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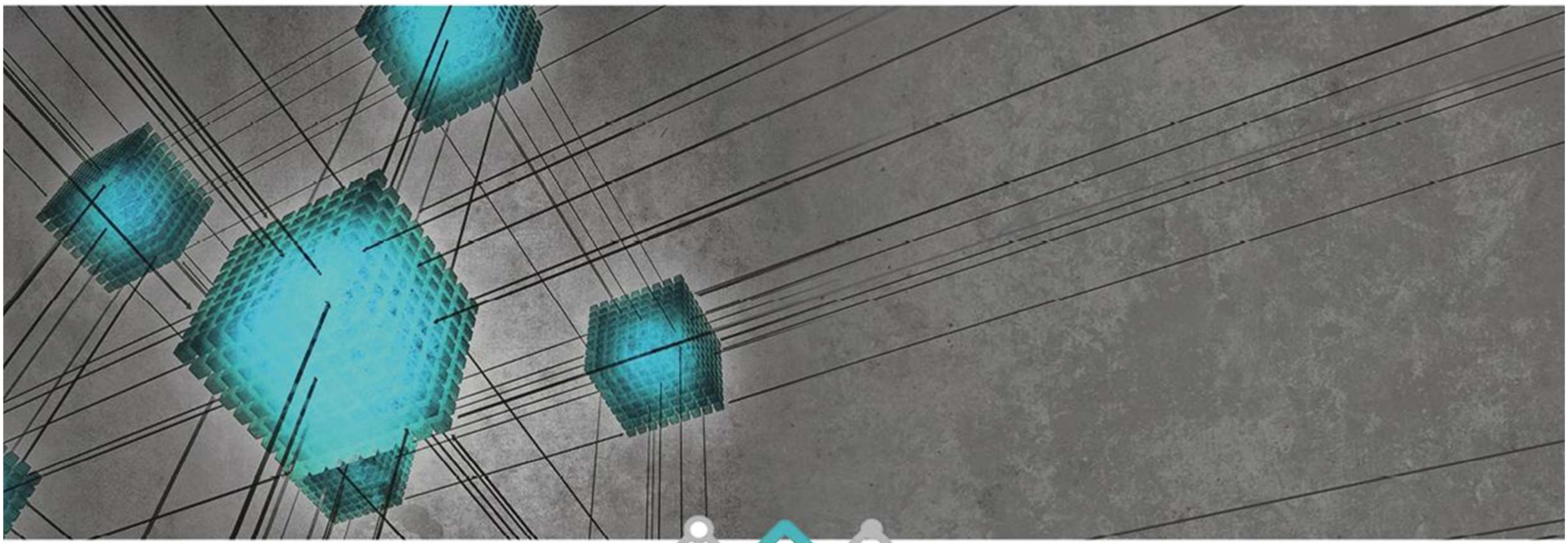

INTEROPERABILITY
OF HETEREOGENEUS
IOT PLATFORMS.

Periodic Technical Report

Part B

Project Number: 687283

Project Acronym: INTER-IoT

Project Title: Interoperability of Heterogeneous IoT Platforms

Period Covered: from 1st July 2017 to 31st December 2018

Periodic Report: 2nd

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:0.1

Security: Confidential

February 11th, 2019

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Disclaimer

Executive Summary

The present document provides the Project Progress Report (PPR) for the second and final review to be held on 20th and 21st February 2019 in Valencia. The review will assess the progress of the project from M19 to M36. In April 2018 (M27) a technical review to assess technical and management aspects of the project was already held, including evaluation of the participation in IoT-EPI. The different recommendations suggested by the expert reviewers were incorporated to the project and corrective actions were applied.

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 last 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 five blocks as indicated in the template from the participant's portal, starting with a brief introduction about the project and its main challenges. The five 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 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, although a thorough analysis is included in D8.6 and D8.7. The fourth block includes the list of deliverables and milestones of the period. 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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1.0	Final version	All	89

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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.

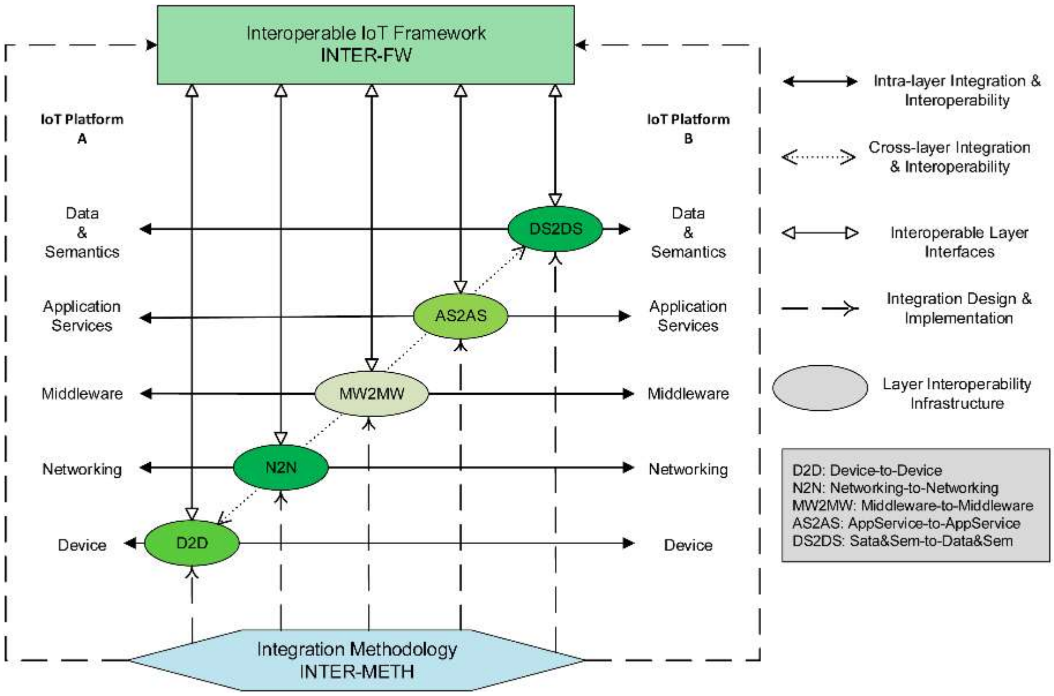

Figure 1. INTER-IoT concept and vision

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.

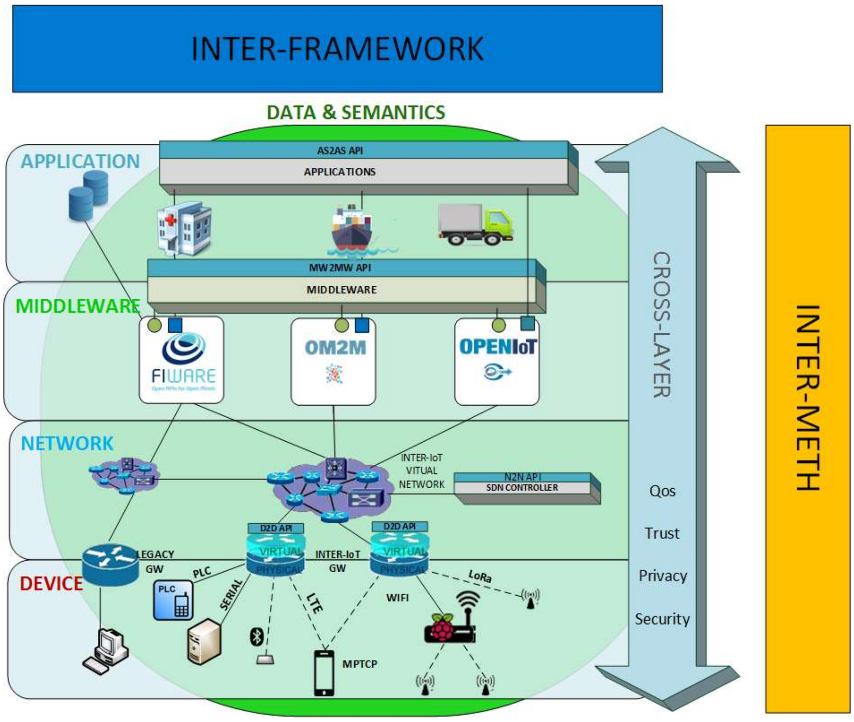

Figure 2. INTER-IoT layered approach

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 has not been defined as an 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 objectives. 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:

- A refinement of a Reference Architecture for the interoperability of IoT platforms has been done, with the feedback from the initial instantiation to INTER-IoT components in WP3. This action has produced a new Reference Architecture with new concepts added to some architectural viewpoints, and the extension of other viewpoints, not completely described in the previous Reference Architecture version, and has been released in D4.2 (M19-M24).
- The INTER-IoT Global Ontology GOIoTP has been revised and documented, merging the work developed in T3.5 with INTER-FW (M19-M24).
- A new Global Ontology (GOIoTPex) has been created and properly documented. Both ontologies have been used within WP3 components, giving support to the different tasks of WP3 for a correct usage, and for making the necessary adaptations to these ontologies (M19-M24).
- The INTER-FW (INTER-IoT Framework) has been designed and a first version of the design and its documentation has been released (M21).
- A first version (v1) of the INTER-FW Configuration and Management Framework for Heterogeneous IoT Platforms has been implemented and released for internal use in the project. This INTER-FW v1 has been revised and new features have been added according to the feedback from pilot partners and stakeholders (M19-M21).
- The final version (v2) of the INTER-FW has been implemented based on the design and analysis documents in addition to the feedback received from project partners representing end-users (Noatum, VPF, ASLTO5, UPV-Sabien), advisory board and stakeholders (M21-M30).
- A Software development framework for INTER-IoT extension has been analyzed and designed. The purpose of this development framework is to make it easy for third parties to extend the capabilities of INTER-IoT. The first software tools for INTER-IoT Extension have also been released and documented(M21). The second version was released in M30.
- An API manager for securing the access to the INTER-API has been configured and deployed (versions 1 and 2). An Identity Server has been incorporated, making the necessary configuration and integration aspects with the API Manager and INTER-FW (M26). This Identity Server allows to configure the authentication and authorization to INTER-FW components and features (M19-M30).
- The user interface of the user management, XACML policies and associated developments have been made in order to provide a real fine-grained authorization tool (M30). The tool is associated to devices and platforms views.
- A first design of INTER-API has been created, deployed, integrated in the API Manager and revised according to internal feedback(M21).
- The final version of the INTER-API has been released in M30 fixing problems and considering change requests required by partners and stakeholders.
- The INTER-FW web app has been debugged and is under use in the two pilots and has been tailored for integration with the different third parties requiring it (M30-M36).
- During months 27-36 a refinement of the user interface has been performed including missing features for the usage of the different interoperability layers, improving the deployment and scalability methods, integrating with contributions from third parties coming from the open call and generating a better user experience in general.

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:

- Implementation of multiple device controllers that support different device access networks and protocol, also an implementation of a rules engine as a gateway extension to allow device to device interoperability with independency of an IoT Middleware and finally, development of multiple physical-virtual connector implementations to support different communication scenarios (persistent connection for streaming, non-persistent for mobile communications).
- Implementation of a network solution in a real use case to test the performance and improve characteristics that weren't studied in the first stage of the project. Additionally, the automatization of the solution set-up, analysis of scalability mechanisms, feasible extensions that can be included in the solution. Finally, even that none of the SDN network components have access to the content of the packets, creation of a private and resilient infrastructure is a basic requirement for the network; TLS is implemented for all communication between switches and the controller and full monitoring of the network has been implemented.
- Development and deployment of INTER-MW bridges for the eHealth pilot and development of bridges by Open Call projects, also a registry service has been implemented through the Parliament DB and services have been expanded to support querying through the REST API. Finally, definition and development of the components in charge of creating, running, managing and storing composite IoT Services.
- Definition and development of an IoT Service catalogue for NodeRED to perform register, catalogue and discovery of IoT services. Automatic instantiation of service composition tools and node catalogues from INTER-FW.
- Implementation of IPSM alignment format from XML to RDF/XML and a repository to store alignments and ontologies.
- Dockerisation of INTER-LAYER software components which means that can be deployed in any Docker supported environment.
- Development of a single security framework to provide a common authentication platform to each software component of INTER-LAYER.
- Definition of open APIs in each software component that allows future developments to provide new interoperability mechanisms.
- Integration of all GUI tools to access and manage the INTER-LAYER software components in a single environment through INTER-FW.
- Creation of a documentation site that compiles all information of the INTER-LAYER software components including guides and tutorials for users and developers.

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 using a component-based and web-based approach, fully supporting the INTER-METH application.
- Development of the Ontology aligner tool, supporting IoT systems ontology alignment.
- Application of INTER-METH (and the INTER-CASE tool) to INTER-Health and INTER-LogP use case.
- All deliverables D5.1, D5.2 and D5.3 were timely submitted.

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:

- Definition of the INTER-LogP validation plan that assess the success of INTER-IoT in the port environment, included in D7.1.
- Definition and execution of FAT tests (D7.2).
- Definition and execution of SAT tests (D7.3).
- Deploy and configure the three IoT platforms: WSO2 for the port, Seams for the terminal, and Azure for the haulier company. In a firs stage, these deployments were carried out in a controlled environment (pre-production), before to connect them to the production systems.

- Once the IoT platforms were tested, they were integrated with the legacy systems in the port and terminal. For that, we needed to publish real time data from static databases and create a broker where the data is published.
- Installation of new devices, like pirs, publishing data directly to the IoT platform. We used the INTER-IoT Gateway to gather the data and publish it directly to the IoT platform.
- Definition and implementation of the ontology for the three companies. We developed and ontology with data from gate access, environment, and lighting for the port and the terminal. In addition, a truck ontology for the haulier company.
- Implementation of the services to provide access to the data in each IoT platform. There is an API that allows you to retrieve data or subscribe to devices. These services are used by INTER-MW to access real-time or stored data. The access to these services is secured with a token.
- Implementation of specific bridges to interoperate with INTER-IoT for the WSO2, Seams and Azure platforms. The bridges are deployed in the INTER-MW and can interoperate with it.
- Installation of the equipment needed in the dynamic lighting scenario. Althougt most of the devices were already installed, for the pilot we needed new pirs sensors and low consumption lights.
- Definition and implementation of three scenarios where the whole INTER-LogP system is tested, i.e. gate access, wind gust and dynamic lighting. Each of them have an INTER-MW client to get the data from different platforms, data processing, a database, and a dashboard to show the results.
- Analysis of the data generated in the pilot to complete the kpis. We are monitoring 235 devices in INTER-LogP such as gate access, machinery, trucks, lights, pirs, weather stations, etc.
- Cooperation with the third parties with the pilots tested in the port.

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:

- Implementation of the scenario for chronic disease prevention described in D2.4, based on a remote monitoring of objective measures and subjective parameters under the control of doctors. A dedicated Professional Web Tool (PWT) for monitoring objective and subjective information, integration of universAAL platform for monitoring medical measures (blood pressure, weight) and of BodyCloud platform for continuous activity monitoring (blood pressure, weight, physical activity and questionnaires on eating habits and physical activity).

- Implementation of alerts based on data received from the mobile app. These alerts will be triggered in the case that weight, blood pressure and/or physical activity values are out of the defined ranges.
- Implementation of multi-language infrastructure in the PWT to support English and Italian languages, although other languages could be added.
- Implementation of a CRUD management for devices, users and INTER-IoT “things”. It is a functionality thought for system administrators.
- Implementation of a Diagnostic Tool that can be accessed through administrative PWT section. This tool lets verify the state of the system by listing the platforms registered at INTER-IoT, the “things” registered in a platform and allows the registration of the Diagnostic Tool as a client of this “thing” to receive the messages that it sends using INTER-IoT
- Implementation of the security measurements defined in the research protocol for scientific and technical data presented and approved by the Bioethics Committee, according to the national directive in Italy (DL 196/2003) and the new European law (REG. UE 2016/679) that entered into force on 25th May of 2018. It was at the level of authentication and authorization to the PWT, universAAL monitoring app and BodyCloud mobile app through roles management and tokens (JWT) to access the INTER-MW. Also included security to access to the database-management system (DBMS), at the table and data level, and the data exchange between the different components of the pilot.
- As INTER-Health is a pilot that requires continuous operation because of the sensible data coming from real patients, a log mechanism has been developed in order to check malfunctions. Additionally a watchdog mechanism has been developed as part of INTER-Health pilot to detect inactivity, disconnection or errors of the main server deployed in ASLTO5 premises.
- The Factory Acceptance Test was done in two phases: a test environment and a preproduction environment. Tests were passed satisfactorily enough to proceed to production.
- During the pilot start, 100 subjects for the Control Group were recruited, and another 100 subjects for the Experimental Group. They received 25 sphygmomanometers (only those subjects with high blood pressure value), 100 scales, and 100 bracelets for the prevention program.

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:

- All Ethical and Privacy advisory board requirements were met. INTER-Health pilot started on December 2017 with the Control group. Experimental group then started on March 2018. Both groups finished on December 2018 successfully.

- INTER-Health pilot has been working and maintained since December 2017 (M24) with the release 1 version of INTER-IoT.
- INTER-LogP pilot experiments started in M30 in Valencia port area. Four different experiments were set up: i) weather stations interoperability; ii) truck tracking platform interoperability; iii) gate access port-terminal interoperability and iv) multi-provider dynamic lighting control in shared port areas.
- INTER-LogP pilot experiments keep working after project finish, since they provide valuable information for the entities.
- Open calls deployed field activities between M21 and M30, where some of them used data from real scenarios in laboratory conditions (e.g. CEA, AUEB or IRIDEON), and some other in real scenarios composing the INTER-Domain pilot (e.g. E3TCITY, NEMERGENT, UPF or U. Twente).
- An intermediate (M25) and a final (M34) evaluations of the open calls demonstrated their collaboration to the field trials.
- In M21, during the mid-term technical review held in Athens, several demonstrators where shown, including one field demonstrator of the platforms interoperability through INTER-IoT, where heavy machinery, lighting devices and terminal trucks where involved.
- Semantic alignments and specific field applications where been developed and deployed for the piltos INTET-Health and INTER-LogP.
- The technical assessments of the project results demonstrate that the identified KPIs, some introduced in mid-term technical review (Athens, M21) have achieved the goals established in the project.
- Pilots have been used as drivers for demonstrations and showcases to new stakeholders and companies, e.g. the e-World trade fair in Essen included four different demonstrations associated with the pilots.

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.

Below is a list of the actions taken to address objective 7. Additional detail is provided in D8.7. The following actions have been taken to establish a business framework among project partners:

- Establishing common goals and strategies has been an ongoing process throughout the project and will facilitate work beyond the end of the project. The following documents were prepared which highlight this shared vision and working strategy.
  - Joint exploitation plans established for project partners (Annex B D8.7)
  - Joint exploitation plans established for 3rd parties (Annex D D8.7)
  - The product specific LLAVA matrixes created (D8.7)
  - Open source community engagement strategy put in place (chapter 6, D8.7)
- The creation of policies, relationship contracts and arrangements has been undertaken as part of the project to formalise relationships moving from the research phase to the exploitation phase of the project. The following documents are available in the deliverables.

- The creation of an IPR register and agreement among partners how each product is to be included in the register
- Joint ownership agreement created (Annex E D8.7)

- Tools and systems put in place to allow collaborative working on a technical level moving beyond the scope of the project.
  - shared repository created
  - documentation repository created
- Specific exploitation workshops took place in Plenary meeting in Ljubljana (M14) and in Eindhoven (M26) discussing the different exploitation approaches envisioned by the partners. An encounter with investors (business angels) took place in M26 in Eindhoven and in M28 in London where some training about product positioning and exploitation management where developed.
- Collaboration with open call projects was established during their participation in several ways: i) technical collaboration through direct contact via phone or email, and an official communication channel in Slack; ii) business and exploitation collaboration to align the open call developments with INTER-IoT strategy; iii) scientific collaboration to share and disseminate the most important findings during the participation of third parties; and iv) administrative collaboration to provide the financial support and helping with bureaucratic tasks.
- Cooperation with other projects has also been performed in several ways: i) with projets of the IoT-EPI; sharing information about architectural approaches, implementations of modules or different technical and scientific strategies to address the problems of IoT platforms interoperability. Some examples are the collaboration with BIG-IoT in the security and privacy modules definition or the collaboration with BIoTOPE and SIMBIoTE to define best solutions for semantic interoperability among platforms; ii) collaboration with IoT call projects such as ACTIVAGE, where INTER-IoT was selected as interoperability layer, allowing to expand the ecosystem of supported IoT platforms by implementing 8 new bridges; and iii) collaboration with other domain-specific projects such as MG-7-3-2018 PIXEL where INTER-IoT is also selected as the interoperability layer for IoT platforms in the context of port-specific systems or Transforming Transport, where data analytics is performed through INTER-IoT components or in H2020 5GENESIS in which GW and N2N components will be included in a port together with two of the third parties (NEMERGENT and INFOLYSIS).
- Collaboration and cooperation with private businesses have been promoted leading to successful release of commercial products that use important INTER-IoT developed features such as PRIME-IoT (RINI) and integration of sensing products as in the case of NEWAYS.
- INTER-IoT partners have contacted several software development communities to explore collaboration and community engaging. This is the case of FIWARE Foundation and Eclipse community.
- INTER-IoT has promoted the collaboration with external private companies to find new business opportunities and exploitation strategies. Thanks to this collaboration one startup has been created and numerous bilateral collaboration agreements have been signed to make business out of the different project results.

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 40 papers published or accepted in journals, magazine, book chapters and books.
- Signature of the contract with Springer to publish a book with INTER-IoT results during 2019.
- Organization of scientific events (i.e. workshops and conferences), consolidation of GLOBE-IoT workshop in top quality events.
- Development of demos to be showcased in different events, such as the e-World event in Essen (Feb 2019).
- Keynotes and tutorials in conferences and events (e.g. EAI INTER-IoT conference).
- Non-academic talks made in different fora related with IoT or the different application domains addressed in the proposal.
- Industrial dissemination activities mainly driven by stakeholders and companies of the consortium (e.g. TRON 2017 and 2018, IoT Week 2018, CTAC2018, SMARTPORTS 2018 or ALICE events)
- Web site set up and periodic updates.
- Presence in social networks (LinkedIn, Facebook and Twitter), active distribution of information that has been enhanced through the gathering of target audiences.
- Participation in different IoT-EPI events, including organization and animation the last sessions in London in February 2018. The participation was already evaluated in the technical review in April 201
- Interaction with IoT-LSP cluster and specific projects (i.e. ACTIVAGE and IoF2020).
- Supervision of different MSc and PhD Thesis, some already presented and other under development.
- Master and PhD courses, and lectures associated with INTER-IoT content and basics.
- Launching of the MSc programme on IoT interoperability at UniCal.
- Links with other projects: with members of the consortium (TT, ACTIVAGE or IoF2020) and without members of the consortium (FIWARE, PIXEL, COREALIS)
- Advisory Board contributions, mainly in dissemination and exploitation.
- Definition of business models and exploitation plans have been developed at individual and joint levels (e.g. INTER-LogP business model used as example in IoT-EPI workshop in London).
- Strategy to lease with FIWARE foundation by means of delivering different INTER-IoT components as FIWARE enablers.
- Discussions with different SDOs in order to receive endorsement to the architecture.
- UPV Startup Company plans under study by administration at UPV due to changes in the Science Law in Spain.

Specific details about impact actions are available in section 3 and D8.6.

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

2.2.1 Technical Review

The following tables describe the recommendations provided by the reviewers after the Brussels Technical Review (M27). For each recommendation the consortium has described the objectives to be achieved by the recommendations from our understanding and the different actions performed to achieve these objectives.

R1	*Management*
Organise/schedule the final review meeting at an end user site, which is to be decided in liaison with the Commission Project Officer.	
Organisation of the review meeting in Torino (Italy) or Valencia (Spain).	
After different conversations with the PO, we agreed to hold the review meeting in Valencia (Spain) at Port of Valencia premises on 20th and 21st February 2019.	

R2	*Technical*
External feedback (e.g., from ETSI, IIC, FIWARE and/or the like) on the project's architectural findings as benchmark of its value/validity is to be solicited.	
The consortium through WP3 and WP4 has developed an architecture for INTER-IoT. The architecture is mainly reflected in D4.1 and D4.2, however contributions from WP3 and other deliverables from WP4 include content associated with the architecture. Following the recommendation the consortium needs to discuss with different entities in order to receive feedback regarding the value of the proposal.	
The consortium has established different liaisons with different entities in order to discuss the validity of the architecture and different components. The official endorsement from the different organisations or do not exist, or has to follow a specific process that is long and sometimes does not fit with the main goal of the orgnisation. The consortium has held discussions with: • AIOTI, with presentations in Brussels and in Bilbao during the IoT-Week. INTER-IoT architecture is in-line with AIOTI HLA, however INTER-IoT is not proposing the architecture to build up new IoT platforms but make them interoperate, so there is a complementarity, members of the consortium are participating in WG3 and contributed to some use cases. Additionally there are permanent contacts with WPG5 (IoT and e-health). • IoT-LSP, during the AG02 meetings UPV has led the discussions about architecture in the ACTIVAGE project and comparing it with the other architectures in order to achieve validation. ACTIVAGE arc • FIWARE, different discussions with CTO and COO of FIWARE, and participation in FIWARE Summit 2018 in order to discuss results associated with the architecture. Main conclusion is that although some components of the architecture may fit in FIWARE ecosystem, FIWARE is conceived as an interoperability system itself. • Universaal IoT is an early created foundation, UPV is member of the organization, SABIEN is part of the steering board. There is no certification process defined, however after preliminary discussions INTER-IoT is fully complementary with INTER-IoT. • ECLIPSE SENSINACT, was a third party of INTER-IoT, during the execution of the	

contribution several discussions have been held in order to align INTER-IoT architecture with the new ECLIPSE project. • International Data Spaces Association, INTER-IoT architecture has been aligned with RAMI4.0 and one of the developments performed around INTER-IoT out of the scope of the project is an IDS connector in order to allow connectivity of INTER-IoT with data markets. The discussion comes from two members of the IDS association (INNOVALIA and FIWARE foundation) to whom the architecture was presented. • Big Data Value association, the INTER-IoT architecture is being used in one of its lighthouse projects (Transforming Transport) by ITI member of the steering board of BDVa and it has proofed to be compatible with the interest of the association. • EFFRA, UPV as member of the association has been present in different events, although in the Industry 4.0 the contacts are still preliminary. Additionally three of the third parties involved in the open call have brought the discussion about the architecture and partial components to different forums: • Vrije Universitat Brussels presented the architecture, use and integration of its contribution in the OneM2M conference in 2017 and in 2018. Feedback was positive, and links between components of the ETSI architecture and INTER-LAYER were analysed. • University of Twente discussed the architecture and the integration of the semantic component with ETSI SAREF. Currently he is participating in the extension of the ontology named as SAREF4Health. • NEMERGENT discussed the architecture in the PSCE forum as potential candidate for integrating services in emergency management events. The discussion is ongoing in this area and in February 2019 there will be a new meeting. So the discussions are ongoing with different entities and through the participation of different events and meeting the INTER-IoT architecture will be presented and discussed in different forums.

R3	*Technical*
An inventory of lessons learnt (or a user's guide) is recommended to be compiled for the necessary efforts to be invested to develop the "(IoT legacy) connector technologies" ("the green boxes").	
The objective of this recommendation is to clarify and be able to measure the effort required by new users of INTER-IoT components to work with the interoperability component. Mainly the recommendation addresses the IoT legacy connector technologies that are linked to INTER-MW and use the semantic component of INTER-IoT.	
The consortium has reflected in a white paper the ten more important lessons learnt from the use of integration of IoT legacy connector technologies. The lessons learnt have been extracted from four different sources that have been involved in the development process during the project lifetime: • Consortium partners that have designed and configured the different components and have realized which the most difficult aspects are. The consortium partners had to deal with the legacy components to be integrated in the two pilots. • Third parties from the open call, which were mentorized by the consortium partners and gave feedback from the integration of their legacy components and they highlighted the lack of clarity and improvement in documentation and software. • Participants from other projects that currently are now enlarging the community: o H2020 Transforming Transport in which the integration performed with INTER-IoT has been used by different entities in the pilot in the port of Valencia. o LSP ACTIVAGE in which five new IoT components have been integrated and	

three from the INTER-IoT ecosystem have had to be adapted. UPV has dealt with them and the previous lessons learnt have helped and shortened the integration time. o H2020 PIXEL in which four new ports are integrating their legacy systems in INTER-MW. • Other agents interested in the use of INTER-IoT components that have contacted the consortium and are getting access to the repositories and developing connectors to their legacy systems in different domain areas. The lessons learnt document has been structured as a white paper with the main difficulties to be found in order to help newcomers to INTER-IoT ecosystem, and it is supported by documentation available in the software repository with different examples available. It has been one of the technical documents used by UPV in the open call of other projects (e.g. LSP ACTIVAGE) to provide technical support to third parties. The document has been delivered in two successive versions. The most updated one is available in the project website in the url https://files.inter-iot.eu/Whitepaper_Lessons_Learnt_Final.pdf.

R4	*Technical*
The project should better document what remains of the INTER-METH output, and what it will bring to the INTER-Health pilot.	
The recommendation from the expert reviewers advised the consortium to better document the work associated with INTER-METH. The objectives associated with the recommendation are: • Identify the output of INTER-METH and include it in D5.3, which is the last deliverable of the WP. • Apply it to the health pilot (INTER-HEALTH).	
The project in its deliverable D5.3 illustrates how INTER-METH driven by INTER-CASE supports the INTER-Health use case from analysis to maintenance. This application use case is fully included in the INTER-CASE tool accessible through its web link as it will be shown in the Final review demo. Moreover, we applied INTER-METH driven by INTER-CASE also to the INTER-LogP use case from analysis to design. Benefits are clear from the Integrator viewpoint as they can apply the integration methodology in a guided way, from analysis to maintenance, by keeping track of all the most important information needed to implement each workflow of each INTER-METH phase. Usability of INTER-METH driven by INTER-CASE has been also evaluated as KPI and the outcome is supportive for our approach. Finally, in the INTER-HEALTH pilot we used INTER-METH/CASE to drive/guide its development.	

R5	*Technical*
Now that the pilots are nearly fully deployed, and can be operated, the Project should ensure that a useful feedback from this operational phase is provided in the next deliverables.	
The recommendation addresses the main results from the pilots to be included in the different deliverables. Deliverables mainly from WP6 and WP7 should include this results.	
The workplan of INTER-IoT is use case driven. The three WP that are directly related with the pilots are WP2, WP6 and WP7. The first of these WP, includes the definition of the use cases	

and scenarios and started to define the different operational aspects of the pilots.

WP6 provided the implementation of the pilots. The WP adopted an industrial approach and included the FAT and SAT analysis. D6.3 (M32) included the analysis of the operational aspects and execution of the pilots, including those related with the third parties. In the deliverable we prioritized the operational aspects of the different pilots.

Additionally WP7 is related with the evaluation of the project, the final deliverable D7.3 included the evaluation of different KPIs. The KPIs were revisited after the midterm review (M21) and the technical review (M27) to include more aspects associated with operational aspects.

R6	*Dissemination*
The project's architectural findings need to be properly promoted by allowing their assessment by external stakeholders, for example, by way of a scientific conference/journal paper (see R2).	
The consortium needs to publish some scientific contribution related with the architecture.	

The architecture is a key contribution from the project. Before receiving the recommendation from the reviewers this point has already been decided by the consortium and the consortium has already published some contributions including architectural components of INTER-IoT:

- In the book "Integration, Interconnection and Interoperability of IoT Systems" edited by Springer, there are two chapters presenting the architecture:
  - G. Fortino; C. Savaglio; Palau Salvador, Carlos Enrique; Suárez de Puga-García, Jara; M. Ganzha; M. Paprzycki, Miguel Montesinos, Antonio Liota and Miguel Llop Chabrera. "Towards Multi-layer Interoperability of Heterogeneous IoT Platforms: The INTER-IoT Approach" defined the architecture.
  - Maria Ganzha, Marcin Paprzycki, Wiesław Pawłowski, Paweł Szmeja, Katarzyna Wasielewska, "Towards Semantic Interoperability Between Internet of Things Platforms", including the ontological aspects of the architecture in a descriptive way.
- The two IoT-EPI published books included contributions of the INTER-IoT architecture in a preliminary way.
- The journal article: "Semantic interoperability in the Internet of Things: An overview from the INTER-IoT perspective", published in Journal of Network and Computer Applications in 2017 extends in a formal way the semantic interoperability architecture of INTER-IoT.

Considering the previous publications associated with the architecture, and the keynotes provided by the consortium in different events associated with the INTER-IoT architecture: Carlos Palau (2), Eneko Olivares (1), Giancarlos Fortino (1), and Roel Vossen (1). And evaluation the level of degree and detail of the architecture we discarder to submit the architecture to a conference, as more timely results are required in such events and our interest was to achieve impact. A journal due to the nature of the review process can take up to two years to be published, so we decided to publish a book with all the results from INTER-IoT following a narrative process, from architecture to technical developments, and pilots to lessons learnt.

The selected editorial is SPRINGER, we negotiated the contract during 2018, it has already been signed and the book will be submitted during the first quarter of 2019 and published before summer 2019, with the intention to present it during the IoT week in which SPRINGER will have a booth and different representatives of the consortium will be present.

The structure of the book is:

- CHAPTER 1. INTRODUCTION
- CHAPTER 2. REQUIREMENTS OF INTEROPERABILITY AND USE CASES
- CHAPTER 3. INTER-IoT REFERENCE ARCHITECTURE
- CHAPTER 4. INTERLAYER: A LAYERED APPROACH FOR IoT PLATFORM

INTEROPERABILITY
- CHAPTER 5. SEMANTIC INTEROPERABILITY
- CHAPTER 6. INTER-FRAMEWORK: AN INTEROPERABILITY FRAMEWORK TO SUPPORT IoT PLATFORM INTEROPERABILITY
- CHAPTER 7. INTER-METH: INTEROPERABILITY METHODOLOGY
- CHAPTER 8. INTEROPERABILITY APPLICATION IN E-HEALTH
- CHAPTER 9. INTEROPERABILITY APPLICATION FOR TRANSPORTATION AND LOGISTICS IN PORTS
- CHAPTER 10. INTEROPERABILITY ECOSYSTEM
- CHAPTER 11. FUTURE OF IoT PLATFORM INTEROPERABILITY

Chapter 3 is the one related with the reference architecture, and due to the length and previous and following chapters it will be able to contain better and more accurate information.

R7	*Business Impact*
The project pilots are recommended to be used to drive the future project's exploitation planning/impact creation.	

The recommendation addresses the main results from the pilots to be included in the different deliverables. The main objectives of the recommendation are:
- To use INTER-Health as showcase of the success of INTER-IoT to provide interoperability among different health platforms.
- INTER-LogP is being used as showcase of the success of INTER-IoT to provide interoperability among different port stakeholder through its IoT platform.
- To use the contributions from the third parties as showcase for project planning and exploitation of the results.

The consortium has run different actions in order to promote and use pilot results as a pivotal action for the exploitation of the results and create impact. Regarding these aspects in different workshops, trade fairs and stakeholder events we have used mainly pilots as demonstrations in order to show the power and performance of INTER-IoT.

Dissemination actions and impact creation are detailed in full in D8.6. In addition to promoting the whole set of technology that make up the large-scale pilots, individual pieces of technology and solutions based on parts of these pilots are also being promoted. The solutions selected for full analysis are laid out in D8.7 Section 3.3 and 3.5.

As an example, INTER-IoT has attended twice IoT Week as a consortium, and the partners have assisted to other fairs, e.g. ABC attended TRON in Japan twice, NEWAYS attended ELECTRONICA in 2018 or UPV attended ALICE event in 2018. The pilots have been used to make some promotion and creating impacts among stakeholders mainly. Last example has been the attendance to e-World conference in Essen in February 2019 in which we presented as a consortium the different pilots in a booth.

The consortium has had in mind and has developed this action and recommendation even before May 2018, when the recommendation was issued as in the overall goal of the project since it submission we indicated it was a pilot/use-case oriented project.

Different actions have been performed in relation to the pilots associated with the recommendations.

INTER-HEALTH

The consortium and the pilot team has been working in generating the showcase above mentioned. INTER-Health has been packaged as a demo kit, which includes a bracelet to measure the physical activity (number of steps and minutes) and a sphygmomanometer to measure the blood pressure. The server is available at UPV-SABIEN premises. A demo user is used to show how data travels, through INTER-IoT, from one platform to another. Furthermore, we have generated graphic (infographic, cards) and multimedia material (videos, success stories of stakeholders) to explain:

1. Benefits of using INTER-IoT
2. Steps should be followed to adopt INTER-IoT as interoperability enabler
3. Lessons learnt to be taken into account in a health context

The consortium has used this demo kit in different events, and with different stakeholders that are interested in working with it.

Directly linked with INTER-HEALTH, RINI has packed some results in their product PRIME-IoT and has presented it as an alternative to the pilot in different event with potential customers and stakeholders.

Dissemination in the Health domain has been carried out in:

- Arab health event, Dubai, 29 Jan-1 Feb 2018
- IoT Invest, Talis Capital, London UK, 2 March 2018
- Integrated services: organizational healthcare models in the framework of chronic diseases, Turin, 26-27 March 2018
- ECO 17: Transforming care through digital health, Lancaster UK, 4 Dec 2018.
- Arab health event, Dubai, 27 - 30 Jan 2019

INTER-LogP

Port environments are usually a technological level lower than other industrial sectors. So companies involved in the project have taken advantage to apply the an IoT platform to manage their devices. Furthermore they are exchanging that is being use to improve the efficiency of their processes and the resources management. That allow them to provide a better service to their clients. The actions carried out to achieve this objective are:

1. Explain to the port community the benefits of migrating their systems to IoT platforms.
2. Present the benefits of exchange not only documents, but data with other companies in the transport chain. And how INTER-IoT makes easy the interoperability.
3. Provide documentation to the system integration with INTER-IoT.

Since the review in Athens, dissemination in the logistic domain has been carried out in:

- INTEGRA2 Port conference Port of Tarragona, Spain, 20 April 2017
- ICHCA International Conference. Las Palmas, 2-6th October, 2017.
- Jornada SmartPorts 2018. Madrid. 22nd February 2018.
- Conference of ATPYC in Spanish National Ports “JORNADA TÉCNICA DE INNOVACIÓN Y TECNOLOGÍA EN LA GESTIÓN PORTUARIA”. Innovation Strategies in Valenciaport for next decade challenges, Madrid, Spain, 6 March 2018
- PEMA AGM 2018: Digitalisation Signals “Fourth Industrial Revolution” For Global Ports Sector, Bilbao, Spain, 15 March 2018
- Container Terminal Automation Conference, London, 14-15th March 2018
- MARLOG7 The International Maritime Transport and logistics Conference INNOVATION in ports the Gateway to the Future, Alexandria, Egypt 18 March 2018
- SITL (Semaine Internationale du Transport et de la Logistique), Paris, 20-23 March 2018
- Interoperability of IoT Platforms applied to the transport and logistics domain, Vienna, Austria, 16 April 2018.
- Cargo Innovation Conference: The impact of digitization in container terminals, Venlo Netherlands, 7 June 2018

Initial contacts made with several different Port authorities, in Europe and Worldwide (Tokyo, Shanghai)

R8	*Business Impact*
The role of the future System Integrator for IoT deployment is to be centrally considered in the project's further efforts on business model development.	
The INTER-IoT future business development has reinforced their efforts to attract the attention of Systems Integrator for IoT deployment because they are one of the most important potential customer segment of the INTER-IoT Platform. This type of customers already have their customer base and sales/marketing in place, and they look for state-of-the-art reliable solutions as Inter-IoT to improve their integration offerings.	
In previous deliverable D2.2 of WP2, some of the INTER-IoT partners like PRO and ABC contemplated this figure into its initial individual business models as customer Segment. In the Joint initial business models all the INTER-IoT partners agreed to consider them also as customer segments in the INTER-LAYER and INTER-METH business Models. In the final version of deliverable D8.7.b submitted in M33: • In section 3 there is a schema that describes the exploitation strategy of INTER-IoT where System Integrators outside of the INTER-IoT consortium have been considered threefold as: 1) Users of the INTER-IoT community product (Fremium) that helps them to speed up their IoT development/solutions for the end client. 2) Members of the Open Source Community at the Business side, boosting specific features contributing with code. 3) Customers of the INTER-IoT Commercial Product, that identify a specific problem to solve in their business by paying for specialised support and customisation offered by the partners of INTER-IoT consortium. • In section 5.3, some partners of INTER-IoT consortium have taken into account the figure of the System Integrators in their individual and Joint Exploitation as follow: 1) - PRO plans to be a technology INTER-IoT provider by offering professional engineering services to other ICT companies and system integrators 2) - ABC will provide “custom” manufacturing solutions for customers that have problems with legacy installations and connection services of different systems (warehouse, production, quality control) or heavy-duty machinery. 3) - XLAB proposes to provide customization and consultancy services to ICT companies and system integrators, mostly based on the Inter-Middleware product (awarded by the Innovation Radar 2018). • In section 5.7.1., both INTER-IoT consortium and third parties from Open call (19 commercial entities) plan to boost existing commercial scenarios through its active participation in industrial dissemination events to attract the attention of existing and new potential customers in EU among them System Integrators, thus increasing the INTER-IoT business ecosystem. • In section 6, the OSS Community of INTER-IoT by means of Community Building will support System Integrators types (1) and (2) providing access to a repository with the latest code and a documentation server which are available for the developer in M36. • In section 7, within the marketing process, the INTER-IoT consortium has identified a priority market opportunity in Smart City sector where IoT system integration can be foreseen in this sector. Some companies from the consortium such as PRO, XLAB and ABC have experience with consultancy and open software development in this sector as they have detailed in the questionnaires of the Annexes A and B of D8.7.b. So the role of integrator has been targeted and in the different presentations and dissemination events the main targets have been integrators and stakeholders.	

<table>
<tr><td>R9</td><td>Business Impact</td></tr>
<tr><td colspan="2">Concrete exploitation plans of all the project partners need still to be elaborated (and started to be implemented).</td></tr>
<tr><td colspan="2">Consortium partners need to further work in the different exploitation plans, and start the implementation of the proposed activities.</td></tr>
<tr><td colspan="2">As part of the work in D8.7, individual and joint exploitation plans have been prepared by all partners (chapter 5, D8.7). These plans were updated between D8.7a and D8.7b. Each of these plans includes strategy as to how the products will be brought to the market (question 15, annex A and C, D8.7). These strategies include:
• promoting trial results from the large-scale pilots,
• participation in trade shows and fairs
• utilizing company websites and current sales teams to promote products
• obtaining proper certification
• promoting INTER-IoT as an additional capability available in consulting services

Additionally, these plans have been improved using the LLAVA methodology as described in chapter 2 of D8.7. The LLAVA matrixes for each partner are included in Annex F.

In addition to partner specific actions taken, individual products have been evaluated in chapter 3 of D8.7. These product specific evaluations identify the customers to be approached. Consortium partners have also utilized project outputs and promotion done by project channels such as Facebook, LinkedIn, twitter and the project website to showcase results. Moving forward, the INTER-IoT GitHub will also be utilized to promote the project.</td></tr>
</table>

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. All the activity has been executed as expected with minor delays and deviations that have been solved as they have been detected. For internal communication and adequate interaction between the partners, the project has scheduled five plenary meetings during the period under review:

- Eindhoven (Netherlands) 6th-7th July 2017
- Paris (France) 29th-30th October 2017
- Eindhoven (Netherlands) 13th-14th February 2018
- Prague (Czech Republic) 15th-16th May 2018
- Torino (Italy) 4th-5th October 2018
- Brussels (Belgium) 29th-30th November 2018
- Additionally for specific management procedures the consortium realized:
  - Code Camp in Warsaw (Poland) 13th-19th November 2017
  - Midterm review open call third parties in Valencia (Spain), 17th-18th January 2018
  - Code Camp in Valencia 5th-8th March 2018
  - Code Camp in Ljubljana 18th-21st June 2018
  - Final review open call third parties in Valencia (Spain), 23rd-24th October 2018

During the period the project held a technical review in Brussels on 20th April 2018.

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, until the final activity of the initiative. Activity related with IoT-EPI was reviewed and evaluated during the technical review held in April. After the closure of IoT-EPI, INTER-IoT has kept collaboration with different IoT-EPI projects, mainly SYMBIOTE and BIG-IoT, and marginally with VICINITY. Additionally INTER-IoT has been invited by IoT-LSP to participate in different events mainly to present the architectural findings.

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

- Distribution of the interim payment was performed when the transfer was received from EC.
- The project generated an amendment on 24th March 2018, that was signed in June 2018. The amendment included the recommendations from expert reviewers, so as different adjustments for the execution of the project (e.g. change of software licence to Apache 2.0).

Additionally, UPV performed the mid-term payment and final payment to the third parties involved in the open call.

Task 1.3: Risk management strategy is considered a major and critical issue and has continued under execution as in the previous period. Risk management has been led by PC and WPL, however the different members of the PMC have participated in risk management. During the different Advisory Board meetings discussions about risks have been held. Additionally the Ethical Advisory Board together with the External Ethical Advisor have assessed and managed Ethical risks.

Following recommendation from the expert reviewers, risk management focused on the ten most relevant risks that were selected by the consortium during the plenary meeting in Paris after the reception of the evaluation report. Detailed analysis of the selected risks is provided in section 3 of this report.

In M30 the final risk management report was submitted to EC, however risk management activity was held, focusing on the pilots, third party interaction, dissemination and business activity.

Task 1.4: The Advisory Board has continue in contact with the consortium, and has participated in different activities. Current members are:

- 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. Andrzej Jankowsk (INTEL), POLAND. Position: Internet of Things Ecosystem Manager in Intel Corporation for Central Europe region.
- Dr. Mihael Mohorčič (Institute Jozef Stefan - IJS), SLOVENIA. Position: Research Director

Individual interaction with the members has been held, and a teleconference have been held with the members of the advisory board 24th January 2018. Mr. Matus Maar from Tallis Capital attended the Plenary Meeting in Eindhoven in February 2018 and participated in the Exploitation Workshop with the consortium providing relevant comments about the future monetization of the findings. Following this meeting RINICOM and ABC were invited to attend IoT Invest conference in London (2nd March 2018) in order to interact with different Capital Risk entities.

The AB members have been informed of the final findings and results of the project. The comments provided by them have allowed to find new market opportunities and the possibility of using the technology in different application domains, like water management, smart cities and energy management.

The Ethics Advisory Board has continued the monitoring of all the highlighted issues provided by in the Ethical Review Report. Members of the board have not changed since it was created and the support of the external advisor (Dr. Maurizia Rinaldi) has been continuous.

Task 1.5: Once selected the different third parties, the activity in this task was completed and the management of the third parties was transferred to T6.4 (INTER-DOMAIN Pilot). The final selected third parties completed their activity in October 2018. The third parties 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).

During the period under review three global meeting associated with the third parties were held:

- First review of the large contributions was held in July 2017 during the plenary meeting in Eindhoven.
- Mid-term review in Valencia in January 2018
- Final review in Valencia in October 2018.

During the execution of the third parties activity several telcos and synchronization communication was held with the third parties:

- Training sessions with IRIDEON and UPF in Barcelona in February 2018
- Meeting with VuB in Brussels in February 2018
- Meetings with NEMERGENT, TU Wien and CEA during the IoT Week in Bilbao June 2018.
- Meeting with INFOLYSIS and AUEB in Athens in July 2018.
- Several integration meetings with E3TCITY in Valencia.
- Training meetings in Valencia with CEA and U. Twente.

The third parties participated in several dissemination activities independently and together with the members of the consortium. Several industrial dissemination activities were held by third parties. Especially active where TU Wien and U. Twente.

U. Twente and VuB participated also in standardization meetings with ETSI, in two areas SAREF and OneM2M. Both third parties presented the architecture and semantic interoperability mechanisms.

Activity with the different third parties is ongoing in further collaborations and exploitation, mainly by the SMEs:

- NEMERGENT has included INTER-LAYER in their portfolio to include IoT platforms and sensing devices in their emergency management system and the MCPTT protocol. Promoting the results in the framework of PSCE.

- INFOLYSIS has included N2N component of INTER-IoT in their controller solution. UPV together with INFOLYSIS is including virtual GW and NDN component in a 5G solution that is being deployed in the port of Limassol (Cyprus) in the framework of a 5G-PPP initiative named 5GENESIS.
- E3TCITY is exploiting INTER-LAYER solution in some of their deployments and contracts as they have extended their activity to INTER-MW in addition to INTER-GW.
- Availability plus has added AS2AS component to their portfolio, in order to manage secure storage of IoT data.

In addition several third parties are suing INTER-IoT results and lessons learnt in different research projects at national and international level:

- AUEB is using the virtual GW in H2020 IoT3 SOFIE project.
- NEMERGENT is including INTER-LAYER in 5GENESIS and CRISISTECH projects.
- U. Twente is including GOIoTP in SAREF4HEALTH project.
- CEA is using the developed bridge with modified components in H2020 LSP ACTIVAGE project for interoperability in the DS Grenoble. Additionally in the demonstration they integrated data from two additional projects: BIG-CLOUT and FESTIVAL IoT project.
- UPF is releasing INTER-IoT components in the new version of HARE protocol, named INTER-HARE.

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.
- Submission of a second amendment in March 2018.
- Quality control of the deliverables and results of the project.
- Application of an improved risk management mechanism.
- Establishment of the AB and 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, supporting the execution and exploitation activity by the third parties.

2.3.1.3 Deviations

No significant deviations produced, except ASLTO5 not having effort in task 1.3, and due to the requirement of developing ethical risk assessment same effort had to be moved to this WP.

2.3.1.4 Corrective Actions

No corrective actions have been required.

2.3.2 Work Package 2 – Requirements and Use Cases

Completed in M12, in the previous period.

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. The work done during the last period of the project (M19-M36) regarding WP3 has involved:

- Finalization of all development tasks of the INTER-LAYER solution. Each task focused on each of the layers of INTER-LAYER as well as cross-layer with various common developments of security, integration and scalability.
- Organization of three different *code camps* jointly with WP4 in order to encourage team work and advance development works. All three of them (Warsaw in M23, Valencia in M27 and Ljubljana in M30) were very successful.
- Maintenance of our development environment. As described in the last report, we kept using and maintaining the whole Continuous Integration setup and we gave access to the Open Call third parties to use our development environment.
- Creation of a private documentation infrastructure in order to start compiling the different instructions, general information, configuration, etc. All third parties had access to this private documentation and finally it was curated and released to the public as described in deliverable 3.3.
- Migration to open source. As described in the last deliverable of this work package, a lot of effort was focused also in cleaning the source code, generating the correct license and headers and finally the distribution of our source code to Github.
- Compilation and distribution of ready to install binaries was also performed during this period, distributed under our central repository (Nexus) and private docker registry. These docker images were also migrated to a public infrastructure (Dockerhub).
- Two deliverables were also compiled during this period: D3.2 in M21 containing the last technical specifications of the INTER-LAYER solution with the detailed state of the art, design and solution development updates and progress from previous deliverable D3.1. D3.3 was submitted in M30 focused on the software distribution and documentation of INTER-LAYER as well as the release features, extensibility and distribution plan for each of the solutions.

2.3.3.1 Progress

Progress by task

Task 3.1: Since M18 the work done in this task was focused in the improvement of various aspects of the D2D Gateway, testing, integration with INTER-FW, documentation and release. The development work in the gateway included: refactoring the whole project for a better structure, decoupling all the core components with interfaces, minor improvements of all the core components, new connector implementations (secure websocket, MQTT and UDP), improvements of existing extensions and development of new extensions (Modbus, rules engine, storage, etc.) and a gateway command line installer.

As for the integration of INTER-FW it was focused on improving the existing GUI, integration with the security framework from cross-layer and the integration of an automatic virtual gateway deployer. In parallel, documentation and release planning of the gateway solution was also done.

Task 3.2: The last activities performed under this task involve the implementation of security mechanisms in the application and the testing of the solution, measuring the needed parameters to compute the KPI and validate its fulfilment. Within this testing phase, we focus in network parameters as the latency or the bandwidth. Finally, last improvements on the solution, its API, the INTER-FW portal tab and the collaboration with other layer solution as with virtual gateway to create a synergy together and be applied in different use cases based on virtualization, or the creation of nodes for Application and Service interoperability solution.

In addition to the technical work we prepared documentation for software developers, worked on the definition of the software license and the project migration to GitHub.

Task 3.3: The work performed since M18 spread through several areas. In order to efficiently support parallel, and sometimes competing, Inter-IoT developments, during this period we defined three branches of INTER-MW: (1) INTER-Health version; (2) Support to Open Calls version and (3) New developments. By the end of T3.3, all three branches have been merged and thoroughly tested.

During the first Code Camp in M23 the development work was focused on the needs of the INTER-Health pilot. We also discussed and designed better integration of semantic technologies (closely related with T3.5), which resulted in an improved messaging library. The outcome of this part was an enhanced design of INTERMW. During the second Code Camp (M27) we focused on issues regarding bridge development related to debugging and testing, and code enhancement related to that. As for INTER-MW design, we refined the types of messages used in INTER-MW. This work resulted in a development of a set of unit tests, integration tests and code examples. They are extremely useful not only for the further development of INTER-MW, but also to support 3rd party developers of bridges for IoT platforms.

In addition to the technical work we prepared documentation for software developers, worked on the definition of the software license and the project migration to GitHub.

To summarise, progress was achieved in the following areas, which is also reflected in the results section: strengthening of the INTER-MW code base and better integration with DS2DS, deployment of the eHealth pilot, integration of platforms, implementation of the deployment framework, design and development of services, publication to open source and migration to public repositories and strengthening the collaboration with Open Call projects.

Task 3.4: In the previous stage the AS2AS core solution has been defined and tested. In this stage the main task was the integration of the different components involved to provide a complete release of the solution. In addition, this solution has also been integrated in Inter-FW.

The other tasks performed are related with IoT services and with the components of the interoperability solution. Regarding IoT services it was generated new nodes and web services to provide access to services and support nodes and web services to facilitate the tasks of data conversion and interaction between services. Regarding the interoperability solution are focused in: Layer management mechanisms to allow the operation with running instances, interaction with APIs, deal with security issues and management of Docker containers. Integration of the node repository and the flow repository to facilitate the accessibility to services and composed services. Improve the accessibility offering to users the elements in a graphical way. Finally, develop a full documentation about the interoperability solution and evaluation of the solution in order to compute the required KPIs.

Regarding to the collaboration with Large Scale Pilots, specifically Activage project, part of the solution developed in this task has been introduced as a service composition tool. The purpose is that during the realization of that project a considerable number of nodes are generated to access the services of the platforms involved. The services involved will be available in the interoperability solution developed in AS2AS. Furthermore, a collaboration with Activage during this period, was an interoperability demonstration to connect the services of historical data of three platforms of this project in a common database that convert and store their data in a common data format.

Task 3.5: The work during these 3 months included improvements to performance, functionalities, and usability of IPSM and IPSM-AF. The overall performance of IPSM was improved with code changes and updates of used libraries. In addition to the streaming translation capabilities (utilizing Apache Kafka) a REST service, allowing for translation of single messages was added to IPSM. IPSM REST was also extended with additional convenience functions, such as version reporting, logging-level management, and more verbose response messages (including error messages). To simplify the deployment process the IPSM infrastructure, including IPSM-core and Apache Kafka, has been containerized using Docker image deployment size was slightly reduced.

A new, RDF/XML-based version of the IPSM Alignment Format was defined. The new format was extended to include support for Turtle (TTL – Terse Triple Language) as the language for RDF patterns in alignment cells. This change improved human readability of alignments. Additionally, IPSM which now fully supports the new format, can also perform automatic conversion of the legacy IPSM-AF files to the latest version of the format. In particular, the conversion process automatically transforms alignment cells into the TTL format. All the alignments used within INTER-IoT deployments, that utilized the old IPSM-AF were converted to the new format.

All new functions and changes to IPSM and IPSM-AF were reflected in IPSM Dashboard, and included in updated documentation.

Task 3.6: In the period covered by this report, work has been focused in cross functionalities, security, scalability and documentation of the solutions. First, improvement of security modules of INTER-Layer solutions and the design of standard users with pre-defined roles to access the different solutions from INTER-FW portal. Second, development of cross-layer interaction modules in order to test and analyse the behaviour of several components working with each other.

Scalability mechanisms were also tested focused in the automatic deployment of the software components of INTER-LAYER as Docker instances in a Docker Swarm or Kubernetes virtual infrastructure.

Finally, the solution offered together with INTER-FW has been finished, including the implementation of specific security mechanisms in each software component of INTER-LAYER that integrates with the INTER-FW user management and OAuth2 login mechanism offered by WSO2 Identity Manager.

2.3.3.2 Results

Results by task

Task 3.1: Results for this task during this period regarding the gateway itself have been: a working distribution of both the physical and virtual parts of the gateway, extension modules to connect to different devices and middleware platforms, docker images of the virtual part and an automatic installer of the gateway distributions. Another result is the GUI developed that integrates with INTER-FW, the integration of solutions from the Opencall projects as well as the corresponding gateway documentation.

Finally, the gateway was thoroughly tested in order to validate and compute as a result multiple KPI.

Task 3.2: As results of this last period we obtained the security mechanisms in place, the improvement performed over the different components; the N2N solution itself, the API unification to be align with the other INTER-Layer solution, the nodes developed for AS2AS to retrieve network information directly from the Application and Services layer in order to create service composition and the INTER-FW tap panel, to enhance the data access from the UI portal and display the network related information in more structured manner. Moreover, the outcomes of the testing phase are collected in a report published in D7.2 that contains the results of the testing and the compliance with the requirements and KPI established at the beginning of the project.

Task 3.3: As for platforms integration, uAAL and BodyCloud bridges have been developed to support all functionalities required by the eHealth scenario. Feedback from pilots and open calls has been used to strengthen and refine unit tests, integration tests, documentation and the code base. The following bridges have been developed as part of WP6, Open Calls and other H2020 projects: Azure, Sensinact, SEAMS2, universAAL, WSO2 port, FIWARE, OM2M, e3tcity, Semantic Middleware, BodyCloud, SENIORSOME, OpenIoT, IoTivity and Sofia2.

A registry service has been implemented through the Parliament DB. REST API supports registry querying. Underlying the registry service, a discovery mechanism has been implemented in order to obtain devices information from IoT platforms and store in the registry. Several strategies, based on platform capabilities are provided in order to optimise network traffic and system load.

For the deployment framework implementation, the complete INTER-MW deployment, including external components (RabbitMQ, Parliament DB) has been "Dockerised". This means that INTER-MW can be deployed in any environment that supports Docker/Docker Compose. Respective instructions have been written and provided to open call projects. Depending on user needs, INTER-MW and IPSM can be deployed as a "bundle", thus simplifying the setup process. Additionally, specific instructions have been prepared explaining the deployment of platform bridges.

Another result are stable versions of INTER-MW that have been deployed for the pilot phase of INTER-HEALTH and INTER-LogP.

Documentation that explains INTER-MW basics, user guide, installation guide and developers guide have been published on a public server. INTER-MW is available as open source project on GitHub under the Apache 2.0 license.

Task 3.4: Main result of this period is the last release of the AS2AS interoperability solution. It provides a layer of abstraction to perform the interoperability between IoT platform and services. The core solution is accessible through its docker image. Instance manager control the instances of the dockerized solution and facilitates different instances working concurrently in a scalable way and located in different servers.

The components developed and APIs of this solution have been integrated in Inter-FW, for that reason, the developers and users can access through the framework to all the functionalities offered and using its security mechanisms. Mainly, they can access and manage the available services and flows. In addition, users and developers can create, use, delete or modify instances of the solution. At the same time, web tools or services help in the development of new nodes or service connection tasks. Finally, documentation and procedures to deal with all aspects that involve the interoperability solution.

Task 3.5: During this period, the results obtained include: writing and updating IPSM-AF files for pilots and demos as well as offering IPSM and IPSM-AF support for all other tasks and open calls, updates and documentation of IPSM-AF, IPSM and IPSM Dashboard. Finally, the improvement of IPSM performance was also achieved during this period.

Task 3.6: The following results were obtained during this last period: security solution and integration with each INTER-LAYER software component in INTER-FW, implementation of the different interactions between the software components of each layer and the solution of virtualization and automatic deployment of Docker containers.

2.3.3.3 Deviations

No major deviations, appeared in the activity of WP3, however as the main development WP, different aspects appeared as in any software project.

Task 3.1: A deviation was caused by a major refactoring of the code. It was necessary in order to improve readability of the whole project for a better integration of new modules.

Task 3.2: Deviation in the implementation of security mechanism for the solution. Also, the defined API was not homogenized with the other API solutions, they needed to be unified for INTER-API integration.

Task 3.3: No deviations have been identified.

Task 3.4: In principle it was decided to use Docker Swarm as a technology to manage the running instances in docker, but finally, it was decided to use Kubernetes to manage and deploy containerized applications. This decision was taken after a research where it was observed that Kubernetes is more popular than Docker Swarm despite being more complex.

Task 3.5: No deviations have been identified.

Task 3.6: No deviations have been identified.

2.3.3.4 Corrective Actions

Following recommendations received during the first project review, three Code Camps have been organised. Following the assessment of the Open Calls interim review, we have strengthened the collaboration with them through dedicated mailing lists, Slack channels and teleconferences.

Task 3.1: As stated in the deviations section, project clean up and refactoring was needed in order to improve readability and module integration.

Task 3.2: Implementation of security mechanisms that differ a little with the first security proposal. Slightly modifications on the API in the INTER-Layer N2N solution adapting the format of the calls and, thus, modification of the INTER-FW portal.

Task 3.3: No corrective actions were needed.

Task 3.4: Use of Minikube, a tool that facilitates running Kubernetes locally, decreasing the complexity level of Kubernetes.

Task 3.5: No corrective actions were needed.

Task 3.6: No corrective actions were needed.

2.3.4 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 is 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. It finished also officially in M30 with the release of the second deliverable software composed by INTER-FW Engine, User Interface and INTER-API.

During the period under evaluation(M19-M36), four deliverables have been released: “D4.2 Final Reference IoT Platform Meta-Architecture and MetaData Model (M24) “, coinciding with one project milestone: “MS9: Final architecture release” (M24); “D4.3 Interoperable IoT Framework Model and Engine v1” (M21); “D4.5 Interoperable IoT Framework API and Tools v1 (M21)”; and “D4.6 Interoperable IoT Framework API and Tools v2” with also meet the milestones “MS8: Interoperability API, Tools and framework engine initial version” and “MS12: Interoperability API, Tools and framework engine final version”. It is noticeable that the deliverable D4.4 has been merged with 4.6 in a single document and software release, following the recommendations of the reviewers.

The activities of this work package finished in M30 although connection with other WPs such as WP6 (integration activities) and WP7 (evaluation) have maintained some activities mainly in refining and documenting activities.

2.3.4.1 Progress

Progress by task

Task 4.1:

The task progressed as planned. During the period of report, this task has finished its activity. The reporting period correspond to the second part of the revision of the INTER-IoT Reference Architecture and Meta-Data Model.

In this second part, a full revision of the previous document has been executed as planned. Domain model, information model and functional view have been revised, as well as new concepts such as security model have been introduced.

The task met its deadline releasing the document D4.2 - Final Reference IoT Platform Meta-Architecture and Meta Data Model (re-scheduled in agreement with the project officer for M25).

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.

During the period, in T4.2 was finalized the definition of GOIoTP and GOIoTPex (INTER-IoT ontologies) and achieved version 1.0 by the end of M24, which was fully harmonized with, and implemented in INTER-MW messaging, and fully supported by IPSM. Development was extended beyond that and minor changes were introduced to the ontologies, which resulted in the current version 1.1. The changes were made in order to facilitate introduction of GOIoTP and GOIoTPex into LOV (Linked Open Vocabularies) ecosystem.

The ontologies are documented, and the ontology files are versioned and available publicly, all with accordance to W3C ontology publishing guidelines and best practices.

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 focus of the task is the design, so that a methodological approach was chosen from the beginning. I the period under review, M18-M27 we can distinguish two different activities:

- **Activities towards the first definition of INTER-FW (M13-M21).** Analysis and design of the software systems that support INTER-FW. These activities are bundled and released in the document D4.3: Interoperable IoT Framework Model and Engine v1 – Initial specification and implementation of the INTERFW model and engine (month 21). 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).
- **Activities of redesign/definition of new features (M22-M27).** Analysis and design of missing features, new features detected and redesign of already planned or implemented features that mislead the objectives or whose functionality have been identified as faulty. During these months, the better integration of the INTER-IoT users in the different affected modules (INTER-FW, INTER-API, API-Manger) has been redesigned towards a better security management.
- **Activities of support to development and integration (M28-M30).** After the design of new features and refinement of user interfaces, interaction with user, etc. the activities in this task were the support with documentation to the implementation activities carried out by development tasks within this work package (T4.4 and T4.5) and the integration tasks on WP6.

Task 4.4:

The objective of this task is the software implementation of the features designed in T4.3. The task have released a first and final versions of the INTER-FW web application (M21 and M30 respectively), demonstrated in the review in Athens (September 2017, M19). Further than this, the activities performed during the period M18-M36 are:

- **Implementation and release of first version of INTER-FW model and engine (M18-M21)**. This content was available at http://vmplsp04.westeurope.cloudapp.azure.com/interiot_wfk/# although currently has been substituted by the final version.
- **Implementation and release of final version of INTER**-FW model and engine (M22-30). This content is currently available at https://interfw.inter-iot.eu.
- **Docker deployment of the configuration and management framework**.
- **General improvement of the user interfaces (M21-M30)**: Gateway, Platforms, Networks and Semantics tabs have been improved according feedback from pilot partners and stakeholders.
- **Improvement of issues and architectural revision (M21-M30)**. According feedback from the first release.
- **Integrated use of Identity Server with INTER-FW and INTER-API (M21-M30)**. Now INTER-IoT uses a Single Sign-On (SSO) mechanism centralized in an Identity Server (IS).

- **Software helpers to extend the INTER-IoT layers (M21-M30)**. Coordinated with the layer developments, the mechanisms to ease the extension of the INTER-IoT Framework has stared. Some layers as D2D (Gateway), MW2MW (Middleware) or DS2DS (Semantics) releasing a final version in M30.
- **Fine-grained authorization mechanism for platforms and device interoperability based in XACML standard (M21-M30). This includes:**
    - Creation of an API in the INTER-FW backend to be able to configure permissions to platforms and machines. These data are stored in the MongoDB database.
    - Creation a simple graphical interface that consumes the API created in previous point.
    - In the existing WSO2 APIM create a new API where the middleware is enabled that takes care of the fine permissions.
    - Creation the middleware for point 3 in java and import it to WSO2 APIM. To create it, it was necessary to overwrite an APIM java class. This middleware makes the requests use the WSO2 IS XACML system.
    - Creation an "XACML attribute finder" (PIP attribute finder) for WSO2 IS that consumes the API created in point 1.
    - Creation XACML rules for the different endpoints in WSO2 IS.

Task 4.5: Due to a high coupling with WP3 and WP4 tasks, this one has been performed in a very collaborative environment in parallel with other development activities, since one of the outputs of these tasks is the individual API, which is the base for T4.5 activities. As reported in the previous PPR, WSO2 API Manager was selected as the (REST) API Manager solution to be used for INTER-IoT. In this reporting period, D4.4/D4.5 have been prepared and submitted, documenting the status of the API.

Following the developments of WP3 and WP4 regarding the deployment infrastructure, Docker API manager deployment is being used. This deployment is being tested on the eHealth and the Inter-LogP pilots.

A complete analysis of different integration approaches with Identity managers have been undertaken, in light of requirements of the INTER-LogP pilot. Finally, WSO2 was selected and integrated with API Manager and XACML authorization mechanism mentioned in T4.4.

During the Open Calls review, two projects have been identified as potential users of the API Manager: Interoperable Situation-Aware IoT-Based Early Warning System and Mission Critical operations based on IoT analytics (MiCrOBIoTA).

2.3.4.2 Results

Task 4.1: The main result of the task is the second version of the Reference Meta-Architecture for Interoperable IoT Platforms. The developed work is included in Deliverable D4.2 that was submitted in Month 25, after re-scheduling the deadline. 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.

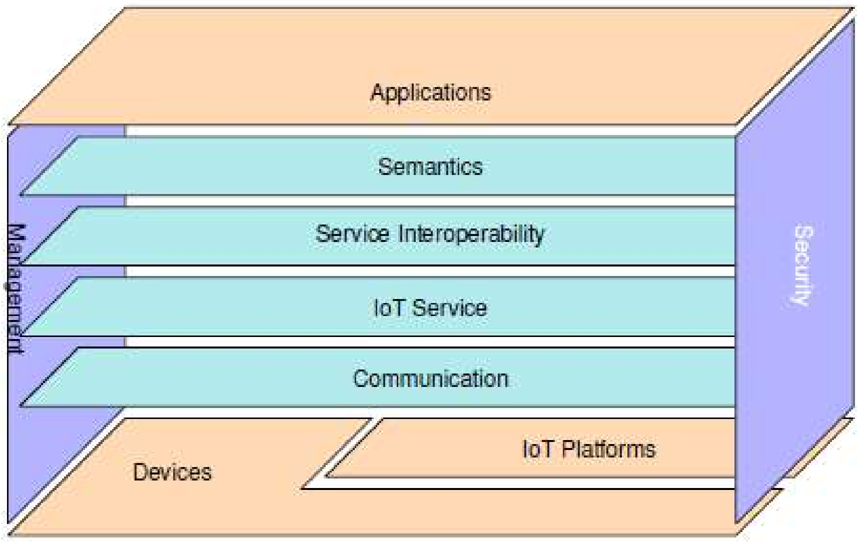

Figure 3: Functional view of the INTER-IoT Reference Architecture (second revision)

In Figure 3, it is depicted one of the results of this task, which consists in the revision 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).

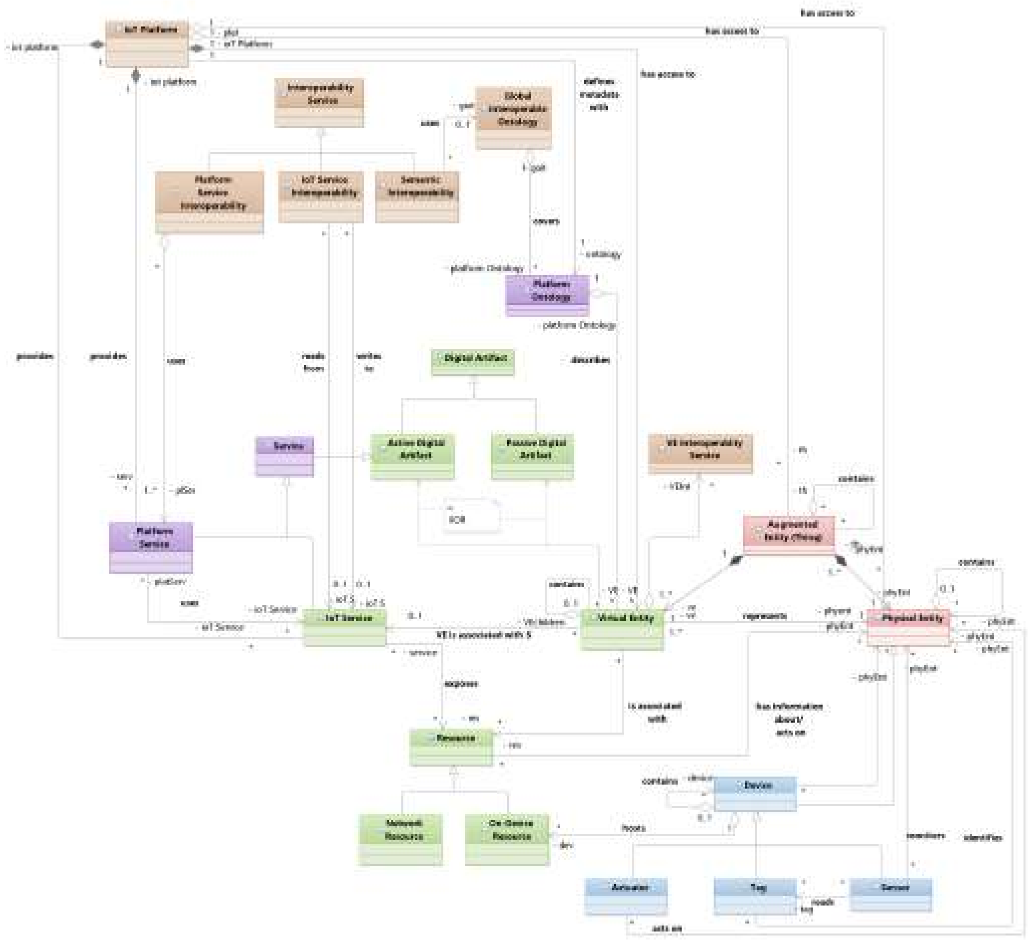

Figure 4: Interoperability of IoT platforms Domain Model, as proposed in D4.2

In the diagram above (Figure 4), it is showed another important result of the first period of T4.2. 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.

Task 4.2: First result is the initial version of the model in the form of two ontologies. GOIoTP (Generic Ontology for IoT Platforms). The Ontology was released in the first period and in this period reported, it has been updated with feedback from pilot partners and stakeholders.

A second ontology, GOIoTP-ex, which is an extension of GOIoTP that extends it with specific entities, also part of the INTER-IoT ontological model has been released and updated. The division of GOIoTP and GOIoTP-ex was made to preserve the generic nature of GOIoTP, while making a more complete and usable model.

Further than this, a comprehensive has been generated to ease the access to the semantics and ontological concepts of INTER-IoT:

- INTER-IoT ontologies (GOIoTP and GOIoTPex) version 1.1
- INTER-IoT ontologies documentation https://docs.inter-iot.eu/ontology/

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 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).
- **D4.3 - Interoperable IoT Framework Model and Engine v1** – Initial specification and implementation of the INTERFW model and engine. This document was delivered in time and included a comprehensive documentation of the activities performed in WP4.
- **D4.6 Interoperable IoT Framework API and Tools v2** – Final specification of the software including deployment and
- **During M21-36**, the documentation generated is internal and based on the collaborative tools used commonly by the development team of the consortium (Slack, Gogs git repository, horde, Google Docs).
- **Release of INTER-FW official documentation.** Available at https://docs.inter-iot.eu/docs/framework/latest/

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 Web app, 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 main results of this period are:

- First public version of the INTER-FW (M21).
- Identity Server deployment, configuration and integration with API Manager and INTER-FW (M26).
- Final version of the INTER-FW(M30).

- Final version of the identification and authorization mechanisms.

During the period, three global INTER-IoT *codecamps* have been organized, with duration of one complete week each one. The first one, held in November 2017 in Warsaw had a special group treating the centralization of the INTER-IoT users and authorization mechanisms. The second *codecamp* (Valencia, March 2018) had a group focused in the evolution of the first release. The fourth was held in Lubljiana in June 2018.

Task 4.5: This task has as main goal the proper design and implementation of the IoT interoperable framework APIs and tools for programming and managing Interoperable IoT Platforms. During this reporting period, D4.5 Interoperable IoT Framework API and Tools v1 and D4.6 Interoperable IoT Framework API and Tools v2 (final version) have been submitted. It allowed initial testing of the platform (Azure deployment) and the usage in the INTER-Health Pilot for communication with the PWT. The built-in access management using oAuth and username/password methods has been tested and demo application prepared. The results of this task are used in both INTER-IoT pilots and in several open-calls.

2.3.4.3 Deviations

Task 4.1: No significant deviation. Task finished in Month 24 and delivered its major outcome in M25.

Task 4.2: No significant deviation. Although not planned before, the development continued after the release of INTER-IoT ontologies version 1.0 (and after T4.2 ended), and into version 1.1.

Task 4.3: No significant deviation. The task produced results in the estimated time.

Task 4.4: Task progressing according to the plan. No significant deviation.

Task 4.5: No deviations. The task was closed producing the expected results.

2.3.4.4 Corrective Actions

Task 4.1: Not needed.

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

Task 4.3: Not needed.

Task 4.4: Not needed.

Task 4.5: New sub-task was needed, where to unify the syntax / semantics of the API of different layers. The goal is was to implement this access through the API Manager without affecting INTER-Layer components

2.3.5 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.

It is worth noting that after Athens review (M18) we redefined the objectives of T5.2 and T5.3 to address the Project reviewers' comments. Therefore there are some deviations with respect to the original plan and corresponding mitigation actions.

2.3.5.1 Progress

Task 5.1: The task has finalized the INTER-IoT design patterns, specifically CROSS-Layer e INTER-FW and has produced the deliverable D5.1.

The plan has been followed as expected, all INTER-IoT design patterns were defined and linked to WP3 and WP4 results, and D5.1 submitted on M24.

Task 5.2: The task has finalized the INTER-IoT integration methodology (INTER-METH), specifically the phase of implementation, deployment, testing, and maintenance were fully defined and has produced the deliverable D5.2.

The plan has been followed as expected, the INTER-METH was fully defined and linked to WP3 and WP4 methods and architecture, and D5.2 submitted on M24.

Task 5.3: The task has finalized the INTER-CASE tool. Specifically, the final tool is web-based and able to fully support the phases of analysis, design, implementation, deployment, testing and maintenance. Moreover, the application of INTER-CASE to the use case INTER-Health with reference to all phases has been fully realized.

The plan has been followed as expected, the INTER-CASE was fully correlated with INTER-METH and applied to INTER-Health and also to INTER-LogP, and D5.3 submitted on M30.

2.3.5.2 Results

Results by task

Task 5.1: The main results achieved refer to the definition of design patterns for Cross-Layer (INTER-Layer) and INTER-FW. Specifically, we only focused on a specific Cross-Layer Pattern involving Security aspects. Moreover, we defined an INTER-FW pattern for heterogeneous platform federation. Table 5.1 reports a summary of the defined patterns. All INTER-IoT design patterns are documented in D5.1 submitted on M24.

Pattern Name	Layer	Intent	Problem & Solution	Applicability
INTER-IoT SSL CROSS-Layer secure access	CROSS	Ensuring the security of the interactions with external interfaces (i.e. APIs) of every layer that composes INTER-IoT.	As INTER-IoT architecture is composed by diverse layers, the access to each of these layers, as well as the interactions among them, must be secure. In INTER-IoT, layer access will be secured with Secure Sockets Layer (SSL) that employs the pattern of INTER-IoT SSL. Every INTER-IoT layer exposes a REST API that represents an external interface accessible to external factors, such as other INTER-IoT layers, users, or IoT platforms.	This pattern is applicable for the interactions of any actor with the INTER-IoT layers APIs. The access can also be done internally among a pair of different layers.
Configuration delegation pattern	INTER-FW	Configuration of multiple instances of heterogeneous IoT platforms or IoT artefacts in a single place, abstracting from singularities of each individual case and offering a global view.	Interoperability services management implies the availability of the configuration information of the multiple heterogeneous original resources in a single place. Exposing the configuration of the different IoT artifacts, generalizing the common points and hiding the differences enables a general overview at different interoperability levels and, thanks to the homogenization of the view of the heterogeneous, it is also allowed the operation of the data access mechanisms or authorization actions at the highest level.	This pattern is applicable for providing a common interface for elements at the same abstraction level. This pattern can be applied recursively, exposing a façade common for the different layers, allowing the replication of the pattern until building a single administration and management view for the convenience of the end-user.
API façade	INTER-FW	Create a single unique API for IoT artifacts interoperability.	Complex interoperability systems (such in the case of INTER-IoT) can't be represented/exposed in a single API but in an array of complementary systems that all need to be used to fulfil the user needs. This pattern gives a buffer or virtual layer between the interface on top and the API implementation on the bottom. It essentially creates a façade – a comprehensive view of what the API should be and importantly from the perspective of the app developer and end user of the apps they create.	This pattern is applicable to homogenize the access to interfaces heterogeneous by nature, making easier and simpler the access and comprehension on the overall goal of the system. The API façade can also compound several atomic actions on the subsystems.

Table 1: Cross-Layer and INTER-FW design patterns

Task 5.2: The main results achieved refer to the definition of the INTER-METH phases of Implementation, Deployment, Testing, and Maintenance. In Figure 5, only the Testing phase is reported. All INTER-METH phases are documented in D5.2 submitted on M24.

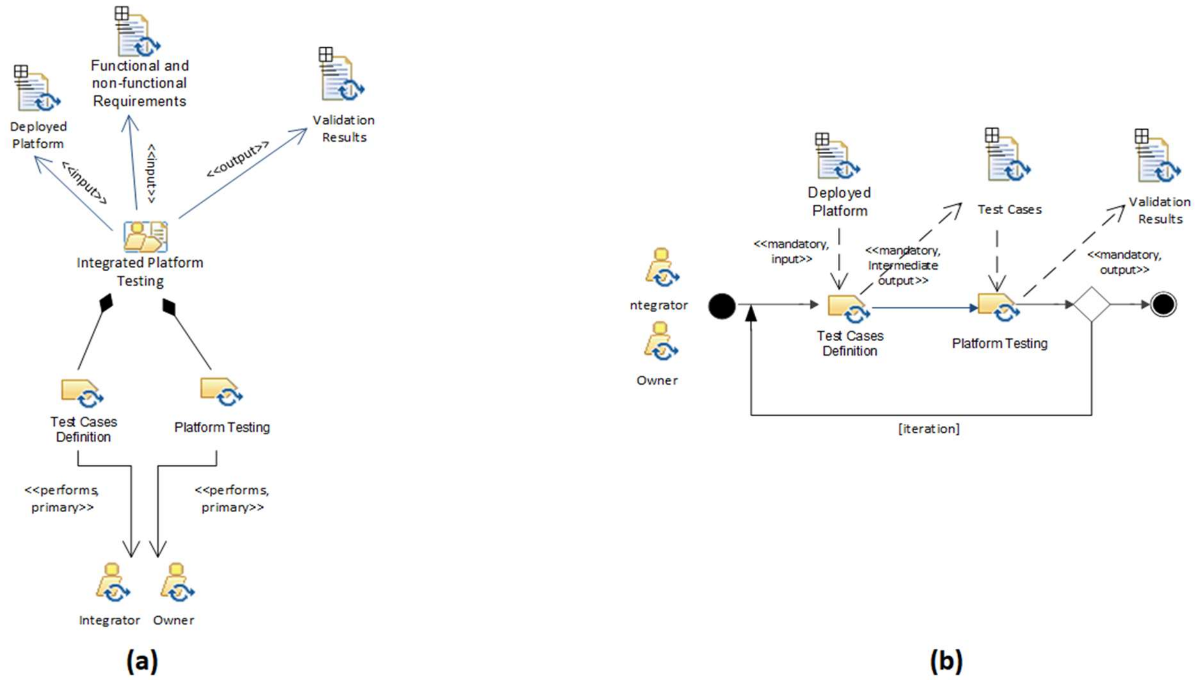

Figure 5: SPEM-based process fragments of INTER-METH Testing phase

Task 5.3: The main results achieved refer to the full implementation of the INTER-CASE tool using **Xonomy**[1]**,** to model the information of input and output workproducts from/to each phase as well as their graphical visualization and storing into the repository, and **jQuery**[2], to implement the web-based container for the navigation among the Xonomy enabled phase management. For instance, Figure 6-9 portray the Xonomy-based panels screenshots supporting the Analysis phase of the fully developed INTER-Health use case (integration between BodyCloud and UniversAAL).

[1] http://www.lexiconista.com/xonomy/

[2] https://jquery.com

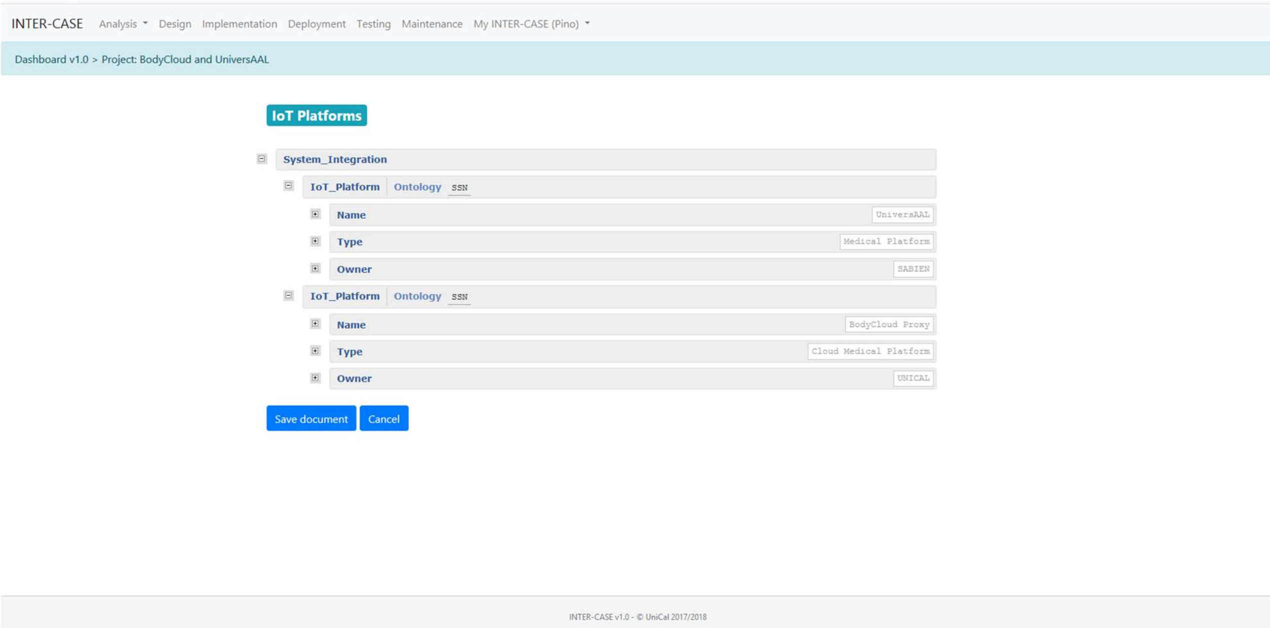

Figure 6: Xonomy-based GUI of the Analysis Phase of INTER-Health: IoT Platforms definition

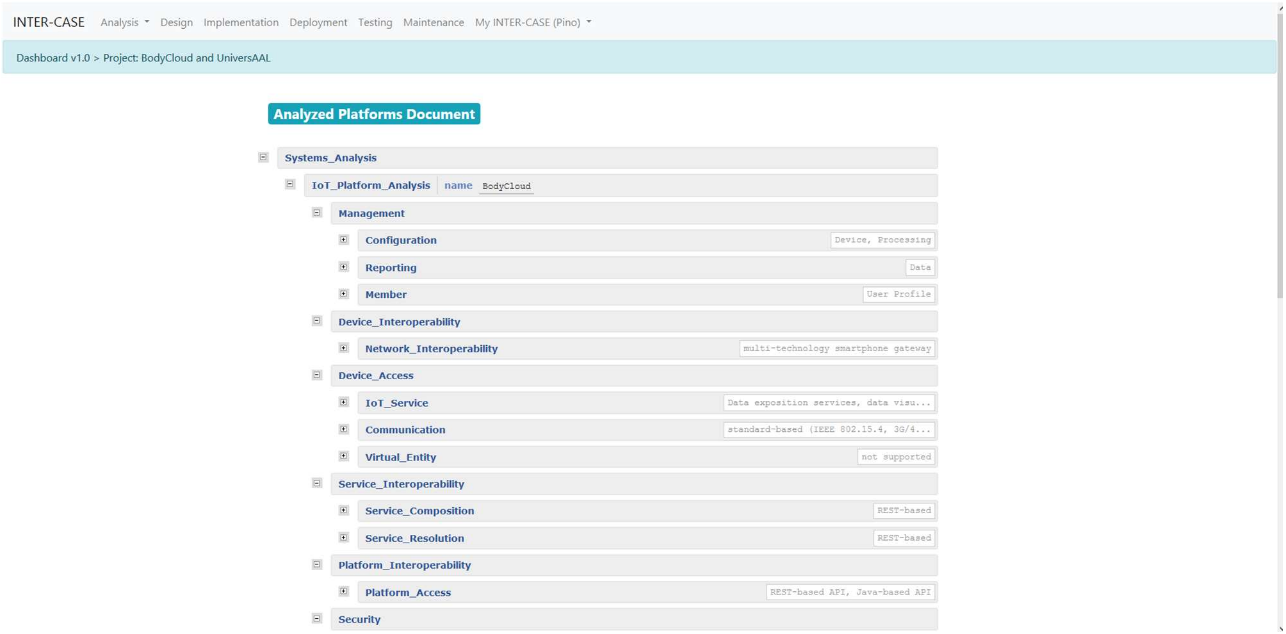

Figure 7: Xonomy-based GUI of the Analysis Phase of INTER-Health: Analysed Platform document

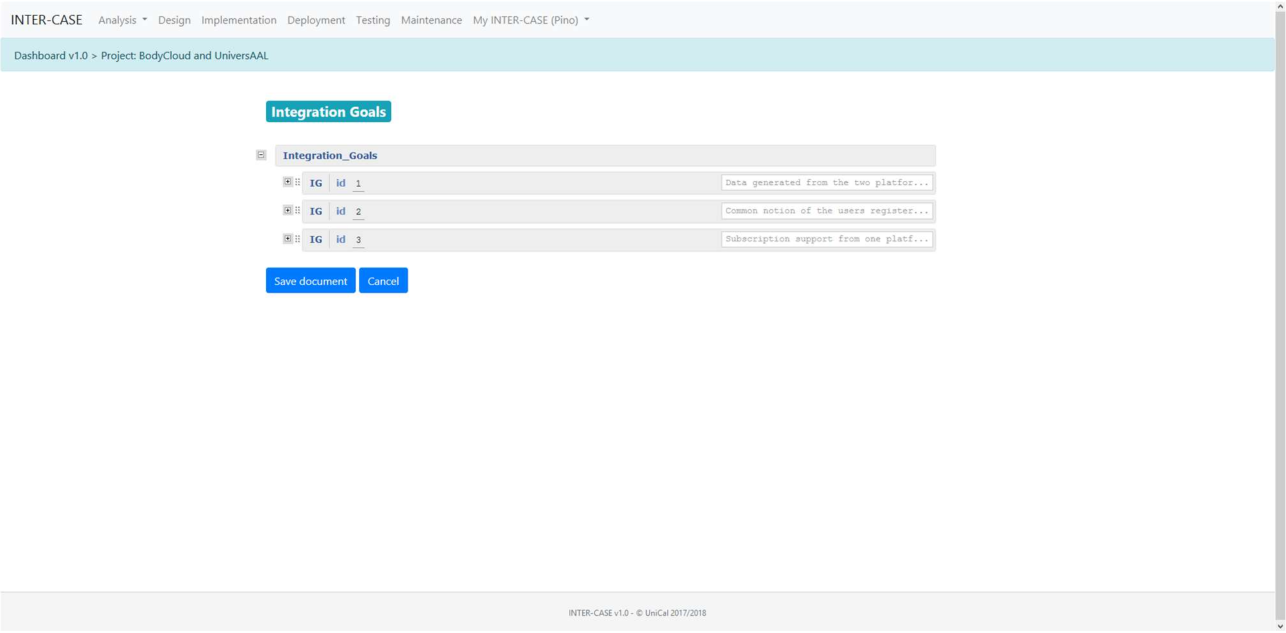

Figure 7: Xonomy-based GUI of the Analysis Phase of INTER-Health: Integration Goals

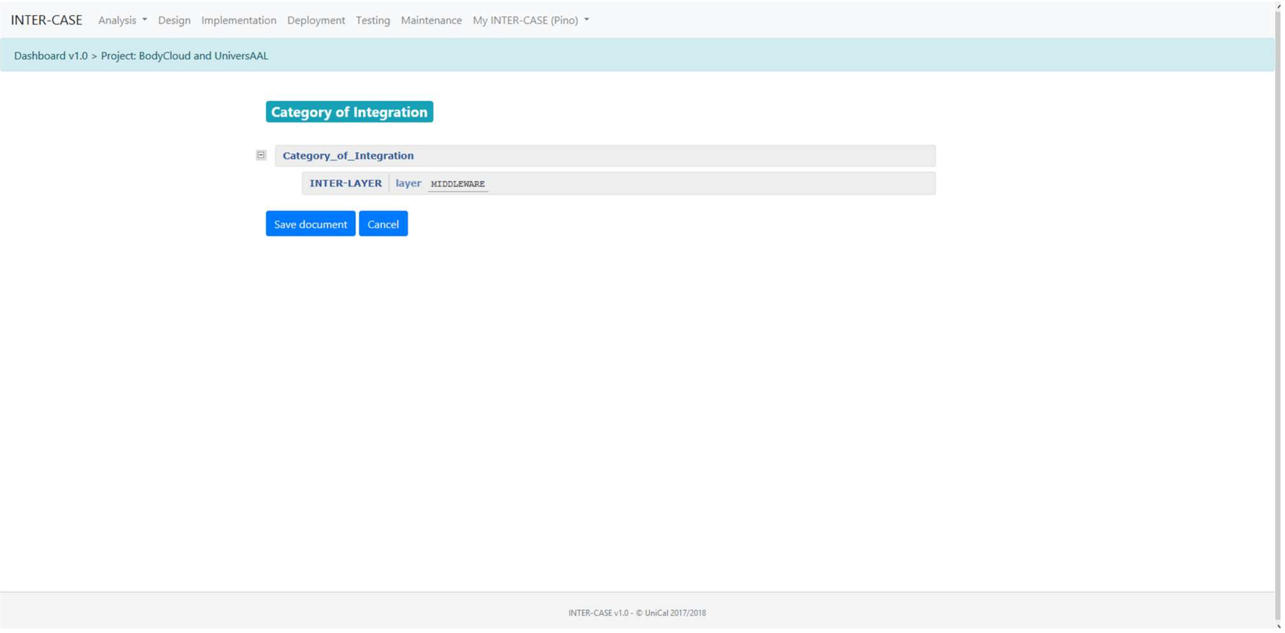

Figure 8: Xonomy-based GUI of the Analysis Phase of INTER-Health: Category of Integration document

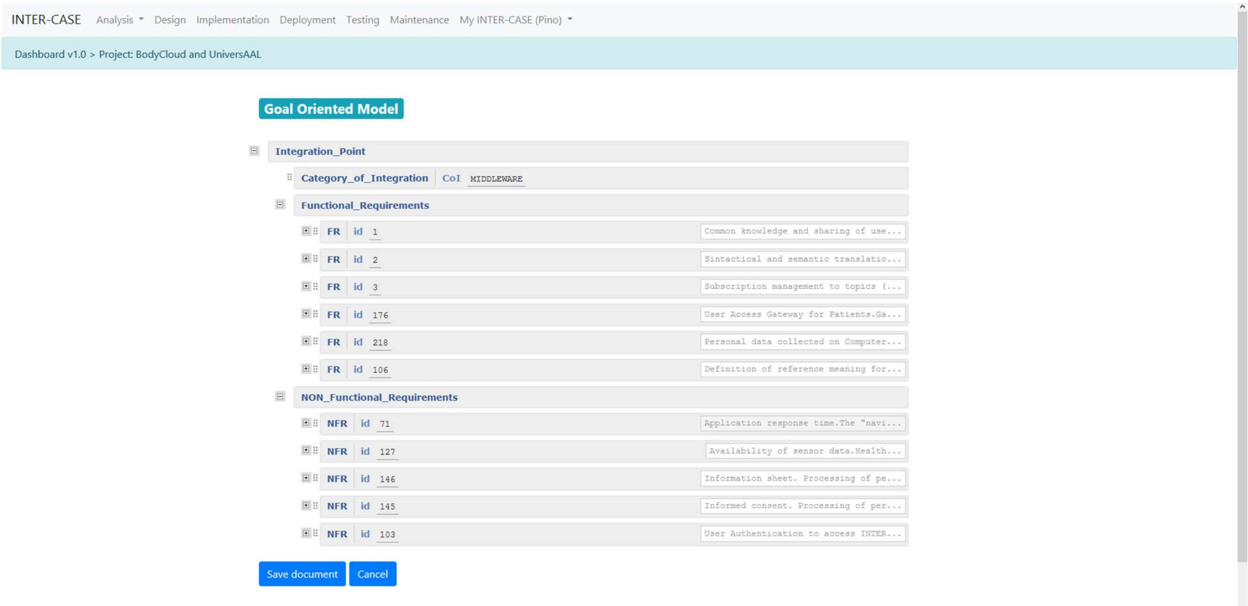

Figure 9: Xonomy-based GUI of the Analysis Phase of INTER-Health: Goal-oriented Model

2.3.5.3 Deviations

T5.1: Task ended on M24 according to the plan.

T5.2: Task ended on M24 according to the plan.

T5.3: There are some deviations so far with respect to our original plan and project objectives fulfilment. Specifically, according to the Reviewers' comment delivered after the mid-term review in Athens (which suggested to be less ambitious with INTER-METH and its supporting tool), we defined the tool to be as lightweight as possible. Specifically, the tool doesn't provide any support to automate the development of the INTER-METH phases: the phases are executed manually and the tool is able to drive the application of the methodology (and store all the related info in XML-like files) through interrelated GUIs per each phases of the INTER-METH process. Moreover, we added also the application of INTER-METH to the INTER-LogP use case that was not planned but requested by the Reviewers in the M27 technical review.

2.3.5.4 Corrective Actions

T5.1: No corrections were needed.

T5.2: Here we just avoided to provide a case study of INTER-METH application as we moved such activity to T5.3.

T5.3: The corrective action was related to the aforementioned change of final objective with the aim of having a lighter non-automatic tool just supporting the integrator in its integration activity keeping trace of its integration work.

Additionally as explained in the use of resources there were an effort swap between UniCal and PRO in order that the partners could focus and put more effort in the activities corresponding to WP4 and WP5.

2.3.6 Work Package 6 – Integration and pilot deployment

The integration and pilot development work package (WP) has started beginning of July 2017, since then the deliverables D6.1 System integration Plan, D6.2 Factory Acceptance Plan and D6.3 Site acceptance plan have been releases. And the pilots and open calls have developed and integrated their solutions with INTER-IoT and in the production environment.

The deliverable D6.1 System Integration Plan describes the high level integration plan of the pilots and open calls. It describes the system to be integrated, the test strategy and approach, defect reporting and the high level test and integration environment.

The deliverable D6.2 Factory Acceptance Test is a document which combined the Factory Acceptance Test document of the pilots and open calls into one document. It describes the test strategy for the FAT in addition to the test strategy described in D6.1, the FAT for each pilot. The FAT for the pilots describe the System in which the pilot is being integrated, The deliverables and version needed for the tests, requirements and scenarios, the test environment and tools, and finally the test descriptions and a test result overview.

The deliverable D6.3 Site Acceptance Test is build up the same way as the FAT, with the difference being that it regards the integration at the customers site. This means that the SAT describes the integration at production site and should result in acceptance of the finished product by the end customer.

2.3.6.1 Progress

Progress by task

Task 6.1:

For the pilots and the open calls the system integration plan has been created, D6.1. For each a system description has been made describing the functionality and architecture of the project and the environment in which it will be deployed. This has been documented in The D6.1 System Integration plan.

For the pilots and the open calls task the factory acceptance test document D6.2 was created, describing the tests to be done in the “factory” setting in the Factory Acceptance Test document. It describes an extended system description with relation the task 6.1, the use test environment which at this point still contains simulated and stubbed functionality. These FAT documents where followed during testing of the initially developed system and increments in to the final system. This provided an overview of the state of the product during “factory” integration.

For the pilots and the open calls the site acceptance test D6.3 has been created, extending the factory acceptance test plan with new tests and replacing the simulated and stubbed functionality with the actual production functionality and systems. These SAT documents where used during testing after deployment in the production site to prove the products functionality and stability to the end customer.

Task 6.2:

During the work in this task, we have deployed and integrated the three IoT platforms: port, terminal and haulier company. For each of them we defined an ontology and created the proper services to give access to the data.

The integration of each of the IoT platforms with INTER-IoT is done through a specific bridge developed. This bridge provide all the services needed in the pilots (discovery, register new devices, subscribe, unsubscribe, etc.).

In INTER-LogP, we defined three scenarios where we are testing INTER-IoT in a port environment. First, we have developed a dashboard with gate access data coming from the port and the terminal. In this dashboard, the port operator is able to see in real time the status of the gates and the queues in some parts of the port.

Secondly, we have developed wind gust alert system. In the dashboard, the port and the terminal safety operator are able to see alerts when the value is greater than a threshold. When a port authority sensor detects an alert, the operations in the terminal can be stopped.

Finally, we developed a dynamic lighting system. For that, we installed pir sensors and low consumption lights in the port and the terminal. When some activity is detected in the terminal railway station, the port lights in that direction turn on. In the same way, when some activity is detected in the railway switchgear by the port pir, the terminal lights in this area turn on.

After the deployment of the three scenarios, we have tested and evaluated the result during some months.

Task 6.3:

The work done in the previous period was focused on the definition of the pilot, based on a common strategy to integrate and test the INTER-IoT approach by means of implementing a system for fostering healthy lifestyle to prevent chronic diseases. In this period, it was dedicated to the implementation, test phases and pilot execution.

The health pilot is based on the implementation of a dedicated Professional Web Tool (PWT) for monitoring objective and subjective information, integration of universAAL platform for monitoring medical measures (blood pressure, weight) and of BodyCloud platform for continuous activity monitoring (blood pressure, weight, physical activity and questionnaires on eating habits and physical activity). In addition, the integration of the corresponding INTER-FW components to provide interoperability between the different platforms, of which the ones of interest in INTER-Health are the INTER-IoT Middleware and INTER-IoT API. The integration of the PWT with the INTER-MW was developed as active mode. It means that there is a daemon mechanism asking periodically to INTER-IoT for available data. This daemon is in charge of obtaining a token for security, registering a “thing” associated to a patient, asking for messages and parsing them. Furthermore, an extension to the API-REST that realize these tasks and the application to do periodic calls to that API was developed.

Initially this solution was thought as temporal, until the final version of the corresponding INTER-IoT components would be ready. This new version of INTER-MW worked with a more synchronous approach, which would have required a total modification of the working mode of the PWT. It would have implied to re-develop completely the communication, messages and parsing between the web tool and the INTER-IoT REST API. In addition, the combination of different technologies (Java, .Net), platforms (Microsoft, Linux) and their versions and subsequent incompatibilities made the components behave inconsistently during the deployment phase, compared with the test, pre-production and production servers. Therefore, to not put at risk the successful deployment of the INTER-Health pilot, it was decided to not replace the solution in place with the aforementioned new version.

Additionally to the planed use cases, others developments have been done, such as alerts based on data received from the mobile app. These alerts are triggered in the case that weight, blood pressure and/or physical activity values are out of the defined ranges. The PWT has been also prepared to be multi-language. A typical CRUD was implemented to manage devices, users and INTER-IoT “things” and was aimed at system administrators.

To improve the maintenance tasks and test the state of the system after a recovery or upgrade a Diagnostic Tool has been added to the administrative section of PWT. This tool acts as an external client different of PWT connected to INTER-IoT. This tool allows to list the different platforms registered in the system that has “things” registered. When a platform is selected the list of all the “things” that has registered are listed allowing choose one to register the Diagnostic Tool as a client of the messages generated from that thing. The messages are showed in real time in a list until the tool is closed and none information is stored.

Due to the sensitive data treated in the pilot, it has been needed the implementation of security measurements according to the national directive in Italy and the new GPRD. It was at the level of authentication and authorization to the PWT (it was moved to ASP .NET CORE 2 in order to be integrated with OAUTH v2), communication between platforms, access to the database and the data exchange between the different components of the pilot. In completion to this, a watchdog has been implemented to detect when the system is down and check the status of INTER-MW.

Before and during the execution of the pilot there were three dedicated servers: test and pre-production servers at UPV-SABIEN, and the production server at ASLTO5 facilities in Chieri (Italy) managed by the IT department of the organization. Developers involved in the health pilot have only access to the test server. After testing the components as standalone, they test them all together with the rest of components of the pilot. Once they worked properly, these components were moved to the pre-production server, and finally to the production server. This represents the Factory Acceptance Test. It was done in two phases: a test environment and a preproduction environment. There was a short time between the development and deployment phases due to the duration of the pilot execution, which needed to run for at least 10 months. Tests were passed satisfactorily enough to proceed to production FAT

There was a first phase where the PWT was tested by the health professionals in ASLTO5, to get familiar with the system. After that, medical devices were included to validate the values. It was at the beginning of March.

For the first counselling 100 subjects were recruited for the Control Group, of which 80 were female (80%) and 20 male (20%). 33 subjects are overweight (32%) with a Body Mass Index between 24.9 and 29.9 kg / m2; 55 subjects are obese (53.4%) with a Body Mass Index greater than 30 kg / m2. The average age of the subjects is 47 years. 67% of subjects have a high risk of developing chronic-degenerative diseases.

Also for the first counselling, 100 subjects were recruited for the Experimental Group, of which 67 females (67%) and 33 males (33%). 100 scales, 100 step bracelets and 25 sphygmomanometers were delivered. 30 subjects are overweight (30%) with a Body Mass Index between 24.9 and 29.9 kg / m2; 32 subjects are obese (32%) with a Body Mass Index greater than 30 kg / m2. The average age of the subjects is 46 years. 54% of subjects have a high risk of developing chronic-degenerative diseases. 25 subjects had Normal-High values of arterial pressure (systolic pressure ≥130 and / or diastolic pressure ≥85).

Task 6.4:

For the open calls the Factory Acceptance Test and Site Acceptance Test documents have been created. The project have all finished development and presented their work during the open call review. During the open call review all open call were approved, thus approving the cross domain task. D8.6 includes the information regarding the evaluation of the third parties and the results provided by them.

2.3.6.2 Results

Results by task

Task 6.1:

Deliverables in WP6 are not the outcome of a single task. The three deliverables released in WP6 are D6.1 (M20), D6.2 (M25) and D6.3 (M33).

- **D6.1:** defines the high-level test plan and the system descriptions and integration plans of the individual pilots and open calls. This document describes the process being used during Factory Acceptance Testing and Site Acceptance Testing.
- **D6.2:** defines the Factory Acceptance Test of the pilots and open calls which all have their own FAT document for their project. D6.2 combines these documents in one document. The execution of the FAT gave an overview of the readiness of the product. It tested the completeness and checked that requirements were met and proved the functionality. It also gave the customer a first view of the product and provide the ability to work with the product and even adjust some requirements if issues were found.
- **D6.3:** defines the Site Acceptance Test of the pilots and open calls which all have their own SAT document for their project. D6.3 combines this into one document. During the SAT tests the deployed system has been tested and proven. The SAT followed the same principles as the FAT but described and tested the system integrated in the customer systems.

Task 6.2:

The main result is the development of the three IoT platforms with all the needed services and bridges to interoperate among them. Furthermore, three application have been developed, one per each scenario in INTER-LogP.

Task 6.3:

As main and direct results of the pilot can be identified the implementation of the Professional Web Tool, universAAL and BodyCloud bridges plus specific mobile applications to integrate medical devices. It implied the definition and implementation of specific parsers and alignments to translate universAAL and BC data to INTER-IoT and vice versa, and tools for monitoring the good performance of the system, as well. Some of the components have been implemented several times in order to evolve accordingly INTER-IoT components. Furthermore, due to the sensitive data managed, it was identified interesting security use cases, in the sense of user management and other security decisions at more general level that can be translated into good practices for future adoption.

Task 6.4:

The open calls developed their system parts and integrated them with the INTER-IoT framework. Multiple bridges were created to integrate opencall solutions into the INTER-IoT framework. Management of the open call is described in detail in deliverables from WP6 but also in deliverable D8.6 and D7.3. Every third party performed as specified in the collaboration agreement and two of the third parties developed a multidomain use case and pilot (i.e. NEMERGENT and U. Twente).

Several pilots performed live demos using the premises of the port, and other performed inlab testing with synthetic data sets or virtual sensors. The results of the third parties are available and some of them are active contributing to INTER-IoT ecosystem.

2.3.6.3 Deviations

Task 6.1:

No deviations have been identified.

Task 6.2:

No deviations have been identified.

Task 6.3:

INTER-Health pilot started with 6 weeks of delay due to some accumulated delays in the developments of some INTER-IoT components. However, it has not had an impact on the development of the pilot as mitigation measures were applied. Mainly the control group was deployed in a first phase, patients of the experimental group started 3 months later.

Additionally, an upgraded set of scripts and containers for INTER-IoT components (not new versions of those components) were deployed half-way through the pilot in order to increase the stability of the operation. This had no impact on the ongoing operation of the pilot nor solved the issues identified at the time, although it did facilitate recovery procedures.

Task 6.4:

No deviations have been identified.

2.3.6.4 Corrective Actions

Task 6.1:

No corrective actions were taken

Task 6.2:

No corrective actions were taken

Task 6.3:

No corrective actions were taken, a part of the ones explained in the previous section

Task 6.4:

No corrective actions were taken

2.3.7 Work Package 7 – Evaluation and assessment

The evaluation and assessment work package began in January 2018 (M25). It draws on work done in previous work packages with the primary outputs being D7.1 evaluation plan (M27), D7.2 Technical evaluation and assessment report (M32), and D7.3 final evaluation report (M36). Its primary purpose is to fully evaluate the technology developed in terms of functionality and interoperability, the usability and results in terms of the pilots, and the overall process evaluation looking to improve future development and implementation of INTER-IoT technology in other application domains.

2.3.7.1 Progress

Progress by task

Task 7.1:

The primary focus of this task was the development of the plan for evaluation of INTER-IoT technology (T7.2), the pilots (T7.3), and the processes (T7.4) around the conduct of the project and its future use. All partners contributed to task.

The overall methodology was directly influenced by the CREATE IoT project deliverable 01.04. The work began with the identification of the dimensions and fields of measure to be used throughout the evaluation process. The dimensions identified for evaluation were exploitation, the pilots, impact, interoperability and ethical societal, gender and legal issues. Each of these dimensions is further broken down into fields. A map of the chosen system is available in Table 1 of D7.1. The fields are then further broken down to group individual KPIs identified in the project shows the number of KPIs for each dimension. KPIs are defined for each field in each dimension so an objective measure of success can be made. Further discussion of the handling of the KPIs can be found in future sections of this document and D7.1. The methods described there are the result of work done in this task.

Dimensions	Number of KPIs
Exploitation	25
Pilots	17
Impact	14
Interoperability	44
Ethical, societal, gender, and legal issues	13

Table 2: Dimensions and KPIs

The plans for collection and management of the KPI data are set out in D7.1 section 2.2 and the associated subsections of section 4. They involve a combination of desk research, interviews, and questionnaires. Relevant stakeholders have been addressed to collect the necessary data during Task 7.2-7.4. KPI analysis is also covered in D7.1.

Each evaluation plan follows a similar format. First the purpose is defined, the stakeholders are identified, and the approach/setup is described. This is followed by the definition of all relevant KPIs and the specific data collection methods and measures to be used for the associated KPIs.

The technical evaluation's purpose has been defined to address the existence and functionality of the technical components developed in the INTER-IoT project. Task 7.2 is responsible for carrying out this evaluation. The stakeholders interested in the results are identified as future users, administrators, and developers of INTER-IoT systems/solutions. They will have different interests in the results of the evaluation dependant on the part of INTER-IoT they are using and their level of technicality. For a complete list of the relevant KPI measures defined and the associated measurement methodology, please see D7.1 section 4.1.

The evaluation of pilot results will address INTER-IoT in specific application domains. Task 7.3 is responsible for carrying out the planned evaluation prepared as part task 7.1. The INTER-LogP and INTER-Health pilots will be the focus. Technical components as well as stakeholder satisfaction will be addressed. For a complete list of the relevant KPI measures defined and the associated measurement methodology, please see D7.1 section 4.2.

The process evaluation methodology has been defined to assess INTER-IoT internal processes and tools which have been used to create the INTER-IoT technology and facilitate the pilots. The effectiveness of these methods to produce the planned outcomes will be assessed. Reusability of these methods will also be reviewed to inform future users of INTER-IoT looking to build on the work done and groups who want to use the technology developed for commercial or future project ends. A complete list and definitions of the relevant KPIs and the associated measurement methodology is available in D7.1 section 4.3.

Work to develop a plan for internal and external use of the evaluation findings has also been completed. Stakeholder actions will obviously depend heavily on the outcome of the evaluation. They will be stakeholder specific and will be used to drive future development work and inform exploitation activities.

An ethical evaluation of the issues surrounding evaluation has also been prepared. Key steps have been taken to ensure the integrity of evaluation. Internal review of the evaluation plan has been undertaken and all project partners have been included in its preparation to insure transparency. KPI leading partners have also been identified so those responsible for evaluation are auditable.

Task 7.2:

The primary objective of this task is to present the technical evaluation of the project. Work carried out focused on the assessment of technical KPIs which give an insight into the technical maturity of INTER-IoT and its components. 45 of the 113 KPIs are covered by Task 7.2 and readdressed in D7.3. This represents nearly all of the project’s technical developments (apart from large scale pilots which are covered in T7.3).

Areas where the technology is performing well are highlighted as well as areas where additional work could be done.

Development and functional KPIs have performed particularly well with multiple individual KPIs far exceeding the goals set. Documentation for all aspects of the project is underway. Improving the coverage and quality of this important aspect of the project will show improvements in the associated KPIs in D7.3. Additionally, KPIs whose testing is tied to pilot activities are often lower than the target. D7.3 will show progress in these areas as well.

Task 7.3:

The primary objective of this task is to present the evaluation of the pilots. Work carried out focused on the assessment of KPIs specifically addressing the large scale pilots. 18 of the 113 KPIs are covered by Task 7.3 and addressed in D7.3.

Areas where the technology is performing well are highlighted as well as areas where additional work is needed. The KPIs measured in this task are a mixture of technical and project efficacy measures. The full set of KPIs has been collected as part of the pilots and these measures has driven development in WP6.

Task 7.4:

A survey of project partners, open call member and end users was undertaken to assess the project's success. This information has been used to steer future work and contributed directly to the KPI values of Dimension 5: ethical, societal, gender, and legal evaluation. Some KPIs were given multiple questions, while others were based on a single question. The survey was based in Google Forms. The survey ran from 1 November until 20 December 2018.

2.3.7.2 Results

Results by task

Task 7.1:

A full definition of the evaluation methodology has been produced and is available in D7.1. This addresses the technical evaluation plan, pilot evaluation plan, and process evaluation plan. A detailed description of the KPIs is in section 5 of this document and D7.1.

The results of using this methodology are presented in section Task 7.2, 7.3 and 7.4. They are presented in full in D7.2 and D7.3 along with the calculation of the associated KPI, field and dimensional scores.

Task 7.2:

Overall, the report is very positive and reflects the work done as part of the INTER-IoT project consortium. Additional work will be done to complete the assessment of the remaining technical and non-technical KPIs during the final stage of the project with the final evaluations included in D7.3 delivered in M36 of the project.

Task 7.3:

The technical performance of the Pilots was at the level expected, whereas some areas of clinical impact associated with the health pilot were below the targets set. While it is possible to take action associated with technical performance issues, we are not able to influence the results of clinical studies. The KPIs associated with the impact of patient health are targets set by the clinical teams. Once the protocol was written, the methodology and the results associated with the study must be presented as is. Future deployments of INTER-Health will consider the results of this trial and use the systems in the most appropriate way with expectations set by the trial outcomes.

Task 7.4:

105 individuals participated in the survey. At least 1 member from each project partner and open call participant completed the survey. 65% of the completed surveys were from potential purchasers of solutions based on INTER-IoT. The remaining 35% were from universities and research institutions. The results of each KPI are recorded in Section 3.2 of this deliverable.

2.3.7.3 Deviations

Task 7.1:

A full review and update of the data collection, KPI subdivision and score calculation methodology was undertaken. The data collection methodology and/or scoring methodology have been updated for 12 of the KPIs. The changes represent improvements in the clarity of the methodology as well as addressing bias which could be introduced by outliers in individual KPI scores. Full description of the changes in included in D7.2 and D7.3.

Task 7.2:

No significant deviations were noted.

Task 7.3:

No significant deviations were noted.

Task 7.4:

No significant deviations were noted.

2.3.7.4 Corrective Actions

Task 7.1:

By presenting the calculated KPI, field and dimension scores in 2 ways—as planned in D7.1 and with a maximum limit for any individual KPI score set to 100—a more complete understanding of the data is realized. The overall INTER-IoT score is 160 utilizing the methodology outlined in D7.1 and 91 for the adjusted methodology.

Task 7.2:

No corrective actions were necessary.

Task 7.3:

No corrective actions were necessary.

Task 7.4:

No corrective actions were necessary.

2.3.8 Work Package 8 – Impact creation

The general objective of this WP is to organize in a coherent way the activities leading to maximize 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 individual exploitation and joint based on OSSW 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, IPR, licensing, etc.)
- Build community and support around the OSSW Business Model
- Reach in an early phase of the project a consensus on an Open Source

2.3.8.1 Progress

Progress by Task

Task 8.1: The Communication Task executed the Communication Strategy as planned to raise awareness for potential users and promoting long-term sustainability of the project results. While during the first period the communication was more focused in preparing the tools for reaching our intended audience, in the second period the communication aimed at reaching the target audience.

Our web site has been the main entry point for providing information on the project developments. 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. Other communication means were used, in particular Facebook, Linkedin and Twitter. However, as the specific solutions developed by the project needed a more focused, B2B communicaiton, most of the effort has been spent in reaching out potential customers and markets, trying to develop a solid base for the exploitation of the technology developed. In other words, rather than a loud noise with no specific target, we focused our communication strategy towards the sectors that seemed more inclined to foster the adoption of the selected technologies. The poster and the leaflets were distributed in several events.

Furthermore, NEWAYS developed a specific booth that will be used in several events, starting from the E-world fair in Essen (4-8 Febrary 2019). Communication activities will not end with the “natural“ end of the project, but will continue supporting the exploitation of the project results.

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 (both scientific 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 a relevant number of scientific papers has been published. Furthermore, substantial number of activities are already planned for the next few months.

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

Task 8.3:

The task focused on the coordination, preparation and submission of the D8.7.

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 webexes 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,

Analytical part of the deliverable also included industry trends, swot analysis, competitor analysis, regulatory considerations for e-health, marketing operations, requirements for certification and standardisation, conclusions

Task 8.4:

The Exploitation Team (ET) has continued working in the elaboration of the individual and exploitation strategy plans by following the roadmap of the INTER-IoT Exploitation Plan included in D8.3 (M4), starting with the third phase called “Second iteration of the joint and individual Exploitation Plans” that will run from M18 to M32.

This period started with the delivery on time of the *D8.6 Final Report on Impact Creation* and the *D8.7.b Business Models and marketing Operations* that contains the second iteration of the Individual Exploitations plans of the INTER-IoT partners and the Joint Exploitation Plan for INTER-IoT based on open software.

During the 6th INTER-IoT Plenary meeting celebrated in Paris on November 29th-30th (M23), the ET celebrated an Exploitation meeting to discuss and analyse the comments and recommendations of the EU reviewers during the review meeting in Athens (M21). The discussion was focused on several aspects such as to turn the exploitation planning/impact creation into concrete actions, to redefine the OSSW plan in order to join to existing communities and to further analyze the IPR issues.

On January 2018 (M25) the ET participated in the following TF webinars: Strategy and stakeholders engagement, Marketplace mechanisms, Technology Inclusivity, Community support, Ecosystem Openness and Technology Advancement. Therefore, the ET participated in the IoT-EPI celebrated in London February (5^{th}-7^{th}) (M26). INTER-IoT helped actively to develop the concept of the workshop itself, organising and animating a session, driving the discussion and analysing the results afterwards.

The ET held interviews with the third parties in order to assess and support their exploitation strategies during the midterm evaluation (January 2018) and the final evaluation (October 2018). The different reports included information related with these aspects that have been summarized in D8.6 and D8.7.

During M25 the ET prepared a workshop to conduct the activities to go on with the second iteration of the Joint and individual Exploitation Plans, taking into account the comments the last comments of the EU reviewers, the TF inputs and the contact with third parties of the open call.

The workshop was celebrated in Eindhoven on (13^{th} -15^{th}) February (M26) and the ET focused the attention in the following issues: exploitable products selection, map of individual exploitation leads and exploitation perspectives, IPR analyses, discussion about INTER-IoT as an open source project.

During the plenary meetings in Prague (15^{th}-16^{th} May 2018) and Torino (3^{rd}-4^{th} October 2018) a refinement to the individual exploitation plans were performed, alternative for Phase IV “go to market” strategy and refinement of the business models.

Finally, during this period (M19-M36) the ET has continued monitoring the market and reviewed the initial INTER-IoT exploitable products defined in D8.7.a and consolidated in D8.7b according to the achievements of exploitation activities during project’s lifecycle as an iterative process by using Lava Matrix Methodology.

2.3.8.2 Results

As in the first period, the project used 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 D8.6 reports in details 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 continued strong during this period with a large number of publications. Industrial dissemination actions were performed. It is important to notice that the participation to industrial fairs gave us also the feeling of “how” to tune a future product offer based on the technological results.
- Communication results in terms of the different channels used by the project. During the second half of the project the consortium kept he project image up and focused the communication towards the channels our specific audience was tuned into. In terms of communication INTER-IoT partners have continued collaborating actively with IoT-EPI, and with other projects like IoT-LSP cluster; n particular, a whole workshop at the IoT-EPI meeting in London was organised, prepared and animated by INTER-IoT.
- Exploitation in close relationship with the final release of D8.7 includes a review of the plan for OSSW 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.

- 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).

2.3.8.3 Deviations

No significant deviation. Participation in IoT-EPI and extra dissemination activities.

2.3.8.4 Corrective Actions

No corrective actions.

3 Impact

3.1 Update of the plan for exploitation and dissemination of results

Dissemination activity has been described in different deliverables, the activity from M19-M36 is covered in D8.6. The dissemination activity has aimed during the life of the project to establish a critical mass and long-term commitment from different selected target groups. Therefore, results from various project activities have been disseminated to the widest possible, though precisely selected, communities through a number of focused activities.

The dissemination plan established at the start of the project and reported during the first period of the project, considered a continuous activity since the start of the project, and has evolved with flexibility during its lifetime. The evolution has been affected 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 has grown till now and will grow in the future. The project partners have been working together in areas related with IoT interoperability for several years before the start of the project, during the lifetime of the project have consolidated the activity and new lines, application domains and target groups have been established. Scientific dissemination has not suffered the typical 'slow start' effect, as some of the work were already ongoing at the kick-off of the project and were linked to INTER-IoT. The consortium, not only the academic partners, but also the industrial ones, have tried to become a reference through different actions. On the other hand, last year of the project has increased and improved the consolidation of industrial dissemination.

D8.6 reported in detail the impact creation activity during the second period of the project M19-M36. In this section we will provide some quick facts and results related with the activity.

D8.3 and D8.5 identified the target audiences and explained the preliminary activity performed within M1-M18. The target audiences remain the same, although during the second period we have stressed industrial dissemination and stakeholder access in order to pave the way for future and current exploitation of results:

- 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

We have continued developing activity in the two axis of dissemination: scientific and industrial. Each dissemination activity has had their own development plan. D8.6 cover the achieved results in detail during the life of the project.

3.1.1 Scientific Dissemination

Scientific dissemination has been a key impact enabler, and the consortium has made 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 during the whole life of the project. 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 D8.6.

Members of the consortium have continued organizing 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 M19-M36 period has helped to consolidate the workshop Globe-IoT that is co-chaired by Prof. Fortino and Prof. Palau, and includes in the Steering Board and Technical Program Committee members of the consortium and the Advisory Board not only from Academia but industry. The second edition was held in las Vegas (USA) in 2017 together with IEEE CCNC; third edition in Orlando together with IEEE/ACM IoTDI in 2018 and fourth edition will be held in Limerick (Ireland) together with IEEE WF-IoT.

Another highlight is the agreement with Springer publishing company in order to publish a book about INTER-IoT project that is currently under review by the editorial and will come out during 2019. The book will include a dedicated chapter for INTER-IoT architecture as recommended by the reviewers, although partial versions of the architecture have already been published in different conferences and journals.

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. As a highlight a master program on interoperability of IoT has been established in UniCal coordinated by Prof. Fortino and with participation of the members of the consortium (e.g. Prof. Carlos E. Palau or Prof. Antoni Liotta) and from the Advisory Board (Prof. Meng Zhou).

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). During the first period demonstrations and participation in events like SIDO 2017 or IoT Week 2017, the participation was focused on demos associated with partial components of INTER-IoT. Our presentations attracted considerable interest and allowed to establish additional links for further exploitation.

During the period under evaluation, the consortium has been stressing the pilot results and we have been using them in order to drive dissemination toward stakeholders. Although we have continued attending events like IoT Week 2018 on our own and outside the umbrella of IoT-EPI. The consortium has prepared different demo kits and have attended different events and presented the results to specific stakeholders that could be interested in the results. D8.6 includes details on these presentations and attendance to events.

The final event associated with INTER-IoT, and clarifies the interest of the consortium in continuing pursuing the exploitation of the results is going to be held in Essen (Germany) from 5th-7th February 2019 at the e-World conference in which the whole consortium will hold a booth presenting the results of the project, but focusing on the exploitation and benefits of the consortium. The booth has been designed during the last leg of the project by NEWAYS and has been used in other event named ELECTRONICA in Munich (Germany) in November 2018. The booth will be used in different events if needed in order to promote INTER-IoT events.

3.1.3 INTER-IoT Booth design

With the view on (WP8) Impact Creation, NEWAYS (large industrial partner within the consortium), during the project already came up with the idea to translate the knowledge, building blocks and architecture of the INTER-IoT project into a booth to be used at fairs in which the abstract technologies of INTER-IoT would be translated into 'real-world' scenarios and applications, starting from the results of the pilots, so we can use as drivers to exploitation.

The booth has been considered as the global merging of all individual and collective showcasing and presentation associated with industrial dissemination of partial and global results of the project. The basic idea was that all- & cross-level interoperability of the INTER-IoT architecture would be present and that the application advantages would be show for every existing 'smart-x' market available. (smart-logistics, smart-health, smart-energy, smart-agriculture, …).

The INTER-IoT technology was translated into a smart office booth, making visitor able to feel, touch and activate elements and see the interaction and results of it on a large dashboard. The main topic of the booth is showing the capabilities & results of the INTER-IoT project by translating the architecture into real world electronics, sensors, interfaces,… Furthermore it shows the high level of complicated SW (in several languages) that has been developed, but providing and showing means to facilitate its use.

Depending on which fair you're at, or what application domain you're targeting at, you can articulate a story through a script.

For example on an energy fair: when having a large office building, the number of required working spaces can be minimized using the logging system (RF ID cards & presence motion sensors in the chairs) so an optimal occupation of desks can be achieved. In this way, up to 20% less desks are required and less energy (light, heating, ..) will be spend. The same is applicable on the cost side regarding logistics: it is not required anymore to empty on a fixed schedule base the trash bins, or water the plants. The trash bins and plants will trigger you when action is required. This saves time, energy and thus costs. And the sensors that are required, can be designed fully customized if required, depending on what you want to measure, which environment it will be used, … Same stories can be created for automotive, industry, agriculture, … .

The interactive elements of the booth are:

- People can scan a personalized (name & picture) RFID card and then select a work spot (desk) using by a small touchscreen.
- The desk chairs are equipped with movement sensors to detect presence (occupation) of the work spots, when the chairs are moved this is shown on the dashboard (large touch screen TV).
- The trash bins are equipped with level sensors, when something is thrown into a trash bin the content-level of that bin will change on the dashboard (large touch screen TV).
- Two soil sensors are installed in plants to measure the moisture of the soil, water can be added to the plants or the sensors can be removed from the plants to trigger a moisture level change, which is than real time shown on the dashboard (large touch screen TV). A nice feature is that you can see the color of the plants change on the dashboard from green to brown when the moisture level is too low.
- The room temperature and humidity is monitored using a sensor which is also shown on the dashboard (large touch screen TV).
- Different portable components can be deployed and included in the booth, like gateways, e-health kits like PRIME-IoT.

- The dashboard is on a large touchscreen, the touchscreen can be used to go to the detailed information, in real time, of the 'smart office': Office overview, Trash bins content, Soil sensors moisture levels, room information, movements, Temperatures, scanner and settings that the dashboard provide current and history information on the selected topic.
- To go to the real time dashboard (please try it!!), scan the following QR code:

Figure 10. QR code to access real-time dashboard

The general overview of the dashboard is:

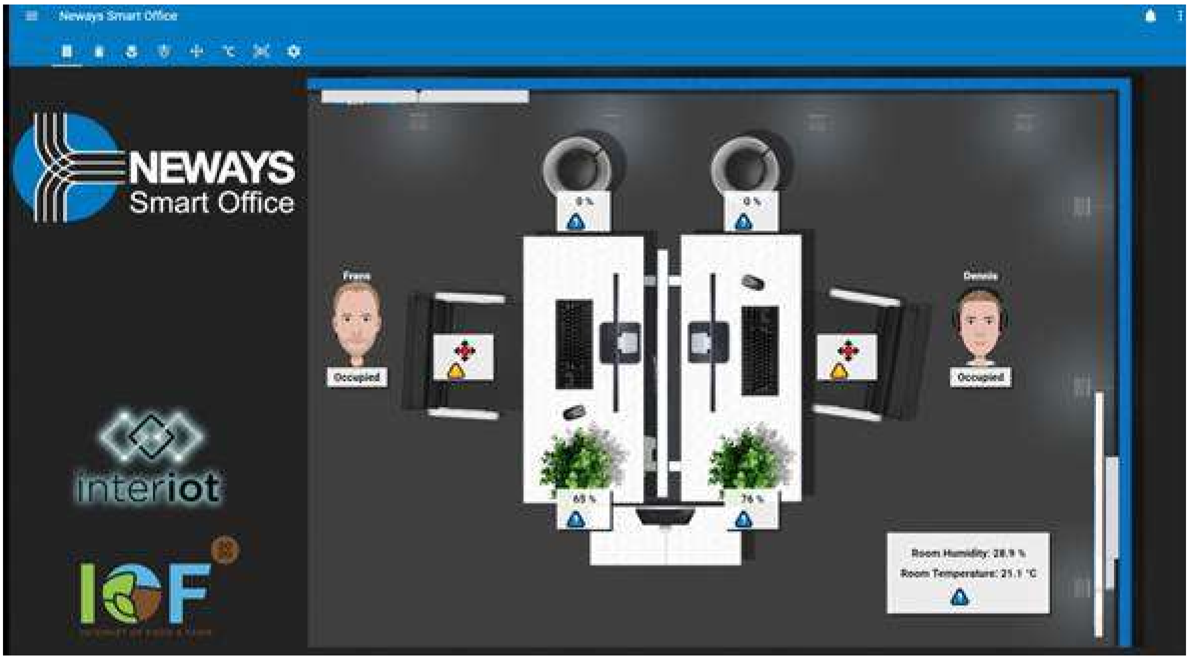

Figure 11. Real-time dashboard screenshot

The interoperability among different Internet of Things (IoT) platforms is shown by using the architecture drawings (posters & on the computer screens) and the gateway devices shown on the booth. The devices are placed on the booth in such a way that it is easy to compare them with the compare to the architecture. Also by having the ability to 'play' with the sensors and see in real-time the impact on the large dashboard, interoperability is demonstrated.

And with regard the meaningfulness for industry: Is the solution of this interoperability a result of the research work within the INTER-IoT project? (who developed the solution for interoperability), the response is: *"Yes, it is: This solution is a direct result of the INTER-IoT project. Within this project we went through all 'standard' development phases from research, defining requirements, setup a reference architecture, develop all required building block, integrate them and finally have* *them tested in two large scale pilots: the INTER-Log-P Pilot in the port of Valencia (Spain) and the INTER-Health Pilot in Torino (Italy)".*

The project has already been using this booth on two large industrial fairs.The first one on AgriFoodTech in Den Bosch (NL) and the second time on the E-World Smart Energy Fair in Essen (D) with a team that consisted out of several consortium partners: NEWAYS (lead), UPV, RINI, SRIPAS and ABC. Links to the news:

- https://www.newayselectronics.com/news/neways-electronics-demonstrates-iot-in-interactive-environment
- https://www.newayselectronics.com/app/uploads/2019/02/190204-Neways_E-world.pdf

Figure 12. Pictures of INTER-IoT booth

3.1.4 Communication Results

Communication process within the project has continued following the same structure and process as previously discussed and indicated in the deliverables of WP8. The reporting of the last period in included in D8.6 submitted on M36. 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:

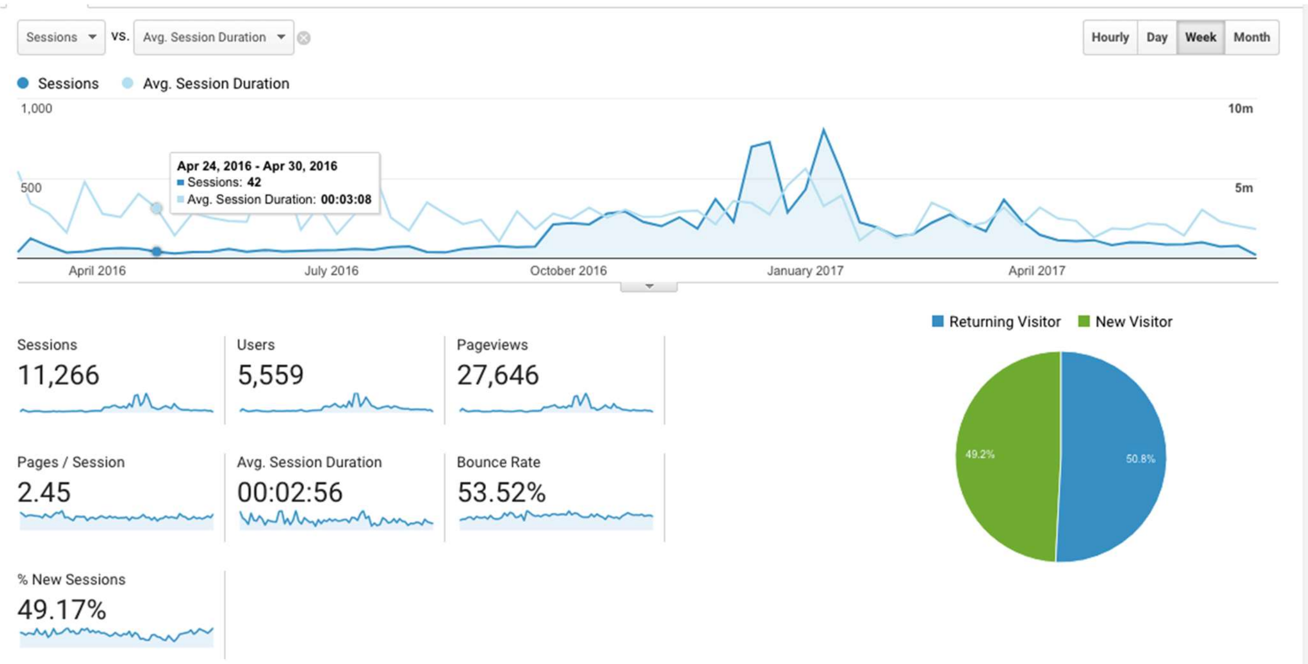

Figure 13. Monitored Website Traffic (1st period)

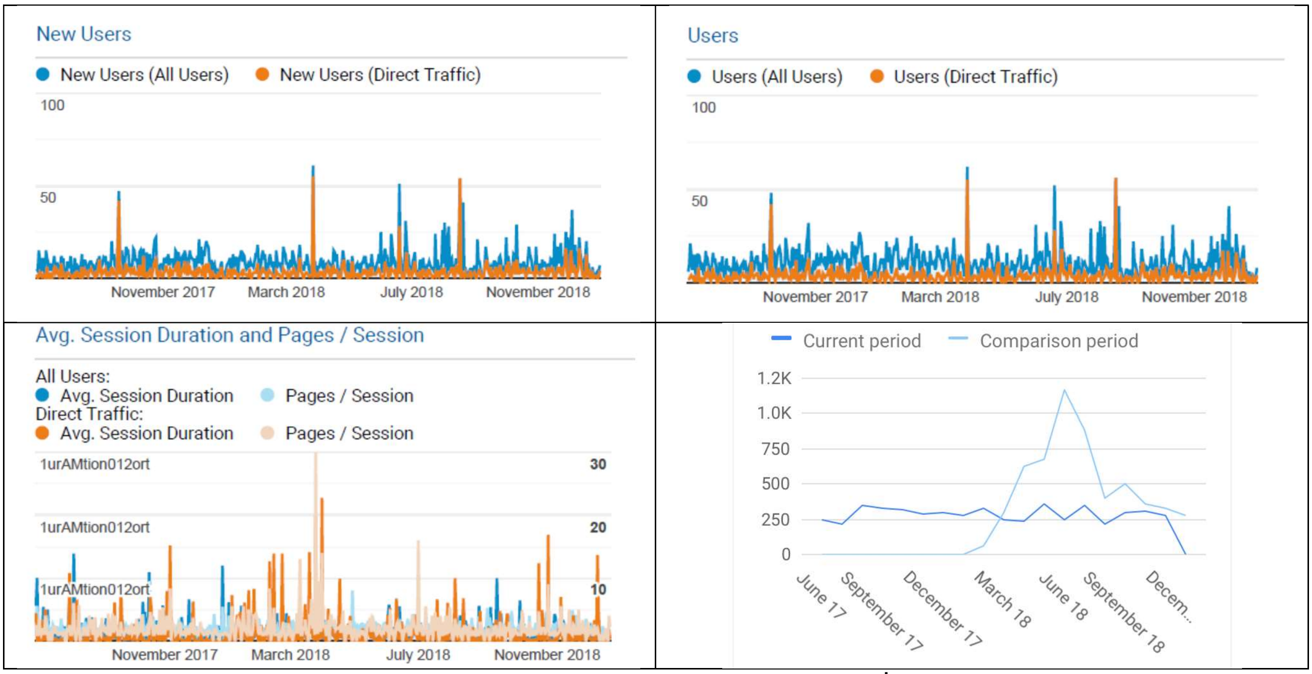

Figure 14. Monitored Website Traffic (2nd period)

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 3. Social Networks Activity

Social Media	Followers	Actions
Twitter	600+	100+
LinkedIn	280+	100+
Facebook	500+	500+

3.1.5 Liaisons with other projects

D8.3 considered in the communication action the liaison with different projects, and a preliminary plan was drafted. As explained during the first period review as the relationship with IoT-EPI increased and as in 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. The strategy was structured in five phases as explained in D8.3. Figure 15 structures the different phases.

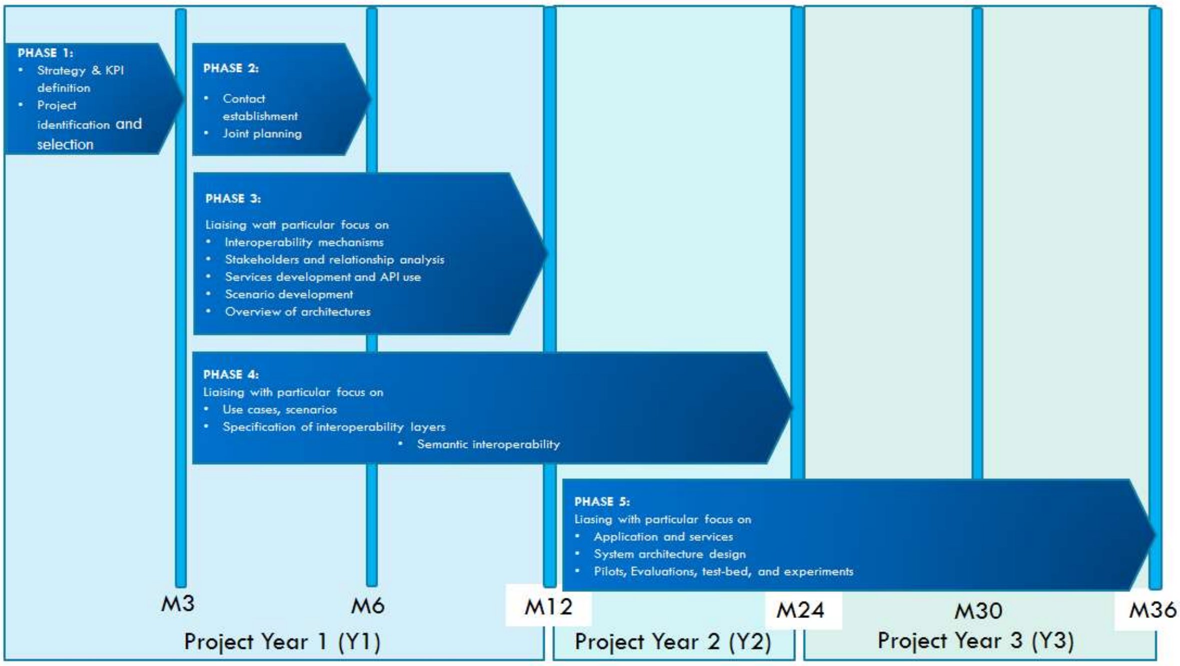

Figure 15. External Liaisons Strategy Structures in Phases

After completing the different phases, from the projects initially analyzed from different criteria, the results of the liaisons where the following:

- IoT-EPI (http://www.iot-epi.eu) group of nine different projects with which INTER-IoT has been interacting, as a whole the results of this interaction was presented in the technical review of M27. Special links were established with:
    - SYMBIOTE (https://www.symbiote-h2020.eu/) as the developed architecture has similarities with INTER-IoT. With this project and BIG-IoT we held a joint session with the IoT-LSP in Bilbao. No further developments were performed.
    - BIG-IoT (http://www.big-iot.eu) as the concept associated with API and security has been discussed in different meetings. With this project and SYMBIOTE we held a joint session with the IoT-LSP in Bilbao. No further discussions have been

performed to create a joint API, however the release as a draft ECLIPSE initiative by the project has risen potential new collaborations between the teams.

- AGILE (http://www.agile-iot.eu) as the concept of gateway presents some similarities with INTER-IoT D2D layer. No further contacts between the projects.
- VICINITY (https://www.vicinity2020.eu), although initially was not identified as an individual target for liaison, further discussions in IoT-EPI final event, IoT-Week and IoT-LSP architecture workshop raised the potential collaboration between the project and the consortium in the area of SAREF. A highlight has been the discussion between U. Twente (third party), INTER-IoT consortium and UPM (VICINITY partner) regarding SAREF and the proposition of SAREF4HEALTH.

- IoT-LSP (https://european-iot-pilots.eu/) cluster of the five IoT1 LSP projects, different interactions have been held, and INTER-IoT has participated in two events presenting the reference architecture and a summary of IoT-EPI conclusions. Although these were global actions with all the projects, regarding specific projects:
  - 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. The reference architecture has been adopted adapted as it is highlighted in D3.2 and D5.1 of the ACTIVAGE project. Although UPV is partner in this consortium, several discussions have been needed in order to be able to achieve this action.
  - 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. NEWAYS is partner in this consortium and has performed different actions in order to disseminate the development of INTER-IoT in the architecture, however no further actions have been performed.
- 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. Several joint meetings have been held between INTER-IoT team and the pilot managers related with sea transport as VPF and NOATUM are partners in this consortium and UPV participate as third party. The API of INTER-LogP has been used by transforming transport pilot as a source of IoT data for analytics.
- 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. No further actions performed.
- 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. Results from INTER-IoT have been adopted by CEA in the pilots of this project.

During the last year of the project, new opportunities appeared and five new liaisons have been established:

- PIXEL (http://www.pixel-ports.eu) in which an interoperable platform gathering data from different IoT platforms will be used to improve environmental information in the ports of the future. INTER-IoT is the selected solution to provide such interoperability and provide data to the system. UPV, PRODEVELOP and X-LAB are part of the consortium and after 8 months of execution the architecture and INTER-LAYET will be used in the project.
- 5GENESIS (http://www.5genesis.eu) aims to deploy 5G development in experimental pilots in different areas. In this project UPV together with two SMEs that participated as third parties in the INTER-IoT open call (INFOLISYS and NEMERGENT) will provide the INTER-IoT SDN interoperability component improved with third parties contribution in the project. The solution will be deployed in two pilots in the smart city of the municipality of Egaleos (Athens) and in the port of Limassol (Cyprus). Through the participation in this project, UPV has joined 5G-PPP standardization WG contributing in IoT interoperability.
- IoT3 call projects:
    - CHARIOT (Cognitive Heterogeneous Architecture for Industrial IoT) (https://www.chariotproject.eu), invited IoT to present the reference architecture in the first workshop of the project on 11th October 2018. Every architecture material has been provided and the possibility of holding a seminar with the project during 2019 although INTER-IoT is finished is still open.
    - SOFIE (Secure Open Federation for Internet Everywhere) (https://www.sofie-iot.eu/), AUEB third party in INTER-IoT proposing ACHILLES solution indicated that they will use developments of INTER-IoT open call in the project mainly associated with the access control protocol and INTER-GW.
- GHOST (Safe-Guarding Home IoT Environments with Personalised Real-time Risk Control) (https://www.chariotproject.eu), a project from the security call shares some partners from ACTIVAGE consortium with UPV and as they participation in the application of the architecture of INTER-IoT in ACTIVAGE they have invited INTER-IoT to make a presentation regarding the reference architecture in a workshop and establish a collaboration. Although INTER-IoT project is finished, the consortium plans to continue working and supporting the developments we will attend.

Other projects and companies have been interested in the architecture and the consortium has prepared an information package regarding the architecture, good practices and information about the open source developments.

3.1.6 Exploitation

The project selected an Exploitation Team (ET) composed by one member per partner. The ET reviewed the INTER-IoT business models (joint and individual) elaborated in WP2 and included in D2.2 (M6), and included them in D8.3 (M4) and in D8.7 in its two versions a (M18) and b (M30). 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 joint and individual exploitation templates attached in D8.3 and later on in the D8.7 versions 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 (D8.6) during this period are direct connected with the Exploitation Plan in order to create impact and have been reported in different deliverables.

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. Additionally UPV project coordinator has been in contact with the spin-off section of the university in order to analyze business opportunities for the creation of a INTER-IoT start up.

Figure 16 presents the structure of actions proposed by the exploitation team. During period M19-M36, Phase III (2nd JIESP iteration) and Phase IV (go to the market). From M28 to M32 the ET has been working in INTER-IoT product definition and IPR management in order to be prepare the effective Business Plan to go into the market at the end of the project. For that goal, the ET analysed the questionnaires of the second iteration and LLAVA Matrix models, to obtain the first iteration global map of individual and joint exploitation expectations followed by one-to-one interviews with INTER-IoT partners in order to consolidate the last global map. Additionally, the link with the third parties has allowed to test how the exploitation by different kind of entities can be performed.

All the details regarding business models, exploitation actions and exploitation plans for the individual partners are detailed in D8.7 and in D8.6.

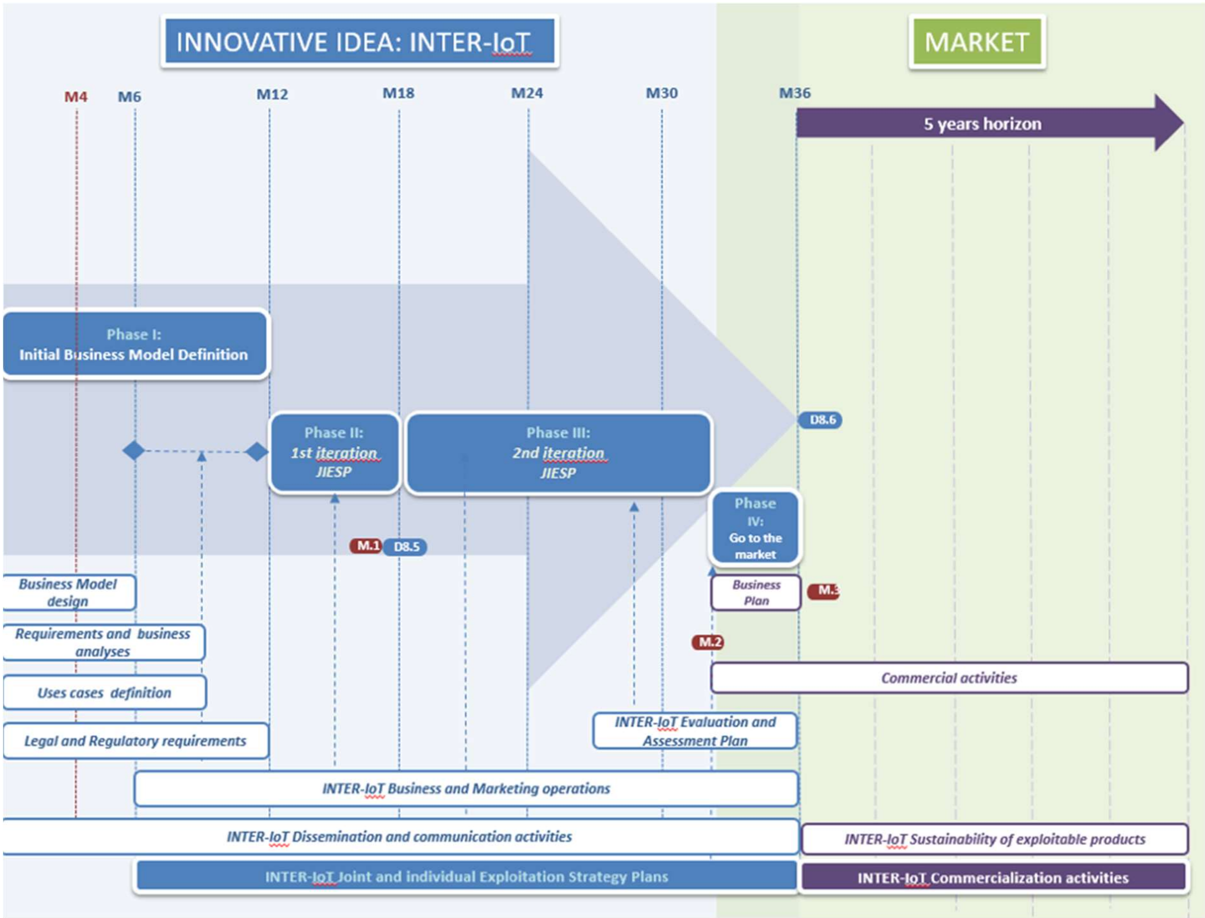

Figure 16. Exploitation Plan actions

The exploitation plan scheme (Figure 17) has been updated after the technical review, interaction with third parties and discussions with the advisory board. The role of integrators has proven to be key in the future of interoperability and a new business area like data markets will bring new possibilities to INTER-IoT.

Figure 17. Exploitation Plan scheme

4 Deliverables and Milestones

4.1 Deliverables

Table 4. List of Deliverables

Del No	Del Rel No	WP No	Title	Lead Benef.	Nature	Diss. Level	Est. Del. Date	Receipt Date
D5	D1.5	1	Risk Management v3	UPV	Report	CO	30 Jun 2018	29 Jun 2018
D14	D3.2	3	Methods for Interoperability and Integration v.2	XLAB	Report	PU	30 Sep 2017	02 Nov 2017
D15	D3.3	3	Methods for Interoperability and Integration Final Version	UPV	Report	PU	30 Jun 2018	03 Jul 2018
D17	D4.2	4	Final Reference IoT Platform Meta-Architecture and Meta Data Model	ABC	Report	PU	31 Dec 2017	03 Feb 2018
D18	D4.3	4	Interoperable IoT Framework Model and Engine v1	PRO	Report	PU	30 Sep 2017	07 Oct 2017
D20	D4.5	4	Interoperable IoT Framework API and Tools v1	XLAB	Other	PU	30 Sep 2017	05 Oct 2017
D21	D4.6	4	Interoperable IoT Framework API and Tools, Model and Engine v2	XLAB	Other	PU	30 Jun 2018	30 Jun 2018
D22	D5.1	5	Design patterns for Interoperable IoT Systems	SRIPAS	Report	PU	31 Dec 2017	01 Jan 2018
D23	D5.2	5	Full-fledged Methodology for IoT Platforms Integration (INTER-METH)	UNICAL	Report	PU	31 Dec 2017	01 Jan 2018
D24	D5.3	5	CASE tool for Automated Application of INTER-METH Methodology	UNICAL	Other	PU	30 Jun 2018	05 Jul 2018
D25	D6.1	6	Integration plan and operational framework	NEWAYS	Report	PU	31 Aug 2017	31 Aug 2017
D26	D6.2	6	Use case oriented pilots first version	NEWAYS	Report	PU	31 Dec 2017	07 Feb 2018
D27	D6.3	6	Use case oriented pilots final version	NEWAYS	Report	PU	30 Sep 2018	01 Oct 2018
D28	D7.1	7	Evaluation plan	XLAB	Report	PU	31 Mar 2018	02 Apr 2018
D29	D7.2	7	Technical Evaluation and Assessment report	RINI	Report	PU	30 Sep 2018	28 Sep 2018
D30	D7.3	7	Final evaluation report	RINI	Report	PU	31 Dec 2018	26 Dec 2018
D36	D8.6	8	Final Report on Impact Creation	ABC	Report	PU	31 Dec 2018	26 Dec 2018
D37	D8.7	8	INTER-IoT Business Models and Marketing Operations	RINI	Report	CO	30 Jun 2018	01 Oct 2018

4.2 Milestones

Table 5. List of Milestones

Mile Stone No	Mile Stone. Name	WP No.	Lead Beneficiary	Delivery Date from Annex-I (Project Month)	AchievedYes/No	Actual/Forecast Achievement Date	Comments
MS6	Integration Plan ready	WP6	NEWAYS	M20	YES	31 Aug. 2017	D6.1 Released
MS7	First Project review WP1 1 - UPV 20 First project review held	WP1	UPV	M20	YES	26 Sep. 2017	First revision held in Athens (Greece) together with IoT-EPI event
MS8	Interoperability API, Tools and	WP4	PRO	M21	YES	30 Sep. 2017	D4.3 and D4.5 released

	framework engine initial version						
MS9	Final architecture	WP4	ABC	M24	YES	3 Feb. 2018	D4.2 released
MS10	INTER-METH ready	WP5	UniCal	M24	YES	31 Dec. 2017	D5.2 released
MS11	Final methods for interoperability and integration	WP3	UPV	M30	YES	30 Jun. 2018	D3.3 released
MS12	Interoperability API, Tools and framework engine final version	WP4	PRO	M30	YES	30 Jun. 2018	D4.4 and D4.6 released
MS13	CASE too	WP5	UniCal	M30	YES	5 Jul. 2018	D5.3 and CASE tool released
MS14	Pilots ready	WP6	NEWAYS	M30	YES	30 Jun. 2018	D6.3 released and pilots finished
MS15	Final evaluation	WP7	RINI	M36	YES	31 Dec. 2018	D7.3 released
MS16	Final project review	WP1	UPV	M36	NO	20 Feb. 2019	Final review will be held after the submission of this PPR

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 one amendment was submitted to:

1. Request from the reviewers to merge deliverables and reduce milestones.
2. Adjust some budget aspects as requested by several partners.

Table 30 shows the planned resources for the whole project duration and per reporting period. As indicated in the first project review, the planning of the use of resources for UPV is less balanced than the other partners because SABIEN, the research institute that 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 7 shows the planned use of resources in both periods of the project for the different partners.

Table 6. 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 8 although not required, differentiate the planned use of resources for UPV between the two research teams for clarity in the analysis.

Table 7. 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

Table 9 presents the use of resources per partner and per WP in the period M1-M18, 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. Table 10 provides the same information for period M19-M36, and Table 11 provides the results for the whole project, adding period 1 and period 2.

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

Table 8. 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**

Table 9. Use of Resources M18-M36

		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	12,5	0	0,5	0,5	0	0,5	0,5	0	0	0	0	0	1	1	16,5
	Actual	14,23	0	0	0,53	0	1,12	0,5	0	0	0	0	3	2,1	0,94	22,42
WP2	Planned	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Actual	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WP3	Planned	23,45	0	6	5,15	4,87	3,03	4,77	0	0	9,2	12,5	0	6,31	3,99	79,27
	Actual	33,78	0	4,5	5,62	9,05	3,53	4,55	0	0	8,73	14,14	0	8,6	3,45	95,95
WP4	Planned	7,81	0	6,4	16,06	4,02	0,81	1,71	0	0,25	8,32	9,2	0,15	2,33	0	57,06
	Actual	7,42	0	1,9	23,81	3,27	3,03	3,85	0	0,29	9,6	8,96	0,19	6,3	0,18	68,8
WP5	Planned	9,5	0	11,61	10,25	0	1	0	0	0	1,88	20,17	0	0	0	54,41
	Actual	14,16	0	18,47	5,1	0	1	0	0	0	2,1	18,94	0	0	0	59,77
WP6	Planned	29	0	9	6	5	11	9	7	11	8	14	12	3	16	140
	Actual	42,05	0	9	8,52	5,12	12,46	9	0,31	11,07	8,78	13,79	12	2,9	16,37	151,37
WP7	Planned	21	0	7	7	5	9	11	9	9	9	6	7	5	10	115
	Actual	16,76	0	7	7,51	5,83	9,72	11	0,27	9	9,84	6	9	7,1	9,67	108,7
WP8	Planned	9,2	0	2,1	3,4	2	1,25	1,13	4	2,2	3,8	1	2,8	4,3	2	39,18
	Actual	16,56	0	2,5	4,25	3,44	1,56	0,65	6,19	3,06	4,52	0,18	3,88	9,5	3,15	59,44
TOT	Planned	112,46	0	42,61	48,36	20,89	26,59	28,11	20,78	22,45	40,2	62,87	21,95	21,94	32,99	**502,2**
	Actual	144,96	0	43,37	55,34	26,71	32,42	29,55	6,77	23,42	43,57	62,01	28,07	36,5	33,76	**566,45**

Table 10. Use of Resources M1-M36

		P01 UPVLC	P02 TI	P03 UniCal	P04 PRO	P05 TUE	P06 VPF	P07 RINI	P08 AFT	P09 NOATUM	P10 XLAB	P11 SRIPAS	P12 ASLT05	P13 ABC	P14 NEWAYS	TOT
WP1	Planned	27	0	2	2	0	2	2	0	0	0	0	0	2	2	39
	Actual	25,5	0	2	2,23	0	2,67	2	0	0	0	0	5	2,9	1,94	44,24
WP2	Planned	9	11	6	7	5	19	7	14	14	7	8	18	8	10	143
	Actual	10,63	10,81	6,02	7	5	25,23	7	13,9	14,04	7,01	8,71	12,91	6,9	10,67	145,83
WP3	Planned	43	0,5	14	11	17	11	16	0	0	20	31	0	9	14	186,5
	Actual	47,05	0,46	14	11,42	21,96	12,48	16	0	0	20,23	30,48	0	10,3	12,63	197,01
WP4	Planned	13	0,5	12	27	9	8	6	2	2	16	19	2	7	2	125,5
	Actual	12,33	0,39	6	36,81	7,27	8,84	6	1,76	2,2	16,07	17,73	4	11	2,21	132,61
WP5	Planned	20	0	27	18	0	3	0	0	0	6	36	0	0	0	110
	Actual	19,7	0	33	9,6	0	2,97	0	0	0	6,04	34,02	0	0	0	105,33
WP6	Planned	29	0	9	6	5	11	9	7	11	8	14	12	3	16	140
	Actual	42,52	0	9	8,52	5,12	12,46	9	0,31	11,07	8,78	13,79	12	2,9	16,37	151,84
WP7	Planned	21	0	7	7	5	9	11	9	9	9	6	7	5	10	115
	Actual	16,76	0	7	7,51	5,83	9,72	11	0,27	9	9,84	6	9	7,1	9,67	108,7
WP8	Planned	13	0,5	4	6	4	4	5	6	4	6	5	6	8	4	75,5
	Actual	20,15	0,27	4	7,45	5,29	5,21	5,65	7,29	4,55	6,82	6,32	8	15,2	4,8	101
TOT	Planned	175	12,5	81	84	45	67	56	38	40	72	119	45	42	58	**934,5**
	Actual	194,63	11,93	81,02	90,54	50,47	79,58	56,65	23,53	40,86	74,79	117,05	50,91	56,3	58,29	**986,55**

5.1.1 Explanation of the use of resources

Regarding deviations, there is no significant deviations in the use of resources by the different partners and all of them have used the resources following the principle of best value for money. Regarding the tables it has to be commented:

- PRO and UniCal, respectively WP4 and WP5 leaders detected that both required more activity from their teams in WP4 and they agreed on swap six MM between WP4 and WP5 and UniCal and PRO respectively. So PRO take some activities of UniCal in WP4 and UniCal did the same in WP5. The agreement was ratified by the PCC in the Prague Plenary Meeting in May 2018 and the corrective action has provided a good result. This is the rationale behind the deviations of PRO and UniCal in WP4 and WP5 with regard the initial planned effort.
- AFT had some difficulties due to reorganization to perform its activities integration activities in WP6 and WP7 regarding INTER-LogP pilot due to a reorganization and lack of resources. VPF, PRO, and UPV covered the tasks, this is the reason of an over consumption of resources in this WP for this partners.
- SABIEN (one of the entities of UPV) put more effort in WP6 during the setup of the pilot, adding more use of personal to this WP.
- For ASL TO5 the deviation between the planned MM and the actual MM are due to the clarifications asked from the European Commission Expert Report for the Ethics and security management of medical data for the INTER-Health pilot. After the first period of reporting (M1 - M18) ASLT05 requested to change the MM distribution, although it was not included in the amendment by mistake of the PC. The actual MM higher than those foreseen in the WP1 were shift in order to respond to the Bioethical Committee and to the Expert report for the preparation of all the documentation and due to the GDPR new privacy regulation we have made an extra effort for the privacy management. The actual MM higher than those foreseen in the WP7 were due to the extra effort needed from the internal medical staff for the pilot deployment.
- Every partner but specially UPV (Project Coordinator) and ABC (WP8 leader) have used more resources in WP8 due to participation in IoT-EPI and activity in dissemination and communication.

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

- **RINI:** Following on from the efforts in Period 1 of the project, Rinicom deemed it necessary to continue to utilise the expertise of non-salaried staff (i.e. SME owner and an additional Director). This was to ensure the consistency of high-quality input during the remaining 18 months of the project. The unit hours for the non-salaried staff are based on the EU guidelines of 30.12€ per hour which can be equated to 13.90PMs in real terms. 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 15.65PMs. Adding the Salaried and Non-Salaried PMs together brings us to a total of 29.55PMs for period 2 which is marginally higher than the planned PMs of 28.90, resulting in an overspend of 0.65PMs for the project as a whole. The slight overspend is due to junior staff being allocated to the project with a lower value than €6000 per PM, we do however expect the financial budget to be on target.

Table 11. RINI efforts detail Period 2

	WP1	WP3	WP4	WP6	WP7	WP8	Total
Salaried Staff	0	3.3	1	9	2	0.35	**15.65**
Non-salaried staff	0.5	1.25	2.85	0	9	0.3	**13.9**
Total	**0.5**	**4.55**	**3.85**	**9**	**11**	**0.65**	**29.55**

- **ABC:** During the course of the project, ABC opened an office in Czech Republic which was designed to follow certain aspects of the project. Therefore, the effort is the combination of salaried staff in Czech and non-salaried staff (SME Owner) in France. The use of these resources was to ensure the consistency of high-quality input during the remaining 18 months of the project. The unit hours for the non-salaried staff are based on the EU guidelines (4800 EUR/month multiplied by the FR coefficient, 115.7%). 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 36.5 PMs. Of these, 12 PM are from Salaried staff in Czech (total cost 62.935,92 EUR) and the rest are from SME owners in France. Adding the Salaried and Non-Salaried PMs together brings us to a total of 36.5PMs for period 2 which is higher than the planned PMs, resulting in an time overspend of around 25% PMs for the project as a whole. The more time was due in specific WPs, such as WP 1 (mainly for a proper risk analysis and organisation of meetings), in WP4 (complete re-assessment of the Functional Model and Functional Architecture) and WP8 (to push communication tot the proper channels and to plan the following exploitation of the results). However, the lower cost of the staff allowed us to be below the targeted budget for the project.

5.1.2 Unforeseen subcontracting

Not produced

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

Not produced