Processor, information sheet, informed consent, data collection folder, research protocol, CE Devices and datasheets (provided by technical partner), European project financial documents. Additionally, Ethical Clearance for controlled testing in South Manchester University Hospital has been obtained, for the potential extension of INTER-Health pilot results in other stakeholders that currently are customers of members of the consortium.

D6.1 related with integration will discuss certification issues regarding INTER-Health pilot, although it will be analyzed with more detail during the execution of T6.3. RINI has attended a dedicated course on CE marking of medical devices and all the documentation for the certification of potential results will be planned during the execution of the pilot and all the developed work will be in agreement with the processes and patterns associated with CE marking, however it has to be considered that the long process to obtain CE marking will continue after the end of the project.

R14. For the OS SW route planned to be taken (not only) for the D2D gateway, it may be reasonable to e. g, team-up with the Eclipse foundation to achieve momentum and visibility.

The consortium revisited OS SW strategy after the technical review, and the visited roadmap for whole INTER-IoT produced software was included in D8.5 and D8.7a. This strategy is subject to be reviewed and improved depending on the evolution of the project and different teaming schemes with other initiatives.

Till now, INTER-IoT participated in ECLIPSECON and started some contacts with the ECLIPSE Foundation, first step was the change of the license model to Apache 2.0 (to be used by the whole project), which is more adequate for teaming with different OS SW initiatives. Additionally, two Eclipse projects won the open call, one related with the OM2M initiative (as participant and user) and another related with the SENSINACT initiative, already started in January (as coordinator). These two contributions together with other small participations related with OS SW initiative, and the participations of the consortium are going to provide enhanced visibility to INTER-IoT.

Additionally in Geneva during the IoT-Week (June 2017) a joint meeting IoT-EPI projects and IoT-LSP projects, introduced the possibility of using OS SW developments from projects in LSP. Some initial contacts have been made with ACTIVAGE, IoF2020 and SYNCHRONICITY. The use of IoT-EPI developed software in Large Scale scenarios may provide enhanced visibility.

2.2.2 Ethics and Security

As requested by the Ethical Review, this section addresses the recommendations, reactions and proposed solutions to the ethical points raised in the assessment. The description of the responses to the different recommendations include technical details about their fulfilment. Section has been named Ethics and Security as it includes aspects related with both aspects and both are relevant to the project.

R1. An Ethics Advisory Board and an external Ethics Advisor are appointed by M15 to monitor, guide and counsel the variety of ethical issues at stake with the project activities and their results.

After several discussions with the Project Officer in order to address the recommendation, it was agreed the Ethics Advisory Board was composed by the key members of the INTER-HEALTH use case (ASLTO5, UniCal, SABIEN-UPV) as it is the most critical; the responsible of the INTER-LogP use case (VPF) because as indicated by the Ethical Reviewer some scenarios in this pilot may have ethical implications; and the Project Coordinator in order to link ethical decisions and strategy with the execution of the project.

The Ethics Advisory Board is composed by: Anna Costa (ASLTO5), Gianluca Aloi (UniCal), Vicente Traver (SABIEN-UPV), Luisa Escamilla (VPF) and Carlos E. Palau (UPV). Due to the large expertise in the medical sector and as an SME related with the pilot Eric Carlson (RINI) has been included as observer.

The recommendation included the appointment of an external Ethics Advisor, after different discussions and invitations submitted to different potential participants, the Ethics Advisory Board appointed Dr. Maurizia Rinaldi, with large expertise in Ethics assessment related with medical trials.

The Ethics Advisory Board was appointed during the PCC meeting of 15th February (M14) meeting the deadline proposed by the Ethics Reviewer. The Ethics Advisory Board has reviewed the deliverables produced since then (D8.5, D8.7a and D1.4), and has included a section of Ethical Risks as required in Risk Management and Analysis and Deliverable D1.4. Additionally, the Ethics Advisory Board has managed to deliver the different documentation to ASLTO5 Bio-Ethics Committee in order to get the approval for the development of the trials.

R2. An "ethics and security" section is included in the next annual management report (D1.6) providing the following information or documents:

The Ethics and Security section has been included in the PPR / D1.6 and current section (2.2.2) provides response to the review.

- ***R2.1 Additional descriptions are needed to describe the Consortium policies and procedures to protect the rights human subjects in the foreseen pilots:***

The following sections address the individual requests associated with the consortium policies and procedures related with the use of data in the INTER-IoT pilots.

A definitive list of *all* the types and formats of personal data that the project will generate/collect from pilot human subjects. The list should be definitive and include data sources integrated as a result of the Open Call.

In accordance with the standard medical protocols for the obesity prevention and global management[11][12] drawn up by the WHO, to assess the health status (underweight, normal-weight, overweight, obesity) of a subject (of a certain age). During a visit to an outpatient objective measurements (weight, height, BMI, blood pressure and waist circumference) and subjective ones (eating habits and physical activity practice) are collected.

Physical activity, as well as eating habits is a subjective measure and is usually detected by instruments such as frequency questionnaires. Today the technology provides the ability to measure objectively physical activity practiced through wearable devices furniture, items falling into the network of the Internet of Things (IoT).

To develop the INTER-HEALTH pilot the selected subjects will be divided in two group: a Control Group – CG (that will perform the Traditional Nutritional Counseling) and Experimental Group –EG (that will perform the Experimental Nutritional Counseling).

During Nutritional Counseling (First nutritional counseling and Subsequent Checks) at the Nutrition Outpatient both for the Control Group's subjects and the Experimental Group's subjects will carry out detections of both objective and subjective data that will be charged by healthcare operators in the Computerized Nutrition Folder that is off-line. Collected data will be the following:

- Objective data:
  - Personal data (name, surname, gender, age, address);
  - Personal data (civil status, educational level, social and economic status);
  - Anthropometric data (weight, height, Body Mass Index -BMI, blood pressure, waist circumference)

[11] World Health Organization. Obesity: Preventing and Managing the Global Epidemic. WHO Obesity Technical Report Series 894. Geneva, Switzerland: World Health Organization; 2000.
[12] World Health Organization. Physical Status: The Use and Interpretation of Anthropometry. Technical Report Series 854. Geneva, Switzerland: World Health Organization; 1995.

  - Hematochemical data (blood glucose, blood insulin, hemoglobin, glycated hemoglobin, cholesterol level, HDL, LDL, blood triglyceride, blood nitrogen, AST, ALT, GGT, blood creatine, urea, blood urea, blood albumin, prealbuminemia, TSH, T3, T4, erythrocyte sedimentation rate).
- Subjective data:
  - Food anamnesis (breakfast, main meals, vegetables consumption, fruit consumption frequency, red and / or white meat consumption frequency, processed meat consumption frequency, egg consumption frequency, cheese consumption frequency, fish Consumption frequency, legumes consumption frequency, bread and pasta and substitutes consumption frequency, dry fruit consumption frequency, oil consumption frequency, animal fats consumption frequency, salt consumption frequency, herbs and spices consumption frequency, sugar And / or honey consumption frequency, sweetening consumption frequency, sweet consumption frequency, water consumption frequency, alcohol consumption frequency, sugary drink consumption frequency)
  - Physical activity practice (daily physical activity, organized physical activity).

In particular the EG subjects will be provided in a gratuitous way for all the duration of the study, of a kit of electromedical devices (weight scale, sphygmomanometer and bracelet for physical activity) and an application for detecting the measurements from the kit Devices and online compilation of a questionnaire on eating habits and the physical activity practice, for decentralized monitoring of their lifestyles at their homes and mobility.

Using devices such as weight scale, sphygmomanometer and physical activity bracelet will be detected the objective measurements with this frequency:

- **Weight** with weekly frequency;
- **Blood pressure**, only for subjects who at the first nutritional counseling (t0) at Nutritional Outpatients exhibit Normal-High pressure values (systolic pressure ≥130 and / or diastolic pressure ≥85) with daily frequency, morning and evening;
- **Physical activity** (number of steps and duration of physical activity practiced) with daily frequency.

In particular, the EG subjects for physical activity will be used as an indicator the steps number and the duration of physical activity recorded by mobile wearable devices, referring respectively to the 10,000 steps to be taken daily and to 150 minutes of physical activity to be performed weekly

With the online questionnaire on eating habits and the physical activity practice, the "subjective measures" will be taken with the following frequency. **Eating habits** and the **physical activity practice** with biweekly frequency.

In INTER-LogP pilot, sensors and devices attached to port infrastructures, cameras, machines, cranes, containers, trucks and other vehicles will provide most of the monitored data. Some scenarios in the pilot foresee also the use of wearable devices, mainly smart phones, to support logistics and transport operations as well as to enhance security and safety measures.

The recording of images and the use of other devices in the port area can potentially capture human-related data. Compliance of the ISPS code and other security measures can even need the storage of human-provided-data and even biometric data (i.e. fingerprints, face recognition parameters). The ISPS (International Ship Port Security) code is an amendment to the Safety of Life at Sea (SOLAS) Convention (1974/1988) on minimum security arrangements for ships, ports and government agencies. This code came into force in 2004 and it prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to "detect security threats and take preventative measures against security incidents affecting ships or port facilities used in international trade"[13]. Port Authorities and port operators duly inform the people accessing to the port protected area that they are entering in a surveilled area where they can be recorded or other data about them can be captured or requested for the compliance of ISPS and security protection. The information given to the people also includes the mentions to the applicable legislations and what are their rights under these circumstances.

Although the port authority and port operators can be managing human-related-data and human-provided-data, the personal data registered by these entities will not be considered necessary for the execution of the pilot. When it will come to evaluate different scenarios where people is involved, data considered in Inter-LogP will only include the identifiers of the devices carried by the people (i.e. mobile phone number) but it will not be able to retrieve the human identity from the pilot data and the disclosure of any other human-related or human-provided data to these entities. In conclusion, the data handled by the pilot for the experimentation and evaluation will not disclose any personal data registered on the systems of the companies and authorities as they need to respect the regulations regarding personal data protection.

In the case that any scenario in the pilot introduce sensors on equipment, cranes or vehicles able to geolocate these assets and the workers using these assets, the people that will use these assets will be also duly informed about the recording of such information, the mentions to applicable legislation on personal data protection and the rights these workers have for the access, rectification, cancellation and opposition in front of the capture of this data.

Additionally, in those scenarios where it is planned to use data coming from wearable devices owned by a person, it will be always requested and registered the consent of the person to use the data captured by the device. The person will also be informed about the nature of the data shared. In some scenarios of the pilot the data shared will be the name and person identification document number, the mobile phone and the e-mail, its geographic location when they are in certain areas, the distance/time to destination or the speed. This data will not be transmitted and recorded unless the person gives its consent. This person will be able to deny the consent to use his data in the pilot at any time and existing data will be deleted. Data collected from personal wearable devices during the pilot will be anonymized after the finalization of the pilot.

Regarding INTER-DOMAIN, which will be the result of the integration of the open call third parties collaborations and the existing INTER-IoT pilots, no proposal coming from the Open Call will provide any data set from humans in the INTER-HEALTH pilot. The only exception is collaboration from University of Twente (Interoperable Situation-Aware IoT-Based Early Warning System) that plans to address the emergency scenario, in which data traces from potential victims of an accident will be monitored. In this case the data sets will be related with those used in INTER-HEALTH pilot and will be managed in the same way as the data sets produced in INTER-HEALTH:

- Objective data:
  - Personal data (name, surname, gender, age, address);
  - Anthropometric data (weight, height, blood pressure)
- Subjective data:
  - Potential injuries during the emergency event
  - Activity developed by the subject at the time of the emergency
  - Medical track of the individual

However, as the emergency event will be a simulated situation, the selected subjects will provide their consent and the data will be anonymized INTER-IoT servers.

Description of all the means of collection of personal data (i.e. actual technologies used – medical and tracking devices, etc.)

[13] ISPS Code, Part A

The technologies to be used in the collection of personal data in the INTER-HEALTH pilot, have been approved by the Bio Ethics Committee of ASLTO5. The specific devices and their models have been provided in the report that is available for review. The actual technologies used:

- Software of Health Operator (Computerized Nutritional Folder of Nutritional Counseling);
- Weight Scale;
- Sfigmomanometer;
- Bracelet for physical activity;
- Online questionnaire for eating habit and physical activity practice;
- The program installed on the subject's smartphones to detect the "objective measures" sent by the devices: weight scales, sphygmomanometer and bracelet for physical activity and the "subjective measures" of the online questionnaire on eating habits and physical activity practice;
- Server provided by UPV-SABIEN, installed on ASL TO5 organization network, in order to fulfill the requirements specified by the Bio Ethics Committee, the architecture of the data gathering process has been centered in order to provide privacy and full control of the gathered data.

Additionally the research personnel responsible for such collection in the INTER-HEALTH pilot, will be attached to ASLTO5 partner:

- **Project Manager:**
  - Dott.ssa Margherita Gulino SCIAN ASLTO5
- **Collaborators:**
  - Dott.ssa Monica Minutolo SCIAN ASLTO5
  - Dott.ssa Ilaria De Luca SCIAN ASLTO5
  - Dott.ssa Anna Costa SCIAN ASLTO5
  - Dott.ssa Marina Mortara SCIAN ASLTO5
  - Dott.ssa Elisa Strona SCIAN ASLTO5
  - Dott.ssa Fortunata Maio SCIAN ASLTO5

On the other hand, in order to carry out the pilot, personnel from UPV-SABIEN and UniCal will be in contact with the data but not with the whole gathering process that will be performed entirely by ASLTO5.

Regarding INTER-LogP, the collection of personal data will be mainly associated by GNSS systems for the geolocation of vehicles, other equipment and wearable devices that can potentially identify also the geolocation of the people using these devices. It will also include a server controlled by Valenciaport Foundation that could manage basic user data (name, identification, phone and e-mail) and the consent on using and recording geolocation data coming from users' wearable devices for the experimentation.

The research personnel for the collection of personal data in INTER-LogP will be attached to Valenciaport Foundation partner:

- **Project Manager:**
  - Miguel Llop. Valenciaport Foundation
- **Collaborators**
  - Luisa Escamilla. Valenciaport Foundation.
  - Pablo Gimenez. Valenciaport Foundation.
  - Jordi Arjona. Valenciaport Foundation

On the other hand, in order to carry out the pilot, personnel from UPV, Prodevelop and Noatum will be in contact with the data for the conduction of the pilot, the experimentation and the evaluation. However, the management of the consents with the people and organizations participating in the pilot will be gathered by Valenciaport Foundation.

Description of pilot participants with definitions of inclusion and exclusion criteria.

INTER-HEALTH pilot will last about one year. The deployment will begin in October 2017 and envisages the recruitment of approximately 200 healthy subjects. Different inclusion and exclusion criteria have been defined in order to obtain a more accurate results, and have followed the stated requirements for clinical trials by the ASLTO5 Bio Ethics Committee:

- Inclusion criteria:
    - Healthy subjects with age> = 18 years;
    - Healthy subjects who have the opportunity to continue their outpatient training for at least 1 year.
- Exclusion criteria:
    - Subjects with Food Behavioral Disorders;
    - Subjects with serious psychiatric disorders that alter the relationship with reality;
    - Subjects with cardiovascular disease, tumors, diabetes and hypertension;
    - Subjects who require a single appointment to have a dietetic scheme or food advice.

Subjects considered eligible will be included in the non-invasive and health risk-free study developed in INTER-IoT. This is an Observational Study, so the recruited subjects considered eligible will be divided into two Groups based on the presence or absence of a "Technological Prerequisite", that is to have an Android smartphone with the ability to use that technology. For the purposes of experimentation, the absence of the "Technological Prerequisite " determines the inclusion of the subject in the Control Group (CG) represented by all subjects submitted only to Traditional Nutritional Counseling (Nutritional Counseling at the Nutritional Outpatient), while the presence of such "Technological Prerequisite" determines the insertion of the subject into the Experimental Group (EG) represented instead by subjects undergoing Experimental Nutritional Counseling (Nutritional Counseling in Nutritional Outpatient and Decentralized and Mobility Monitoring Lifestyles).

For INTER-LogP and INTER-DOMAIN monitoring of people will not be performed in a continuous basis, e.g. emergency use case in the case of INTER-DOMAIN. The restrictions for potential participants in INTER-DOMAIN are directly related to port and transport workers, so the inclusion criteria is the following:

- Inclusion criteria:
    - Subjects with age> = 18 years;
    - Port agents' workers with legal employment contract in force.
    - Transport workers with legal employment contract or license in force.
- Exclusion criteria:
    - Port visitors.

Potential benefits, risks or discomfort for human participants involved in research activities

The project has not identified any research-related risks or discomfort involved for the human participants. On the other hand we have identified different preliminary benefits that will be extended during the execution of the project:

- Centralization of data from different sources, i.e. data gathered by in-home devices and from medical devices at ASLTO5 premises.
- Reduction in the time consumed by the human participants in moving from their homes to the doctors premises.
- Reduction of CO_2 footprint, as less public or private transportation will be used to attend periodically to ASLTO5 premises.
- Analysis of different living patterns that may improve quality of life of the human participants from the non-intrusive data gathering.

Recruitment and rejection/drop out strategies

Recruiting and rejection/drop processes have been clarified on request by the Bio Ethics Committee from ASLTO5. For recruiting subjects, ASLTO5 has organized health days to promote proper lifestyles (promoting proper nutrition and physical activity practice) during which it has performed the presentation of the INTER-IoT project and mobile health use case, through the use of informational material and the distribution of leaflets and posters. The brochures and leaflets distribution about the health use case was also done through family doctors and other stakeholder (Municipality, sports and cultural associations).

Below is the list of local events organized on the ASL TO5 territory for recruitment:

- 28-29 May 2016 “Re e regine di cuochi” at “Palazzina di caccia di Stupinigi”.- Population Involvment;
- 25 June 2016 “Giornata della salute” Piobesi T.se. - Population Involvment;;
- 27 Agoust 2016 “Giornata del Benessere 360°” Carmagnola.- Population Involvement;
- 25 September 2016 “Sagra del pane” Piobesi T.se.- Population Involvement;;
- 2 October 2016 “Festa dello sport” Nichelino –involvement of the Sports Department of Nichelino Municipality, of various sport associations and the population;
- 10 October 2016 “Campagna Obesity day” Nichelino, Moncalieri, Carmagnola, Chieri. - Population Involvment;;
- 12 October 2016 “Il bugiardino di fata Zucchina” recording interview with Renata Cantamessa
- 20 November 2016 “Giornata della salute” Piobesi T.se. - Population Involvment;
- 20 May 2017 “Giornata della salute” Piobesi T.se. - Population Involvment;
- 21 May 2017 “Lions Ten” Footrace Santena – Poirino (TO)
- 4 June 2017 “Giornata di prevenzione della salute” Castelnuovo Don Bosco (AT)

The strategies performed to act on drop out concerned:

- Informatics technology used in Mobile Health Pilot has been designed to stimulate the motivation of recruited subjects and thus to reduce drop-out, in fact, through the use of a "Prevention Program", which, as a calendar, helps the subject to remind the measurements type and frequency (Weighting once a week, blood pressure detection for border-line subjects in the morning and evening, detection of daily physical activity, detection of eating habits And physical activity practice twice a month). This technology aid serves precisely to avoid the distraction that may be due to the abandonment of the study as documented in scientific literature[14].
- Direct telephone call of the subject recruited by the ASL TO5 health operator, after reception of “alert”, which indicate worsening of objective or subjective measurements during decentralized and mobility monitoring of lifestyles through the Computerized Nutritional Folder. This intervention can also be a motivation for recruited the subject to not abound the study as documented by scientific literature[215].
- The informatics technology used in Mobile Health Pilot has been designed to stimulate the motivation of recruited subjects and therefore to reduce drop-out, in fact, by sending alert and / or motivational messages directly to the smartphone of the subject recruited according to the Values measured by the devices during home measurements and the results obtained

[14] Mukund Bahadur KC, Murrayb PJ: Cell Phone Short Messaging Service (SMS) for HIV/AIDS in South Africa: A literature review. Stud Health Technol Inform 2010, 160:530-534.

[15] Reynolds NR, Testa MA, Su M, Chesney MA, Neidig JL, Frank I, Smith S, Ickovics J, Robbins GK: Telephone support to improve antiretroviral medication adherence: a multisite, randomized controlled trial. J Acquir Immune Defic Syndr 2008, 47:62-68.

from the evaluation of the devices themselves and by the operator. This technology aid serves to reduce the drop-out rate of recruited subjects as documented in the literature.[16][17]

In particular for weight detection with the scale by the subject recruited in the experimental group, weighing is evaluated every 4 weeks: if the weight increases, the alert should start with the subject via notification message and the healthcare operator Is alerted by displaying the value in the Computerized Nutritional Folder; If the weight decreases it must start the "motivational message" only to the subject via notification message:

- Alert to the subject: "Beware, your weight has increased! Improve your lifestyle".
- Motivational message to the subject: "Congratulations, you are losing weight! Continue like this".
- Alert to the operator: "Patient code - Alert weight" that contact by phone call the person to give advice.

For the detection of blood pressure with the sphygmomanometer by the subject recruited in the experimental group, the progress is evaluated every 7 days: if the subject's blood pressure increases, the healthcare operator is alerted by displaying the value in the Computerized Nutritional with "Patient Code - Pressure Alert" which contacts both the subject and the family doctor to provide advice.

In order to detect physical activity with the bracelet by the subject recruited in the experimental group in the evaluation of the "steps number", the following alert or motivational messages should be sent to the subjects via notification message:

- 0-4999 → "Beware, you're sedentary, move more!"
- 5000-7499 → "Your level of physical activity is low and take advantage of every opportunity to move!"
- 7500-9999 → "Congratulations! You just have a little effort to reach the recommended physical activity level!"
- 10000-12499 → "Great! Continue to Keep You Alive"
- ≥ 12500 → "Great! Continue to Keep You Alive"

If the steps number taken are 0-4999, the alert must also be sent to the operator who is warned by displaying the value in the Computerized Nutritional Folder with the words "Patient Code -" Alert steps "that contact the by phone call the person for advice. In assessing the "duration" of physical activity, if the sum of the duration of physical activity every 7 days is:

- <150 min / week. → alert to the subject "The physical activity you are doing is not enough yet.
- → operator alert "Patient Code - Duration Physical Activity Alert" which contact by telephone the person to give advice.
- ≥ 150 min/week. → Motivational message to the subject "Congratulations, keep moving so!"

For the detection of the eating habits and physical activity practice through the online questionnaire from the subject recruited in the experimental group, for the correct and / or incorrect eating habits

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[16] Dunbar PJ, Madigan D, Grohskopf LA, Revere D, Woodward J, Minstrell J, Frick PA, Simoni JM, Hooton TM: A two-way messaging system to enhance antiretroviral adherence. J Am Med Inform Assoc 2003, 10:11-15.

[17] Lawrence Mbuagbaw, Lahana Thabane, Pierre Ongolo-Zogo, Richard T Lester, Edward Mills, Jimmy Volmink, David Yondo, Marie José Essi, Renée-Cecile Bonono-Momnougui, Robert Mba, Jean Serge Ndongo, Francois C Nkoa, Henri Atangana Ondoa. The cameroon mobile phone sms (CAMPS) trial: a protocol for a randomized controlled trial of mobile phone text messaging versus usual care for improving adherence to highly active anti-retroviral therapy. Mbuagbaw et al. Trials 2011, 12:5. http://www.trialsjournal.com/content/12/1/5.

and physical activity practice will start the "motivational message" only to the subject via notification message. While in the face of eating habits and physical activity practice totally incorrect there will be the alert to the health operator who is alerted by displaying the value in the Computerized Nutritional Folder that contact the subject by phone personally for advice.

Outcome and evaluation measures

The indicators used in the study to evaluate the effectiveness of the Experimental Nutritional Counseling instead of the Traditional Nutritional Counseling are:

- **Body Mass Index** (BMI); is an objective measure that allows to assess the health state of subjects (underweight, normal weight, overweight, Level 1, Level 2 and 3rd level obesity), allowing to make the diagnosis of overweight and obesity. This indicator can be used to monitor over time the health status of individuals assisted at the NO; so can allow the medical staff to verify, during the cheks, if this health status is maintained, improved or worsened. The effectiveness of the experiment can be measured by evaluating whether the treatment received by the group of persons assisted with Experimental Nutritional Counseling (Experimental Group) compared to the one received by the group of persons assisted with the traditional nutritional counseling (control group) produced greater number of "successes". Considering "Success":
  - In normal weight, maintaining weight at 6 months, in the period from the visit to the next control that takes place six months after the visit;
  - In overweight patients, a decrease in six months by at least 5% of the BMI in the period following the Visit to the next control that takes place six months after the visit;
  - In 1st level and 2nd level obese patients, a decrease in 12 months at least 5% of the BMI in the period following the Visit to the next control that takes place 12 months after the visit;
  - In 3rd level obese patients, a decrease in 12 months at least 10% of BMI in the period following the Visit to the next control that takes place 12 months after the visit.
- **Waist Circumference**, is another method to diagnose overweight and obesity, values greater than 94 cm in men and 80 cm in women are considered high risk factor level to develop cardiovascular diseases. This indicator can be used to monitor over time the health status of individuals assisted at the Nutritional Outpatient
- **BMI and CV related chronic risk pathology**: The correlation between BMI and CV gives us a greater indication of the subject's health and in particular about the risk factors associated with overweight and obesity such as: type 2 diabetes, hypertension, illnesses Cardiovascular, and stroke.
- **The detection by the health operator of the physical activity practice** reported by the subject during the visit to the Nutritional Outpatient, is a subjective measure, which is a lifestyle that when it is not correct (physical inactivity) becomes a common risk factor at the basis of major chronic diseases. So the amount (hours / daily and hours / week) and the type of physical activity practiced (no type of activity; light activity, moderate and intense) related to the subject, it will become an indicator that can allow the medical staff to control during the various checks whether this lifestyle is maintained, improved or worsened. In particular for the subjects of the "Experimental Group" the physical activity will be used as an indicator of steps number and physical activity duration recorded by wearable mobile devices referring to the 10,000 steps to be performed on a daily and 150 minutes a week.
- **The detection by the health operator of the eating habits** reported by the subject during the visit at the Nutritional Outpatient is a subjective measure, which is a lifestyle that when it is not correct (incorrect diet and high-calorie) becomes a common and modifiable risk factor at the basis of major chronic diseases. So eating habits such as: the quality of foods (various food groups), amount of food consumed daily / weekly and daily frequency of consumption of the main meals (breakfast, lunch, dinner and snacks) related to the subject will become an indicator that may allow health staff to verify, during the various checks, if that lifestyle is maintained, improved or worsened.

- **The Drop-out rate** of the group of persons assisted with the experimental nutritional counseling (Experimental Group) compared to the one received by the group of persons assisted with the traditional nutritional counseling (control group), can express the effectiveness of the trial. We will use two quantitative indicators of Drop-out:
    - Absolute quantity Drop-Out Indicator = N ° of users leaving for study / 12 months;
    - Relative quantity Drop-Out indicator = N °of users leaving by choice from the study / 12 months / number of followers.

Training methodologies to use the technologies by pilot participants

INTER-HEALTH pilot tools training will consist of two sequential phases:

- A first phase in which the partner UPV-SABIEN and UNICAL will form the ASL TO5 healthcare staff for the use of technology, Computerized Nutritional Folder with Prevention Program, Device Kit (scale, sphygmomanometer, bracelet, smartphone application, online questionnaire), Operating Instructions Device Kits.
- A second phase in which ASL TO5 healthcare staff will be able to do training to the subject performing the pilot on the technologies to be used, device kits (scale, sphygmomanometer, bracelet, smartphone application, online questionnaire) with the instructions for use. At this stage, participants will also be handed over to the pilot: the INFORMATION SHEET of the experimental study and the INFORMATION to PERSONAL DATA TREATMENT.

INTER-LogP users will profit from previous knowledge of the procedures of regular operation in port environments, so the training will focus on the new features of the developed tools that will integrate the different data sources from the IoT platforms. The training activities for INTER-LogP users will consist of:

- INTER-IoT general concept and specific use cases, scenarios and approaches.
- INTER-METH guidelines and CASE tool usage.
- INTER-FW use, including the Web App and the INTER-API.

INTER-DOMAIN training will be a joint activity between the third parties and the consortium partners. There will be specific training (with ethical impact) regarding those collaborations in which application support is needed, moreover in the collaboration with the University of Twente.

Templates of informed consent and information sheets for pilot participants. Such documents should provide pilot participants complete and transparent details on the aims, methods and implications of the research, the nature of the participation, the personal data collected (including those collected or processed by third parties) and its uses, as well as any benefits, risks or discomfort that might be involved.

The information that will be provided to pilot participants in INTER-HEALTH pilot will be:

- Information Sheet of the experimental study
- Declaration of consent for the participation in the experimental study
- Information on processing personal data
- Declaration of consent for processing personal data

Regarding INTER-LogP the devices and things will be containers, cranes, trucks and other elements in the port and container terminal. In this case, the users will be informed about the capture of information and/or images in specific areas or equipments.

In some scenarios, personal devices such as smart phones will be used, mainly for the geolocation of these devices and potentially the identification of the person. In this cases a consent will be requested from the persons participating in the trials and experimentation study. The description of the trials to the company managers, workers and operators will be provided.

Regarding INTER-DOMAIN there will be a single collaboration related with emergency management in which different human subjects will be monitored, in this case the information provided will be:

- Information Sheet of the experimental study

- Declaration of consent for the participation in the experimental study
- Information on processing personal data
- Declaration of consent for processing personal data

If during the execution of the different collaborations, new needs appear they will be added and provided to the participants.

- ***R2.2 Specific details concerning data protection provisions, including anonymization techniques and coding system methodologies adopted to guarantee personal data protection according to EU laws and regulations – including Reg. 2016/679 which will apply from 2018 when pilot activities will still be carrying on.***

Regarding data protection strategies different actions will be provided by the different participants in the pilots. In the case of INTER-HEALTH as indicated in D2.5 will meet according to EU laws and regulations – including Reg. 2016/679. Specific measures will be guaranteed mainly by UPV-SABIEN (after TIM withdrawal) and UniCal as technical partners in INTER-HEALTH pilot, but supported by the other partners developing components within the project. Specific technical measures to guarantee data protection and personal data treatment:

- Data transfer procedure to the server involves deleting the local data copy stored in the Smartphone Memory Buffer Received on the ASLTO5 Server;
- Bi-directional communication between the application resides on the subject's Smartphone and the server will be done by using login mechanisms, combined with the HTTPS secure communication protocol, to assure server authentication, privacy protection, encryption, and integrity of the server Data exchanged between the communicating parties; Also the biomedical data will travel in anonymous form as they will be associated with an alphanumeric code generated by the server and therefore not associated with the subject's identification data;
- The data communication protection between biomedical wireless devices and the developed mobile gateway application installed on the patient’s Smartphone, will be guaranteed by proprietary mechanisms supported by device manufacturers; it is worth noting that such mechanisms will not be altered in any way by the partner.
- Data collected by the mobile gateway application will temporarily reside in the memory buffer of the patient smartphone waiting to be transmitted to the ASL TO5 server; it is worth noting that the procedure for transmitting data to the server implies the automatic delete of the local data copy stored, once the reception and the correct feedback have been made
- The bi-directional communication protection between the mobile gateway application installed on the patient's Smartphone and the remote server located at the ASL TO5 structure will be guaranteed by using the HTTPS secure communication protocol that secures server authentication, privacy protection, the encryption and the integrity of the data exchanged between the communicating parties.
- Within the communication mentioned in the previous point, it should be noted that biomedical data will travel anonymously as they will be associated with an alphanumeric code generated by the server and therefore they are not directly associated with any patient personal identification data.
- Update and maintenance service of the mobile gateway application will be provided in case of errors and/or malfunctions of operation.

In INTER-LogP and INTER-DOMAIN, data coming from the different IoT Platforms of the Port Authority of Valencia and Noatum will not include any personal data able to identify people to respect the data protection obligations from these organizations. In the case of Noatum terminal, some data could be traced to machine operators like Terminal Truck location and speed, or crane operator joystick activity. The technical measures to ensure data protection and personal data treatment is the following:

- The assignment of operators to machines (terminal trucks, cranes, container handlers, etc) is managed by an internal application called GESTIR, which is not accessible from Noatum's IoT platform.
- The information flowing through Noatum's IoT Platform is completely anonymized in terms of personal data. No access to GESTIR is done within the IoT Platform. Device measurements are handled with the only identification of the machine name (e.g. 'RTG049'), with no attribute or reference to operators.

The access to InterLogP will be done exclusively to the IoT Platform, so no personal data will be involved.

- ***R2.3 Provisions for data security and recovery, as well as secure storage and transfer, of sensitive data. More detailed information are also needed to describe security policies and procedures for each data security level already identified (e.g. in D8.4) and other levels possibly resulting from additional data collection and processing from third parties involved from the Open Call.***

INTER-Health pilot will not integrate results from the Open Call. Thus, anybody external to ASL TO5, except for UPV-SABIEN authorized personnel, will not have access to gathered data. Regarding data transfer, the biomedical data will be transferred in anonymous form as they will be associated with an alphanumeric code generated by the server and therefore not associated with the subject's identification data;

The following steps to avoid the destruction and loss, even accidental, of the data:

- Data exchanged between biomedical wireless devices and the mobile gateway application that resides on the patient's Smartphone will be protected from destruction and/or loss through proprietary mechanisms supported by device manufacturers; It is specified that such mechanisms will not, in any way, be altered and/or modified by any partner
- Data collected by the application will be protected from destruction and/or loss through a temporary storage mechanism within the patient's smartphone until the transmission to the ASLTO5 server is completed and until the receipt of a specific acknowledgment message will activate a deletion procedure of the data copy stored in the local memory buffer.

- ***R2.4 Names of the appointed Data Controller(s) and Data Processor(s).***

Two roles have been defined within the project in each of the three pilots:

- INTER-HEALTH:
  - Data Controllers: Anna Costa (ASLTO5) and Marina Mortara (ASLTO5)
  - Data Processors: Álvaro (UPV-SABIEN) and Gianluca (UniCal)
- INTER-LogP:
  - Data Controllers: Miguel Llop (VPF) and Francisco Blanquer (NPV)
  - Data Processors: Pablo Giménez (VPF), Miguel Ángel Llorente (PRO) Andreu Belsa (UPV)
- INTER-DOMAIN:
  - Data Controllers: Miguel Llop (VPF), Francisco Blanquer (NPV) and Jara Suárez (UPV)
  - Data Processors:
    - From INTER-IoT consortium: Pablo Giménez (VPF), Miguel Ángel Llorente (PRO) Andreu Belsa (UPV)
    - From the third parties: Toni Adame (UPF), Jose O. Fajardo (NEMERGENT), Joao Moreira (U. Twente), Joao Encarnaçao (IRIDEON), Harilaos Koumaras (INFOLYSIS), Javier Escalera (E3TCITY), Georges Polyzos (AUEB), H. Truong (TU Wien), Gianfranco Modoni (CNR), Gunther Hoffman (AvailabilityPlus), Stephane Bergeon (CEA) and Ann Braeken (VUB). However only U.Twente and partially NEMERGENT may need to deal with critical data.

The criteria to select the Data Controllers is associated with technical capabilities and responsibilities as stakeholders in the large scale trials. And for Data Processors is mainly related with technical capabilities and the need for the execution of the project applications and services.

- ***R2.5 As a result of the involvement of third parties from the Open Call, additional details are necessary to confirm that such involvement complies with EU law and regulations (including the new data protection Regulation 2016/679) and the definitions and obligations included in the Annotated model Grant Agreement of the Horizon 2020 Framework (Articles 26, 27, 29, 31, 36, and 37). In particular, the following information is required***

The activity developed by third parties is considered a collaboration between the each of the third party and the consortium. The third parties receive funding in order to validate INTER-IoT solution and the consortium benefits enlarging the ecosystem. The figure of collaboration was determined following the Spanish Law for Public Institutions. As the coordinator entity (UPV) is a public university additional restrictions for cascade funding had to be applied.

Each third party had to sign a collaboration agreement with UPV as coordinating entity in the name of the consortium as established by INTER-IoT Consortium Agreement. The collaboration agreement establishes the different aspects that regulate the interaction, communication and collaboration between third parties and the consortium. These agreements were fully aligned by the legal department of UPV with the Annotated model Grant Agreement of H2020 Framework.

Describe all datasets shared, collected and/or processed by third parties from the Open Call, indicate which datasets are considered personal sensitive data and support such collection with appropriate justification reflecting the principles of proportionality, benevolence, and privacy.

No sensitive data sets are going to be shared with the third parties, as no third party collaboration is going to be integrated in the INTER-HEALTH use case. Every third party solution is going to be integrated in the INTER-DOMAIN use case. At the same time no personal sensitive data is going to be shared and processed by the third parties.

U. Twente collaboration is going to deal with an emergency management use case, in this situation simulated data from different people will be provided in order to be integrated in the proposed system. If finally the proposed solution is integrated in a real deployment the required datasets to be used by the application will be:

- Medical Records of potential injured people
- Real-time measurements of vital constants of the injured people.
- Tracking of Ambulances and emergency vehicles.

Describe how third parties will guarantee the compliance with EU and H2020 standard ethical guidelines on data privacy and protection.

Third parties have signed the Collaboration Agreement with INTER-IoT consortium, in this agreement compliance with EU and H2020 guidelines on data privacy and protection is addressed. The Collaboration Agreement always extends the Annotated Grant Agreement and the INTER-IoT Consortium Agreement that is based in the DESCA model. Article 11.3 deals with processing of personal data and it is detailed the responsibility of the signing third party in this activity. The corresponding article states:

11.3 Processing of personal data

The provisions set out in this Article 11.3 cover the collection and processing of Personal Data in completion of or in connection with the Contribution and/or in connection with the exercise of Access Rights by the Third Party.

Unless otherwise required by law, the Third Party, shall act as the data controller in respect of Personal Data collected and processed in the completion of or in connection with the Contribution. In this capacity the data controlling Third Party shall be liable for compliance with all the applicable statutory data protection laws.

The Third Party is obliged to protect Personal Data against loss, damage, unauthorized access, alteration and distribution or other unauthorised processing: for this purpose, appropriate technical, organisational and personnel measures adequate to the manner of the processing of Personal Data shall be taken.

Acting as data controller, the Third Party shall be responsible for obtaining, if required by applicable law, any statutory written approvals from the applicable competent data protection authority before starting the Contribution with or in any manner involving any Data Subjects.

The Third Party shall provide the Coordinator with a copy of all such written approvals so that they can be provided to the European Commission.

The Third Party undertake to bind any and all of their data processors, including if necessary the Coordinator and/or any other INTER-IoT Consortium member and their sub-contractors, to a data processing agreement in compliance with the applicable statutory data protection laws and pursuant to article 17 of Directive 95/46/EC. A copy of any such data processing agreements shall be provided the Coordinator. As part of such agreement the Third Party shall ensure that no Personal Data are processed for any other purpose than that of the Contribution and that processed data are pertinent and not redundant insofar as concerns the purposes for which they were collected and subsequently processed.

With the sole exception of those cases in which the preservation of data is required by law, the Personal Data will be erased or at least anonymized by the data controller and/or processors, from wherever they are stored, as soon as the Personal Data are no longer necessary for the specific Contribution purposes; such erasure mechanisms being either destruction, demagnetisation or overwriting. In the event of termination of this Agreement for any cause, the Third Party will no longer be permitted to process Personal Data in the framework of the INTER-IoT project or through the INTER-IoT Solution.

The Third Party acknowledges that the INTER-IoT Solution comply with the required standard data security measures according to any laws as applicable to the Third Party. The Third Party, moreover, acknowledges that the Coordinator and any other any other INTER-IoT Consortium member, if appointed as data processors, are not responsible for compliance with any data protection or privacy law applicable to the Third Party and not directly, explicitly and specifically applicable to data processors.

Notwithstanding the above, the Parties agree that any Result of the INTER-IoT project, of the Contribution, Feedback, Confidential Information and/or any and all data and/or information that is possibly, disclosed or otherwise made available between the Parties during the implementation of the Contribution and/or for any Exploitation activities ("Shared Information"), shall not include – if not strictly necessary for the purposes of the Contribution and in full compliance with applicable data protection laws – personal data as defined by Article 2, Section (a) of the Data Protection Directive (95/46/EEC) (hereinafter referred to as "Personal Data").

Accordingly the Parties agree that they will take all necessary steps to ensure that all Personal Data is removed from the Shared Information, made illegible, or otherwise made inaccessible (i.e. de-identify) to the other Parties prior to providing the Shared Information to such other Parties.

Additionally, Article 11.2 deals with Communication and Dissemination and indicating that it has to be done always in accordance with the applicable statutory data protection laws.

Describe how the Consortium will obtain all necessary rights (transfer, licenses or other) on results generated by third parties during project activities (see Grant Agreement, Article 26.3).

The Collaboration Agreement extends the signed Grant Agreement between EC and INTER-IoT Consortium. The rights to access to licences and developed components are included in the Collaboration Agreement. The Third Parties and INTER-IoT Consortium could protect some background knowledge through Annex 7 of the Collaboration Agreement. Only three entities (Availability Plus, CNR and AUEB) have protected some background, however access to the consortium has been granted.

On the other hand the Collaboration Agreement clarifies the rights and property of the results after the end of the participation in INTER-IoT.

Describe how data processing from third parties will affect the project's general data repository management.

Data processing from third parties will not affect the project's general data repository management as there is no third party involved in INTER-HEALTH. Regarding the other pilots, only in the INTER-DOMAIN pilot third parties will process data. However, the repository will not be affected by this management.

R3. In the next Risk Management Plan deliverable (D1.4 due in M18), include a thorough ethics risks assessment and related mitigation strategies of the foreseen risks associated to all domains and field trials, with particular attention to those involving human subjects (including assessment and management of adverse events to ensure the safety of the participants – e.g. psychological burden, stigmatization, medical device safety issues, etc.).

Deliverable D1.4 has been delivered (30/6/17) with a new section related with Ethics Risks, which have been provided by the Ethics Advisory Board and the supervision of the External Ethics Advisor.

2.3 Explanation of the work carried per WP

2.3.1 Work Package 1 – Coordination and Management

Universitat Politècnica de Valencia (UPVLC) as Project Coordinator (PC) has been leading work package 1 (WP1), and the five tasks in which the WP is divided. As a project coordinator, organized and contributed to the achievement of all the required milestones. Such milestones set the ground for the ulterior developments of the project as well as helped the project to gain visibility through its involvement in multiple workshops and other publicity activities in the framework of IoT-EPI. The project consortium has generated ten deliverables, associated with WP1 (3), WP2 (3) and WP8 (4), whose quality control has been performed following the project handbook procedures.

2.3.1.1 Progress

Progress by task

Task 1.1: The task has managed project planning and coordination. Six WP have started in the period under evaluation, all the activity has been executed as expected qith minor delays and deviations that have been solved as they have been detected. Different management tools have been deployed: (i) Horde for calendar, information repository and management procedures; (ii) JIRA for VOLERE methodology support and risk management; (iii) mailing lists and reporting; and software repository tools. For internal communication and adequate interaction between the partners, the project has scheduled five plenary meetings during the period under review:

- Valencia (Spain), 12th-13th January 2016 Kick off meeting;
- Cosenza (Italy), 18th-19th May 2016.
- Lancaster (UK), 20th – 21st September 2016.
- Ljubljana (Slovenia) 1st-2nd February 2017.
- Valencia (Spain), 4th-5th January 2017.
- Additionally for specific management procedures the consortium realized:
  - WP2 workshop in Paris (France), 25th February 2016
  - WP4 workshop and Kick off meeting in Madrid (Spain),7th July 2016.
  - IoT-EPI preparation meeting in Valencia 21st June 2016.
  - WP3/WP4 developer workshop 21st-22nd November 2016.
  - WP4 Architecture meeting 6th April 2017.

The project has held biweekly telcos since the start of the project, using ISL tool provided by XLAB, additional telcos to handle specific issues have been also scheduled.

INTER-IoT project has been interacting with IoT-EPI and associated projects and the different task forces developed within the cluster. Activity related with IoT-EPI has been:

- Participation in the IoT-EPI kick off meeting in Brussels 29th January 2016.
- Design and development of a promotional INTER-IoT video following IoT-EPI specifications.
- Organization together with EC and the two CSA (UNIFY-IoT and BE-IoT) the first IoT-EPI event with more than 150 people registered in Valencia (Spain) during 22nd-24th June 2016.
- Participation in the IoT-EPI TF meetings and associated events in Vienna (Austria) 11th -13th October 2016.
- Participation in the IoT meet up and greet and IoT Challenge in Berlin 16th-17th March 2017. The IoT-EPI event for the previous days was cancelled due to Berlin Airport strike.
- Participation in SIDO 2017 (Lyon, France) on 5th-6th April 2017 and IoT-Week (Geneva, Switzerland) 6th-9th June 2017 and associated events.

Members of the consortium have participated in different telcos related with the Task Forces and participate in the writing of the position papers.

Quality control is a task performed in the framework of this task, as indicated in the project handbook. All project deliverables are reviewed project-internally by two persons, who have not contributed to the deliverable itself (as far as possible) in order to ensure that project deliverables are of the best possible quality and that they are consistent in its content (an internal planning and schedule has been organised for such reviews). In turn, the deliverable editor performed the reviewer's suggestions and requested – if needed – extensions within 2 weeks after internal review submissions. In addition, all deliverables have been read and commented on in parallel to those experts' reviews above by the technical manager and coordinator, too.

Task 1.2: Administrative and financial management of the project has advanced as expected:

- Distribution of prefinancing was executed during the first month of the project, so as redistribution of returned prefinancing from TI to the new partner and partners assuming remaining tasks from the workload.
- The project has generated two amendments:
    - First one in order to fix some mistakes in delivery dates and responsibilities of some deliverables, additionally due to the interaction with IoT-EPI and in order to advance results, it was agreed with the PO (Mr. Achilleas Kemos) to re-schedule WP3 kick-off to M5 (May 2016).
    - Second one in order to arrange TI withdrawal from the project, requested in November 2016, and distribute the assigned tasks.
- Fluent communication with the three PO of the project has been held: Mr. Achilleas Kemos (M1-M6); Mr. Georges Lobo (M7-M16) and Mr Joel Baquet (since M16)
- An amendment to the Consortium Agreement was signed in June 2016 in order to entitle PC to sign Collaboration Agreements with the third parties in the name of the INTER-IoT Consortium, in order to adequate the open call process to the Spanish Law for Public Institutions.

Task 1.3: Risk management strategy is considered a major and critical issue and D1.3 (M6) provided the risk management policy for the project. JIRA has been selected as supporting tool for risk management and a risk template was generated. After the technical review held in October 2016 and the reception of the evaluation report in November 2016, a recommendation from the experts was attended in order to improve and make risk management more practical. A new version of D1.3 was submitted on 31st January 2017 improving the new risk management policy, and providing a new set of risks.

The criteria to classify and prioritize the risks was updated and more practical risks were introduced, following the principles recommended by the Project Management Body Of Knowledge (PMBOK®) of the Project Management Institute (PMI). Frequent risk management meetings (15 days periodicity) have been held in order to have tight control of the execution of the project. Additionally, in every Plenary meeting and individual WP meeting risk assessment has been performed. A worklog has been maintained and continuously updated in order to control the evolution of the different risks.

In January 2017 the consortium received an Ethics Evaluation Report and a recommendation was issued regarding risk management. The report recommended the addition of a new section in the risk management policy explicitly linked to Ethics, so the different risks already detected, were moved to that section and new risks derived from the reviewer recommendations were included in the corresponding section. D1.4 was submitted in M18, with the continuation of the execution of the revisited risk management policy from D1.3 (version 2) and the inclusion of the Ethics risk section.

Risk management has been led by PC and WPL, however the different members of the PMC have participated in risk management during the first 18 months of the project. During the different Advisory Board meetings discussions about risks have been held. Additionally the newly created Ethical Advisory Board together with the External Ethical Advisor have assessed and managed Ethical risks.

Task 1.4: The Advisory Board of the project was appointed on M9 of the project, it includes by now 7 members in total, three from relevant stakeholders (two large port authorities and one from a Health National System), two academic (one from a University and another from a research center), one from capital risk entity and another from a large industry related with IoT.

Initial members were:

- Jose García de la Guia (Port Authority of Valencia), SPAIN. Position: CIO.
- Prof. MengChu Zhou (New Jersey Institute of Technology - NJIT), USA. Position: Full Professor of Information Technologies.
- Frank Molendijk (Port Authority of Rotterdam), THE NETHERLANDS. Position: CIO
- Francesco Giuliani (IRCCS Casa Sollievo della Sofferenza), ITALY. Position: Research Director.
- Matus Maar (Talis Capital), UK. Position: Partner and Director.
- Dr. Arkadiusz Hruszowiec (INTEL), POLAND. Position: Business Development Manager at Intel Corporation,for the South-East European Industrial Market
- Dr. Mihael Mohorčič (Institute Jozef Stefan - IJS), SLOVENIA. Position: Research Director

Andrzej Jankowsk who is Internet of Things Ecosystem Manager in Intel Corporation for Central Europe region substituted Dr. Arkadiusz Hruszowiec since 1st June 2017. The AB is not closed and we consider the possibility of enlarging the number of members if needed.

Individual interaction with the members has been held, and two teleconferences have been held with the members of the advisory board:

- 13th December 2016, in which the main architecture and situation of the project was presented. First inputs from the AB were received and used mainly to fix priorities in product development.
- 17th May 2017, in which an update of the architecture components and developments were presented. The core of the presentation was devoted to product identification, business models and ecosystem building through the open call results.

The two Advisory Board Meetings consisted out of a presentation program followed by open discussions with a ”Questions and Answers” session. Inputs from the advisors had been gathered, and INTER-IoT discussed and decided upon their particular use. Deliverable D8.5 includes the main conclusions from these two meetings.

The Ethics Advisory Board is composed by:

- Anna Costa (ASLTO5),
- Gianluca Aloi (UniCal),
- Vicente Traver (SABIEN-UPV),
- Luisa Escamilla (VPF) and
- Carlos E. Palau (UPV).

Due to the large expertise in the medical sector and as an SME related with the pilot Eric Carlson (RINI) has been included as observer. Dr. Maurizia Rinaldi, with large expertise in Ethics assessment related with medical trials, has been appointed as External Ethical Advisor.

Task 1.5: The Open Call started to be prepared in M6 and was launched in M10 (13th October 2016). The task was led by UPV, supported by the WPL and with singular help from the rest of the partners. The legal structure has been organized by UPV which is a Public Spanish University and certain legal issues had been fixed in order to cope and meet Spanish legislation so as H2020 regulations for third parties.

The main objective of the open call has been testing the INTER-IoT proposed components and methodology through new scenarios, platforms and components to achieve interoperability between IoT platforms. The proposals will provide support to validate INTER-IoT proposal and components in scenarios deployed in different application domains. Allowing the evolution of the INTER-IoT products or parts of them (i.e. INTER-LAYER, INTER-FW and INTER-METH) as a whole to match the needs of proposers, but at the same time evolve their products in order to add new interoperability features.

The call was open to individual European SME, Universities and Research Centres that could contribute to the INTER-IoT paradigm. Selected entities have become third parties of UPV. An amendment to the Consortium Agreement was made in order to allow the signature of the collaboration with the third parties.

In order to achieve a high impact of the open call, and reach a large number of entities, the consortium performed different communication actions that proved highly effective:

- 2 events
  - IoT meet-up Vienna (openning of the open call)
  - Event in Valencia related with Entrepreneurship
- e-means
  - 4 massive e-mails sent, to a gathered mailing list of more than 500 entities.
  - Mail sent internationally by Spanish NCP
  - Support from the regional diffusion center of CV Universities
  - Concurrent posts on our website, Twitter, LinkedIn and FaceBook
- 1 Publication in EC Participants Portal
- 1 webinar w/ ~32 participants (recording available)
- 14 tweets and re-tweets, **4** posts on LinkedIn (INTER-I T account), 8 posts in FaceBook (INTER-IoT account
- Direct communication (e-mails) with Associations, local communities, NCPs, possible applicants & dissemination of posts to personal networks

Interaction with IoT-EPI in order to promote the open call was held during the whole process. The information was announced in the web site and social networks.

The Consortium developed an Open Call management tool based in Open Conf open source tool:

- Full control on statistics and requirements for the open call
- Submission and evaluation integrated in a single tool
  - Consensus also through the tool
  - Creation of the role of observer to monitor the whole process
- Every action logged by the system for traceability
- Templates fully adequate for the process
  - Minor points could not be automated
  - Satisfaction from the evaluators and for the applicants
- The database of submissions, evaluation process and communications is stored for revision:

Some figures regarding the submission process:

- 73 opened applications
- 63 submitted applications, 63 eligible ones
- 19 Large proposals 44 Small proposals
- 1 mistake in selecting the type of proposal (large proposal marked as small)
- 41% of the applications were closed the last day (53% in the last 3 days)

Table 1. Open Call submitted applications

Country	Registered	Uploaded
Austria	2	2
Belarus	1	0
Belgium	1	1
Croatia	1	0
France	5	4
Germany	1	1
Greece	11	10
Italy	10	10
Netherlands	3	3
Norway	1	1
Poland	1	1
Portugal	3	1
Romania	3	1
Serbia	1	1
Spain	25	24
Sweden	1	0
United Kingdom	3	3
Total	73	63

The successful applicants, who have been awarded funding have been required to sign a collaboration agreement with UPV, INTER-IoT Project Coordinator, in order to be able to receive the funds, become third party of the project, access to developments and start the collaboration.

A call for independent external reviewers was released; two external observers were appointed with no conflict of interest with the open call applicants. Every proposal was checked to ensure that it met requirements before it was sent for evaluation to the INTER-IoT Experiment Evaluation Committee (EEC). This committee consisted of two external observers and the PCC. The two observers monitored the whole process in order to ensure tracking of every action.

Each application was assessed by two external experts. The experts were individuals with experience in the fields of innovation linked to this Open Call and also with the highest level of knowledge. The selected experts signed a declaration of confidentiality concerning the evaluation process and the content of the proposals they evaluated. They declared their absence of any conflict of interest for the assigned tasks.

After the applications were evaluated they were ranked by the Evaluation Committee. For both the large and small contributions, the Evaluation Committee provided feedback and give a score for each of the evaluation criteria. A ranking list was assembled with all proposals that score above the thresholds (the proposals were evaluated under five criteria: (i) Relevance to INTER-IoT; (ii) Impact and sustainability; (iii) Technical excellence; (iv) Quality of implementation (v) Quality of the team, the thresholds to be applied to the different criteria are 4/4/3/3/3 over 5 for the different criteria, and 18 as a global threshold over 25). The EEC met and made a final funding decision based on the ranking list. In case of applications receiving an equal score the prevalence criteria was the marks in criteria 1, criteria 2, criteria 3, criteria 4 and criteria 5.

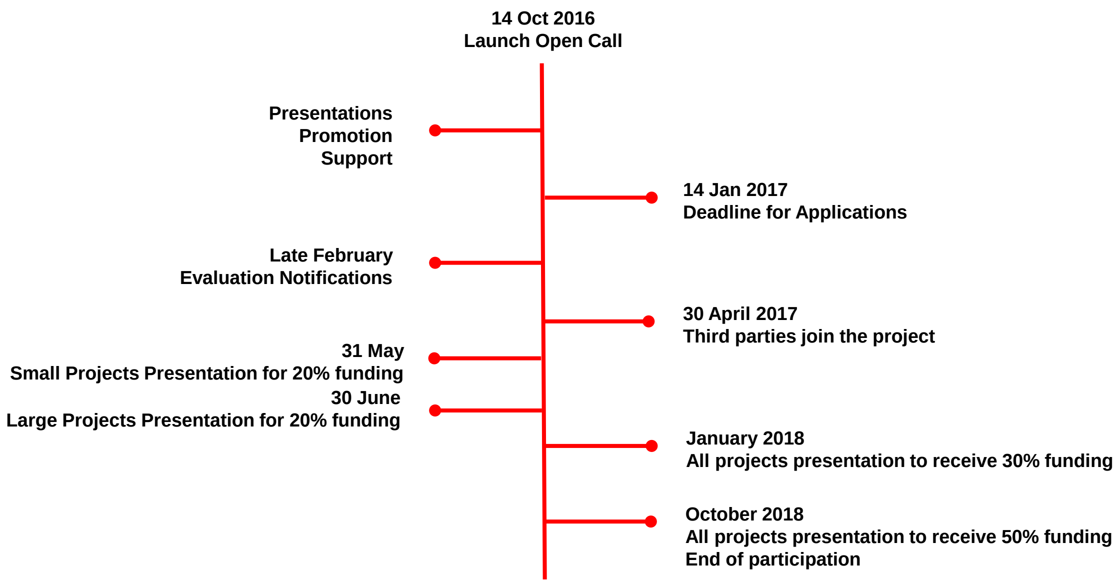

Figure 3. Timeline of the whole open call process

The observers played a key role and they performed specific activities as they assisted the PCC in order to provide support in the evaluation process:

1. Training session on 13th February 2017 related with INTER-IoT concept; evaluation process; developed evaluation tool management and observer options in order to manage the whole process.
2. On 13th February 2017 the assignation matrix of the proposals vs evaluators was provided to the observers. Assignation was performed by the Consortium considering gender, expertise and nationality of the reviewers and the applicants. Two evaluators were assigned to each proposal and one of them was selected as advocate/rapporteur. The observers validated the assignment on 16th February 2017, in order to assess the fair and correct assignation the observers had access to the evaluators CVs, proposals, and the evaluation process online management tool.
3. On 17th February 2017 the evaluation process started and the observers accessed the platform in order to check the different individual reports and discussion between the evaluators to reach consensus. The observers validated the fairness of the process and did not find any activity and evaluation not attending the stated procedures.
4. On 10th March 2017 the Open Call panel was held between the observers and the PCC, the proposals were ranked and the observers validated the process.
5. On 28th March 2017 after validation by the Project Officer the Evaluation Reports were sent to the applicants and the observers were informed on this aspect

The observers guaranteed that the process was fair in order to select the third party collaborations.

Regarding the evaluation process some statistics:

- Thresholds:
  - 11 large collaborations were over thresholds.
  - 21 small collaborations were over thresholds

- Small contributions[18]
    - 15 proposal addressed D2D
    - 4 proposals addressed N2N
    - 11 proposals addressed MW2MW
    - 6 proposals addressed semantic concepts
    - 16 proposals addressed application and services concepts
    - 4 proposals addressed security concepts

The final selected applications were:

- Large contributions:
    - Integrating sensiNact platform with INTER-IoT Framework, CEA - Commissariat à l'énergie atomique et aux énergies alternative, (France).
    - INTER-OM2M, Vrije Universiteit Brussel, (Belgium).
- Small contributions:
    - INTER-HARE platform: Integration of multiband IoT technologies, Universitat Pompeu Fabra (Spain).
    - Mission Critical operations based on IoT analytics (MiCrOBIoTA), Nemergent Solutions S.R.L., (Spain).
    - Interoperable Situation-Aware IoT-Based Early Warning System, University of Twente, (The Netherlands).
    - SENSHOOK, Irideon SL, (Spain).
    - SOFOS: A software-defined end-to-end IoT gateway with virtualization capabilities, INFOLYSIS P.C., (Greece).
    - E3Tcity Smart City Platform and Devices Integration, E3TCity, (Spain).
    - ACHILLES: Access Control and autHenticatIon deLegation for interoperabLE IoT applicationS, Athens University of Economics and Business – Research Center (AUEB), (Greece).
    - INTER-HINC: Interoperability through Harmonizing IoT, Network Functions and Clouds, TU Wien - Vienna University of Technology, (Austria).
    - A Semantic Middleware for the information synchronization of the IoT devices, Institute of Industrial Technologies and Automation - National Research Council (ITIA-CNR), (Italy)
    - SecurIoTy - security for the IoT, AvailabilityPlus GmbH, (Germany).

Some data about the entities that succeed in the open call:

- Country:
    - Large proposals (FR and BE)
    - 10 Small proposals (4 ES, 2 GR, 1 IT, 1 NL, 1 GE, 1 AU)
- Type of organization:
    - UNI (BE, ES, GR, NL, AU)
    - RTO (FR, IT)
    - SME (3 ES, GR, GE)

[18] The number of proposals is over 44 small contributions as some proposals addressed two aspects, e.g. MW2MW and semantic concepts so they have been considered twice

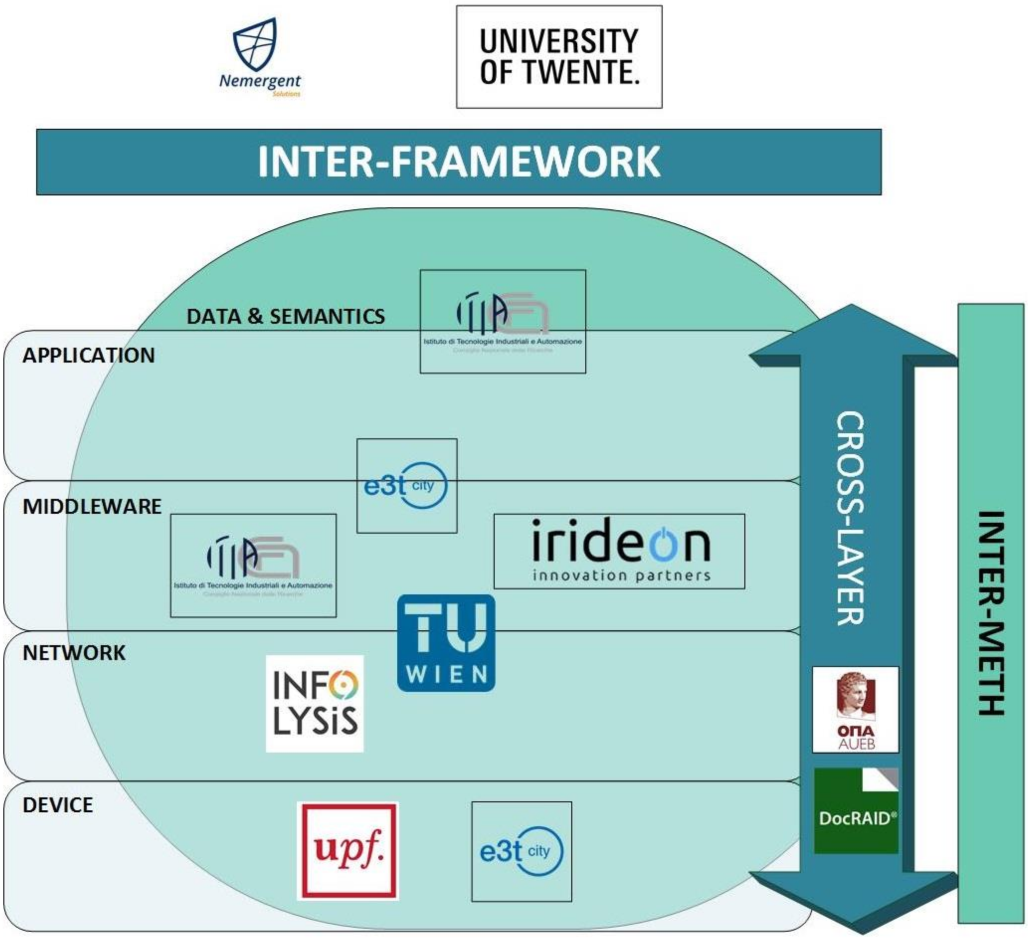

Figure 4. INTER-IoT areas covered by the Small Contribution third parties

First evaluation of the small collaboration of the open call was held on 29th-30th May. During the presentation the third parties presented the work done so far, presented a potential business model individual and joint with INTER-IoT and project progress report. The ten small contributions made the presentation and received the pre-financing. Currently the assigned mentors within INTER-IoT are supervising their work. Large collaborations have made their presentation in M19 during the 6th plenary meeting in Eindhoven (out of the period under evaluation).

Table 2. WP1 Partner contribution summary table

Partner	Main Contributions
UPV	• Coordination of the project. • Administrative tasks • Advisory Board coordination and interaction • Risk management • Organisation of the Open Call including technical and managerial aspects. • Support to the Ethical Advisory Board.
TI	• Although the partner withdrew on M12 and it has no manpower in WP1 participated in risk management activities and in the open call promotion.
UNICAL	• Advisory Board coordination and interaction. • Risk management.

	• Organisation of the Open Call including promotion and selection of reviewers. • Participation in the Ethical Advisory Board.
PRODEVELOP	• Advisory Board coordination and interaction. • Risk management. • Organisation of the Open Call including promotion and selection of reviewers.
TUE	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and selection of reviewers and in the interaction with the AB.
VPF	• Advisory Board coordination and interaction. • Risk management. • Organisation of the Open Call including promotion and selection of reviewers. • Participation in the Ethical Advisory Board as leader of INTER-LogP pilot.
RINICOM	• Advisory Board coordination and interaction. • Risk management. • Organisation of the Open Call including promotion and selection of reviewers. • Participation in the Ethical Advisory Board as observer.
AFT	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and selection of reviewers and in the interaction with the AB.
NOATUM	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and selection of reviewers and in the interaction with the AB.
XLAB	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and mentoring of third parties and selection of reviewers and in the interaction with the AB.
SRIPAS	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and mentoring of third parties and selection of reviewers and in the interaction with the AB.
ASLTO5	• Although the partner has no manpower in WP1 participated in risk management activities, some aspects of the open call like promotion and selection of reviewers and in the interaction with the AB. • Participation in the Ethical Advisory Board and support for the selection of the External Ethical Advisor.
ABC	• Advisory Board coordination and interaction. • Risk management. • Organisation of the Open Call including promotion and selection of reviewers.
NEWAYS	• Advisory Board coordination and interaction. • Risk management. • Organisation of the Open Call including promotion and selection of reviewers.

SABIEN[19]	• Since the institute joined the proposal, has participated in risk management and interaction with the AB. • Participation in the Ethical Advisory Board as leader of INTER-Health pilot

2.3.1.2 Results

Main results associated with the execution of the WP is the adequate coordination of the activities organised in WP that required an intercommunication between them. Main achievements:

- Execution of the different administrative and financial activities as required by the project.
- Deployment of the different collaborative tools in order to manage the execution of the project.
- Submission of the deliverables and accomplishment of MS in due date, delays have always been justified and agreed with the PO after analysing the corresponding rationale, e.g. delay of 15 days of D4.1 in order to adequately address the requirements coming out from the resubmission of D2.3 as requested by the reviewers.
- Quality control of the deliverables and results of the project.
- Application of an improved risk management mechanism.
- Establishment of the AB and start of the interaction with it obtaining advice and guidance for the project.
- Establishment of the Ethical Advisory Board and attendance to the ethical recommendations from the reviewer.
- Execution of the Open Call process with the launch, promotion, evaluation and selection of the different third parties.

2.3.1.3 Deviations

No significant deviations produced, out of the extra week provided to submit proposals to the open call that did not affect the whole evaluation process.

2.3.1.4 Corrective Actions

No corrective actions have been required.

[19] Although in the financial reporting SABIEN is part of UPV, in order to clarify the contribution of the two UPV research groups we have split contributions between UPV and SABIEN.

2.3.2 Work Package 2 – Requirements and Use Cases

WP2 has been in charge of gathering and defining the set of technical requirements for the development of INTER-IoT framework and for each of its core components, definition of the initial business models and description of scenarios and use cases in which interoperability between IoT platforms is needed. This work package was led by VPF started on month 1 and finished on month 12. All partners in the consortium have participated actively during the work carried out from M9 to M12 in every task. The first three tasks of the work package, finished before month 9, were related to stakeholders and market analysis, definition of the business models, and requirements.

WP2 as a whole was developed using the VOLERE[20] methodology that has proved to be the most adequate to extract conclusions and provide results following a systematic approach, and which has been widely used in different research projects with participation of the consortium members. Additionally, all the requirements, scenarios, and use cases were registered in JIRA, an online tool to manage all the WP2 progress. All the information compiled and produced in this WP is accessible online through this tool.

2.3.2.1 Progress

Progress by task

Task 2.1: led by AFT, was developed between M1-M3 and the main outcome was deliverable D2.1 "Stakeholders and Market Analysis Report". The task provided an insight of the current IoT market landscape and the vision of different technologies supporting it. The activity had two phases a stakeholder analysis and a market analysis:

- The stakeholders' analysis was carried out through direct contact with stakeholders, following an INTER-IoT product oriented approach. With this analysis, the consortium identified the initial needs for the five components of the project: INTER-LAYER, INTER-FW, INTER-METH, INTER-LopP and INTER-Health. The identification of stakeholders set the basis to start developing cooperation with them, to focus on the requirements gathering process and, ultimately, to ensure a successful outcome for the project. The analysis took into account both demand and supply points of view and both qualitative and quantitative aspects.
- The market analysis was produced mainly through desk research, workshops, market studies, report analysis and consultation with IoT market experts, including our participation in IoT-EPI and AIOTI forums. The market analysis comprised existing solutions and trends, including vendor specific solutions, research projects and existing and proposed standards. We analyzed more than 110 representative products, although we were aware than a high spread of products exists. This first market analysis let us have a deeper insight of the current market offer and their need to interoperate. We classified the products in 16 different domains which show a high level of heterogeneity, with many product classes accounting for very low portions of each product domain. The market analysis was complemented in WP3 with the state of the art reports on the different INTER-IoT layers: device, network, middleware, application services and data & semantics.

Stakeholders and products will be updated and refined during the whole life of the project in the JIRA repository. Theinitial generic products were further refined and D8.7a when the exploitation strategy was reviewed, providing a new vision of the products resulting from the execution of the project from the information gathered in this task, inputs from the industry and the Advisory Board.

[20] http://www.volere.co.uk/

Task 2.2: was executed between M1 and M6 and it initiated the definition of the business options at strategic level from the very beginning. This task produced the deliverable D2.2 “Business Model Design” and it was tightly linked and coordinated with task 8.4 for the exploitation task. VPF led this task and all partners have contributed in a very productive manner with their individual business plans. The applicable individual business models for IoT that were described showed many good options to deploy INTER-IoT solutions and they helped the project to identify the opportunities of collaboration and synergies among the consortium. During T2.2 the consortium elaborated specific business plans for the three initial technical products considered in INTER-IoT (INTER-LAYER, INTER-FW and INTER-METH) which consider the models for the joint exploitation of the results of the project. These results have evolved during the execution of the project as the consortium has identified specific a more detailed products from the information gathered during the period.

The business model design took into account economic considerations (i.e., how will project results, be sustainable and create value); Component considerations (i.e., how will the business be done: selecting customers, differentiating its offerings, defining the tasks of each organization, configuring its resources, going to market, providing added value to customers and gathering profit objectives) and strategic outcomes (i.e., the design of key interdependent systems that create and sustain a competitive business).

Task 2.3 was executed between M1 and M9. In this task, led by VPF, all the partners identified the necessary requirements to begin the development of the different components that compose INTER-IoT. For the selection of the requirements, different criteria were considered. The most important input was the needs provided by the stakeholders in the interviews, as they will be the final users of the project results. We also investigated the most important requirements to achieve an interoperability with IoT systems. Finally, we took into account the wide experience of the partners in formulating the requirements.

We followed a 5-step iterative process of identifying, capturing, defining, analysing, and reconciling the requirements using VOLERE methodology. We firstly identified the different sources which provided us useful requirements for our work, including our own knowledge, stakeholders, regulation or standards. We made an inventory by product and characterised the requirement following a common template. Finally, we created different task forces per product to refine and reconcile the requirements. The results have been a comprehensive set of requirements based on more than 200 requirements which were registered in the JIRA repository by all partners of the consortium.

As a result of the task we produced deliverable D2.3 “Requirements and Business analysis with the list and the analysis of all the requirements”. After the technical review in M9, all the requirements were reviewed following the advice from the external experts, and redefined to be more focused on the real development of the different components, since we had a deeper knowledge of the use cases defined in T2.4. In addition, a prioritization of the requirements was carried out, which allowed the consortium to establish a first phase with the main functionalities of the system. The results of this deliverable are currently being used in all the activities executed in WP3, WP4 and WP5 and starting in M19 also in WP6. The new version of the deliverable D2.3 Requirements and Business analysis was delivered in M13.

Task 2.4: was executed between M1 and M12 and was led by TI. Following the VOLERE methodology, we developed the definition of the business scenarios related with the two application domain pilots considered in the project (INTER-LogP and INTER-Health) and for the cross domain, considering that depending on the open call third parties selected some of the cross domain scenarios may be modified for WP6 trials.

The scenarios were written as a story script detailing all the steps that every actor should follow. Furthermore, we designed the use case diagrams of each scenario in this task where individual use cases were identified to build the scenario, identify the actors involved and the main interactions among them. For the definition of the use cases, we used the information coming from the requirements, interests from the stakeholders and the work carried out in WP3, WP4 and WP5.

Each use case identified was thoroughly analysed to define the specifications. Specifications of use cases consider:

- Actors that interact and participate in the use case;
- Assumptions or pre-conditions that need to be satisfied for the use case to perform;
- Flow of events that will occur when the use case is executed;
- Expected results: Shows the expected outcomes after the use case execution; and
- Design choices to be made by the designers in WP3, WP4 and WP5.

All the information developed in the task has been stored in the JIRA repository where it can be consulted and updated throughout the project. All the partners were involved in the design and development of the uses cases.

Task T2.5: led by VPF, was carried between M7 and M12 and examined legal and regulatory requirements for the project. All partners contributed providing references and information about national legislations of their respective countries. The purpose of this task was ensure that all the development and pilots carried out during the project will comply with all the corresponding laws and regulations. This was especially relevant for the scenarios concerning the health pilot, where could be sensitive data from patients, regarding this aspect ASLTO5 partner was required to submit a description of the activity to the corresponding Bio Ethics Committee, the report was an application of T2.5 results.

For the analysis of the legislation, three levels have been analysed following the VOLERE methodology. In the first place, all European legislation (directives and regulations) has been sought in relation to all the topics to which the project may refer: trust services, data protection, interoperability, network security, logistics, e-Health, etc. Then, partners analysed their national legislation according to the European law. We focused in depth in the logistic and health legislation in the two countries where the pilots will take place: Spain and Italy. Finally, we take into account international considerations and good practices in order to interoperate with different standards.

For the development of the document, NPV and ASLTO5 focused in the national legislation in Spain and Italy in their respective fields, transport and health. AFT sought the European legislation. Moreover, VPF analysed the international practices and recommendations and compiled the contributions. Finally, all partners contributed with their national legislation in the field of IoT.

Table 3. WP2 Partner contribution summary table

Partner	Main Contributions
UPV	• Search and analysis software and IoT products • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas model of INTER-LAYER • Initial definition of requirements in INTER-LAYER • Analysis and prioritization of all the requirements • Use cases definition for INTER-LAYER • Upload to JIRA all the results
TI	• Lead task T2.4. Compile the deliverable D2.4 • Search and analysis of health products and devices • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization

	• Initial definition of requirements in INTER-Health • Scenarios definition for INTER-Health • Use cases definition for INTER-LogP • Upload to JIRA all the results
UNICAL	• Search and analysis of software and IoT products • Interviews with stakeholders to present the project and get their needs • Contribute to the joint Canvas model of INTER-METH • Initial definition of requirements in INTER-METH • Use cases definition for INTER-METH • Upload to JIRA all the results
PRODEVELOP	• Search and analysis of software and IoT products • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas model of INTER-FW • Initial definition of requirements in INTER-FW • Analysis and prioritization of all the requirements • Use cases definition for INTER-FW • Upload to JIRA all the results
TUE	• Search and analysis of software and IoT products • Interviews with stakeholders to present the project and get their needs • Initial definition of requirements in INTER-FW • Analysis and prioritization of all the requirements • Scenarios definition for INTER-LogP • Use cases definition for INTER-LAYER • Upload to JIRA all the results
VPF	• Lead the WP and tasks T2.2, T2.3 and T2.5. Compile de deliverables D2.2, D2.3 and D2.5 • Search and analysis of logistic products and devices • Analyse VOLERE methodology and define templates for products, stakeholders, requirements, use cases and scenarios • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas models • Initial definition of requirements in INTER-LogP • Analysis and prioritization of all the requirements • Scenarios definition for INTER-LogP • Use cases definition for INTER-LogP and INTER-FW • Upload to JIRA all the results • Analysis of the legislation in Spain • Search for European legislation and international practices and recommendations
RINICOM	• Search and analysis of health products and devices • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas models • Initial definition of requirements in INTER-Health • Analysis and prioritization of all the requirements

	• Scenarios definition for INTER-Health • Use cases definition for INTER-Health • Upload to JIRA all the results • Analyse the legislation in England
AFT	• Lead task T2.1. Compile the deliverable D2.1 • Search and analysis logistic products and devices • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Initial definition of requirements in INTER-LogP • Analysis and prioritization of all the requirements • Upload to JIRA all the results • Analyse the legislation in France • Search for European legislation
NOATUM	• Search and analysis logistic products and devices • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Initial definition of requirements in INTER-LogP • Analysis and prioritization of all the requirements • Scenarios definition for INTER-LogP • Upload to JIRA all the results • Search for port and logistic legislation
XLAB	• Search and analysis software and IoT products • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas models • Initial definition of requirements in INTER-LAYER • Analysis and prioritization of all the requirements • Use cases definition for INTER-LAYER • Upload to JIRA all the results • Analyse the legislation in Slovenia
SRIPAS	• Search and analysis software and IoT products • Interviews with stakeholders to present the project and get their needs • Contribute to the joint Canvas models • Initial definition of requirements in INTER-LAYER • Analysis and prioritization of all the requirements • Use cases definition for INTER-LAYER • Upload to JIRA all the results • Analyse the legislation in Poland
ASLTO5	• Search and analysis health products and devices • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Initial definition of requirements in INTER-Health • Analysis and prioritization of all the requirements • Scenarios definition for INTER-Health • Use cases definition for INTER-Health • Upload to JIRA all the results • Analyse the legislation in Italy • Search for health legislation
ABC	• Search and analysis software and IoT products

	• Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Initial definition of requirements in INTER-FW • Analysis and prioritization of all the requirements • Scenarios definition for INTER- Health • Use cases definition for INTER-LAYER • Upload to JIRA all the results
NEWAYS	• Search and analysis software and IoT products • Interviews with stakeholders to present the project and get their needs • Canvas business model definition of its organization • Contribute to the joint Canvas models • Initial definition of requirements in INTER-LAYER • Analysis and prioritization of all the requirements • Scenarios definition for INTER-LogP • Use cases definition for INTER-LAYER • Upload to JIRA all the results • Analyse the legislation in Netherlands

2.3.2.2 Results

We have produced the five expected deliverables in time during the work carried out in this WP:

- D2.1 Stakeholders and market analysis report
- D2.2 INTER-IoT Business Models
- D2.3 INTER-IoT requirements and business analysis
- D2.4 Use cases manual
- D2.5 Legal and regulatory constraints analysis and specification

We have also developed an online database with the different elements analysed: existing products, requirements, scenarios, stakeholders, and use cases. Some of these elements are being updated during the project.

Finally, we have defined an initial business model of each of the companies participating in the project, which has been used to develop the exploitation plans. The developed business models have been updated in the intermediate D8.7a.

2.3.2.3 Deviations

No significant deviations produced.

2.3.2.4 Corrective Actions

Although no deviations have been produced in the execution of the WP, according with the recommendations from the reviewers, the consortium improved the defined requirements including their prioritization. Two criteria has been followed, the stakeholders needs that already had been gathered and the application of the MoSCoW methodology That means that, although all requirements are important, they should be prioritized to deliver the greatest and most immediate business benefits early, categorizing the importance of the different requirements when developing them. For that, this methodology classifies the requirements in Must have, Should have, Could have, and Won't have. As a result of this work, a new version of the deliverable D2.3 was delivered on month 13 as required.

2.3.3 Work Package 3 – Layer interoperability

WP3 involves all development and documentation about all INTER-LAYER solutions. As well as all development infrastructure and tools configuration. During the second quarter of the project (M9 to M18) dedicated servers for all development tools were arranged and configured, including: private git repositories (Gogs), continuous integration server (Jenkins CI), code quality inspector (SonarQube), private artifact repository (Nexus) and private Docker image repository (Docker Registry). The complete Continuous Integration solution set up is shown in Figure 5.

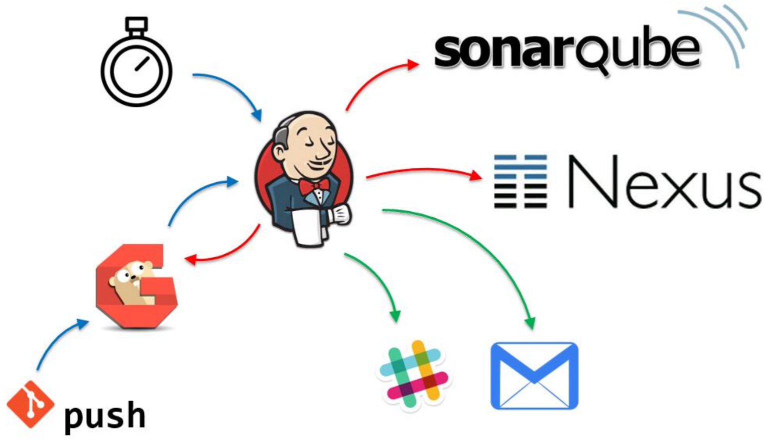

Figure 5. CI tools setup

Documentation, state of the art, architecture design of the products developed in each task, sequence diagrams, etc. has been compiled and provided in deliverable D3.1 that was submitted in M12. All the updates and corrections will be documented under deliverable D3.2 in M21.

The results are presented by task, as WP3 is related to INTER-LAYER and the main goal of the product is that every solution was modular and used depending on the interoperability pattern, use case and scenario.

2.4 Progress

2.4.1 Work Package 3 - Layer Interoperability

Progress by task

Task 3.1: The work carried out in this task has been focused in the design and software development of the different modules of the physical/virtual gateway. The work started merging ideas, structure and patterns from four already existing IoT Gateways: (i) Prime IoT (product of RINICOM partner), (ii) BodyCloud (product of UNICAL partner), (iii) Python IoT Gateway (product of UPV partner) and (iv) Eclipse Kura (open source). However, even if the work has been inspired by those existing gateways, all the code has been written from scratch.

Most of the OSGi bundles (and framework wrapper) are in last stages of development including: Gateway Framework, Access Network Controller, Protocol Controller, Device Controller, Registry, Device Manager, Dispatcher, Measurement Storage, Configuration, Physical Core Module, Virtual Core Module, Connector, Commons, Middleware Controller, Logging and some extensions (API, Console, Orion MW Controller, PanStamp Device Controller).

Currently most of the effort is devoted for bundles planned for the second half (mainly focused in Device Interoperability so they need a functional gateway as a basis), including: Discovery, Rules

Engine and future extensions are being planned (for middleware and device protocols/access networks).

Task 3.2: INTER-IoT solution for N2N layer is based in the use of two innovative technologies, on one side SDR (Software Defined Radio), and for the other, SDN/NFV (Software Defined Networking/Network Function Virtualization).

SDR allows for an adaptable entry point to INTER-IoT. Progress to date has seen us implement a bi-directional packet based OFDM system running on a Picozed SDR 2x2 development platform. We are developing the INTER-IoT SDR on a Xilinx Zynq-7000 with dual ARM-A9's processors. They are surrounded by programmable logic (FPGA fabric), the agile RF transceiver is the Analog Devices AD9361. GNU radio blocks have been created and modified to facilitate this process.

From the other side, SDN/NFV provides seamless integration between virtual elements within our INTER-IoT deployment. The creation of this software-defined network with a controller adapted for the IoT deployments is being performed. Currently, modules related with information about the topology, and information about the content and configuration of the virtual switches we are going to manage are developed.

SDN/NFV component as explained in the result section is based in the RYU controller, although some activity has been performed with other widely used controller as Open Day Light. The activity in the task will serve as support for large scale deployments, mobility of devices between different gateways in the same network and for QoS management. T3.1 gateway will include a SDN/NFV module in order to be integrated, if required, in a networked environment.

Task 3.3: Activities in this task have been aligned with the establishment of an abstract middleware layer and subsequent attachment of IoT platforms to it. These attachments have been established using bridges, which connect the platforms to the abstraction layer, and thus avoid the need to interconnect all platforms among themselves in a P2P fashion. We also provided a mechanism for their communication within this layer. The critical part of bridges development is related to correctly translating IoT platform semantics to a common representation. This part of the task is still in progress (see below) and directly linked with T3.5 and T3.6 as there is a need of a cross-layer coordination.

The communication mechanism within the MW2MW layer was implemented through the deployment and usage of a message broker (the solution is based in apache kafka[21]). We also developed a general broker API, upon which we built all the communication within middleware, while at the same time hiding away the actual message broker implementation and thus enabling interchangeability of these.

In order to facilitate an optimal communication between all internal MW2MW components, we used a common data model, which we based on the ontological reference metadata model that we created in INTER-IoT (T4.2). It includes core components that are shared between IoT platforms that have been identified standardized in ontologies. Through a common data model, we both improved efficiency of internal data transfer, as well as allowed components to make assumptions about structure and content of data. Thus, we enabled the internal MW2MW components to implement functionalities, specific to the IoT domain, and offered them in one common data model. The definition of the common data model is incremental, as it depends on developments in other layers, analysis carried out in WP4 and functionalities exposed by IoT platforms. This also affects the efforts

[21] https://kafka.apache.org/

needed to develop a fully functional bridge by any platform owner or operator in order to interoperate with INTER-IoT.

We lifted the models of platforms participating in communication through MW2MW to ontologies and semantically translated them in the IPSM component. With this, we achieved the possibility to express commonalities between data models of IoT platforms in a unified way that is in a common model, despite the possibility of having different semantics.

Intensified collaboration among key partners involved on INTER-MW message definition resulted in adopting the W3C standard JSON-LD as common INTER-IoT language. JSON-LD directly references ontology entities and represents data via "triples". An important reason for the selection of JSON-LD as common data format is that triples can be subsequently persisted in a "triple store" and queried via SPARQL query language. This allows us to speed up the implementation of Discovery and Registry services as well. In particular, SPARQL queries can be used for any kind of discovery mechanism. A good example of an open source triple store is Parliament. For that reason, we have deployed and tested it, and we are using this solution. Finally, we define JSON-LD as the common language and triple store(s) for INTER-IoT metadata persistence and query/discovery.

Task 3.4: IoT Platforms have several IoT Services and these use to be domain-oriented and very heterogeneous, this may happen to become a problem for interoperability. This heterogeneity hinders the interoperation and communication of the services, for that reason some solutions in form of protocols or paradigms have tested to solve the interaction problem. T3.4 is dealing with interoperability at this level.

After the state of the art analysis, we have designed and developed a solution related with Flow-Based Programming as a paradigm that defines applications as “black-box” process, which exchange data through predefined connections with message passing for the Application and Service Interoperability Layer. These black box processes can be connected to create different solutions without the need of being modified internally by an end-user.

The tool provided by this working environment has been studied in depth, and a new solution is being developed based on it adapted to the specific needs of INTER-IoT. In order to offer all the desired functionalities of interoperability among services. We are adapting and modifying the needs related to cross layer, studying what it offers and what we can offer at the level of security and authentication and at the framework level with the APIs that will be offered.

We have put effort into developing solutions to enable a number of IoT services to be available in our development environment. Therefore, developers can implement new methods of accessing services, and users have access to those services. The advantage of interoperability at this layer is the possibility of creating a catalogue of services from different platforms

Access to IoT services has been achieved by accessing its REST APIs and wrapping them through a node with a series of functionalities for the user. For those services that do not have REST API other alternatives have been looked for, for example, in the accesses to SOAP web services or adapting the existing libraries to the language Node.js.

For now, these services are offered to the user when registering them in their environment, but we are working on a more complete solution for registration and discovery of services platforms, that will be provided in the next release.

Task 3.5: Initially we performed a detailed state of the art regarding other projects activities and contributions in the field of semantic interoperability, tools for matching and merging ontologies, tools for lifting different data formats to ontologies. A set of tools was selected that can assist the user in ontology and alignment preparation (results are part of scientific dissemination; they will be considered in WP5). Later, the functionalities of the Inter Platform Semantic Mediator (IPSM) were identified and the architecture of the solution was designed.

The work done in T3.5 has been focused on the development and implementation of the IPSM component, specifically the semantic translation functionality. Semantic translation (according to the design) is based on ontology alignments and deployment-specific central ontology. The central ontology is based on the GOIoTP (output of task T4.2). It has been decided that IPSM will be configured with ontology alignments between IoT artefact and the central ontology (uni- or bidirectional). Additionally, the format for storing alignments was defined along with API to be used by other INTER-IoT products.

Besides the implementation of the translation process, sample data and utility tools to test the solution have been prepared.

Task 3.6: In order to provide interoperability methods between layers, not just at the same layer level, we provide cross-layers functionalities for this interaction. On one hand, the design of open APIs to exchange information between solutions and with Inter-FW, to achieve that all components in each one of the layers can be accessed by external applications.

On the other hand, a complete study of security mechanisms to provide reliable and trustable access to each one of the layer solutions. Thus, authentication and access control mechanisms to enter in the applications of each one of the layers are being designed and will be implemented in the near future.

Finally, different bridges will be deployed as a shortcut to connect one layer to the other, for example, the access from the middleware to the IPSM translator, something basic for the correct performance of the system or the creation, at application level, of different Nodes to connect with the other solutions; IPSM, Gateway, etc. In addition, the interconnection between virtual gateways and with the platform will take place through the SDN network designed in T3.2.

Table 4. WP3 Partner contribution summary table

Partner	Main Contributions
UPV	• State of the art of all tasks (T3.1 to T3.6) and also technical documentation (architecture, design) of tasks 3.1, 3.2, 3.3, 3.4 and 3.6 • Development of project structure and different bundles for the Physical/Virtual Gateway (T3.1) • Installation, configuration and modification of modules of the SDN solution (T3.2) • Support for INTER-MW development, including integration of INTER-MW demo for IoT Week (T3.3) • Definition and development of specific nodes and flows for IoT Service Interoperability (T3.4) • Developed testing module for IPSM (T3.5) • Collaborated in the study and definition of security mechanisms and other Cross-Layer components (T3.6) • Created and maintained all development tools and infrastructure.
UNICAL	• Collaborated in the state of the art of tasks 3.1, 3.4 and 3.6 and also technical documentation (architecture, design) of tasks 3.1, 3.3 and 3.6 • Development of modules for the Gateway (T3.1) • Definition of APIs and implementation of modules for INTER-MW(T3.3) • Definition of demo scenario for Device Discovery (T3.3).

	• Analysis and testing of IoT services of Microsoft Azure (T3.4) • Implementation of changes in Node-Red GUI and functionality nodes (T3.4) • Collaborated in the study and definition of security mechanisms.
PRODEVELOP	• Collaborated in the state of the art of tasks 3.1, 3.3, 3.4, 3.5 and 3.6 and technical documentation (architecture, design) of tasks 3.3, 3.4 and 3.6. • Review of the architectural solution of T3.1 and T3.2 • Analysis and contributions to the global architecture for T3.3 and T3.4 • Creation and configuration of various modules for INTER-MW (T3.3) • Development and integration of the Inter-MW Demo for IoT-Week (T3.3) • Analysis of services in FIWARE, creation and modification of several nodes (T3.4) • Collaboration for the AS2AS IoT-Week demo (T3.4) • Participation on IPSM workshop and analysis of FIWARE and UniversAAL syntax and semantics (T3.5). • Collaboration in the analysis of security solutions and definition of security modules (T3.6). • Study of platform level security in FIWARE (T3.6). • Contribution to the overall architectural coherence, boundaries with WP4 modules and coordination with other software results.
TUE	• Collaborated in the state of the art of tasks 3.1, 3.2 and 3.4 and technical documentation (architecture, design) of tasks 3.1 and 3.2. • Development an Access Network Interface for serial data to communicate with the INTER-IoT Gateway (T3.1). • Design the integration of QoS component over Ryu controller (T3.2). • Review and test various SDN implementations, Ryu and POX between them (T3.2) • Implemented the North- and Southbound command line interfaces of INTER-IoT SDN and QoS module components and design of the GUI of the QoS component (T3.2). • Design of security mechanisms for SDN and QoS, and development of security mechanisms for CLI (T3.6)
VPF	• Collaboration in the state of the art of tasks 3.3 and 3.4 and technical documentation (architecture, design) of tasks both tasks • Set-up development environment of WSO2 and definition of Device registry module (T3.3) • Documentation, demo definition and development of PCS node (T3.4) • Search of logistic data and testing of triple-store Parliament (T3.6)
RINICOM	• Collaboration in the state of the art of tasks 3.1, 3.2, 3.3, 3.4 and 3.5 and technical documentation (architecture, design) of tasks 3.1 and 3.2. • Design and development of PRIME-IoT gateway (T3.1) • Development of AN modules for the Gateway compatible with PRIME-IoT (T3.1) • SDR selection of development platform, firmware development, hardware implementation and testing (T3.2) • Review IBM Bluemix platform and D2D bridge interface, hpwever it was (T3.3). • Collaboration exploration of node-RED with Docker (T3.4). • Review and contribution on D2D bridge interaction with IPSM (T3.5). • Analysis of HL7 and development of requirement for INTER-Health (T3.5).

	• Creation of repository for both SDR and PRIME-IoT, currently in a private area to be moved to INTER-IoT repository.
XLAB	• Collaboration in the state of the art of tasks 3.2, 3.3, 3.4, 3.5 and 3.6 and technical documentation (architecture, design) of tasks 3.3 and 3.4. • Task management, architecture, implementation, testing and API documentation of several components (T3.3) • Coordination of INTER-MW development, including integration of INTER-MW demo for IoT Week (T3.3) • Introduction of semantic message format implementation into INTER-MW (T3.3). • Analysis of related technologies, examples and testing of Node-RED (T3.4) • Review message format implementation (T3.5) • Support of MW2MW to open call partners (T3.3)
SRIPAS	• Collaboration in documentation and state of the art of tasks 3.3, 3.4, 3.5, 3.6 and technical documentation (architecture, design) of tasks 3.3 and 3.4, 3.5 and 3.6 • Design, implementation and configuration of messaging component and helper tools (T3.3) • Collaboration on INTER-MW and DS2DS Demo for IoT-Week (T3.3 and T3.5) • Analysis of Node-RED and Hypercat, design and implementation of nodes and flow samples (T3.4) • Research on tools that can be used to assist the used in preparation to add platforms with and without explicitly defined semantics. (T3.5) • Design of the semantic translation mechanism based on ontology alignments.(T3.5) • Design and implementation of a prototype for the Inter Platform Semantic Mediator (IPSM) (T3.5) • Design of the INTER-IoT Alignment Format specification (T3.5) • Design and implementation of the PSM component (T3.5) • Document REST API of the IPSM component (T3.5). • IPSM Dashboard web application (T3.5) • Design and implementation of mechanisms to secure DS2DS components (T3.6)
ABC	• Collaboration in documentation and state of the art of tasks 3.1, 3.2, 3.3 and technical documentation (architecture, design) of task 3.3. • Set up environment for T3.1 (installation of dedicated machine with software tools, getting familiar with the tools, understanding task and dependencies). • Contribution to the general architecture (T3.1 and T3.3) • Understanding the work needed, analysis of existing platforms (T3.3)
NEWAYS	• Collaboration in documentation and state of the art of tasks 3.1, 3.2, 3.5, 3.6 and technical documentation (architecture, design) of tasks 3.1, 3.2 and 3.3. • Development of planning and organise progress meetings (T3.1) • Development of modules for the Gateway (T3.1) • Collaboration in the Gateway Wiki documentation (T3.1) • Collaboration on INTER-MW Demo for IoT-Week (T3.3) • Deployment of share instance of OM2M bridge (T3.3)
SABIEN	• Collaboration in technical documentation (architecture, design) of tasks 3.3

	• Collaboration with Inter-MW Demo for IoT-Week: Preparation and hardware material. (T3.3) • Development of universAAL Bridge and provide insight about universAAL platform to task leaders when requested (T3.3)
TI	• Collaboration in documentation and state of the art of tasks 3.1 and 3.5.

2.4.1.1 Results

Results by task

Task 3.1: Main result obtained in this period is a fully functional gateway separating the physical and virtual part for heavy tasks (architecture shown in Figure 6). As stated in the progress section, all the core bundles required that cover basic functionalities of the gateway are in last stages of development and multiple tests and demos using PanStamp devices and FIWARE IoT Middleware have been successfully carried out.

Finally, technical documentation related with the gateway architecture and functionalities has been produced: deliverable D3.1 (already submitted) and D3.2 (under preparation) with the state of the art and technical specification of the D2D solution, deliverable D4.3 (under preparation with the technical relation between the Gateway and INTER-FW and the Gateway Wiki documentation.

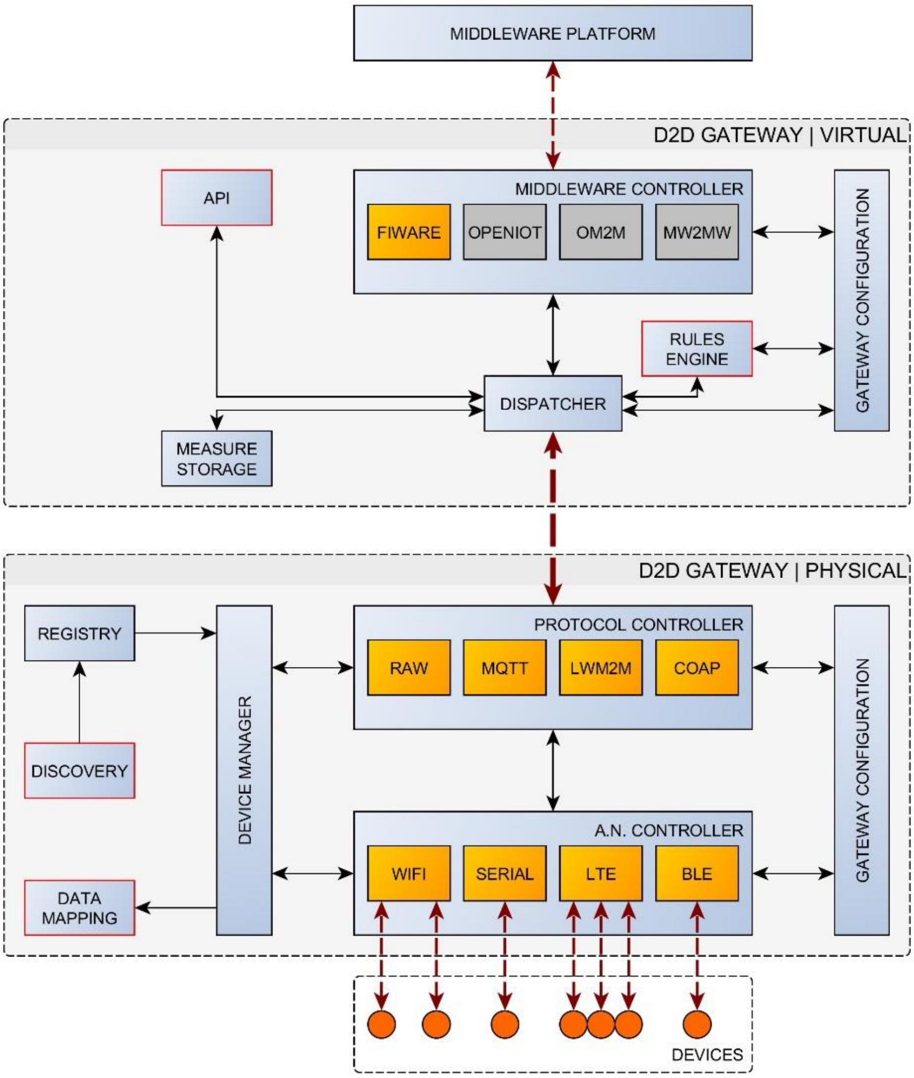

Figure 6. Physical-Virtual Gateway architecture

Task 3.2: For the SDR solution, transmit and receive functionality has been achieved. The baseband sample rate is 520 kHz as this is the fastest that the current configuration can deal with. Current work operates at around 1.4 GHz (1.4GHz and 1.38GHz) but this could be changed via the IIO configuration. The data interface into the system is being created so Ethernet traffic can be passed to the SDR component and thus INTER-IoT. Control over the systems operating frequency is achieved.

For the SDN solution (architecture can be seen in Figure 7), we installed and configured a complete virtual network with the switches provided by OpenVSwitch (OVS) technology and modified the chosen controller Ryu, in order to provide new functionalities following our requirements. Moreover, we started the implementation of the quality of service module, a command console to manage switch configurations within the network and a graphical web interface to visualize the topology and information of the network, information about the switches: its tables, port and flows, and information about the QoS configuration of the network, including meters, queues, differentiation of services, etc.

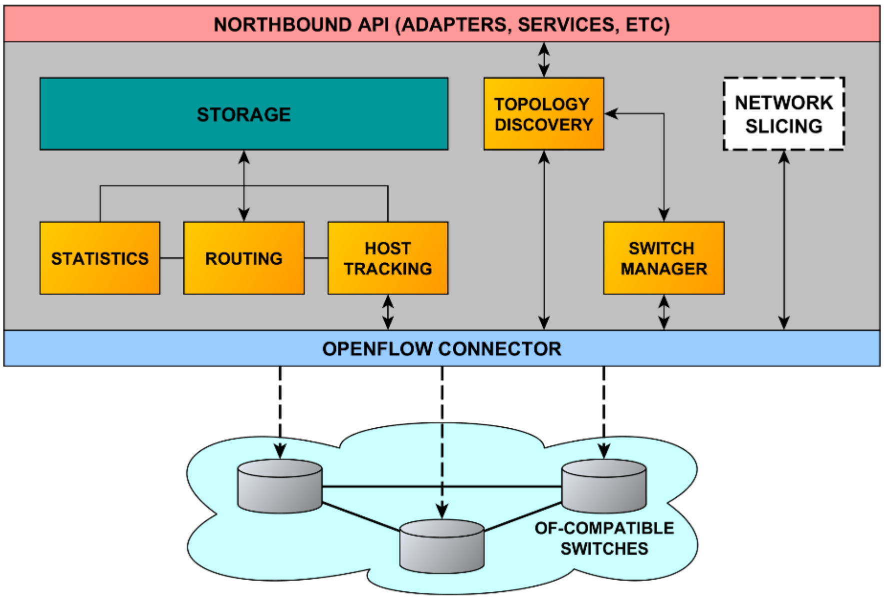

Figure 7. SDN for IoT interoperability solution architecture

Task 3.3: Main contribution is the implementation of the Communication & Control modules, a data flow manager, and a platform request manager. Next to them, we also implemented an abstract broker API, through which we can use multiple broker implementations (RabbitMQ, Kafka, etc.). We created initial versions of bridges to selected IoT Platforms, defined the data model, established the messaging and prepared the API's for WP4. In Figure 8 we can see the architecture of MW2MW solution developed in this task.

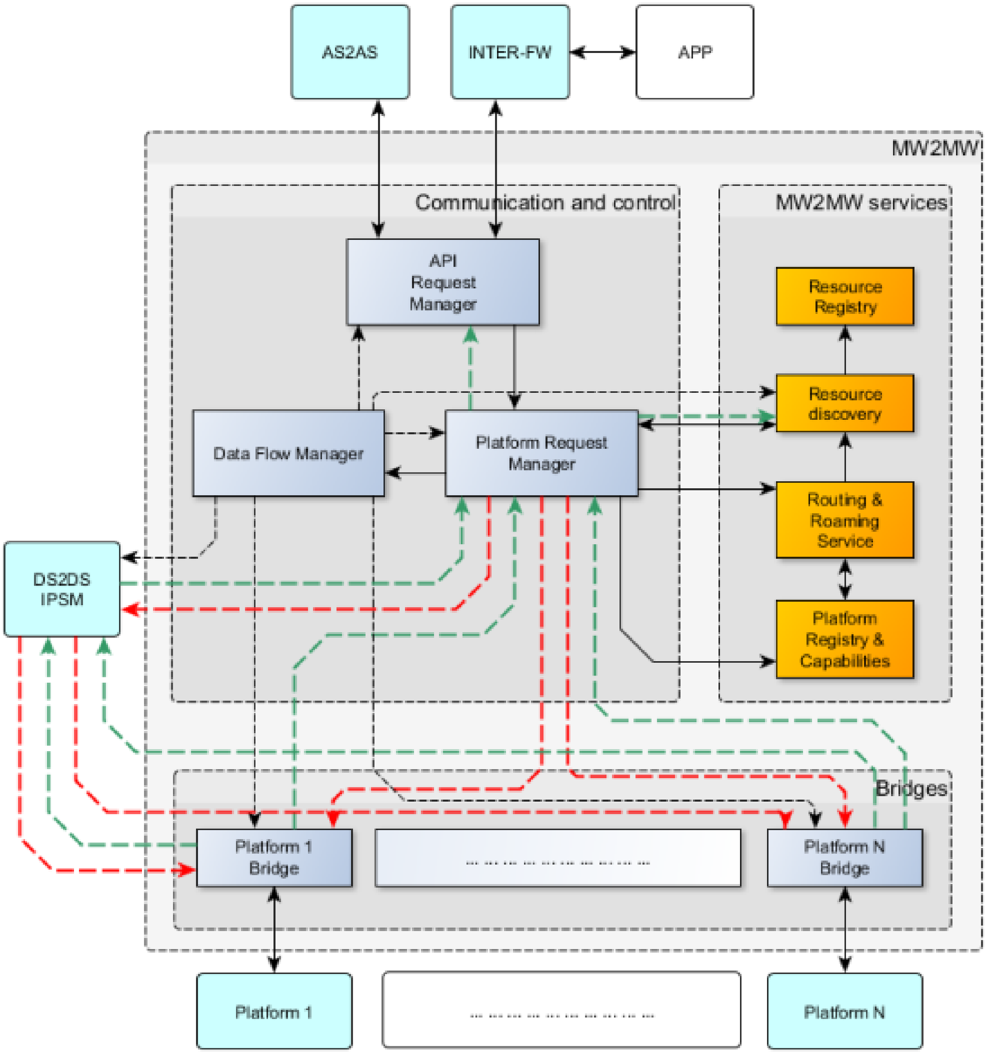

Figure 8. MW2MW architecture

We validated the MW2MW in the IoT-Week Demo in Geneva. More details about the results of our work can be found in deliverable D3.1 and forthcoming D3.2.

Task 3.4: Main result is the INTER-IoT AS2AS interoperability tool and the different services that currently have nodes to be included in it (i.e. FIWARE PROTON, FIWARE STH, Valencia Port PCS and IPSM), as well as several documentation in order to provide new services to be connected to the INTER-IoT AS2AS interoperability tool. In Figure 9 we can see the architecture of AS2AS solution.

A validation of the AS2AS interoperability solution was presented in the IoT-Week Demo in Geneva, where a service composition between different IoT applications was successfully achieved.

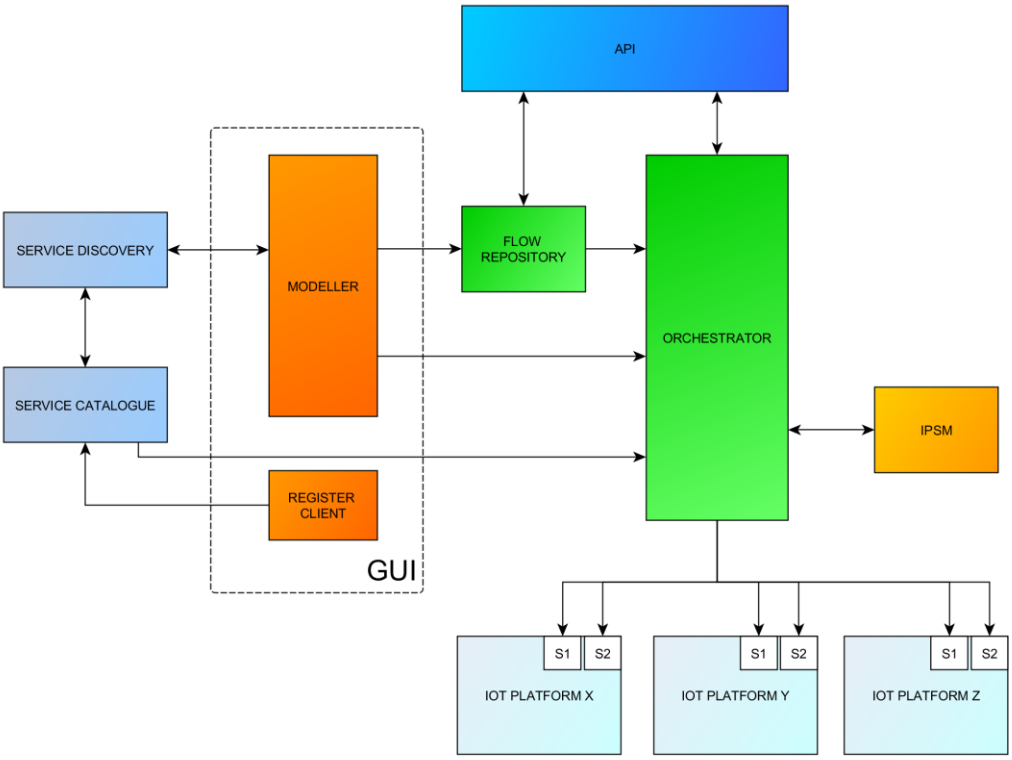

Figure 9. AS2AS solution architecture.

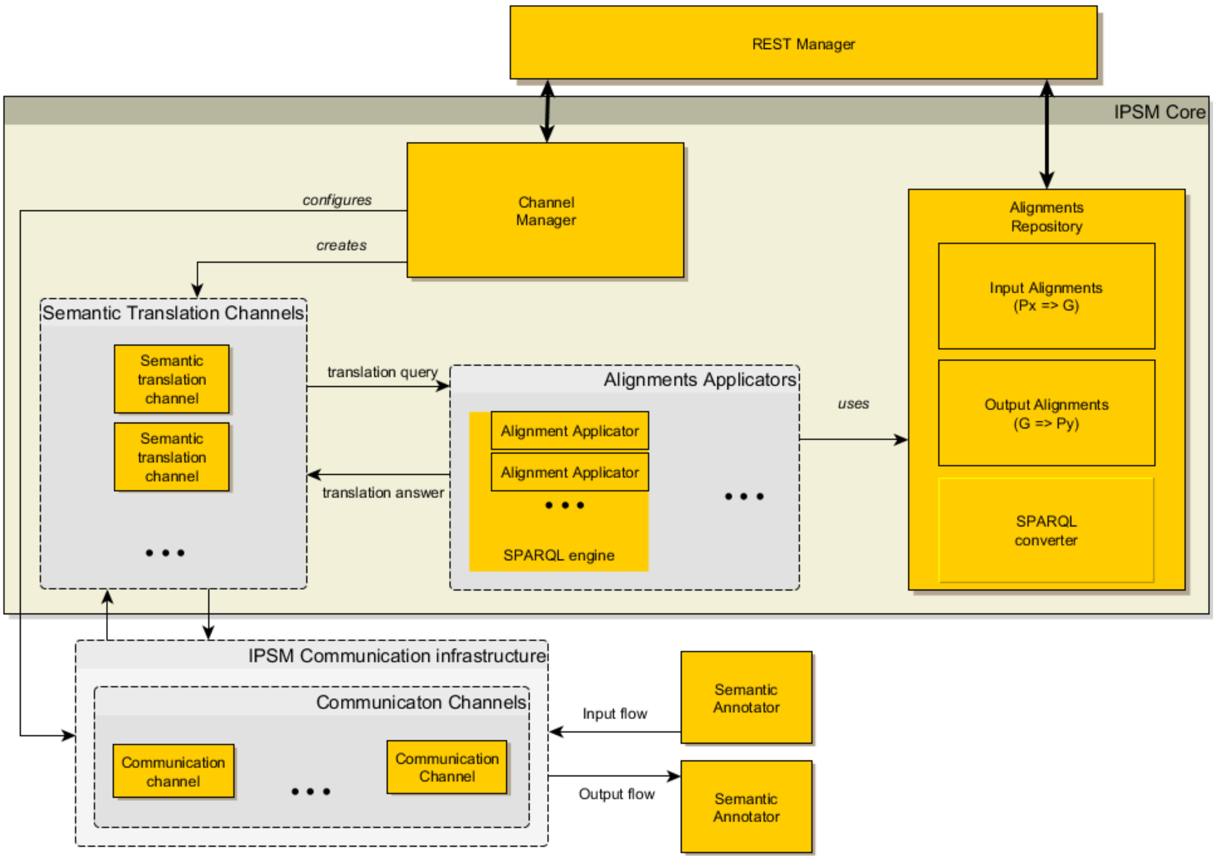

Figure 10. IPSM architecture

Task 3.5: The results on this task so far include the research on tools that can be used to assist in the preparation to add platforms with and without explicitly defined semantics - input to the methodology for achieving semantically interoperable IoT platforms. Also, the design of the innovative semantic translation mechanism based on ontology alignments and the design and implementation of a prototype for the Inter Platform Semantic Mediator (IPSM), architecture shown in Figure 10. In addition, the materials published in the git repository included proof of concept (light) implementation, sample messages and scenarios to present how the utilization of IPSM will look like. Moreover, the design of the INTER-IoT Alignment Format specification (formalized as XSD) and the design and implementation of the Inter Platform Semantic Mediator (IPSM) component that implements the alignment-based semantic translation for RDF, have been performed. The documentation of the REST API of the IPSM component to enable easy integration. The IPSM Dashboard web application that provides GUI to configure and manage IPSM component.

A validation of this task was presented in 9th Asian Conference on Intelligent Information and Database Systems and a scenario for semantic translation between four platforms were shown in IoT-Week 2017.

Task 3.6: Since this task is devoted to the common components between layers and elements aiding for layer interaction, all results are included as part of the components developed in the other layers. Main contributions from this task to INTER-LAYER are: APIs developed in each layer to interact with other layers (including Nodes for Node-RED), IPSM component for INTER-MW, and specific docker image of the virtual gateway to test the deployment of the N2N solution.

In addition, all security mechanisms that will be implemented in WP3 and WP4 have been designed and studied as part of this task; since there is a tight relationship between the security implementations in each layer and the security backend and mechanisms developed for INTER-FW. E.g., all credentials to access the interoperability solution components in each layer are stored in the backend developed as part of INTER-FW. A figure describing these security mechanisms can be found later in this document (Task 4.3).

As requested in the technical review in R7 the PPR identifies the contribution of every partner to the different sw artifacts developed within the project, not only the gateway but all the other components.

Table 5. Gateway partner contribution summary table

GATEWAY	Contribution
UPV	• Developed project structure and build tasks- Developed physical and virtual initialization framework • Developed modules: Commons, Registry, Device Manager, Physical core, Virtual core, Connector, Configuration, Console, Logging, Api, Orion MW Module • Collaborated in modules: Protocol Controller, AN Controller, Dispatcher, MW Controller
UNICAL	• Developed modules: Protocol • Controller, Protocol modules with the first implementation of CoAP module
TUE	• Developed modules: communication over serial. • Developed libraries: interface of AN Controller
RINI	• Gateway AN module development. • PRIME -IoT Gateway hardware selection and development; selection and purchase of: (i) hardware platform; (ii) firmware development; (iii) hardware implementation and integration and (iv) development of PRIME-IoT test procedures

ABC	• Setting up environment (Eclipse, etc).
NEWAYS	• Developed modules: Commons, Dispatcher • Developed Test setup

Table 6. SDR partner contribution summary table

SDR	Contribution
RINI	• Firmware development • Hardware implementation and integration • Development of SDR test procedures

Table 7. SDN partner contribution summary table

SDN	Contribution
UPV	• Installation and configuration of virtual switches and controller. • Developed modules: web application (topology and statistics). • Modified modules: switch.
TUE	• Start implementation preliminary QoS component over Ryu framework • Developed CLI module for Ryu controller • Designed the GUI of the QoS component

Table 8. INTER-MW partner contribution summary table

INTER-MW	Contribution
UPV	• Collaborated with Inter-MW Demo for IoT-Week • Define interfaces of the code for discovery • Deploy and share an instance of Parliament. • Test and deploy an instance of Open IoT
UNICAL	• Defined API of the Platform Registry and Capability component • Implemented the Platform Registry and Capability component and its command-line test application • Collaborated with Inter-MW Demo for IoT-Week
PRO	• Creation of the communication environment (message brokers). • Development of the FIWARE Orion Bridge. • Developments and integration for the Inter-MW Demo for IoT-Week
VPF	• Start development environment • WSO2 interoperability
XLAB	• Implementation of the middleware (task management, technical architecture, implementation of common components) • Creation of INTER-MW API documentation • Coordination of INTER-MW's Geneva demo implementation • Introduction of SRIPAS's message format implementation into INTER-MW.
SRIPAS	• Implementation of Messaging component, including JSON-LD message structure, metadata and payload data models, Java interfaces for metadata and payloads • Code generator for semantic messages - Collaboration for Inter-MW Demo for IoT-Week, Integration of message structure with IPSM. • Parliament triple store as an approach to the discovery mechanisms implementation (detailed installation description and demo with SPARQL tutorial)

NEWAYS	• Collaborated with Inter-MW Demo for IoT-Week • Deploy and share an instance of OM2M bridge
SABIEN	• Collaborated with Inter-MW Demo for IoT-Week: Preparation and hardware material • Development of universAAL Bridge

Table 9. Application and Services partner contribution summary table

APLICATION AND SERVICES	Contribution
UPV	• Define structure and modules • Deploy the Node-RED environment • Creation of nodes to access to the IoT services • Leading Application and Services Interoperability Demo for IoT-Week
UNICAL	• Basic changes of the GUI of Node-Red environment • Basic implementation of nodes to show some AS2AS INTER-IoT functionalities
PRO	• FIWARE STH node • Helper nodes • Modification of several nodes • Collaborated with Inter-AS Demo for IoT-Week
SRIPAS	• Implementation of Node-RED IPSM node • Implementation of testing Node-RED flows.

Table 10. IPSM partner contribution summary table

IPSM	Contribution
UPV	• Programming of SCALA module used for IPSM testing.
RINI	• Contribution on how D2D bridge will interact with the IPSM
SRIPAS	• Implementation of a prototype for the Inter Platform Semantic Mediator (IPSM) • Design of the INTER-IoT Alignment Format specification (formalized as XSD). • Implementation of the PSM component for semantic alignment- Documented REST API of the IPSM. • The semantic translation demo with IPSM prepared for 9th Asian Conference on Intelligent Information and Database Systems, Kanazawa, Japan, April 3-5, 2017 and seminar in Aizu University, Japan 28-29.03.2017. • IPSM Dashboard web application that provides GUI to configure and manage IPSM component. • The DS2DS layer demo that was presented in the IoT-Week (June 2017).
XLAB	• Analysis of IoT Middleware messages, contribution to MW2MW message format requirements

Table 11. Security Modules partner contribution summary table

SECURITY MODULES	Contribution
UPV	• Development of security mechanisms for the Gateway and the SDN controller
TUE	• Developed security mechanisms of CLI for QoS and SDN
SRIPAS	• Design and implementation of mechanisms to secure DS2DS components

2.4.1.2 Deviations

Task 3.1: Task progressing according to the plan. No significant deviation, however after the design of the Gateway (reflected in D3.1), some auxiliary modules covering functionalities that were not planned in the initial specification have been developed (such as the Console and Logging Extension, the Physical and Virtual Core Modules that orchestrate the other bundles, as well as a generic Device Controller) and have taken effort from other (less critical) bundles.

Task 3.2: Task progressing according to the plan. No significant deviation, however after testing one of the controllers that seemed more suitable to manage the IoT virtual network, OpenDayLight, we realize in the complexity of this software and its heavyweight so we decide to pivot to another lighter, simpler and more modular software with the controller called Ryu. With this change we acquire simplicity and the capacity of customize the controller according to our requirements. At the moment, the development of the module regarding offloading is in standby until the first development iteration finish successfully.

Task 3.3: Task progressing according to the plan. No significant deviation, however as requirements changed over time, we also developed bridges for other platforms that were not originally planned, such as WSO2 (due to an evolution of SEAMS platform) and universAAL (substituting eCARE as SABIEN joined the consortium). Tasks that required significant effort have been a proper definition of the internal (message) data structure supported by a common INTER-IoT ontology definition and realisation of Registry and Discovery services.

Task 3.4: Task progressing according to the plan. No significant deviation except for the effort spent in deploying single instances of the different IoT platforms.

Task 3.5: Task progressing according to the plan.

Task 3.6: Task progressing according to the plan.

2.4.1.3 Corrective Actions

Task 3.1: As stated in the deviations section, some new (not planned) modules had to be developed; this is being documented in deliverable D3.2. As a correction measure, some effort from other (less critical) bundles has to be shifted and experienced minimum delay. Extra effort in the second half of the project will be devoted to complete the bundles that were delayed in the first half.

Task 3.2: The SDN controller initially selected (OpenDayLight) was switched for a more suitable controller (Ryu).

Task 3.3: No corrections were needed.

Task 3.4: No corrections were needed.

Task 3.5: No corrections were needed.

Task 3.6: No corrections were needed.

2.4.2 Work Package 4 - Interoperability framework API

WP4 aims to create a framework for interoperability, including a reference architecture, a meta-data model, a framework engine and an API with tools to manage and make use of the interoperable platforms. The framework will be strongly linked with the results from WP3, using each of the INTER–LAYER components to expose the features to platform integrators and third parties. Thus, the coupling with this WP3 is high, and consequently the developments made on WP3 have been agreed and coordinated with WP4 activities. WP4 results are directly linked to the potential creation of an ecosystem of developers around INTER-IoT results.

The activity of the WP4 officially started in M7 (July 2016), although as already mentioned, preliminary works were made previously in collaboration with WP3 to define the joint work, common interfaces and overall structure about the solution. These preliminary works were performed between M5 and M6 (May-June 2016) and consisted in several coordination meetings with the WP3 task leaders and WP4 task leaders to define high-level architecture, tentative calendars for collaboration and the baseline of the boundaries between the both work package, interfaces and features shared.

As planned in the official document of work, during the period under evaluation, it has been released one deliverable: “D4.1 Initial Reference IoT Platform Meta-Architecture and MetaData Model (M12) “, coinciding with one project milestone: “MS4: Initial architecture release” (M12). Apart from these official milestones of the calendar, additional milestones were set, in agreement with the coordination of the project and all the participant partners. The objective of these intermediate deadlines has been to consolidate the interim results and set baselines to enable the coordination between tasks and subtasks inside the work package. These intermediate milestones were: INTER-FW Use cases analysis – V1, INTER-FW Specification – Draft; INTER-FW Architecture specification – V1. INTER-FW Frontend analysis and mock-up – Draft; and INTER-FW Backend analysis – Draft. The documents will be partially or completely included in the forthcoming deliverable D4.3 “Interoperable IoT Framework Model and Engine V1 “.

The structure of this WP describes an early start of the conceptual design and definition tasks (T4.1 and T4.2) in M7 prior to start of the software development tasks (T4.3, T4.4 and T4.5) in M13.

2.4.2.1 Progress

Progress by task

Task 4.1: The task is progressing as planned. Partners had a kickoff as soon as the WP started, in M7 with a specific workshop in Madrid, and precise plans for the whole duration of the task were drafted. The focus of this task is mainly to establish a Reference Architecture which should be used as a base for further developments in the WP and in the whole project.

The plan has been followed during the period under review: Deliverable D4.1, which sets a solid base for the Reference Architecture of INTER-IoT, has been prepared and submitted. Immediately after the submission of this document; the work on a final Reference Architecture and is now fully undergoing. In particular, a one-day workshop with all partners was been organized in April, in order to finalize the plan and refine the concepts for the final iteration of the INTER-IoT RA. This work revises and complements the INTER-IoT RA and Meta data model including the experience acquired during the integration, testing and pilot phases, as well as fully reviewing the modelling views proposed in the first version according the lessons learned during the instantiation of these ideas in WPs 3 and 4. The activity regarding the reference architecture has been based in IoT-A RA, and also in the activity developed in AIOTI and in INTER-IoT WP3.

Task 4.2: The objective of this task is to produce a metadata model for interoperable IoT Platforms. The model is generic and broad, encompassing the basic objects and structure of data that is a common base that enables data interoperability in IoT. After a careful analysis of the literature, previous work and needs for interoperability between IoT platforms INTER-IoT consortium has chosen OWL ontology as a format to store the model, and reuse standardized ontologies already present and implemented in the IoT space. We also designed our ontology to be modular. Reuse and modularity are core principles of ontology engineering in general, and Linked Data in particular.

The scope of the ontology, and modular structure was prepared after analysis of INTER-IoT requirements, which we took as a set of guidelines to decide what objects should be describable with our model. We have also analyzed the current state-of-the-art of IoT ontologies and chosen specific ontologies to reuse as modules in our model. We have connected the modules and filled missing scope with our own ontological axioms.

The description of the process used to construct the ontology, as well as the initial results were written down in D4.1. The activity developed in the task has a tight link with T3.5 and T5.2.

The tasks is progressing adequately, in parallel with activities in WP3, WP4 and including a support for ontologies specification and, when needed, selection in WP6. By the time of this report, the task progress is completely aligned to the execution of the rest of work package and tasks collaborating with T4.2.

Task 4.3: The main goal of the task will be the design of a framework (INTER-FW) to manage the interoperability mechanisms created in WP3 (INTER-LAYER) and through which interoperable IoT Platforms can be programmed and managed.

The task started in M13, as the rest of the software development related tasks of the work package, thus, the period reported in this document is M13-M18. The focus of the task is the design, so that a methodological approach was chosen from the beginning. Firstly, a review of the objectives, requirements and scenarios was performed. This involved the detailed analysis of the results of WP2 and its processing into use cases and technical requirements to support the implementation phase. Once reviewed the specifications provided by partners and stakeholders (T2.3 and D2.3), a definition of 'framework' for INTER-IoT was agreed and developed, defining a full set of set of functionalities and the scope of the technical solution, documented in D4.3 to be released in M21. After this, a state of the art of technologies, examples of successful frameworks with different approaches and a proposal of application in INTER-IoT was performed among all the partners involved in the task.

The architecture of the solution was designed and specified (also reported in D4.3), in collaboration with WP3 to establish the boundaries of both work packages (especially relevant the definition of the limits between cross-layer and framework features) the first version of the modular architecture was released in M14 and revised in M16. The following figure depicts the current version of this component distribution and its relation to the Layer Interoperability Infrastructure (WP3) and INTER-API (T4.5).

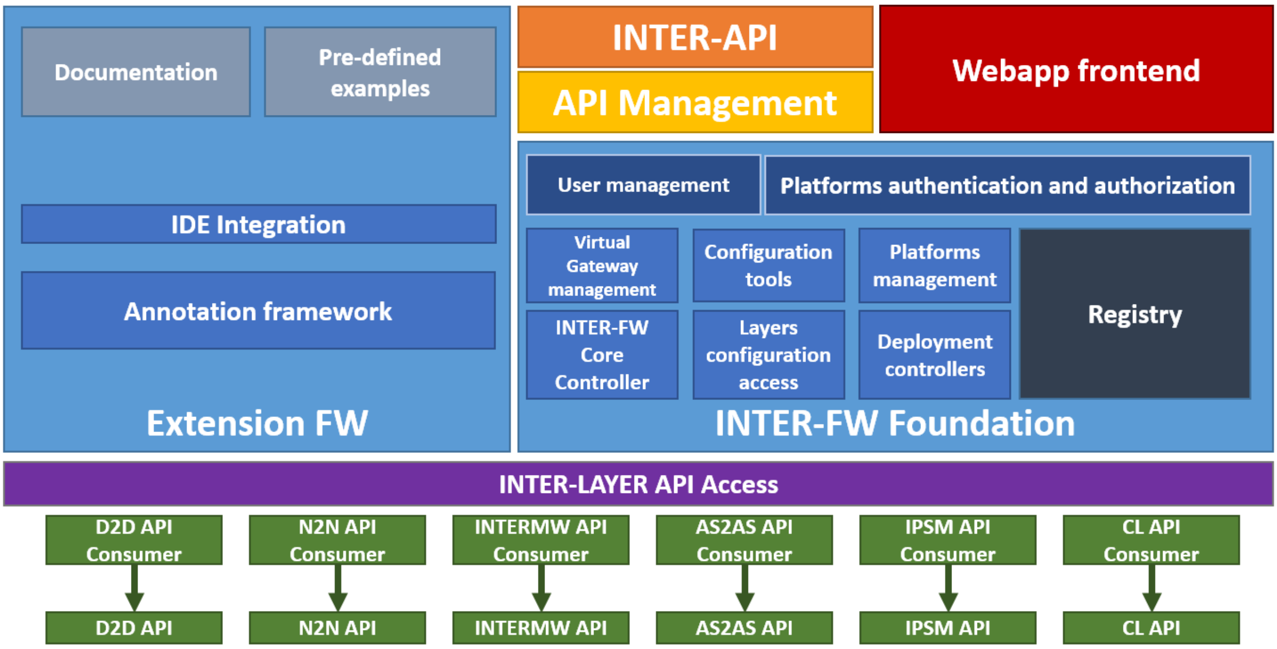

Figure 11. INTER-FW API Component Distribution

According to figure 5, the main features offered in the INTER-FW are:

- Management framework, which includes all the features to register platforms, INTER-IoT gateways, services, and the management of users access and authorization, and,
- the extension framework, a lightweight set of features to enable extensibility and future compatibility to new platforms and standards. The extension framework strongly relies in the layers design, so that WP4 only adds tools, libraries and documentation to make this extensibility easier to external developers.

After the architectural definition, a complete analysis has been made (M16-M17) considering the use cases identified during T2.4 execution and fully described in D2.4. The resulting documentation is an input for the design of the webapp fronted (completed in M18) and a reference guide for the development in T4.4.

Task 4.4: The objective of this task is the software implementation of the features designed in T4.3. Started in M13, during the period under review this task has mainly focused in the evaluation of technologies, development framework and the technological choice of the components. The activity on this task, especially the first three months has been lower than the average of the task, due to the need of having preliminary results from the design task (see 2.3.4.3 'Deviations' and 2.3.4.4 'Corrective actions' for further details).

The task has supported the design (validating intermediate results with technological viability checks) and technology selection for frontend, backend, deployment and identity management modules. In particular, for the fronted it has been analyzed the use of the React.js, Angular.js and Vue.js frameworks (Javascript), Vaadin (Java) and Bootstrap (HTML/CSS); in the backend, it has been evaluated the use of Node.js, Express JS(Javascript) and Spark Framework (Java); for deployment and virtualization technologies, it has been mainly considered the use of Docker, Swarm and Vagrant. For the authentication and authorization management, OpenStack Keystone, WSO2 IdM and Spring Security have been considered. Other full stack application development frameworks, such as MeteorJS have also been included in the evaluation.

In month M16 an the technology stack was finally selected and started the development of the webapp, including the navigation, UI components and a lightweight backend to support it. The webapp is being developed from scratch using already existing components, customizing them when needed. Currently, there is a stable version of the management application publicly available, as well as internal alfa versions available only for the consortium,

Task 4.5: This task, started in M13, aims at implementing INTER-FW as software APIs at the different interoperability layers and building connectors for devices, objects, communication services. The task is extremely coupled with WP3 tasks, since one of the outputs of these tasks is the individual API, which is the base for the T4.5 activities. During the period of this report, the task has supported the creation of the individual APIs in WP3, gathering and analyzing the description of each API.

A state of the art and technology evaluation of API description languages (API Blueprint, RAML, Swagger) was made in order to choose a single format to document the layer APIs and INTER-API, main result of this task. Swagger (OpenAPI) format has been chosen for API. Apart from this, several API Manager solutions have been considered, to support the distribution, maintenance and monitoring of the INTER-API. WSO2 API Manager has been chosen for this purpose.

The whole API infrastructure (INTER-LAYER components, INTER-LAYER APIs, WSO2 API Manager) has been deployed on Azure Cloud virtual machines in order to support the integration with the Webapp developed in T4.4 and subsequent development of demonstrators (project review; WP6 use cases; Open Call projects support).

Table 12. WP4 Partner contribution summary table

Partner	Main Contributions
UPV	• ARM and Meta-data model: ○ FIWARE functional model ○ OpenIoT functional model ○ Sofia2 functional model ○ ThingSpeak functional model ○ Communication model ○ INTER-IoT functional and communication model • INTER-FW ○ Presentation and design of mock-ups related with layers (T3.1,T3.2, T3.4 for the INTER-FW portal) ○ Analysis of security mechanisms to carry out within the framework and in the communication between framework and layers. • INTER-API ○ Analysis of the APIs related with tasks: T3.1, T3.2 and T3.4
UNICAL	• ARM and Meda-data model: ○ Butler Functional Model ○ iCore Functional Model ○ Review of deliverable ○ BodyCloud use case survey ○ Section on "Device Registration" in Butler ○ Section on "Observation" procedure in Butler ○ Contributions to D4.2 • INTER-FW ○ Agent-Based frameworks state-of-the-art analysis and report ○ Log-In use case ○ Managing platform permissions use case ○ Study of Nodered in light of the activities related to Services web pages of the web console

	○ Initial analysis of the web console security backend (gateway + services access/role control)
PRO	• ARM and Meta-data model ○ UniversAAL Functional Model ○ AWS IoT Functional Model ○ Predix Functional Model ○ Strong contribution to INTER-IOT RA, INTER-IOT Domain Model and all over the document (first deliverable). ○ Contribution to set the methodology for the task ○ Contributions to the meta-data model with the platforms used in the company (FIWARE, uAAL) ○ Functional models harmonization • INTER-FW ○ Analysis of overall navigation, global sections, middleware-level layer, user management, configuration ○ Analysis of SDF in middleware and services layer ○ Component architecture created ○ Sequence diagrams for identified use cases ○ Security analysis for platforms: FIWARE, WSO2 ○ SOTA of AP Description Languages; API Managers • INTER-API ○ Analysis of API Managers ○ Preliminary tests on API Management ○ Initial set of features for API Management in INTER-IoT
TUE	• ARM and Meta-data model ○ Review of FIWARE functional model. ○ Contribution to D4.1 ○ Contribution to OM2M message content models. • INTER-FW ○ Use case design for QoS and SDN features in D4.3 ○ Design and description of GUI and CLI interfaces for QoS and SDN features ○ Use case design for gateway in D4.3 • INTER-API ○ Development of QoS and SDN command line interfaces
VPF	• ARM and Meta-data model ○ WSO2 functional model and functional view ○ Platform interoperability and integration ○ Sota: Rest alternatives ○ Review WP4 requirements • INTER-FW ○ Front-end analysis: Analysis of requirements and design ○ Mock-up of the webapp ○ Back-end analysis: Analysis of requirements
RINICOM	• ARM and Meta-data model ○ Review of IoT-A deliverables and architecture ○ Review of IoT-A deliverables and architecture and review of "Enabling things to talk". ○ Review of IBM Bluemix/Watson platforms. • INTER-FW ○ Front end review and contributions to mock-up. ○ Back end review and contributions to mock-up.
XLAB	• ARM and Meta-data model

	◦ Contributions to D4.1 (meta architecture, All Join platform, assistance to other sections) • INTER-FW ◦ Contributions to the INTER-FW analysis document ◦ D4.3 contributions (API Sections – analysis, UI sequence diagrams) ◦ D4.3 (API sections- design) ◦ SOTA of API Managers • INTER-API ◦ Test of Swagger ◦ Unifying Swagger documentation of INTER-LAYER components ◦ Task planning and initial approach to INTER-API design and implementation. ◦ T4.5 task planning ◦ Deployment of WSO2 API Manager to Azure and definition of interfaces, users and access levels
SRIPAS	• ARM and Meta-data model ◦ Contributions to INTER-IoT Domain Model and Information Model ◦ Task planning(T4.2) and documentation including homeworks and telcos ◦ Research into existing IoT ontologies and verification with respect to INTER-IoT requirements for the metadata model ◦ Design and engineering of GOIoTP and GOIoTP-ex ontologies ◦ Multiple sections in D4.1 regarding metadata model • INTER-FW ◦ Design of semantics related views, including description of functionalities, wireframes and diagrams. ◦ Sequence diagrams for IPSM interaction ◦ GraphQL research • INTER-API ◦ Contribution to INTER-LAYER APIs specification in the form of a documented API of IPSM component.
ABC	• ARM and Meta-data model ◦ Applying IoT-A concepts to INTER-IoT ◦ Checking for consistency of contribution from all partners related to the Functional Model taxonomy ◦ Leading the work in this area ◦ Contribution all over the task ◦ Monitoring and synchronization with T4.2
NEWAYS	• ARM and Meta-data model ◦ Review of IoT-A deliverables and architecture. ◦ Contributions to D4.1 in the communication channel section,
ASLTO5	• ARM and Meta-data model ◦ Contribution 4.1: Use cases for domain Model ◦ E-care description contribution ◦ FM taxonomy template ◦ Description Use cases for architecture in D4.1 ◦ Workshop during 5th Valencia meeting
AFT	• ARM and Meta-data model ◦ Review of metamodel and meta architecture; ◦ Contribution to Use cases for domain model; ◦ Contribution to use-cases for D4.2;

	○ Review of draft D4.2; ○ Participation in workshop during 5th Valencia meeting.
NPV	• ARM and Meta-data model ○ Use cases elicitation for T4.1 and T4.2 activities. ○ Domain specific contributions for domain model.
TI	• ARM and Meta-data model ○ Contributions to functional models

2.4.2.2 Results

Results by task

Task 4.1: The main result of the task is the design of the Reference Meta-Architecture for Interoperable IoT Platforms. The developed work is included in Deliverable D4.1 that was submitted, with a slight delay (2 weeks) due to presence of several deliverables to be finished at the same time (including the resubmissions requested after the review in October) and the Christmas holiday season. The delay was agreed with the PO in order to accommodate some reviewed content from some deliverables requested after the technical review.

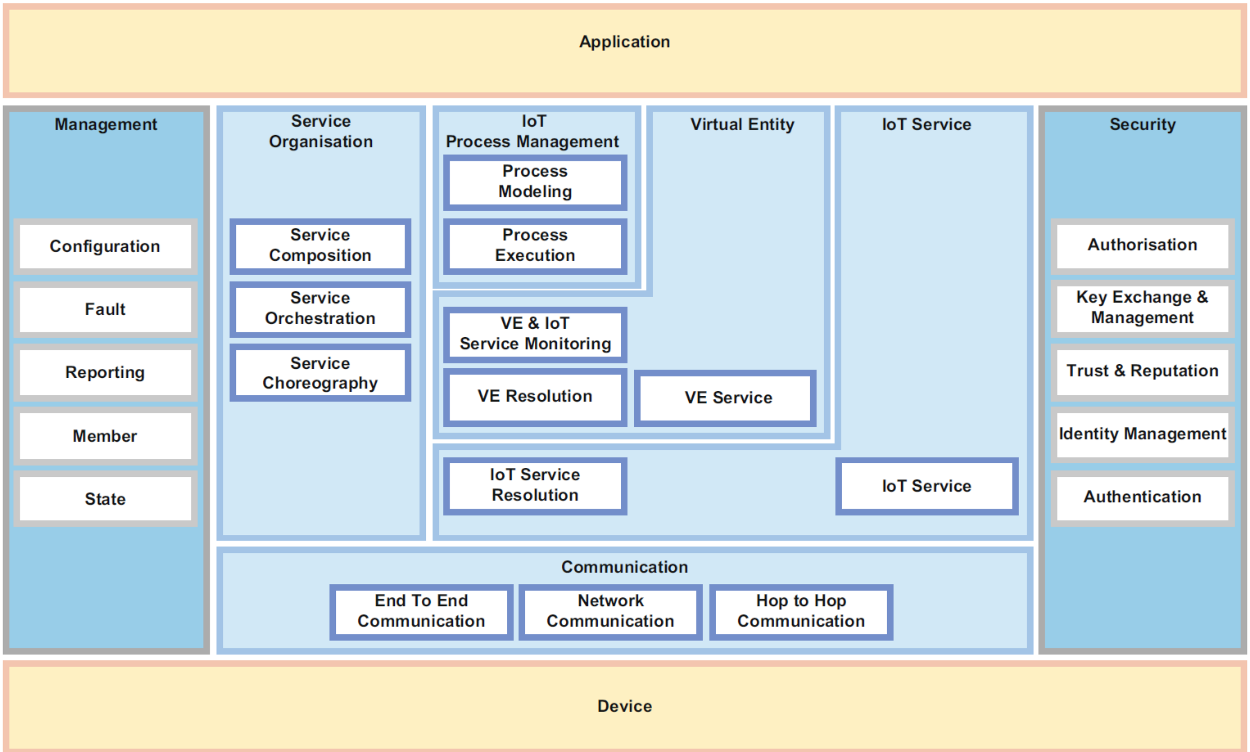

Figure 12 Functional view of the INTER-IoT Reference Architecture

In figure 6, it is depicted one of the results of this task, wich consists in the revion the functional view of IOT-A reference architecture to address the specific case of the interoperability mechanisms of heterogeneous IoT platforms (instead of single IoT platforms definition proposed in IoT-A).

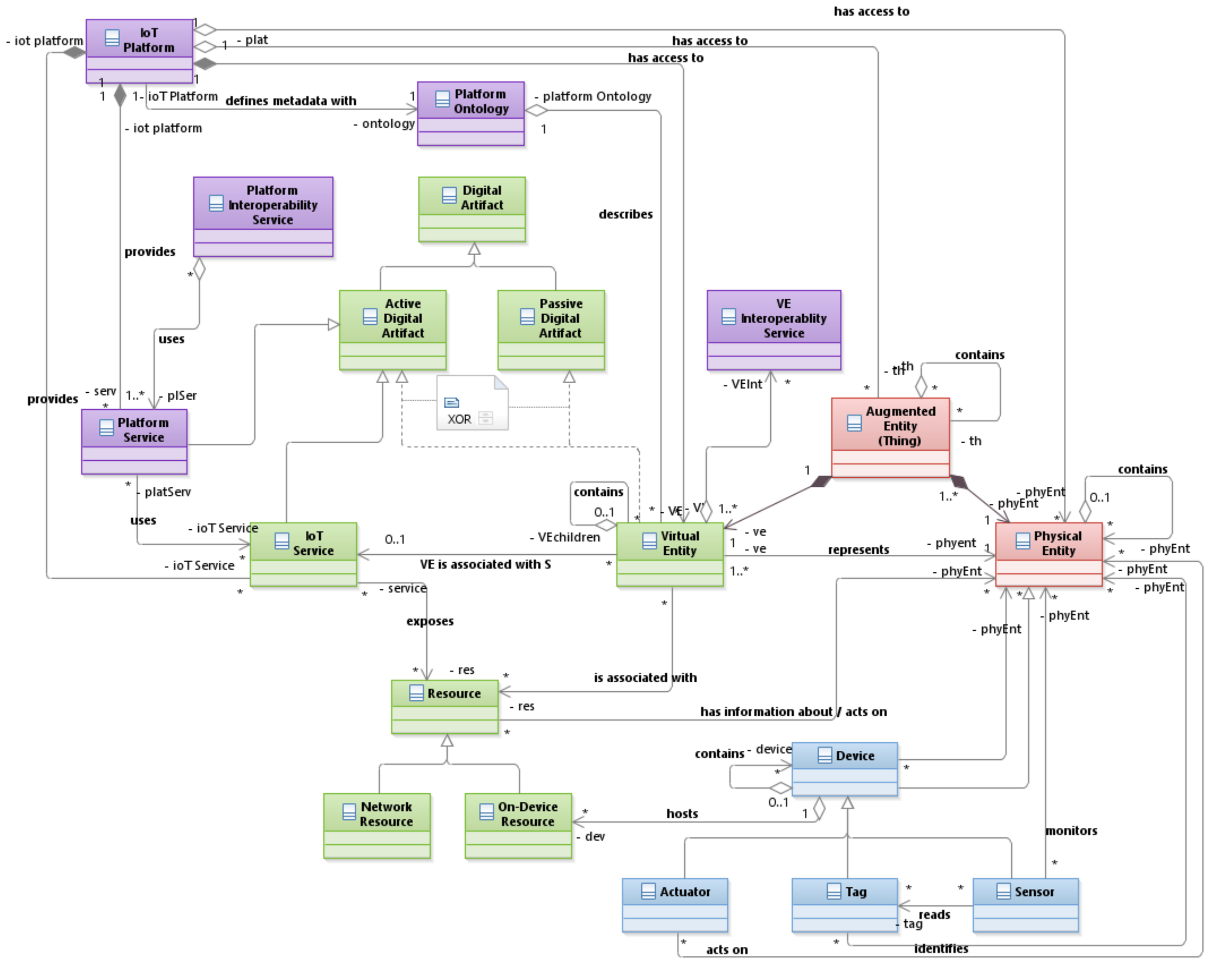

Figure 13 Interoperability of IoT platforms Domain Model, as proposed in D4.1

In the diagram above (Fig. 7), it is showed another important result of the first period of T4.1. It depicts the proposed domain models for platforms interoperability, which sets up a reliable reference to build the different interoperability layers, as proposed in the project, sharing a common domain model with univocal concepts and well defined functionalities.

The final version of the architecture is under development and it will be released in deliverable D4.2. (M24).

Task 4.2: First result is the initial version of the model in the form of two ontologies. GOIoTP (Generic Ontology for IoT Platforms), which is a model that provides an ontological base for any IoT artifact, including INTER-IoT, to either be used directly in implementation, or to be aligned to. It covers entities most commonly required and implemented in IoT ontologies. We also included entities required by interoperability systems (such as INTER-IoT) that are not usually a part of IoT ontologies (e.g. description of a platform or middleware).

GOIoTP is a modular ontology using and extending standardized ontologies, including SSN/SOSA, GeoSPARQL vocabluary, NASA SWEET and others. It is conceptually divided into modules for devices, observations, platfoms, services, geolocation, units & measurements, and 2 annotation modules: user and provenance.

And the second ontology is GOIoTP-ex, which is an extension of GOIoTP that extends it with specific entities. The division of GOIoTP and GOIoTP-ex was made to preserve the generic nature of GOIoTP, while making a more complete and usable model. For instance, GOIoTP defines a place for specification of units of measurement, but does not propose any units. GOIoTP-ex extends this model by including definitions for SI units. This way, GOIoTP is generic and can be used with imperial units (if one wishes so). At the same time INTER-IoT uses, defines and offers a specific set of units, ready to be used.

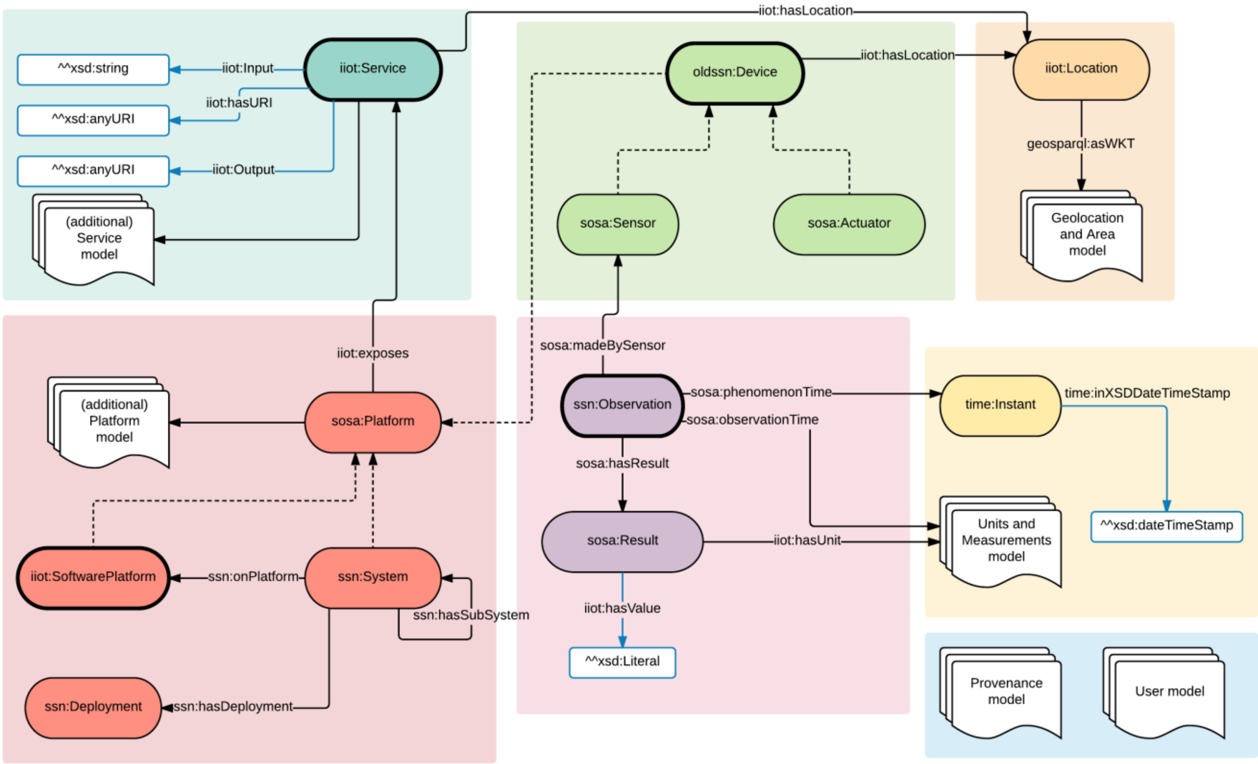

Figure 14 GOIoTP overview

Results from this task (both GOIoTP and GOIoTP-ex) are being successfully used in WP3 in INTER-MW (T3.3) messaging to define structure of payloads in messages. Our ontologies have also been used as central ontologies in initial IPSM (T3.5) tests, and will be used in pilot implementations, as well as a recommendation for IPSM central ontology in generic INTER-IoT deployments. Version 1.0 of both ontologies will be released alongside D4.2.

Task 4.3: During the period reported, this task has generated a range of technical documents aimed at supporting the development activities carried out in T4.4 and, partially, T4.5. These documents are considered intermediate internal milestones of the project, and are listed below:

- INTER-FW Use cases analysis – Version 1. Based on the use cases and scenarios originally identified by the consortium and stakeholders and reported in D2.4 (M15).
- INTER-FW Specification – Draft version (M16). Version 1 to be released in M21 as part of the D4.3)
- INTER-FW Architecture specification – Version 1 (M17).
- INTER-FW Frontend analysis and mock-up - Preliminary version (M18) (Version 1 to be released in M19 and to be included in D4.3).
- INTER-FW Backend analysis – Preliminary version (M18) (Version 1 to be released in M20 and to be included in D4.3).

This intermediate/internal documents and design components will be included in deliverable D4.3 (M21).

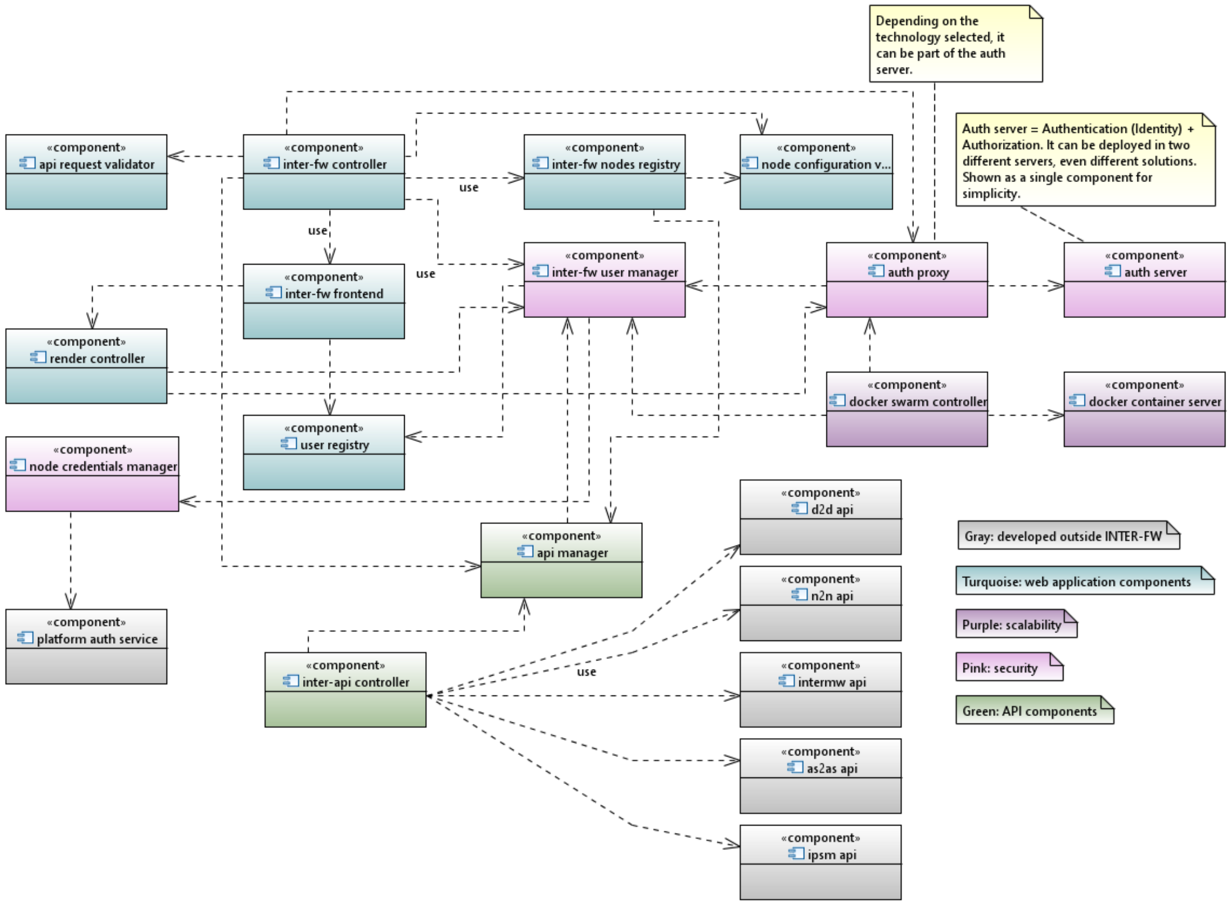

Figure 15 Component diagram of INTER-FW management framework

The figure above represents the component architecture designed for the INTER-FW web application to support IoT platforms interoperability, configuration and management. This diagram is reported in D4.3.

The backend and the frontend of the management application have been analysed and designed separately, generating a documentation which is the main support to task 4.4 (implementation). One of these materials is the global model design of the application, represented below:

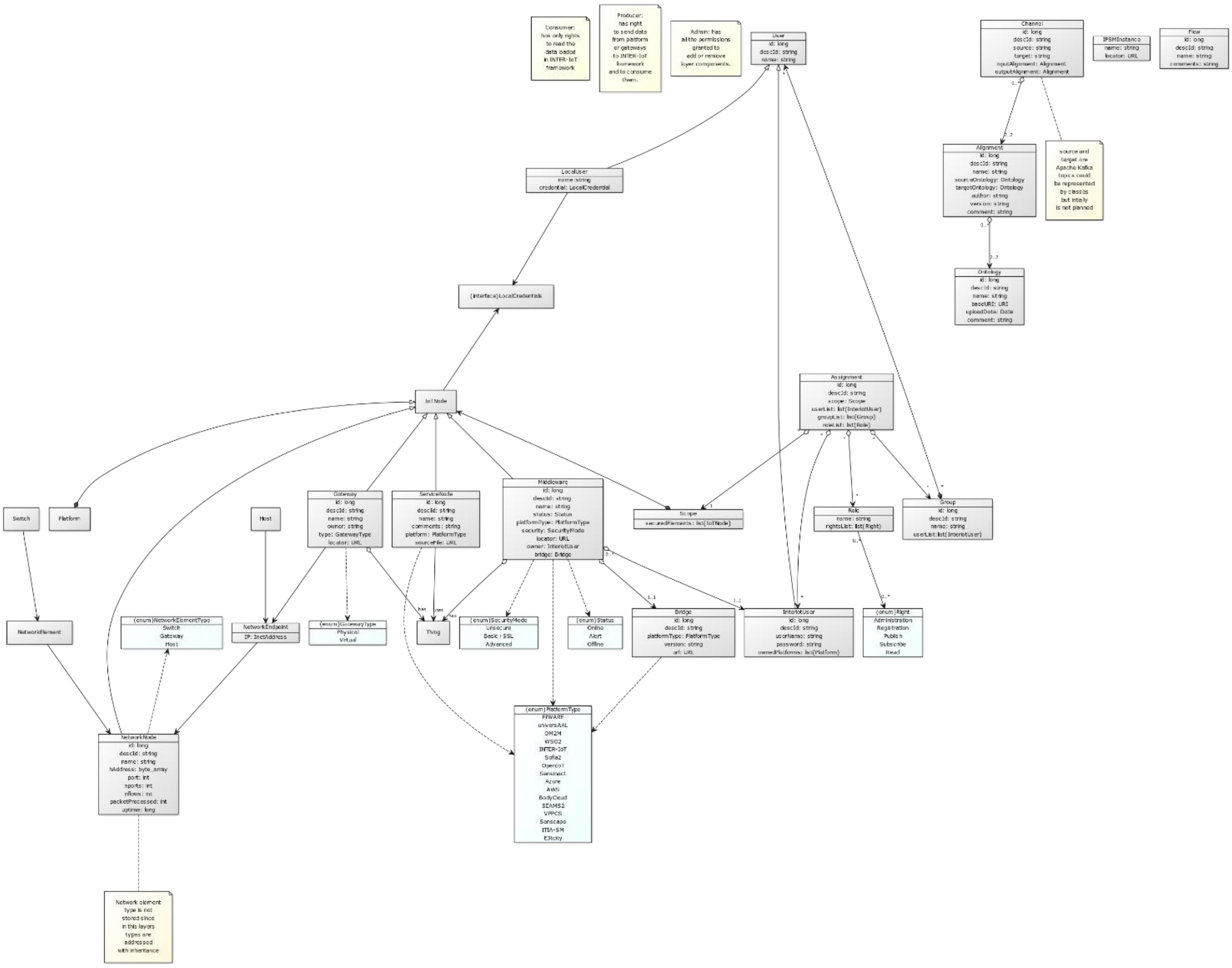

Figure 16 Application model diagram with relations

Other activity of T4.3 which has reported results is the definition of a global framework for basic security (authentication and authorization) mechanisms across the layers, multi-tenancy and scalability of the solution. The following picture sows a diagram of the main modules involved in this solution, to be developed in collaboration with T4.4 and T3.6.

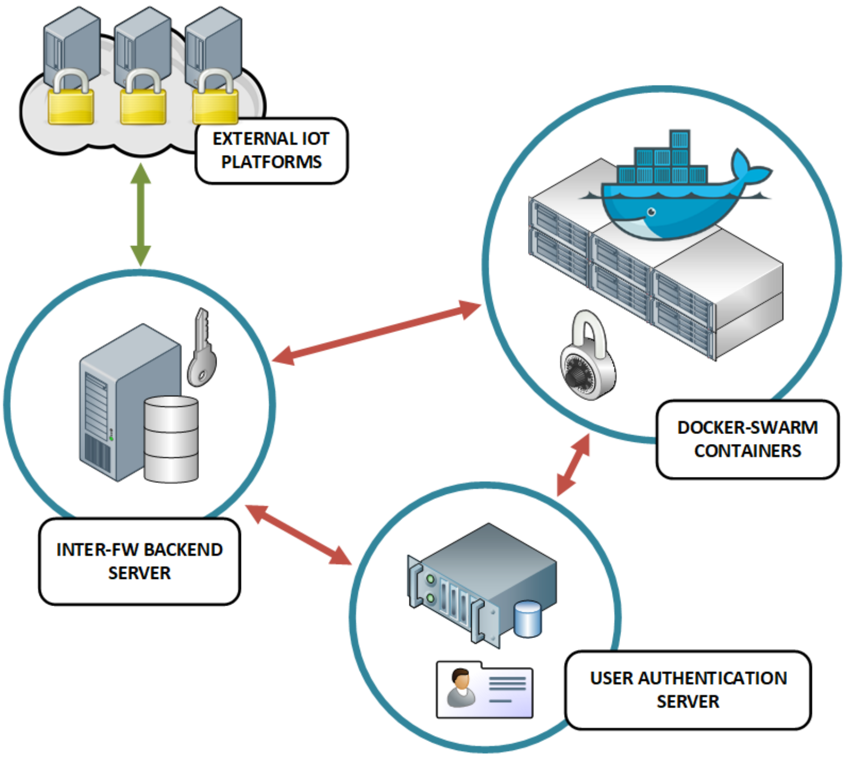

Figure 17 Generic security solution for INTER-FW and INTER-LAYER interfacing, as proposed in D4.3.

Task 4.4: The interoperable framework engine has as main goal to provide access to the interoperability mechanisms developed in WP3 and provide a coordination and management between them in order to be used by IoT platform managers, third parties and service developers that may require interoperability. The engine will have different views, and in the current period, it has been launched an alfa version of the Webapp, available publicly in the Azure test environment for the project http://vmplsp04.westeurope.cloudapp.azure.com/interiot_wfk/#.This version is periodically updated, although some tools can be unstable or unreachable sometimes, since the development of the solution is ongoing.

The Webapp shows the full set of tabs relative to each interoperability layer as well as several transversal features. During the next period, these tabs will become gradually functional, it is expected to have a basic demonstrator for M21 and a complete functional version in M24.

The extension framework is included in several developments of WP3. In particular, T3.1 includes guidelines and design principle to develop new communication (device) adapters and new platform connectors; T3.3 has an annotations framework, based Java native annotations and Reflections library. Other tasks are expected to provide an extension solution for the framework in the next period.

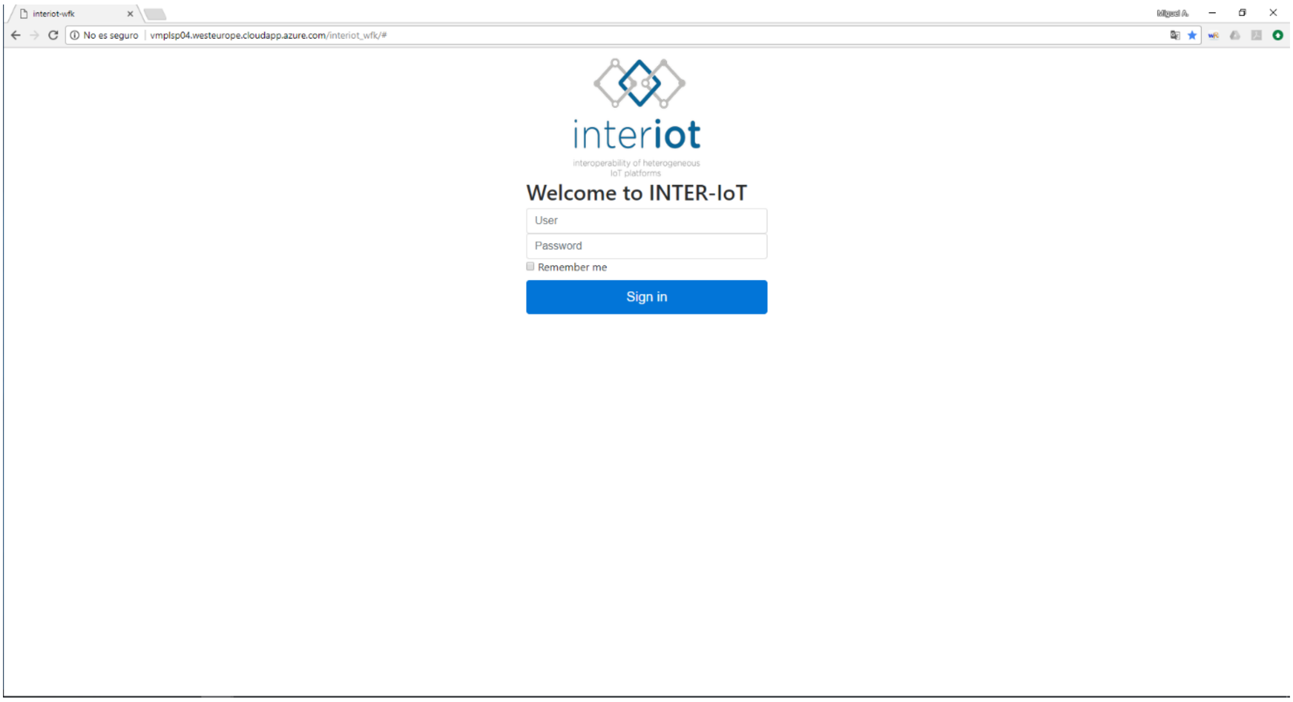

Figure 18 Log in page of the INTER-IoT Web Application for IoT platforms interoperability management

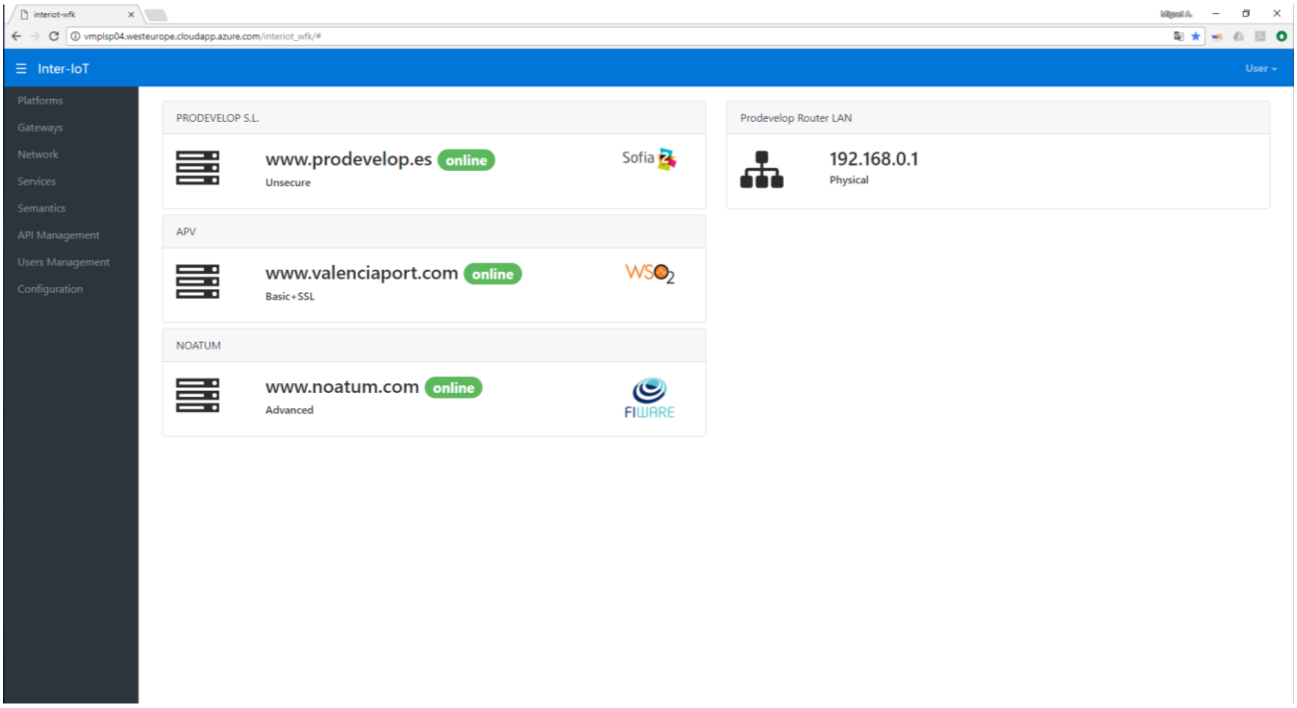

Figure 19 Main view. summary of IoT Platforms to INTER-IoT

Task 4.5: Has as main goal the proper design and implementation of the IoT interoperable framework APIs and tools for programming and managing Interoperable IoT Platforms. The main result during the period under review has been the state of the art analysis of API Management solutions and the analysis and design of the INTER-API solution, both to be included in D4.3 (M21).

As part of development efforts, the WSO2 API Manager has been deployed in the the INTER-IoT Azure instance and already interfaced with some INTER-LAYER components, thus allowing and initial assessment of the proposed solution. This results supports the integration with the Webapp developed in T4.4 and subsequent development of demonstrators (project review; WP6 use cases; Open Call projects support).

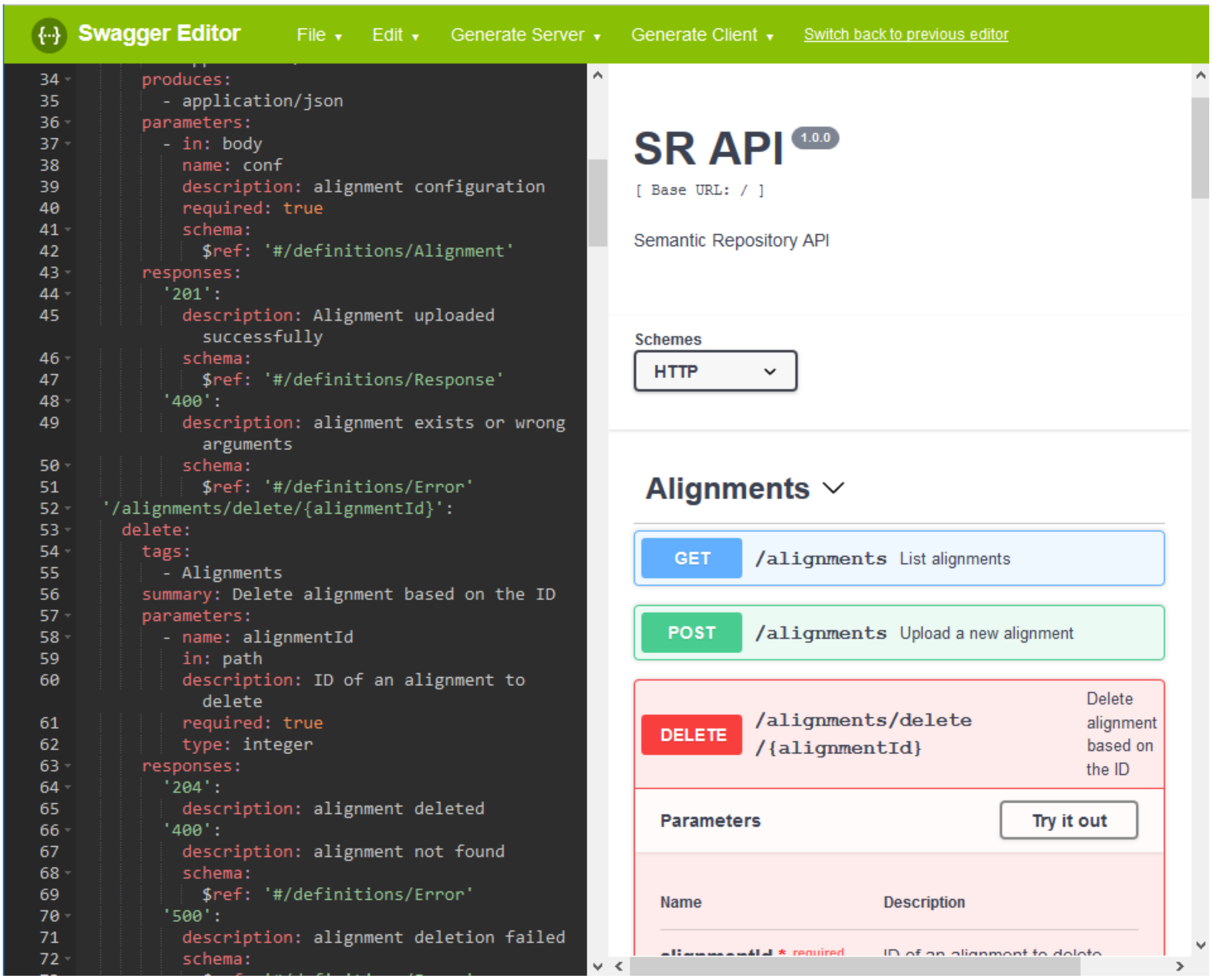

Figure 20 Screenshot of the swagger definition of INTER-API

The following table summarizes as requested in R7 from the technical review the main contributions towards the development of the different software artifacts from WP4.

Table 13. INTER-FW WebApp implementation partner contribution summary table

INTER-FW WebApp	Contribution
PRO	• Development of the Web Console navigation. • Backend for web console. • Database and global application. • Implementation of features in platforms tab. • Connection to service orchestrator. • Configuration and users view.
TUE	• Implementation of GUI and CLI of QoS and SDN features • Implementation of sample artefacts concerning gateway

Table 14. INTER-FW Software Development Framework partner contribution summary table

INTER-FW Software Development Framework	Contribution
PRO	• General mechanisms for bridges extension. • Mechanisms for adding and interchanging the communication infrastructure (brokers). • Helpers for software configuration and redeploy.
UPV	• Extension mechanisms for D2D Layer

Table 15. INTER-API partner contribution summary table

INTER-API	Contribution
UPV	• Design of the APIs connectors related with tasks for D2D, N2N and AS2AS.
PRO	• Test of API Managers. Initial integration in the webapp.
TUE	• Development of QoS and SDN APIs
XLAB	• Including REST API accessibility to INTER-MW • Creation of MW2MW API layer • Deployment of WSO2 API Manager • Integration of some Inter Layer components with the API Manager

2.4.2.3 Deviations

Task 4.1: Task progressing according to the plan. No significant deviation The workplan and schedule has forced to speed up some technical decisions in order to provide an input to some depending task in the design and analysis phases. This is particularly relevant for tasks of WP3 which started earlier that T4.1 and needed inputs in the very early stages of this task.

Task 4.2: Task progressing according to the plan. No significant deviation. Some adjustments had to be done, since the task started a new redesigned version of SSN ontology was published. The decision was made to move from the old SSN[22] to new SSN/SOSA[23] (Sensor, Observation, Sample, and Actuator). The new ontologies provided a better core for GOIoTP as they included actuation, which was previously missing. The new model of Observation, also included in SOSA, proved to be much better fit for our requirements. In the end, using SOSA we were able to reduce the number of referenced ontologies and custom extensions, thus simplifying the model without reducing the scope.

Task 4.3: Task progressing according to the plan. No significant deviation. As T4.3 and T4.4 officially start and end at the same time. Since T4.4 activity consist fundamentally in the implementation of the designs provided by T4.3, the dependency is absolute. Besides, T4.3 needed to validate some WP3 developments since the majority of WP4 developments relies on WP3 tasks. These circumstances forced to start some T4.3 activities earlier and draft preliminary solutions. After the

[22] https://www.w3.org/2005/Incubator/ssn/ssnx/ssn
[23] https://www.w3.org/TR/vocab-ssn/

official kick-off of the task, the workload in the first moths have been significantly over the average expected for this task, to speed-up the first results for T4.4.

Due to the accumulation of commitments in M21 and leveraging the prompt kick-off mentioned, the submission of D4.3 will be advanced several weeks.

Task 4.4: Task progressing according to the plan. However, according to the high dependency of this task with T4.3 (see previous paragraph), the kick-off of this task has been slower than originally planned in order to receive the needed inputs.

Task 4.5: This task is dependent on the outputs of WP3 T3.1-T3.6. The lack of availability of consolidated version of Layer APIs in the early months delayed the effective kick-off of this task. However after M18 the activity it is foreseen to be inline with the planned activity and INTER-API and deliverable D4.5 will be available on time.

2.4.2.4 Corrective Actions

Task 4.1: As mentioned in 2.3.4.3, speeding up some preliminary decisions and coordinating strongly with WP3 in analysis and design phases have helped to overcome some deviations.

Task 4.2: The adaptation to the new SSN/SOSA was needed and required some extra effort.

Task 4.3: Starting the activities before the official kick-off to provide validations to WP3 tasks and concentrating efforts in the first stages to let T4.4 to start the effective development as soon as possible. Setting up intermediate milestones to allow an effective start of the T4.4.

Task 4.4: Concentrating efforts after having the intermediate milestones ready.

Task 4.5: Increased effort to document APIs exposed by single Inter Layer components. Subsequent efforts resulted in a decision to document all Inter Layer APIs in Swagger/OpenAPI format on order to support a unified approach to integration.

2.4.3 Work Package 5 - Methodology for the Integration of IoT Platforms

The main goal of WP5 is the definition of a full-fledged methodology (INTER-METH) for the integration of heterogeneous IoT platforms. To fulfil this goal, the methods and the fundamental infrastructures for IoT interoperability produced in WP3 and WP4 will be used and systematically incorporated into the process phases of the methodology.

WP5 is subdivided into three tasks, and the main technical goals are related with defining design patterns for Interoperable IoT Platforms, which will drive the design of interoperable IoT platforms. This will provide support for the definition of a novel methodology (INTER-METH) for the integration of IoT platforms, which will support the development of interoperable IoT platforms according to requirements analysis, design, implementation, deployment, testing and maintenance phases. The WP includes the implementation of a CASE tool for supporting the automated application of the INTER-METH methodology.

In the following sections, we report the progress of WP5 with respect to the WP objectives and the defined *workplan* and a summary of the obtained results. It is worth noting that there are no significant deviations and corresponding mitigation actions.

2.4.3.1 Progress

Progress by task

Task 5.1: The task has developed an in-depth analysis of the state-of-the-art about design patterns for integration in the IoT domain was performed, and will be included in deliverable D5.1. Consecutively, it had been provided an elicitation of micro (general-purpose and domain-specific) design patterns for IoT systems interoperability. On the basis of the definition of the micro-patterns, the work was focused on the definition of the INTER-LAYER-oriented Design Patterns, which include design patterns supporting integration at each layer: device, networking, middleware, application and services, and data and semantics. The proposed patterns are considered as operative and with the aim of actually being used in the design phase of INTER-IoT-driven IoT systems interoperability and integration.

The plan has been followed as expected, micro-patterns have been identified, designed and relationship established with WP3, WP4 and the different considered application domains, with a clear link with T3.5 and T4.2. Moreover, a preliminary version of deliverable D5.1 document has been kept updated, including all results so far.

Task 5.2: As explained in the DoA and in different documents of the literature there is no specific formal methodology to specify and define IoT platform interoperability in heterogeneous application domain. First phase in the execution of the task developed the State-of-the-art Analysis about general-purpose and IoT-specific methodologies for systems integration.

Main efforts in T5.2 were devoted so far to the definition of the INTER-METH methodology and its correlated process, which is organized in phases (Analysis, Design, Implementation, Deployment, Testing and Maintenance) and activities per phase. Specifically, this activity is further split into (a) definition of the abstract methodology for IoT systems integration, which has been completed; (b) Instantiation of the abstract methodology specifically for INTER-IoT that is an on-going effort. In the latter case, the Analysis phase related to INTER-IoT has been already defined in detail. Moreover, the D5.2 document has been kept updated, including all results so far.

The task is advancing as expected and the definition of the methodology will be included in deliverable D5.1 (M24) as planned, with a further development to be included in deliverable D5.2 (M30). Different intermediate milestones have been fixed and achieved during the execution of the task.

Task 5.3: The main goal of the task is the development of a CASE tool to provide an automated implementation of INTER-METH. The activity in the task has been organised and a clear implementation plan has been produced in order to align the results of T5.1 and T5.2 and from WP3 and WP4 with the development of the tool.

Activity started with the development of the State-of-the-art Analysis about general-purpose and IoT-specific CASE tools for systems integration. The analysis reviewed different open source efforts in the area in order to link them with INTER-METH results. Then, participants detailed design specification of the INTER-CASE tool, including the definition of the XML files, representing input and output of each phase of INTER-METH and the realization of the mock-ups of the GUI supporting the system integrator.

The activity and progress in the task is advancing as planned and after the definition and specification of the tool the next period of the task will be devoted to the implementation. Results will be detailed in deliverable D5.3.

Table 16. WP5 Partners' contribution summary table

Partner	Main Contributions
UPV	• SotA: Analysis of Orchestration and Edge patterns (T5.1) • Identification of micro-patterns from several layers (T5.1) • Design patterns of D2D, N2N, AS2AS (T5.1) • Collaboration with PRO and VPF regarding GoF and VOLERE contributions (T5.1 and T5.2) • SotA: Analysis of current methodologies for the integration of network and telecommunication systems (T5.2) • General feedback on the abstract INTER-METH methodology (T5.2) • SotA: Analysis of existing telecommunication case tools (T5.3)
UNICAL	• Analysis of Agent-oriented patterns, IoT Patterns, and Health-care Systems Patterns (T5.1) • Elicitation of micro-patterns for opportunistic data collection and dissemination from heterogeneous devices through mobile gateway at D2D layer (T5.1) • Definition of design patterns at D2D layer (T5.1) • Analysis of agent-oriented methodologies and IoT methodologies (T5.2) • Overall SotA analysis of the methodologies (T5.2) • Definition of the abstract INTER-METH methodology using SPEM (T5.2) • Instantiation of the concrete Analysis phase of INTER-METH (T5.2) • Analysis of CASE tools supporting agent-oriented methodologies (T5.3) • Overall SotA analysis of the CASE tools (T5.3) • Definition of the Specifications of the INTER-CASE tool according to the phases of INTER-METH (T5.3) • Definition of XML files driving input and output of INTER-METH phases (T5.3)
PRO	• SotA: GoF patterns and Cloud based patterns (T5.1) • Analysis of micro-patterns (T5.1) • Definition of AS2AS Patterns with the help of UPV (T5.1) • SotA: Analysis of CMMI and IOT-A methodologies (T5.2) • General feedback to the abstract INTER-METH methodology (T5.2) • SotA: Analysis of CASE Tools for UML definition (T5.3) • Contribution to overall specifications of the INTER-CASE tool, phase by phase (T5.3)
VPF	• SotA: Analysis of patterns in logistics (T5.1) • WSO2 message communications patterns (T5.1) • SotA: Analysis of methodologies in logistics (T5.2)

	• SotA: Analysis of VOLERE methodology and implementation tool (T5.3)
XLAB	• SotA: Enterprise Bus, Micro-services (T5.1) • Analysis of requirements for Design patterns (T5.1) • Definition of MW2MW layer design patterns (T5.1) • SotA: Waterfall methodology overview and analysis (T5.2) • Exploring links between WP5 and WP4/WP3 (T5.2 and T5.3) • SotA: CASE tools for "System of systems" (T5.3)
SRIPAS	• SotA: Analysis of: Enterprise Integration Patterns, Ontology Patterns and Reactive Patterns. (T5.1) • Preparation of a micro-patterns template. (T5.1) • Review of and support for micro-pattern contributions. (T5.1) • Defining semantic patterns. (T5.1) • Preparation of the INTER-IoT Design Patterns, primarily, on the basis of research concerning micro-patterns. (T5.1) • New contribution (related to semantic patterns) to the Design Patterns document. (T5.1) • SotA: Analysis of agile methodology. (T5.2) • Initial / preliminary analysis of best practices concerning creation of alignments, based on early observations (in particular concerning semantic interoperability of geospatial data) (T5.3) • Analysis of tools supporting the semantic aspects of the methodology, i.e. alignment creation, lifting data from popular sources (e.g. RDB, XML) to OWL, ontology visualization, ontology editors (textual and GUI), ontology alignment and merging tools. (T5.3) • Formulation of requirements for the semantics-oriented part of the INTER-CASE (to provide support for the alignment creation process), referring to Design/Implementation phases (T5.3)

2.4.3.2 Results

Results by task

Task 5.1: The first fundamental result of T5.1 is an in-depth State-of-the-art (SotA) analysis that includes discussion of: (i) the definition of design patterns, (iii) categories of existing and documented patterns with their relevance in the IoT domain, (ii) existing templates to formalize pattern definition. Design patterns methodology has become increasingly popular for software system design since 1990s when the classic book "Gang of Four"[24] was published. Its focus is only on design patterns in object-oriented programming, however it serves as a basis for the development of many other patterns that span other aspects of software engineering. Design patterns provide a way to build an end-to-end solution in well-specified ways and to provide an understanding of the use of different components of the system in a system context. A specific architecture can be constructed from a set of design patterns, and from this the (dynamic) behaviour of the system may be modelled and analysed.

Although these results will be later included in deliverable D5.1, they are included in the PPR for clarity in the evaluation of the work. Table 17 reports all the analysed patterns during the reporting period.

[24] Design Patterns: Elements of Reusable Object-Oriented Software" by E. Gamma, R. Helm, R. Johnson, and J. Vlissides (Gang of Four, GoF)

Table 17. Analyzed Design Patterns.

Pattern Type	Included Patterns	Short Notes
Object-oriented Patterns "Gang of Four"	23 patterns classified into three groups (Creational Patterns, Structural Patterns, Behavioural Patterns) and two scopes (Object and Class).	They form the basis in software engineering design patterns and serve as an important source for object-oriented design theory and practice. However, it should be noted that they address only object-oriented programming.
Integration Patterns	Enterprise Integration Patterns, Enterprise Service Bus, Micro-Services	The patterns provide technology-independent design guidance for developers and architects to describe and develop robust integration solutions. Specifically, these patterns are also applicable to IoT domain where platforms are integrated with message-based communication.
Reactive Patterns	Divided into six categories: Fault Tolerance and Recovery, Replication, Message Flow, Flow Control, State Management and Persistence, Resource Management	Reactive patterns are applicable to any distributed application. Messages, Message Flow and Flow Control are groups of patterns that are candidates to guide the development of system components, abstracting from the chosen technology.
Agent Design Patterns	Meeting, Locker, Messenger, Facilitator, Organized Group, Conversation, Facilitator, Agent Proxy, Protocol, Emergent Society, Blackboard, Meeting, Market Maker, Master/Slave, Negotiating Agents	They could be used to allow integration, interconnection, and interaction between agent-based and non-agent software components and systems.
Ontology Patterns	ODP Wiki and ODP Public Catalog, Alignment Patterns	Ontology design patterns are a reusable successful solution to a recurrent (ontology) modeling problem. The INTER-IoT approach is based on ontologies an semantic translation using ontologies alignments.
IoT Patterns	Connected Things, Information Model, Interaction, Application Programming, IoT Infrastructures, IoT Security, EDGE-based	They form a collection of concepts that are common to IoT solutions, and provide opportunities for standardization and commonality.
Security Patterns	Core Security Patterns, The Open Group Security Design Patterns, Microsoft Patterns and Practices group catalog	They refer to general-purpose security (no IoT), including confidentiality, integrity, and availability.

Cloud Patterns	Horizontally Scaling Compute, Queue-Centric Workflow, Auto-Scaling, Multi-latency, Busy Signal Pattern, Node Failure, Colocate, Multisite Deployment	They could be useful to create solution integrating Cloud and IoT systems.
Use case patterns	• Port Logistics: Geo-fence & Automatic identification and data capture • Health Care: Standardized Device Service & Quality Management	Besides software engineering design patterns, we identified typical use cases / solutions in two INTER-IoT pilot application domains.

The second result we achieved is the elicitation of micro-patterns in the area of IoT interoperability from functional and non-functional viewpoints. Such patterns are the basis to design IoT systems integration and are grouped according to the INTER-IoT layers. In Table 18, we report all the elicited patterns, the full description of them will be provided in deliverable D5.1 (M24).

Table 18. Elicited Micro-Design Patterns for IoT Systems.

INTER-IoT Layers	Micro Pattern Name/s
D2D	Edge Provisioning Pattern, Virtualization, Request/Response, Discovery, Event subscription, Publish/Subscribe
N2N	Reactive patterns (Flow control), Reactive patterns (Message Flow), Security Pattern (Applying Zero Trust* to NFV, Foundation Security Blueprint and Implementation of Foundation Security Pattern), Design patterns for connected things (Virtualization), Communication patterns for IoT (Reliable messaging), Communication patterns for IoT (Asynchronous messaging), "S&D network pattern [Patterns for the Design of Secure and Dependable, Software Defined Networks]", Edge provisioning pattern
MW2MW	The Simple Component Pattern, Messaging Bridge, Message Broker, Pub-Sub Channel, Recipients list, Envelope Wrapper, Message Endpoint, Forward Flow, Self-contained Message, Edge provisioning patterns (device registration)
AS2AS	Edge Orchestration Pattern, Orchestration Patterns, Composite, Discovery, Virtualization (optional), Flow Based Pattern, Node-Red Patterns (group)
DS&DS	Alignment-based with Central Ontology Translation Pattern, Modularized Central Ontology Pattern
Cross-Layer	Edge provisioning pattern of device credentials and authorization, Security Pattern (Applying Zero Trust* to NFV, Foundation Security Blueprint and Implementation of Foundation Security Pattern)

Finally, the third result achieved is the full-fledged definition of the INTER-LAYER-oriented Design Patterns, which include design patterns supporting integration at each layer: device, networking, middleware, application and services, data and semantics. In order to define the patterns, we used the specification approach of the reference GoF Book. In Table 19, we report the specified design patterns.

Table 19. The INTER-Layer-oriented Design Patterns.

Pattern	Layer	Short Description (Intent)
GW Event Subscription (Publish/Subscribe)	D2D	Provide a way of sending and receiving data from smart objects to their destination. Also, it allows for D2D interoperability among heterogeneous devices.
D2D REST Request/Response	D2D	Allows a request and response message exchange for the communication with IoT platforms at the gateway across the middleware.
INTER-IOT Pattern for Orchestration of SDN Network Elements	N2N	Monitoring and Configuration of SDN elements (virtual-switches) with an orchestrator component (Controller) exchanging flow and control messages. The main goal of the Orchestration of SDN Network Element pattern is to provide interoperability between different domains connected to a network or between different networks topologies and/or configurations.
INTER-MW Simple Component Pattern	MW2MW	The intent of this pattern is to partition INTER-MW into multiple components, which operate as close as possible to the ideal of doing only one thing, and doing it in full.
INTER-MW Message Broker	MW2MW	A component that facilitates passing of messages between decoupled INTER-MW components.
INTER-MW Self-contained Message	MW2MW	Each message contains all the information that is needed for execution of a particular action.
INTER-MW Message translator	MW2MW	Translation of messages into and out of INTER-MW's internal message format and platform's proprietary data models and data formats.
AS2AS Flow Based Pattern	AS2AS	To generate a service execution flow that allows an interoperation and composition of services from different IoT platforms.
AS2AS Orchestration Pattern	AS2AS	To adapt the orchestration of service patterns to an INTER-IoT solution that is in charge of the interactions among different IoT services to produce a specific process.
Service Discovery	AS2AS	To enable the consultation of available services from IoT platforms, as well as its potential use through the AS2AS INTER-IoT solution, that utilizes a Node-RED interface.
Alignment-based Translation Pattern with central ontology	DS2DS	Semantic translation between IoT artifacts, based on alignments (correspondences) between artifacts' ontologies and central ontology.

Task 5.2: The engineering methodology INTER-METH aims at supporting the integration process of heterogeneous IoT platforms to obtain interoperability among them and allow implementation and deployment of IoT applications on top of them. To date, no proposals in the IoT area provided a systematic methodology driving the integration of heterogeneous IoT platforms. It is widely recognized that using an engineering methodology is fundamental in any engineering application domain (e.g. software engineering, co-design hardware/software, systems of systems, civil engineering, etc). In fact, the manual and non-systematic application of complex techniques, methods and frameworks would very likely lead to an increase of the degree of errors during the integration process.

The first fundamental result of T5.2 is an in-depth State-of-the-Art analysis that includes general-purpose and special-purpose methodology for software systems development and systems integration. In Table 20, we report all the analysed methodologies.

Table 20. Analyzed Methodologies for software/systems development/integration.

Methodology	Key Characteristics
CMMI	Support for Process Improvement and associated appraisal method SCAMPI (Standard CMMI Appraisal Method for Process Improvement)
Waterfall	Well-defined and easily applicable process
Agent-oriented Methodologies	• Conceptualization based on the Agent Paradigm • Easy analysis of requirements based on goals • Exploitation of simulation for system validation
IoT Methodologies	The use of reference meta-models such as AIOTI, IoT-A, ACOSO-Meth for IoT System Development
VOLERE	Support for systematic elicitation of requirements based on use cases and scenarios
Agile/Scrum	Agile process useful for complex projects with dynamic requirements evolution
Model-driven Interoperability	• Interoperability models for IoT systems/services integration
System of Systems (SoS) Integration	• Methods for the classification of available design patterns for SoS engineering/integration • Approaches to SoS engineering and methodology that are based on the V-Model
Telecommunication Systems Integration	• Enterprise service bus • Systems Virtualization
Systems Integration Best Practices	• Continuous Systems Engineering, Integration and Test (SEIT) process • System Architecture Skeleton (see also IOT-A Methodology)
IOT-A Methodology	• Architecture Reference Model (ARM) • Unified Requirements • Architectures generation model

On the basis of (a) the aforementioned methodologies analysis and (b) an in depth analysis of INTER-METH Requirements, Use Cases, Functionalities and Scenarios, we defined the abstract version of INTER-METH by exploiting the OMG-standard SPEM notation for process definition. The attribute “abstract” means that the methodology can be instantiated to obtain specific methodologies for IoT systems integration. The process is envisioned as iterative waterfall, including the following six phases: Analysis, Design, Implementation, Deployment, Testing and Maintenance. Each phase produces work-products (requirements, design diagrams, coded platforms, system deployment, and validation results) that are inputs for the successive phase/s. Iteration could involve single phases, set of successive phases or the whole process, thus assuring adaptability to new requirements.

Figure 5 portrays the process of INTER-METH. In particular:

- The *Analysis* phase formalizes the integration requirements, both functional and non-functional (e.g. real-timeliness, reliability, security, privacy, trust).
- The *Design* phase produces the design of the integration in terms of diagrams of (i) interoperability layer infrastructures and related interfaces, and (ii) programming and management patterns, to fulfil the elicited requirements.
- The *Implementation* phase focuses on the implementation of the design work-product/s to obtain the full-integrated (hardware and/or software) system.
- The *Deployment* phase involves the definition of the operating set-up and of the configuration of the integrated IoT platform.

- The *Testing* phase allows defining and performing tests to validate the integrated platform according to the functional and non-functional requirements.
- The *Maintenance* phase manages the upgrade and evolution of the system.

The proposed abstract process could be associated to any specific IoT systems integration approach. The instantiation of such process for INTER-IoT will be strongly connected to INTER-LAYER (developed in WP3) and INTER-FW (developed in WP4).

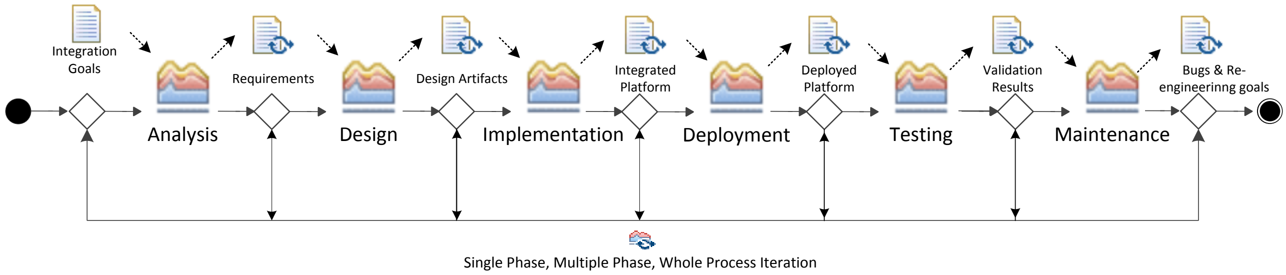

Figure 21. INTER-METH Process.

Each phase is first defined through a non-formal structured summary, which includes Description, Objectives, Actors, Expected Results, Main Execution, then is specified in detail according to a more formal SPEM-based approach that identifies Activities, Tasks per Activity, Roles (i.e. types of Actors who perform one or more tasks), and working products (results of activities, i.e. intermediate and final outputs of each phase). Activities are finally specified using a workflow style of modelling. Although we defined all phases of the process, for the sake of space, we will only present the Analysis phase in the following to provide an effective exemplification.

In Table 21, we report the structured summary of the Analysis phase that is self-explanatory.

Table 21. Summary of the Analysis phase.

Description	Given two or more IoT platforms/systems to be integrated, the integration requirements need to be elicited. On the basis of the elicited requirements, the design of the IoT platforms integration could be then carried out.
Objectives	To elicit the requirements for the integration of IoT platforms/systems
Actors	The actors are: (a) The developer of the integration (aka Integrator), who carries out the integration interconnection of heterogeneous IoT platforms; the Integrator is an active performer. (b) The platform Owner, who will obtain the integrated platform; (c) The involved Platforms to be integrated.
Expected Results	Set of (functional and non-functional) requirements for the integration of the identified IoT platforms/systems
Main execution	1. On the basis of the Integration Goals, each platform is analysed according to the functional and non-functional viewpoints of the five IoT platform layers (device, networking, middleware, application services, data&semantics) and of the cross-layering. 2. According to the Step 1, the requirements of integration among the layers of the platforms to be integrated are defined according to iterative tasks enclosed in activities.

The Requirements Analysis activity, which is the only main activity of the Analysis phase, was subdivided into three main tasks that are performed by the Integrator (see Figure 8 and Table 22) according to the workflow depicted in Figure 9:

1. *IoT Platforms Analysis*: each platform/systems to be integrated/interconnected is analyzed in terms of the 5 reference layers (device, networking, middleware, application services, and data & semantics) and of the cross-layer functionalities. Such analysis will produce a well-formalized analysis document (Analyzed Platforms Document).
2. *Functional Requirements Elicitation*: On the basis of the Integration Goals document and of the Analyzed Platforms Document, the functional requirements are elicited and included in the Functional Requirements document.
3. *Non-functional Requirements Elicitation*: On the basis of the Integration Goals document, the IoT Platforms Analysis document, and the Functional Requirements document, the non-functional requirements are elicited and included in the Non-functional Requirements document.

The functional and non-functional requirements are finally merged by the task *Requirements Merger* in the Functional and non-functional document final activity work-product.

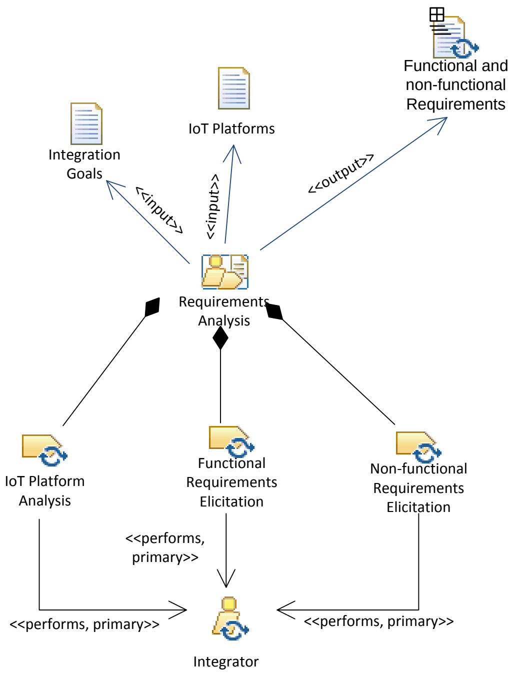

Figure 22. The Analysis phase described in terms of activities, roles, and work products

Table 22. Tasks of the Requirements Analysis activity

Activity	Task	Task description	Role involved
Requirement Analysis	IoT Platforms Analysis	Analysis of the platform/systems to be integrated/interconnected	Integrator
Requirement Analysis	Functional Requirements Elicitation	Definition of the Functional Requirements for IoT platforms integration	Integrator
Requirement Analysis	Non-functional Requirements Elicitation	Definition of the Non-functional Requirements for IoT platforms integration	Integrator
Requirement Analysis	Requirements Merger	Merging the function and non-functional requirements into the final work-product	Integrator (or automatic)

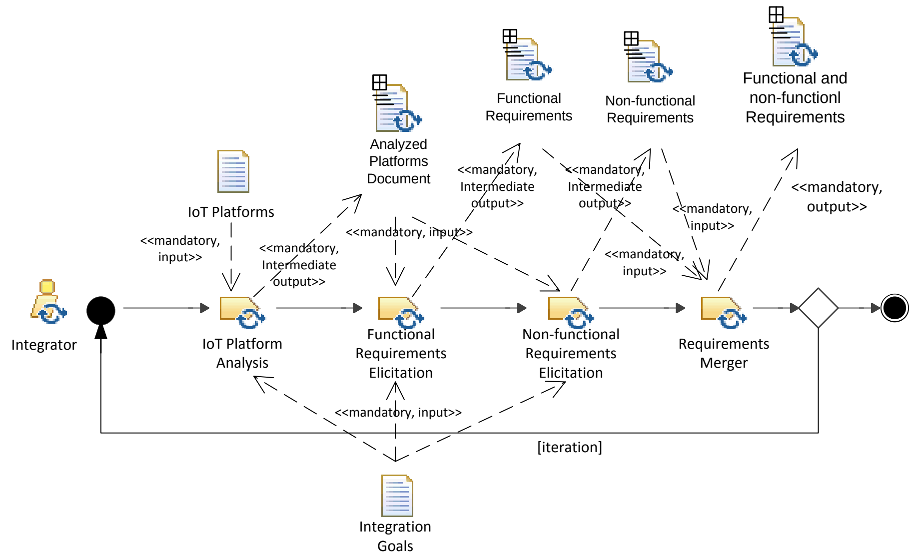

Figure 23. The workflow of tasks of the Requirement Analysis activity

The presented (abstract) Analysis phase for eliciting IoT systems integration requirements has been finally instantiated according to INTER-LAYER and INTER-FW outcomes. In the following, we will schematically report the obtained INTER-METH Analysis phase based on INTER-IoT.

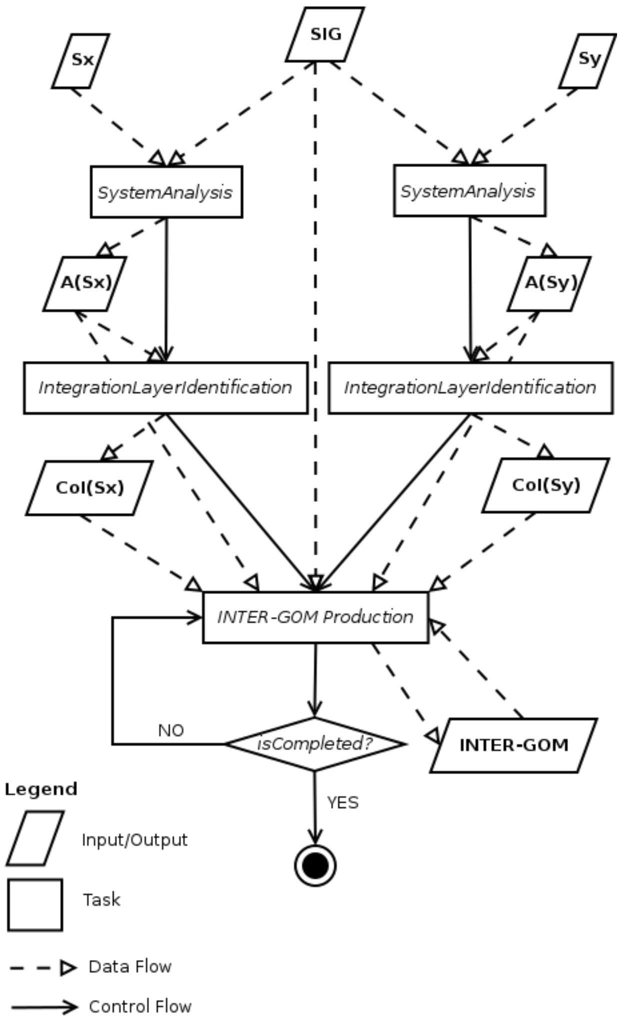

Figure 24. INTER-METH Analysis Phase based on INTER-IoT.

According to the schema portrayed in Figure 24, given two heterogeneous IoT systems: S_x e S_y, and a Set of Integration Goals (SIG), the following tasks are executed:

1. **Task_SystemAnalysis**: S_x e S_y are analysed according to the INTER-IoT reference architecture based on IoT-A (see D4.1 deliverable).
2. **Task_IntegrationLayerIdentification**: According to the SIG and to the Analyzed Systems (A(S_x), A(S_y)), a set of INTER-IoT integration layers (device, networking, middleware, application services, data & semantics, cross-layering) are identified, hereafter called Categories of Integration (CoI).
3. **Task_INTER-GOM_Production**: According to SIG, [A(S_x), A(S_y)], and the [CoI(S_x), CoI(S_y)], the INTER-GOM (Goal Oriented Model) is defined, representing functional and non-functional requirements.
4. **Task_Iteration**: The INTER-GOM definition is iterated 1 or more times to obtain the final model that will represent the formal requirements model and will drive the Design Phase.

Task 5.3: The first fundamental result of T5.3 is an in-depth State-of-the-art (SotA) analysis that includes CASE tools for supporting general-purpose and special-purpose software and systems engineering methodologies.

In Table 23, we report all the analyzed CASE tools.

Table 23. The Analyzed CASE tools.

Case Tool	Brief Analysis
TROPOS tools	Goal-oriented analysis (from TROPOS) to analyse integration goals. Thus, the GR-Tools could be reused and/or customized to define IoT platform integration goals.
Tools from PASSI, INGENIAS and ELDAMeth	Agent-oriented domain conceptualization from PASSI, INGENIAS and ELDAMeth, to formalize integration requirements in the form of a high-level agent system design. Here, it is difficult to reuse tools supporting conceptualization as they are much more oriented to design MAS.
VOLERE methodology Tools	The VOLERE methodology helps to describe, formalize and track the project market analysis, requirements, use cases and scenarios in an explicit and unambiguous manner. Several commercial tools support VOLERE methodology. However, they are scarcely reusable for INTER-CASE.
AGILE-related CASE tools	They can be grouped in project management tools and software development tools. However, INTER-METH is not an Agile methodology thus such tools are scarcely reusable.
Systems of Systems CASE tools	Usually very specific CASE tools (non open-source) exist correlated to SoS methods (context diagram, functional modeling, holistic requirements modeling, need means analysis, the analytic hierarchy process and viewpoint analysis)

The following high-level specifications have been defined for the INTER-METH CASE tool (hereafter called INTER-CASE):

1. Tool defined as a suite of tools
2. 6-sub-tools for each phase of the INTER-METH process: analysis, design, implementation, deployment, testing and maintenance. Each tool only provides information support to the phase that is then executed externally (manually or with other already existing and available

tools, or with tools developed ad-hoc such as the ontology aligner for IoT systems ontology design). Thus the aim is to produce contextual documentation by connecting one phase to the next one.

3. Input/Output files to/from each phase are based on XML
4. XML file repository containing all workproducts (even intermediate products)
5. Web-based Tool centered on “Forms-based GUI”. Forms are created on the basis of the XML files.

In Figure 25 a schema of the INTER-CASE tool is reported.

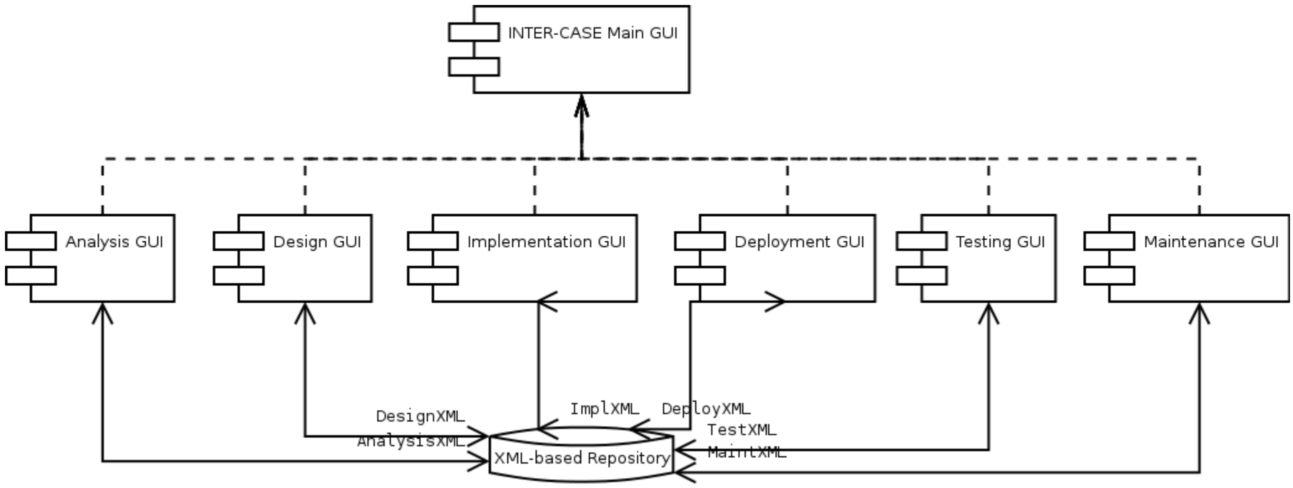

Figure 25. INTER-CASE Tool schema.

In the following we report the (simplified) AnalysisXML file schema. Specifically, we only report the high-level attributes (such attributes are declined in a finer grain; for the sake of space, we omitted the details). The XML file is organized in two main parts: *inputSpecification*, which specifies the input to the Analysis phase (IoT platforms and integration goals), and *outputSpecification*, which specifies the output of the Analysis phase (Lists of Functional Requirements and Non Functional Requirements).

```
<AnalysisPhase>
    <inputSpecification>
        <IoTSystems>
            <Platform1Name> … </Platform1Name>
            <Platform2Name> … </Platform2Name>
        </IoTSystems>
        <Integration Goals>
            <IG1>…</IG1>
            …
            <IGn>…</IGn>
        </Integration Goals>
    </inputSpecification>
    <outputSpecification>
        <FRList>
            <FR1>…</FR1>
            …
            <FRn>…</FRn>
        </FRList>
        <NFRList>
            <NFR1>…</NFR1>
            …
            <NFRn>…</NFRn>
        </NFRList>
```

</outputSpecification>
</AnalysisPhase>

2.4.3.3 Deviations

T5.1: Task progressing according to the plan.

T5.2: Task progressing according to the plan.

T5.3: There are no significant deviations so far with respect to our plan and project objectives fulfilment. The only small deviation we can identify is about the beginning of the development of the INTER-CASE tool. In fact, it has been slightly delayed in order to have more clear and detailed specifications and to select an open-source web-based framework for its implementation (that has been under selection between two options: (a) https://github.com/davidmoten/xsd-forms and (b) http://www.lexiconista.com/Xonomy/xonomy.pdf, which are being currently tested.).

2.4.3.4 Corrective Actions

T5.1: No corrections were needed.

T5.2: No corrections were needed.

T5.3: The corrective action is to speed-up the first phase of the INTER-CASE development due to the detailed specifications and the effective web-based framework (being selected) allowing rapid prototyping of the CASE tool.

2.4.4 Work Package 6 – Integration and pilot deployment

The integration and pilot development work package (WP) has started beginning of July 2017, actually M19 of the project and it is out of the period under evaluation. However, some activity has been performed by the consortium in both pilots in order to prepare them to have a seamless start in the execution of the trials. Additionally, deliverable D6.1 will be released in M20.

2.4.4.1 Progress

Progress by task

Task 6.1: In preparation of the integration of the INTER-IoT platform we have defined several steps to come to an integration plan. The first step is of course to setup a high level system overview of both main pilots (LogP and eHealth)

This high level system overview is given in the following Figure:

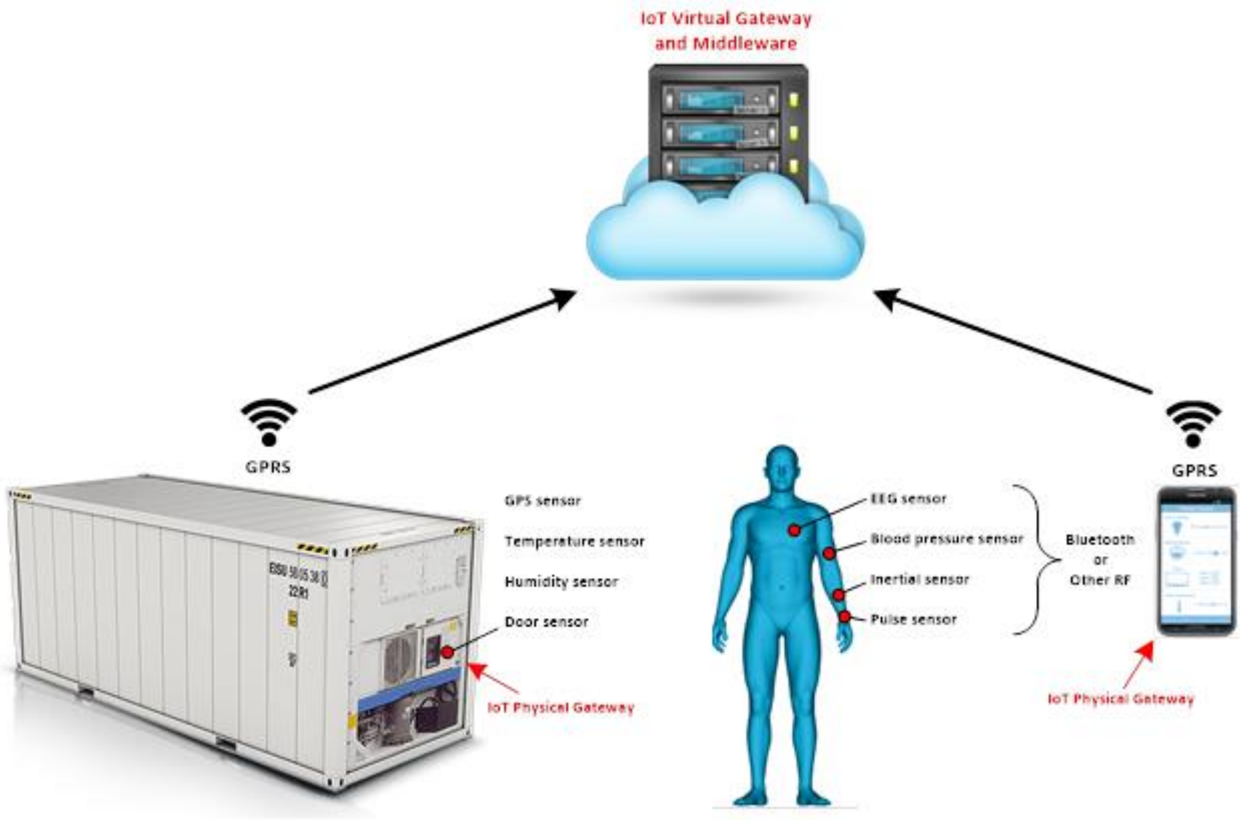

Figure 26. High Level INTER-IoT System Overview

This system overview will be the start of the integration work package. For each of the open calls a similar description will be made to create an integration approach for each use case. A general integration approach will be tailored to include each separate use case.

In order to test the INTER-IoT framework and prepare for field integration a test environment has been created. The test environment exists of two major parts, the first part is the virtual environment, we have created an Azure virtual network on which al virtual parts of the system will be deployed and tested. The second part is to test the gateway and connected devices. For this we have setup raspberries with several sensors to simulate the final sensors and devices.

Physical devices and third-party devices can couple into the INTER-IoT system at different levels, depending on their 'intelligence'. All three levels are indicated in the architectural Figure below.

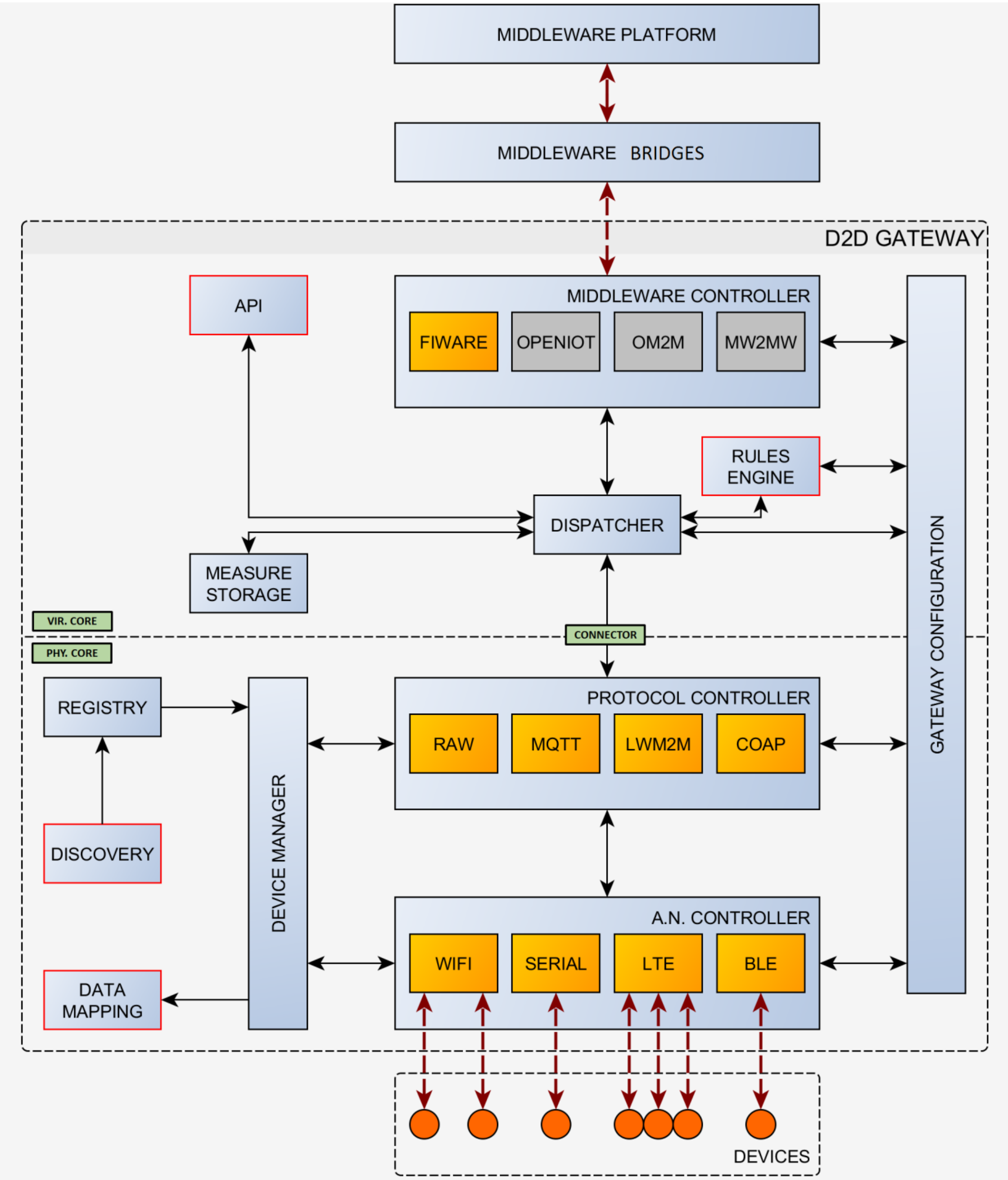

Figure 27. INTER-IoT Layered approach for integration

A physical sensor or device can be coupled either through the Access Network layer (lowest intelligence). A device with medium 'intelligence' can be coupled to the virtual part of the gateway, we have foreseen a connector to which any device can be coupled. Or the high 'intelligence' systems can be coupled directly onto the middleware layer. They need a bridge in order to connect the INTER-IoT middleware.

2.4.4.2 Results

Results by task

Task 6.1: In order to control issues that will pop-up during integration an issue tracking process has been defined and implemented in JIRA.

The process is defined to be according the following Figure:

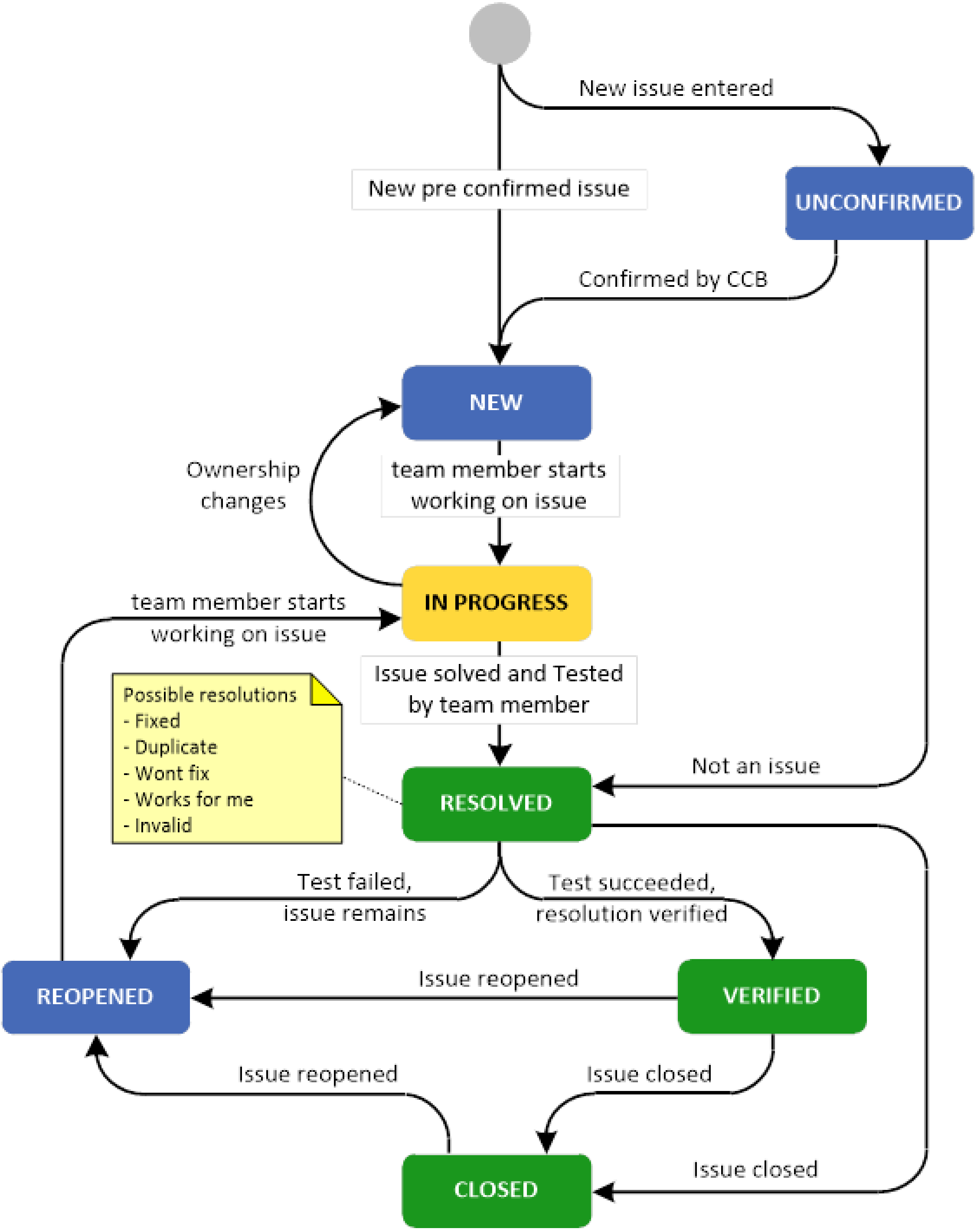

Figure 28. Issue-control process at integration

Task 6.2: The goal of INTER-LogP pilot is to demonstrate the need for a system that allows the exchange of data and messages among the different actors of the port community. In this case, as can be seen in Figure 1, there are three main actors: the port, the terminal and the haulier company. INTER-IoT has to provide interoperability between the IoT platforms of the port and the terminal, and give access to other devices from other companies, like trucks.

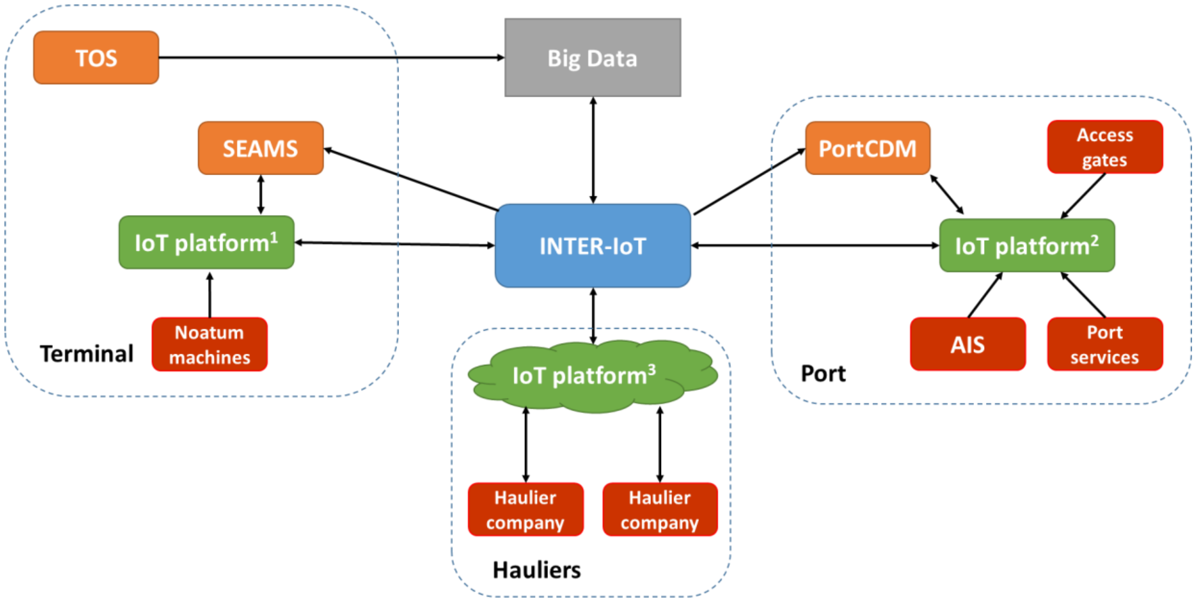

Figure 29. INTER-LogP pilot design

Both the port and the terminal have a large number of sensors and devices that produce large amounts of data, which can be interesting for other entities. Furthermore, they need data from other companies to provide a better service to their clients.

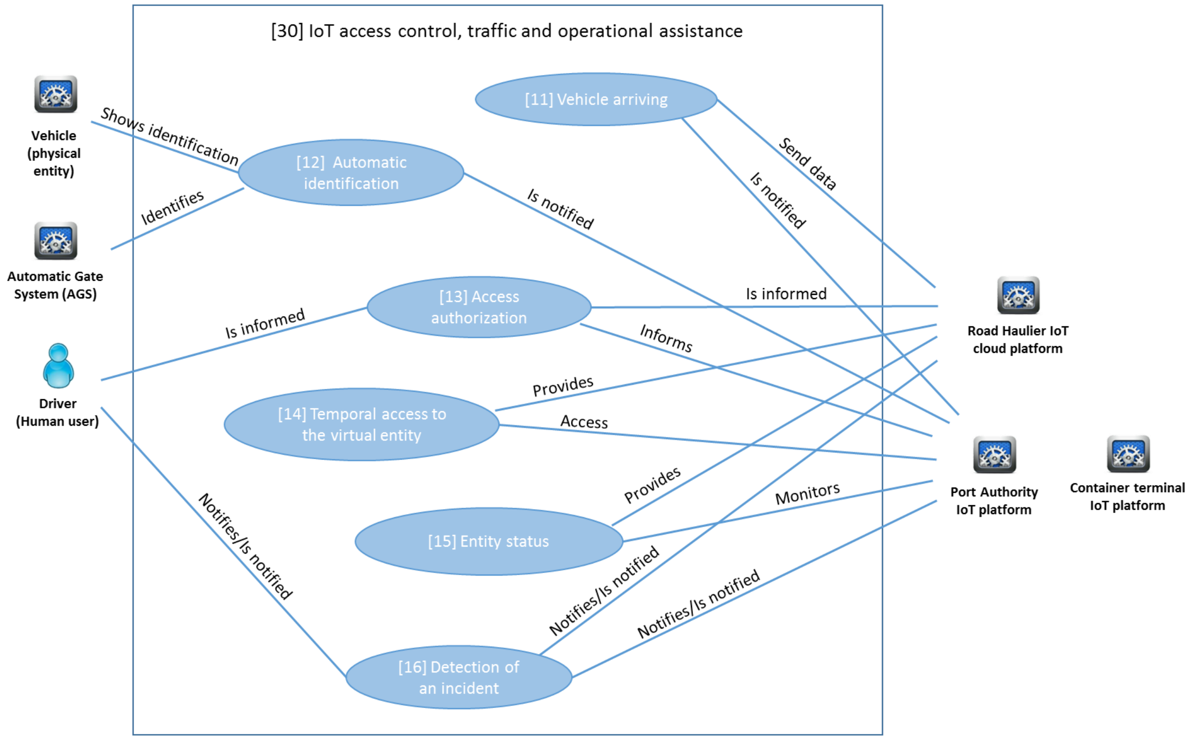

Figure 30. INTER-LogP scenario with use cases

The main objective in the defined scenario is a service to control access, monitor traffic and assist the operations at the port. Several IoT platforms will be able to identify trucks and drivers using different devices and they will share data under predefined rules through an interoperability of the platforms involved. This information can be used to monitor the truck inside the port by the Port Authority platform (security and safety purposes) and to manage more efficiently resources in the terminal. This also will allow avoid queues in the access gates to the port and the terminal.

T6.3: The goal of the INTER-Health pilot is demonstrating how to foster healthy lifestyle and prevent chronic diseases by monitoring subjects' physical characteristics, nutritional behavior and activity. The pilot will consist of 200 subjects: 100 subjects following a traditional monitoring without IoT devices and 100 subjects with devices. These last ones are the ones using the INTER-IoT solution. They first attend a nutritional counseling at ASL TO5 where their initial physical characteristics are measured, using IoT Devices on the premises (BMI, waist circumference, weight, blood pressure…). Each subject receives a prevention program. Then at home, while they follow it, they measure their characteristics using their phone and IoT devices. The subjects will visit ASL TO5 each 6 month for check-ups. The healthcare professional in charge of monitoring each user will have access to the history of all the measurements through a dedicated web application.

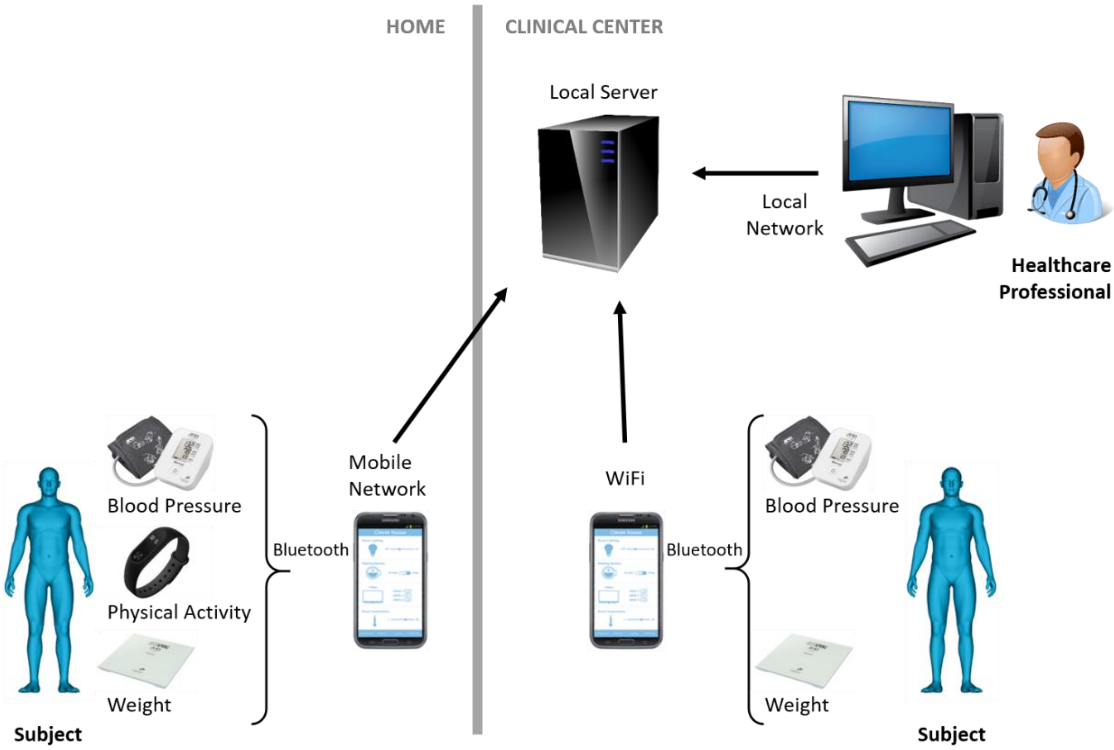

Figure 31. INTER-Health pilot overview.

The Local Server is located at the premises of the clinical center. It runs the following components: The INTER-IoT Framework, the instance of universAAL, the Professional Web Tool (PWT) in .NET and its Database in a SQL Server.

The INTER-IoT Framework runs in its Virtual Machine and contains all INTER-IoT Modules needed for the pilot, of which the ones of interest in INTER-Health are the INTER-IoT Middleware and INTER-IoT API.

The universAAL instance is an OSGi container with all the universAAL Modules needed for the pilot, of which the ones of interest in INTER-Health are the REST API, and all the modules that compose the basic universAAL Middleware.

The .NET Framework hosts the PWT Web Application, which will finally allow healthcare professionals to manage all the data within the pilot.

The SQL Server hosts the Database used by the PWT to store its data.

The setup of the mobile phone used at the clinical center differs from those used at each subject's home. The mobile phone used at the clinical center is an Android Phone running the universAAL Android App and a dedicated app for getting measurements from Bluetooth devices. The mobile phone used by the subjects is an Android Phone running the BodyCloud Android App.

The Bluetooth devices used at the clinical center differ from those used at each subject's home. The models used at the clinical center are A&D Medical UA 767PBT (Blood Pressure) and A&D Medical UC 321PBT (Weight) which are regular Bluetooth devices. The models used by each subject are A&D Medical UA 651BLE (Blood Pressure) and A&D Medical UC 352BLE which are Bluetooth Low Energy devices, in addition to the Xiaomi Band 2 (Physical Activity).

The PCs used by Healthcare Professionals at the clinical center to access the PWT are their own regular PCs.

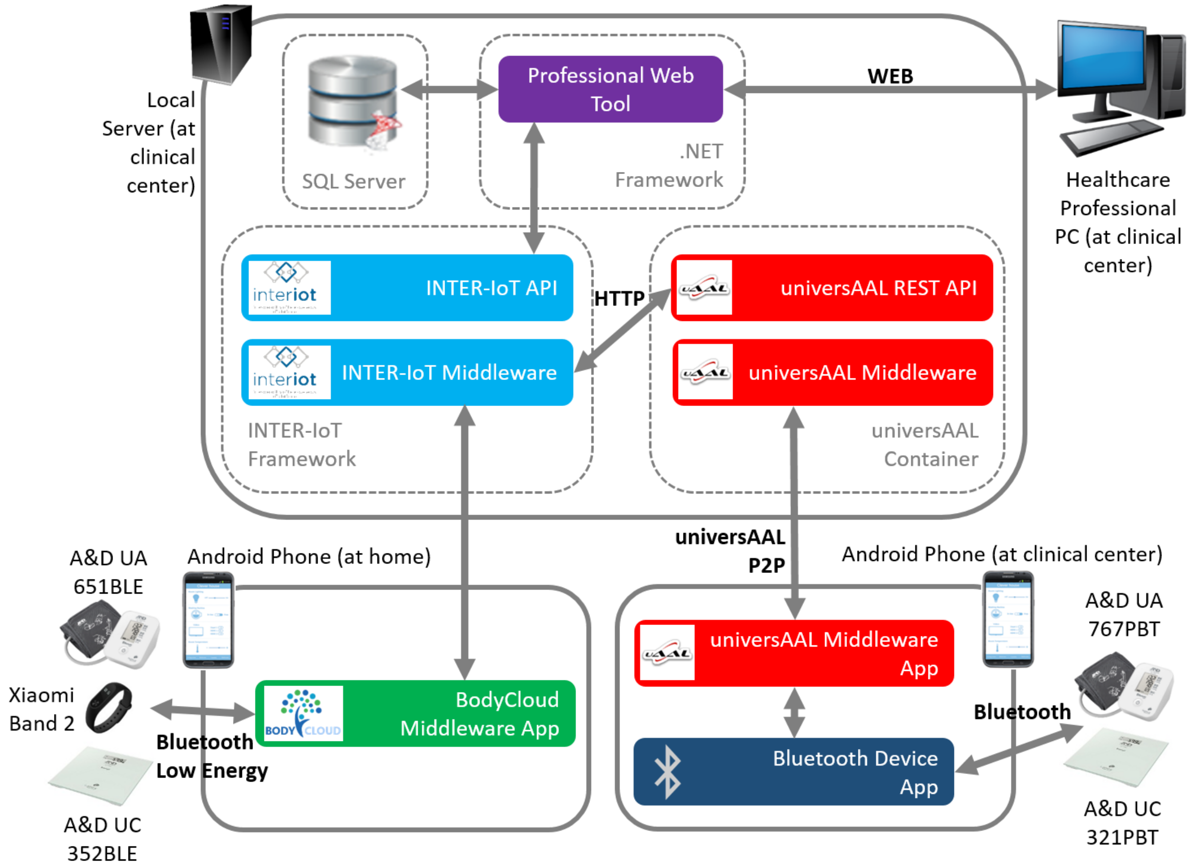

Figure 32. INTER-Health Architecture.

2.4.4.3 Deviations

So far no deviations have been detected

2.4.4.4 Corrective Actions

Since there have not yet been any deviations, corrective actions have not been needed yet.

2.4.5 Work Package 7 – Evaluation and assessment

WP not started yet

2.4.6 Work Package 8 – Impact creation

The general objective of this WP is to organise in a coherent way the activities leading to maximise impact for the overall project. The overall main objective for each partner in the project is to have a structured, complete and achievable way to exploit the project results. In case of Industrial partners, this reflects in developing a sustainable business model strategy, while for research-oriented partners this implies a proper communication of results to the scientific community. In particular, the specific objectives of this WP are:

- Prepare and follow a plan for the dissemination and exploitation of results.
- Raise awareness and reinforce the project visibility through the project web site, flyers, and social networks targeting end-users, stakeholders and at large the general public.
- Disseminate the scientific and policy oriented research done in the framework of **INTER-IoT** by participating to academic and policy oriented conferences, by presenting working papers and scientific contributions, and by submitting scientific articles to peer-review journals.
- Describe business models, deployment, interoperability and operational strategies validated by ports, end users and operators.
- Exhibit **INTER-IoT** prototypes in relevant industrial events.
- Provide courses and educate PhDs, focusing on **INTER-IoT** technological and operational results.
- Transfer **INTER-IoT** results to operations and product development departments.
- Reach in an early phase of the project a consensus on joint and individual exploitation strategies that will satisfy all participants involved in the **INTER-IoT** consortium, avoiding any conflict between the partners (incl. agreements on the use of foreground, IP, licensing, etc.).

2.4.6.1 Progress

Progress by Task

Task 8.1: The Communication Task established and executed as planned a Communication Strategy to raise awareness for potential users and promoting long-term sustainability of the project results. During the initial phase, the communication was more focused in preparing the tools for reaching our intended audience that will be fully reached in the second period. While the project promoted its concepts and results since the very beginning, it will be in the second period - when most of INTER-IoT results will be ready – when the communication activity will reach its peak.

In particular, a website was developed at the very beginning of the project (M2), together with a logo and publications template. Far from being irrelevant, the logo and the clean and fresh image allow external stakeholders to immediately understand the project's seminal concepts and the relevance for their needs.

The website has been maintained since its publication and modified, listening to the users' comments and the internal needs. During the Open Call, a very relevant number of visits were registered, and the accessibility and clearness of the site was praised by many.

Furthermore, a poster and a leaflet were conceived, and social media presence has been established (i.e. LinkedIN, Facebook and Twitter). The communication activity has maintained continuous collaboration with IoT-EPI in order to reach a larger audience and disseminate also the other project members. Additionally, since M12 and the lick off on IoT-LSP cluster there is also a tight liaison established with it.

Task 8.2: The Dissemination of Project Results Task, with the goal to deliver results to the predefined communities is successfully executed is following the Data Management Place (D8.4). Activities can be divided into three categories: (i) publications of results in top-notch scientific books / journals, (ii) organization of and participation in events (scientific, industrial and community oriented), and (iii) publications in community-oriented magazines (primarily devoted to the communities associated with planned pilots). In all these categories large number of activities took place, and are reported in detail in part A of this PPR and also in deliverable D8.5 (submitted in M18). Furthermore, substantial number of activities are already planned for the next 6-12 months.

It is worth noting, that results of the project have been presented not only in the EU, but also in USA, China and Japan. Further dissemination in India is planned for September 2017

Task 8.3: The task focused on the development of the proposed business model, with a tight collaboration with IoT-EPI corresponding task force. The main results of the activity in this task has been submitted in the preliminary version of deliverable D8.7, submitted as D8.7a in M18 as requested by the external experts.

More specifically, on the organisational side of the task the following activities were conducted: development of the overall document structure, collection of all the supporting materials from partners and from the external sources, organisation of a number of teleconferences with partners to monitor the progress and to encourage the submission of the required contributions

In relations to the content of the deliverable, the following work was completed: a few iterations of introduction and executive summary were produced, market analysis was completed and discussed with a number of external stakeholders, including members of the advisory board, and additionally the activity regarding the exploitation templates was refined after the redesign of the questionnaire. As during the period under review the 12 third parties from the open call were selected, their preliminary potential business models were analysed and included in the report as it was considered that the start of the ecosystem may bring new ideas that will be later developed during the execution of the collaborations.

Analytical part of the work performed also included industry trends, SWOT analysis, competitor analysis, regulatory considerations for e-health, marketing operations, requirements for certification and standardisation. In this aspect, CE marking strategy, mainly in INTER-HEALTH area was worked out. The consortium is aware that the process is long, slow and several documentation will be provided, and it will be difficult to achieve any CE marking during the live time of the project, however it has been considered highly interesting to plan a strategy and develop activities in order to have continuity after the end of the project.

Task 8.4: Exploitation activities have gone through different phases as more results from the project and a better definition of the products have been achieved. During M1 to M4 the contribution about Exploitation to the Impact Creation Plan was done with the definition of the roadmap of the Exploitation Plan to be followed till the end of the project, as was reflected in deliverable D8.3.

The definition and consolidation of the Exploitation Team (ET) composed of 14 members, each member from each partner was carried out on M5. And preliminary activity was presented by the consortium during the participation at IoT-EPI TF-4 Business Model with the presentation INTER-LAYER BM at Workshop in Valencia (23rd - 24th June 2016), M6, and also in biweekly TF4-Business Models online conferences and webinars. Additionally, several meetings were held with stakeholders and with advisory board members in order to gather feedback from the proposed plans.

On M12, the EU Commission asked for the review of the D8.3 (M4) in terms of strengthening the industrial Dissemination Strategy and the standardization and Open Source strategies of the project as well as the for enforced of the joint and individual exploitation templates taking into account aspects such as value network, competitors and market alternatives etc. On M13, the reviewed version of D8.3 was submitted and the LLAVA Matrix methodology was adopted, in order to analyze the most promising markets for our solutions and develop a sound and effective exploitation plan, per consortium and per partner taking into account aspects as competitors, partnerships, IPR aspects, etc. The application of the methodology has been included in the intermediate version of deliverable D8.7 and will be fully developed by in the final version of the deliverable in M30.

The INTER-IoT consortium had also engagement with business and investment community. More specifically, RINI arranged representation of TALIS Capital (one of the venture firms specialising in investment into IoT sector) on INTER-IoT Advisory Board. This cooperation is proved to be quite useful as through TALIS Capital network, RINI (and INTER-IoT project in general) is receiving the continuous updates on the latest technological advances in IoT sector. Furthermore, TALIS Capital will be directly engaged in the later stages of the project by reviewing and optimising the developed business model and advising on potential exploitation paths.

The first iteration for the elaboration of the joint and individual Exploitation Plans, taking into account the templates of D8.3, started in M14 during the workshop held by the ET in Slovenia. During this workshop, the collaborative INTER-IoT business model and scenarios proposed in WP2 were discussed and the partners were asked to present their first iteration of the joint and individual Exploitations Strategy Plans by filling the templates from D8.3. During this workshop, the INTER-IoT consortium agreed in the selection of the license Apache 2.0.

During the 5th Plenary Meeting celebrated in Valencia (M16), the ET joined in parallel sessions to work together on the exploitation vision of the project, and the interaction between the Community Product, promised in the DoW, and the Commercial Product that will address the further exploitation challenges beyond the duration of the project. These activities culminated in a Joint Exploitation Plan based on an open source strategy that were included in D8.7 (M18) and also on the second Report on Impact Creation D8.5 (M18).

During this period the ET has also monitored the market and reviewed the initial INTER-IoT exploitable products defined in WP2, according to the achievements of exploitation activities during project's lifecycle as an iterative process by following the LLAVA Matrix Methodology.

In order to define the INTER-IoT Value Proposition, the Exploitation Team (ET) asked to all partners of the consortium to fill in several templates related to the products and components they are implementing in the context of INTER-IoT, the technologies they are bringing in, the services they are offering, similar initiatives and advantages over them, etc. In parallel to this phase, INTER-IoT has worked on an open call and the D8.7 includes also business models and market strategies proposed by the selected third parties, as they are the first members of the INTER-IoT ecosystem.

Table 24. WP8 Partner contribution summary table

Partner	Main Contributions
UPV	• Contribution to communication activities in T8.1 • Contribution to scientific Dissemination (details of the publications are included in part A of the PPR and in deliverable D8.5). • Organisation of the first IoT-EPI meeting in Valencia (June 2016). • Participation in different industrial dissemination events: ECLIPSECON 2016, SIDO 2017 and IoT Week 2017.

	• Definition of the organisation Individual and Joint exploitation plans.
	• Participation in the different TF of IoT-EPI, with activity related to position paper writing, communication and participation in teleconferences and meetings.
	• Event organisation associated with INTER-IoT:
	  ○ "1st International Workshop on Interoperability, Integration, and Interconnection of Internet of Things Systems" (I4T 2016), Berlin, Germany, 4-8 April 2016
	  ○ Workshop "Globe-IoT 2017: Towards Global Interoperability among IoT Systems", Las Vegas, USA, 8-11 Jan. 2017
	• Different seminar and keynotes provided.
	• Teaching of the PhD course "IoT Interoperability" at UPV in 2016 and 2017.
	• Two PhD presented partially funded by INTER-IoT, five more under preparation.
	• Participation in product definition and value proposition of INTER-IoT.
	• IoT-EPI promotional video
	• Co-editing of December 2016 IEEE Computing Now issue about IoT interoperability
	• Promotion of INTER-IoT open call.

UNICAL	• Contribution to communication activities in T8.1
	• Contribution to report on communication activities
	• Contribution to scientific Dissemination (details of the publications are included in part A of the PPR and in deliverable D8.5).
	• Definition of the organisation Individual and Joint exploitation plans.
	• Participation at the IoT-EPI TF-2 "Platform Interoperability" Workshop, Valencia, M6
	• Chairing Session "IoT Architectural Approaches", IoT-EPI TF-2 "Platform Interoperability" Workshop, Valencia, M6
	• Event organisation associated with INTER-IoT:
	  ○ Special Session "INTER-IoT: Towards IoT Systems INTERoperability (INTER-IoT)" in 14th IEEE International Conference on Networking, Sensing and Control, May 16-18, 2017, Calabria, Southern Italy
	  ○ "1st International Workshop on Interoperability, Integration, and Interconnection of Internet of Things Systems" (I4T 2016), Berlin, Germany, 4-8 April 2016
	  ○ Workshop "Globe-IoT 2017: Towards Global Interoperability among IoT Systems", Las Vegas, USA, 8-11 Jan. 2017
	• Seminar/Keynote speech "Towards Multi-Layer Interoperability of IoT Platforms: the INTER-IoT approach", held at:
	1. Data Science Center (DSC/e) of Eindhoven University of Technology, Netherland, 8 May 2017;
	2. New Jersey Institute of Technology, Newark, USA, 12 Jan, 2017;
	3. BodyNets 2016 Conference, Turin, Italy, 15 Dec. 2016;
	4. OnTheMove Federated Conferences & Workshops (OMT 2017), Rhodes, Greece, 27 Oct. 2016;
	5. International Conference on Internet and Distributed Computing Systems (IDCS 2016), Wuhan, China, 28 Sept. 2016.
	• Seminar "Towards Interoperable, Cognitive and Autonomic IoT Ecosystems: an Agent-based Approach", held at Data Science Center (DSC/e) of Eindhoven University of Technology, Netherland, 8 May 2017.
	• Seminar ""Enabling IoT Interoperability through Opportunistic Mobile Multi-Technology Gateways", held at Wuhan University of Technology, School of Logistics Engineering, Wuhan, China, 6 July 2016.

PRODEVELOP	• Contribution to communication activities in T8.1 • Contribution to report on communication activities • Contribution to Dissemination in T8.2 • Contribution to report on dissemination activities • Contribution to the initial TOC to the D8.7 • Contribution to market analyses, Llava Matrix Methodology • Contributions about market analyses and Exploitation (as leaders of T8.4) • Leadership of T8.4 • Elaboration of the INTER-IoT Exploitation Plan in T8.4 • Review of the initial INTER-IoT exploitable products defined in WP2 • Elaboration of the Joint and Individual Exploitation Templates • Coordination and elaboration of D8.3 for M4 • Coordination and elaboration of the reviewed D8.3 submitted in M13 • Proposal of working with LLAVA Matrix Methodology • Participation at the IoT-EPI TF-4 Business Model, making a presentation INTER-LAYER BM at Workshop in Valencia (24th- 23rd June), M6 • Participation at TF4-Business Models online conferences and webinars • Contribution to give information about technology, value proposition and tangible products collected by XLAB and the Port of Valencia • Definition of the organisation Individual and Joint exploitation plans. • Contributions to the second report on Impact Creation D8.5 • Constructing the INTER-IoT global exploitation vision together with XLAB and UPV • Coordination of the workshop held by the ET in Slovenia during the 4th Plenary Meeting (M14) • Participation at the 5th Plenary Meeting celebrated in Valencia (M15) where the ET joined in parallel sessions to work together on the exploitation vision of the project

TUE	• Contribution to scientific Dissemination (details of the publications are included in part A of the PPR and in deliverable D8.5).
	• Communication of TU/e Activities related to INTER-IoT in facebook, corporate websites, presentations and email footers.
	• Oral promotion of INTER-IoT concerning IoT-related courses - for educational purposes
	• Event organisation associated with INTER-IoT:
	    ○ Co-chair of the IEEE IoTDI International Workshop on Interoperability, Integration, and Interconnection of Internet of Things Systems, April 2016, Berlin, Germany http://plasma.deis.unical.it/events/I4T2016/
	    ○ Co-chair of the 14th IEEE International Conference on Networking, Sensing and Control, May 16-18, 2017, Calabria, Italy, http://icnsc2017.dimes.unical.it/
	    ○ Track co-chair of the 7th International Conference on Emerging Ubiquitous Systems and Pervasive Networks. September 19-22, 2016, London, U.K. http://cs-conferences.acadiau.ca/euspn-16/
	    ○ Steering committee member (founding Chair) of the 4th IEEE Workshop on QoE Centric Management, September 2016, Würzburg, Germany http://www.qcman.org
	    ○ Co-chair of the Mini-symposium on Intelligent processes for the Internet of Things, September 12, 2016, Eindhoven, The Netherlands https://www.tue.nl/universiteit/faculteiten/electrical-engineering/onderzoek/centre-for-wireless-technology/nieuws/19-

	07-2016-phoenix-mini-symposium-intelligent-processes-for-the-internet-of-things-12-september-2016/ o Special session Co-Chair of the IEEE International Conference on Systems, Man, and Cybernetics (Collaborative Wireless Sensor Networks and Internet of Things), October 9-12, 2016, Budapest, Hungary, http://smc2016.org/ o Co-chair of the 6th IEEE ICDM Workshop on Data Mining in Networks, December 12, 2016, Barcelona, Spain http://damnet.reading.ac.uk/ o Track Co-chair of 14th International Conference on Frontiers of Information Technology, “Computer and Communication Networks and Cloud Computing”, December 19-21, 2016, Islamabad, Pakistan http://fit.edu.pk/ • Introduction of the DSC/e Lecture Giancarlo Fortino, Towards Interoperable, Cognitive and Autonomic IoT Ecosystems: an Agent-based Approach, May 08 2017 • Definition of the organisation Individual and Joint exploitation plans. • Participation in several conference calls related to exploitation • Preparation of IoT-related courses based on INTER-IoT results
VPF	• Review the script for the project promotional video • Publication in social media • D8.3: Provide port and industrial magazines for future publication. • Definition of the organisation Individual and Joint exploitation plans. • D8.4: Define data owners in INTER-LogP pilot • Write a dissemination article in VPF's newsletter • Complete individual and joint exploitation plan • Review and complete exploitable results • Participation in the business models and regulations associated with port transportation and logistics application domain. • Dissemination activities with stakeholders
RINICOM	• Press release preparation and promotion, • Promotional material preparation, • Interaction regarding exploitation with stakeholders and capital risk companies. • Social media and website updates • Preparation and Interview with collaborative media for Sky tv, Editing of the final version of the film • Promotion of open call to EMIS and other UK companies • Market data gathering from partners and external end users. Contributions to exploitation plan, • Business analysis and exploitation plan preparation. • Definition of the organisation Individual and Joint exploitation plans. • Collection, review and consolidation of partner exploitation questions. • Responsible partner and editor of D8.7a.
XLAB	• Contributions to D8.3, D8.5 and D8.7 • Collecting meaningful dissemination venues and addressing reviewer’s comments • Constructing the exploitation vision together with PRO and UPV • Collecting the technology, value proposition and tangible products together with the Port of Valencia • Consultation for deliverable structure and exploitation activities. • Participation at the EPI IoT: TF-4 Business in Valencia (24th- 23rd June) • Participation at TF4-Business Models online conferences and webinars. • Definition of the organisation Individual and Joint exploitation plans.

AFT	• Internal presentation of project objectives and results to AFT regional delegates in order to raise awareness of institutional stakeholders (transport policy makers and industry) • Contacts with transport sector stakeholders in order to prepare exploitation activities • Direct presentation of project objectives and initial results to Transport professional organisations in order to enhance expectations and possibly demand for use of project results by transport companies in France. • Introduction of project representatives (Alessandro Bassi) to FutureDRV consortium (Erasmus+ programme) in order for European vocational Education and Training stakeholders to take into consideration INTER-IoT project results when mapping future professional drivers skill requirements. • Presence at the 2017 SITL so has to discuss need and use of project results within the transport and logistics sector. • Participation in “les rencontres de la mobilité Intelligente 2017” (Paris,FR). • Definition of the organisation Individual and Joint exploitation plans.
SRIPAS	• Contribution to scientific Dissemination (details of the publications are included in part A of the PPR and in deliverable D8.5). • Participation in different industrial dissemination activities and interaction with stakeholders. • Creation, inviting members, and supplying steady stream of information to the Facebook group (490 members • Disseminating project results to multiple (30+) Facebook groups that are focused on issues related to the topic(s) of the project • Inviting members and supplying steady stream of information to the LinkedIn group (262 members) • Disseminating project results to multiple social media channels (e.g. Google+, Viadeo, Xing, Collabratec, etc.) • Supplying steady stream of information to the Twitter stream (414 followers) • Contributions to communication activities in T8.1 • Contributions to D 8.4 • Contribution to the joint and individual business modelling & exploitation plans • Definition of the organisation Individual and Joint exploitation plans.
NOATUM	• Contribution to communication activities in T8.1 • Contribution to report on communication activities (The Container Terminal Automation Conference 2017, NAVIS WORLD 2017, TOC Europe • Contribution to Dissemination in T8.2 • Contribution to report on dissemination activities • Participation in the business modelling workshops in Valencia • Review of the initial INTER-IoT exploitable products defined in WP2 • Fill in the templates of joint and individual exploitation Plans for NOATUM • Contribution to give information about technology, value proposition and tangible products collected by XLAB and the Port of Valencia • Definition of the organisation Individual and Joint exploitation plans.
ASL TO5	• Contribution to scientific Dissemination (details of the publications are included in part A of the PPR and in deliverable D8.5). • Contribution to communication and dissemination activity through preparation and organization of local event for presentation of Mobile health pilot, participation to National Health Conference and publication on a specialized Health Journal • Contribution for Elaboration of Business Model • Fill in template for Joint and Individual Exploitation plan • Contribution for D 8.3 “Impact Creation Plan” Section 4.4 Medical Data Management”

	• Contribution for D8.4" Data Management Plan", D8.5 "Report on Impact" and D8.7 "Business Models and Marketing Operations • Participation at the 5th plenary meeting in Valencia, during workshop for exploitation • Definition of the organisation Individual and Joint exploitation plans.
ABC	• Created text for Web Site and flyer • Supervised work from graphic and communication company • Prepared deliverable D8.4 and D8.5 • Contributed to D8.3 with the Communication Section • Created Communication Plan and Editorial Plan • Presented INTER-IoT in International events and to Industrial Customers • Prepared and submitted Communication Questionnaire, and analysed results • IoT-EPI participation in several meetings and calls • Definition of the organisation Individual and Joint exploitation plans.
NEWAYS	• Communication of Neways activities in the IoT project via LinkedIn, facebook, corporate website, e-mail footers, twitter and Xing • (intermediate) reporting of Neways results • Participation in the business modelling workshops in Valencia • Contribution to the joint and individual business modelling and exploitation plans • Participation in several conference calls regarding business modelling • Contribution to the joint and individual business modeling & exploitation plans • Definition of the organisation Individual and Joint exploitation plans. • Participation in several conference calls regarding exploitation • Filled in templates of joint and individual exploitation Plans for Neways
SABIEN	• Contribution on the exploitation strategy definition and framework • Contributions on the market analysis (as reported in D8.7) • IPR strategy definition • Definition of the organisation Individual and Joint exploitation plans.
TI	• Definition of the organisation Individual and Joint exploitation plans. • Contributions in the market analysis • Support for industrial dissemination and communication activities.

2.4.6.2 Results

The project made use of many communication channels to make public all the results for different audiences and relevant actors (e.g. SMEs, IoT application developers, infrastructure integrators and operators). The deliverable D8.5 (M18) reports in detail (i.e. providing all the quantitative data in terms of publications and events) all achievements for INTER-IoT activities of the impact creation plan described in D8.3 (M4) that was revised in D8.3 v2 (M12) in order to include the recommendations of the project reviewers in the different three planned areas:

- Dissemination results in terms of contributions to books, journal papers, conferences, workshops, and events, considering two kind of dissemination actions, scientific and industrial. Scientific actions started early in the project due to the long-term collaboration between project partners in the areas addressed by the project, and the delay between the conception of the main ideas and the start of the project; while the industrial dissemination actions have already started, the plan is to increase them in the second half of the project, as soon as the technological results will be solid.
- Communication results in terms of the different channels used by the project. During the first 12 months of the project the consortium created the image of the project and started to communicate results using broad channels (e.g website and social networks), following the

communication plan, a questionnaire was submitted to the different agents already contacted during the market analysis (D2.1) to understand other communication channels and exploit them in order to increase impact. In terms of communication INTER-IoT partners have continued collaborating actively with IoT-EPI, and with other projects like IoT-LSP cluster.
- Exploitation in close relationship with D8.7a (released as an intermediate deliverable as requested by the reviewers), includes a review of the plan for OS delivery of the INTER-IoT products and the evolution of the actions taken by the exploitation team in this area.

The different actions related with the creation of impact have been addressed to different actors, already identified in D2.1 (namely, Market and Stakeholder analysis) and by the definition of the dissemination, communication and exploitation plans. The main agents towards the consortium focused to achieve impact, as indicated in D8.3, have been:

- SME: are a major target for INTER-IoT, as INTER-IoT products will help the SMEs to open boundless business opportunities and unparalleled possibilities to develop new services and improve current portfolios, including the exploitation of new user-centric business models in sectors such as Transport/ Logistics, m-Health and cross-domain. Five of the third parties from the open call are SMEs. Several actions in dissemination and communication have been addressed to create impact among SME and clusters of SME. One of the main goals related with the exploitation strategy is that SME within and outside the project are able to use the different defined products with independence of the application domain in which they develop their activity.
- Integrators: can benefit from the outcomes of the project and with the new definition of INTER- IoT products will allow them to embed different IoT objects and also to improve the applicability of INTER-IoT technologies on robustness, cross platform interoperability and cost of ownership. Moreover, the need of interoperability including communications, semantics and security will be required in future deployments in which more than one platform was involved. An example of the impact with these kind of agents has been achieved in the liaison with H2020 IoT1 LSP and through different communication actions.
- Telecom Operators: have always been interested in new kind of services and data to be transported in their networks. Although some of European Telecom operators are abandoning the vertical markets, the advent of 5G is going to increase the link between IoT interoperability and Telecom Operators. It may be considered that 5G should develop and exploit network programmability functions to capture the IoT market. INTER-IoT products are of high interest for telecom operators and we are addressing the agents with the channels and actions identified for them (e.g. interoperability as a service or the link between SDN/NFV and IoT interoperability).
- Stakeholders and end users are the primary target of INTER-IoT products and for creating impact, with independence of the application domain. Currently the two areas addressed have been transportation and logistics and mobile health, however through the open call and INTER-DOMAIN pilot we have addressed other application domains like emergency management and smart cities. Many of the dissemination and communication actions, for the industrial sector are addressed to stakeholders and end users, some of them have been developed and some others have been planned for the second half of the project. During last IoT-Week event in M18, IoT-EPI projects presented the results to IoT-LSP projects, and INTER-IoT made its corresponding presentation and the result will potentially be used in areas like AHA (Active and Healthy Aging) or Farming.
- Academics: with three universities and two research centers in the consortium and involvement in several major clusters, the impact created in this environment through scientific dissemination, PhD and MSc thesis, courses –just to name a few- will be large. Actions have been taken in different areas, and actions to be taken in the second half of the

project are already planned (e.g. inter university courses or MSC actions related with IoT interoperability).

2.4.6.3 Deviations

No significant deviations in the different tasks

2.4.6.4 Corrective Actions

No corrective actions needed in the WP

3 Impact

3.1 Update of the plan for exploitation and dissemination of results

As described in Deliverable D8.3 dissemination activities aim to establish critical mass and long-term commitment from different selected target groups. Therefore, results from various project activities will be disseminated to the widest possible, though precisely selected, communities through a number of focused activities. The dissemination plan considered a continuous activity since the start of the project, but with flexibility and possibility of evolving during the lifetime of the It should be stressed that the dissemination activities have been continuous and that the plan of such activities will evolve throughout the lifetime of the project. The evolution will be caused both by the growth of internal knowledge (e.g. discovery of new target group, like conferences, research cluster or as a result of the Open Call); as well as changes in the ecosystem of research in which INTER-IoT project will grow. The project partners have been working together in areas related with IoT interoperability for several years before the start of the project, so the project has not suffered the typical 'slow start' effect in terms of dissemination activities, as some of the work were already ongoing during the negotiation phase of the project and were linked to INTER-IoT.

Deliverable D8.5, updated some of the content regarding the plan. However, the identified target audiences, identified in the dissemination plan in D8.3 have remained the same:

- Academic institutions
- R&D departments of industrial companies
- Start-ups
- Business in general, including the remaining stakeholders
- EU-funded projects
- General public, including IoT enthusiasts

Following the recommendation of the project reviewers we split dissemination activities in two blocks:

- **Scientific dissemination:** Disseminate the scientific and policy oriented research done in the framework of INTER-IoT by participating to academic and policy oriented conferences, by presenting working papers and scientific contributions, and by submitting scientific articles to peer- review journals.
- **Industrial Dissemination:** Disseminate the different exploitable services and products of INTER- IoT in the main industrial conferences and exhibitions of the sectors and markets addressed in the project (Ports, Health, IoT, etc.), in order to attract the attention of potential customers and users.

Each dissemination activity had their own development plan and the following sections describe the achievements during the first 18 months of the project.

3.1.1 Scientific Dissemination

Scientific dissemination is a key impact enabler, and the consortium is making a cooperative effort in order to deliver substantial number of high impact publications. Following the scientific dissemination plan the main publication targets have been journals, conferences, workshops and book chapters. The activity has been very successful, considering as well that the period is from M1 to M18. The identification of the relevant venues was identified in D8.3, and the list is periodically monitored and updated. And specific figures and contributions have been provided in deliverable D8.5.

Members of the consortium have also organized a number of scientific events, in line with the activity of the project. It should be stressed that these events are either stand-alone (and in this case organized under the umbrella of respective organizations, e.g. European Alliance for Innovation), or associated with events organized by well-established organizations representing IT professionals (e.g. the IEEE).

The next period of the project (M19-M36) will bring more activities related with dissemination as the technical project results are increasing and WP6 related with pilots and real testing is starting. It has to be highlighted that as part of the dissemination strategy some activities related with academics are undergoing, such as joint seminars or joint PhD thesis, and will be consolidated during the second half of the project.

3.1.2 Industrial Dissemination

Since the beginning of the project, industrial dissemination was one of our key goals. As a matter of fact, there was a number of industry focused presentations already delivered mainly to application domain stakeholders: port authorities (Spanish, French and European), national health systems (Spanish, Italian and British), smart cities (Spanish, French, Italian, Slovenian and Polish) or energy (Polish and Slovenian). Furthermore, we have participated in the SIDO 2017 and IoT Week 2017, in which the consortium presented three demos related with INTER-IoT products. Our presentation attracted considerable interest, including representatives of IBM and W3C. Furthermore, while it is rather difficult to be certain that the Facebook-based dissemination is well-targeted towards business community, the situation changes when LinkedIn (our group) and Twitter (our account) are considered. Here, it is clear that messages that have been posted reach out to the business community (both these channels are, clearly, oriented towards professionals).

Nevertheless, the following observation has to be made. It is rather difficult to reach-out to the business community with no running software / prototype in hand. Therefore, in the first period of the project mainly exploratory and long-term actions were undertaken in this domain, while in the second part, with the initial modules actually working, we are ready to stress industrial dissemination in three areas:

- IoT in general,
- e-health related IoT issues,
- IoT in logistics.

Several events were already identified in D8.3 and some of them have already been selected for attendance during the second half of the project in which potential for success of our ‘products / results’ in the business community could be achieved as was clearly visible during the IoT week. The project will perform different showcases to stakeholders during Y3 of the project in Torino and Valencia, location of the pilots.

Furthermore, we fully expect that majority of the collaboration from the Open Call will generate results that will be natural to communicate to the business audience. Here, it is worth noting that, in the latter case, it will be our partners (from the Open Call) who will take part (hands-on) in the dissemination activities. The two large scale collaborations are tied to ECLIPSE, through the OM2M project and the recently open sensiNact project. Both aspects started with the presence of INTER-IoT in ECLIPSECON 2016, will provide a possibility of promoting INTER-IoT results, attending to ECLIPSECON 2017 together with the partners of the open call. During the Advisory Board meetings it was suggested by the stakeholder members and the representing person of capital investments present results to industrial community when demonstrations were ready. Henceforth, we are certain that it is now after first demos have been released when we have reached the point when we have product(s) to leverage to disseminate to outreach to our target business audiences.

3.1.3 Demo and Posters for Industrial Events

During the first 18 months we prepared three demo, to be shown mainly at Industrial events, in order to explain what our products were able to do in practical context. For what concern the Application and Services layer, we show several isolated services interoperating between each other using INTER-IoT - NodeRED tool. Two trucks are moving around Valencia and a CEP (FIWARE/Proton) service fires an event 10km before approaching the port. Then all the service composition wiring comes into play and all information is extracted and collapsed regarding the truck destination (consulting the Port Community System service, PCS) and previous port calls that the truck serviced (consulting the Short Time Historic service of FIWARE, STH) and displayed in a GUI dashboard.

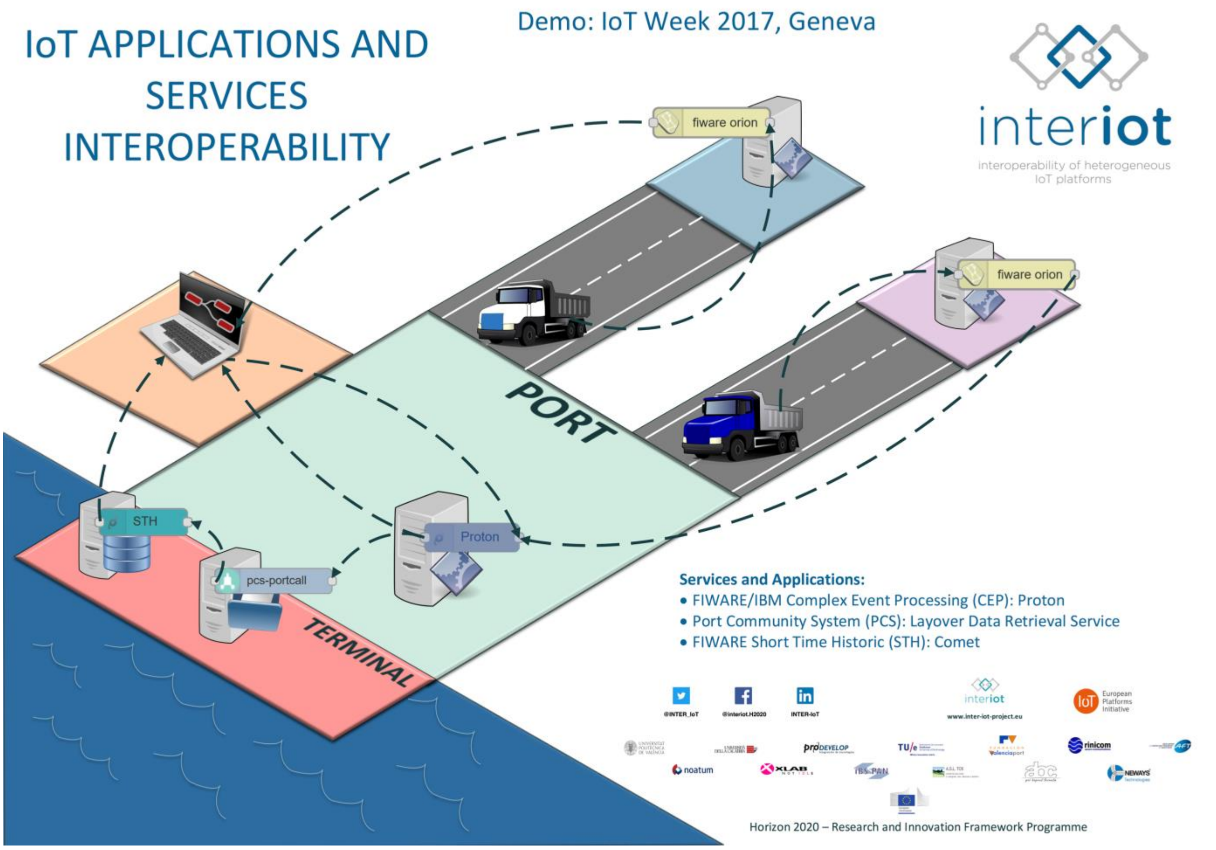

Figure 33. Poster for Application and Services Layer Event

For what concern the Demo on the Middleware, we focus on the Integration of Universaal (UaaL) and Orion (FIWARE). The specific setup is the following: the Scale goes to Mobile phone (acting as a gateway, via bluetooth) and the phone sends the sensor information to UaaL (via Wifi). INTER-MW bridges the information of UaaL with Orion (FIWARE) then a GUI to visualize the measurements is subscribed to Orion to prove that the bridging works.

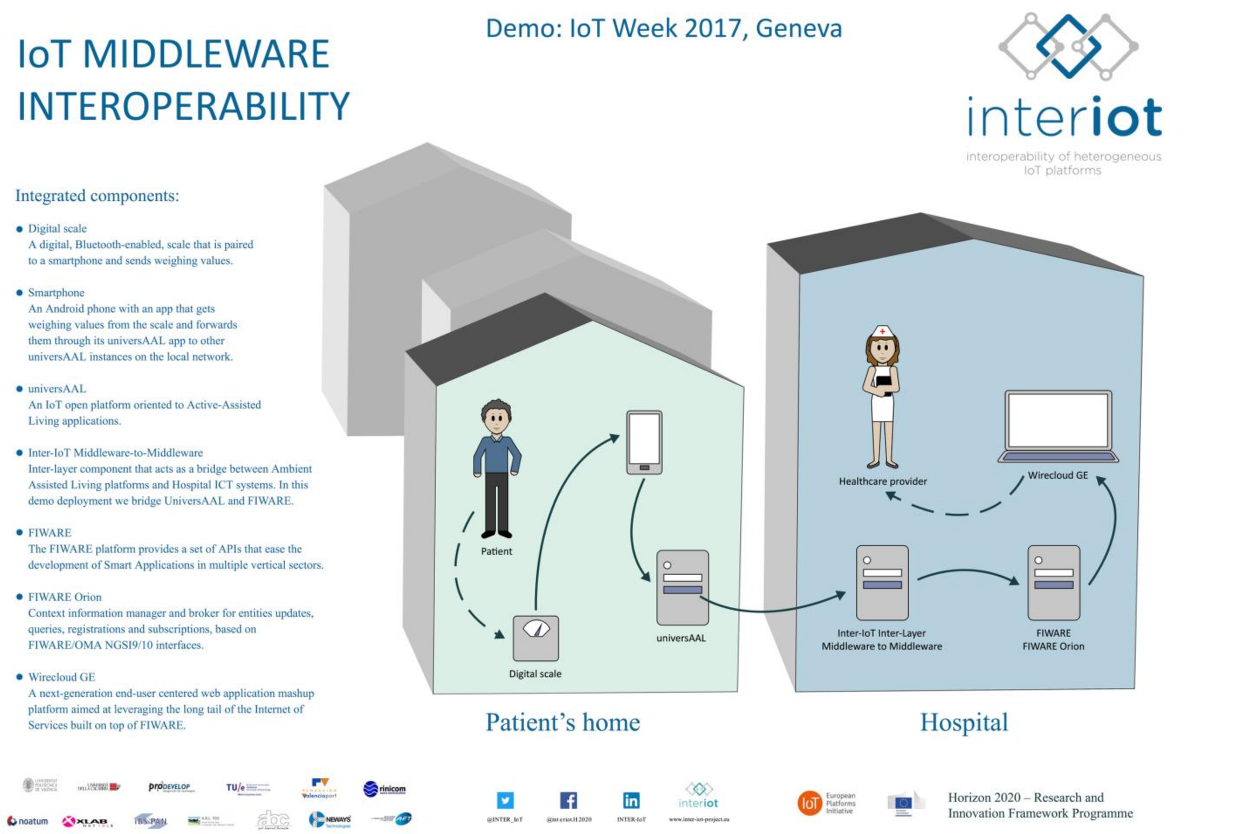

Figure 34. Poster for IoT Middleware Layer Event

The aim of DS2DS demo was to present the functionality of semantic translation performed by IPSM component. The background story for the demonstration is as follows:

- There are 4 IoT artifacts/platforms that cooperate in e.g. a port environment. They have the following roles: P1 – produces sensor observations; P2 – analytical platform that should receive observations produced by P1; P3, P4 – business logic platforms that consume observations published by P2.
- The architecture of IPSM assumes existence of a central ontology (CO) specific for a deployment and based on GOIoTP. In this case central ontology is based on SOSA and geoSPARQL for geospatial data representation.
- Each platform uses a different ontology:
  - **P1** http://platform1.eu/sensors# extending SSN and wgs84_pos for geospatial data (e.g. Open- IoT)
  - **P2** http://platform2.eu/sensors# extending SAREF and wgs84_pos for geospatial data
  - **P3** http://platform3.eu/sensors# extending SSN and wgs84_pos for geospatial data (e.g. OPEN-IoT)
  - **P4** http://platform4.eu/sensors# extending SSN and geoRSS for geospatial data (e.g. IoT-Lite)

The IPSM architecture is based on communication channels created between components. Each semantic translation channel uses two alignments (performs two translations) – from source ontology to central ontology, and from central ontology to target ontology. Considered translation channels:

1. Between P1 and P2
2. Between P2 and P4
3. Between P2 and P3

Each pair of messages is de facto the same message in terms of metadata, but the payload changes due to applied alignments. The demonstration included two scenarios: (1) performing semantic translation between selected IoT artifacts and inspecting the results, (2) running continuous translation of messages generated by one of the IoT artifacts and measuring number of translation per second.

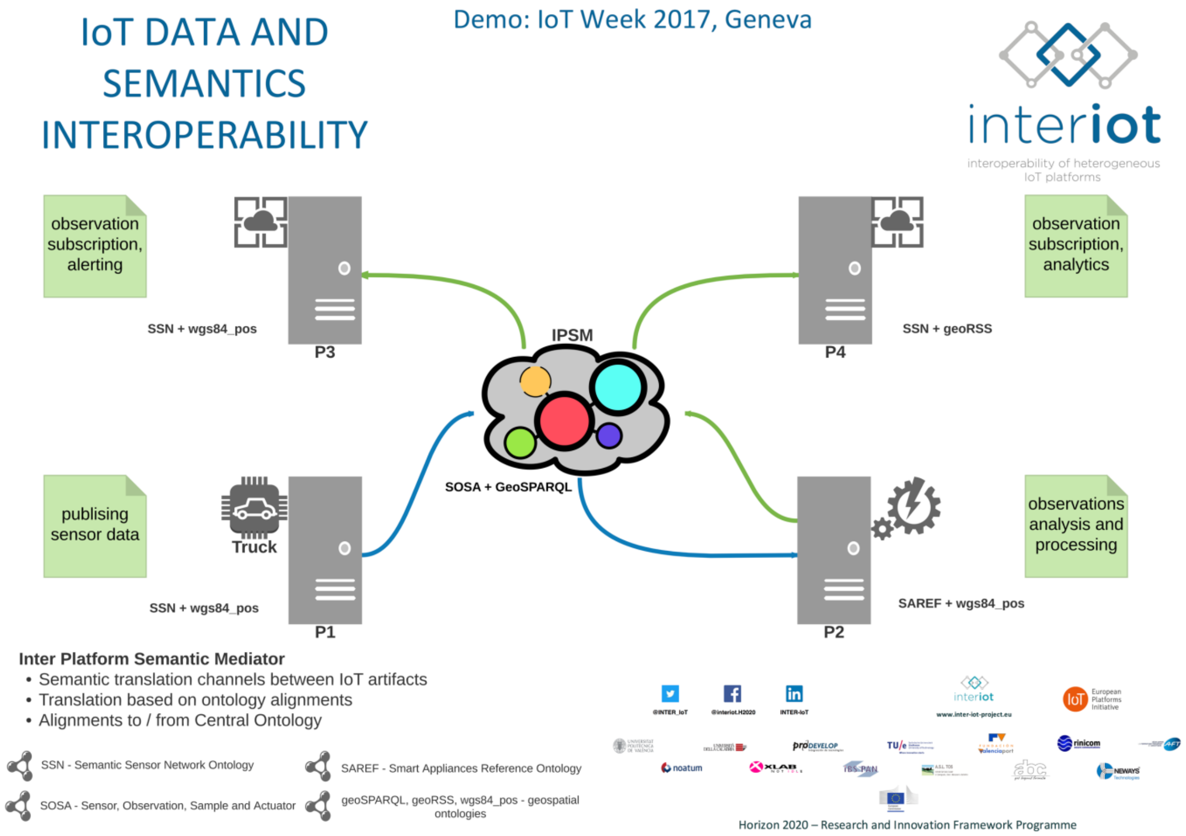

Figure 35. Poster for IoT Data and Semantics Layer Event

3.1.4 Communication Results

One of the key aspects of INTER-IoT communication strategy is the identification of the target audience. In order to perform this activity, we submitted a questionnaire to our most relevant stakeholders (most of them identified during the market analysis provided in D2.1) in order to understand the best way to approach the communication towards them. The stakeholders were selected from the ones identified in WP2 (Deliverable D2.1). Out of all stakeholders contacted, which represented a ”Delphi” set, around half of them replied to the questionnaire. Hereafter the analysis of the answers which are relevant for the Communication Channels. It is important to notice that the answers were mainly given by people that can heavily influence the respective companies on new technologies (C-level executives, Directors, ...).

Table 25. Communication Results Summary

From which source do you get the most valuable information on Technology Products for your company?	The highest number of replies is from direct search on Internet (around 30%), then with direct communication with R&D partners (25%).
From which source you believe you don't get any interesting information?	Apart from newsletters, which got the highest number of replies, the other replies vary from social media to emails to mainstream media.
Ideally, how often would you like to be informed about new technological developments that could have an impact on your current activities?	Here, we have an almost flat uniform distribution from once a day to once every six months
Did you participate as a delegate to some Fair / Event in the last 2 years? If so, which ones?	The highest number (by far more than 50%) of replies was none; Among the ones that went to some event, TOC Amsterdam is the most common reply
Do you plan to participate to some Fair / Event in the next year? If so, which ones?	Answers were similar to the previous questions, with a large number of replies saying "none" and the majority of the rest TOC Amsterdam
How often do you use social media for your business (Twitter, LinkedIn, Facebook, etc.)?	While the majority of answers were regularly (30%), the second biggest group was never (either because of no interest or because company does not support that activity).

The web site has been the main communication mean during the period under review, together with the different social networks. Regarding the Web Site, traffic has been monitored since the very beginning of the project. Hereafter the graphs summarizing it:

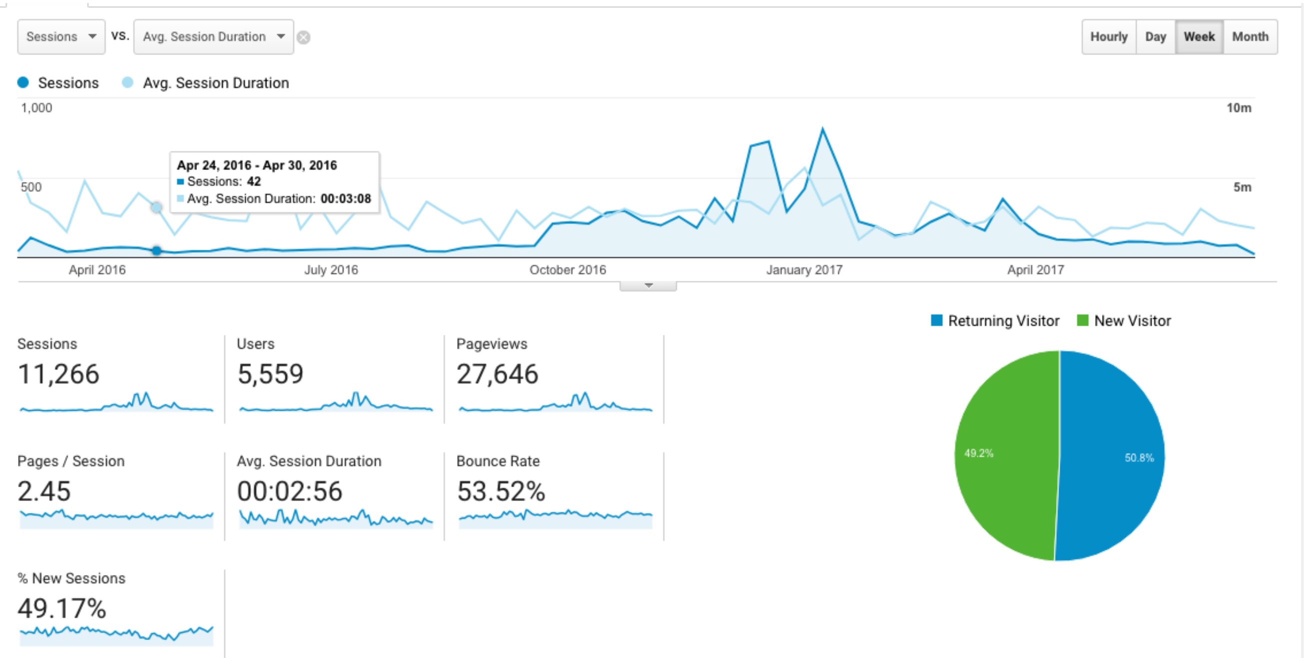

Figure 36. Monitored Website Traffic

It's very clear that during the open call the web site was very popular, as many people were checking the details of the call. The total number of user, in excess of 5000, is also very good and promising, as we expect this number to grow significantly as soon as some of our results, including the open source software and the deliverables, will be ready. I's also important to see that while the average session duration is growing, which means that the users stay longer on the site; in other words, is not people that landed by mistake on our site and then fly away after a few seconds, but are reading and exploring what INTER-IoT has to offer.

For what concerns standard social media (such as LinkedIN, Twitter, Facebook), the project set up from the very beginning the different accounts. While these channels do not seem to be the most appropriate to reach the stakeholders identified in the highest quadrant, we do feel that it's important to have a presence for both the general public and for the stakeholders that do follow these media.

Table 26. Social Networks Activity

Social Media	Followers	Actions
Twitter	400+	78
LinkedIn	250+	30+
Facebook	380+	hundreds

3.1.5 Liaisons with other projects

D8.3 considered in the communication action the liaison with different project, and a preliminary plan was drafted, however as the relationship with IoT-EPI is ongoing and since January 2017 H2020 IoT1 LSP projects started, the consortium decided to apply a specific strategy in order to manage this action and focus on answering the question with whom the INTER-IoT project plans to engage, when, where, and on which basis. Driven by this underlying question, this section draws current status of the projects external liaisons plan.

The liaison strategy is split into the following five phases over the project duration:

- Phase 1: defined the external liaisons strategy and the initial set of Key Performance Indicators (KPI) for documenting the execution of the strategy. In addition, the first phase in external liaisons dealt with the identification and selection of candidate projects with which INTER-IoT plans to engage. The above criteria determine the frame based on which a selection of candidate projects is made.
- Phase 2: the purpose consisted in reaching out to previously identified candidate projects. Contacts to partner projects were established and a joint planning in terms of common interests and the organizational aspects of a mutual exchange among involved projects was foreseen. The time frame for establishing contacts was kept as short as possible to allow shifting the focus at an as early as possible point in time to liaising with partner projects on a content-oriented basis.
- Phases 3 and 4 were planned to start in parallel with phase 2. Phases 3 and 4 grouped liaising activities along the key set of focal points INTER-IoT will adopt and work upon in the respective time frame. These time frames were in-line with INTER-IoT's project plan, plus the envisioned focal points are aligned with the key project assets.
- Phase 5 is more focused on pilots and evaluation of the results.

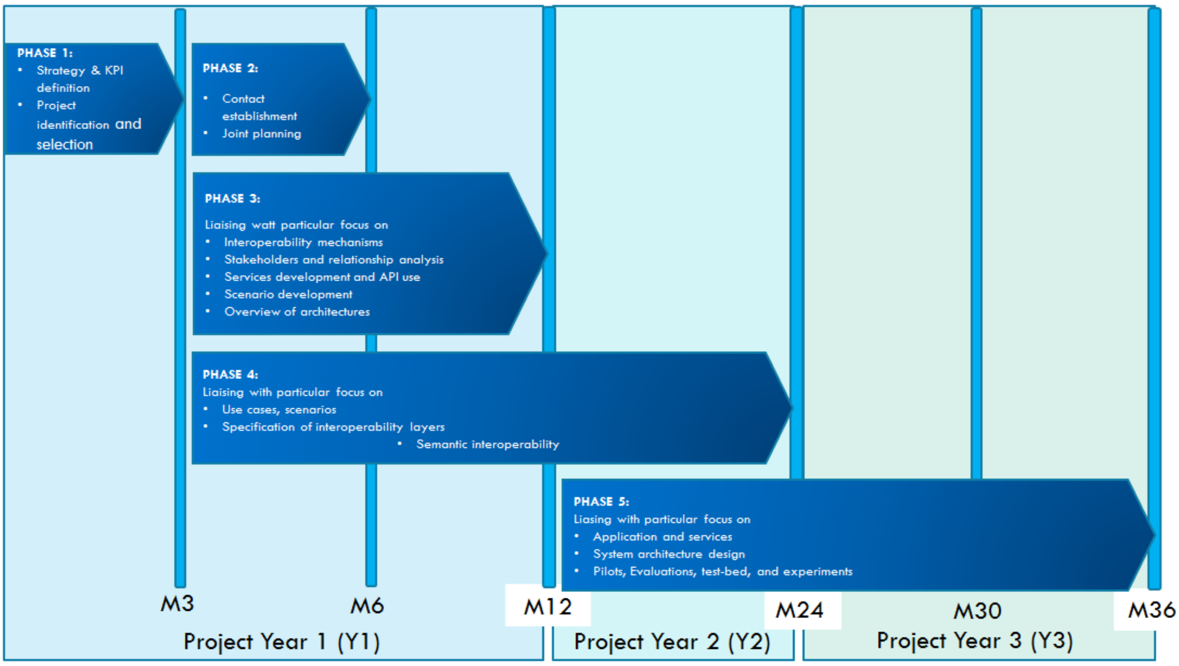

Figure 37. External Liaisons Strategy Structures in Phases

The following projects were selected initially during the first year of the external liaisons plan:

- IoT-EPI (http://www.iot-epi.eu) group of nine different projects with which INTER-IoT has been interacting. Special liaison with
  - SYMBIOTE (https://www.symbiote-h2020.eu/) as the developed architecture has similarities with INTER-IoT,
  - BIG-IoT (http://www.big-iot.eu) as the concept associated with API and security has been discussed in different meetings,
  - AGILE (http://www.agile-iot.eu) as the concept of gateway presents some similarities with INTER-IoT D2D layer.
- IoT-LSP (web site not available yet) cluster of the five IoT1 LSP projects, a meeting with the five projects was held during IoT Week in order to establish relationships between projects, till now specific interactions with:
  - ACTIVAGE (http://www.activageproject.eu) dealing with interoperability for Active and Healthy Aging (AHA), the link is with the interoperability layer and semantics between IoT platforms, as INTER-IoT MW2MW layer and IPSM meet the requirements.
  - IoF2020 (http://www.iot2020.eu) related with farming and food industries and the need for interoperability, the interaction is twofold related with the interoperability layer and the gateway.
- H2020 Transforming Transport (http://www.transformingtransport.eu/) require INTER-IoT API and INTER-LAYER components to access data in INTER-LogP environment. The pilot for Big Data will deployed over INTER-IoT pilot.
- H2020 F-INTEROP (http://www.f-interop.eu/) FIRE project related with the provision of remote interoperability, the IoT interoperability as a service can be offered in the platform.

- ITEA3 APPS (http://www.apps-project.eu/)intends at future surveillance systems by exploiting the benefits of different sensor modalities. PRO is approaching architectural components of INTER-LAYER with APPS components, and searching for synergies with INTER-LogP and the APPS pilots at Port of Rotterdam.
- BIG-CLOUT (http://big-clout.eu) the project uses interoperability between IoT platforms in smart cities environment and the use of the information for big data analytics.

The projects selected for liaison have been analysed in terms of different criteria:

- C1: In which ways could INTER-IoT profit from liaising with the project in question?
  - C1.1: Could INTER-IoT's interoperability mechanisms profit?
  - C1.2: Could INTER-IoT's stakeholder and relationship analysis profit?
  - C1.3: Could INTER-IoT's INTER-FW and API profit?
  - C1.4: Could INTER-IoT's scenarios development profit?
  - C1.5: Could INTER-IoT's overview and/or the specification of solutions profit?
  - C1.6: Could INTER-IoT's definition of use cases profit?
  - C1.7: Could INTER-IoT's SMART objectives profit.
  - C1.8: Could INTER-IoT's system architecture design be influenced?
  - C1.9: Could INTER-IoT evaluations, its test-bed, and/or experiments profit?
  - C1.10: Are there any other than the previously mentioned areas in which INTER-IoT could profit from that project?
- C2: In which ways could the project in question profit from liaising with INTER-IoT?
  - C2.1: Could that project profit from INTER-IoT's interoperability mechanisms?
  - C2.2: Could that project profit from INTER-IoT's stakeholder and relationship analysis?
  - C2.3: Could that project profit from INTER-IoT's INTER-FW and API?
  - C2.4: Could that project profit from INTER-IoT's scenario development?
  - C2.5: Could that project profit from INTER-IoT's overview and/or the specification of solutions?
  - C2.6: Could that project profit from INTER-IoT's definition of use cases?
  - C2.7: Could that project profit from INTER-IoT's SMART objectives.
  - C2.8: Could that project profit from INTER-IoT's system architecture?
  - C2.9: Could that project profit from INTER-IoT evaluations, its test-bed, and/or experiments?
  - C2.10: Are there any other than those previously mentioned areas in which that project could profit from INTER-IoT?

Table 27. Analysed Project's Liaisons per criteria

	C1: In which ways could INTER-IoT profit from liaising with the project in question?										C2: In which ways could the project in question profit from liaising with INTER-IoT?									
	C1.1	C1.2	C1.3	C1.4	C1.5	C1.6	C1.7	C1.8	C1.9	C1.10	C2.1	C2.2	C2.3	C2.4	C2.5	C2.6	C2.7	C2.8	C2.9	C2.10
SymbIoTe	x	x		x	x	x	x	x	X	x	X	X	x	x	x	x	x	x	x	x
BigIoT		x	x	x	x	x	x	x	X	x		X	x	x	x	x	x	x	x	X
AGILE	x						x	x	X	x	X	X					x	x	x	X
ACTIVAGE		x		x	x	x	x			x	X	X	x	x	x	x	x	x	X	x
IoF2020		x		x	x	x	x			x	X	X	x	x	x	x	x	x	x	x
TT				x	x					x		X	x	x	x	x	x	x	x	X
F-INTEROP							x		x			X			x		x	x	X	
APPS											X	x	x	x		x		x	x	X
BIGCLOUT				x					x	x	x	x	x	x	x	x		x	x	x

3.1.6 Exploitation

The project selected an Exploitation Team (ET) composed by one member per partner. The ET reviewed D8.3 and INTER-IoT business models (joint and individual) elaborated in WP2 and included in D2.2 (M6). The selected business scenarios (transport and logistics and m-Health) were considered as the baseline for exploitation. On M6, the INTER-IoT consortium also participated at the EPI IoT celebrated in Valencia (June 23-24). Some INTER-IoT partners assisted and participated in the TF-4 Business Model workshop with the presentation of the INTER- Layer BM at Workshop in Valencia (June 23-24). The INTER-IoT project received feedback from other projects as well as from IoT experts with previous expertise in IoT business models.

The ET participated in TF4-Business Models online conferences and webinars during this period as TF Community Building, TF Business Models and Data Business Models. Besides, on M12 the EU Commission asked for the review of the D8.3 (M4) in terms of strengthening the industrial Dissemination Strategy and the standardization and Open Source strategies of the project. The joint and individual exploitation templates attached in D8.3 were also enforced following the LLava Matrix Framework and Lean Innovation Process (that has been proposed and used in T8.3: Business and Marketing Operations). This methodology has helped the ET to have a common and particular vision of INTER-IoT business models on the selected business scenarios with the identification of customer segments, common needs, value promise, set of exploitable products, value network, competitors and alternatives, revenue models, SWOT analyses and IPR issues. It is also important to point out, that the communication and dissemination activities reported during this period are direct connected with the Exploitation Plan in order to create impact and have been reported in previous sections. The INTER-IoT consortium had also engagement with business and investment community. More specifically, RINI arranged representation of TALIS Capital (one of the venture firms specialising in investment into IoT sector) on INTER-IoT Advisory Board. This cooperation is proved to be quite useful as through TALIS Capital network, RINI (and INTER-IoT project in general) is receiving the continuous updates on the latest technological advances in IoT sector. Furthermore, TALIS Capital will be directly engaged in the later stages of the project by reviewing and optimising the developed business model and advising on potential exploitation paths.

The INTER-IoT consortium had also engaged with the business and investment community. TALIS Capital, a venture capital firm specialising in investment into IoT sector, SaaS, and security, is now a member of INTER-IoT Advisory Board. They invest around the world while maintaining their focus on the UK and Europe. TALIS specialise in bringing state of the art technology together with conventional businesses to produce reliable revenues for their clients. This cooperation has proved to be quite useful for the project. Through TALIS Capital's network, the INTER-IoT project is receiving continuous updates on the latest technological advances in IoT sector. Furthermore, TALIS Capital will be directly engaged in the later stages of the project, reviewing and optimising the developed business model and advising on potential exploitation paths.

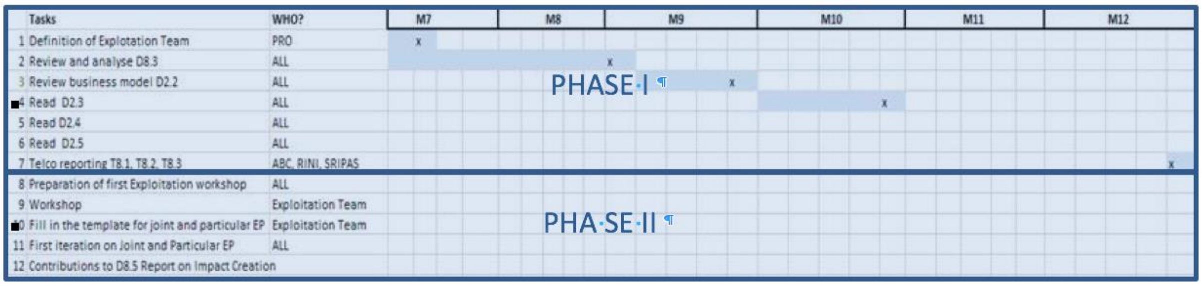

Figure 38. Global Exploitation Plan

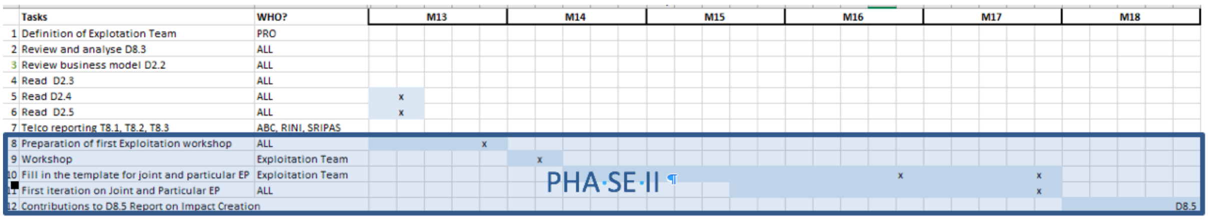

Figure 39. Exploitation Plan Phase II

The second phase called "Phase II: First iteration of the joint and individual Exploitation Plans (M12-M18)" started on M12 and finished by the time of this report on M18. The first iteration of the joint and individual Exploitation Plans started in M14 during the workshop held by the ET in Slovenia and was finished in M16. During M13 the ET prepared a workshop to be held on M14 to conduct the activities to start the first iteration of the Joint and individual Exploitation Plans. The workshop was celebrated in Slovenia and the ET presented the results of the WP2 in order to have a clear picture of the initial business models (joint and individuals) as starting point for Exploitation Plan. Therefore, during this workshop, the collaborative INTER-IoT business model and scenarios defined in WP2 were discuss and the ET requested also to rank the business scenarios according to risk, cost, opportunities etc. from the perspective of INTER-IoT as a project. In addition, to start with the execution of the first iteration of the joint and individual Exploitation Plans, the partners were asked to present the first iteration of the joint and individual Exploitations Strategy Plans on M16 as internal milestone MS1 by filling the templates attached in D8.3. Regarding Joint Exploitation Plans, the ET asked the INTER- IoT partners to identify and describe the joint exploitation opportunities envisioned at this stage of the project, its role in the project and their vision about long-term sustainability of INTER-IoT Platform for commercialization. The ET proposed the following types of business models for a joint exploitation plan:

- B2C/ B2B based on OS plus Professional consultancy services
- B2B not OS: License
- Specific B2B. Collaborations BM between concrete partners

Further discussion about open source strategy were carried out analysing the possible OS licenses to be adopted. Finally, the INTER-IoT consortium agreed in the selection of the license Apache 2.0. Regarding the Individual Exploitation Plans, the ET asked to the partners to explain in depth their business selected scenarios from their own organizations perspective and to identify opportunities for exploitation to be explored until M32. On M15, during the 5Th Plenary Meeting celebrated in

Valencia. The ET joined in parallel sessions to work together on the exploitation vision of the project, and the interaction between the Community Product, promised in the DoW, and the Commercial Product that will address the further exploitation challenges beyond the duration of the project. These activities culminated in a Joint Exploitation Plan based on an open source strategy that has been included in D8.7 (M18).

Taking into account the aforementioned Joint Exploitation Plan based on open software, the partners presented their first iteration of their Joint and individual Exploitations Plans on M16 and the ET agglutinated them to be included in D8.7. The ET has also monitored the market and reviewed the initial INTER-IoT exploitable products defined in WP2, according to the achievements of exploitation activities during project's lifecycle as an iterative process (LLAVA Matrix Methodology). In order to define the INTER-IoT Value Proposition, the Exploitation Team (ET) asked to all partners of the consortium to fill in several templates related to the products and components they are implementing in the context of INTER-IoT, the technologies they are bringing in, the services they are offering, similar initiatives and advantages over them, etc

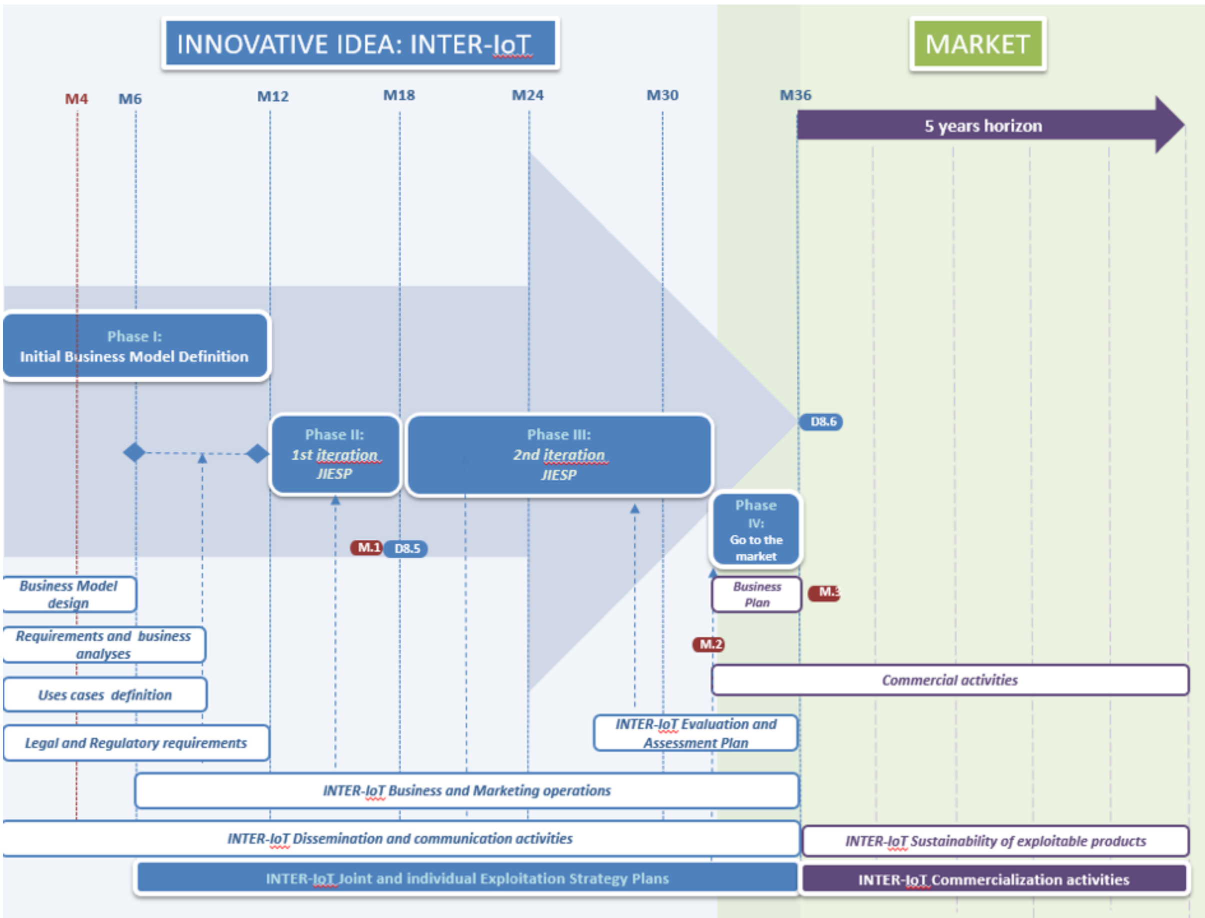

Figure 40. Exploitation Plan Phase II actions

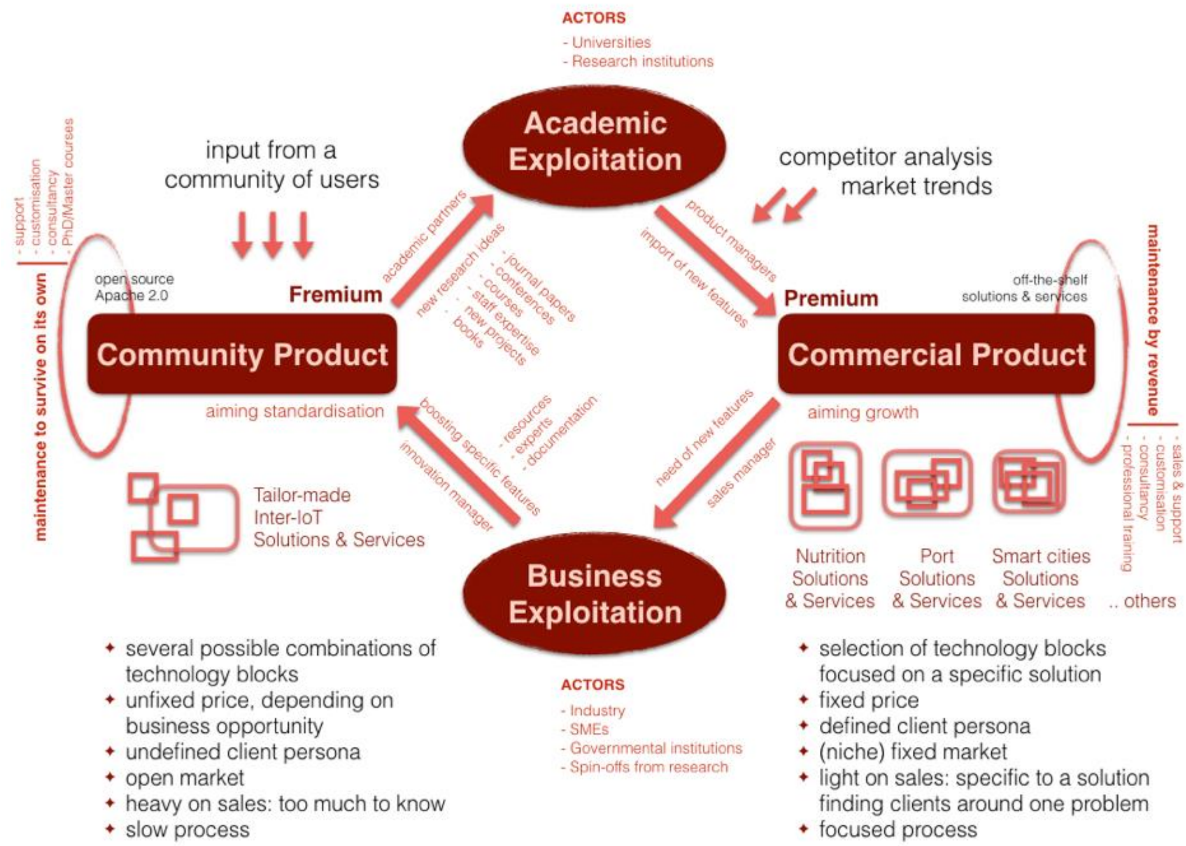

Figure 41. Exploitation Plan Phase II scheme

4 Deliverables and Milestones

4.1 Deliverables

Table 28. List of Deliverables

Del	Del.#	Del. Name	WP No.	Lead Beneficiary	Nature	Dissemination Level	Delivery Date from Annex-I (Project Month)	Delivered Yes/No	Actual Delivery Date	Comments
D1.1	D1	Project Management Handbook	1	UPV	Report	CO	31/01/2016	Yes	31/01/2016	None
D1.2	D2	Data Management Plan	1	UPV	ORDP	CO	30/06/2016	Yes	01/07/2016	This deliverable was submitted late due to an error in SYGMA
D1.3	D3	Risk Management v1	1	UPV	Report	CO	30/06/2016	Yes	01/07/2016	This deliverable was submitted late due to an error in SYGMA
D1.4	D4	Risk Management v2	1	UPV	Report	CO	30/06/2017	Yes	30/06/2017	None
D1.6	D6	First annual management report	1	UPV	Report	CO	30/06/2017	Yes	29/8/2017	This deliverable was submitted late due to an error in DoA as it is the PPR.
D2.1	D8	Stakeholders and market analysis report	2	AFTIFTIM	Report	PU	31/03/2016	Yes	31/3/2016	Actual date of submission is SYGMA is 14/11/2016 as it has to be resubmitted due to a mistake of the PO.
D2.2	D9	INTER-IoT Business Models	2	VPF	Report	PU	30/06/2016	Yes	01/07/2016	This deliverable was submitted late due to an error in SYGMA
D2.3	D10	INTER-IoT Requirements and Business Analysis	2	VPF	Report	PU	30/09/2016	Yes	31/01/2017	This deliverable was re-submitted
D2.4	D11	Use cases manual	2	TI	Report	PU	31/12/2016	Yes	29/12/2016	None
D2.5	D12	Legal and regulatory constraints analysis and specification	2	VPF	Report	PU	31/12/2016	Yes	29/12/2016	None
D3.1	D13	Methods for Interoperability and Integration v.1	3	UPV	Report	PU	31/12/2016	Yes	31/12/2016	None
D4.1	D16	Initial Reference IoT Platform Meta-Architecture and Meta Data Model	4	ABC	Report	PU	31/12/2016	Yes	16/01/2017	This deliverable was submitted late after discussion with the PO.

D8.1	D31	Virtual Presence	8	ABC	Other	PU	29/02/2016	Yes	29/02/2016	None
D8.2	D32	Leaflet and Poster	8	ABC	Other	PU	29/02/2016	Yes	29/02/2016	None
D8.3	D33	Impact Creation Plan	8	PRODEVELOP	Report	PU	30/04/2016	Yes	31/01/2017	This deliverable was resubmitted.
D8.4	D34	Data Management and Sustainability Plan	8	ABC	Report	PUB	30/06/2016	Yes	01/07/2016	This deliverable was submitted late due to an error in SYGMA
D8.5	D35	Report on Impact Creation	8	ABC	Report	PU	30/06/2017	Yes	30/06/2017	None
D8.7	D37	INTER-IoT Business Models and Marketing Operations	8	RINICOM	Report	CO	30/06/02018	Yes	30/06/2017	The submitted deliverable is an intermediate version as requested by the technical experts

4.2 Milestones

Table 29. List of Milestones

Mile StoneNo	Mile Stone. Name	WP No.	Lead Beneficiary	Delivery Date from Annex-I (Project Month)	AchievedYes/No	Actual/Forecast Achievement Date	Comments
1	Kick-Off Meeting	1	UPV	01/02/2016	Yes	12/01/2016	The kick off meeting was held at UPVLC premises from 12th January to 13th January 2016. Every partner attended the meeting.
2	Initial Business Model ready	2	VPF	01/07/2016	Yes	30/06/2016	D2.2 related with INTER-IoT Business Models was submitted
3	Requirements gathered	2	VPF	1/10/2016	Yes	30/09/2016	MS is associated with the submission of D2.3 and the completion of Requirements gathering. The MS has been done on time
4	Initial architecture release	3-4	ABC	01/01/2017	Yes	16/01/2017	MS is associated with the submission of D4.1, that was delayed so as the MS.
5	Use cases defined	2	VPF	01/01/2017	Yes	31/12/2016	MS is associated with D2.4 delivery and it was delivered on time.

5 Explanation on the Use of Resources

5.1 Use of resources

There are no significant deviations in any tasks, objectives or scheduled activities and no deviations are foreseen in the following. During the 18 months of execution of the project two amendments were submitted and both had impact on the use of resources:

1. The Grant agreement had some errors in terms of manpower assigned to different tasks. The Consortium launched an Amendment request to the Grant Agreement in May 2016 to get it fixed, as instructed by the PO, together with other elements.
2. TI withdrawal and incorporation of SABIEN-UPV as the most adequate partner, and reassignment of different tasks between PRO, SRIPAS and UPV. SABIEN is a research institute inside UPV and their use of resources is reported as UPV partner.

Table 32 presents the use of resources per partner and per WP, the information provided includes the planned and the reported use by each partner. Totals per partner and per WP are provided. Planning of resources has been considered uniform per task throughout the project, so although this first period corresponds to 50% of the time of the project the planned resources are estimated to be 46,76%. Table 30 shows the planned use of resources in both periods of the project.

The planning of the use of resources for UPV is less balanced than the other partners because SABIEN, the research institute that has substituted TI will develop the majority of its activity during second period of the project so the workload is increased. Reporting is done together as both SABIEN and UPV lay under the same PIC number.

Table 30. Planned Use of Resources for Project Duration

	UPV	TI	UniCal	PRO	TU/e	VPF	RINI	AFT	NOATUM	X-lab	SRIPAS	ASLTO5	ABC	NEWAYS	TOTAL
M1-M18	62,54	12,5	38,39	35,64	24,11	40,41	27,89	17,22	17,55	31,8	56,13	23,05	20,06	25,01	432,3
M19-M36	112,46	0	42,61	48,36	20,89	26,59	28,11	20,78	22,45	30,2	62,87	21,95	21,94	32,99	492,2
Total	175	12,5	81	84	45	67	56	38	40	62	119	45	42	58	924,5

Table 31, although not required, differentiate the planned use of resources for UPV between the two research teams for clarity in the analysis.

Table 31. UPV internal planning

	UPV-DCOM	UPV-SABIEN	TOTAL
Planned M1-M18	60,19	2,35	62,54
Planned M19-M36	74,81	37,65	112,46
Total	135	40	175

Regarding deviations, although they are minimal some clarifications are needed:

- The project started with some problems in hiring people during the first 9 months and some attention had to be placed to the different regulations for hiring people within the different countries within the consortium, additionally there is an increasing problem in hiring adequate people in companies and in the universities. This was reported during the technical review.

- On the side of UPV there is a light underuse of resources due to two main reasons: (i) resignation of two researchers three months after starting their contracts, without being able to substitute them until M19 of the project due to the new research regulation of the university approved in September 2016 and entering into force in January 2017 and (i) more experienced people (with higher salaries) participated in the project team, leading to less manpower reported. This misalignment will be compensated in the second part of the project as UPV has a stronger participation in the integration of developments in the pilots from the patners and from the third parties from the open call.
- VPF overspent manpower during the first period of the project that will be compensated in the second period, because as leader of WP2 they had to make an extra effort regarding requirements gathering. Additionally, less experienced researchers that required more effort to perform the activity participated in the team, leading to a higher use of resources but with an adequate economical balance.

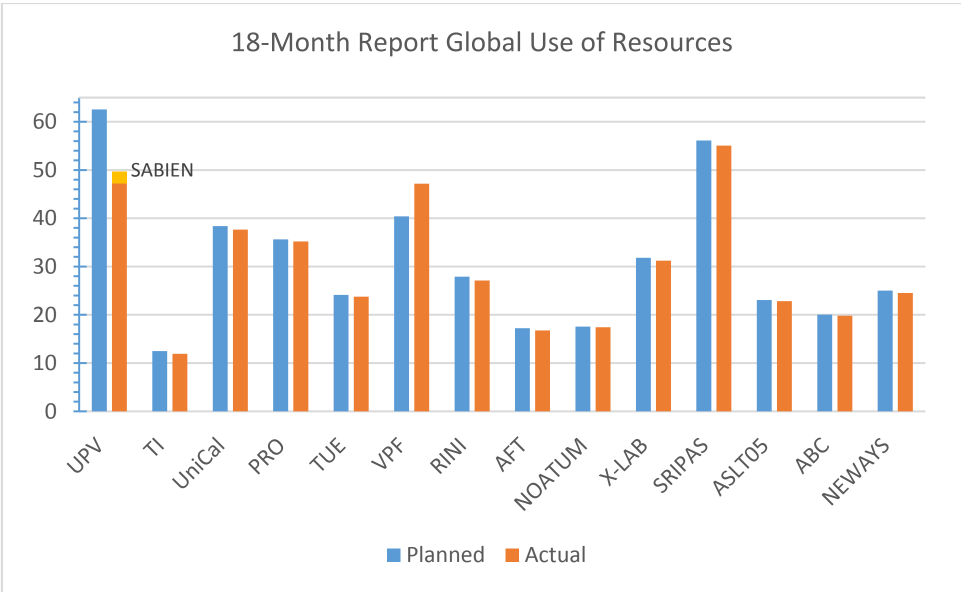

Figure 42. Use of Resources Summary

Part A of the Project Progress report contains the detailed financial information and reporting from the thirteen partners of the consortium. Two clarifications regarding the financial reporting:

- TI provided the termination report in January 2017 and it was accepted by EC, redistribution of the prefinancing returned by TI was done between the partners that have assumed their tasks.
- Following the structure of the open call UPV has distributed prepayment to the small contributions third parties (120.000€) in M18, so still 730.000€ of the budget support to third parties remains available and not distributed. In M19 50.000€ of the prepayment have been distributed to the large contributions, but have not been included in the cost statement.

Table 32. Use of Resources M1-M18

		P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	
		UPVLC	TI	UniCal	PRO	TUE	VPF	RINI	AFT	NOATUM	XLAB	SRIPAS	ASLT05	ABC	NEWAYS	**TOT**
WP1	Planned	14,50	0,00	1,50	1,50	0,00	1,50	1,50	0,00	0,00	0,00	0,00	0,00	1,00	1,00	22,50
	Actual	11,27	0,00	2,00	1,70	0,00	1,55	1,50	0,00	0,00	0,00	0,00	2,00	0,80	1,00	21,82
WP2	Planned	9,00	11,00	6,00	7,00	5,00	19,00	7,00	14,00	14,00	7,00	8,00	18,00	8,00	10,00	143,00
	Actual	10,63	10,81	6,02	7,00	5,00	25,23	7,00	13,90	14,04	7,01	8,71	12,91	6,90	10,67	145,83
WP3	Planned	19,55	0,50	8,00	5,85	12,13	7,97	11,23	0,00	0,00	10,80	18,50	0,00	2,69	10,01	107,23
	Actual	13,27	0,46	9,50	5,80	12,91	8,95	11,45	0,00	0,00	11,50	16,34	0,00	1,70	9,18	101,06
WP4	Planned	5,19	0,50	5,60	10,94	4,98	7,19	4,29	1,22	1,75	7,68	9,80	1,85	4,67	2,00	67,66
	Actual	4,91	0,39	4,10	13,00	4,00	5,81	2,15	1,76	1,91	6,47	8,77	3,81	4,70	2,03	63,81
WP5	Planned	10,50	0,00	15,39	7,75	0,00	2,00	0,00	0,00	0,00	4,12	15,83	0,00	0,00	0,00	55,59
	Actual	5,54	0,00	14,53	4,50	0,00	1,97	0,00	0,00	0,00	3,94	15,08	0,00	0,00	0,00	45,56
WP6	Planned	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Actual	0,47	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,47
WP8	Planned	3,80	0,50	1,90	2,60	2,00	2,75	3,87	2,00	1,80	2,20	4,00	3,20	3,70	2,00	36,32
	Actual	3,59	0,27	1,50	3,20	1,85	3,65	5,00	1,10	1,49	2,30	6,14	4,12	5,70	1,65	41,56
TOT	Planned	62,54	12,50	38,39	35,64	24,11	40,41	27,89	17,22	17,55	31,80	56,13	23,05	20,06	25,01	**432,30**
	Actual	49,67	11,93	37,65	35,20	23,76	47,16	27,10	16,76	17,44	31,22	55,04	22,84	19,80	24,53	**420,10**

5.1.1 Explanation of the use of resources RINI (P7) and ABC (P13)

RINICOM and ABC are SME of the consortium and part of their activity has been developed by non-salaried staff. The individual explanation is:

- **RINI:** At the time of submitting the proposal, the Person Months estimated to successfully deliver the project were based on the utilisation of actual salaried resource. However, due to the nature of the project, RINI deemed it necessary to include non-salaried staff (i.e. SME owner) to provide the relevant expertise in line with the DoA to make sure the tasks were completed to a high standard. The unit hours for the non-salaried staff are based on the EU guidelines of 30.12€ per hour. The hours for non-salaried staff are reported using detailed timesheets which in real terms can be converted into Person Months, making a total of 20.80 PMs for Period 1. This added to the 6.30 PMs claimed for actual salaried resource brings us to a total of 27.10 PMs for period 1 which is in line with the PMs initially forecasted for Period 1.

Table 33. RINI efforts detail

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total
Salaried Staff	0	0	5,80	0	0	0	0	0,50	6,30
Non-salaried staff	1,50	7,00	5,65	2,15	0	0	0	4,5	20,80
Total	1,50	7,00	11,45	2,15	0	0	0	5	27,10

- **ABC:** At the time of submitting the proposal, it was not clear the status of ABC during 2016, as there were plans to change the legal status from SARL to SASU. Therefore, in the proposal and regular reporting the Person Months estimated to successfully deliver the project were counted. As plans changed, and the legal status stayed SARL so far, ABC then reverted in the reporting to “unit-hours”. The hours for non-salaried staff are reported using detailed timesheets which in real terms can be converted into Person Months. All ABC effort was reported as unit-hours for a total of 19.80 PM.

5.1.2 TI withdrawal effect on the use of resources

TI withdrew from the project on M12, for the period under evaluation M1-M18, the planned use of resources before its departure was of (24,86 MM), when actually TI only used 11,93MM. Tasks planned to be carried out by TI have been taken over by SABIEN-UPV (starting M13), PRO, SRIPAS and UPV[25]. Next table show the distribution of the activity regarding tasks left by TI for the first period.

Table 34. TI dedication distribution M1-M18

Partner	MM	Tasks
TI	11,93	WP2 (all tasks), WP8 (all tasks) and preliminary activity in WP3 (T3.1) and WP4 (T4.1)
SABIEN	2,35	WP3 (T3.1), WP5 (T5.1), WP8 (all tasks) and preliminary activity in WP6 (T6.3)
PRO	4,20	WP3 (T3.5) and WP4
SRIPAS	5,54	WP3 (T3.5) and WP5 (T5.1)
UPV	0,32	WP3 (T3.1)

[25] A detailed analysis of TI withdrawal and corresponding resignation of tasks was submitted to EC together with the second amendment.

Considering that for PRO, SRIPAS and UPV the resources are the increase in the manpower the partners after assuming tasks of TI.

The total manpower from the five partners is 24,68 MM, approximately the manpower planned to be used by TI in the development of the tasks during the period under review. The remnant manpower will be used in the next period.

5.1.3 Unforeseen subcontracting

Neways made use of unforeseen external knowledge. Because specific knowledge of virtual middleware software was not available within Neways we hired an external expert for this.

He worked on WP3 Task 3.3. To be more specific on the OM2M middleware bridge that allows OM2M devices to be connected onto the INTER-IoT middleware. He has participated in T3.3 under the task lead of XLAB. For this task specific Java and middleware knowledge was required which is not in the field of expertise of Neways.

Neways is an electronics company. For this purpose embedded software is included in the portfolio. However embedded software only lies within the gateway layer of the INTER-IoT. We have no experience in the virtual parts of the INTER-IoT. Since Neways also participates in T3.3 which covers the virtual middleware section we had to rely on external knowledge for programming the OM2M bridge. By hiring an external expert we were able to improve our knowledge in this field of expertise and at the same time meet the INTER-IoT deadlines.

We hired the expert from a preferred supplier of Neways. We have a contract on Holding Level with the supplier to ensure we get the best value for the lowest price.

5.1.4 Unforeseen use of in kind contribution from third party against payment or free of charges

Not produced