interiot

interoperability of heterogeneous IoT platforms

Interoperability of Heterogeneous IoT Platforms

D 2.1 Stakeholders and market analysis report

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The INTER-IoT Consortium

Universitat Politécnica de Valencia, UPV, Spain

Telecom Italia S.p.A., TI, Italy

Università della Calabria, UNICAL, Italy

Provedelop S. L., PRO, Spain

Technische Universiteit Eindhoven, TU/e, Netherlands

Fundación de la Comunidad Valenciana para la Investigación, Promoción y Estudios Comerciales de Valenciaport, VPF, Spain

Rinicom Ltd., RINI, United Kingdom

Association pour le développement de la formation professionnelle dans les transports, AFT, France

Noatum Ports Valenciana S.A.U, NPV, Spain

XLAB razvoj programske opreme in svetovanje d.o.o., XLAB, Slovenia

Systems Research Institute Polish Academy of Sciences, SRIPAS, Poland

Azienda Sanitaria Locale TO5, ASLTO5, Italy

Alessandro Bassi Consulting, ABC, France

NEWAYS Technologies BV, NEWAYS, Netherlands

Executive Summary

The aim of the Stakeholders and Market Analysis is to provide an insight of the current IoT market landscape and the vision of the different technologies supporting it, considering that several alliances, initiatives and Standards Development Organisations (SDO) are currently developing their own market approach in a broader range. INTER-IoT[1] has primarily narrowed the analysis to interoperability issues and specifically to the areas addressed by the project (i.e. the five resulting products identified by the consortium and defined in the proposal: Inter-Layer, Inter-Framework, Inter-Meth, Inter-LogP, Inter-Health). The document is based on existing solutions and trends - where special attention is paid to vendor specific solutions, existing and proposed standards and research projects - an analysis of the market of specific interoperability mechanisms. To produce this report four different approaches have been considered: (i) Desk research; (ii) in-depth interviews with market experts and INTER-IoT stakeholders (partners or supporting members); (iii) market studies/reports analysis; and (iv) user's surveys and workshops. The main objective has been to identify stakeholders' needs and the availability of solutions giving answer to these needs in the framework of INTER-IoT.

The identification of stakeholders has helped to start developing cooperation between these stakeholders and the project team and, ultimately, assuring successful outcomes for the project. The analysis has taken into account demand and supply points of views and both qualitative and quantitative aspects have been considered. The interaction with the stakeholders will not be limited to task T2.1 and the production of the analysis resulting in the present deliverable, as they will be interacted throughout the whole project duration but mainly in the demonstration and evaluation phases, in order to validate that the different resulting products of the project meet the identified requirements and fulfil the different scenarios (tasks T2.3 and T2.4).

This deliverable is the result of the activity carried out in T2.1. WP2 as a whole and specifically this task has been developed using the VOLERE[2] methodology that has proved to be the most adequate to extract conclussions and provide results following a systematic approach. The methodology is explained at the start of the deliverable, in order to provide the required foreground to understand the work developed in WP2, and which will be completed by following deliverables in its framework. The deliverable is completed by an annex with the different templates filled by the stakeholders regarding their requirements so as the different products investigated. The annex is included in order that the deliverable is self-contained, however the JIRA[3] tool is being extensively used in order to support the VOLERE methodology, and the information is available for internal use by the consortium.

[1] http://www.inter-iot.eu

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

[3] https://es.atlassian.com/software/jira

List of Authors

Organisation	Authors	Main organisations' contributions
VPF	Miguel Llop, Pablo Gimenez, Alexandre Sánchez, Mª Luisa Escamilla, Eduardo Olmeda	Initial version INTER-LogP results and product analysis Final review and quality check of the deliverable
UPV	Carlos E. Palau, Benjamín Molina, Eneko Olivares, Regel González-Usach, Andreu Belsa	INTER-LAYER stakeholder analysis coordination, Contribution to INTER-FW analysis Product analysis, Stakeholders and product information gathering Final review and quality check
TU/e	George Exarchakos, Antonio Liotta	INTER-LAYER stakeholder and product analysis and classification per country and type
PRO	Miguel Montesinos, Christophe Joubert, Amelia del Rey	Stakeholders and product descriptions for INTER-LAYER, INTER-FW and INTER-LogP. Analysis and coordination of INTER-FW product.
XLAB	Mariano Cecowski, Robert Plestenjak	Stakeholders and product descriptions for INTER-LAYER, INTER-FW and INTER-LogP. INTER-LAYER product analysis. Overall deliverable review
RINICOM	Garik Markarian	INTER–Health stakeholder contributions Internal Review of D2.1 deliverables
ASL TO 5	Margherita Gulino, Claudio Maggi, Angelina Della Torre, Domenica Pata, Monica Minutolo, Anna Aldrighetti, Bartolomeo Avataneo	INTER–Health stakeholder and product contributions

UNICAL	Giancarlo Fortino, Wilma Russo, Gianluca Aloi, Pasquale Pace, Raffaele Gravina	INTER–Meth stakeholder and product contributions – analysis and report INTER–Health stakeholder and product contributions
TI	Carlo Aldera, Alberto Delpiano, Fabio D'Ercoli, Giovanna Larini	INTER–Health stakeholder and product contributions – analysis and report INTER-Health stakeholders and products analysis coordination Internal Review of D2.1 deliverables
NEWAYS	Ron Schram, Roel Vossen, Johan Schabbink, Frans Gevers	INTER-Layer Stake holder and product analysis and report. Product information gathering
SRIPAS	Katarzyna Wasielewska-Michniewska, Paweł Szmeja, Wiesław Pawłowski	INTER-Health, INTER-LogP, INTER-FW, INTER-Layer, INTER-Meth – stakeholders contribution
AFT	Moncef Semichi, Sarah Koneke, Kimvy Bui	INTER-LogP results and product analysis D2.1 Stakeholders & Market Analysis Draft Report
NOATUM	Francisco Blanquer	INTER-LogP results and product analysis
ABC	Alessandro Bassi, Jitka Slechtova	INTER-HEALTH, INTER-LogP, INTER-FW, INTER-LAYER, INTER-METH stakeholders and products contribution Contribution to INTER-METH stakeholders and product analyses

Change control datasheet

Version	Changes	Chapters	Pages
0.1	Creation and completion	All	26
0.2.1	INTER-LAYER results	3.1	156
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Abbreviations

Abbreviation	Explanation
AGS	Automated Gate System
AIS	Automatic Identification System
AMRG	Advanced Modem Router Gateway
API	Application Programming Interface
ATC	Anatomic Therapeutic Chemical Classification of Drugs
BMI	Body Mass Index
BP	Blood Pressure
CEP	Complex Event Processing
CHOP	Configure, Heal, Optimize, Protect
CNR	National Research Council
DAS	Distributed Agent Systems
D2D	Device to Device
DGPS	Differential Global Positioning System
EC	European Commission
ECG	Electrocardiography
ELDA	Event-driven Lightweight Distilled StateCharts-based Agents
EMS	Electronic Manufacturing Services
FI-PPP	Future Internet Public-Private Partnership
GOS	Gate Operating System
GPS	Global Positioning System
ICDx	International Classification of Disease
ICF	International Classification of Functioning, Disability and Health
ICT	Information and Communications Technology
IEIIT	Institute of Electronics, Computer and Telecommunication Engineering
IHTSDO	International Health Terminology Standards Development Organisation
IIG	Information Intelligence Group's
ILIs	Interoperability Layer Interfaces
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	Architectural meta-model for IoT interoperable platforms

INTER-META-DATA	Metadata-model for IoT interoperable semantics
INTER-API	Programming library
INTER-CASE	Computer Aided Software Engineering tool for integration
IoT	Internet of Things
IOTRC	Internet of Things European Research Cluster
ISO	International Organization for Standardization
ITU	International Communications Union
LCD	Liquid-Crystal Display
LED	Light-Emitting Diode
LIIs	Layer Interoperability Infrastructures
LOINC	Logical Observations Identifiers Names and Codes
LPWA	Low-Power Wide-Area
M2M	Machine to Machine
MBaaS	Mobile Backend as a Service
NHS	National Health System
NPO	Non-profit organisation
OGC	Open Geospatial Consortium
OIC	Open Interconnect Consortium
OM2M	Open M2M
OHS	Operational Health and Safety
PCS	Port Community System
PLC	Programmable Logic Controller
R&D	Research and Development
RFID	Radio Frequency Identification
Ro-Ro	Roll On-Roll Off
SCADA	Supervisory Control And Data Acquisition
SDK	Software Development Kit
SEAMS	Smart, Energy-Efficient and Adaptive Management Platform
SME	Single Medium Enterprises
SOS	Sensor Observation Service
SWOT	Strengths, Weaknesses, Opportunities, and Threats
SSN	Semantic Sensor Networks
TOS	Terminal Operating System
VTS	Vessel Traffic Services
WP	Work Package
WPL	Work Package Leader

1 INTRODUCTION

1.1 Internet of Things

The connection of intelligent machines, fitted with a growing number of electronic sensors, via the Internet, is known as the 'Internet of Things' (IoT). With the IoT, any physical and virtual object can become connected to other objects and to the Internet, creating a fabric of connectivity between things and between humans and things. The IoT is now widely recognised as the next step of disruptive digital innovation.

The International Communications Union (ITU) and the European Research Cluster on the Internet of Things (IERC) provide the following definition: IoT is a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes and virtual personalities and use intelligent interfaces. They are seamlessly integrated into the information network.

The design of the Internet and specifically the extension of the Internet to the IoT relies on the convergence of the infrastructure with software and services. A common practice is required to think/design cross solutions between software and infrastructure in order to provide integrated solutions for some of the complex problems in the current and future systems of systems. In the IoT environment this convergence is evident, and the continuous evolution generates more and more smart connected objects and platforms that are embedded with sensors and their respective associated services, in some cases considering virtualization.

IoT is the network or associations between smart connected objects (physical and virtual) that are able to exchange information by using an agreed method (including protocols) and a data schema. IoT deployments are increasing, the same as standards, alliances and interest for homogeneization. All of this isgiving a strong push to the IoT to be today's considered as one of the most promising emerging technologies. As an example, Gartner (one of the world's leading information technology research and advisory company), estimates the number of web-connected devices will reach 25 billion by 2020. In other words, more devices appliances, cars, artefacts, and accessories will be connected and will communicate with each other, and with other objects, thus bringing amplified connectivity and better supply chain visibility. The applications of the IoT are numerous i.e. every object could be transformed into a smart object that sends several valuable information to other devices. As an example, in the port industry IoT could be applied to shipping containers, the equipment that handles them, the trucks that carry them and, even, the ships that move them around the globe.

According to the European Commission (EC) the IoT represents the next step towards the digitisation of our society and economy, where objects and people are interconnected through communication networks and report about their status and/or the surrounding environment. Furthermore, IoT can also benefit the European economy generating economic

growth and employment; according to a recent European Commission study revenues in the EU28 will increase from more than €307 billion in 2013 to more than €1,181 billion in 2020 (as shown in Figure 1).

IoT is an emerging area that not only requires development of infrastructure but also deployment of new services capable of supporting multiple, scalable and interoperable applications. The focus is today associated with cloud deployments, virtualizations and the elimination of silos avoiding the existence of application domain specific developments, AIOTI and EC are pressing in this line. IoT has evolved from sensor networks and wireless sonsor networks to a most clear description and definition refering to objects and the virtual representations of these objects on the Internet and associated infrastructure. It defines how the physical things and virtual objects will be connected through the Internet and how interact amongst them and communicate with other systems and platforms in order to expose their capabilities and functionalities in terms of services and accessible trough open APIs and frameworks. IoT is not only linking connected devices by using the Internet; it is also web-enabled data exchange in order to enable systems with more capacities to become smart and accessible; creating webs of objects and allowing integration of data, services and components.

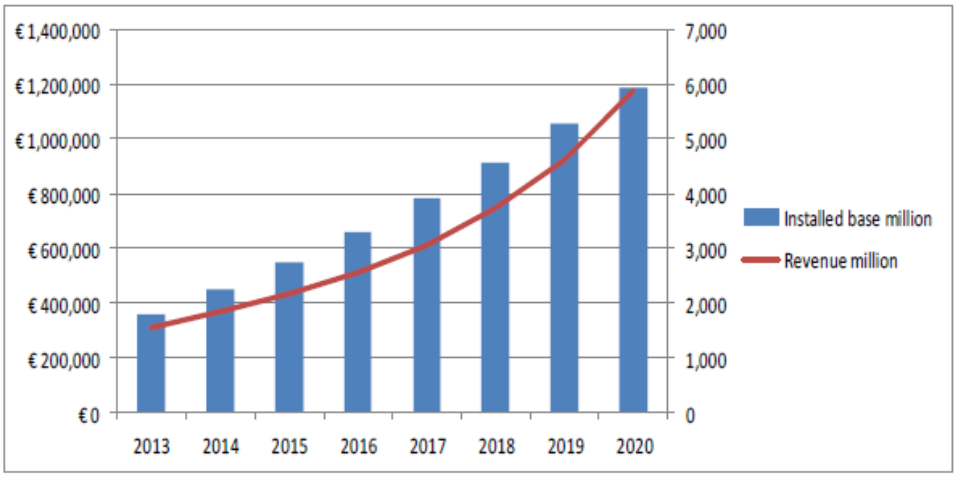

Figure 1: IoT Installed Base and Revenues in EU 28 2013-2018

There are several challenges associated with IoT and its evolution, but one majorissue is related with inteteroperability. IoT is mainly supported by continuous progress in wireless sensor and actuator networks and by manufacturing low cost and energy efficient hardware for sensor and device communications. However, heterogeneity of underlying devices and communication technologies and interoperability in different layers, from communication and seamless integration of devices to interoperability of data generated by the IoT resources, is a challenge for expanding generic IoT solutions to a global scale, with the extra aim of avoiding silos and provide solutions that are application domain agnostic like those proposed in INTER-IoT.

1.2 IoT interoperability

Many projects have dealt and/or are dealing with developing IoT architectures in diversified application domains. However, the conceptual realization of IoT is far from achieving a full deployment of converged IoT services and technology. The widespread of vertically-oriented closed systems, architectures and application areas has generated a fragmentation that needs to be overcomed. Lack of interoperability causes major technological and business issues such as impossibility to plug non-interoperable IoT devices into heterogeneous IoT platforms, impossibility to develop IoT applications exploiting multiple platforms in homogeneous and/or cross domains, slowness of IoT technology introduction at a large-scale, discouragement in adopting IoT technology, increase of costs, scarce reusability of technical solutions or user dissatisfaction. Current research in IoT is focused on providing integrated solutions and primarily on the feature that enable convergence or what is called as Interoperability.

Interoperability is a property referring to the ability of systems and organizations to work together. The overall challenge of achieving interoperability of heterogeneous IoT platforms is to deliver an IoT extended into a web of platforms for connected devices and objects. They will support smart environments, businesses, services and people with dynamic and adaptive configuration capabilities. Interoperability of heterogeneous IoT platforms will be the way to achieve the potential benefits derived from a scenario where everything is linked, interoperability between several heterogeneous platforms is of outmost importance.

Interoperability can be generalized as the feature for providing seamless exchange of information to, for example, personalize services automatically or simply exchanging information in a way that other systems can use it for improving performance, enable and create services, control operations and information processing. This type of scenarios requires increased interoperability in service management operations. The INTER-IoT Project, aware of this fact, aims to provide an interoperable open IoT framework (with associated engineering tools and methodology) for seamless integration of heterogeneous IoT platforms available in the same or different application domains.

INTER-IoT will provide all the building blocks needed to achieve interoperability, including a framework, methodology and associated APIs and tool-boxes. Assuring that interoperability will be kept as the different products and architectures may evolve in the market. The benefits of INTER-IoT will be:

- At the **device level**, seamless inclusion of novel IoT devices and their interoperation with already existing, even heterogeneous ones. This will allow fast growth of smart objects ecosystems.
- At the **networking level**, seamless support for smart objects mobility and information routing. This will allow design and implementation of fully connected ecosystems.
- At the **middleware level**, seamless service discovery and management system for smart objects and their basic services. This will allow global exploitation of smart objects in large (even extreme) scale (multi-platform) IoT systems.

- At the **application service level**, reuse and exchange (import/export) of heterogeneous services between different IoT platforms.
- At the **data and semantics level**, common interpretation of data and information based on global shared ontology in order to achieve semantic interoperability.
- At the **integrated IoT platform level**, rapid prototyping of cross-platform IoT applications.
- At the **business level**, faster introduction of IoT technology and applications across multiple application domains.

By using the aforementioned approach, IoT platform heterogeneity will be turned from a crucial problem to a great advantage as there will be no need to wait for a unique standard for an interoperable IoT. Instead, interoperable IoT, even on a very large scale, will be created through a bottom-up approach.

1.3 Scope of the Inter-IoT project

INTER-IoT 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 will allow 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 and associated approach has been defined to be use case-driven. And it will be implemented and tested in three realistic large-scale pilots:

- Port of Valencia transportation and logistics involving heterogeneous platforms with ~400 smart objects.
- An Italian National Health Center for mobile health involving ~200 patients, equipped with body sensor networks with wearable sensors and mobile smart devices.
- A cross domain pilot involving IoT platforms from both application domains will be deployed and tested in the premises of the Port of Valencia.

Furthermore, the project will analyse 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. 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, always in the scope of open interoperability.

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.

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. INTER-IoT will be based on three main building blocks:

- Methods and tools for providing interoperability among and across each layers of IoT platforms (INTER-LAYER);
- Global framework (INTER-FW) for programming and managing interoperable IoT platforms; and
- Engineering Methodology (INTER-METH) based on CASE tool for IoT platforms integration/interconnection.

The project results will be specifically tested in the two independent application domains that will lead to two independent products, namely: INTER-LogP and INTER-Health. Thus, as an outcome of the project, INTER-IoT will provide these five products that could be introduced in the market for a wider implementation and exploitation. The market analysis and stakeholders will be based in the existence of these five products, and the interest generated in the stakeholders.

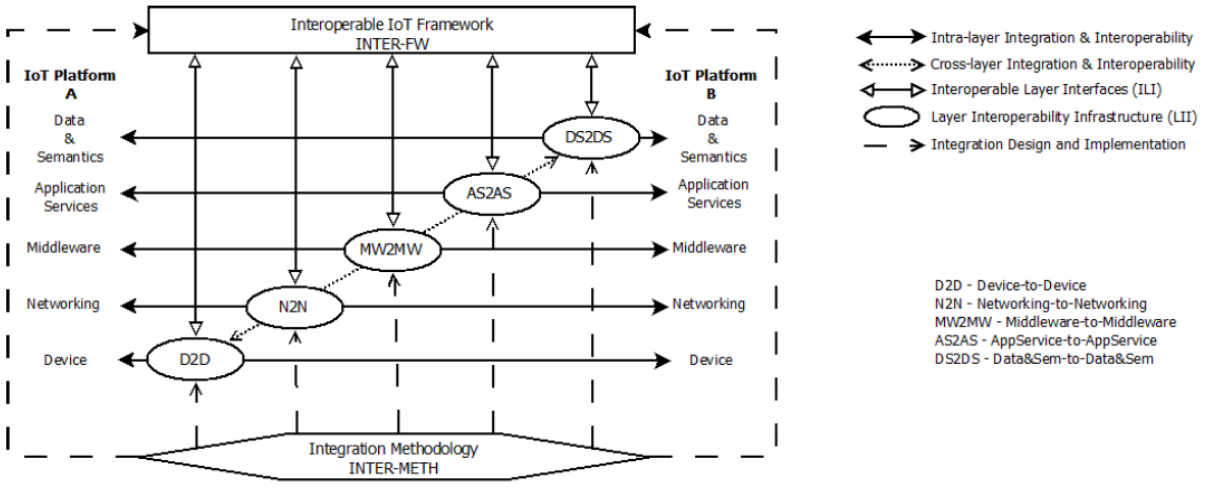

Figure 2: INTER-IoT approach abstract schema

INTER-LAYER

INTER- IoT uses a layer-oriented approach to fully exploit specific functionalities of each layer (device, networking, middleware, application services, data & semantics) (see Figure 2). Although the development of a layer-oriented approach is a research challenge, as compared to a global approach, it has a higher potential to deliver a tight bidirectional integration among

heterogeneous IoT platforms, notably guaranteeing independence, thus providing higher performance, modularity and reliability and, what is extremely important, more control on functional and non-functional requirements. In addition, the data and semantics level provides a global shared ontology and methods in order to achieve IoT platform semantic interoperability.

INTER-LAYER includes the design of device-to-device interaction based on multiprotocol/access mechanisms, the design of software defined interoperable modules for mobility and routing, the development of an open service discovery and management framework for smart objects, the design and implementation of smart IoT application service gateway and virtualization and the definition of a common ontology for IoT platform semantic interoperability.

INTER-FW

The Interoperability IoT Framework (INTER-FW) aims at providing global and open platform-level interoperability among heterogeneous IoT platforms coupled through specifically developed Layer Interoperability Infrastructures (LIIs) and Interoperability Layer Interfaces (ILI). INTER-FW will rely on an architectural meta-model for IoT interoperable platforms, on a metadata-model for IoT interoperable semantics and it will provide a programming API and tools providing global-level management of the integrated IoT platforms.

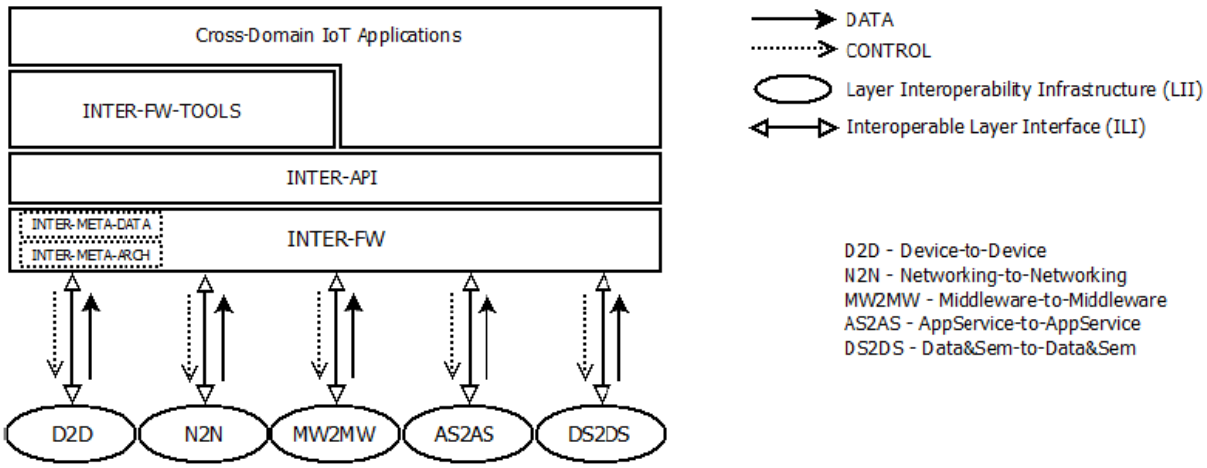

Figure 3: Abstract schema of the INTER-FW

Figure 3 shows the abstract schema of the INTER-FW. INTER-FW will advance the state-of-the-art by providing a general and effective method for inter-platform interoperability, addressing at a global level: real-timeless, reliability, security, privacy, trust. In particular, INTER-FW will thoroughly address privacy and security-related risks and challenges resulting from use of IoT devices.

INTER-METH

The engineering methodology INTER-METH aims at defining a systematic methodology supporting the integration process of heterogeneous IoT platforms to obtain interoperability among them and allow implementation and deployment of IoT applications on top of them. It is widely recognized that using an engineering methodology is fundamental in any engineering application domain (e.g. software engineering, codesign hardware/software, civil engineering, etc.). The manual and non-systematic application of complex techniques, methods and frameworks would very likely lead to an increase of the degree of errors during integration. INTER-METH includes a Computer Aided Software Engineering tool for integration (INTER-CASE).

INTER-IoT considers two application domains: transportation and logistics in a port environment and m-health. Around these two application domains, three use cases will be built and packaged as products of the project:

1. INTER-LogP for “Smart Port Transportation for Containers and Goods”;
2. INTER-Health for “Decentralized and Mobile Monitoring of Assisted Livings” and
3. INTER-DOMAIN in which IoT platforms from both application domains plus some additional ones will be integrated.

INTER-LogP

INTER-LogP use case illustrates the need to achieve seamlessly interoperability of different heterogeneous IoT platforms, oriented to port transport and logistics. The considered application domain identifies several physical transport entities (trucks, containers, semi-trailers, cranes, tractors and other container handling machines) owned by different companies. The possibility to capture in real time sensor-based data coming from these physical moving assets and connecting them to transport and logistic infrastructures is an opportunity to drive optimal real-time execution as well as automation of transport and logistics operations. The capture and sharing of real time sensor-based data across different organisations is today a big challenge as there is not any solution in the market able to attend this need and overcoming the complexity of implementing IoT solutions connecting different sensors, systems and products. Sensor-based technology is already being pushed by the transportation and logistics industry. However, what it is lacking is the ability to effectively capture and share the data relative to the movement of vehicles and goods and convert it into actionable insights capable of driving improvements across the supply chain. The lack of use of IoT oriented platforms and their interoperability is today a main obstacle.

For example, almost any person, truck, machine and equipment have been outfitted or it is relatively easy to do so with GPS devices and other sensors to capture information such as location, speed and idle time. With this information, companies have been able to compile and assess several indicators like delivery times, fuel consumption or emissions. However, these companies are not able to design and establish connections with platforms managed by other operators in the supply, logistics and transport chains. The global and interconnected nature of today’s supply chains needs a greater collaboration among supply chain partners.

The interoperability of heterogeneous IoT platforms can provide a framework for real-time multidirectional information sharing to help in creating true supply chain collaboration.

INTER-Health

INTER-Health scenario for Decentralized and Mobile Monitoring of Assisted Livings' Lifestyle aims at developing an integrated IoT system for monitoring humans' lifestyle in a decentralized way and in mobility, to prevent health issues mainly resulting from food and physical activity disorders. By exploiting the integrated system - INTER-Health - the patient's 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.

The INTER-DOMAIN solution has not yet been considered as an initial product to be offered since its requirements and domain is still unknown until the open call takes place. Only when a couple of third party entities with the clear goal of fostering the adoption of INTER-IoT developments are selected, the INTER-DOMAIN could be considered as a product to be offered to the market.

2 METHODOLOGY

The methodology that has been selected as a reference for most of the tasks involved in Work Package 2 (WP2), and also for T2.1 and D2.1 is VOLERE. The VOLERE methodology is used in INTER-IoT mainly because of its simplicity. It helps project partners to describe, formalize and track the project market analysis, requirements[4], use cases and scenarios in an explicit and unambiguous manner.

Besides being a success in past projects. VOLERE has been used by thousands of organizations around the world in order to define, discover, communicate and manage all the necessary requirements for any type of system development (e.g. software, hardware, commodities, services, organizational, etc.) VOLERE can be applied in almost all kinds of development environments, with any other development methods or with most requirements tools and modelling techniques. To produce accurate and unambiguous requirements, the VOLERE methodology uses techniques that are based on experience from worldwide business analysis projects, and are continually improved. Additionally, a number of the project partners have already experience with the VOLERE methodology. Hence, they did not have to accomplish an extra learning effort.

The VOLERE methodology provides several templates to deal with the different techniques and activities that it includes. In a quick view, the VOLERE Requirement Process that this methodology suggests can be summarised as follows:

1. Define the Purpose of the Project
2. Stakeholders Identification and Analysis
3. Business Use Cases
4. Scenarios
5. Writing the Requirements (functional requirements and non-functional requirements)
6. Validation of requirements (completeness, relevance, testability, coherency, traceability, and several other qualities before they allow it to be passed to the developers)
7. Communicating the Requirements
8. Requirements Completeness

The consequent application of the VOLERE methodology is not only useful in the initial phases of the project but it is also helpful in specifying a reference point for the later stages. During the implementation and management, it can be used to track and evaluate the progress of the individual work packages and the overall project. Besides being efficient and easy to use, the VOLERE methodology provides a mechanism for all partners to specify requirements, needs, use cases and scenarios in a standard format. Thereby, specifying additional context of an element such as the rationale and the acceptance criteria helps to build a common

[4] S. Robertson y J. Robertson, Mastering the Requirements Process, Addison-Wesley, 2013.

understanding of the overall system. Furthermore, defining priorities helps to clarify the focus of the project. In order to achieve this goal, and support the methodology we will be using JIRA tool.

The INTER-IoT Project as a whole considered that choosing this methodology could help us to achieve our goals and the ICT30 objectives. Applying VOLERE for the requirement discovery process is essential to be assured that we are solving the real problem and also to make our products more attractive and more appropriate to the different customer segments. In addition, the INTER-IoT partners consider that, to be excellent and successful in the consecution of the project's objectives, it is imperative to identify and deeply understand our customers and project's stakeholders and create the best solutions by a thorough understanding of the market and the needs for an interoperability of heterogeneous IoT platforms. This first deliverable and the work behind have been concentrated on building these capacities.

The stakeholders involved during the first three months of the project as well as the market analysis made so far are presented in this report and they should be seen as a starting point for the project. Each stakeholder and product identified so far has been registered in an on-line tool using JIRA software following the templates defined in this task and these records will be available along the project's life cycle. This repository will help to search, access, review, and register new stakeholders and products identified after completion of this task as the project progresses. The repository introduced for the project will not only keep track of stakeholders and existing related products but also it will be used for the publication and sharing of scenarios, requirements and use cases which will be defined in subsequent tasks.

2.1 Stakeholders and market analysis

Stakeholders

Stakeholders' analysis is part of a rigorous and complete requirements specification being carried out in WP2 and it describes the process of identifying and selecting the people who have an interest in the new products and results that are planned for the project. The stakeholders' group being involved in this task has also included anyone who may have any influence on the project's outcomes, may be affected by the product or may have any knowledge needed to uncover the requirements of these products. The identification and involvement of relevant stakeholders is very important to be able to capture the requirements for the interoperability of heterogeneous IoT platforms.

Stakeholder analysis has been made on a product basis. As INTER-IoT scope has four initial different products, the stakeholder's analysis has been made for each of these products: INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP and INTER-Health.

Although there could be other kind of stakeholders, the following list of potential classes of stakeholders was initially defined for the identification process carried out by all the partners in the consortium:

1. Client/sponsor
2. Customer
3. Subject-matter experts
4. Members of the public
5. Users of the current system
6. Marketing experts
7. Legal experts
8. Domain experts
9. Usability experts
10. Representatives of external associations
11. Business analysts
12. Designers and developers
13. Testers
14. Systems engineers
15. Software engineers
16. Technology experts
17. System designers

It is clear that the European Commission (EC) is the sponsor of INTER-IoT as it is the funding entity of the project. Consequently, it will be one of the most relevant stakeholders and we will try to establish the optimal value for it. Although the EC will likely influence on the outcomes of the project, it will not be the customer of the project's products and results.

To easily identify the stakeholders of each product, we have used a stakeholder's map as it has been described in the publication of "Mastering the Requirements Process: Getting Requirements Right" used as a reference for the VOLERE methodology. The stakeholder's map shows the organizational rings surrounding the product and the classes of stakeholders who inhabit on these rings. The stakeholder map will determine which classes of stakeholders are relevant to the project and which roles are needed to represent them.

Each product being considered in INTER-IoT has a stakeholders' map representation in this document. The picture below shows the stakeholders map template.

At the center of the stakeholder map is the intended product (i.e. INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP, INTER-Health). Surrounding the intended product is a ring representing the operational work area –stakeholders who will have some direct contact with the product. In the next ring, the containing business will include the stakeholders who benefit from the product in some way, even though they are not in the operational area. Finally, the outer ring, the wider environment, contains other stakeholders who have an influence on or an interest in the product. Note also the detailed and multiple involvement of the core team members is emphasized by the fact they span all the rings.

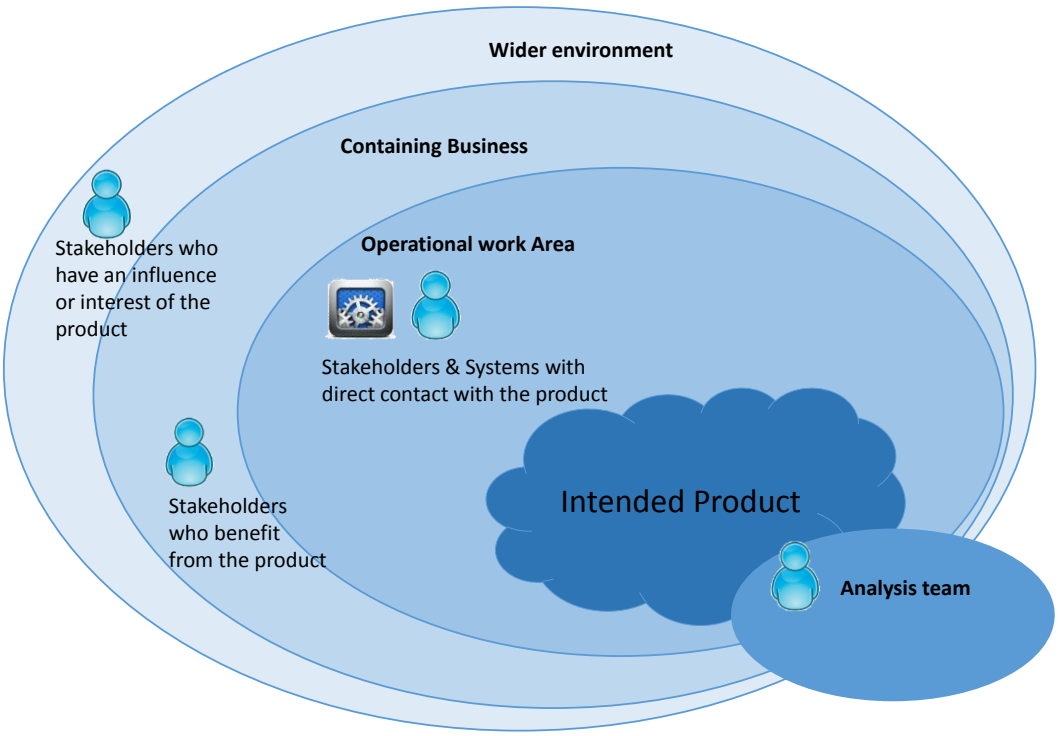

Figure 4: Stakeholders' map template

Each stakeholder identified for each product has been characterised through the template (shown in Table 1) designed for the project. This template has helped to easily identify, classify and manage potential stakeholders. The process of characterising the stakeholders has helped to start developing cooperation between these stakeholders and the project team.

The stakeholder's template has also helped to identify other stakeholders who may also be involved in the product design and implementation. The file has also helped to identify existing products and systems being used, produced or provided by the stakeholders related with the INTER-IOT products as well as new products or systems which might be required before or during the adoption of INTER-IoT solutions. Many of the products identified during the stakeholder analysis have been considered in the market analysis described below.

Table 1: Stakeholder template

Product Name: ***Name of the product analysed (INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP, INTER-Health)***		
Stakeholder's Name: *Name of the stakeholder*		Stakeholder's Acronym: *For inclusion in the map*
Stakeholder's Profile & Role: **Profile:** *Stakeholder's profile* **Role:** *Description of the role within the product*		
Contact Person: *Stakeholders' contact*	Email: *Stakeholder contact's e-mail*	Position: *Contact position*
Stakeholder's Class: *Sample list provided above*	☐ Can appear in public reports ☐ Shall remain anonymous	☐ IoT Demand side ☐ IoT Supply side
Stakeholder's Needs: *Description of the needs of the stakeholder for the Inter-IoT product analysed* ☐ Interested in participate in INTER-IOT open calls		
Existing Products & Systems involved: *Identification of existing products and adjacent systems of the product*	New products & Systems required: *Identification of additional products and systems required for the* introduction *of the product*	

New Stakeholders	Stakeholder's class
New stakeholders suggested or required for the design and implementation of the product to comply with the needs identified	*Class of the new stakeholders identified*

Reason of involvement: *Why the stakeholder has been identified*	Identified by: *Partner who has identified the stakeholder*	Registration Date: *Date of registration*

Market analysis

The market analysis process is a must to do task in order to identify products that are being introduced or are already in the market which are related with the project in one of the following ways:

- as a component or module of the solution;
- as a complementary product;
- as a beneficiary, client or consumer of the solution or
- as a concurrent product.

The products identified during the stakeholders analysis need to be taken into account to identify characteristics, capabilities, objectives and needs of these products under the point of view of interoperability of heterogeneous IoT platforms. The market analysis has been done in combination with the stakeholders analysis, this has allowed us to identify the readiness and willingness of different stakeholders to participate in interoperable IoT scenarios, different systems and products that could be involved and systems and products that would be required to participate in those scenarios.

This process has been quite relevant as we have identified that many existing products are not yet ready to participate in an interoperable IoT environment and they need to be transformed and complemented with other components like IoT gateways and platforms to meet the interoperability requirements. This represents a new market niche as there do not exist yet a wide adoption of IoT aware solutions and interoperable IoT products. The market analysis also helps to identify relevant standards and protocols that products are supporting and that INTER-IoT products would need to assess.

Several products identified by INTER-IoT stakeholders have been characterised in products' files in order to be registered and further analysed afterwards. These products are the result of the presentation of the five INTER-IoT products, and the association with their own products or other products known by them. The knowledge provided by the stakeholders has allowed us to extend the knowledge coverage to different areas associated with IoT.

The Table 2 shows the product's template. The template includes the name of the product; the product class; the acquisition or licence options; references or web addresses to access further information; a brief description and the services provided by the product. The file also records the partner who has identified the product and the reason why it is registered, including its relation with any of the INTER-IoT products.

Table 2: Product template

Market Analysis			
Product's Name: *Name of the identified product*			
Product Class: *Hardware, Software, Methodology, Platform, Standard …*	**Context:** *Local, national, European, international, …*	**Access mode:** *Open, Close, subscription, license, …*	
Web address:		(Logo)	
Product Description: *Brief description of product*			
Product Services: *Main services of product*			
Links and Documents: *Useful links*			
Reason of involvement: *Partner project*	**Related to IoT Product:** *Name of the IoT product associated (INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP, INTER-Health)*	**Identified by:** *Partner who has identified the stakeholder*	**Registration Date:** *Date of registration*

2.2 JIRA Repository

JIRA is a commercial software for issue tracking in software development manufactured by Atlassian. This commercial software can be licensed for running on-premises or as a hosted application. JIRA provides bug tracking, issue tracking, and project management functions. The main features of JIRA for agile software development are to plan development iterations, generate iteration reports and bug tracking functionality.

Because stakeholder's needs, products, scenarios or requirements are elements that can evolve throughout the project, it is necessary to have a tool which allows to keep them updated and accessible among all stakeholders at any time.

The project repository will keep updated and easily accessible the details of stakeholders, market analysis identified products, scenarios, requirements and use cases after the submission of the respective deliverables submitted at the date of delivery.

JIRA implementation

The access URL for the project repository is jira.inter-iot.eu. Each partner of the project has its own credential to access, and there is an extra credential to provide access to external reviewers when required. Figure 5 illustrates Inter-IoT Project on JIRA home page.

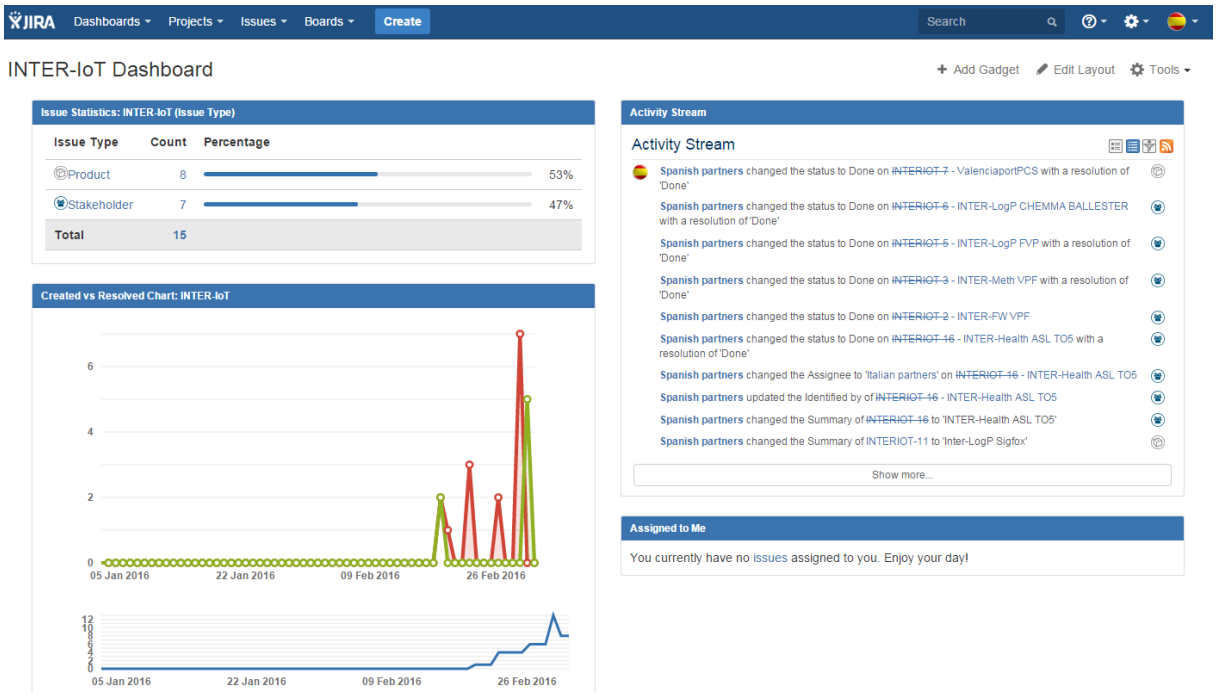

Figure 5: JIRA home page

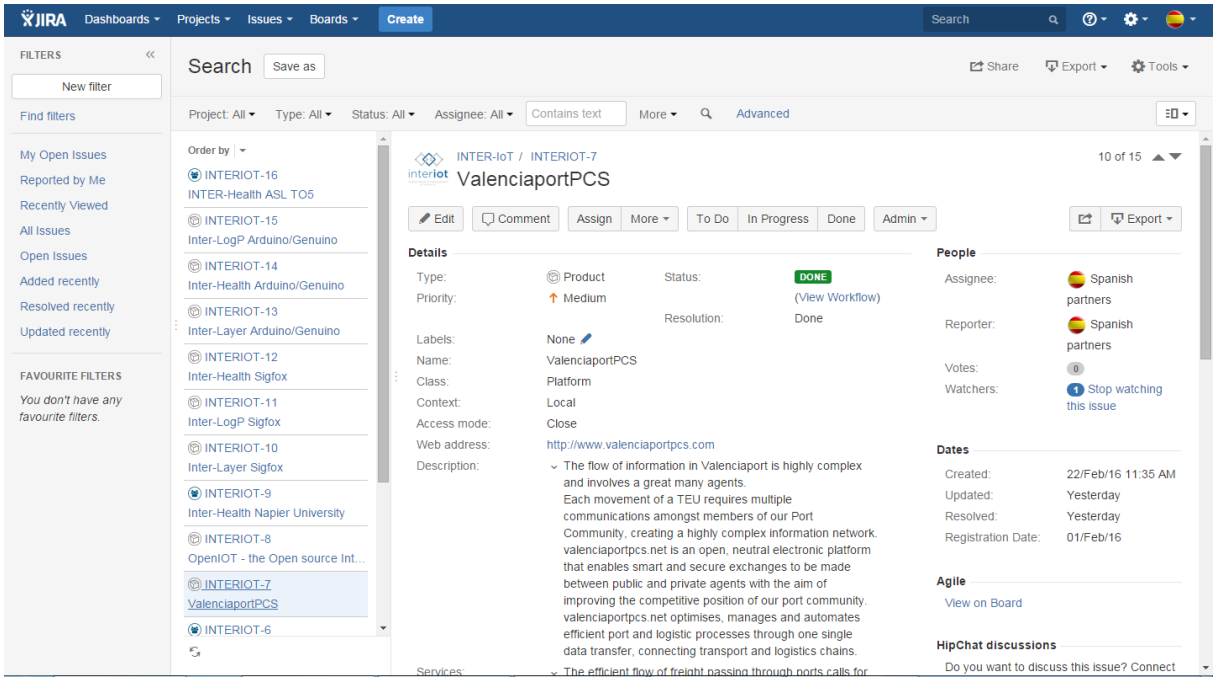

Figure 6: View of different issues

Once in the application the user can access all stored information and can filter by type of issue (i.e. stakeholder, product, scenario, requirement, or use case) or by any field or metadata of the form (as shown in Figure 6).

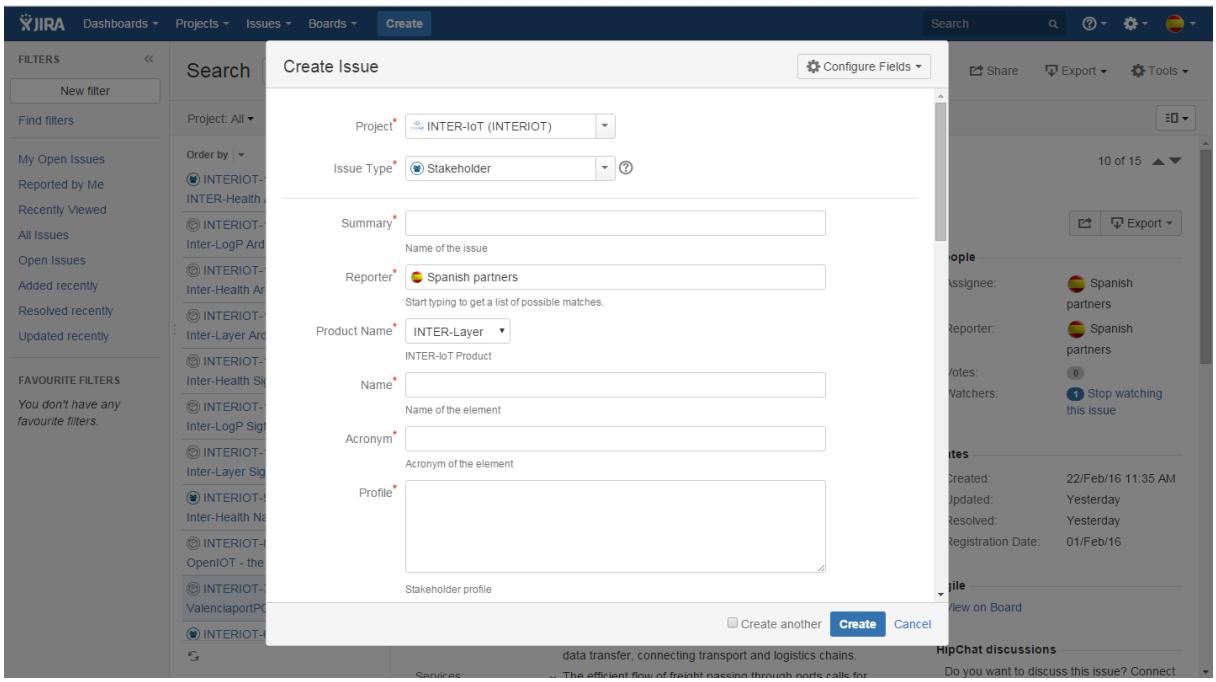

Figure 7: Create a new issue

To create new issues, the user can execute the *create button* option at the top menu as it can be seen in the figure above. The user can also select the type of issue (Stakeholders, Products, Requirements or Use cases). The templates used for filling the different issues are personalized according to the designed created following the respective methodology.

3 STAKEHOLDERS

The stakeholders' analysis has been carried out through an INTER-IoT product-oriented approach, as stakeholders have been identified separately with regard to each project product (INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP and INTER-Health). The addressed stakeholders are interested from one product to all.

3.1 INTER-LAYER stakeholders' analysis

3.1.1 Introduction

The IoT enables physical objects to see, hear, think and perform jobs by having them "talk" together, to share information and to coordinate decisions. The IoT transforms these objects from being traditional to smart by exploiting its underlying technologies such as ubiquitous and pervasive computing, embedded devices, communication technologies, sensor networks, Internet protocols and applications. Smart objects along with their supposed tasks constitute domain specific applications (vertical markets) while ubiquitous computing and analytical services form application domain independent services (horizontal markets). Thus, most current existing sensor networks and IoT device deployments work as independent entities of homogenous elements that serve a specific purpose, and are isolated from "the rest of the world". In a few cases where heterogeneous elements are integrated, this is done either at device or network level, and focused mostly on unidirectional gathering of information. A multi-layered approach to integrating heterogeneous IoT devices, networks, platforms, services and applications will allow heterogeneous elements to cooperate seamlessly to share data, infrastructures and services as in a homogenous scenario.

Layer (and cross-layer) interoperability is fundamental to provide global interoperability between IoT platforms. To fully address layer interoperability, INTER-IoT project will provide and develop INTER-LAYER, a suite with all the building blocks needed to achieve interoperability:

- Device-to-device interaction based on multiprotocol/access mechanisms;
- Design of software defined interoperable modules for mobility and routing;
- Development of an open service discovery and management framework for smart objects;
- Design and implementation of smart IoT application service gateway and virtualization;
- Definition of a common ontology which will facilitate access to the heterogeneous data, which will be collected and managed by integrated IoT platforms.

Interoperability provided by INTER-LAYER can be provided at different levels, depending on the requirements and needs of the platform, application domain and use case associated with

it. Components of the INTER-LAYER component suite will address interoperability at different layers:

- At the device level, seamless inclusion of novel IoT devices and their interoperation with already existing, even heterogeneous ones.
- At the networking level, seamless support for smart objects mobility and information routing, including software defined networks.
- At the middleware level, seamless service discovery and management system for smart objects and their basic services to allow global exploitation of smart objects in large (even extreme) scale (multi-platform) IoT systems.
- At the application service level, reuse and exchange (import/export) of heterogeneous services between different IoT platforms, through and API and extendable marketplace.
- At the data and semantics level, common interpretation of data and information based on global shared ontology in order to achieve semantic interoperability between heterogeneous data sources.

Typically, solutions to achieve interoperability in IoT are addressed to one specific layer. And broad interoperability solutions are typically addressed to use a gateway or provide a common architecture providing an official standard. Standards address mainly one layer of the interoperability architecture, and therefore the number of protocol converters or middleware connectors is very high and several times there is an incompatibility between these components. Interoperability is then a major business line for different IoT stakeholders and vendors.

During the interviews carried out with stakeholders, it is clear that the main companies and entities associated or related with INTER-LAYER are not interested in breaking silos, they prefer to have their platform, device, software component adopted by an alliance or association. The interest is mainly solving a problem in a specific application domain, e.g. transportation or m-health, and only the middleware related stakeholders are interesting in semantic interoperability, as they consider they can integrate at middleware level the different underlying technologies (e.g. FIWARE or SOFIA2). At the business level, use of INTER-LAYER may provide a faster introduction of IoT technology and applications across multiple application domains.

Development of gateways connected to different wireless networks is the main solution the manufacturers addresses, abut with certain exceptions (e.g. following OSGi standard) there is no homogenization for interoperability at this level. At service layer, OGC is providing a relevant contribution associated with interoperability, and the link with INTER-LAYER is relevant.

However, there is a lack in the use of virtualization for interoperability, with little exceptions from different stakeholders. And the same happens with semantic interoperability and the definition of ontologies, with the exception of some middleware developer stakeholders and

research projects, although some IoT linked organisations and SDO like AIOTI or ETSI (OneM2M) are considering semantic interoperability a major issue in the coming years, as included in INTER-LAYER.

The main barrier that has been found for the adoption of INTER-LAYER by different stakeholders is the risk that the solution may become another standard or architecture to add to the large list of current standards and algorithms. Stakeholders are less prone to address vertical markets rather than horizontal. A vendor developing gateways for smart cities focuses on this application domain and considers other markets as marginal.

3.1.2 Stakeholder participants

The INTER-Layer product is centred in interoperability mechanisms across various layers: device to device, network, middleware, application/services and data/semantics. Therefore, the area of knowledge and research is significant and thus multiple companies and entities are involved. We will try to summarize and classify the selected representative stakeholders concerning the different layers.

At this time of development of this report, the number of stakeholders which have been interviewed for the INTER-LAYER product is 53. The work carried out for this product has been very intensive and most of them took place via phone, as there was little time to make presence interviews. Most of the interviewed stakeholders did also identify further stakeholders which ended up in a total number of 243 stakeholders; however, due to time constraints, they have not been interviewed in order to better analyse and classify the existing ones.

- The stakeholders that took part in the study have been categorized as follows:
- Public authorities
- Research institutions and projects
- Private research and development companies
- Telecommunication operators
- Standardization bodies
- End-user companies

The templates used for gathering the information from the companies and the detailed description and information about them are included in the section 2.1.

Public authorities

The authorities involved in the Project will play an important role in it, as they will lead the adoption of the product in different environments. The main authorities related to the Inter-Layer product are listed below.

Table 3. Public authorities (INTER-LAYER)

Stakeholder	Description
DG CONNECT – European Commission	The sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.
Autoridad Portuaria De Vigo	Responsible for running the largest port in Galicia and owner of a SmartPort platform.
A Coruna city council Ayuntamiento de A Coruña	Public body responsible of managing the city of A Coruna, including the smart city platform based in SOFIA2.
Azienda Sanitaria Locale TO5	Public body in charge of the health system in the area of Torino.

Research Institutions & Projects

This group is composed by universities, a non-profit organization, and related projects to Inter-IoT. These entities work on technologies related to installing, distributing, connecting and operating IoT components. They may operate at one or several layers related to Inter-Layer sensors, protocols, gateways, data processing, middleware, semantics and interoperability. Stakeholders are subdivided in universities, non-profit organizations and active research projects.

The universities involved in research are listed in Table 4:

Table 4. Research Institutions & Porjects (INTER-LAYER)

Stakeholder	Description
Universitat Politècnica De Valencia	Spanish public university, with several research centers and projects related with IoT
Technische Universiteit Eindhoven	Technical public university in The Netherlands, with different projects and research areas related with IoT.
Systems Research Institute, Polish Academy of Sciences (SRIPAS)	Public Polish research center active primarily in the domain of methodological foundations for systems analysis.
University of Calabria	Italian public university with different research groups and projects related with IoT
Turin University	Italian public university with research teams related to smart cities platforms and applications.

As non-profit organizations we can find the ones listed in Table 5:

Table 5. Non- profit organizations (INTER-LAYER)

Stakeholder	Description
ValenciaPort Foundation	Non-profit organisation works on the innovation of the port, transport and logistics sectors.
Association pour le développement de la formation professionnelle dans les transports	Non-profit organisation devoted to the development of vocational education and training in the Transport & Logistics sectors.
AIOTI-UPV	Group of research groups related with IoT at UPV and associated research institutes.
VTT Technical Research Centre of Finland	Leading research and technology research center in the Nordic countries.

Related projects on this topic (IoT interoperability across several layers) all projects within the ICT-30 cluster are listed below:

Table 6. ICT-30 projects (INTER-LAYER)

Stakeholder	Description
ICT-30 SymbioTe	H2020 RIA SymbIoTe (Symbiosis of smart objects across IoT environments): interoperability mechanisms at different layers.
ICT-30 TagItSmart	H2020 RIA TagItSmart: connectivity and interoperability of funny tags.
ICT-30 BIG-IoT	H2020 RIA BigIoT (Bridging the Interoperability Gap of the IoT): interoperability mechanisms at different layers.
ICT-30 BIoTope	H2020 RIA BIoTope (Building an IoT Open innovation Ecosystem for connected smart objects): use of open standards for platform interoperability.
ICT-30 Vicinity	H2020 RIA Vicinity (Open virtual neighbourhood network to connect IoT infrastructures and smart objects): interoperability at semantic layer.
ICT-30 Agile	H2020 RIA AGILE (An Adaptive and Modular Gateway for the Internet of Things): interoperability through an open gateway.

Private research and development companies

Technology companies engaged in research, software development, device manufacturing, systems integration, etc.

Table 7. Private research and companies (INTER-LAYER)

Stakeholder	Description
Instituto de Tecnología Informática (ITI)	Research association of SME and industries related with software development
ETRA I+D	ETRA's mission is putting in the market the most advanced solutions and services either directly or through the 10 companies of the Group.
Infoport Valencia	Infoport is a technology services company specializing in the logistics sector and port.
Amiga Ventures	Amiga provides services to allow companies to undertake the digital transformation of their business, from strategy and design to maintenance and continuous improvement.
Kii	Kii helps developers and device manufacturers meet their high-performance demands with an end-to-end platform optimized for building and running enterprise mobile and IoT initiatives.
Amplía	Amplía is a company that pioneers of Internet of Things solutions, specialized in wireless communication solutions and software engineering.
Engineering Ingegneria Informatica S.p.A.	ENGINEERING is the head company of the ENGINEERING Group. Engineering is currently the first IT group in Italy.
Itaca SRL	Itaca is a spin-off company of University of Calabria and University of Salento, operating in Information & Communication Technology (ICT) field.
Prodevelop	Prodevelop is a solution developer and systems integrator with a high expertise in port & maritime solutions and public administration, especially smart cities.
Thales Services SAS	Thales Services (THS) belongs to Thales group, which is a large industry player specialized in critical systems for government and companies.
XLAB d.o.o.	XLAB is a company providing technology solutions for enterprises and products for, among others, high volume and speed services such as Internet of Things.

Vemco SP z.o.o.	Vemco is a company with a main focus on computer networks and access-control systems.
BetterSolutions SA	BetterSolutions has knowledge and experience in designing, developing and deploying systems based on IoT platforms.
Neways	Neways is an international company active in the EMS (Electronic Manufacturing Services) market.
Energy Solutions	Energy Solutions is a marketer of innovative solutions with high technological value in the area of Smart Environment.
Alessandro Bassi Consulting (ABC)	SME related with innovative business solutions related with ICT and specifically IoT.
Fincons	Consulting and development group of companies related with different ICT areas, including IoT.
Things	Agency related with design and innovation in the area of IoT, including new business and services models.
Intel Technology Poland SP z.o.o.	Leading international company in hardware development and specifically in IoT.
Transport Route Service	French transport service provider specialized in hauling goods for the carpentry industry.
NOATUM	Strategic terminal offering advanced handling services for container and other kind of goods.
Orbita Ingenieria S.L.	SME providing technology related with IoT and automation to the port community.
Everis	Spanish consulting firm covering different aspects related with ICT.
Comsoft Sistemi	SME related with the ICT market in different components of the value chain.
INDRA	Large Spanish industrial company related with ICT in different application domains including transport, health and defence.
CSE	SME focused on hardware development and industrial manufacturing of devices.
VMZ Berlin betreibergesellschaft MBH	SME whose business area is urban mobility and traffic management services.
Bestech4U	Startup developing innovative smart technologies associated with M2M and IoT.
Every European Digital Poland sp. z o.o	SME developing IoT solutions and consulting services.

Multinational Solutions Provider for Government and Institutions (GIS)	Multinational solution provider for government and institutions, working for customs authorities and ministries for the simplification of trade.

Telecommunications operators

For Inter-Layer, we have interviewed few Telco, listed below:

Table 8. Telcos (INTER-LAYER)

Stakeholder	Description
Orange Polska S.A.	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Poland, part of Orange Group (France Telecom).
Telecom Italia	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Italy, owner of TIM.

Standardization bodies

The Inter-IoT consortium were only able to interview one SDO, listed below

Table 9. SDOs (INTER-LAYER)

Stakeholder	Description
Open Geospatial Consortium (OGC)	International not for profit organization committed to making quality open standards for the global geospatial community.

End user companies

Some end users have been interviewd, listed in Table 10.

Table 10. End users (INTER-LAYER)

Stakeholder	Description
ISECO S.L.	SME software control development company integrating sensors in a proprietary control centre and SCADA.
Sentinel d.o.o.	Sentinel is a Croatian company providing a hardware and software bundle for the monitoring of personal vessels and charter fleets.
TeleTransfusion	SME providing service for remote pre-transfusion evaluation of blood samples by specialists.

3.1.3 Stakeholders by company type

In a more detailed classification, the stakeholders can be divided into the following categories:

Table 11. Stakeholders by company (INTER-LAYER)

Private research and development companies	ABC Amiga Ventures BestTech4EU BetterSolutions Consoft Sistemi S.P.A CSE Energy Solutions Engineering ETRA I+D Everis Every European Digital Poland (EEDP) Fincons INDRA Infoport Valencia Intel Technology Poland SP z.o.o. ITI Kii Multinational Solutions Provider for Government and Institutions NEWAYS NOATUM Orbita Ingenieria S.L. Prodevelop Thales Services Things Transport Route Service (TRS) Vemco SP z.o.o. VMZ XLAB d.o.o.
Telco & Users	ISECO S.L. Orange Polska S.A. Sentinel Telecom Italia

	TeleTransfusion
Research Institutions	AFT AIOTI-UPV SRIPAS TUE Turin University UNICAL UPVLC VPF VTT
Public Authorities	ASL TO5 Autoridad Portuaria de Vigo (APVIG) Ayuntamiento de A Coruña (A Coruña City Council) DG Connect
Projects	ICT-30 Agile ICT-30 BIG-IoT ICT-30 BIoTope SimbioTe ICT-30 TagItSmart ICT-30 Vicinity
Standards	Open Geospatial Consortium (OGC)

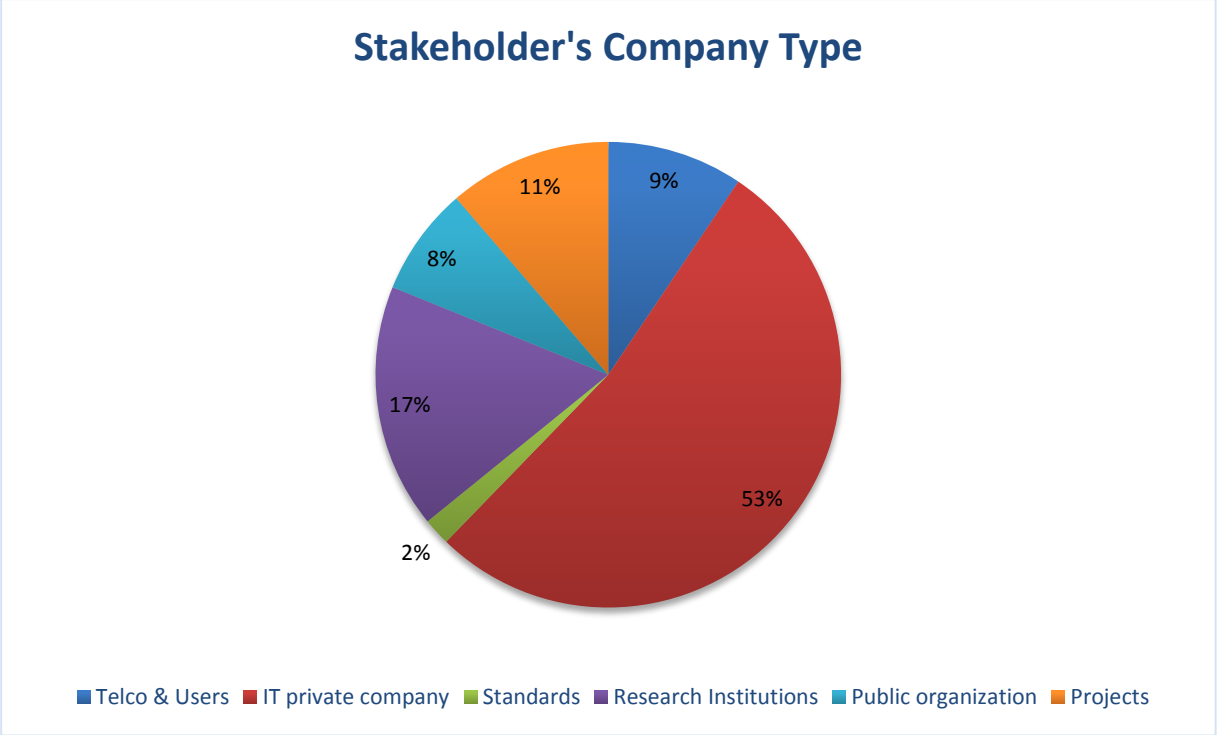

Figure 8: INTER-LAYER Stakeholder's Company Type

At the graph we can observe that more than half of the identified stakeholders are from private companies. Research institutes together with research projects add up to almost a third of all identified stakeholders. Finally, the public authorities together with the standards and telco & users form the remaining part (less than a quarter).

3.1.4 Stakeholders by country

Stakeholders can be differentiated by their country, as listed in Table 12.

Table 12. Stakeholders by country (INTER-LAYER)

Belgium	Amplía CETIC DG Connect ICT-30 BIG-IoT ICT-30 TagItSmart ICT-30 Agile ICT-30 BIoTope ICT-30 Vicinity ICT-30 SimbioTe

	Be-IoT IERC Unify-IoT AIOTI
China	HUAWEI
Croatia	Sentinel
Denmark	Maersk
Finland	ETRA I+D Fincons Haltian VTT NOKIA
France	ABC AFT INRIA Multinational Solutions Provider for Government and Institutions REPLY Sigfox Thales Services Transport Route Service (TRS)
Germany	Conlock IIC Kii SIEMENS VMZ Vokswagen Mercedes SAP
Greece	CSE Ubinu
International	Open Geospatial Consortium (OGC) OneM2M
Italy	ASL TO5 Cellnex

	Consoft Sistemi S.P.A CSI Holonix MSC OFFICINE ARDUINO Telecom Italia Engineering TSC Consulting Turin University UNICAL University of Catanzaro
Poland	Asta Labs BetterSolutions Every European Digital Poland (EEDP) Orange Polska S.A. SRIPAS Vemco SP z.o.o. Intel Technology Poland SP z.o.o.
Slovenia	TeleTransfusion XLAB d.o.o.
South Korea	SAMSUNG
Spain	AIOTI-UPV Amiga Ventures Autoridad Portuaria De Vigo (APVIG) Ayuntamiento de A Coruña (A Coruña City Council) Banner BestTech4EU EDAE Energy Solutions Everis Geomobile IMASCITI INDRA Infoport Valencia ITI NOATUM

	Orbita Ingenieria S.L. Pesyr I+D Prodevelop SANITAS Seat SOFIA2 UPVLC VPF Agata
Sweden	ERICSSON SICS Swedish ICT
Switzerland	SwissCom
Nederland	CARGOTEC Cisco DPWorld ISECO S.L. NEWAYS NXP Semiconductors N.V. PTC TUE
UK	resin.io AQMesh Containersafe
USA	NEST Texas Instruments Ford GENERAL ELECTRIC IBM MICROSOFT ORACLE
Unknown	PRIVACY AUTHORITIES Sick Things

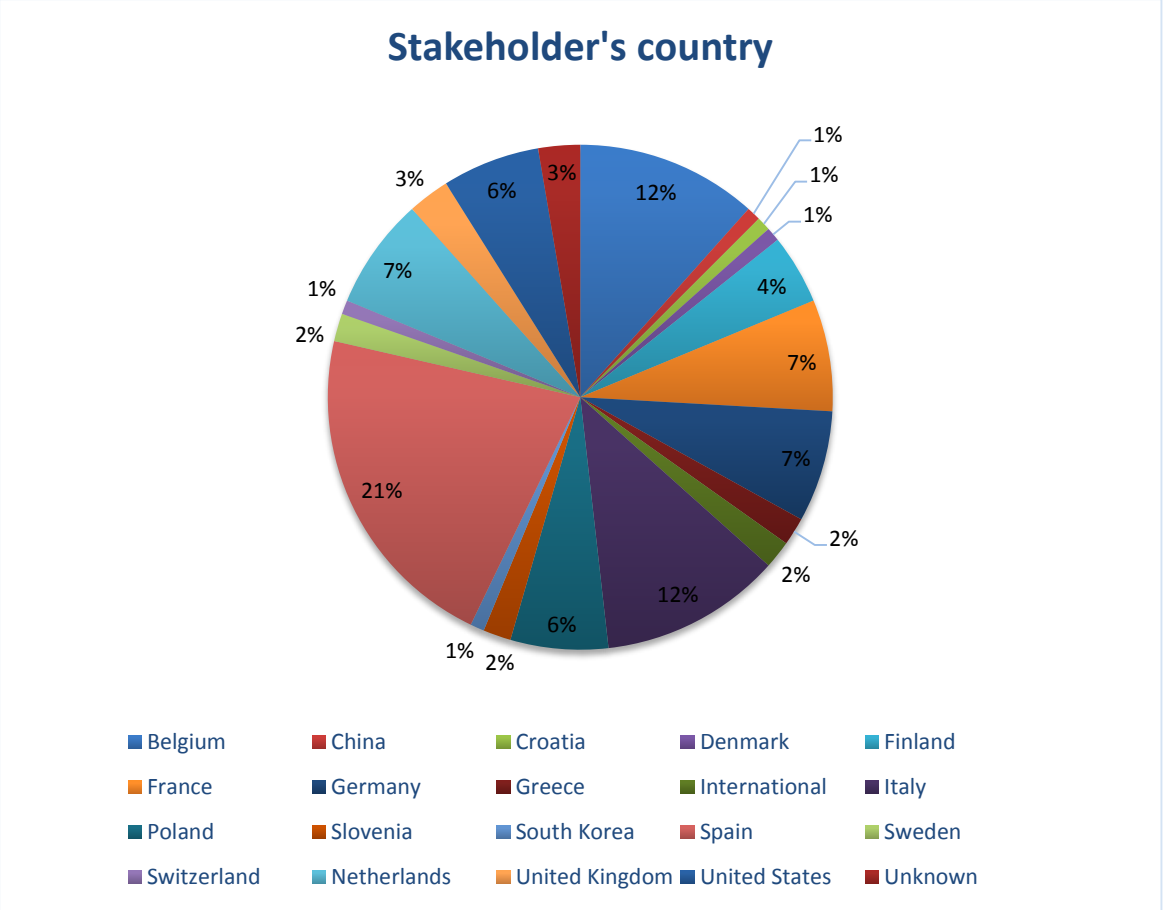

Figure 9: INTER-LAYER Stakeholder's country

According to the figure above, 114 stakeholders have been identified from 19 countries. In numbers, 4 countries (Spain, Italy, Belgium and Germany) account for more than half of the available funding.

3.1.5 Stakeholders map

Following the Volere methodology, the stakeholder's map for the INTER-LAYER product is as follows.

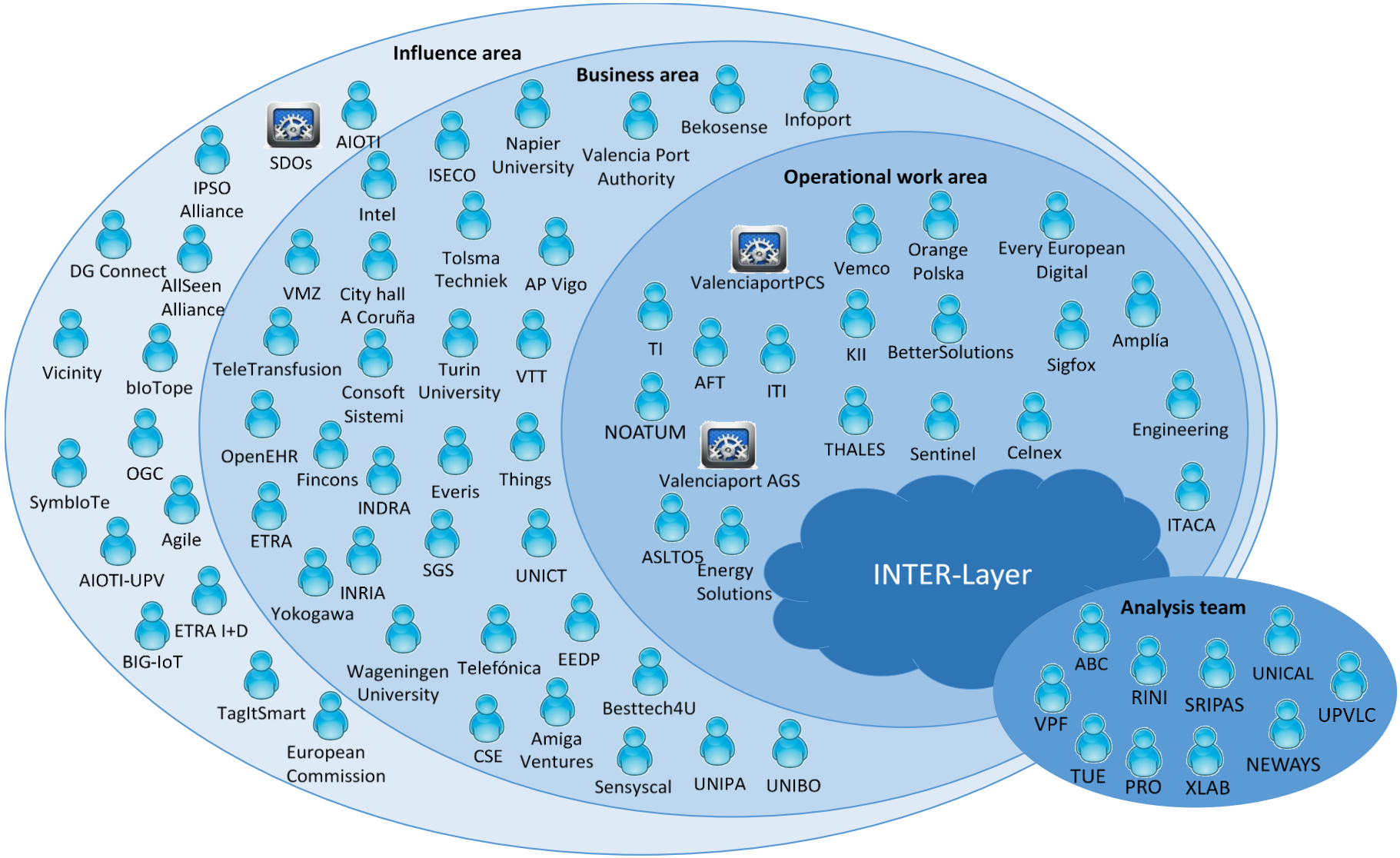

Figure 10: INTER-LAYER Stakeholder's map

If we classify the stakeholders by how involved they are in the design, development and execution of Inter-Layer, we obtain a map as shown above. There are four main areas in this map, corresponding to the degree of influence that each stakeholder could have:

- **Analysis team:** Is the core team in the design and development of INTER-LAYER. It is comprised by all project partners that lead the project and are directly involved with Inter-Layer (e.g. UPVLC, PRO, UNICAL, VPF, etc.).
- **Operational work area:** Every stakeholder that has direct a contact with INTER-LAYER (e.g. SigFox, ValenciaPort PCS), has enough knowledge in the product (e.g. AFT) or has a main role in the development and execution of Inter-Layer (e.g. NOATUM, ASL TO5) will fall under this ring.
- **Business area:** Stakeholders that are affected in some way by INTER-LAYER (but not enough to have a main role) are located in this ring. Some stakeholders are interested in contributing to Inter-Layer (e.g. Infoport, ETRA) or testing and adopting Inter-Layer (e.g. Valencia Port Authority). Their business models may influence the business models developed within Inter-IoT regarding Inter-Layer.
- **Influence area:** In the outer ring stakeholders that have an influence or some interest with INTER-LAYER are located. Other IoT related projects (e.g. BIG-IoT, Vicinity), IoT alliances (e.g. AIOTI, AllSeen), I+D companies (e.g. ETRA I+D), etc. Standardization organizations also play an important role in this ring, as the developed Inter-Layer product should follow or be in line with the recommendations and working groups implied in these bodies.

3.1.6 Stakeholders by class

Following the Volere INTER-Layer, the stakeholders can be classified according to the role they will play in the INTER-Layer. Therefore they can be distinguished the following classes.

Table 13. Stakeholders by class (INTER-LAYER)

Political beneficiary	DG CONNECT
Client	Transport Route Service VPF
Customer	NOATUM CON VPF ASL TO5
Subject-matter experts	NEWAYS CON Vemco SP z.o.o. BS OPL

	Intel Technology Poland SP z.o.o. UNITO VDR bestech4U S.L.U. Transport Route Service ITI
Systems engineers	ENG NEWAYS TU/e Kii Multinational Solutions Provider for Government and Institutions
Software engineers	Orbita Ingenieria S.L. Inforport Valencia
Technology experts	ENG UNICAL Pesyr I+D Telecom Italia CON TU/e Amiga Ventures ABC Kii Every European Digital Poland sp. z o.o. Energy Solutions
Domain Experts	EDAE TU/e ICT-30 SymbIoTe ICT-30 TagItSmart ICT-30 BIoTope ICT-30 Vicinity ICT-30 Agile ICT-30 BIG-IoT
Designers and developers	UNICAL ENG NEWAYS UPVLC XLAB d.o.o. CSE Sentinel TT SRIPAS

	Every European Digital Poland sp. z o.o. ISECO S.L. ETRA I+D AIOTI-UPV
Representatives of external associations	AFT
IoT Operator	VMZ

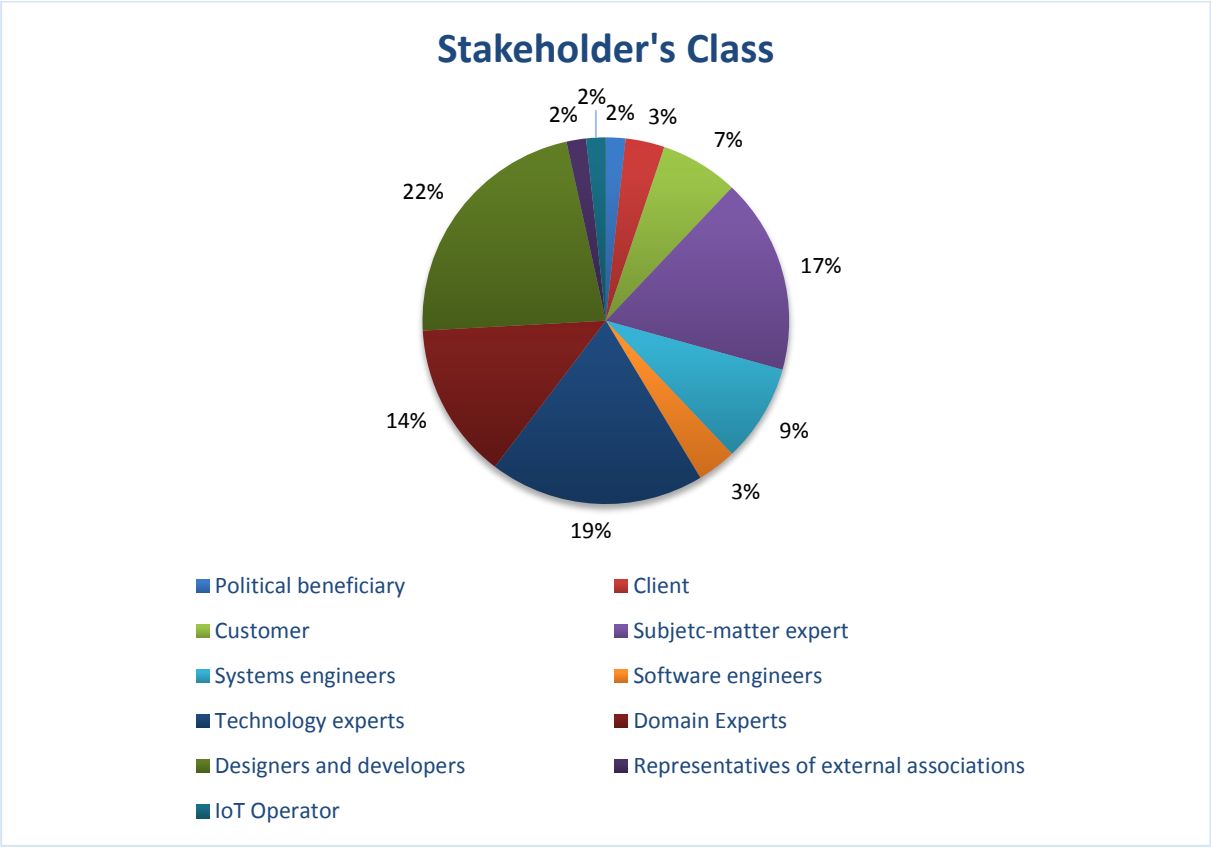

Figure 11: INTER-LAYER Stakeholder's class

From the graph above it is observed that a high number stakeholders are final users (clients or customers). As well as it is acknowledge technological support from IT sector companies (Systems engineers, Software engineers, Technology experts, Domain experts). Moreover it is observed a wide variety of representatives at the logistics and port sector (Subject-matter experts).

3.1.7 Stakeholders by IoT Demand/Supply

In the field of Internet of Things each of the stakeholders can provide (Supply side) or receive (Demand side) information. On the supply side it is identified at first research entities and

development companies, and on the contrary on the demand side it has been identified final users such as public administration bodies (Port authorities) and related companies with the transport, logistic, shipping and port sector.

Table 14. Stakeholders by IoT Demand/Suppy (INTER-LAYER)

IoT Demand side	IoT Supply side
NOATUM	ENG
NEWAYS	UNICAL
Telecom Italia	ITI
CON	Orbita Ingenieria S.L.
Sentinel	CON
TT	UPVLC
VPF	XLAB d.o.o.
AFT	Amiga Ventures
DG CONNECT	BS
VPF	OPL
ASL TO5	UNITO
UNITO	ABC
Energy Solutions	ICT-30 SymbIoTe
Transport Route Service	ICT-30 TagItSmart
CON	ICT-30 BIoTope
TT	ICT-30 Vicinity
VMZ	ICT-30 Agile
AIOTI-UPV	ICT-30 BIG-IoT
	TU/e
	Inforport Valencia
	VDR bestech4U S.L.U.
	Kii
	Every European Digital Poland sp. z o.o.
	Multinational Solutions Provider for Government and Institutions
	CON
	AFT

	DG CONNECT
	CSE
	ISECO S.L.
	ETRA I+D
	AIOTI-UPV

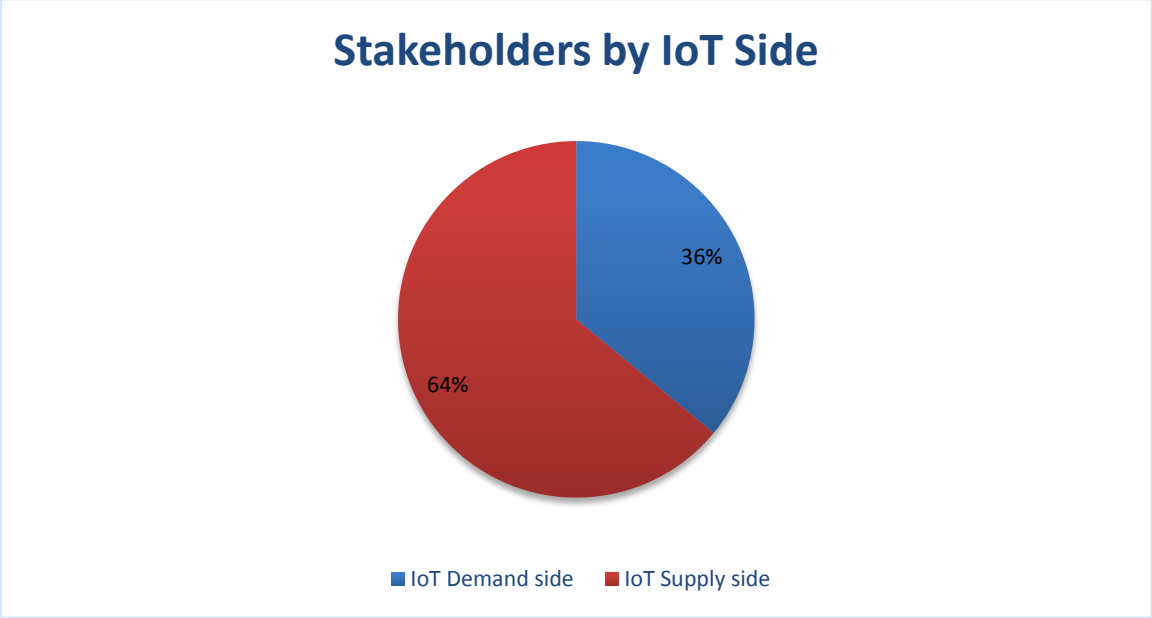

Figure 12: INTER-LAYER Stakeholder's by IoT side

Although there has been identified more IoT stakeholders on the supply side rather than the Demand side, it is needed to remark that on the IoT supply side are stakeholders with enough empowerment to demonstrate that there is interest in the INTER Layer product.

3.1.8 Stakeholders with interest in Open Call participation

Within the project INTER-IoT, an open call will carry out. All those stakeholders who meet the stated requirements can apply it. Stakeholders who have shown some interest are the following.

Table 15. Stakeholders with interest in Open Call (INTER-LAYER)

Interested in participating in open calls	Not interested in participating in open calls
Inforport Valencia	VDR bestech4U S.L.U.
Amiga Ventures	GIS
Kii	Transport Route Service
Every European Digital Poland sp. z o.o.	UNICAL

Energy Solutions	ENG
ENG	Telecom Italia
NOATUM	UPVLC
Orbita Ingenieria S.L.	TU/e
NEWAYS	XLAB d.o.o.
CON	Sentinel
BS	TT
OPL	VPF
AIOTI-UPV	Amiga Ventures
UNITO	SRIPAS
	Vemco SP z.o.o.
	ABC
	AFT
	DG CONNECT
	ICT-30 SymbIoTe
	ICT-30 TagItSmart
	ICT-30 BIoTope
	ICT-30 Vicinity
	ICT-30 Agile
	ICT-30 BIG-IoT
	CSE
	VMZ
	ISECO S.L.
	ETRA I+D
	ITI
	ASL TO5

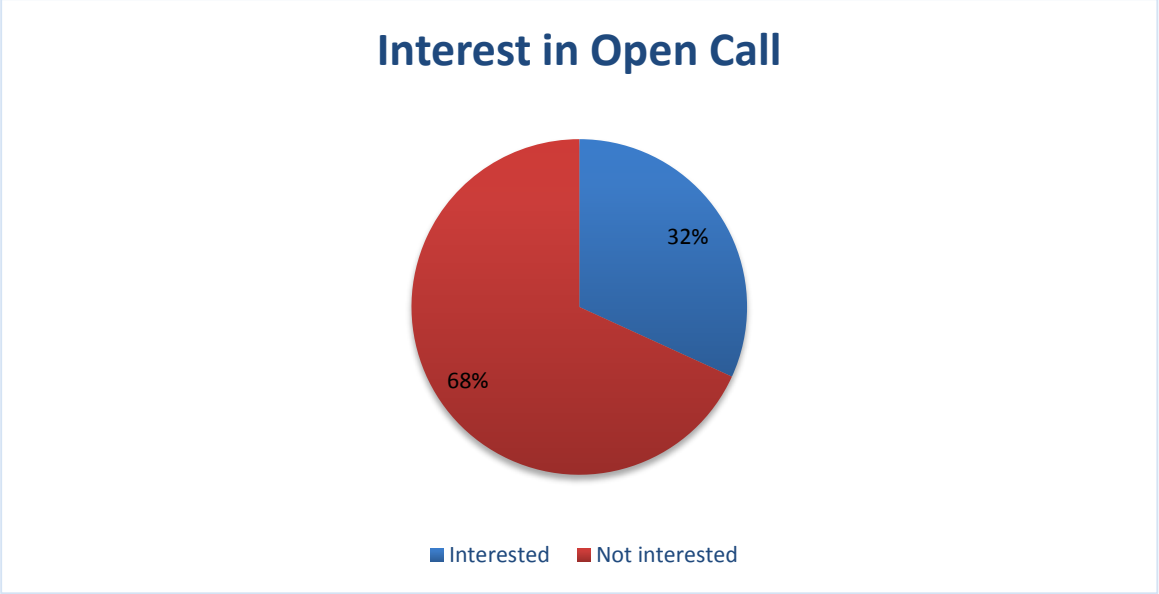

Figure 13: INTER-LAYER Stakeholder's interest in the open call

In the above graph you can see that there is a large number of stakeholders who are not interested in the open call. This is because end users and customers do not have enough infrastructure to request it. Therefore it can be concluded that the majority of other stakeholder has shown much interest in participating in the project.

3.1.9 Products involved by Stakeholders

In today's market there are numerous products related to the INTER-Layer product. In order to make a complete market analysis it is necessary to know what are those most relevant and used within the Inter-Layer product sector. In the list below, it can be seen those which are being used by stakeholders or would be interested in acquiring some products similar to the mentioned.

Endpoint Hardware (Embedded systems, devices, sensors, actuators, etc.)

- Passive RFID tags
- QR tags,
- FunCodes (2D barcode decoding)
- Reader RFID tag
- Reader QR Tag
- Reader Barcode
- Video camera - Observation
- Video system - Plate Recognition
- Smart phones, tablets & Smart watches

- PLCs - Industrial, Medical SIL3, Human Safety SIL3
- Sensors – Temperature, Sound, Co2, PH, Salt, Sulfuric, Geophone velocity, Gas flow, Water Flow
- Actuators -
- GPS-Localization & Tracking

Endpoint Application/Software

- SCADA Systems in health environments
- GateCCR Container Code Recognition
- GateLPR Licence Plate Recognition
- LPR (License plate readers)
- eHealth
- RabitMQ
- MuuMap
- TagItSmart API
- TagItSmart framework
- BIG-IoT API

Local network (communication network Layer)

- Body Area Network (BAN)

Field Area Network (communication network Layer)

- Cellular 2/3/4G/LTE
- Wi-Fi (IEEE802.11)
- BT
- LoRa
- DUST
- Ethernet (IEEE802.3)
- EtherCAT
- Profinet
- G3-based PLC (IEEE P1901.2)
- ZigBee
- IPv4, IPv6
- TCP/UDP
- EAP-TLS Based Access control Solution
- WirelessHART
- ISA100.11a
- IEEE802.15.4e

- TSCH
- RPL
- Centralized and decentralized scheduler
- QoS
- Differential monitoring
- SDR techniques
- Smart Grid KPI
- Advanced Modem Router Gateway (AMRG) – IoT gateway

Web-service

- Reddit
- ElasticSearch

Services Public Cloud

- OGS SOS [Open Geospatial Consortium - Sensor Observation Systems]
- MongoDB

Services Private Cloud

- BodyCloud
- Energy - Lighting
- Energy - Gas
- Energy – Water
- Dropbox
- One drive
- Google Cloud
- Horde
- JIRA
- RabitMQ
- ElasticSearch

IoT Platform (Application /Service Domain)

- BodyCloud
- eCare TILAB
- eHealth platform
- Consoft Sistemi
- SIMACOP (command & control)
- OGS SOS [Open Geospatial Consortium - Sensor Observation Systems]

- FP6 PROMISE Project
- Open platform 3.0
- FI-WARE
- OpenUWEDAT
- Open-IoT
- IoTLab
- IoTA
- Sofia2
- Azure IoT
- Google IoT
- VLCi
- MoBaaS
- TarquinIoT
- BUTLER

Network Systems

- SIMACOP (command & control)
- Navigo Digitale
- nAssist
- KIOLA
- Traffic information center
- Incident management center
- SCADA System
- SCADA Systems (in health environments)
- SEAMS & Machines BlackBox
- CATOS
- TOS intermodal (railway)
- CraneTMS Traffic Management System
- Yard CraneOCA Obstacle Collision Avoidance
- Yard CraneSCA Stack Collision Avoidance
- MuuMap

Management (Platforms) Systems

- Trucks Pre-booking
- MuuMap
- Traffic Safety Management Center (Cegesev)
- Traffic Management Center (CGT)
- NOC (electric vehicles)
- Water management products

- Security products
- UPV CARTA listed products and projects
- IMASCITI

Software

- RabitMQ
- ElasticSearch
- SAGE

Standards

- OGS SOS [Open Geospatial Consortium - Sensor Observation Systems]
- ETSI, W3C WoT, W3C SDW, W3C Linked Data Platform (LDP), IETF core OGC, ACE, SWE WG, oneM2M, MS WG, OIC / IIC, MAS WG on IoT, IEC TC 119 on printed electronics
- Open API standards O-MI and O-DF
- TinyMesh, OSGI VM, ZigBee, WLAN, Bluetooth Mesh, LinkSmart/Hydra, Ebbits, Ontologies from Ready4SmartCities,
- SmartCoDe FP7, ETSI
- ALLSEEN Alliance, OMA, IPSO

3.1.10 Stakeholders needs

To effectively introduce and promote the use of IoT solutions based on IoT interoperability across several layers, and define design requirements of INTER-LAYER, it is necessary to take into account the needs of all stakeholders at various layers. Identified stakeholders has stated specific needs that they have found of importance. These needs have been analysed and classified attending to the type of stakeholder. These are the identified needs we have found for these classes of stakeholders with respect to the INTER-FW product:

Public authorities

Public authorities may have different needs depending on the context they are. The needs will be different for a stakeholder at European, state, or local level. As well, needs depend on the stakeholder's aim, to foster IoT ecosystems and achieve platform digital leadership, or the development and use of a particular IoT solution. Three different publica authorities have been addressed and are interested in the INTER-LAYER product.

At European and national level, the stakeholders want to achieve a leadership:

- In digital platforms for industry. In order to achieve this goal the most important need of any business or service is the availability of interoperable open platforms to support

a digital transformation and break the silos between the application areas (e.g. health, home)

- Technologies such as IoT, CPS, Cloud, and Big Data.
- Development of open platforms that will foster a vibrant IoT ecosystem.
- The identified stakeholder at European level EC as an organization that finances research projects in the field of Internet of things:
- It has to coordinate and promote synergies between projects.
- It has to get the sustainability beyond the project life time and prepare the ground for large-scale pilots from the result of the projects.
- To achieve digital leadership and promote synergies among projects, interoperability among platforms is necessary.

At national level the stakeholder analysed is related to port, transport and logistics activity. The needs are at the moment mainly focused on the services layer, as there have not been currently identified the needs for accessing to raw sensor data at the device or network layer. However, an interesting possibility to exploit is to allow the future access from the Port IoT platform to sensor data from external agents (for instance, terminals). In this case, device or networking layer could be the most prominent needs although service layer is also desirable:

- Availability of appropriate systems for port operations. It is required efficiency, connectivity, integration and modernization of port elements and systems.
- Creation of IoT platforms interoperable with other IoT platforms owned by other companies like rail companies and other logistics operators.
- Interoperability and efficient information management are key factors for the competitiveness of any company involved in transportation due to the vast quantities of information created and interchanged, and the need of that interchange among different services.
- Integration of heterogeneous networks of smart objects (such as devices, tags or sensors) and different port services, providing interoperability across the different layers (services, devices, etc.).
- Access to Port Authority sensor data to third party agents from the Port Community, to allow the integration of these data in their own systems, and the future integration and interoperability among different elements and systems.

At a local level, the Smart City platform and services have a very remarkable importance. IoT local services such as telemedicine and assisted living need the introduction at several levels of the IoT interoperability solution to correlate elements such as nutritional outpatients, family doctors and end-users, in order to make concrete the holistic vision of IoT Health, identifying new standard access and interoperability. The needs fall mainly in:

- Interoperability, for the interconnection of a local, public Smart City IoT platform with external IoT platforms from agents and organizations working in the city (Port, utilities, etc.).
- To provide the best services to the local citizens, leveraging IoT possibilities.

- Interoperability among several platforms to enable its integration, such as other Smart City initiatives or local service companies, is essential, as well as having a common ontology for enabling interoperability at a semantic level.

Research institutions & Projects

Despite strong commonalties in the needs of Research institutions such as universities, non-profits organizations and funded research projects there is a clear differentiation between those needs.

Universities although higher education institutions are important research centers, and have an important role in the development in IoT and specifically in INTER-IoT project. The main needs of this kind of stakeholders are:

- A layer solution that provides the interfaces able to link sensors, tags and smart objects registered in one IoT platform to other IoT platforms, owned by different entities and using different standards.
- To allow the connection of the systems of an IoT solution at various levels between each other (device, network, M2M, application, service...) and with other existing or future IoT platforms.
- To achieve Global IoT platform interoperability, a solution to support the whole interoperability between two or more already implemented or available IoT platforms in order to manage data flows in a transparent manner.
- To develop a semantic model of the application domain which integrates data from identified IoT platforms. Including a shared ontology should include concepts describing general IoT platform architecture.
- In more detail, referring to each particular layer, universities and public research centers seek:
    - In the device layer a solution that is able to provide transparent access and management to heterogeneous IoT devices for the purpose of integrating most of the own IoT devices and defining new network algorithms, protocols and applications atop the device layer.
    - In the networking layer a solution that allows a fast and reliable networking communication and integration among dissimilar IoT devices supporting several network addressing (6LoWPAN, IPv4, IPv6) and routing (RPL) protocols. This solution is mainly needed to define new protocols and applications atop the networking layer.
    - In the middleware layer a solution that is able to couple the middleware components of the heterogeneous IoT platforms by using overlay middle components such as mediators and brokers, and virtualized middleware components to provide unified access to the three middleware services (discovery, management and communication) for IoT devices.

- In the application service layer a solution to make interoperable and/or integrate application services furnished by heterogeneous IoT platforms.

Non-profit research organizations mainly consider the usefulness of INTER-LAYER for developing and using IoT solutions, applications and services, to solve a particular need. There is a special focus on logistics, localization, and specific business solutions. Actually the needs of universities are also extendable to this kind of stakeholders, however the needs are more specific:

- To support the definition and testing of the interoperability elements (e.g. interfaces) at middleware, application service, data & semantics and cross-layer interoperability.
- To get a set of building blocks that enable the transformation of smart objects, or information coming from external sources, into real IoT interoperable solutions.
- To fill the gaps of these networks that still lack of interoperable IoT functionalities and provide the secure and trusted mechanisms to connect with heterogeneous IoT networks in specific scenarios.
- To provide the capacity of easily creating IoT interoperable solutions for different, particular needs, in a secure and trusted environment. s.
- To achieve real interoperability, as in practice even between nominally interoperable solutions, there may be interoperability problems (due to e.g. versions that differ too much), and noted that at middleware and platform level there are mainly proprietary solutions, fact that become a necessary challenge for interoperability.
- To integrate current legacy systems and frameworks from different developers. The IoT framework that provides truly interoperability between layers and systems is expected to become the facto standard.
- It is required the integration of new technologies, mainly in the communication layer such as Sigfox and 5G.

Project, mainly IoT platform projects from ICT30 cluster seek interoperability with the layer-oriented INTER-IoT, across several layers. In this way ICT30 projects guarantee interoperability with INTER-LAYER. Platform or services projects that require interoperable layers, and are not willing to necessarily build them, such as TagItSmart, can integrate those layers from INTER-IoT. In these cases, those projects need the sufficient layer interoperability from smart objects to the application level required for the platform. Some specific needs:

- To define a minimum common interoperability component at each layer in order not to generate new standards.
- To cooperate in order to generate contributions to standardization bodies, in order not to compete.
- To provide security, trust, and privacy to every layer interoperability introducing adequate mechanisms and tools.
- To man an equivalent interoperability stack based on the following domains: Device, Smart Space, Cloud and Application, to the considered INTER-LAYER approach.

- To allow mobility, roaming and transfer of smart objects (real and vitual) among different platforms, even when they are managed by different stakeholders.
- To generate an IoT ecosystem in which developers can easily migrate services from one platform to another thanks to commonalities in interoperability mechanisms at any layer.

Private research and development companies

Private companies share the need to have an IoT system interoperability component layer-oriented, in order that they can decide how to interoperate with other platform depending mainly on their area of activity. A general interesting remark is that in order to avoid the creation of IoT silos, very IoT platform design should consider interoperability, reliability, security, privacy and trust, to interact with existing open and legacy IoT platforms.

The stakeholder shows interest in evolving and testing its solutions in an interoperable IoT ecosystem where new devices could be easily connected and interoperate with its solutions in a more cost-effective approach that facilitates the adoption of the solutions for the addressed ecosystem and application domain. The main needs highlighted by the different stakeholders (private companies) regarding that need to be provided by INTER-LAYER are

- The benefit from INTER-LAYER to implement INTER-IoT framework over different layers, allowing a more flexible implementation and guaranteeing the implementation in devices that non-necessarily integrate the complete layer stack, and may take advantage of Inter-Layer existing functionality to implement its framework over any layer.
- The ability to provide interoperability at various levels (from device to application level) allows the different products to be better connected in two ways. In the first way, besides providing custom interfaces and easily integrate with other platforms, without having to allocate resources for custom interfaces.
- To address communication problems and reliability in devices when connecting to the different gateways and platforms or peer-to-peer with other devices using wireless and wired means.
- To provide an integration of layer-interoperable IoT platforms with Big Data techniques, methodology and solutions. IoT platforms are able to generate large amounts of data (Big Data), and the management of these large scale data represents a challenge: typically, data requires real-time massive storage, quick access, and intelligent analysis to unlock the data value, as well as data monitoring, real-time analysis and understandable visualization of relevant data. Elements of the Big Data Ecosystem to cover are:
    - Cloud Computing infrastructures and Real-Time optimization
    - Collection of Non-Transactional Social and Heterogeneous Data
    - Data Engineering (Improvement of the quality, integrity and consistency of data and database performance)

    - Data Analysis for Transactional Data and Data Visualization
- Device to Human protocols, to transmit data between an IoT device and a human device.
- Each layer should provide functionalities and services to components of other layers by means of standardized APIs; tools to check unauthorized access to layer's functionalities should be developed. Providing a cross-layer link with INTER-FW product.
- To enable and support relationships, communications and agreements between stakeholders or solution providers, in order to promote the involvement of new devices, networks, middlewares, application services and data to consequently increase the value of the whole platform. With the inclusion of a management and monitoring functionality to achieve operational interoperability, considering the definition of profiles, to recognize the infrastructure and match it to the appropriate network reconfiguration mechanism to enable existing sensor, actuators and smart objects networks into an IoT interoperable solution.
- Implementation and exploitation of technologies, software and data integration patterns to enable heterogeneous devices, networks, middlewares, application services and data to be used and integrated together. Communication protocols, connectors, and APIs have to rely on standards: open source implementations supported by communities have to be addressed.
- Definition and implementation of an omni-comprehensive, shared ontology, to understand and to manage features and capabilities of heterogeneous devices, networks, middlewares, application services and data. Tools to manage semantic models, (semi) automatic data integration and mapping, and semantic consistency should be developed. Every ontology has to follow international standards or at least be based on them.
- Operational intelligence tools should be used to analyse in real time events and understand the status of the platform (i.e. complex event processing). Practical reasoning and goal oriented systems could be exploited to apply high level policies in order to realize reactive and proactive systems, able to autonomic computing capabilities (i.e. to realize systems which are compliant to self-* features)
- Security by design techniques, to implement a technological stack and the services needed to make the infrastructure secure both globally and at node level. It is still open issue to manage an authorization, authentication and access rights assignment protocols in an efficient way. It is very important that data and services should be protected.
    - Data ownership: sensors as data sources are owned by different third parties; IoT platform should support data ownership management, data-flow monitoring, and access management.
    - Data privacy: in case of personal data processing, IoT platform should meet standards required by local/international data protection entity.

  - Data security: IoT platforms store and processes sensitive (from the point of view of our customers in dairy industry) data; for example, quantity of resources available for pick-up per supplier.
- Intelligent systems should be exploited to realize IoT platforms able to be aware about their internal status and the surrounding environment, and able to apply intelligent and autonomous behaviours both at global and at node level.
- Adoption of Sensors as a Service paradigm could be useful to exploit sensors' features in a standardized way, so to ensure scalability and usage of the whole platform. Allowing access to data from external agents and also access to allow access to sensor data from external agents from open and legacy systems. Providing a set of building blocks that enable the transformation of existing sensor, tags and smart objects' networks into real IoT interoperable solutions
- Innovative and smart techniques to enhance the engagement of heterogeneous devices that could be plugged in the platform.
- To provide a comprehensive and educated services layer, as several stakeholders don't identify current needs for accessing raw sensor data at the device or network layer.
- Tools for providing generic services to IoT solutions, and the ability to interconnect complementary business by merging cross-domain information. Various variants of business rules engines. The problem is to analyze large amounts of data generated continuously and detect a number of conditions (in two variants, simple and complex).
- To manage sensor heterogeneity, because several platforms and deployments use highly specialized sensors and measuring devices, provided by numerous competing suppliers using different communication standards and data models, result in high expenditures on integration and interfacing of each device type.
- To provide support for actuators components as IoT platform should enable easy data exchange with IoT gateways installed in vehicles; Raspberry Pi-based embedded systems acting as gateways for Wireless Sensor and Actuator Network) WSAN nodes. Interfaces able to link sensors, actuators and smart objects registered in one IoT platform to other IoT platforms, owned by different entities and using different standards.
- To integrate legacy developed system by the different vendors in different ecosystems with independence of the application domain. INTER-LAYER needs to fill the gaps of these networks that still lack of interoperable IoT functionalities and provide the secure and trusted mechanisms to connect with heterogeneous IoT networks in the port, transport and logistics scenarios.
- To include a way for different devices to interact through a middle framework capable of managing the different kind of dynamics. INTER-IoT through INTER-LAYER has to be an open platform reducing the risk for a platform's support to be abandoned with the evolution of communication standards, reducing on the long term interoperability problems.

- Usability of different communication systems such as Wi-Fi, servers (big data database, standard database), virtualization (device level, application level), cloud (capacity, external communications)
- Each layer should provide a set of easy, modular and extensible APIs, considering or merging all existing protocols. Following the IoT-A paradigm is important as different companies have some prototype following IoT-A vision for which they have implemented a set of M2M concepts targeting proprietary devices that are attached via USB.
- Security and operational implications (e.g. low energy consumption at device level) is important for all layers. Furthermore, detailed descriptions of interfaces and involved operational parameters are needed. While connecting devices at various layers, it is important to know the various possibilities (e.g. protocols) to be used, but also some performance or benchmarking parameters to decide the best option for each scenario.
- To improve a seamless device to device interaction and an open service discovery and management framework, as well as common ontologies related to devices.

Telecommunications operators

Telecommunications operators are interested in a general knowledge about possible use cases of IoT Platforms and devices, followed by technical solution. As well they seek the integration of the most suitable technology to:

- To integrate devices and measures from smart objects
- To translate and match data and semantics in order to integrate data belonging to third party platforms
- To integrate services belonging to third party platforms

Standardization bodies

The Open Geospatial Group highlights the importance of semantics and service interoperability in INTER-Layer. As well, OGC demands the reuse of existing proven working standards, such OGC standards, and to provide recommendations to the existing standard organization if some new use cases are required. Also the Open Geospatial Group demands effective communications with the active working group members in the standard organizations to ensure the most effective implementation of the standards, and benefit from the feedback of experts.

End user companies

End user companies have the following needs:

- Integration of heterogeneous sensors using different medium access control networks

- Integration of legacy systems and frameworks from different developers
- Offering of processed data and alarms to a suite of different applications
- Exchange of information from sensors to actuators using different networks
- Ability to connect services through different transportation means in the network layer (e.g. Wi-Fi, GSM)
- Routing of data between different gateways in a pilot site
- Semantic representation of the information
- Interoperability with relevant standard middlewares like FIWARE, SOFIA2 or Universaal.
- Capability to merge of information from other services (weather, rental prices, etc.)

Merging all the stakeholder's needs into a single table can offer a better approach to what the identified stakeholders are looking for in INTER-LAYER. We have processed the common needs scoring the number of times each need arises for the different stakeholders. The table below is ordered in descendant way with the number of occurrences of each stakeholder need.

Table 16. Stakeholders' needs (INTER-LAYER)

Stakeholder need	No	Public authorities	Univ. & Research	R&D Projs.	Private Companies	Telecom Ops.	Standard Body	End users
Security at any layer	15	x	x	x	x			
Security access control	15		x	x				
Trust at any layer	12		x	x				
Privacy at any layer	8		x	x				
Interoperability among open IoT platforms	7	x	x	x	x			x
Semantics&Ontologies	7	x	x	x	x	x	x	x
Interoperability across layers	6	x	x	x	x	x		x
Access to heterogeneous sensors	5	x	x	x	x			
Reliability at any layer	4	x	x	x				
Device interoperability	4	x						
Integration of legacy systems	4	x	x	x	x			x
Standard need	4				x		x	
Service Discovery	3				x			
Merge of all existing protocols	3				x			
Integration of third-party services	2	x	x	x	x			x
Break silos	2	x						
Management of large-scale data	2	x	x	x	x			x
Usability of different communication mechanisms	2	x	x	x		x		

Integrate devices from heterogeneous networks	2	x			x			x
Reuse of existing standards	2		x	x	x		x	
Interoperability with relevant middleware standards (FIWARE, SOFIA, Universaal)	2				x			x
Active collaboration with standarization groups	2		x	x			x	
Routing of data between different gateways	2		x		x			x
Ethics	1	x						
Data ownership management	1				x			
Real Interoperability in practice	1		x	x				
Easy migration of services among platforms	1		x	x				
Ease to create IoT interoperable solutions/ Foster IoT ecosystem	1	x	x	x				
Semi-automatic data integration	1				x			
Semantic consistency	1				x			
Ontology follows international standards	1		x	x	x		x	
Translate data and semantics from other platforms	1		x	x	x		x	
Efficient Data Management	1			x				
Device 2 Human protocols	1				x			
Testing procedures	1		x	x				
Tools to check unauthorized access to layer's functionalities	1				x			
Tools to manage semantics models	1				x			
Operational implications	1	x	x					
Recognise and add sensors automatically	1							
Easy use of services layer	1	x			x			
Sensors as a service	1				x			

Integrate devices and measures from smart objects	1	x			x		x
Integration of virtual smart objects	1	x					
Mobility, roaming and transfer of smart objects across platforms	1	x					
Follow the IoT-A paradigm	1			x			
Autonomic computing capabilities	1			x			
Real time events analysis	1			x			
Intelligent and autonomous behaviour at global and node level	1			x			
Awareness of internal status and environment	1			x			
Exchange of information from sensors to actuators using different networks	1				x	x	x
Seamless device to device interaction	1	x	x				x
Use of SDN/NFV	1	x	x				
Integration with BigData	1	x	x			x	x

We have categorized the stakeholder's needs for INTER-LAYER into 9 groups:

Table 17. Stakeholders' needs categories (INTER-LAYER)

Category
Device interoperability
Network interoperability
Middleware Interoperabily
Application interoperability
Semantic interoperability
Cross-layer interoperability
Policy
Security
Standards

Each need has been assigned a specific category:

Table 18. Stakeholders' needs categorization (INTER-LAYER)

Stakeholder need	Category
Security at any layer	Security
Security access control	Security
Trust at any layer	Security
Privacy at any layer	Security
Interoperability among open IoT platforms	*Interoperability[5]
Semantics&Ontologies	Semantic interoperability
Interoperability across layers	Cross-layer Interoperability
Access to heterogeneous sensors	Policy
Reliability at any layer	Security
Device interorperability	Device Interoperability
Integration of legacy systems	*Interoperability
Standard need	Standards
Service Discovery	Application interoperability
Merge of all existing protocols	*Interoperability/Standards
Integration of third-party services	Application Interoperability
Break silos	Policy
Management of large-scale data	Application interoperability
Usability of different communication mechanisms	Network Interoperability
Integrate devices from heterogeneous networks	Device interoperability
Reuse of existing standards	Standards
Interoperability with relevant middleware standards (FIWARE, SOFIA, Universaal)	Middleware interoperability
Active collaboration with standarization groups	Standards
Routing of data between different gateways	Network interoperability
Ethics	Policy
Data ownership management	Policy
Real Interoperability in practice	*Interoperability
Easy migration of services among platforms	Application Interoperability
Ease to create IoT interoperable solutions for particular needs/ Foster IoT ecosystem	Policy
Semi-automatic data integration	Semantic interoperability
Semantic consistency	Semantic interoperability
Ontology follows international standards	Semantic interoperability/Standards
Translate data and semantics from other platforms	Semantic interoperability
Efficient Data Management	Application interoperability
Device 2 Human protocols	Device interoperability
Testing procedures	Policy
Tools to check unauthorized access to layer's functionalities	Security
Tools to manage semantics models	Semantic interoperability
Operational implications	Policy
Recognise and add sensors automatically	Device Interoperability
Easy use of services layer	Application interoperability

[5] *interoperability refers to interoperability at every layer

Sensors as a service	Application interoperability
Integrate devices and measures from smart objects	Application interoperability
Integration of virtual smart objects	Application interoperability
Mobility, roaming and transfer of smart objects across platforms	Network/Middlewate interoperability
Follow the IoT-A paradigm	Policy
Autonomic computing capabilities	Cross-layer interoperability
Real time events analysis	Application interoperability
Intelligent and autonomous behaviour at global and node level	Device interoperability
Awareness of internal status and environment	Cross-layer interoperability
Exchange of information from sensors to actuators using different networks	Device/network interoperability
Seamless device to device interaction	Device interoperability
Use of SDN/NFV	Network interoperability
Integration with BigData	Semantic/Application interoperability

Counting the number of times that each need appears for every category and summarizing per category leads to this distribution of stakeholder's needs:

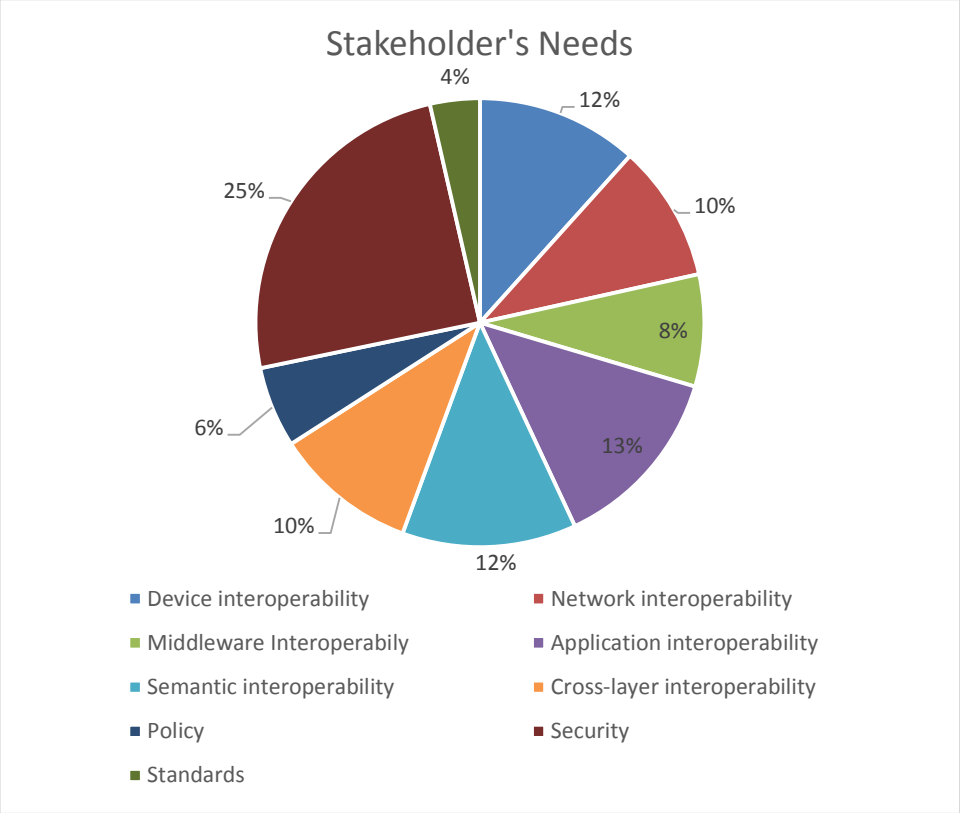

Figure 14: INTER-LAYER Stakeholder's needs by category

3.1.11 Conclusions

The market analysis performed regarding INTER-LAYER product, raises as first main result the need for interoperability between IoT platforms. The need for interoperability appears in terms of new standards being proposed and in the interest from developers and designers to add to their products new plugins, services and connectors allowing the interoperability with open platforms like FIWARE, SENSINACT or UNIVERSAAL. However as stated by AIOTI in WG3 documentation the number of standards, recommendations and vendor alliances grows, making difficult, nearly impossible to allow global interoperability of products. This is the reason that a product like INTER-LAYER, offered as a suite of interoperability mechanisms is interesting for the interviewed stakeholders.

The stakeholders that are currently interested in the INTER-LAYER product cover different technology sectors associated with the IoT industry: software developers, integrators, hardware manufacturers at sensor and network level, users in different application domains. The number and classification of stakeholders is adequate for the proposed task and balanced following different criteria (class or geography), and several products have been identified from this group. Technology experts have highlighted the need of a product like INTER-LAYER that currently is only partially available, mainly as smart gateways for a specific application domain (e.g. home automation of e-health) or as enablers for different middlewares (e.g. FIWARE or SOFIA2). Typically stakeholders related with this product, foresee interesting market opportunities, however they only consider the INTER-LAYER components related to their business, not considering it as a whole.

Another conclusion extracted from the analysis is that the current IoT market is very fragmented since there are many different products available for the different actors. The three main drawbacks extracted from the analysis are: (i) several deployed platforms are not open and it is difficult to achieve interoperability with other proprietary platforms and even with other open platforms; (ii) several IoT platforms are isolated and the information gathered is only usable through SCADA systems (either open or proprietary) connected to them; and (iii) IoT platforms are designed and deployed in independent application dependant silos (e.g. transport and logistics, health or smart agriculture). Stakeholders inquired have found that INTER-LAYER will need to combine various existing hardware and software solutions so as new designed components in order to provide interoperability between open IoT platforms and allowing connectivity at different layers for proprietary IoT platforms. At the same time INTER-LAYER may allow connectivity and exchange of data from currently isolated IoT platforms. The main challenge will be the use of application dependent products in different application domains, INTER-LAYER in combination with other INTER-IoT product like INTER-METH will allow this kind of solution.

As a matter of fact there is a clear need of a product like INTER-LAYER, and one of the main areas in which the product will be key is semantic interoperability. Stakeholders that are aware of the concept, associate it with the meaning of content being exchanged between IoT platforms. The stakeholders have a clear idea that to achieve semantic interoperability that is

one of the INTER-LAYER layers, there is a need of adapting services and defining a common ontology in order to represent information representation. The global ontology will have to consider several application domains, in order to access to a common knowledge representation model. The recommendation of IERC and AIOTI as main European stakeholders with influence capability is the linking of data sources to facilitate application integration and reuse of data, a proposal also addressed by OGC. ETSI with OneM2M and FIWARE follow different approaches. The aim and meaning of semantic interoperability as the higher layer of INTER-LAYER is controversial for stakeholders, as they see the interoperability suite more as protocol converter rather than other kind of product.

The stakeholder analysis has shown that there are a lot of needs not solved so far in terms of interoperability technology as INTER-LAYER may provide. These needs are framed under different categories, where we highlight the interoperability as it was expected, and will conveniently addressed in the form of requirements for WP3 in which INTER-LAYER will be defined and developed. Security concerns stakeholders and has been highlighted in each individual interview, with a special focus in privacy and ownership of the data when interoperability is performed.

To conclude, the current demand of IoT solutions for interoperability is traversal for any application domain and the increasing number of solutions and standards do not facilitate the adoption. Therefore, it can be foreseen that the exploitation of the INTER-LAYER product as a whole or as a suite with individual components could be very successful in the market.

3.2 INTER-FW stakeholders' analysis

3.2.1 Introduction

Most existing sensor networks and device deployments currently work as an independent entity of homogenous elements that serve a very specific purpose, and isolated from the rest of the world. In the cases where heterogeneous elements are integrated, this is done either at device level, or network level, and mostly one-directionally gathering information.

As will see in the analysis of stakeholders, there is a great need for interoperability around IoT. So far, technology providers and IoT platform developers are offering solutions on their own, with a huge lack of cooperation or joint forces among these agents. There are too many standardization initiatives, but none of them prominent enough to be considered as the guide everyone should adhere to. There are no past reference architectures to be used as a guide. Only in the very recent past some initiatives as the AIOTI starts to define these references, not finished nowadays.

The result of this situation is that existing IoT platforms are de facto silos, isolated from the others. The deployment of a new IoT platform imply a huge effort in ad-hoc integration with specific sensors, sensor networks, communication layers, application & services or third party IoT platforms and solutions. Lack of interoperability causes major technological and business-

oriented issues such as impossibility to plug non-interoperable IoT devices into heterogeneous IoT platforms, impossibility to develop IoT applications exploiting multiple platforms in homogeneous and/or cross domains, slowness of IoT technology introduction at large-scale, discouragement in adopting IoT technology, increase of costs, scarce reusability of technical solutions, user dissatisfaction.

As we will see in this section there is a great demand for accessing heterogeneous sensor data and devices regardless of the manufacturer or management platform, taking profit of the possibilities offered by semantics and standardization. There is a great demand for having available APIs and tools for making different IoT platforms interoperable. And there is a concern about security aspects that must be taken into account.

There are a lot of IoT platforms and initiatives, but there are no specific products focussed on interoperability among IoT platforms apart from traditional integration frameworks, not focussed on the IoT realm.

Therefore, the analysis of stakeholders and products is essential for a subsequent definition of INTER-FW requirements.

3.2.2 Stakeholder participants

The INTER-FW product is centred in systems integrators and developers mainly. There are a big number of affected stakeholders from different types of organizations. For this reason, the selection of a minimum set of representative has been attempted.

At this time of development of this report, the number of stakeholders which have been interviewed for the INTER-FW product is 57.

The stakeholders that took part in the study have been categorized as follows:

Public authorities

The authorities involved in the Project will play an important role in it. This group mainly consists of public bodies at different levels (national, regional, local) and the European Commission. The European Commission is the sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.

Public organizations participating in the project or the pilot demonstration are specifically involved due to the dual consideration of public body and relevant stakeholder.

Table 19. Public authorities (INTER-FW)

Stakeholder	Description
DG CONNECT – European Commission	The sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.

IoT platform owners/operators

In this group we include stakeholders that own and operate an IoT platform for diverse business needs. This group of stakeholders share in common the need to integrate their IoT platforms with external systems, be them IoT platforms, sensors, devices, applications or services.

The group of stakeholders owning an IoT platform are the following:

Table 20. IoT platform operators (INTER-FW)

Stakeholder	Description
NOATUM PORTS	Terminal offering: Bulk terminals, Container terminals, Multi-purpose terminals, Rail terminals, Ro-Ro and vehicle terminals.
Autoridad Portuaria De Vigo	Responsible for running the largest port in Galicia and owner of a SmartPort platform.
Ayuntamiento de A Coruña	Public body responsible of managing the city of A Coruna, including the smart city platform based in SOFIA2.
VMZ Berlin betreibergesellschaft MBH	SME whose business area is urban mobility and traffic management services.

End users with Sensor/devices owners

In this group we include stakeholders that own and operate multiple sensors or devices without having a specific IoT platform. This group of stakeholders share in common the need to integrate with external systems, be them IoT platforms, sensors, devices, applications or services, but lacking an own IoT platform. In some cases they may need a future IoT platform.

The group of stakeholders owning sensors or devices without an IoT platform are the following:

Table 21. End users (INTER-FW)

Stakeholder	Description
ValenciaPort Foundation	Non-profit organisation works on the innovation of the port, transport and logistics sectors.
Aubry Transports	AUBRY is a haulier based in the Lorraine region operating domestic and European freight transport.
Rouillé & Coulon	Rouillé & Coulon is a logistics and a transport services provider based in 5 locations scattered throughout France performing domestic and European and domestic activities.
Tolsma Techniek	Tolsma is a supplier of Potato storage systems. They want to connect the entire loop of the growth cycle.

Bekosense	Bekosense is a farming firm that is developing diagnostics equipment for farms.
Creative Systems Engineering (C.S.E.)	CSE engineers have experience in the design and implementation of both hardware and software systems.
Sentinel d.o.o.	Sentinel is a Croatian company providing a hardware and software bundle for the monitoring of personal vessels and charter fleets.
Teletransfusion	SME providing service for remote pre-transfusion evaluation of blood samples by specialists.

IoT Platform Provider

In this group we include stakeholders that has developed owned or shared IoT platforms and offer technological solutions using their IoT platform. They are also involved in the evolution of the platform. This group of stakeholders share in common the need to integrate their platforms with different systems: IoT platforms but also sensors and devices not managed by an IoT architecture.

Table 22. IoT platform provider (INTER-FW)

Stakeholder	Description
Telefonica	Telefonica is a broadband, fixed and mobile telecommunication provider and offers IT services and solutions in several areas.
INDRA	Large Spanish industrial company related with ICT in different application domains including transport, health and defence.
ETRA I+D	ETRA's mission is putting in the market the most advanced solutions and services either directly or through the 10 companies of the Group.

Technology providers/experts

In this group we include stakeholders that offer technological solutions around IoT platforms. This group of stakeholders share in common the need to integrate with different IoT platforms for applying its solutions into the market, generally with the IoT platforms owned by their customers or by agent that interact with their customers. The group of stakeholders are the following:

Table 23. Technology experts (INTER-FW)

Stakeholder	Description
Telecom Italia	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Italy, owner of TIM.

Consoft Sistemi S.p.A.	Consoft Sistemi is an Italian company that expands the group leader's offer, particularly linked to Telecoms in the North African and Middle Eastern markets.
Universitat Politècnica De Valencia	Spanish public university, with several research centers and projects related with IoT
Ingeniería de Aplicaciones Energéticas SL	Ingeniería de Aplicaciones Energéticas SL was born in 2006, from customers' demand on solutions in Energy Management.
Orbita Ingeniería S.L.	SME providing technology related with IoT and automation to the port community.
Prodevelop	Prodevelop is a solution developer and systems integrator with a high expertise in port & maritime solutions and public administration, especially smart cities.
Thales Services SAS	Thales Services (THS) belongs to Thales group, which is a large industry player specialized in critical systems for government and companies.
Neways	Neways is an international company active in the EMS (Electronic Manufacturing Services) market.
Wageningen University	Wageningen University is a catalyst between companies and the research dept. of the university, and is specialised in agriculture, horticulture and aquaculture.
Yokogawa Process Analyzers	It is a supplier of different on-line tools for industrial process analytics. Liquid analysers are used for monitoring process chemistry, providing process optimization and control.
Technische Universiteit Eindhoven	Technical public university in The Netherlands, with different projects and research areas related with IoT.
Infoport Valencia	Infoport is a technology services company specializing in the logistics sector and port.
KII	Kii helps developers and device manufacturers meet their high-performance demands with an end-to-end platform optimized for building and running enterprise mobile and IoT initiatives.
Multinational Solutions Provider For Government And Institutions (GIS)	Multinational solution provider for government and institutions, working for customs authorities and ministries for the simplification of trade.
XLAB d.o.o.	XLAB is a company providing technology solutions for enterprises and products for, among others, high volume and speed services such as Internet of Things.
Amiga Ventures	Amiga provides services to allow companies to undertake the digital transformation of their business, from strategy and design to maintenance and continuous improvement.

Alessandro Bassi Consulting (ABC)	SME related with innovative business solutions related with ICT and specifically IoT.
Things	Agency related with design and innovation in the area of IoT, including new business and services models.
VTT Technical Research Centre of Finland	Leading research and technology research center in the Nordic countries.
Fincons	Consulting and development group of companies related with different ICT areas, including IoT.
Systems Research Institute, Polish Academy of Sciences (SRIPAS)	Public Polish research center active primarily in the domain of methodological foundations for systems analysis.
Vemco SP z.o.o.	Vemco is a company with main a focus on computer networks and access-control systems.
BetterSolutions SA	BetterSolutions has knowledge and experience in designing, developing and deploying systems based on IoT platforms.
Orange Polska S.A.	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Poland, part of Orange Group (France Telecom).
Intel Technology Poland SP z.o.o.	Leading international company in hardware development and specifically in IoT.
ISECO S.L.	SME software control development company integrating sensors in a proprietary control centre and SCADA.
Instituto de Tecnología Informática (ITI)	Research association of SME and industries related with software development

Standardization bodies

In this group we include stakeholders aimed at producing standards related with the Internet of Things or at providing guides and references about the IoT realm, that have expressed interest in INTER-IoT project. This group of stakeholders share in common the need to offer interoperability mechanisms and being compatible among them.

The group of stakeholders for the standardization bodies are the following:

Table 24. SDOs (INTER-FW)

Stakeholder	Description
Open Geospatial Consortium (OGC)	International not for profit organization committed to making quality open standards for the global geospatial community.
AIOTI-UPV	Group of research groups related with IoT at UPV and associated research institutes.

R&D projects

In this group we include as stakeholders research & development projects focussed on the Internet of Things field, that have crossed interests with INTER-IoT due mainly to the joint efforts established by the European Commission for the H2020-ICT30. This group of stakeholders share in common the need to design interoperability mechanisms among IoT platforms.

The group of stakeholders for the standardization bodies are the following:

Table 25. R&D projects (INTER-FW)

Stakeholder	Description
ICT-30 SymbioTe	H2020 RIA SymbIoTe (Symbiosis of smart objects across IoT environments): interoperability mechanisms at different layers.
ICT-30 TagItSmart	H2020 RIA TagItSmart: connectivity and interoperability of funny tags.
ICT-30 BIG-IoT	H2020 RIA BigIoT (Bridging the Interoperability Gap of the IoT): interoperability mechanisms at different layers.
ICT-30 BIoTope	H2020 RIA BIoTope (Building an IoT Open innovation Ecosystem for connected smart objects): use of open standards for platform interoperability.
ICT-30 Agile	H2020 RIA AGILE (An Adaptive and Modular Gateway for the Internet of Things): interoperability through an open gateway.

3.2.3 Stakeholders by company type

In a more detailed classification, the stakeholders can be divided into the following categories:

Table 26. Stakeholders by company type (INTER-FW)

Non-profit organization	ValenciaPort Foundation AFT AIOTI-UPV
Private technology and solutions supplier company	Prodevelop NEWAYS Amiga Ventures ETRA I+D Thales Services Engineering Ingegneria Informatica S.p.A. Infoport Valencia Kii

	Multinational solution Provider for Government XLAB d.o.o. Sentinel d.o.o. Vemco SP z.o.o. Orange Polska S.A. BetterSolutions SA VMZ Berlin betreibergesellschaft MBH Tolsma Techniek Bekosense Creative Systems Engineering Sentinel TeleTransfusion Telefónica INDRA Consoft Sistemi S.P.A. Ingeniería de Aplicaciones Energéticas SL Orbita Ingeniería S.L. Amiga Ventures Alessandro Bassi Consulting (ABC) Things Fincons Intel Technology Poland SP z.o.o. ISECO, S.L. Telecom Italia
Logistic company	NOATUM Ports Aubry transports Rouillé & Coulon Yokogawa Process Analyzers
University/Research Center	Universitat Politècnica De Valencia Technische Universiteit Eindhoven SRIPAS Wageningen University VTT Technical Research Centre SRIPAS Instituto de Tecnología Informática (ITI)
Public Authorities	DG CONNECT – European Commission Autoridad Portuaria de Vigo

	Ayuntamiento de A Coruña
Standardization Bodies/Alliances	Open Geospatial Consortium (OGC) AIOTI-UPV
Projects	ICT-30 TagItSmart ICT-30 BIG-IoT ICT-30 SymbIoTe ICT-30 BIoTope ICT-30 Agile

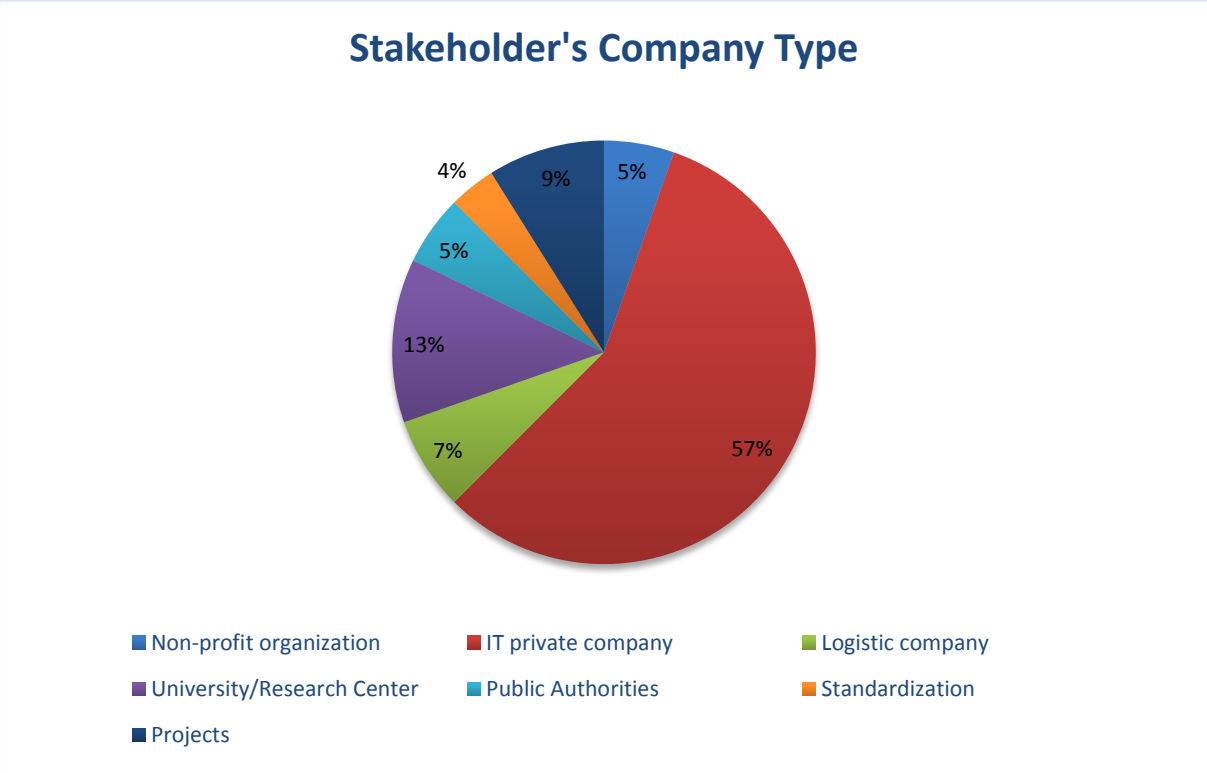

Figure 15: INTER-FW Stakeholder's Company Types

At the graph we can observed that more than half of the identified stakeholders are from private companies, followed by universities/research centers and a set of similar share for R&D projects, logistics companies, NPO's, public authorities and a small representation of standardization bodies/alliances.

3.2.4 Stakeholders by country

Stakeholders can be differentiated by their country.

Table 27. Stakeholders by country (INTER-FW)

Spain	ValenciaPort Foundation Universitat Politècnica De Valencia Prodevelop NOATUM Ports Autoridad Portuaria De Vigo Amiga Ventures ETRA I+D AIOTI-UPV Telefónica INDRA Ingeniería de Aplicaciones Energéticas SL Orbita Ingeniería S.L. ISECO, S.L. Instituto de Tecnología Informática (ITI) AIOTI-UPV Ayuntamiento de A Coruña
Italy	Engineering Ingegneria Informatica S.p.A. Sentinel TeleTransfusion Consoft Sistemi S.p.A. Alessandro Bassi Consulting (ABC) Things Fincons Telecom Italia
France	AFT Thales Services Aubry transports Rouillé & Coulon
Netherlands	NEWAYS Technische Universiteit Eindhoven Tolsma Techniek Bekosense Wageningen University
Poland	Vemco SP z.o.o. Orange Polska S.A. BetterSolutions SA

	Intel Technology Poland SP z.o.o. SRIPAS
Slovenia	XLAB d.o.o.
Germany	VMZ Berlin betreibergesellschaft MBH
Finland	VTT Technical Research Centre
Croatia	Sentinel d.o.o.
Belgium	DG CONNECT – European Commission ICT-30 TagItSmart ICT-30 BIG-IoT ICT-30 SymbIoTe ICT-30 BIoTope ICT-30 Agile
Greece	Creative Systems Engineering
United States of America	Open Geospatial Consortium (OGC)
Japan	Yokogawa Process Analyzers

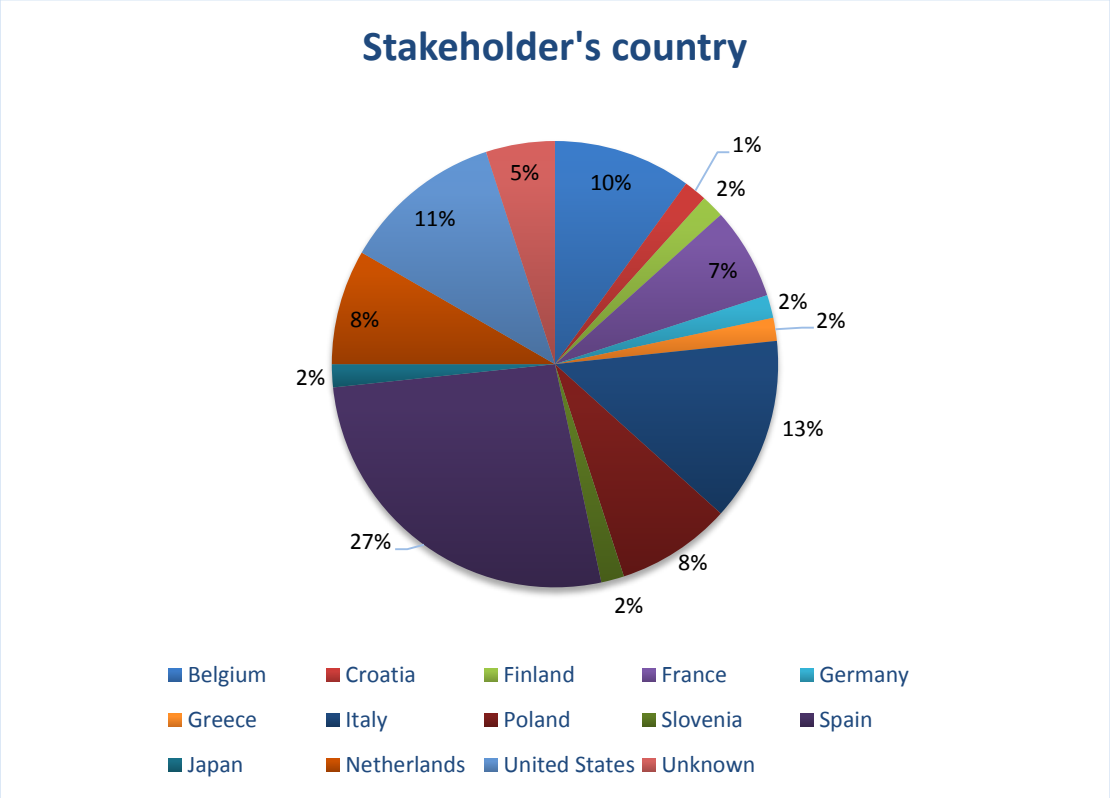

Figure 16: INTER-FW Stakeholder's country

The distribution of stakeholders per country is quite well balanced. There are two remarkable clusters at Spain and Italy, where the pilots are to be tested, but these two clusters sum 43%, under the 50% of the total stakeholder's countries. The rest of the countries are distributed among France, Netherlands and Poland in similar percentages around 10% each. There is a remarkable set of stakeholders at Belgium, but it's unreal, as it represents mainly R&D ICT30 projects. Finally, there is a tail of countries with 1/2 representatives each, which gives a good variety of countries, even with 2 non-EU countries like Japan and USA.

3.2.5 Stakeholders map

Following the Volere methodology, the stakeholder's map for the INTER-FW product is as represented in figure 17.

If we classify the stakeholders according to the design, development and execution of Inter-FW, we obtain a map as shown above. There are four main areas in this map, corresponding to the influence degree of each stakeholder:

- **Analysis team:** Is the core team in the design and development of Inter-FW. It is comprised by most project partners that lead the project and are directly involved with Inter-Framework (e.g. UPVLC, PRO, XLAB, NEWAYS, etc.). Other partners, such as TI, Unical and AFT, relate to another area (business area).
- **Operational work area:** Every stakeholder that has direct a contact with Inter-FW (e.g. CSE, ITI), has enough knowledge on the product (e.g. ETRA) or could have a main role in the development and execution of Inter-FW (e.g. INDRA, Iseco) will fall under this ring.
- **Business area:** Stakeholders that are affected in business ways by Inter-FW (but not enough to have a main role) are located in this ring. Some stakeholders are interested in contributing to Inter-FW (e.g. VMZ) or testing and adopting Inter-FW (e.g. Valencia Port Authority). Their business models may influence the business models developed within Inter-IoT regarding Inter-FW.
- **Influence area:** In the outer ring stakeholders that have an influence or some interest with Inter-FW are located. Other IoT related projects (e.g. BIG-IoT), IoT alliances (e.g. AIOTI), etc. Standardization organizations also play an important role in this ring, as the developed Inter-FW product should follow or be in line with the recommendations and working groups implied in these bodies.

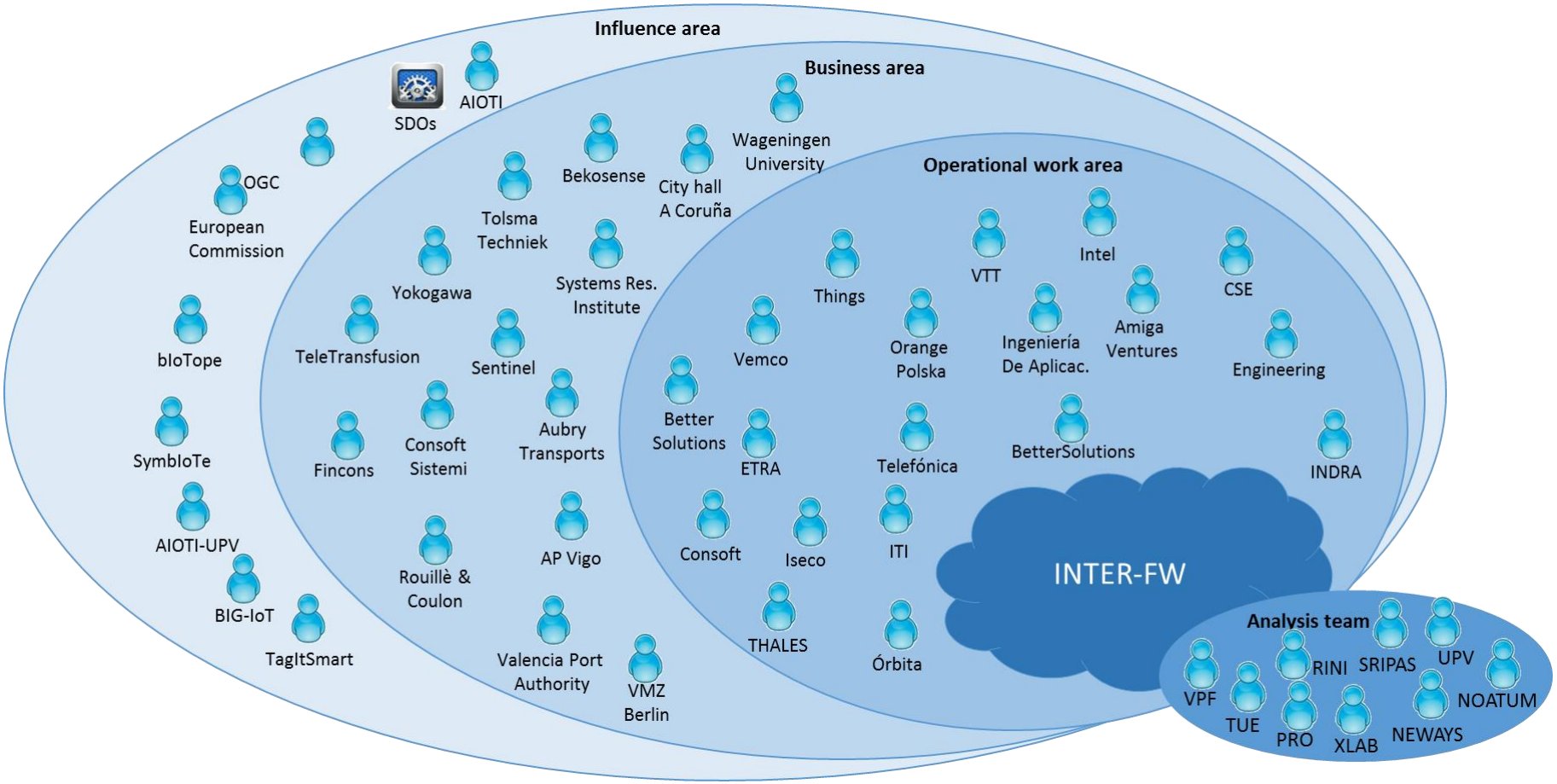

Figure 17 INTER-FW Stakeholder's map

3.2.6 Stakeholders by class

Following the Volere methodology, the stakeholders can be classified according to the role they will play in the INTER-FW product. Therefore they can be distinguished the following classes.

Table 28. Stakeholders by class (INTER-FW)

Client	NOATUM Ports DG CONNECT – European Commission
Customer	VMZ Berlin betreibergesellschaft MBH Tolsma Techniek Bekosense Aubry transports Rouillé & Coulon Wageningen University Autoridad Portuaria de Vigo Ayuntamiento de A Coruña
Subject-matter experts	ValenciaPort Foundation NEWAYS Vemco SP z.o.o. Orange Polska S.A. Consoft Sistemi S.p.A. Telecom Italia
Systems engineers	Orbita Ingeniería S.L. BetterSolutions SA ISECO, S.L. Yokogawa Process Analyzers
Software engineers	Infoport Valencia Creative Systems Engineering
Technology experts	Prodevelop Amiga Ventures Thales Services Engineering Ingegneria Informatica S.p.A. Telefónica INDRA Ingeniería de Aplicaciones Energéticas SL Amiga Ventures Alessandro Bassi Consulting (ABC)

	Things Fincons Intel Technology Poland SP z.o.o. Universitat Politècnica De Valencia Technische Universiteit Eindhoven SRIPAS VTT Technical Research Centre SRIPAS Instituto de Tecnología Informática (ITI) Kii Multinational Solutions Provider For Government
Domain Experts	Open Geospatial Consortium (OGC) AIOTI-UPV ICT-30 TagItSmart ICT-30 BIG-IoT ICT-30 SymbIoTe ICT-30 BIoTope ICT-30 Agile
Designers and developers	AIOTI-UPV XLAB d.o.o. Sentinel d.o.o. TeleTransfusion ETRA I+D
Representatives of external associations	AFT

The distribution of stakeholders per class shows that we have a well-balanced set of stakeholders. However, most of the stakeholders belong to the ICT sector, with technology experts, software & system engineers and designers and developers being the 65% of the whole set. We see that we have a good number of potential customers and domain experts for avoiding the exclusive focus on IT features.

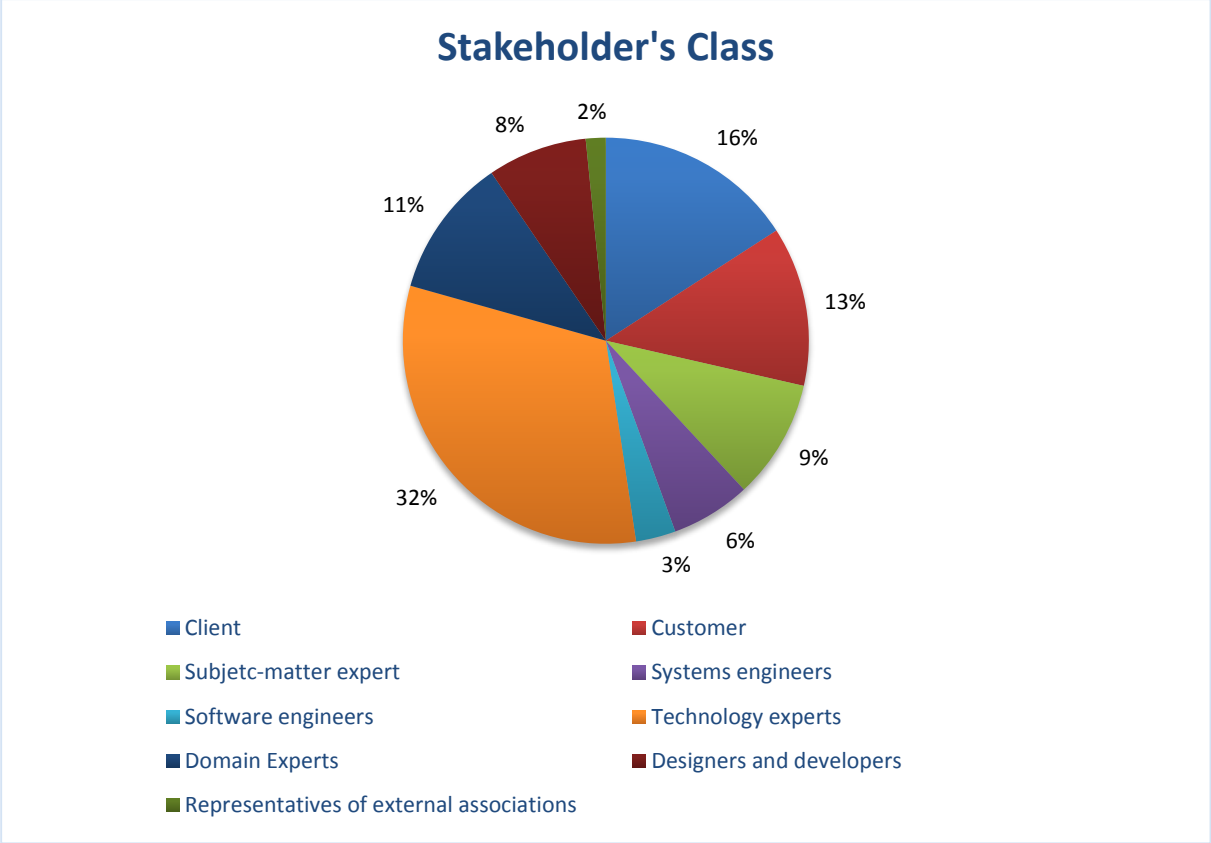

Figure 18 INTER-FW Stakeholder's class

3.2.7 Stakeholders by IoT Demand/Supply

In the field of internet of things each of the stakeholders can provide (supply side) or receive (demand side) information. On the supply side it is identified at first research entities and development companies, and on the contrary on the demand side it has been identified final users such as public administration bodies (port authorities) and related companies with the transport, logistic, shipping and port sector.

Table 29. Stakeholders by IoT Demand/Supply (INTER-FW)

IoT Demand side	IoT Supply side
ValenciaPort Foundation	AIOTI-UPV
AFT	Prodevelop
Sentinel d.o.o.	NEWAYS
VMZ Berlin betreibergesellschaft MBH	Infoport Valencia
Tolsma Techniek	Amiga Ventures
Bekosense	ETRA I+D
Sentinel	Thales Services

TeleTransfusion	Engineering Ingegneria Informatica S.p.A.
NOATUM Ports	XLAB d.o.o.
Aubry transports	Vemco SP z.o.o.
Rouillé & Coulon	Orange Polska S.A.
DG CONNECT – European Commission	BetterSolutions SA
Autoridad Portuaria De Vigo	Creative Systems Engineering
Ayuntamiento de A Coruña	Telefónica
Telecom Italia	INDRA
	Consoft Sistemi S.p.A.
	Ingeniería de Aplicaciones Energéticas SL
	Orbita Ingeniería S.L.
	Amiga Ventures
	Alessandro Bassi Consulting (ABC)
	Things
	Fincons
	Intel Technology Poland SP z.o.o.
	ISECO, S.L.
	Yokogawa Process Analyzers
	Universitat Politècnica De Valencia
	Technische Universiteit Eindhoven
	SRIPAS
	Wageningen University
	VTT Technical Research Centre
	SRIPAS
	Instituto de Tecnología Informática (ITI)
	Open Geospatial Consortium (OGC)
	AIOTI-UPV
	ICT-30 TagItSmart
	ICT-30 BIG-IoT
	ICT-30 SymbIoTe
	ICT-30 BIoTope

	ICT-30 Agile
	KII
	Multinational Solutions Provider For Government

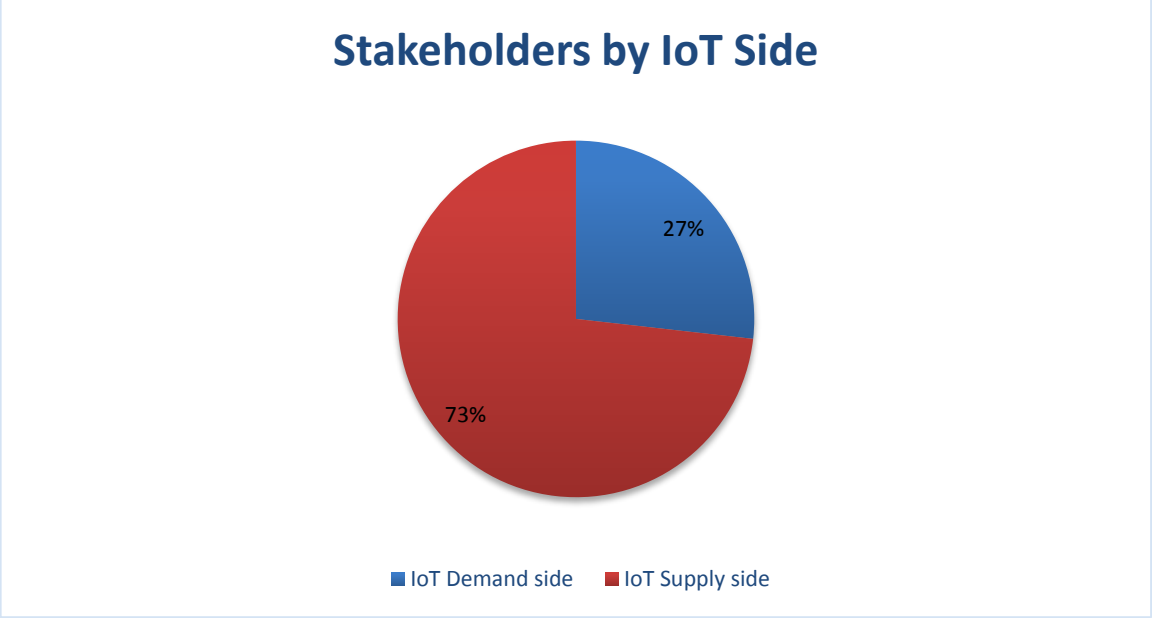

Figure 19 INTER-FW Stakeholder's by IoT side

In the above graph we can see that we have a major number of stakeholders on the IoT Supply side, with 73% of share, while we only have a 27% of share for stakeholders on the IoT Demand side. This is due to the technical characteristics of the product. In fact, the IoT is something recent and market movements are currently clearly located on the supply side than on the demand side.

3.2.8 Stakeholders with interest in Open Call participation

Within the project INTER-IoT, an open call will carry out. All those stakeholders who meet the stated requirements can apply it. Stakeholders who have shown some interest are the following.

Table 30. Stakeholders with interest in Open Call (INTER-FW)

Interested in participating in open calls	Not interested in participating in open calls
Amiga Ventures	AFT
BetterSolutions SA	AIOTI-UPV
Consoft Sistemi S.p.A.	Alessandro Bassi Consulting (ABC)

Creative Systems Engineering	Aubry transports
Ingeniería de Aplicaciones Energéticas SL	Autoridad Portuaria De Vigo
Kii	Ayuntamiento de A Coruña
Orange Polska S.A.	Bekosense
Orbita Ingeniería S.L.	DG CONNECT – European Commission
Infoport Valencia	Engineering Ingegneria Informatica S.p.A.
Instituto de Tecnología Informática (ITI)	ETRA I+D
	Fincons
	ICT-30 Agile
	ICT-30 BIG-IoT
	ICT-30 BIoTope
	ICT-30 SymbIoTe
	ICT-30 TagItSmart
	INDRA
	Intel Technology Poland SP z.o.o.
	ISECO, S.L.
	Multinational Solutions Provider For Government
	NEWAYS
	NOATUM Ports
	Open Geospatial Consortium (OGC)
	Prodevelop
	Rouillé & Coulon
	Sentinel d.o.o.
	SRIPAS
	Technische Universiteit Eindhoven
	Telefónica
	TeleTransfusion
	Thales Services
	Things
	Tolsma Techniek
	Universitat Politècnica De Valencia

	AIOTI-UPV
	ValenciaPort Foundation
	Vemco SP z.o.o.
	VMZ Berlin betreibergesellschaft MBH
	VTT Technical Research Centre
	Wageningen University
	XLAB d.o.o.
	Yokogawa Process Analyzers
	Telecom Italia

As we can see in the following chart, there is only a 19% of the stakeholders who are interested in the open-call to be launched within INTER-IoT project. This figure doesn't affect the stakeholder analysis.

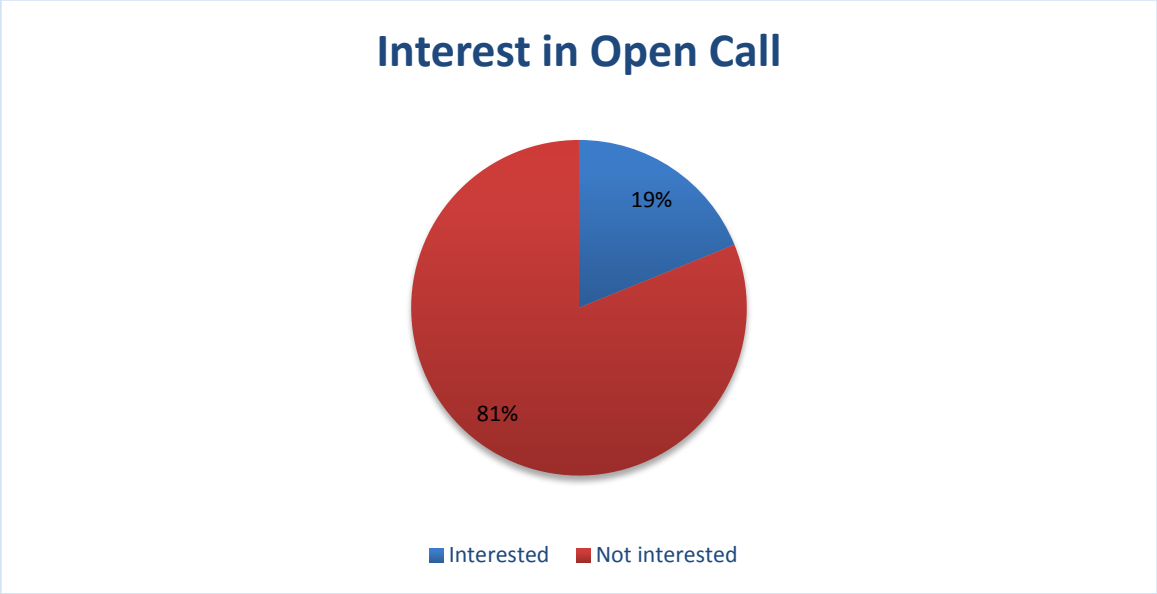

Figure 20 INTER-FW Stakeholder's interest in the open call

3.2.9 Products involved by Stakeholders

The products identified by the stakeholders are classified into different categories depending on the nature and aim of the product. There are IoT platforms, alliances, standards and some other very different categories, all of them offering an interesting viewpoint to be taken into account in the project. The set of categories and the related products are listed below:

IoT Platforms / Smart Platforms

- FIWARE
- NEC Smart Cities
- Open IoT
- VLCi (FIWARE)
- BUTLER
- Google Brillo
- Intoino
- Oracle IoT
- Agata
- Alljoyn Framework
- Eclipse Kura
- Iotivity
- Sofia2
- Azure IoT Suite
- Kii Could

Interoperability IoT Platforms/Frameworks

- Hypercat
- Intel IoT Gateway
- Google Weave

Alliances/Organizations

- IoT M2M Council
- AllSeen Alliance

Communication Frameworks/Architectures

- AirGround
- Demanes

Specific Business Software

- CATOS
- Conlock
- Giraff+
- Kukua
- Sentinel

- Posidonia Operations

Standards

- One M2M
- SensorThings API
- AENOR UNE 178301

The products identified in this analysis have been very diverse. There have been identified a broad set of IoT platforms, which can be seen as a source of requirements for the project or as a set of use cases to be tested at the end. But they can also be seen as competitors, as many of them try to offer interoperability mechanisms for accessing sensor data. It's interesting that some of the identified product are better described as interoperability platforms or frameworks. This group is of special importance to INTER-IoT project. It should be analysed if these products can be integrated, if interesting ideas should be followed, or if they lack specific features that INTER-IoT should address.

3.2.10 Stakeholders needs

Identified stakeholders has stated specific needs that they have found of importance. These needs have been analysed and classified attending to the type of stakeholder. For this classification we have found that the most important categorization parameter is the first grouping, attending to the type of relationship they have with IoT. These are the identified needs we have found for these classes of stakeholders with respect to the INTER-FW product:

Public authorities

The client group are the organizations who fund the development of the product. Apart from the private funding of each partner, this groups is formed by a single stakeholder: the European Commission – DG Connect

DG Connect has established the following needs:

- Develop open platforms to foster a vibrant IoT ecosystem. Opening up to developer communities and creative practices.
- Break the silos between the application areas (e.g. health, home) and technologies such as IoT, CPS, Cloud, and Big Data.
- Prepare the ground for Large-scale Pilots.
- Not to forget about trust, security, ethics, etc. (IoT preparing the hyper-connected society)

It is needed a high impact of the action with:

- A visible and strategic programme

- Coordination and synergies across projects
- Availability and maturing of sustainable IoT platforms based on real ecosystems and developers
- Sustainability beyond the project life time
- Make progress and not reinvent the wheel

The European Commission wants to achieve a leadership in digital platforms for industry. For this, it is needed an availability of interoperable open platforms for any business to support its digital transformation. INTER-FW should be a multisided industry platform, understood as a foundation technology or service that enables a broader, interdependent ecosystem of businesses and requires complementary innovations to be useful, some levels of openness are necessary (i.e. APIs or SDKs) and it is necessary to go through standardization.

For instance, at European and national level the stakeholders want to achieve a leadership in digital platforms for industry. For this, the most important need is availability of interoperable open platforms for any business to support its digital transformation and break the silos between the application areas (e.g. health, home) and technologies such as IoT, CPS, Cloud, and Big Data. This will allow develop open platforms to foster a vibrant IoT ecosystem. Opening up to developer communities and creative practices.

As an organization that finances research projects in the field of Internet of things, the European Commission has a visible and strategic IoT programme. In order to comply that programme, it has to coordinate and promote synergies between projects. It has to get the sustainability beyond the project life time and prepare the ground for large-scale pilots from the result of the projects.

All this will allow the availability and maturing of sustainable IoT platforms based on real ecosystems and developers. Not forgetting trust, security, ethics, etc. (IoT preparing the hyper-connected society)

IoT platform owners/operators

The stakeholders who have deployed IoT platforms have shown needs about INTER-FW product that fall mainly in the field of interoperability. It is considered necessary to have interoperability methods for interconnecting its own IoT platform with external IoT platforms from agents and organizations working with them. There are a set of specific needs from the stakeholders point of view:

- To offer an API (some cite REST) and tools integrated with their own platforms for allowing third developers to access to sensor data in a common and standard way.
- To integrated sensor data with their own IoT platform. Some stakeholders consider interesting to extend its current IoT platform with interoperability APIs and tools for easing a future adding of sensor data from third party agents.
- To configure which information and services is published in an easy way.

- To have internal available APIS and tools for accessing other agents IoT platforms as well as offering these agents the possibility to use these FW, APIs and tools for integrating with the platform.
- Easy integration between platforms.
- High rate of platform's availability, and high response time i.e. suitable to the operative and different modes of transfer/communication.
- The platform should manage security aspects such as:
    - Authorizations
    - User data privacy
    - Log/record
    - Permission access
    - Trust
    - Connection
- Proper device discovery and management are fundamental in order to achieve a functional information system, as well as correctly resolving any dependencies between them.
- Security is also essential for the Incident management center, user data privacy must be guaranteed and secure access to data has to be always validated.

As it can be seen, this group concerns mainly about APIs and integration capabilities and tools to and from their own IoT platform, and also about security aspects.

End users / sensor owners

The stakeholders who are end users of IoT or who owned sensors or devices that might need integration with IoT platforms have some common needs about a future INTER-FW product that fall mainly in the field of data collection and security. There are a set of specific needs from the stakeholders point of view:

- To ease and expedite the interoperability of different IoT platforms providing a solution to many of the challenges that appear in communicating, authorizing, registering, discovering, accessing, roaming, using and linking physical and virtual entities among different and heterogeneous IoT platforms.
- The existence of a common interoperable framework applicable in several domains will provide the capacity of creating open and interoperable IoT solutions where different companies can share information generated by different smart devices and sensors or captured from tags in a secure and trusted environment.
- This common interoperable framework should give confidence on security and trust and be fully compliant with data protection regulations.
- This framework should help IoT architects, engineers and developers to transform existing sensor, tags and smart object networks to interoperable IoT platforms, create new interoperable IoT platforms and connect and configure the relations between two interoperable IoT platforms.

- The data collection is key in the project, regardless of the sensor type.
- The computing is key in the project, regardless of the sensor type. Some require to information merge with external services.
- To get the entire network system setup so it can be used for more sensors.
- To identify a large set of testing procedures for the different modules to be included in the framework (management, security, discovery, etc.). Only with a rigorous list of testing procedures we will be able to offer real interoperability with the proposed Inter-FW product. To only use frameworks that pass certain evaluation criteria.
- Management and discovery are modules within the framework of special relevance for CSE as they develop gateways for residential use where end users require easy of management and high capability of discovering and connecting various heterogeneous devices.
- The ability to connect services through different transportation means (WiFi, GSM, 4G, etc.), communication with different services.
- Need for reliable communication platform.
- It's necessary to advance in the standardization of ontologies.
- It's necessary to advance in the standardization of IoT platforms architectures.
- It's necessary to achieve interoperability among IoT platform components for allowing the substitution/combination of products.
- The implementation of protocols that allow the direct connection with sensors is needed.
- It's urgent to push protocol standardization and open protocol specification in the IoT realm, as it's usual to have manufacturers not following specifications completely (e.g. XBee/Zigbee).
- Apart from an integration at data level, integration at bus level is needed.
- The integration of IoT platforms with reference architectures is needed. For instance integration of SOFIA 2 with FIWARE.

These type of stakeholders have some common concerns. One major need is sensor accessing independently of the IoT platform or sensor type, including discovery capabilities. Other important need is about security concerns (authorization, privacy, trust, access, etc.).

IoT platform provider

The stakeholders who have developed their own IoT platform have similar needs about a future INTER-FW product. There are a set of specific needs from the stakeholders point of view:

- The existence of a common interoperable framework applicable in several domains will provide the capacity of creating open and interoperable IoT solutions, as well to prevent the appearance of vertical silos. The creation of a coexisting and cooperative environment of all the interoperability frameworks is a need in order to avoid the

creation of IoT vertical silos due to incompatibilities between interoperability frameworks.

- To maximize and guarantee the compatibility and interoperability of its IoT services and platforms.
- In the creation of an interoperability framework several commonalities between platforms have been identified a free open source framework API and high-demanding security management.
- Achievement of rapid cross-platform IoT application development
- Security, access scopes and identity management
- Semantics
- Framework APIs to provide a unified view of different IoT platforms and their resources
- An equivalent interoperability stack based on the following domains: Device, Smart Space, Cloud and Application.
- Interoperability to physical and virtualized sensing/actuating IoT resources,
- Scalable and extensible
- To have a framework for their internal developments specific for IoT platforms that can be integrated it into their own development frameworks.

Technology experts

There are a broad group of stakeholders categorized as technology experts with a disparate set of needs about a future INTER-FW product. There are a set of specific needs from the stakeholders point of view:

- API and tools to integrate devices and / or measures from devices /sensors;
- Meta data model to translate /match data and semantics in order to integrate data belonging to third party platforms
- API to integrate services belonging to third party platforms
- The existence of a common interoperable framework applicable in several domains will provide the capacity of creating open and interoperable IoT solutions in Wireless Sensor Networks, command and control systems and health environments.
- This framework should help IoT architects, engineers and developers to transform existing sensor, tags and smart object networks to interoperable IoT platforms.
- High time responses for accessing data -should be 1 second (desired), 2 second (acceptable), 5 second (maximum)-.
- The connectivity should be by using WiFi at the installations, however in large zones it should use other solutions such as roaming, 3G, 4G and switching automatically.
- Reliability with a rate of error less than 5%.
- Security matters. It is needed verified local authentication or trust list. Supposing authentication by WiFi or NFC.
- Minimising consumption through use of smart algorithms (e.g. if there is no change there is no refresh or minimum refresh).

- The product will use platform-platform connectivity (e.g. SEAMS platform) or device (truck driver smartphone)-platform (Dynamic lighting).
- Protocol and requirements are needed in order to commission the development to programmers, that is, to have a framework (INTER-FW) and its related methodology (INTER-METH).
- It is needed to define infrastructure standards in order to be compatible with different levels of IoT. So in this way it is needed to define the level of Infrastructure.
- The implementation of the INTER FW has to be progressive, as the environment is in a large scale it is impossible to implement this technology all at once, it has to be in a progressive manner.
- Security: it has to have different security layers and sub groups, auto logging levels at device level, the digital certificate should be transmitted by different channels. Authentication, Security and Privacy protocols. This common interoperable framework should give confidence on security and trust and be fully compliant with data protection regulations.
- The location/position has to be an element to be consider in order to identify the devices.
- To have framework, API and tools that can easily be used in projects and for providing generic services to IoT solutions, focusing on business needs rather than integration layers, with the ability to merge cross-domain information.
- To have access at the application & services layers and at the semantic level. The API should be used for gathering data from external IoT platforms and for offering external agents to access data from other IoT platforms through an API without knowing anything about protocols. An
- API REST would be suitable, but it’s not restricted to avoid using SOAP. Security is also a requirement.
- Configuration of services should be done easily without programming.
- INTER-FW should provide tools to develop applications where are involved objects belonging to different platforms, with different owners.
- To match, translate and integrate Meta data, Semantics and Services to third party platforms. These Meta models, Semantics and Services should support and provide interoperability of privacy and security related aspects.
- Cloud services and node firmware deployment tools are needed to reprogram at runtime the network.
- To use heterogeneous devices from various vendors in mixed criticality and multi-vendor IoT infrastructures.
- Support push notifications.
- Manage and control the number of API requests.
- Low cost of integration of a new IoT platforms.
- Communication and connection specifications and protocols (wired and wireless).
- Management and Monitoring protocols.

- Data collection and Transport protocols:
  - Device to Device protocols, to transmit data among devices.
  - Device to Server protocols, to collect data from devices to the servers over the IT infrastructure.
  - Server to Server protocols, to transmit data among servers.
  - Device to Human protocols, to transmit data between an IoT device and a human device.
- Interoperability standards, protocols and methods.
- To ease and expedite the interoperability of different IoT platforms providing a solution to many of the challenges that appear in communicating, authorizing, registering, discovering, accessing, roaming, using and linking physical and virtual entities among different and heterogeneous IoT platforms.
- To help IoT architects, engineers and developers to transform existing sensor, tags and smart object networks to interoperable IoT platforms, create new interoperable IoT platforms and connect and configure the relations between two interoperable IoT platforms.
- To be able to quickly recognize connected devices adding them to the ecosystem, showing which actions and behaviours they can perform.
- A usable framework should allow devices to add their functionalities to the ones that it already offers, giving the final user a sense of continuity and a ubiquitous access to their data.
- Frameworks should be able to operate with each other in the same way, communicating without the need for an intervention from the user, remaining completely invisible to them.
- On framework or architectural level to adhere to a few reference architectures: FIRE, IIC IIRA and perhaps IoT-a.
- Application level interoperability, in my understanding, varies from domain to domain. Some have a good base of (standardized) interoperability, others not.
- Lack of advanced semantics – communication with devices is based on many vendor-specific protocols
- In case of integrating many platform (set of devices) each of them is managed separately due to dedicated APIs
- Various variants of business rules engines. The problem is to analyse large amounts of data generated continuously and detection a number of conditions (in two variants, simple and complex). Very important is the quick reaction in real time system (system of systems).
- Easy data exchange with IoT gateways (¿INTER-LAYER?) installed in vehicles; e.g. Raspberry Pi-based embedded systems acting as gateways for WSAN nodes.
- Data ownership – sensors as data sources are owned by different third parties; IoT platform should support data ownership management, data-flow monitoring, access management

- Data privacy – in case of personal data processing, IoT platform should meet European and national standards.
- Offering of processed data and alarms to a suite of different applications.
- Integration of legacy systems and frameworks form different developers

Standardization bodies

The stakeholders who are working on standardization around IoT technologies have stated the following needs about a future INTER-FW product:

- IoT is not only about devices and network, semantics is important and also services.
- Reuse existing proven working standards. Make recommendations to the existing standard organization if some new use cases are required (e.g., make change request to OGC)
- Effective communications with the active working group members in the standard organizations. They are the authors of the standards, and there are many lessons and issues have been considered when the specifications were written.
- Tools for developing new IoT platforms and systems
- Integration and interoperability mechanisms
- Suite of API and SDK to develop new applications

R&D ICT30 projects

Some R&D H2020 ICT30 projects are considered stakeholders. Their vision and needs are taken into account for the design of INTER-FW product:

- The creation of a coexisting and coopetition environment of all the interoperability frameworks is a need in order to avoid the creation of IoT silos due to incompatibilities between interoperability frameworks.
- Some elements in common with other projects that are considered in Inter-IoT are:
    - Achievement of rapid cross-platform IoT application development
    - Security, access scopes and identity management
    - Framework APIs to provide a unified view of different IoT platforms and their resources
    - An equivalent interoperability stack based on the following domains: Device, Smart Space, Cloud and Application.
    - It considers the Introduction of a roaming of things among heterogeneous IoT platforms.
    - It considers interoperability to physical and virtualized sensing/actuating IoT resources
    - Interoperability focused in D2D elements
    - Development of a common framework for the creation of an IoT ecosystem

- BIG-IoT can reuse and build up Inter-IoT framework for providing a standardized API.

Merging all the stakeholder's needs into a single table can offer a better approach to what the identified stakeholders are looking for in INTER-FW. We have processed the common needs scoring the number of times each need arises for the different stakeholders. The table below is ordered in descendant way with the number of occurrences of each stakeholder need.

Table 31. Stakeholders' needs (INTER-FW)

Stakeholder need	No	Public authorities	IoT owners	End users	IoT platform provider	Tech. experts	Standard Body	R&D projects
Access heterogeneous sensors (APIs & tools)	15		X	X		X		
Security management	13	X	X		X	X		X
Interoperability	10	X	X	X	X	X	X	X
Interoperable framework among IoT's	10				X	X		X
FW API for publish/access	9		X		X	X		X
Semantics/Ontologies	9				X	X	X	
Secure access control/management	8		X	X	X	X		X
Trust	5	X	X	X		X		
Break silos	4	X						X
Authorization	4		X	X				
Easy integration	4		X					
Discovery	4		X	X		X		
Computing/analysis capabilities/event detection	4			X		X		
Open platforms	3	X						X
Privacy	3		X			X		
High response time	3		X			X		
Register	3		X	X		X		
Sensor management	3		X	X				
Roaming	3			X		X		X
Create new IoT platforms	3			X		X	X	
Configure relationships among IoT platforms	3			X		X		
Reliability	3			X		X		
Different interoperable layers	3				X	X		X
Transform Physical to Virtual devices	3				X	X		X
Meta data model for integrations	3					X		
Use of standards for different IoT levels	3	X						

Link physical and virtual	3				X		X		
Data protection regulations	2				X		X		
Identity management	2					X			X
Verified authentication	2						X		
API REST	2			X			X		
Share sensor data among agents	2				X		X		
Independence of network layer	2				X		X		
Rapid cross application development	2					X		X	
Location of sensors/devices is important	2						X		
Adhere to reference architectures	2			X			X		
Monitoring protocols/tools	2						X		
Device 2 device protocols	2						X		X
Development framework	2					X	X		
Developer communities	1	X							
Ethics	1	X							
Impact	1	X							
Ecosystems	1	X							
Sustainability	1	X							
Foundation technology	1	X							
Large Scale Pilots	1	X							
Availability	1			X					
Publish configuration	1			X					
Testing procedures	1				X				
Scalability	1					X			
Extensibility	1					X			
Automatic switching between network layers	1						X		
Minimize sensor access / transmissions	1						X	X	
Protocols for direct access to sensors	1			X					
Integration among IoT at bus levels	1			X					
Configure integration without programming	1						X		
Deployment tools for configuring cloud services at runtime	1						X		
Support push notifications	1						X		

Control the number of API requests.	1	X
Low cost of integration of a new IoT	1	X
Device 2 server protocols	1	X
Server 2 server protocols	1	X
Device 2 human protocols	1	X
Recognise and add sensors automatically	1	X
Update sensor capabilities	1	X
Interoperability at application level	1	X
Easy use of INTER-LAYER	1	X
Data ownership management	1	X
Integration of legacy systems	1	X

We have categorized the stakeholder's needs for INTER-FW into 9 groups:

Table 32. Stakeholders' needs categories (INTER-FW)

Category
APIs & Tools
Security
Interoperability
Framework
Semantics
Policy
Framework Capabilities
Standards
Protocols

Each need has been assigned a specific category:

Table 33. Stakeholders' needs categorization (INTER-FW)

Stakeholder need	Category
Access heterogeneous sensors (APIs & tools)	APIs & Tools
Security management	Security
Interoperability	Interoperability
Interoperable framework among IoT's	Framework
FW API for publish/access	APIs & Tools
Semantics/Ontologies	Semantics
Secure access control/management	Security

Trust	Security
Break silos	Policy
Authorization	Security
Easy integration	Framework Capabilities
Discovery	Framework Capabilities
Computing/analysis capabilities/event detection	Framework Capabilities
Open platforms	Policy
Privacy	Security
High response time	Framework Capabilities
Register	Framework Capabilities
Sensor management	Framework Capabilities
Roaming	Framework Capabilities
Create new IoT platforms	Framework Capabilities
Configure relationships among IoT platforms	Interoperability
Reliability	Framework Capabilities
Different interoperable layers	Interoperability
Transform Physical to Virtual devices	Interoperability
Meta data model for integrations	Semantics
Use of standards for different IoT levels	Standards
Link physical and virtual	Interoperability
Data protection regulations	Security
Identity management	Security
Verified authentication	Security
API REST	APIs & Tools
Share sensor data among agents	Framework Capabilities
Independence of network layer	Interoperability
Rapid cross application development	Framework
Location of sensors/devices is important	Semantics
Adhere to reference architectures	Standards
Monitoring protocols/tools	Framework Capabilities
Device 2 device protocols	Protocols
Development framework	Framework
Developer communities	Policy
Ethics	Policy
Impact	Policy
Ecosystems	Policy
Sustainability	Policy
Foundation technology	Framework
Large Scale Pilots	Policy
Availability	Framework Capabilities
Publish configuration	Framework Capabilities
Testing procedures	Framework Capabilities
Scalability	Framework Capabilities
Extensibility	Framework Capabilities
Automatic switching between network layers	Interoperability
Minimize sensor access / transmissions	Framework Capabilities
Protocols for direct access to sensors	Protocols
Integration among IoT at bus levels	Interoperability
Configure integration without programming	Framework Capabilities
Deployment tools for configuring cloud services at runtime	Framework
Support push notifications	Protocols

Control the number of API requests.	Framework Capabilities
Low cost of integration of a new IoT	Framework Capabilities
Device 2 server protocols	Protocols
Server 2 server protocols	Protocols
Device 2 human protocols	Protocols
Recognise and add sensors automatically	Framework Capabilities
Update sensor capabilities	Framework Capabilities
Interoperability at application level	Interoperability
Easy use of INTER-LAYER	Framework Capabilities
Data ownership management	Security
Integration of legacy systems	Interoperability

Counting the number of times that each need appears for every category and summarizing per category leads to this distribution of stakeholder's needs:

Figure 21 INTER-FW Stakeholder's needs by category

3.2.11 Conclusions

There have been found a great interest in INTER-FW product. A good set of stakeholders and products have been identified and analysed. The set of stakeholders is quite well balanced, with several participants coming from IoT owners, end-users, technology experts which give a different perspective that contribute to a holistic view of this future product.

There is a big demand for what this product can offer. As a matter of fact, there are too many needs and too much expectation impossible to achieve. The aim of the product may not have been clearly understood by the participant stakeholders, as some of them expect to have a new IoT platform, as many of the open IoT platforms offer right now. But there are a good set of stakeholders who have understood the existing problems so far and that have proposed good ideas as needs that will guide INTER-FW design process.

The stakeholders need analysis have shown that there are a lot of needs not solved so far. These needs are framed under different categories, where we highlight the interoperability as it was expected. Security concerns stakeholders, but it's not the main goal of the project; nevertheless, it has certainly to be taken into account for the project. APIs % tools and specific framework capabilities will help to the design process, and confirm the need for INTER-FW product; stakeholders are generally concerned about the idea of accessing heterogeneous sensors and devices in a common way through APIs, as well as having APIs and tools for publishing or sharing data among IoT platforms. Another important aspect is the need for a semantic approach as an enabler of interoperability among disparate systems.

The idea of a framework for interoperability among IoT platforms has thus been confirmed by the market.

Regarding the products analysed, there are a great number of IoT platforms with overlapping capabilities about integration. A great effort has to be done to re-use existing technology and focussing on an easy and real interoperability rather than falling under the IoT features that some of the stakeholders are demanding.

3.3 INTER-METH stakeholders' analysis

3.3.1 Introduction

As stated in 1.3 the main aim of the INTER-METH methodology is to support the development of integration/interconnection/interoperability solutions for heterogeneous IoT platforms. The interest in using a methodology similar to INTER-METH is recently arising due to the introduction of a growing number of non-interoperable/heterogeneous IoT platforms.

Although many (hardware/software) development methodologies already exist, none of them was specifically designed to address the aforementioned issues. All the analysed stakeholders agree that the availability of such methodology would facilitate the development of integrated and interconnected IoT platforms. They also deem that there is a real lack of such a kind of methodology that would represent one of the barriers to the wide scale diffusion and use of IoT technologies.

In particular, the availability of INTER-METH would provide a systematic approach to IoT platform integration issues that would allow for an effective design and a rapid prototype of

interoperable solutions so reducing risks of bugs and unreliable components. This would notably add business value to solutions developed according to INTER-METH.

The main issues in defining INTER-METH are mainly related to the absence of a reference standard for IoT systems and the presence of many different standards at the different IoT levels (device, networking, middleware, application, data, semantic) as well as the presence of many different developed IoT systems based on proprietary solutions.

3.3.2 Stakeholder participants

The INTER-METH product is centred on effective methodologies to support the integration and the interoperability of different IoT solutions coming from different application scenarios duch ad mobile health and transport and logistics area. Since this study involves a big area and a high number of companies or entities, the selection of a minimum set of representative has been attempted.

At this time of development of this report, the number of stakeholders which have been interviewed for the INTER-METH product is 49.

The stakeholders that took part in the study have been categorized as follows:

Non-profit organizations

Table 34. Non- profit organizations (INTER-METH)

Stakeholder	Description
ValenciaPort Foundation	Non-profit organisation works on the innovation of the port, transport and logistics sectors.
AIOTI-UPV	Group of research groups related with IoT at UPV and associated research institutes.
Open Geospatial Consortium (OGC)	International not for profit organization committed to making quality open standards for the global geospatial community.
OpenEHR	OpenEHR is a virtual community working on interoperability and computability in e-health. Its main focus is electronic patient records (EHRs) and systems.
VTT Technical Research Centre of Finland	Leading research and technology research center in the Nordic countries.

Private research and development companies

Technology companies engaged in research, software development, device manufacturing, systems integration, etc.

Table 35. Private research and development companies (INTER-METH)

Stakeholder	Description
INDRA	Large Spanish industrial company related with ICT in different application domains including transport, health and defence.
Creative Systems Engineering (C.S.E.)	CSE engineers have experience in the design and implementation of both hardware and software systems.
VMZ Berlin Betreibergesellschaft MBH	SME whose business area is urban mobility and traffic management services
ISECO S.L.	SME software control development company integrating sensors in a proprietary control centre and SCADA.
ETRA I+D	ETRA's mission is putting in the market the most advanced solutions and services either directly or through the 10 companies of the Group.
Instituto de Tecnología Informática (ITI)	Research association of SME and industries related with software development
Consoft Sistemi S.p.A.	Consoft Sistemi is an Italian company that expands the group leader's offer, particularly linked to Telecoms in the North African and Middle Eastern markets.
Herzum	Herzum is an international consulting company, leader in Agile and DevOps and one of the largest Atlassian providers in the world.
Prodevelop	Prodevelop is a solution developer and systems integrator with a high expertise in port & maritime solutions and public administration, especially smart cities.
Thales Services SAS	Thales Services (THS) belongs to Thales group, which is a large industry player specialized in critical systems for government and companies.
Infoport Valencia	Infoport is a technology services company specializing in the logistics sector and port.
Amiga Ventures	Amiga provides services to allow companies to undertake the digital transformation of their business, from strategy and design to maintenance and continuous improvement.
Kii	Kii helps developers and device manufacturers meet their high-performance demands with an end-to-end platform optimized for building and running enterprise mobile and IoT initiatives.
Multinational Solutions Provider for Government and Institutions (GIS)	Multinational solution provider for government and institutions, working for customs authorities and ministries for the simplification of trade.

Orbita Ingenieria S.L.	SME providing technology related with IoT and automation to the port community.
Vemco SP z.o.o.	Vemco is a company with a main focus on computer networks and access-control systems.
BetterSolutions SA	BetterSolutions has knowledge and experience in designing, developing and deploying systems based on IoT platforms.
Alessandro Bassi Consulting (ABC)	SME related with innovative business solutions related with ICT and specifically IoT.
Fincons	Consulting and development group of companies related with different ICT areas, including IoT.
Neways	Neways is an international company active in the EMS (Electronic Manufacturing Services) market.
SenSysCal S.R.L.	SenSysCal S.R.L. is a spin-off of the University of Calabria. Its main activities are related to smart-health, building energy management and WSN/IoT Consulting.
Things	Agency related with design and innovation in the area of IoT, including new business and services models.
Intel Technology Poland SP z.o.o.	Leading international company in hardware development and specifically in IoT.

- Telecommunications operators

Table 36. Telcos (INTER-METH)

Stakeholder	Description
Orange Polska S.A.	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Poland, part of Orange Group (France Telecom).
Telefonica	Telefonica is a broadband, fixed and mobile telecommunication provider and offers IT services and solutions in several areas.
Telecom Italia	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Italy, owner of TIM.

Universities and Research Institutions

This group is composed by universities and research institutions working on technologies or the innovation related to new methodologies to support sensors, protocols, gateways, data processing, middleware, and semantics interoperability. With a relevant goal in publications and standardization.

The universities involved in research are:

Table 37. Universities (INTER-METH)

Stakeholder	Description
Universitat Politècnica De Valencia	Spanish public university, with several research centers and projects related with IoT
University of Calabria	Italian public university with different research groups and projects related with IoT
University of Bologna	Dipartimento di Informatica, Scienza e Ingegneria at the University of Bologna aims to promote and develop researches in the field of science, engineering and information technology.
University of Catania	ARSLAB supports students and researchers in activities related to agent-based system, multi-agent systems, IoT applications, autonomous ground- and flying-robots.
University of Palermo	The Dipartimento of Ingegneria Chimica, Gestionale, Informatica, Meccanica (DICGIM) carries out its activities within three missions of the University: research, advanced training and third mission.
Systems Research Institute, Polish Academy of Sciences (SRIPAS)	Public Polish research center active primarily in the domain of methodological foundations for systems analysis.
Turin University	Italian public university with research teams related to smart cities platforms and applications.

Public authorities

The authorities involved in the Project will play an important role in it. This group mainly consists of port authorities, public administrations and the European Commission. The European Commission is the sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call. The main authorities related to the maritime transport, as well as Public Administrations are the following:

Table 38. Public authorities (INTER-METH)

Stakeholder	Description
DG CONNECT – European Commission.	The sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.
Autoridad Portuaria De Vigo	Responsible for running the largest port in Galicia and owner of a SmartPort platform.
ASL TO5	The Hygiene Nutrition Unit of the Complex Unit of Food and Nutrition Hygiene works in preventive field: promoting an appropriate healthy state and practice of physical activity to prevent the development of chronic degenerative diseases.

Related projects on this topic:

The following projects, can take great advantage from the INTER-METH product because they aim to define a framework or build and promote a marketplace where applications are available.

Table 39. Related projects (INTER-METH)

Stakeholder	Description
ICT-30 SymbioTe	H2020 RIA SymbIoTe (Symbiosis of smart objects across IoT environments): interoperability mechanisms at different layers.
ICT-30 TagItSmart	H2020 RIA TagItSmart: connectivity and interoperability of funny tags.
ICT-30 BIG-IoT	H2020 RIA BigIoT (Bridging the Interoperability Gap of the IoT): interoperability mechanisms at different layers.
ICT-30 BIoTope	H2020 RIA BIoTope (Building an IoT OPen innovation Ecosystem for connected smart objects): use of open standards for platform interoperability.
ICT-30 Vicinity	H2020 RIA Vicinity (Open virtual neighbourhood network to connect IoT infrastructures and smart objects): interoperability at semantic layer.
ICT-30 Agile	H2020 RIA AGILE (An Adaptive and Modular Gateway for the Internet of Things): interoperability through an open gateway.

3.3.3 Stakeholders by company type

In a more detailed classification, the stakeholders can be divided into the following categories:

Table 40. Stakeholders by company type (INTER-METH)

Non-profit organization	ValenciaPort Foundation AIOTI-UPV Open Geospatial Consortium (OGC) OpenEHR VTT
Private technology and solutions supplier company	Telefonica INDRA Creative Systems Engineering VMZ Berlin Betreibergesellschaft MBH ISECO S.L.

	ETRA I+D ITI Telecom Italia Consoft Sistemi S.p.A. Herzum Prodevelop Thales Services Infoport Valencia Amiga Ventures Kii Multinational Solutions Provider for Government and Institutions Orbita Ingeniería S.L. Vemco SP z.o.o. BetterSolutions SA Orange Polska S.A. Alessandro Bassi Consulting (ABC) Fincons NEWAYS SenSysCal S.R.L. Things Intel Technology Poland SP z.o.o. XLAB d.o.o.
University	Universitat Politècnica De Valencia University of Calabria University of Bologna University of Catania University of Palermo SRIPAS Turin University
Public Authorities	DG CONNECT – European Commission Ayuntamiento de a Coruna (Coruna City Council) Autoridad Portuaria De Vigo ASL TO5
Projects	ICT30 TagItSmart ICT30 BIG-IoT ICT30 SymbIoTe ICT30 bIoTope

	ICT30 Vicinity ICT30 Agile

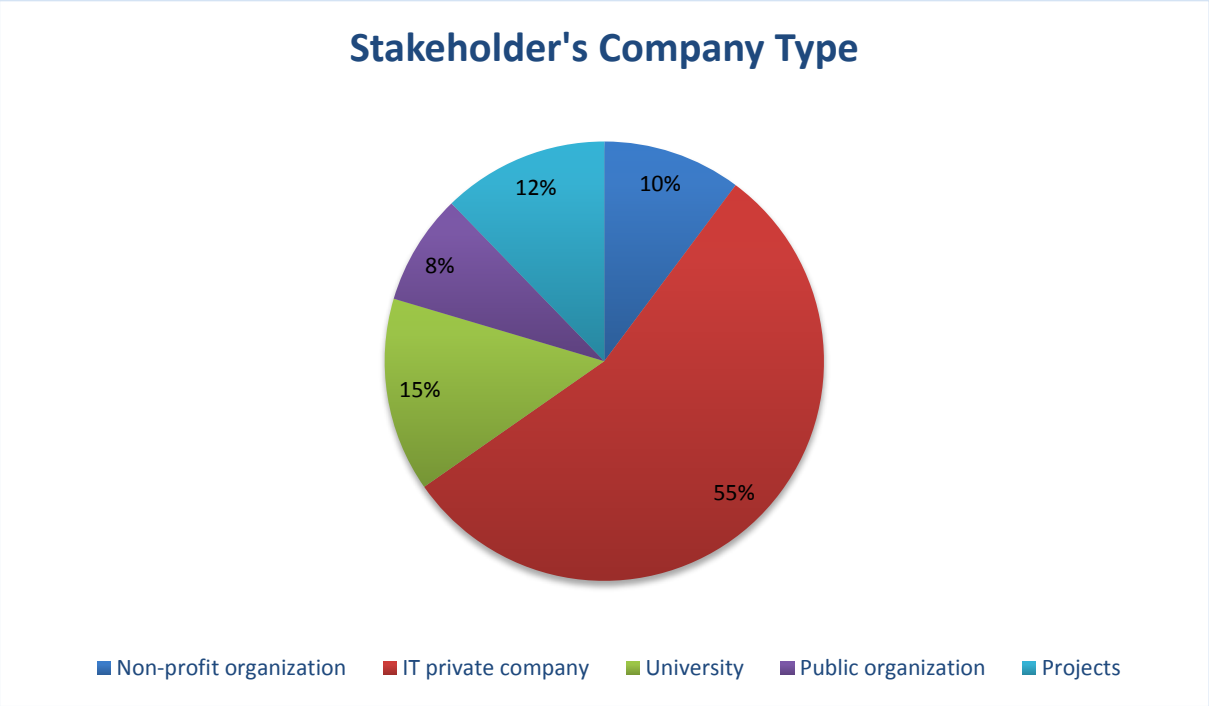

Figure 22 INTER-METH Stakeholder's Company Types

At the graph we can observed that more than half of the identified stakeholders are from private companies, followed by universities and non-profit organization. Afterwards, research projects have been identified as interested party followed by public organizations.

3.3.4 Stakeholders by country

Stakeholders can be differentiated by their country.

Table 41. Stakeholders by country ((INTER-METH)

Spain	ValenciaPort Foundation Prodevelop Infoport Valencia Autoridad Portuaria De Vigo Amiga Ventures ETRA I+D AIOTI-UPV Orbita Ingenieria S.L. Telefonica

	INDRA ISECO S.L. ITI Ayuntamiento de a Coruna (Coruna City Council)
Italy	Fincons Things SenSysCal S.R.L. Telecom Italia Consoft Sistemi S.p.A. Turin University University Bologna University of Palermo Universita of Catania ASL TO5 Herzum
France	Thales Services Multinational Solutions Provider for Government and Institutions Alessandro Bassi Consulting (ABC)
Nederland	NEWAYS
Greece	Creative System Engineering
Poland	SRIPAS Vemco SP z.o.o. Orange Polska S.A. BetterSolutions SA OpenEHR Intel Technology Poland SP z.o.o.
Slovenia	XLAB d.o.o.
Germany	Kii VMZ Berlin Betreibergesellschaft MBH
Belgium	DG CONNECT – European Commission ICT30 TagItSmart ICT30 Agile ICT30 SymbloTe ICT30 BIG-IoT ICT30 Vicinity ICT30 BioTope

Finland	VTT
Canada (International)	Open Geospatial Consortium (OGC)

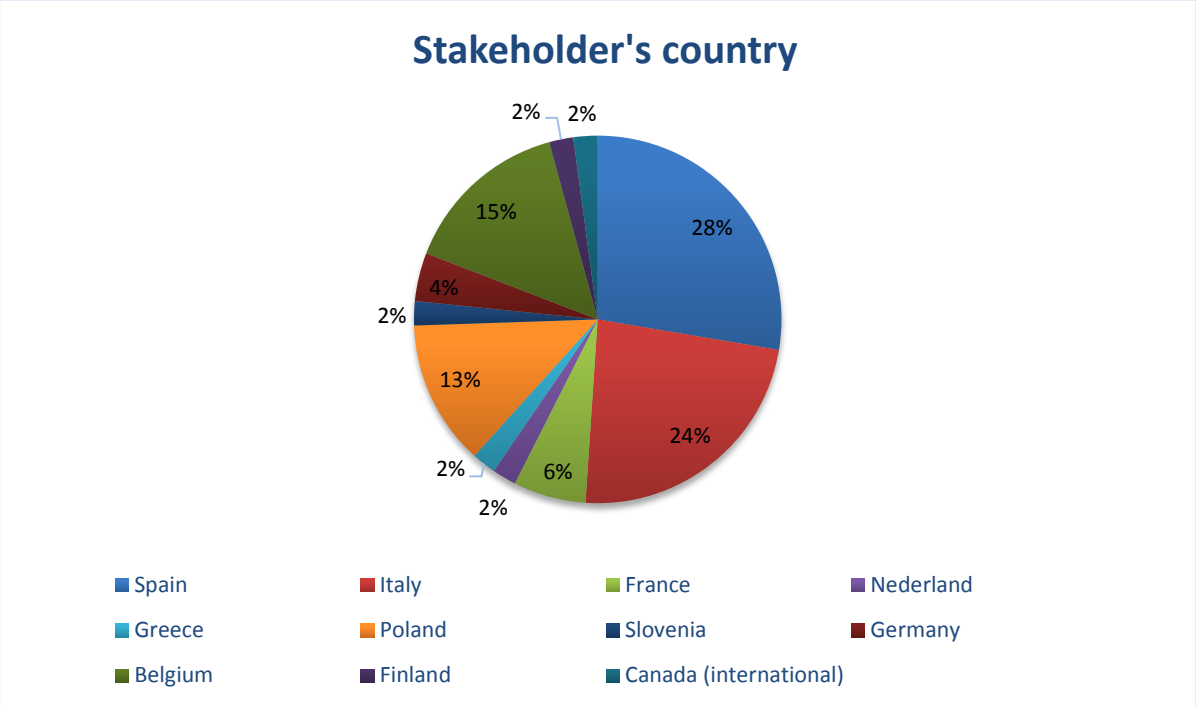

Figure 23 INTER-METH Stakeholder's country

Since the two pilots of the INTER-IoT project take place in the Port of Valencia and in Turin, most stakeholders that are being identified are from both Spain and Italy. Although a variety of stakeholders have been identified from all over Europe, specially, due to the intrinsic European characteristic of the Inter-IoT project and the specific characteristics of the INTER-METH product, the variety of countries is expected to growth during the execution of the project, mainly because of the interest created and communication and dissemination tasks.

3.3.5 Stakeholders map

From the analysis of the stakeholder map (following the Volere methodology) it is possible to verify that the stakeholders interested to contribute to the INTER-METH products are distributed in all the rings. This almost fair distribution further validates the need for the development and the realization of such product. The stakeholder's map for the INTER-METH product is as follows.

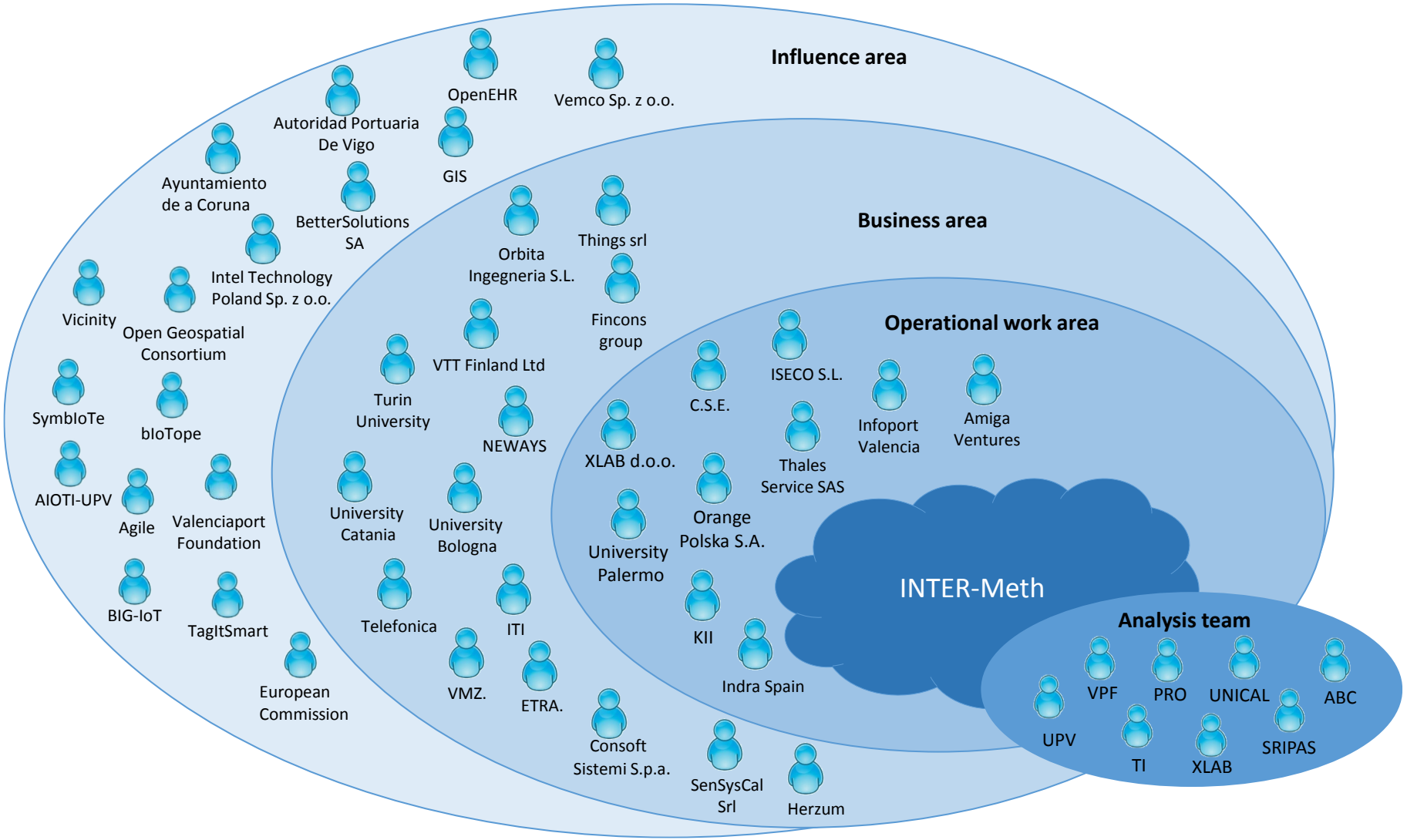

Figure 24 INTER-METH Stakeholder's map

3.3.6 Stakeholders by class

Following the Volere methodology, the stakeholders can be classified according to the role they will play in the INTER-Meth product. Therefore they can be distinguished the following classes.

Table 42. Stakeholders by class (INTER-METH)

Client	DG CONNECT – European Commission
Customer	Autoridad Portuaria De Vigo NEWAYS ASL TO5 Coruna City Council
Subject-matter experts	ValenciaPort Foundation Vemco SP z.o.o. Orange Polska S.A. BetterSolutions SA Telecom Italia Consoft Sistemi S.p.A. Turin University Intel Technology Poland SP z.o.o.
Systems engineers	Multinational Solutions Provider for Government and Institutions SenSysCal S.R.L.
Software engineers	Infoport Valencia Orbita Ingenieria S.L. University of Palermo
Technology experts	Amiga Ventures Kii Prodevelop Thales Services Telefonica INDRA Orbita Ingenieria S.L. Fincons VTT Things Alessandro Bassi Consulting (ABC) Herzum
Domain Experts	ICT30 TagItSmart

	ICT30 BIG-IoT ICT30 Agile ICT30 SymbloTe ICT30 Vicinity ICT30 BioTope University of Bologna University of Catania Universita of Palermo
Designers and developers	XLAB d.o.o. SRIPAS ETRA I+D AIOTI-UPV VMZ Berlin Betreibergesellschaft MBH ISECO S.L. ITI
Representatives of external associations	OpenEHR
Usability experts	Open Geospatial Consortium (OGC)

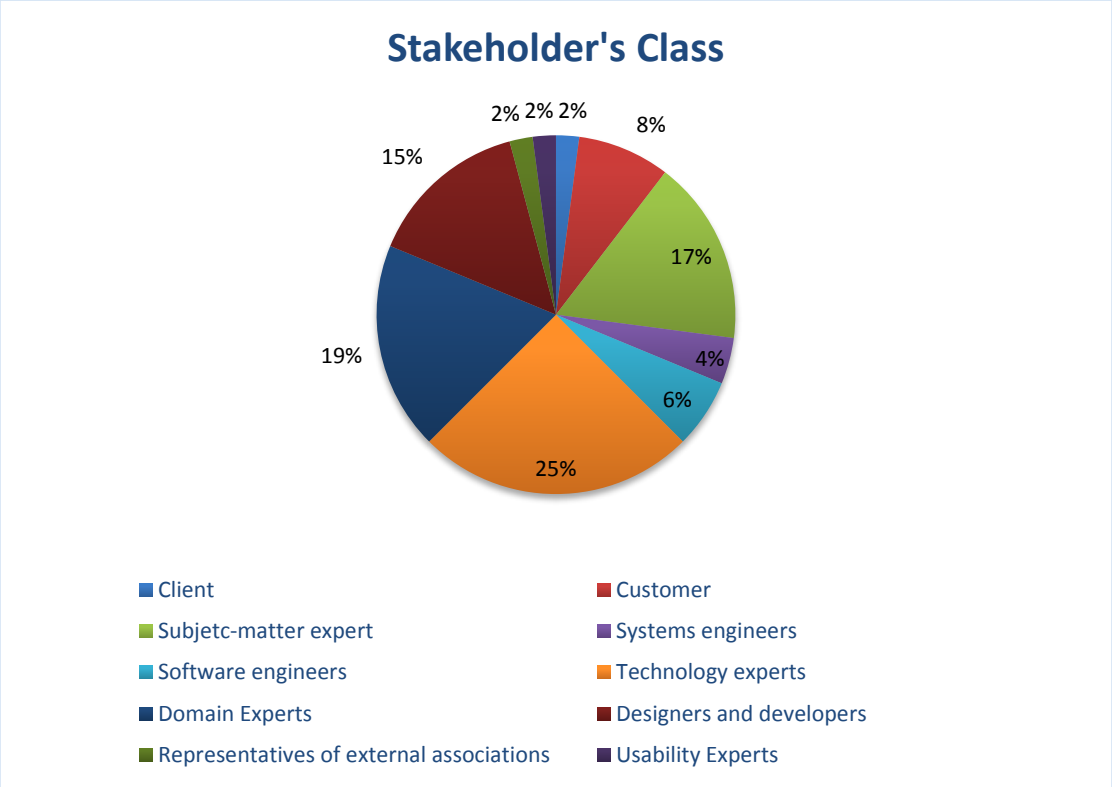

Figure 25 INTER-METH Stakeholder's class

From the graph above it is observed that quite of some stakeholders are technology experts. As well as it is acknowledged technological support from IT sector companies (Systems engineers, Software engineers, Technology experts, Domain experts, designers and developers). Moreover, it is observed a wide variety of representatives at the telecommunication service providers and system integrators (Subject-matter experts).

3.3.7 Stakeholders by IoT Demand/Supply

In the field of internet of things each of the stakeholders can provide (Supply side) or receive (Demand side) information. On the supply side it is identified at first research entities and development companies, and on the contrary on the demand side it has been identified final users such as public administration bodies and related companies.

Table 43. Stakeholders by IoT Demand/Supply (INTER-METH)

IoT Demand side	IoT Supply side
ValenciaPort Foundation	Telefonica
Prodevelop	Infoport Valencia
Open Geospatial Consortium (OGC)	Amiga Ventures
Telecom Italy Group	Kii
Consoft Sistemi S.p.A.	INDRA
Turin University	ISECO S.L.
Universita di Bologna	ITI
Ayuntamiento de a Coruna (Coruna City Council)	Ayuntamiento de a Coruna (Coruna City Council)
Autoridad Portuaria De Vigo	Autoridad Portuaria De Vigo
Thales Services	Fincons
University of Palermo	Itaca SRL
DG CONNECT – European Commission	Things
ASL TO5	SenSysCal S.R.L.
Neways	Orbita Ingeniera S.L.
XLAB d.o.o.	SRIPAS
VMZ Berlin Betreibergesellschaft MBH	Vemco SP z.o.o.
Herzum	BetterSolutions SA
	Orange Polska S.A.
	Alessandro Bassi Consulting (ABC)

	ICT-30 TagItSmart
	ICT-30 BIG-IoT
	ETRA I+D
	Creative System Engineering
	OpenEHR
	Intel Technology Poland SP z.o.o.
	ICT-30 Agile
	ICT-30SymbloTe
	ICT30 Vicinity
	ICT30 BioTope
	VTT
	AIOTI-UPV
	Open Geospatial Consortium (OGC)
	University of Catania
	Multinational Solutions Provider for Government and Institutions

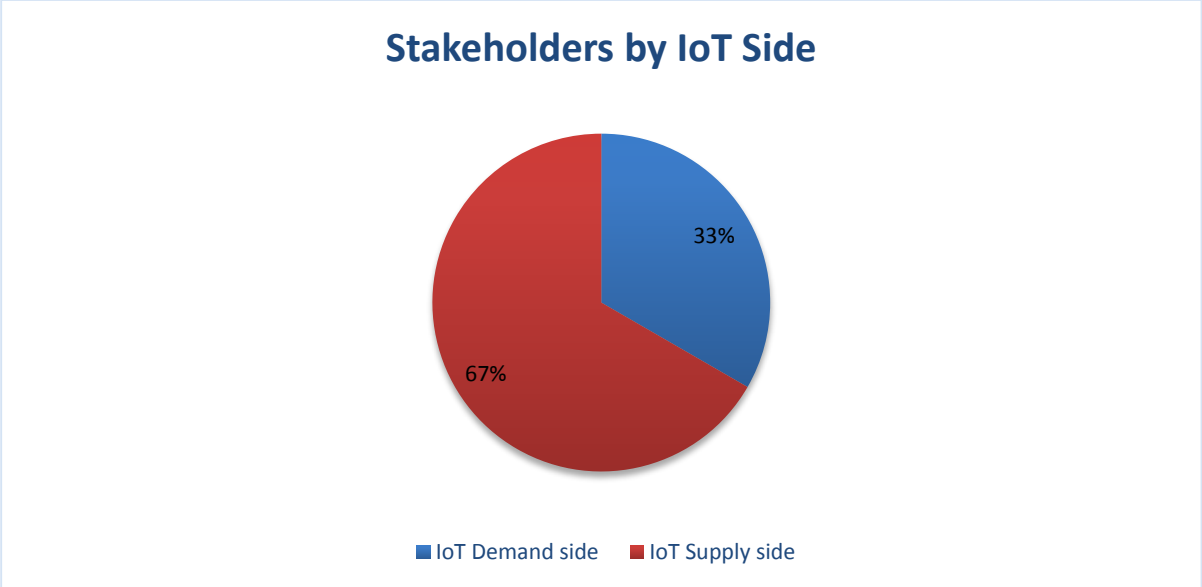

Figure 26 INTER-METH Stakeholder's by IoT side

Although there has been identified more IoT stakeholders on the supply side rather than the Demand side, it is needed to remark that on the IoT supply side are stakeholders with enough empowerment to demonstrate that there is interest in the INTER-METH product.

3.3.8 Stakeholders with interest in Open Call participation

Within the project INTER-IoT, an open call will carry out. All those stakeholders who meet the stated requirements can apply it.

Table 44. Stakeholders with interest in OpenCall (INTER-METH)

Interested in participating in open calls	Not interested in participating in open calls
Orbita Ingeniera S.L.	Telefonica
Consoft Sistemi S.p.A.	INDRA
Turin University	ITI
Infoport Valencia	Ayuntamiento de a Coruna (Coruna City Council)
Amiga Ventures	Autoridad Portuaria De Vigo
AIOTI-UPV	Fincons
BetterSolutions SA	Itaca SRL
Orange Polska S.A.	Things
Creative System Engineering	SenSysCal S.R.L.
Kii	SRIPAS
ISECO S.L.	Vemco SP z.o.o.
	Alessandro Bassi Consulting (ABC)
	ICT-30 TagItSmart
	ICT-30 BIG-IoT
	ETRA I+D
	OpenEHR
	Intel Technology Poland SP z.o.o.
	ICT-30 Agile
	ICT-30 SymbloTe
	ICT-30 Vicinity
	ICT-30 BioTope
	VTT
	University of Catania
	Multinational Solutions Provider for Government and Institutions
	ValenciaPort Foundation

	Prodevelop
	Telecom Italia
	University of Bologna
	Thales Services
	University of Palermo
	DG CONNECT – European Commission
	ASL TO5
	Neways
	XLAB d.o.o.
	VMZ Berlin Betreibergesellschaft MBH
	Herzum

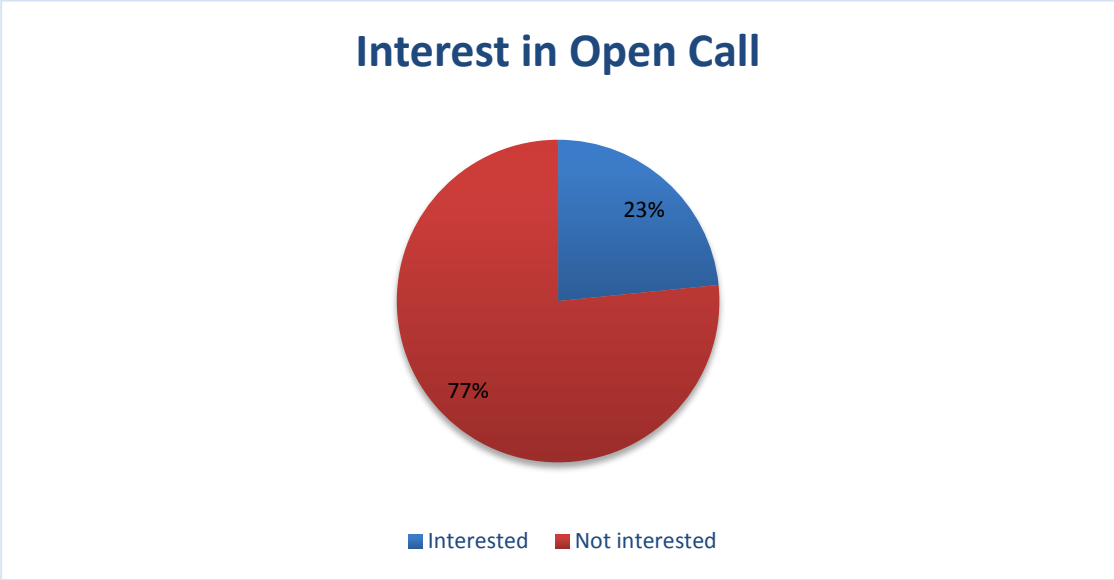

Figure 27 INTER-METH Stakeholder's interest in the open call

In the above graph you can see that there is a large number of stakeholders who are not interested in the open call. This is because most of the stakeholders that are interested in the open call belong to the operational work area of the stakeholder map; thus they have enough infrastructure to request it.

3.3.9 Products involved by Stakeholders

In today's market there are numerous products related to the INTER-Meth product. In order to make a complete market analysis it is necessary to know what are those most relevant. In

the list below, it can be seen those which are being used by stakeholders or would be interested in acquiring some products similar to the mentioned.

IoT Platforms

- SOFIA, SOFIA2 (Smart City IoT platform)
- Consoft Sistemi
- FiWARE
- VLCi
- Thinking Things
- iCloudBroker
- INDRA Smart Platform
- Bosch
- VMZ
- OpenUWEDAT
- MoBaaS
- OpenIOT
- AMRG (Advanced Modem Router Gateway)
- Smart Grid KPI
- DSM
- Open Platform 3.0
- Kii Cloud platform
- BUTLER
- IOTLab

Management Platforms

- MuuMap – BetterSolutions
- Cloud platforms
- Crane RMS Traffic Management System
- Agata (Smart Port platform)
- BodyCloud
- iDynamicx
- GPaaS
- Symphony
- Navigo Digitale
- nAssist
- KIOLA
- TarquinIoT
- Traffic Information Center
- Intelligent Large Scale Data

- Big Data
- Hadoop
- PMIS (Port Management Information Systems
- Terminal Operating Systems (TOS)

Software

- SOC
- CPU
- Comm
- Fincons Smart Manufacturing Platform
- Fincons SmartWaste
- Intel base gateways form 3rd parties
- BT LE 4.0
- MS Azure
- PTC Thingwox
- Matlab
- R
- DgLux
- The Things Net-work
- SCLAK
- Posidonia PCS (Port Community System)
- Prodevelop's PUI architecture
- Computerized Nutritional Folder
- eCARE (Telecom Italia)
- GateCCR container code Recognition
- Gate LPR Licence plate recognition
- Yard Carne OCA Obstacle Collision Avoidance
- SAGE
- MongoDB
- ValenciaPort PCS
- SCADA system

Hardware (sensors, devices, etc.)

- Actuators
- RFID
- Wearable sensors
- Mobile devices
- Beacons
- Yard Crane SCA Stack Collision Avoidance

- Devices and sensors
- SOS (Sensor Observation Service)
- QR codes
- FunCodes

Project results

- FP6 PROMISE
- IoT-A
- UPV CARTA listed products and projects

Standards

- AENOR 178xxx set of standards

3.3.10 Stakeholders needs

Private companies

Private companies share the need to have an IoT system design methodology able to integrate their own systems development tools.

A general interesting remark is that in order to avoid the creation of IoT silos, designers and developers should follow some methodology while designing and integrating IoT platforms. Every IoT platform design should consider interoperability, reliability, security, privacy and trust, to interact with existing enterprise and operational systems and with other IoT platforms.

The stakeholder analysis highlighted the following specific needs for INTER-METH:

- addressing the interoperability requirement during the design phase;
- provision of formal guidelines, systematic methods and a well-defined approach to support IoT interoperability at any level of abstraction, from device-to-device communication to end-user service composition;
- better addressing customers' business needs in terms on providing value propositions on IoT-based solutions;
- fast and accurate estimation of effort and complexity of IoT-based solutions, thus helping in finding best value-for-money for our customers;
- optimization of software development process, by indicating best practices, codes examples, in order to most efficiently exploit the potentiality of the IoT;
- addressing future Application Maintenance phase, understanding the maintenance and support needs associated to the IoT, in terms of effort and costs;
- alignment with standards like AENOR interoperability for Smart Cities;
- quality control of participants.

INTER-METH should consists of an agile and reusable methodology supporting more rapid and robust integration of IoT platforms so making them interoperable, reducing development time, minimizing errors and enhancing the quality of the integrated platform.

Other useful identified needs include:

- Generate code for the integration.
- Generate design documentation that can be part of the technical and deployment documentation.
- To generate APIs and API documentation (e.g. in a swagger way).
- Methods and tools to integrate data belonging to third party platforms
- Methods and tools to integrate devices and / or measures from devices /sensors;
- Methods and tools to integrate services belonging to third party platforms

In addition, stakeholders provided interesting suggestions for INTER-METH. It should:

- try to analyse the IoT domain with a business component approach.
- build a scalable and open "IoT Repository" based on a meta-modelling architecture. This Repository should formalize patterns, standards, architectural reference models, protocols, interoperability models, technologies, ontologies, legacy systems, sensor models about IoT
- involve a process as agile as possible in order not to be stopped in any of the iterative processes of the chain. In any case the iterative process should be particularized for special platforms or use cases; maybe the general idea/approach is fine, but in a second stage it should be possible to be particularize by a company (or consortium), in order to improve efficiency.
- build the required software components that comprises the Incident management center ensures that it will be able to interoperate with any IoT environment.

Private companies, finally, stressed the importance of INTER-CASE.

- The introduction of a CASE based methodology in combination with the Framework will facilitate the development and integration of interoperable systems.
- A step by step methodology to obtain interoperable IoT applications that provides Inter-METH by means of a CASE tool is almost mandatory in order to take the most advantage of Inter-Layer and Inter-FW.
- The CASE tool may allow the deployment and integration of sensors and actuators, so as defining semantic interoperability aspects.

Public authorities

The analysed public authorities need Inter-METH to facilitate the creation of IoT solutions based on Inter-FW and Inter-Layer, and an IoT ecosystem around the Inter-IoT project, to allow a rapid implementation and deployment of applications based on or compatible with Inter-IoT framework.

Creating INTER-METH as common methodology, might provide new input and guidelines for interoperable ecosystem creation, depending on specific scenarios: connection of devices and different platforms, creating new protocols and methods to translate, collect safety and process data and semantics.

An important need is the provision of methodological guidance and the availability of tools to third party agents so to adapt them in their own systems, with main interest at the application & service layer.

In the following we report a set of identified specific needs:

- To offer methodology and a set of tools simple to use for fostering the integration between Coruña Smart City platform and third party developers.
- To have a methodology and a set of tools simple to use to be offered to the city council IT providers in order to integrate IoT information from other stakeholders.
- To have a methodology following AENOR specifications (Comité Técnico de Normalización de AENOR AEN/CTN 178 “Ciudades Inteligentes”).

Projects

Within the H2020-ICT-30-2015 call there are 7 projects that must work together to achieve a framework that allows interoperability between IoT platforms. The needs of these projects are similar to those of INTER-IoT, as it shares the same objectives in the transport and logistics domain. It has been acknowledged that Inter-Meth methodology can effectively be an assistance development software tool, so to allow a rapid implementation and deployment of the different applications compatible with the other 30ICT projects.

Universities and Research centers

Universities are important research centres, and therefore have an important role in the development of this project. Relevant needs at methodological level were collected by several research groups; in the following, the most important requirements are reported:

- The design patterns should be identified and documented during all product development.
- INTER-METH should result in step-by-step instructions on how to integrate existing IoT platforms using tools and methods developed in INTER-IoT.
- Specific care should be devoted to help to analyse/design and map semantics in different systems in order to achieve semantic interoperability.
- INTER-METH should provide systematic engineering approach.
- INTER-METH should consider integration process on device, network, middleware, application, data and semantics layers.
- Organizational models and technologies for interoperability among public authorities’ and agencies’ facilities.

- INTER-METH should support the analysis of the so called “legacy-systems” and take care of the all technological, organisational, ethical and legal constraints. Also the sources of data managed by the application have to be analysed in order to individuate the constraints about the security and privacy.
- It is beneficial to provide tools for simulating the expected behaviours.
- INTER-METH should support Representation of the rules or norm in the domain.
- Probable heterogeneity of implementation platforms for different parts of the systems
- INTER-CASE should support the developers all over the methodology process.
- INTER-CASE should support for (partial) automatic code generation.

A final interesting remark sees the IoT world in the perspective of complex systems. Since a complex system may be considered as composed of a set of other systems it my beneficial, under a design methodology points of view, having means for constructing interoperable and meshing design methodologies where each methodology (or part) is the most efficient one for developing specific part of a complex system.

Non-profit organizations

There are several non-profit research groups and associations, collaborating in the project development. They require a methodology to provide the knowledge, guidance, know-how and a stepwise approach to convert sensors, tags and smart objects isolated networks into IoT interoperable platforms at different layers depending on the requirements of a specific scenario: device to device interconnection of IoT infrastructures (using gateway-based solutions or virtualization), networking protocols, middleware, composition methods for application services, semantic interoperability and methods to translate data and semantics (common communication standards, ontology and semantic data processing).

It also emerged the importance of reusing existing proven working standards and to make recommendations to the existing standard organization if some new use cases are required. The methodology should support the development of conversion tools between third-party data (e.g. OpenEHR) and their ontological representation.

Merging all the stakeholder’s needs into a single table can offer a better approach to what the identified stakeholders are looking for in INTER-Meth. We have processed the common needs scoring the number of times each need arises for the different stakeholders. The table below is ordered in descendant way with the number of occurrences of each stakeholder need.

Table 45. Stakeholders' needs (INTER-METH)

Stakeholder need	No.	Public authorities	Private Companies	R&D Projects	Universities and Research centers	Non-profit organizations
well-defined approach to support IoT interoperability at any level of abstraction	10		X	X	X	
systematic methods for IoT interoperability at any level of abstraction	9		X	X	X	
Formal guidelines for IoT interoperability at any level of abstraction	8		X	X	X	
Optimization of software development process	8		X	X		
Partial automatic code generation for the integration	7		X		X	
CASE based methodology	7		X		X	X
Minimizing errors and enhancing reliability	6	X	X	X		
Semantic interoperability	5				X	X
Ontological representation	3				X	X
Testing procedures	3		X	X		
Rapid cross layer development	3				X	
Generate design documentation	2	X	X			
Methods and tools to integrate data, devices and services belonging to third party platforms	2		X			X
systematic engineering approach	2	X			X	
integration process at any layer	2	X			X	
Methodological guidance	2	X				X
Availability of tools to third-party agents	2	X			X	
Scalability	1		X			
Integration of legacy systems	1		X			
Quality control of participants	1		X			
Organizational models					X	
Privacy	1				X	
Security					X	
Ethics	1					X
Impact	1	X				
Extensibility	1				X	
Configure relationships among IoT platforms						X

We have categorized the stakeholder's needs for INTER-Meth into 7 groups:

Table 46. Stakeholders' categories (INTER-METH)

Category
Tools
Security
Interoperability
Semantics
Cost reduction
Policy
Performance

Each need has been assigned a specific category:

Table 47. Stakeholders' needs categorization (INTER-METH)

Stakeholder need	Category
Well-defined approach to support IoT interoperability at any level of abstraction	Interoperability
Systematic methods for IoT interoperability at any level of abstraction	Interoperability
Formal guidelines for IoT interoperability at any level of abstraction	Interoperability
Optimization of software development process	Performance
Partial automatic code generation for the integration	Tools
CASE based methodology	Tools
Minimizing errors and enhancing reliability	Performance
Semantic interoperability	Semantics
Ontological representation	Semantics
Testing procedures	Tools
Rapid cross layer development	Interoperability
Generate design documentation	Tools
Methods and tools to integrate data, devices and services belonging to third party platforms	Tools
Systematic engineering approach	Cost reduction
Integration process at any layer	Interoperability
Methodological guidance	Cost reduction
Availability of tools to third-party agents	Tools
Scalability	Performance
Integration of legacy systems	Interoperability
Quality control of participants	Performance
Organizational models	Policy
Privacy	Security
Security	Security
Ethics	Policy
Impact	Performance
Extensibility	Performance
Configure relationships among IoT platforms	Interoperability

Counting the number of times that each need appears for every category and summarizing per category leads to this distribution of stakeholder's needs:

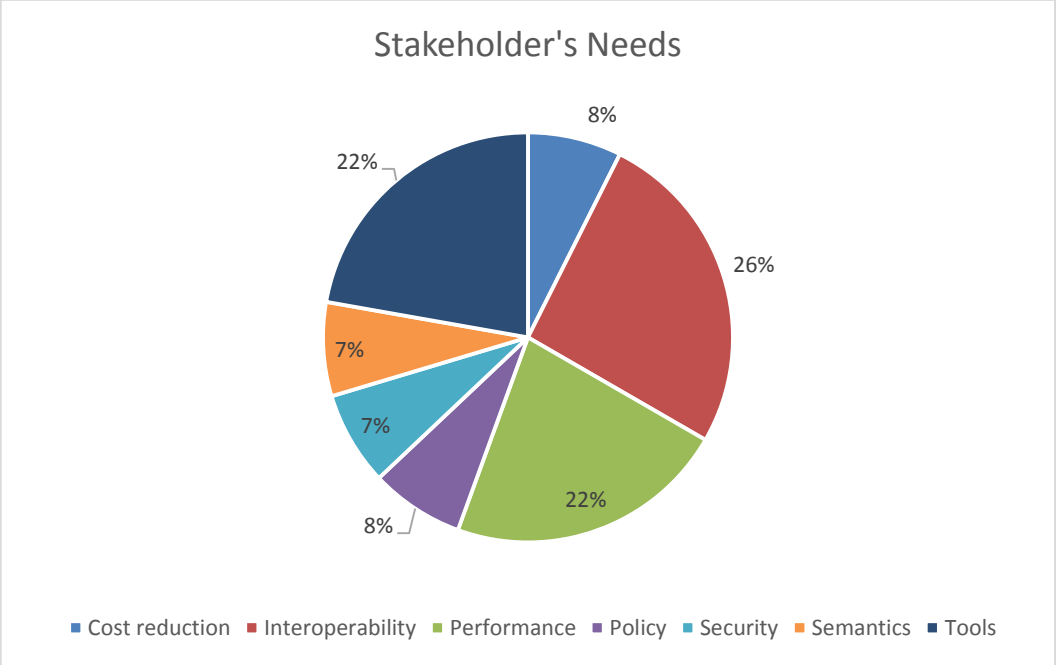

Figure 28 INTER-METH Stakeholder's needs by category

3.3.11 Conclusions

The main conclusion that can be obtained through the conducted market analysis for the INTER-METH product is that the current IoT market is very fragmented since there are many different products available for the different actors. In fact, many of the existing solutions are proprietary, stand-alone solutions that are not connected to each other; therefore, the use of a well-defined methodology can actually support and guide the integration/interconnection/interoperability of different solutions for heterogeneous IoT platforms by offering a systematic approach.

From a business point of view, the conducted market analysis pointed out how the implementation of the INTER-METH product can add value to the IoT chain by guaranteeing a profitable revenue to all the stakeholders involved in this market.

Finally, it can be foreseen that the exploitation of the INTER-METH product, which aims to support the development of IoT ecosystems where several IoT products seamlessly interoperate with each other, could be very successful in the market.

3.4 INTER-LOGP stakeholders' analysis

3.4.1 Introduction

IoT-based solutions in trade, transport, logistics and ports is only starting to emerge and it has a tremendous potential of development and implementation as multiple physical entities moving along the supply chain need to be dynamically connected and collaborate in supply chain operations. The supply chain is about moving things/cargo and communicating the information to many different actors. Therefore, with millions of ocean, air, and road assets, the transport and logistics industry is a key player ready to benefit from the IoT revolution.

According to Drewry report on Global Container Terminal Operators 2015, the global container terminal industry is facing unprecedented challenges as a result of the deployment of ever larger container ships (around 400 meters length and over 18,000 TEUs capacity), combined with the creation of larger shipping line alliances. These two related factors are placing significantly greater demands on ports and terminals driving up operating costs and capital expenditure requirements. They are also having far-reaching consequences on the transport, logistics and supply chains which is making technology imperative for the different actors. Limited space, congestion and other bottlenecks that hinder efficient services have changed the thought of the industry and have begun to acknowledge that nowadays the shipping industry is mainly driven by technology in order to be competitive.

This challenging environment has been one of the reasons of selecting the port of Valencia[6] to experiment with the INTER-FW framework, making at least three representative, selected and heterogeneous IoT platforms interoperate. These IoT platforms will consider the group of IoT platforms that will be deployed in the port community for real-time multidirectional information sharing connected to the PCS (Port Community System) to help creating true supply chain collaboration and the platform used by the NOATUM container terminal to monitor all their machines and handling equipment through a large deployment of sensors. INTER-LogP will be the result of using INTER-IoT in a specific application domain providing support, among others, to containers, trucks, vessels, operators and authorities, with the main goal to improve different performance indicators through a fully working interoperable platform.

As we have concluded after conducting the interviews with transport and logistics companies, the Internet of Things can be deployed in different key areas over the whole supply chain. One of these areas is fleet and asset management. For example, sensors can monitor how often a truck, or gantry crane is in use or idle. Therefore, they may be able to transmit this data for analysis and optimal utilization. A connected fleet could also pave the way for predictive asset lifecycle management.

To effectively introduce IoT in ports, logistics, freight and container transport environments it

[6] The port of Valencia has been in 2015 the fifth biggest port in Europe in terms of container movements,

is needed that:

- Containers, semi-trailers, trucks, wagons, trains, vessels, cranes and other freight or container handling machines become IoT enabled physical entities with different devices attached to them (sensors, tags and actuators) and communication capabilities using constrained or unconstrained networks following IoT protocols and standards.
- Hub and transport infrastructures (ports, terminals, warehouses, logistics hubs, roads, railways) become IoT enabled through sensors, tags and actuators devices (i.e. weather and environmental sensors, gates, access controls, cameras, aids to navigation, road & rail traffic control devices)
- IoT platforms are introduced by port, logistics and transport infrastructure managers as well as port, logistics and transport operators to properly handle IoT enabled heterogeneous physical entities in an interoperable ecosystem.
- IoT platforms are connected to enterprise and operational business platforms (i.e. port community systems, terminal operating systems, port management systems, control systems, fleet management systems). Physical entities can be linked to transport and logistic operations and their involved stakeholders.
- Heterogeneous IoT platforms owned by different managers and operators at ports, logistic centers and transport infrastructures are able to interoperate and share data, services and virtual entities.
- Moving physical entities (i.e. a truck or a container) are able to interact and communicate with different heterogeneous IoT platforms along their route in a secure and trusted way (i.e. using some kind of roaming service) and according predefined business rules. These rules should be able to be configured in function of its location (i.e. by using geofences, tag readers, Bluetooth beacons) or other criteria specified at application level (i.e. in function of its destination).
- The data provided by an IoT entity could be different depending whether the IoT platform belongs, for example, to the owner, a partner, a customer, a service provider or a controller of the physical entity. The owner of a physical entity is aware and accepts the interactions of this entity with other IoT platforms
- Moving physical entities are able to dynamically interact with other fixed assets (i.e. the interaction of a truck with a gate or an access control system) and with other physical entities (i.e. the interaction of a container with the truck transporting it). The dynamic association of physical entities is made following predefined business rules (i.e. by proximity) and enable them to share data (i.e. the position of the truck is giving the position of the container being carried and communication of container sensors can be made through the communications of the truck).

The transformation process of transport, logistics, multimodal and port operations to become IoT enabled described above is also establishing several needs for the INTER-LogP product adoption which were identified during the stakeholder analysis activities:

1) Enabling an organizational, technical and semantic interoperability and integration able to:

a) collect several data on the logistic infrastructures and processes, such as goods status, scheduled deliveries, ownerships, perishability, number of the involved logistic units, security intrusions, operability and so forth;

b) ensure high data gathering rates and data quality using reliable sensors and/or high bandwidth communication systems;

c) develop interoperability adapters to existing solutions, such as integration of another communication protocol and/or data model, use of APIs and so forth;

d) expose functionalities and services for component integration by means of standardized APIs; and development of tools to check unauthorized access to layer's functionalities;

e) define an omni-comprehensive and shared logistics IoT semantic ontology;

f) enable and support relationships, communications and agreements between stakeholder/solution providers;

g) exploit new technologies, software and data integration patterns to enable integration of heterogeneous devices, networks, middlewares, application services and data;

2) Development of advanced logistic services

a) Identification, traceability and monitoring of the logistic units

i) develop/adopt systems capable to aggregate low level data using sensor fusion techniques;

ii) develop technological solutions to automatically discover, register and identify logistic smart objects and logistic operations;

iii) develop/adopt systems implementing location based algorithms;

iv) develop/adopt complex event processing (CEP) systems to aggregate simple geo localized events to high level meaningful events;

v) develop a service to manage the logistic IoT platform and the monitoring process itself, such as implementing self-CHOP (configure, heal, optimize, protect) general features for sensors, devices, infrastructures, units, but also to decide when monitor a logistic units, how to monitor and configure sensors and so forth;

vi) develop a service on discovered events to predict future situations and scenarios, in several perspectives such as security, delivery performance, resource utilization and so forth;

vii) develop a service on a discovered potential unwanted situation or security issue, to automatically apply countermeasures to mitigate or completely address it, such as re-route delivery of a wrong located logistic unit, avoid the delivery of logistic units in unsecure infrastructures and so forth;

b) Optimization techniques of the logistic units movement and storage

i) develop a service to automatically decide how, when and why integrate a new component taking into account the objectives of the logistic IoT platform;

ii) develop a service to reason on how to use the features of a new integrated component depending on the status of the logistic IoT platform;

3) Realize an interoperable logistic IoT ecosystem in order to:

a) give to the ecosystem's actors the opportunity to integrate their solutions with the platform, and also simplify and speed up the integration process, using accessible and permissive licenses and/or open source paradigm;

b) implement a wide set of policies to establish who, where, why and when can use and/or access to a specific logistic infrastructure/unit;

c) develop logistic smart objects (e.g. logistic units), but also understand how to add smart features to existing logistic objects, e.g. adding sensors, actuators and communication systems;

d) develop IoT enabled infrastructures, or add to existing infrastructure technological requirements to be IoT enabled, e.g. adding sensors, actuators and communication systems;

e) develop technological solutions to bring high performance connectivity and localization services to objects and infrastructures, inside connectivity served areas but also in not served areas;

f) build modular services on top of the logistic IoT platform.

A key area INTER-LogP could cover those physical entities that now are unconnected. For example, when a vessel calls at a particular port, several actors need to cooperate in order to complete its arrival in an efficient, reliable and safe way. Through the use of IoT devices in vessels, boats, tug boats or mooring services, the different maritime actors could perform the entry and berth operation in a more efficient, reliable and safe way. Using IoT technologies to monitor ships, containers and equipment instead of current procedures could decrease congestion and reduce current losses derived from bad logistics operations (e.g. over $15Billion in product losses occur every year in the pharmaceutical industry due to temperature and incorrect cold chain shipping control).

One important barrier found in the logistics sector is that many of the existing solutions are proprietary, stand-alone solutions that are not connected to each other. Therefore, the INTER-LogP product will need to combine various existing hardware and software solutions for end-to-end integrity control of supply chains.

A second barrier is that logistics is typically a low-margin and fragmented industry, especially in freight road transport where there are thousands of different suppliers with varying operating standards for local, domestic, and international operations. To successfully implement IoT in logistics, it will be required a strong collaboration, along with high levels of participation between different players and competitors within the supply chain. One of the

aims of INTER-IoT project is to overcome this barrier by creating a thriving IoT ecosystem for the ports and logistics sector where solution and technology providers could meet together in an interoperable environment. Additionally, trust will be essential for data exchange between the different entities and actors involved in a particular supply chain.

IoT can also play an additional role in OHS (Operational Health and Safety) issues, preventing potential collisions and alerting drivers when they need to take a break during shifts, e.g. long-distance truck drivers are often on the road for days in hazardous conditions. Cameras in the vehicle can monitor driver fatigue by tracking key indicators such as pupil size and blink frequency. This is already being applied by Caterpillar, the world largest manufacturer of construction and mining equipment, which is using this technology to keep sleepy truck drivers from getting into accidents.

3.4.2 Stakeholder participants

The INTER-LogP product is centred in transport and logistics area. This is a big area and a high number of companies or entities are involved. For this reason, the selection of a minimum set of representative has been involved during the first stages of the project and the conclusion it that there is a big interest and expectation of the introduction of IoT in transport and logistics.

At the time of development of this report, the number of stakeholders which were interviewed for the INTER-LogP product was 49. The complete description of the stakeholders is presented in the annex of this deliverable using the stakeholders' template.

The stakeholders that took part in the study have been categorized as follows:

Public authorities

The authorities involved in the Project will play an important role in it. This group mainly has considered the European Commission as the sponsor of the project and port authorities as the use case scenario for INTER-LogP is ports.

Table 48. Public authorities (INTER-LogP)

Stakeholder	Description
DG CONNECT – European Commission	The sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.
Port Authority of Valencia	It is the public body responsible for running and managing three state-owned ports of the Mediterranean coast in Eastern Spain: Valencia, Sagunto and Gandía.
Autoridad Portuaria De Vigo	Responsible for running the largest port in Galicia and owner of a SmartPort platform.

Research Institutions & Projects

This group is composed by universities, non-profit organizations, and related ICT-30 IoT projects. These entities work on technologies or in the innovation at ports, transport and logistics sectors.

Many of these entities are researching, developing and creating solutions associated with the IoT and interoperability, like sensors, protocols, gateways, data processing solutions, middleware and semantics and also interested in publication and standardization results.

Other entities are working on achieving and providing solutions that simplify the introduction of IoT in ports, logistics and freight transport under an interoperable framework where different companies can share information generated by different smart devices and sensors in a secure and trusted environment.

In reference to the projects, they aim to define a framework, and to build and promote a marketplace where applications are available.

The universities involved in this research that manifested interest in INTER-LogP are:

Table 49. Research Institutions & Projects (INTER-LogP)

Stakeholder	Description
Universitat Politècnica De Valencia	Spanish public university, with several research centers and projects related with IoT
Technische Universiteit Eindhoven	Technical public university in The Netherlands, with different projects and research areas related with IoT.
Systems Research Institute, Polish Academy of Sciences (SRIPAS)	Public Polish research center active primarily in the domain of methodological foundations for systems analysis.

Non-profit organizations involved are:

Table 50. Non-profit organizations (INTER-LogP)

Stakeholder	Description
ValenciaPort Foundation	Non-profit organisation works on the innovation of the port, transport and logistics sectors.
AFT	Non-profit organisation devoted to the development of vocational education and training in the Transport & Logistics sector.
AIOTI-UPV	Group of research groups related with IoT at UPV and associated research institutes.

Related ICT30 projects related with the application of IoT in transport and logistics are:

Table 51. ICT-30 related projects (INTER-LogP)

Stakeholder	Description
ICT-30 TagItSmart	H2020 RIA TagItSmart (Smart Tags driven service platform for enabling ecosystems of connected objects)
ICT-30 BIG-IoT	H2020 RIA BIG-IoT (Bridging the Interoperability Gap of the Internet of Things)

Transport and logistic companies

This group corresponds to entities that are involved in some way in the transport and logistics sector, they are entities/companies that are potential users of the solutions proposed. These entities are interested in the results of the project and in INTER-LogP product.

Within the scope of the port transport and logistics use case we have selected and classified the companies according to the area of action, these companies are:

- Companies related to road and rail transport.
- Companies related to sea/ocean transport: shipping companies, shipping agents, freight forwarders or logistics operators.
- Companies that manage the transfer of the goods from land to sea transport modes, such as container terminals, Ro-Ro terminal or multipurpose terminals.

Companies involved in the port transport and logistics sector are:

- Hauliers Company.

Table 52. Transport and logistics companies (hauliers)

Stakeholder	Description
Grupo Chemma Ballester	GCB is a company created to develop all kinds of logistics services marine containers.
Transtorres	TT is specialized in traffic of refrigerated containers and dangerous goods.
Syrtrans Logistica	SYRTRANS is an integrated logistics operator specializing in freight and logistics management
SOTRADEL	SOTRADEL is a logistics company that provides freight forwarding, warehousing and regional, national and European transport services.

- Railway Company

Table 53. Transport and logistics companies (railway company)

Stakeholder	Description
Continental Rail	Continental Rail is a private railway undertaking connecting the main ports of Spain with their hinterlands.

- Shipping lines

Table 54. Transport and logistics companies (shipping lines)

Stakeholder	Description
MSC	Mediterranean Shipping Company is a shipping company specialized in the transport of overseas cargo carrier.
Maersk	Maersk Line is a shipping company specialized in the transport of overseas cargo carrier.

- Port terminals

Table 55. Transport and logistics companies (port terminals)

Stakeholder	Description
NOATUM Ports	Terminal offering: Bulk terminals, Container terminals, Multi-purpose terminals, Rail terminals, Ro-Ro and vehicle terminals.
Medcenter Container Terminal Spa	In the port of Gioia Tauro, is a company controlled by Contship Italia Spa, leader in Italy in container terminal operations.
Valencia Terminal Europa S.L.	Is a port terminal based in the port of Valencia, working with RO-RO vessels for manufactured vehicles, trucks and.
Balearia	Balearia is a shipping line which has a passenger and RO-RO terminal in the port of Valencia serving the traffics of passengers and of trucks.
Barcelona Ro-Ro Terminal	It is a port terminal based in the port of Barcelona, working with RO-RO vessels for passengers, manufactured vehicles, trucks and semi-trailers.

IoT products and solution providers

Companies involved in research, software development, device manufacturing, systems integration, etc. are:

- Software development & systems integration

Table 56. Developers & Integrators (INTER-LogP)

Stakeholder	Description
ETRA I+D	ETRA's mission is putting in the market the most advanced solutions and services either directly or through the 10 companies of the Group.
Infoport Valencia	INFOPORT is a technology services company specializing in the logistics sector and ports.
Amiga Ventures	Amiga provides services to allow companies to undertake the digital transformation of their business, from strategy and design to maintenance and continuous improvement.
Kii	Kii helps developers and device manufacturers meet their high-performance demands with an end-to-end platform optimized for building and running enterprise mobile and IoT initiatives.
Amplía	Amplía is a company that pioneers of Internet of Things solutions, specialized in wireless communication solutions and software engineering.
Engineering Ingegneria Informatica S.p.A.	ENGINEERING is the head company of the ENGINEERING Group. Engineering is currently the first IT group in Italy.
Itaca SRL	Itaca is a spin-off company of University of Calabria and University of Salento, operating in Information & Communication Technology (ICT) field.
Prodevelop	Prodevelop is a solution developer and systems integrator with a high expertise in port & maritime solutions and public administration, especially smart cities.
Thales Services SAS	Thales Services (THS) belongs to Thales group, which is a large industry player specialized in critical systems for government and companies.
XLAB d.o.o.	XLAB is a company providing technology solutions for enterprises and products for, among others, high volume and speed services such as Internet of Things.
Sentinel d.o.o.	Sentinel is a Croatian company providing a hardware and software bundle for the monitoring of personal vessels and charter fleets.
Vemco SP z.o.o.	Vemco is a company with a main focus on computer networks and access-control systems.
BetterSolutions SA	BetterSolutions has knowledge and experience in designing, developing and deploying systems based on IoT platforms.

- Device manufactures

Table 57. Device manufacturers (INTER-LogP)

Stakeholder	Description
Neways	Neways is an international company active in the EMS (Electronic Manufacturing Services) market.
Energy Solutions	Energy Solutions is a marketer of innovative solutions with high technological value in the area of Smart Environment.

- Telecommunications operator

Table 58. Telcos (INTER-LogP)

Stakeholder	Description
Orange Polska S.A.	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Poland, part of Orange Group (France Telecom).

3.4.3 Stakeholders by company type

In a more detailed classification, the stakeholders can be divided into the following categories:

Table 59. Stakeholders by company type (INTER-LogP)

Non-profit organization	ValenciaPort Foundation AFT AIOTI-UPV
Private technology and solutions supplier company	Prodevelop NEWAYS Infoport Valencia Amplía Amiga Ventures ETRA I+D Kii Thales Services Itaca SRL Engineering Ingegneria Informatica S.p.A. XLAB d.o.o. Sentinel d.o.o. Vemco SP z.o.o. Orange Polska S.A.

	BetterSolutions SA Energy Solutions Port Technology Company Energy Technology Company Multinational Solutions Provider for Government and Institutions Fuel provider systems company IT Logistic Provider
Transport & Logistics company	Grupo Chemma Ballester Transtorres Continental Rail Valencia Terminal Europa S.L. Balearia Barcelona Ro-Ro Terminal Syrtrans Logistica MSC Maersk NOATUM Ports Medcenter Container Terminal Spa Haulier company 1 SOTRADEL Haulier company 2 Haulier company 3
University	Universitat Politècnica De Valencia Technische Universiteit Eindhoven SRIPAS
Public Authorities	DG CONNECT – European Commission Port Authority of Valencia. Systems Port Authority of Valencia. Infrastructures Autoridad Portuaria De Vigo
Projects	ICT-30 TagItSmart ICT-30 BIG-IoT

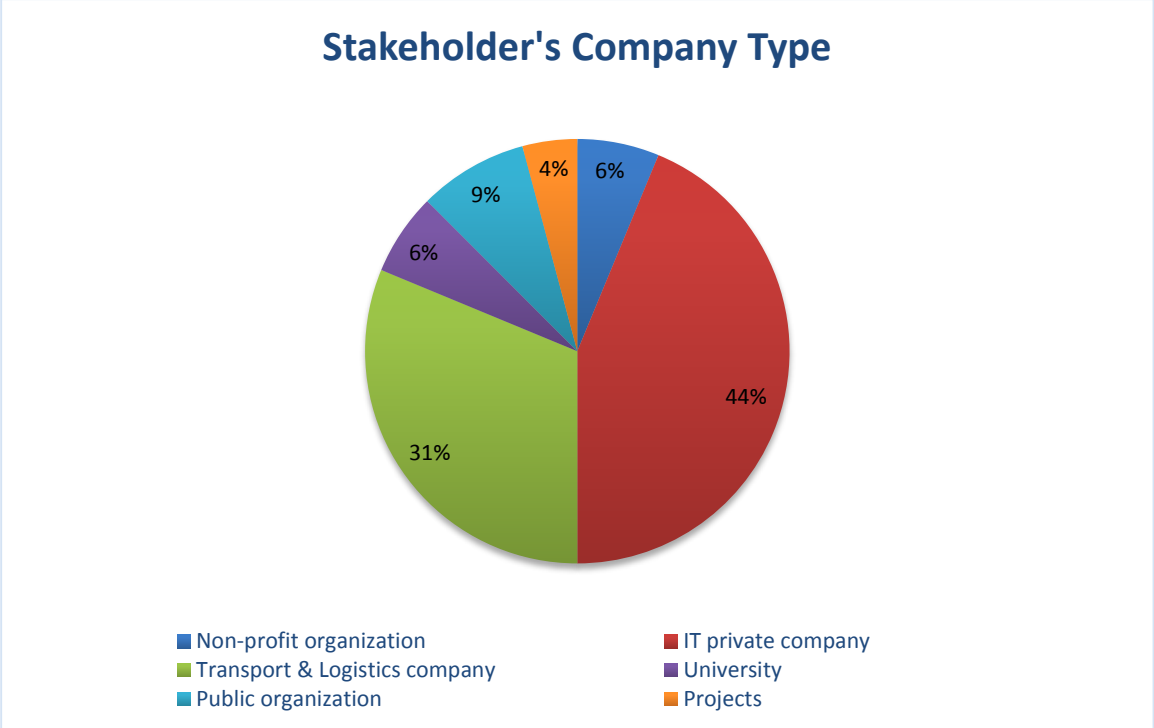

Figure 29 INTER-LogP Stakeholder's Company Types

At the graph we can see that half of the identified stakeholders are private technology and solution supplier companies, followed by transport and logistic companies being almost a quarter of the stake. Afterwards, public entities have been identified as interested parties, followed by universities, non-profit organizations and related projects.

3.4.4 Stakeholders by country

Involved stakeholders can be also classified by their country.

Table 60. Stakeholders by country (INTER-LogP)

Spain	ValenciaPort Foundation Universitat Politècnica De Valencia Prodevelop NOATUM Ports Port Authority of Valencia. Systems Port Authority of Valencia. Infrastructures Infoport Valencia Grupo Chemma Ballester Transtorres Continental Rail Valencia Terminal Europa S.L.

	Balearia Barcelona Ro-Ro Terminal Syrtrans Logistica Autoridad Portuaria De Vigo Amplía Amiga Ventures ETRA I+D AIOTI-UPV Energy Solutions Port Technology Company Energy Technology Company
Italy	Itaca SRL Medcenter Container Terminal Spa Engineering Ingegneria Informatica S.p.A. MSC
France	AFT Thales Services Multinational Solutions Provider for Government and Institutions Fuel provider systems company Haulier company 1 IT Logistic Provider SOTRADEL Haulier company 2 Haulier company 3
Nederland	NEWAYS Technische Universiteit Eindhoven
Poland	SRIPAS Vemco SP z.o.o. Orange Polska S.A. BetterSolutions SA
Slovenia	XLAB d.o.o.
Germany	Kii
Belgium	DG CONNECT – European Commission ICT-30 TagItSmart ICT-30 BIG-IoT
Croatia	Sentinel d.o.o.

Denmark	Maersk

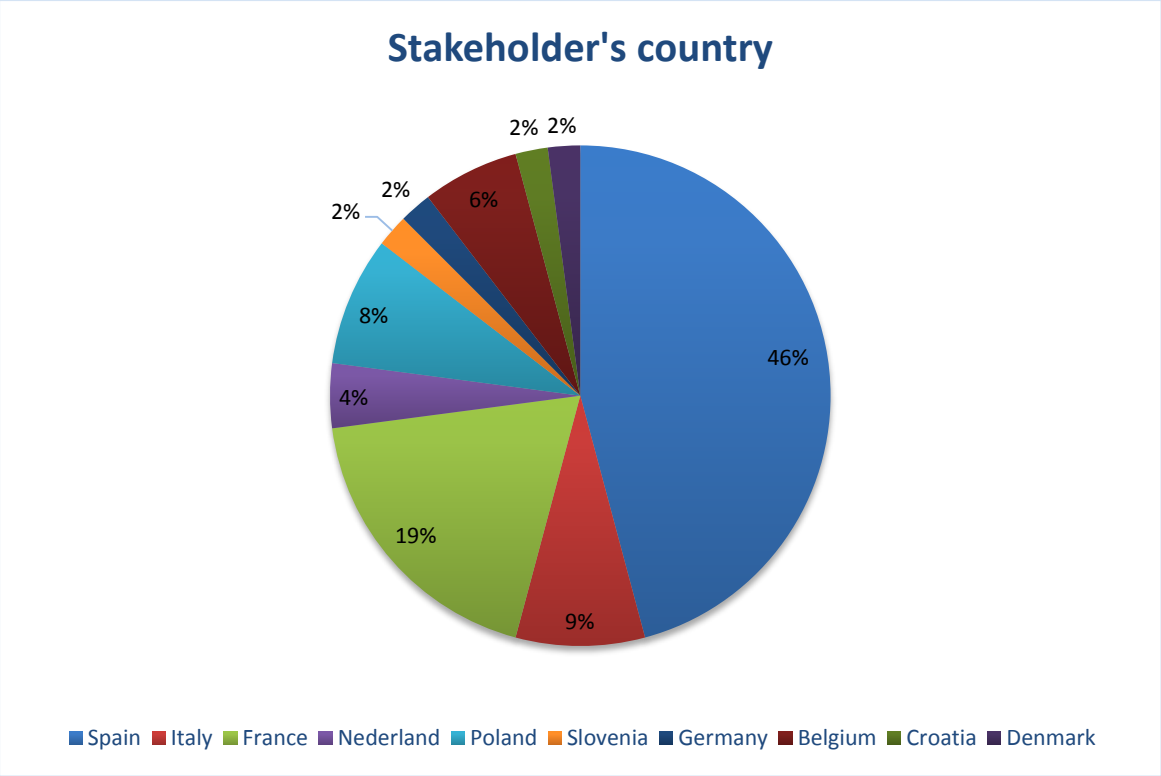

Figure 30 INTER-LogP Stakeholder's country

Since the pilot in the INTER-LogP use case takes place in the Port of Valencia, most stakeholders that are being identified are from Spain. Although a variety of stakeholders have been identified from all over Europe, specially, due to the intrinsic European characteristic of the INTER-IoT project, the quantity of countries is expected to growth during the execution of the project, mainly because of the interest created and the communication and dissemination tasks.

3.4.5 Stakeholders map

Following the Volere methodology, the stakeholder's map for the INTER-LogP product is as follows.

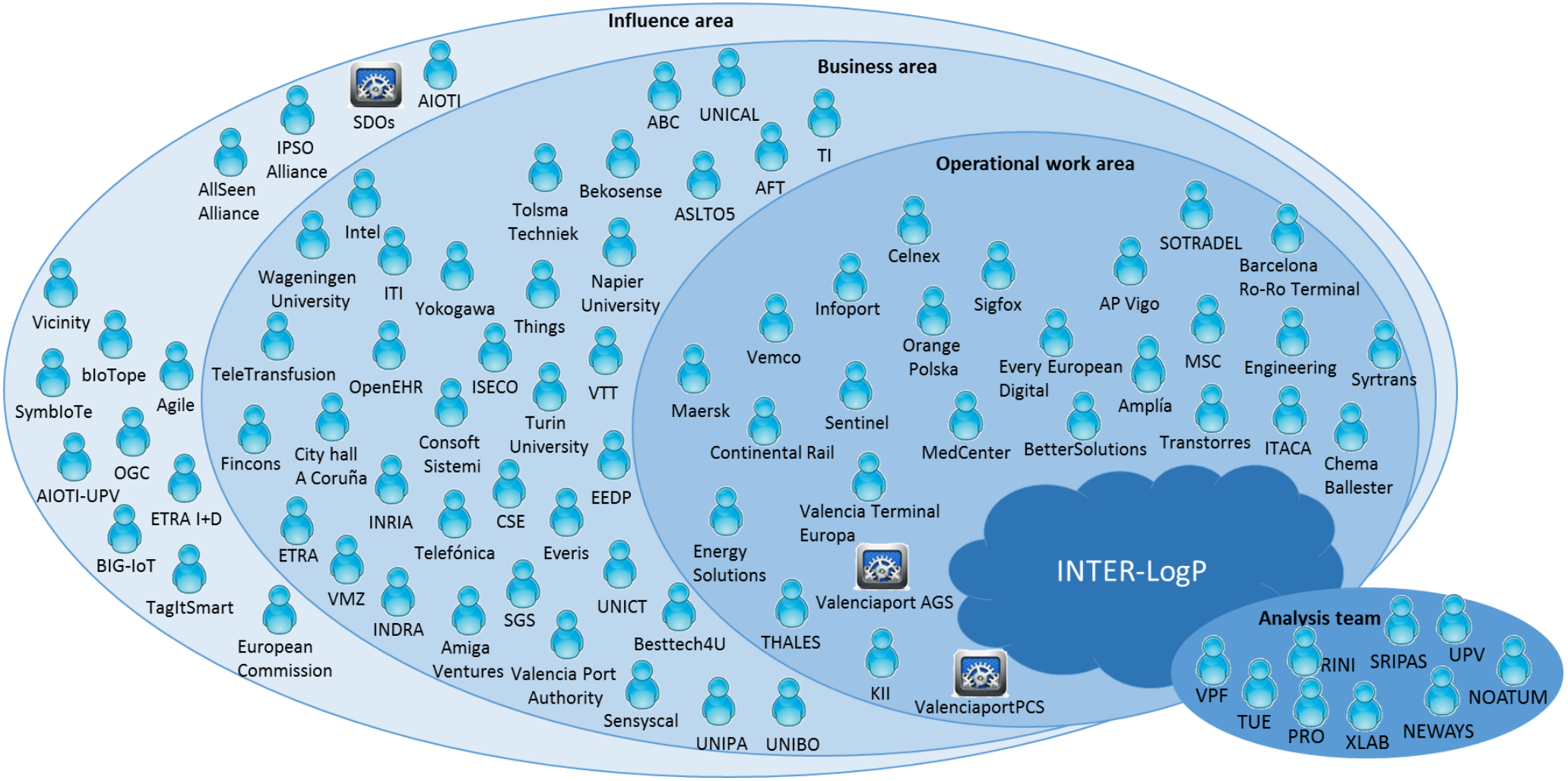

Figure 31 INTER-LogP Stakeholder's map

A glimpse of this map shows that a majority of partners (9 partners) will be at the core of the development of INTER-LogP. They constitute the Analysis team and they will be key stakeholders observing and analysing this product from different perspectives ranging from a direct use of the product to a more distant yet influential relationship with the intended product.

Among those stakeholders, composing the Operational Work Area, who will have direct contact with the INTER-LogP product, it is not surprising that we can find notably IoT hardware and software developers/providers (e.g. Sentinel, orange Polska), IoT platform developers as well as direct participants in port logistics processes ranging from port authorities (e.g. Valenciaport) to transport operators, whether by rail (Continental rail), sea (Maersk, MSC) or road (e.g. SOTRADEL, Syrtrans).

Having a more indirect relationship with INTER-LogP, a larger group of stakeholders composing the Business area include those who oversee port activities (Valencia Port Authority), those who determine the policy influencing or influenced by portal activities (City hall A Coruna), those who develop the IoT solutions that have the potential to be connected to those directly involved in INTER-LogP, and those who study, analyse and develop in general various IoT solutions (e.g. universities). These stakeholders, though they do not have a direct "hands-on" experience with INTER-LogP, stand nevertheless as benefiting from the product that can lead them to adapting their decisions, productions, research and offer so as to match the positive outcomes INTER-LogP will generate.

Finally, some stakeholders will either be influenced or influence INTER-LogP through for instance the results of research activities stemmed from past or ongoing IoT projects (e.g. TagItSmart, Big-IoT), as IoT solutions providers, or even simply as the sponsor of the INTER-IoT project (European Commission).

3.4.6 Stakeholders by class

Following the Volere methodology, the stakeholders can be classified according to the role they will play in the INTER-LogP product. Therefore they can be distinguished the following classes.

Table 61. Stakeholders by class (INTER-LogP)

Client	Grupo chemma ballester Transtorres Continental Rail NOATUM Ports NEWAYS DG CONNECT – European Commission Valencia Terminal Europa S.L. Balearia

	Barcelona Ro-Ro Terminal Syrtrans Logistica Haulier company 1 SOTRADEL Haulier company 2 Haulier company 3
Customer	Port Authority of Valencia. Systems Port Authority of Valencia. Infrastructures Autoridad Portuaria De Vigo MSC Maersk
Subject-matter experts	ValenciaPort Foundation Technische Universiteit Eindhoven Universitat Politècnica De Valencia Vemco SP z.o.o. BetterSolutions SA Orange Polska S.A.
Systems engineers	Energy Technology Company Multinational Solutions Provider for Government and Institutions
Software engineers	Infoport Valencia Port Technology Company Amplía Itaca SRL
Technology experts	Amiga Ventures Kii Engineering Ingegneria Informatica S.p.A. Prodevelop Thales Services Energy Solutions
Domain Experts	Medcenter Container Terminal Spa ICT-30 TagItSmart ICT-30 BIG-IoT
Designers and developers	XLAB d.o.o. Sentinel d.o.o. SRIPAS ETRA I+D

	AIOTI-UPV
Representatives of external associations	AFT
Provider	Fuel provider systems company IT Logistic Provider

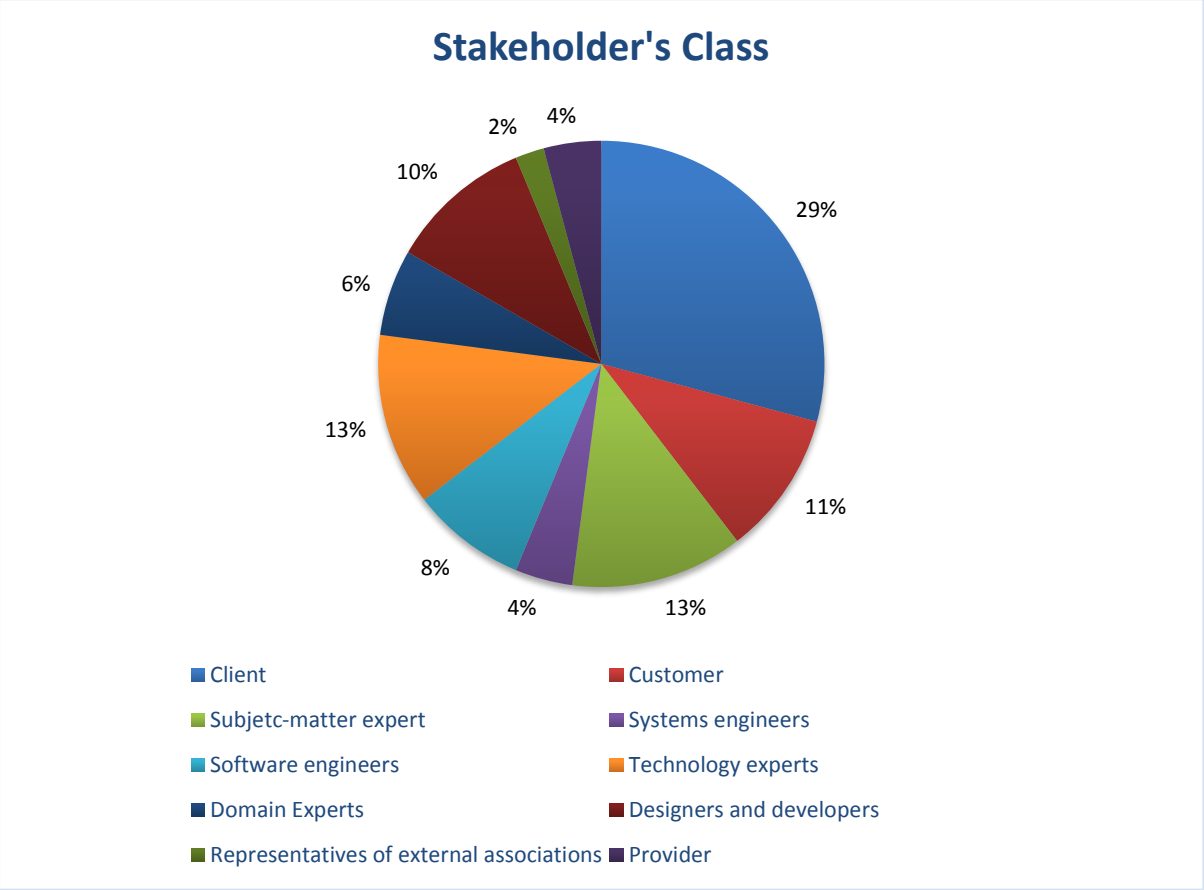

Figure 32 INTER-LogP Stakeholder's class

From the graph above it can be observed that quite of some stakeholders are final users (clients or customers). As well as it is acknowledged technological support from IT sector companies (Systems engineers, Software engineers, Technology experts, Domain experts). Moreover it is observed that a wide variety of representatives at the logistics and port sector (Subject-matter experts) are represented.

3.4.7 Stakeholders by IoT Demand/Supply

In the field of internet of things, each stakeholder can provide (Supply side) or receive (Demand side) IoT technologies and solutions. On the supply side we identify technology, development and systems integrator suppliers and research entities, while on the demand

side we identify final users such as public institutions (Port authorities) and transport & logistics companies.

Table 62. Stakeholders by IoT Demand/Supply (INTER-LogP)

IoT Demand side	IoT Supply side
Port Authority of Valencia. Systems	ValenciaPort Foundation
Port Authority of Valencia. Infrastructures	Infoport Valencia
Grupo chemma ballester	Amiga Ventures
Continental Rail	Kii
Transtorres	Amplía
NOATUM Ports	Port Technology Company
Medcenter Container Terminal Spa	Energy Technology Company
Autoridad Portuaria De Vigo	Technische Universiteit Eindhoven
Thales Services	Universitat Politècnica De Valencia
Sentinel d.o.o.	Engineering Ingegneria Informatica S.p.A.
DG CONNECT – European Commission	Itaca SRL
Valencia Terminal Europa S.L.	Prodevelop
Balearia	AFT
Barcelona Ro-Ro Terminal	XLAB d.o.o.
Syrtrans Logistica	SRIPAS
MSC	Vemco SP z.o.o.
Maersk	BetterSolutions SA
Haulier company 1	Orange Polska S.A.
SOTRADEL	NEWAYS
Haulier company 2	ICT-30 TagItSmart
Haulier company 3	ICT-30 BIG-IoT
	ETRA I+D
	AIOTI-UPV
	Energy Solutions
	Multinational Solutions Provider for Government and Institutions
	Fuel provider systems company
	IT Logistic Provider

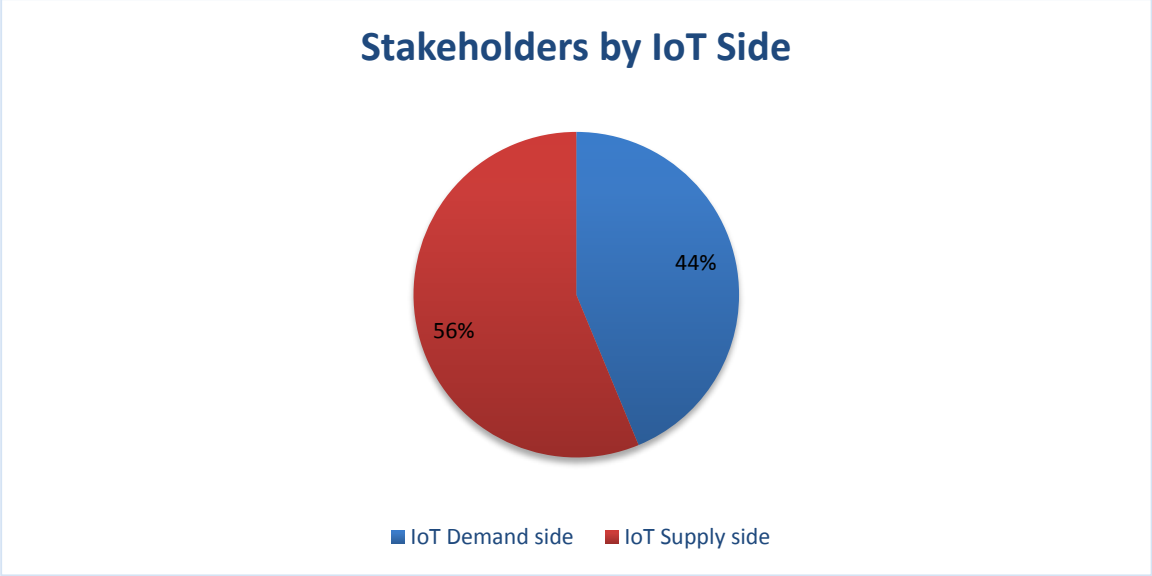

Figure 33 INTER-LogP Stakeholder's by IoT side

Although we have involved more IoT stakeholders on the supply side rather than the demand side, the main reason for this profile is because we have tried to involve a representative group of the logistics & transport activities while trying to assess the interoperability needs for IoT to a wider variety of technology and solutions providers that demonstrated a high interest in checking their products in the Inter LogP use case.

3.4.8 Stakeholders with interest in Open Call participation

Within the project INTER-IoT, an open call will be carried out. All those stakeholders who meet the stated requirements can apply it. Stakeholders who have shown interest in participating in these open calls are the following.

Table 63. Stakeholders with interest in Open Call (INTER-LogP)

Interested in participating in open calls	Not interested in participating in open calls
Infoport Valencia	ValenciaPort Foundation
Continental Rail	Port Authority of Valencia. Systems
Amiga Ventures	Port Authority of Valencia. Infrastructures
Kii	Grupo chemma ballester
Amplía	Transtorres
Port Technology Company	NOATUM Ports
Energy Technology Company	Technische Universiteit Eindhoven
Engineering Ingegneria Informatica S.p.A.	Universitat Politècnica De Valencia
Itaca SRL	Thales Services

Medcenter Container Terminal Spa	Prodevelop
BetterSolutions SA	Autoridad Portuaria De Vigo
Orange Polska S.A.	AFT
AIOTI-UPV	XLAB d.o.o.
Barcelona Ro-Ro Terminal	Sentinel d.o.o.
Energy Solutions	SRIPAS
	Vemco SP z.o.o.
	NEWAYS
	DG CONNECT – European Commission
	ICT-30 TagItSmart
	ICT-30 BIG-IoT
	ETRA I+D
	Valencia Terminal Europa S.L.
	Balearia
	Syrtrans Logistica
	Multinational Solutions Provider for Government and Institutions
	MSC
	Maersk
	Fuel provider systems company
	Haulier company 1
	IT Logistic Provider
	SOTRADEL
	Haulier company 2
	Haulier company 3

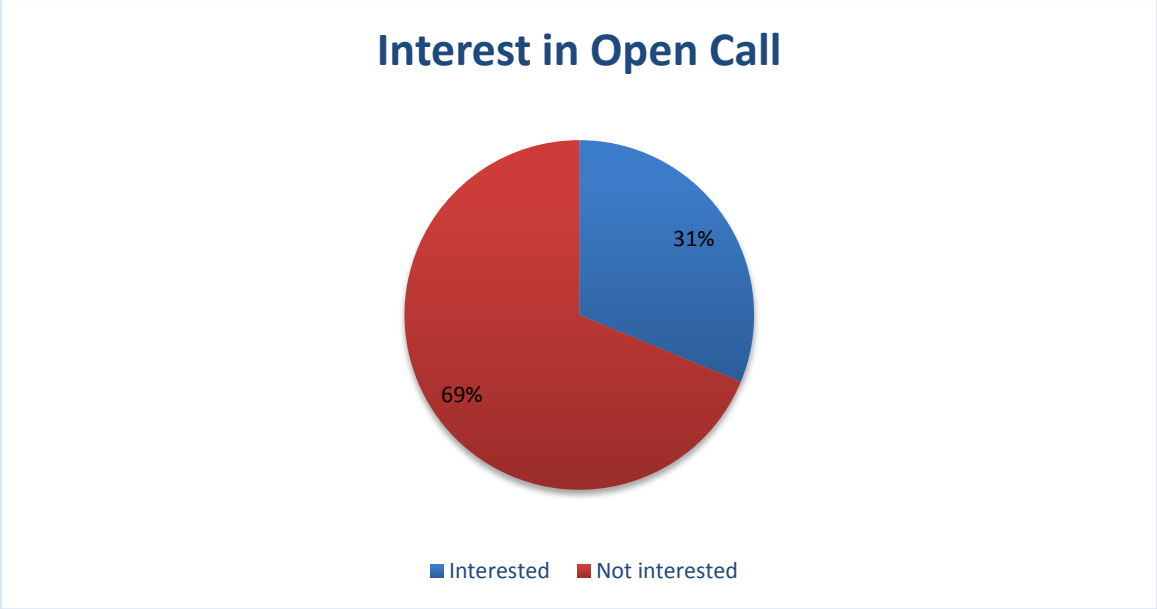

Figure 34 INTER-LogP Stakeholder's interest in the open call

In the above graph we can see that the group interested in open calls are mainly technology providers and systems integrators that are not currently in the INTER-IoT consortium and they are willing to demonstrate and test the interoperability framework in their solutions applied to the transport and logistics use case. The other group is more interested in following up, testing and using the solutions derived from INTER-LogP.

3.4.9 Products involved by Stakeholders

In today's market there are numerous products related to the INTER-LogP use case. In order to make a complete market analysis, it is necessary to know what are the existing products and solutions used in the transportation and port-logistic sector use case and what are the products and components to create an IoT interoperable environment. In the list below, it can be seen those products which are being used by stakeholders or would be needed in the experimentation. A brief description of these products is presented in the annex of this deliverable and it is also registered in the project repository.

Port Systems

- Port Community Systems (i.e. ValenciaportPCS, Posidonia PCS, Gioia Tauro PCS –in development-)
- SCADA Systems
- Automated Gate Systems (i.e. GateCCR Container Code Recognition, GateLPR Licence Plate Recognition)
- Port Management Information Systems (PMIS)
- Terminal Operating Systems (i.e. CATOS)

- Freight handling machines sensoring solutions (i.e. CraneTMS Traffic Management System, Yard CraneOCA Obstacle Collision Avoidance, Yard CraneSCA Stack Collision Avoidance, SEAMS & Machine BlackBox)
- Dynamic lighting system
- Container Tracking Automation (i.e. DPWorld & Termavi)
- Smart Port platform (i.e. Ágata, SPL Hamburg)
- Multi-purpose Terminal Operating System (IXNET)
- Reefer Container Monitoring System (RCMS)

IoT Platforms

- FI-WARE (i.e. VLCi)
- Open-IoT
- Sofia2
- Azure IoT
- Google IoT
- Kii Cloud Platform
- IoT enabling platforms (i.e. JBossMQ, Apache Spark, Apache kafka, …)
- BUTLER

Road Transport Management Platforms

- Fleet management systems for location and oil consumption monitoring (i.e. Mobildata)
- Digital tachograph & driver identification
- Interaction between locomotives, platforms and drivers and devices placed at port-terminals.
- SIMACOP (command & control)
- Traffic Safety Management Center (Cegesev)
- Traffic Management Center (CGT)
- SoTA of the Logistic Information Systems
- Intelligent systems (i.e. PRACTIONIST)
- MuuMap
- UPV CARTA listed products and projects
- Fuel management systems
- Enterprise Resource Planning (ERP)

Software

- LPR (License plate readers)
- RabitMQ

- Electronic Data Interchange (EDI)
- ElasticSearch
- CMS (Content Management System)

Hardware (sensors, devices, etc.)

- Passive RFID tags, QR tags, FunCodes
- Smart phones, tablets & Smart watches
- Sensors (CITYLOC, CITYMICRO, CITYWAY, GEOVAL)
- Electronic seal for containers (GEOVAL)
- Passive ISO-18600-C RFID antennas
- Industrial PLCs, Sensors, Actuators
- Crane /Straddle carrier PLCs
- LoRa, DUST, Body Area Network (BAN)
- NOC (electric vehicles)

Project results

- STIMULO project
- MEDITA's project

Standards

- Sensor Observation Systems (OGC SOS)
- Standardisation: W3C WoT, W3C SDW, IETF core OGC, SWE WG, oneM2M, MS WG, OIC / IIC

3.4.10 Stakeholders needs

During the interviews and contacts established during this first task of the project, an initial identification of the needs has been carried out. The general needs identified for the INTER-LogP use case product were already presented in the introduction of this chapter. Additionally, for each class of stakeholders analysed we have also found the following specific objectives to take into account:

Public authorities and institutions

Public authorities involved in INTER-LogP may have different needs depending on the context they are. The needs will be different for a stakeholder at European, state, local or port level.

For instance, at European and national level, public authorities and institutions want to achieve a leadership in the industry of digital IoT platforms. For them, the most important need from this project is the availability of an interoperable and open environment for any

business to support its digital transformation and break the silos between the application areas (e.g. health, home) and technologies such as IoT, CPS, Cloud and Big Data. This will enable the development of open platforms to foster a vibrant IoT ecosystem, opening up developer communities and creative practices.

The European Commission, as the institution that finances research projects in the field of Internet of things, has a visible and strategic IoT programme. In order to comply with that programme, it has to coordinate and promote synergies between different projects. It is also looking for the sustainability beyond the project life time and for preparing the ground for large-scale pilots from the result of these projects.

Its objective is to allow the availability and maturing of sustainable IoT platforms based on real ecosystems and a wide community of developers. Not forgetting trust, security and ethics issues, preparing the hyper-connected society.

At a port level, this use case represents a unique opportunity for testing interoperable IoT solutions in this field, as INTER-IoT is the unique ICT-30 project that has presented this use case. Big ports are complex ecosystems with a high range of different companies confluencing in the same hub area to carry out transport and logistics activities. Traditionally ports are covering the complex collaborative and data sharing activites using Port Community Systems (PCS). These platforms provide services designed to streamline and facilitate the operating processes of the companies of the port community by using Electronic Data Interchange (EDI) solutions and common databases with specific data access policies driven by business rules commonly agreed by the port community under a data security, sharing, trust and protection framework.

Several port authorities at European level have supported or even created a port community system as a tool to help them to become more competitive whilst allowing them to capture and increase cargo loyalty thanks to improvements in the following areas:

- Efficiency: automated operations by adopting error-free paperless processes.
- Connectivity: connecting port agents dealing with critical business processes.
- Integration: integration of sea-port-land operations between ports, ocean carriers and their shipping agents, freight forwarders and other operators.
- Modernization: modernizing logistics management by connecting agents' systems and using the most advanced information systems.

However, the Port Community Systems are not following an IoT paradigm of physical and virtual entities which prevents to enlarge the capacity of this system to monitor trucks, containers and drivers within the port using new devices like, for example, tags, NFC cards, smart phones & tablets, on-board units.

The creation of an IoT platform interoperable with other IoT platforms owned by other companies like port terminals, rail companies, road hauliers and other logistics operators as well as with other infrastructures' managers like rail infrastructure operators or highways operators is seen as an emerging necessity for the ports of the future where everything will

be connected.

The interoperable IoT platform would be able to be integrated with the PCS. It should allow tracking the location of the trucks inside the port facilities and the identification of the drivers. It should respect privacy and data protection rules. Also should make homogeneous use of disparate sensor using a common ontology for a common understanding. Efficient information management is a key factor of the competitiveness of any company involved in transportation due to the vast quantities of information created and interchanged.

Other important system within the port is Automated Gate System (AGS) to control and identify the arrival and departure of each truck and car in the port. The AGS aims to improve the level of the required security and protection at ports without hampering the fluidity of freight transport by introducing automated systems, real time traceability and new collaboration opportunities within the transport chain.

Currently it is using recognition of plates and container numbers but they are not following an IoT paradigm of physical and virtual entities which prevents to enlarge the capacity of this system to monitor trucks, containers and drivers within the port using new devices like, for example, tags, NFC cards, smart phones & tablets, on-board units. The creation of an IoT platform interoperable with other IoT platforms owned by other companies like port terminals, rail companies, road hauliers and other logistics operators as well as with other infrastructures' managers like rail infrastructure operators or highways operators is seen as an emerging necessity for the ports of the future where everything will be connected.

The interoperable IoT platform would be able to be integrated with the AGS. It should allow tracking the location of the trucks inside the port facilities and the identification of the drivers. It should respect privacy and data protection rules.

In addition, the Port of Valencia will offer a container weighing service to ensure Spanish shippers are able to comply with new international regulations that will come into effect on 1 July 2016. The interoperable IoT platform should be able to be integrated with this new system.

Universities

Universities are important research centres, and therefore have an important role in the development of this project. For the universities the INTER-LogP product is a scenario with different QoS requirements in which they can effectively test INTER -Layer, INTER -FW and INTER –Meth, and test if the functional requirements and expectations are fulfilled or not.

The universities should also develop a semantic model of the application domain which integrate data from identified IoT platforms so that they can be analysed together by the end user. All data exchange standards used in IoT platforms should be considered and a mapping of common concepts should be developed.

Non-profit organizations

There are several non-profit research groups and associations, collaborating in the project development. Some of them are more related to the port environment, and therefore their goal is to improve the functioning of port processes, but other organizations are more focused on the development of new technologies.

There is a consensus that the introduction of IoT in ports, logistics and transport needs to provide a service and an added value for the owners of the different physical entities participating in the processes and an interoperable framework able to create an ecosystem that connect together all these physical entities participating along the execution of the different supply chains.

One of the main features of an interoperable IoT framework is that it should be able to gather information from all the elements that interact. So containers, semi-trailers, trucks, wagons, trains, vessels, cranes and other freight or container handling machines become IoT enabled entities capable to be identifiable, smart, able to capture data coming from sensors using different devices and communicating this data through IoT protocols and standards.

IoT platforms have to be connected to enterprise and operational business platforms (i.e. port community systems, terminal operating systems, port management systems, control systems, fleet management systems) so smart objects are tightly linked with the operations and the stakeholders linked to those operations. Heterogeneous IoT platforms owned by different port, logistics, transport infrastructure managers and operators should be able to interoperate.

A smart object moving and participating in the supply chain (i.e. truck, container) should be able to interact and communicate with different heterogeneous IoT platforms according to predefined business rules.

There are other fields of interest identified in which there are several commonalities with smart cities. For example, the combination of sustainability and environmental concerns with city logistics to comply with constraints such as increasing regulatory obligations, severe congestion at certain moments, urban delivery requirements and citizens' growing demand for better quality and efficiency of deliveries in urban areas. Another example is the deployment of sensors in wide areas to monitor a set of parameters and to process this generated information.

Projects

Within the ICT-30 programme about interoperability of Internet of Things, there are 6 more projects with the objective of achieving an interoperability between IoT platforms. The needs of these projects are similar to those of INTER-IoT, as they share the same objectives although they are not strictly focused in the transport and logistics domains.

These projects can benefit from the compatibility, integration and complementarity with INTER-LogP. They can use it to take advantage of an experimentation environment for the interoperability of heterogeneous IoT platforms, with the aim of lowering market entry barriers for IoT ecosystems in ports, transport and logistics application domains, and allowing interweaving of platforms, things, and users.

Transport companies

Companies related to road transport and rail transport consider that the introduction of IoT in their sector will improve some aspects like:

- Fleet management
    - More efficient fleet management, especially when subcontracting the carriage of goods to third parties.
    - Full visibility of its fleet (i.e. a transport company has only half of its fleet of trucks monitored)
    - Achieve lower costs to monitor their trucks. It is perceived that the introduction of IoT may reduce the cost and complexity to deploy, connect and communicate devices needed in remote places or over vehicles.
    - Predictability and forecasting. The acquisition of real time data is seen as an opportunity to produce a more effective optimisation of the operations facilitating strategic decision-making based in knowledge.
    - Energy efficient, lower fuel cost and environmentally friendlier transport. An IoT platform for transport units could provide the data needed to precisely calculate the carbon footprint, and monitoring and influencing on the fuel consumption and the driving behaviour through a more precise synchronisation of transport operations minimising idle transport times.
    - Receive orders and updates from its clients through its private IoT platform and communicating with other IoT platforms to update and optimise operations.
- Related to port area:
    - Faster, more secure and safer port accesses.
    - Supply chain visibility inside the port areas.
    - Shorter waiting times of trucks inside the port and container terminals.
    - Integrate container depots and origin and destination points in the IoT ecosystem for a faster and seamless communication of the trip.
- Overall
    - Paperless
    - Preventive maintenance of their vehicles
    - Savings on oil consumption
    - More sustainable transport services

Railway Companies are interested in improving:

- Interaction between locomotives, platforms and drivers and devices placed at port-terminals.
- Interaction about position of train convoys and terminals.
- Interaction between trains and infrastructure administrators.
- Developing an “intelligent container platform”
- Geo-localization for locomotives
- Devices to help predictive maintenance in platforms and locomotives
- Devices to increase interconnection between actors within the supply chain

Shipping lines

Shipping line companies have initially been contacted to participate on the container monitoring scenario for reefer containers. Under this scenario they need to receive all the information related to the reefer status, such as temperature, location, energy consumption. The ideal solution would be to connect to a cloud the information related with the Reefer and being able to be accessed both by the Container Terminal and a Shipping Line.

Port terminals

Companies that manage the transfer of the goods from land to sea mode, such as container terminals, Ro-Ro terminal or multipurpose terminals.

The needs for a container terminal related to the usability of IoT are mainly linked to the possibility of:

- inter-operating with the trucks arriving at the terminal;
- knowing the estimated time of arrival of the trucks coming to the terminal;
- Precisely tracing the containers since their arrival up to their departure;
- knowing in real time the position of the trucks, trains and vessels while they are operating at the terminal with the capability of exchanging information and inter-actuating with these units as if they were part of their internal equipment;
- checking the status of the handling machines in real time and providing maintenance, checking consumptions, etc.;
- identifying, locating and registering incidents (i.e. the container is not loaded on the right truck, identifying first that the truck is the one that should be working with the machine):
- identifying automatically the containers carrying dangerous goods, also known as IMO containers (e.g. an IMO container is linked with the communication gateway of the truck which provides information about the location of the IMO container, the type and nature of the goods transported and the safety information required for its transport)
- monitoring in real time the status of reefer and hazards containers;

- connecting with shipping line systems to transfer information about the reefer containers (e.g. temperature, location, …);
- achieving energy savings and efficiency by using, for example, dynamic lights able to operate with external trucks and defining eco or turbo modes of operation for each machine.
- Safety and Security (e.g. being able to communicate and guide external personnel and vehicles in case of emergencies)

The needs for a passenger and RO-RO terminal related to the usability of IoT are:

- Vehicles:
  - Sensing the internal machines operating in the terminal yard where there are thousands of manufactured vehicles, second hand vehicles, trucks and semi-trailers waiting for the subsequent transport leg (whether through sea or inland transport modes).
  - To provide connected vehicle solutions with external vehicles to facilitate planning, monitoring and execution of road operations towards and within the ports.
  - Monitoring and keep track of all these transport units and to control them during the gate-in, gate-out, loading and discharge operations in an efficient way.
  - Monitoring and communicate with existing devices and sensors installed on the trucks carrying the intermodal transport units
  - Passive RFID e-seals for semi-trailers.
- People:
  - New technological solutions for passenger access control systems, able to use electronic boarding passes received in mobile devices or wearables (i.e. smart phones or smart watches) and to validate them on line in real time.

Private technology and solutions supplier companies

There is a very high number of private companies from the supplier side of INTER-LogP, so the variety of needs is wide. A main need established in the project is to develop new interoperable IoT based products for transport and logistics starting from INTER-LAYER, INTER-FW and INTER-METH products. These companies want to get an interoperable framework and related tools able to create an IoT market in the transport and logistics sector, following standards to enable relationships, communications and agreements between stakeholders and solution providers. On top of a transport and logistics IoT ecosystem it is needed to build modular services to achieve technological solutions that bring high value for end users so they are encouraged to transform their activities using IoT.

A second need is the achievement of **interoperability** at different levels. The ability to connect services through different communication channels (Wi-Fi, GSM, etc.), with different services (e.g. different marinas, ports and logistics hubs) and information merge with other services

(weather, rental prices, etc.). In a port environment there exist a large number of heterogeneous sensors, highly specialized sensors and measuring devices, provided by numerous competing suppliers using different communication standards and data models, resulting in high expenditures on integration and interfacing of each device type. An IoT interoperable framework should design unified protocols and support data ownership management, data-flow monitoring and access management by different stakeholders. It should also provide interoperability between existing IoT platforms owned by different logistics and transport infrastructure managers and operators.

It has to be an **integration** of IoT platforms connected to enterprise and operational business platforms (terminal operating systems, control systems, fleet management systems) in which smart objects are tightly linked with the operations and the different stakeholders linked to those operations.

Another major problem is the capability to **analyse large amounts of data** generated continuously and the detection of a number of conditions (in two variants, simple and complex). Very important is the quick reaction in front of the data captured by the devices in real time. It is necessary to provide a framework capable to aggregate low level data using sensor fusion techniques, the implementation of location based algorithms, complex event processing systems to aggregate simple geo localized events to high level meaningful events or a service to manage the logistic IoT platform and the monitoring of its own processes, such as implementing self-CHOP (configure, heal, optimize, protect) general features for sensors, devices, infrastructures, units, but also to decide when monitor a logistic units, how to monitor and configure sensors and so forth. It is also necessary to develop a service on discovered events to predict future situations and scenarios, in several perspectives such as security, delivery performance, resource utilization and so forth. Thereby the IoT framework is able to discover potential unwanted situations or security issues, to automatically apply countermeasures to mitigate or completely address it.

Should consider ensure a high data gathering refresh rates and data quality using high reliable sensors and/or high bandwidth communication systems to collect several data on the logistic infrastructures and processes, such as good status, scheduled deliveries, ownerships, perishability, number of the involved logistic units, security intrusions, operability and so forth.

For instance an Automatic Vehicle Location generates a large amount of data that should be processed in order to provide many value added services. IoT leads to new possibilities to AVL systems, introducing intelligence-driven development of services. In order to exploit the IoT potentiality in a very real way, several conditions must take place at the same time:

- Vehicles are IoT entities provided with on-board logic, collecting data coming from sensors (from canbus, biometric devices, etc.) using different devices and communicating these data through IoT protocols and standards (Complex Smart Asset).

- Hub and transport infrastructures (terminals, roads, stop points etc.) incorporate sensors, become smart and IoT enabled (i.e. weather and environmental sensors, gates, access controls, cameras, aids to navigation, road traffic control devices)
- IoT platform should enable easy data exchange with IoT gateways installed in vehicles; Raspberry Pi-based embedded systems acting as gateways for WSAN nodes (sensors to monitor milk parameters and vehicle/drive/route parameters)

Security is still an open issue on how to manage authorization, authentication and access rights assignment in an efficient way. It is very important that data and services should be protected. Regarding **privacy**, the IoT interoperability framework should meet standards required by European laws in case of personal data protection.

It is important to know how **sensors' discovery,** migration between platforms, optimization techniques of the movement of transport units and storage will be carried out. It should be developed technological solutions to automatically discover, register and identify transport and logistic entities and operations; a service to automatically decide how, when and why integrate a new component taking into account the objectives of the logistic IoT platform and a service to describe how to use the features of a new integrated component depending on the status of the IoT interoperability framework.

In order to carry out the integration of different platforms they need to define an omni-comprehensive and shared IoT semantic **ontology** on transport and logistics, where the communication with devices is based on many vendor-specific protocols. INTER-LogP should allow the tracking of objects carried out on containers. In addition, it should ensure the composition of data coming from different stakeholders and specific for an object, as well as secured and regulated access to these data.

There are stakeholders interested in **testing** and piloting their solution integrated with an IoT interoperable ecosystem in port, logistics and transport for tracking and monitoring goods for government and institutions along cross border flows and during customs transit procedures. It would be interesting give to the ecosystem's actors the opportunity to integrate their own platform solutions, and also simplify and speed up the integration process, using accessible and permissive licenses and/or open source paradigms. For which it is necessary to develop interoperability adapters to existing solutions, such as the integration of another communication protocol and/or data model, use APIs and so forth.

There should be a **simulation** phase and test field in order to develop the product, this is mandatory in order to check if it will affect to the port-logistics operations and it should be able to charge the product in a simulated environment.

The **response time** should be depending on the application, but in the industrial and health environment is less than 50 ms and in general it should be less than 200 ms, although in some applications this time could be higher.

The resultant product should be able to be transferred into a **commercial** product that could be incorporated into a company portfolio. Taking into account this generic objective, some

specific needs for this product are the following ones

- To be port independent, this means that the product should be able to use generic processes and interfaces that can technically be applied to different IT systems existing in other ports.
- To have a customizable product in terms of business adaptations to the needs of different ports.

In the transport, logistics and port scope some stakeholders have demanded IoT technologies to streamline supply cold-chain logistics and account for reliable and safe food processing. In general they need to support for great diversity of logistic scenarios: intermodal terminals, cold-chain quality control, and cargo tracking.

There is also interest in using datalogger products and a new e-seal device product to precisely know the position of a container or vehicle and to control the opening of the container door and its deactivation. Another interests discovered are to find a way to integrate both oil depot and fleet oil management services in a same platform allowing for interoperability between the devices of the clients and other IoT platforms; allowing to provide extra data on fuel consumption, on driving behaviour or any information that would allow to compare driving behaviours among drivers and identify new ways of achieving oil consumption savings; or environmental improvements such as the of use smart lighting.

A smart illumination system requires the definition in real time of position and activity of all users (vehicles, machinery and workers) and the definition of the light needs depending on their position and activity. This lighting level is changing depending on the environment, lighting level needs and other parameters or environmental variables such as emergencies, accidents, crash danger, etc. A smart illumination solution needed to interoperate with devices carried out by workers, vehicles and machinery to calculate and predict the lighting level needs that are required by the OHS law. After the platform has calculated the lighting levels it sends to the user (luminaire) the lighting intensity required.

Merging all the stakeholder's needs into a single table can offer a better approach to what the identified stakeholders are looking for in INTER-LogP. We have processed the common needs scoring the number of times each need arises for the different stakeholders. The table below is ordered in descendant way with the number of occurrences of each stakeholder need.

Table 64. Stakeholders' needs (INTER-LogP)

Stakeholder need	No	Public auth.	Univ.	Non-Profit orgs.	R&D Projs.	Transp. comps.	Shipping lines	Port Term.	Private Tech. comps.
Gather information from containers, semi-trailers, trucks, etc.	33	X		X	X	X	X	X	
A smart object (i.e. truck, container)	32	X				X	X	X	

should be able to interact with different IoT platforms									
Interoperable framework along different supply chains	30	X				X	X		X
Security management	29					X	X	X	X
Full visibility of cargo and equipment	29	X				X	X	X	
Value creation	28	X		X	X	X	X	X	X
Lower market entry barriers for IoT ecosystems in ports	27	X		X					
Predictability and forecasting	27	X				X	X	X	
IoT platform integrated with the PCS, TOS, PMIS, AGS and other business platforms	26	X				X	X	X	
Preventive maintenance	26					X	X	X	
Privacy	26	X				X	X	X	
Paperless	25	X				X	X	X	
Savings on oil consumption	24					X	X	X	
Reliability	24	X				X	X	X	
Identification of the truck drivers	23	X				X		X	
High response time	22	X				X	X	X	
Supply chain visibility inside the port areas	21	X						X	
Energy efficient, lower fuel cost and environmentally friendlier transport	21	X				X	X	X	
Receive orders and updates from its clients through its private IoT platform	21					X	X	X	
Easy to apply in other ports	21	X	X	X					X
Data protection regulations	20	X				X	X	X	

Data ownership management	20	X			X	X	X	
Trust	19	X			X	X	X	
Faster, more secure and safer port accesses	18	X			X			
Large Scale Pilots	18	X		X	X	X	X	
Easy use of INTER-LogP	18				X	X	X	
Shorter waiting times of trucks inside the port and container terminals	17	X			X		X	
Capability to analyse large amounts of data	17	X			X	X	X	
Transform Physical to Virtual devices	16				X	X	X	
Lower costs to monitor trucks and other objects	15				X	X	X	
Ethics	15	X			X	X	X	
More efficient fleet management, especially when subcontracting the carriage of goods to third parties	14				X			
Real time monitoring of reefer and hazard containers	14	X					X	
Verified authentication	14	X			X	X	X	
Interaction between locomotives, platforms and drivers and devices placed at port-terminals	13				X		X	
Easy integration	12	X						X
Being able to communicate (in real time) and guide external personnel and vehicles in case of emergencies	10	X					X	
Break silos	10	X						X
Location of sensors/devices is important	10				X	X	X	

Knowing the estimated time of arrival of trucks to the terminal	8					X	
Real time position of trucks, trains and vessels while they are operating at the terminal	8					X	
Open platforms	8	X					
Ecosystems	8	X					
Geo-localization for locomotives	7			X		X	
Electronic boarding passes for passenger access control systems	7	X				X	
Protocols for direct access to sensors	7						X
Integration of legacy systems	6	X					
Sustainable IoT platforms	5	X					
Integrate container depots and origin and destination points in the IoT ecosystem	5			X			
Developer communities	5	X					

We have categorized the stakeholder's needs for INTER-LogP into 9 groups:

Table 65. Stakeholders' needs categories (INTER-LogP)

Category
Predictability of the supply chain
Security and ethics in the supply chain
Interoperability
Seamless communication in the supply chain
Visibility of the supply chain
Cost Reduction
Greener Supply chain

Each need has been assigned a specific category:

Table 66. Stakeholders' needs categorization (INTER-LogP)

Stakeholder need	Category
Gather information from containers, semi-trailers, trucks, etc.	Visibility of the supply chain
A smart object (i.e. truck, container) should be able to interact with different IoT platforms	Interoperability
Interoperable framework along different supply chains	Interoperability
Security management	Security and ethics in the supply chain
Full visibility of cargo and equipment	Visibility of the supply chain
Value creation	Cost Reduction
Lower market entry barriers for IoT ecosystems in ports	Cost Reduction
Predictability and forecasting	Predictability of the supply chain
IoT platform integrated with the PCS, TOS, PMIS, AGS and other business platforms	Interoperability
Preventive maintenance	Cost Reduction
Privacy	Security and ethics in the supply chain
Paperless	Cost Reduction
Savings on oil consumption	Cost Reduction
Reliability	Predictability of the supply chain
Identification of the truck drivers	Security and ethics in the supply chain
High response time	Seamless communication in the supply chain
Supply chain visibility inside the port areas	Visibility of the supply chain
Energy efficient, lower fuel cost and environmentally friendlier transport	Greener Supply chain
Receive orders and updates from its clients through its private IoT platform	Seamless communication in the supply chain
Easy to apply in other ports	Interoperability
Data protection regulations	Security and ethics in the supply chain
Data ownership management	Security and ethics in the supply chain
Trust	Security and ethics in the supply chain
Faster, more secure and safer port accesses	Security and ethics in the supply chain
Large Scale Pilots	Predictability of the supply chain
Easy use of INTER-LogP	Interoperability
Shorter waiting times of trucks inside the port and container terminals	Predictability of the supply chain
Capability to analyse large amounts of data	Predictability of the supply chain
Transform Physical to Virtual devices	Visibility of the supply chain
Lower costs to monitor trucks and other objects	Cost Reduction
Ethics	Security and ethics in the supply chain
More efficient fleet management, especially when subcontracting the carriage of goods to third parties	Visibility of the supply chain
Real time monitoring of reefer and hazard containers	Security and ethics in the supply chain
Verified authentication	Security and ethics in the supply chain
Interaction between locomotives, platforms and drivers and devices placed at port-terminals	Seamless communication in the supply chain
Easy integration	Interoperability

Being able to communicate (in real time) and guide external personnel and vehicles in case of emergencies	Seamless communication in the supply chain
Break silos	Interoperability
Location of sensors/devices is important	Visibility of the supply chain
Knowing the estimated time of arrival of trucks to the terminal	Predictability of the supply chain
Real time position of trucks, trains and vessels while they are operating at the terminal	Visibility of the supply chain
Open platforms	Interoperability
Ecosystems	Interoperability
Geo-localization for locomotives	Visibility of the supply chain
Electronic boarding passes for passenger access control systems	Security and ethics in the supply chain
Protocols for direct access to sensors	Interoperability
Integration of legacy systems	Security and ethics in the supply chain
Sustainable IoT platforms	Cost Reduction
Integrate container depots and origin and destination points in the IoT ecosystem	Seamless communication in the supply chain
Developer communities	Interoperability

Counting the number of times that each need appears for every category and summarizing per category leads to this distribution of stakeholder's needs:

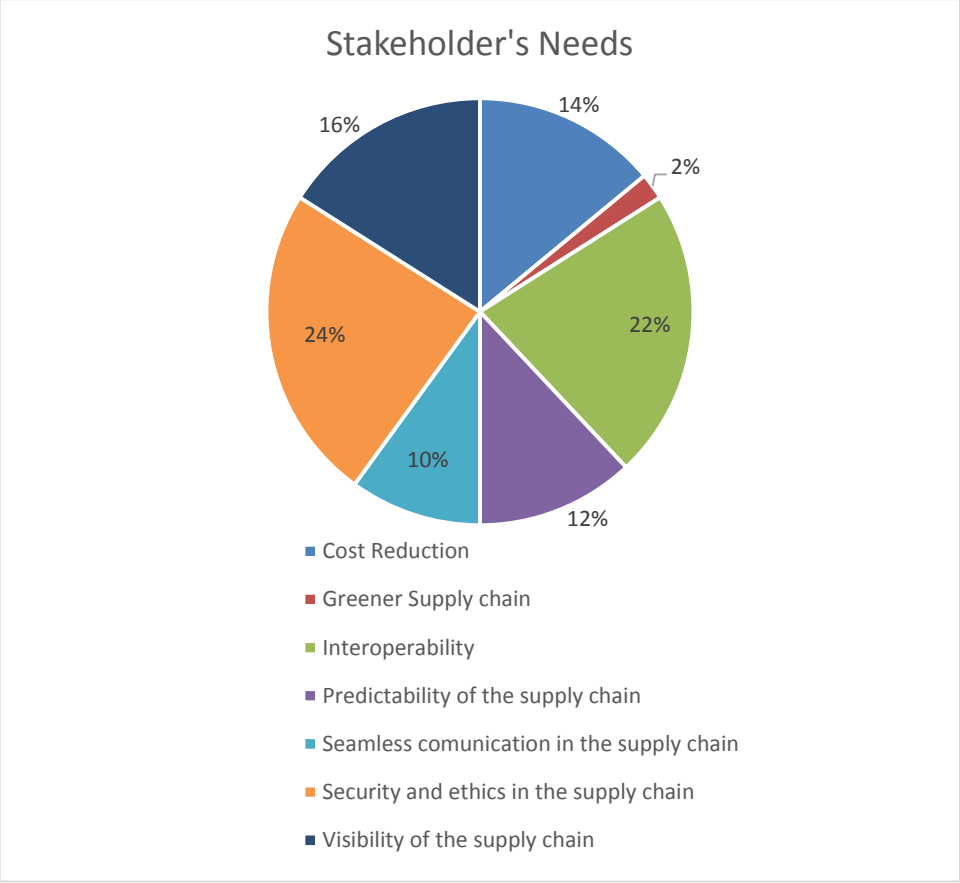

Figure 35 INTER-LogP Stakeholder's needs by category

3.4.11 Conclusions

One of the main conclusions that can be obtained through this stakeholder and market analysis for the INTER-LogP product is that the transport, port and logistics industry is ready for testing the Internet of Things. The stakeholders that are currently interested in the INTER-LogP product cover the whole supply chain actors (port authorities, terminals, shipping companies, truck companies, railway companies, IT logistics companies, etc.).

Additionally, as it has been mentioned before, different actors are demanding IoT solutions that solve current problems that manual handling of data produce in logistics inefficiencies, costly information handling and communication gaps among different actors of the supply chain. In addition, ports and terminals face the challenge to move an increasing volume of trucks, trains, people and containers in a limited space that cannot grow beyond its current size and in peak periods. The use of IoT technology and the INTER-LogP products is seen as an important solution to further improve communications and connect the different objects and actors that are involved in a supply chain. This value that the INTER-LogP product can create for its consumers is vital to help ports and logistics to become more and more efficient. The future belongs to the fast.

Another big conclusion is that the current IoT market is very fragmented since there are many different products available for the different actors. In fact, many of the existing solutions are proprietary, stand-alone solutions that are not connected to each other (e.g. truck fleet management systems). Therefore, the INTER-LogP product will need to combine various existing hardware and software solutions for end-to-end integrity control of supply chains.

In addition to the above, the introduction of the Internet of Things in ports and logistics sector will demand a new level of trust between different companies and actors. The current mind-set of the industry and the lack of transparency between the different actors in the supply chain can be considered one of the most important barriers for the INTER-LogP product. An important shift in the culture of some logistics companies will be needed because the INTER-LogP product will only be used if people and organizations trust in each other and are sure that their privacy and data is not shared for other purposes but to cooperate in some particular business procedures. The INTER-IoT project, aware of this situation, will do an important work in communication and dissemination in order to address these privacy, security and trust fears.

To conclude, the current demand of IoT solutions for transport, ports and logistics, the consumers' needs and the multiple solutions in the market for IoT products is sufficient to consider that a thriving IoT ecosystem for these sectors will be necessary and well accepted by its users. Therefore, it can be foreseen that the exploitation of the INTER-LogP product which aims to be the ecosystem where several IoT products seamlessly interoperate with each other, could be very successful in the market.

3.5 INTER-HEALTH stakeholders' analysis

3.5.1 Introduction

The ongoing evolution of the demographic trend with a growing proportion of elderly and chronic diseases, the modification of the healthcare needs of the population (more attention to healthy lifestyles and greater availability of information), the financial conditions of the countries and changes in the income, the epidemiological evolution, the increasing availability of technologies necessitate a structural redesign and organization of the network of health services where:

- Institutions should develop ethical and sustainable objectives, while respecting the quality of service parameters provided and the economic links;
- Operators must follow the international and national scientific guidelines for the diagnosis and care
- Patients must adopt behaviours (lifestyles, prevention, compliance of the therapeutic process) which impacts on the health and sustainability of the expenditure;
- Enterprises and Universities must contribute to innovation offer.

Telemedicine solutions offer valuable support to this healthcare reorganization. The relevance of Telemedicine in this process and its impact on society and health are internationally recognized. At European level the first eHealth Action Plan was adopted in 2004 which followed over the years numerous initiatives aimed at fostering widespread adoption of eHealth throughout the EU.[7]

Nevertheless barriers continue to exist that limit the adoption of e-health solutions.

The main barriers are due to:

- lack of clear directions on medium / long-term benefits obtained from the use of telemedicine and m-Health services and lack of reimbursement schemes for e-health services;
- lack of acceptance of the e-health solutions among patients, citizens and healthcare professionals and resistance to change
- lack of legal clarity for health and wellbeing e-health and m-health applications and lack of transparency regarding the utilization of data collected by such applications (privacy);
- presence of numerous systems and lack of interoperability between eHealth solutions;
- use of proprietary technologies for device and applications

The INTER- IOT approach aims to help the process of introduction of e-health services by providing tools for interoperability and integration of existing platforms, services and devices, contributing to the establishment of new model of offer based on multi-vendor and multi-product with nothing to lose in terms of efficiency, effectiveness and functionality.

[7] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52012DC0736

This approach will allow offering new health products or services that can be an evolution or a combination of existing products and services or new entries at all.

3.5.2 Stakeholder participants

The INTER-Health product belongs to the health and wellness area.

The identified stakeholders have been categorized as follows:

- Public authorities: European Commission, Data protection authorities, Ministry of Health, National and Regional Health Services
- Health operator: Healthcare Management and Healthcare Institutions, Hospitals, Private clinics, Assistance service provider
- Research Institution &project: Universities, No profit organization, Related research projects
- Private research and development companies: Industry, Research & development companies, ICT companies, manufacturers of devices, service providers.

This is a big area and a high number of companies or entities are involved in it. For this reason, the selection of a minimum set of representatives has been attempted.

At this time of development of this report, the number of stakeholders which have been interviewed for the INTER-Health product is 30.

In the following sections we report general descriptions and where available, the information of stakeholders who were selected and contacted.

In some cases it is impossible to provide clear assignment of an entity to a particular group as, for example, Hospitals which constitute essential part of a University are acting both as a research centre and healthcare operator. For this reasons, some identified stakeholders may appear in a few groups.

Public authorities

Table 67. Public authorities (INTER-Health)

Stakeholder	Description
European Commission	The sponsor of Inter-IoT as one of the 7 projects approved in the ICT30 call.
National Health Service	It is formed by all functions, facilities, services and activities for the promotion, maintenance and recovery of physical and mental health of the entire population.
Ministry of Health	The Ministry of Health protects health as a fundamental right of the individual and interest of the community through the National Health Service.

Piemonte Region	Regione Piemonte is specially committed in collective prevention programs to deal with the main common risk in the population.
The Authority for the protection of personal data	The Authority for the protection of personal data is an independent administrative authority of the public administration responsible for the protection and supervision of privacy.

Health operators

Table 68. Health operators (INTER-Health)

Stakeholder	Description
The Ethics Committee	The Ethics Committee is an interdisciplinary body, functionally independent of the structure in which he is established or for which it carries out its duties.
The family doctor	The family doctor is a practitioner who knows the citizens' health status and, when it's necessary, guides them to the therapeutic course.
The municipality	The municipality is the public body that manages the territory of the town, administered by the Mayor and members of the Board and City Council.
North Manchester General Hospital	The hospital has a full accident and emergency department, which includes a separate paediatric A&E unit. It also offers a full range of general and acute surgical services.
South Manchester University Hospital	South Manchester University Hospital is the leading UK clinical research centre specializing a broad scope of medicine and technologies.

Research Institutions & Projects

This group is composed by universities, non-profit organizations, and related projects to Inter-IoT. These entities are interested in technologies and innovation related to IoT and Mobile Health sectors.

These research entities are interested in the development of interoperable solution to solve the problem of fragmentation of IoT platforms and accessibility of IoT apps in a global market.

Moreover, in relation with INTER-HEALTH product, these entities are working on achieving and providing solutions for the full exploitation of heterogeneous IoT for the patient's monitoring process, where heterogeneity also means the integration of different platforms and communication paradigms.

In reference to the projects, they aim to obtain interoperability of IoT infrastructures to provide value-added services by connecting a wide range of devices, such monitoring sensors related to e-Health applications.

The universities involved in research are:

Table 69. Universities (INTER-Health)

Stakeholder	Description
Edinburgh Napier University	Edinburgh Napier University has over 17,000 students from 100+ countries. Its campuses are located throughout the city of Edinburgh, Scotland's inspiring capital.
Turin University	Italian public university with research teams related to smart cities platforms and applications.
University of Calabria	Italian public university with different research groups and projects related with IoT

Non-profit organizations are:

Table 70. Non-profit organizations (INTER-Health)

Stakeholder	Description
Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), National Research Council (CNR) (Italy)	CNR is the greatest Italian research institution, with several institutes, working in the main fields of scientific and humanistic research.
Inria Lille Nord Europe (France)	Inria, the national institute for research in computer science and control, is dedicated to fundamental and applied research in information and communication science and technology (ICST).
Systems Research Institute, Polish Academy of Sciences (SRIPAS)	Public Polish research center active primarily in the domain of methodological foundations for systems analysis.
OpenEHR	OpenEHR is a virtual community working on interoperability and computability in e-health. Its main focus is electronic patient records (EHRs) and systems.

Related projects on this topic are:

Table 71. Related projects (INTER-Health)

Stakeholder	Description
ICT-30 Agile	H2020 RIA AGILE (An Adaptive and Modular Gateway for the Internet of Things): interoperability through an open gateway.
AIOTI-UPV	Group of research groups related with IoT at UPV and associated research institutes.
ICT-30 Vicinity	H2020 RIA Vicinity (Open virtual neighbourhood network to connect IoT infrastructures and smart objects): interoperability at semantic layer.

Private research and development companies

Private Consulting and training companies

Table 72. Private consulting and training compabies (INTER-Health)

Stakeholder	Description
4MOVE S.R.L.	4MOVE is a company acting in the field of fitness, nutrition, nutritional supplementation and wellbeing in the broad meaning of the word.

Private ICT Company

Table 73. Private ICT companies (INTER-Health)

Stakeholder	Description
Alkemy Tech	Alkemy Tech designs, develops and manages IC technologies that support omnichannel innovation processes of our enterprise customers.
Consoft Sistemi S.p.A.	Consoft Sistemi is an Italian company that expands the group leader's offer, particularly linked to Telecoms in the North African and Middle Eastern markets.
Engineering Ingegneria Informatica S.p.A.	ENGINEERING is the head company of the ENGINEERING Group. Engineering is currently the first IT group in Italy.
Embiq SP z.o.o.	Embiq is an IT company. Its research and development work is customer focused and specialized in the areas of mobile technology, complex building of internet services, servers and hardware development.

SenSysCal S.R.L.	SenSysCal S.R.L. is a spin-off of the University of Calabria. Its main activities are related to smart-health, building energy management and WSN/IoT Consulting.
ISECO SL	SME software control development company integrating sensors in a proprietary control centre and SCADA.
Instituto de Tecnología Informática (ITI)	Research association of SME and industries related with software development.
XLAB d.o.o.	XLAB is a company providing technology solutions for enterprises and products for, among others, high volume and speed services such as Internet of Things.
TeleTransfusion	SME providing service for remote pre-transfusion evaluation of blood samples by specialists.
ThinFilm	ThinFilm is an Oslo based company looking to use printed electronic techniques to add intelligence to objects that have not been possible to connect in the past using traditional electronics.

Healthcare Companies

Table 74. Healthcare companies (INTER-Health)

Stakeholder	Description
Rinicare Ltd	Rinicare is a Lancaster based (UK) SME that brings state-of-the-art technological solutions for healthcare applications.
Slingcare	Slingcare designs, manufactures and sells slings for lifting natural persons in care centres, hospitals etc.

Electronic Manufacturing

Table 75. Electronic Manufacturing companies (INTER-Health)

Stakeholder	Description
Neways	Neways is an international company active in the EMS (Electronic Manufacturing Services) market.

Telecom Operators

Table 76. Telcos (INTER-Health)

Stakeholder	Description
Telecom Italia	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Italy, owner of TIM.

Orange Polska S.A.	ISP & telco services provider for B2B/B2C customers. The biggest telco operator in Poland, part of Orange Group (France Telecom).

3.5.3 Stakeholders by company type

In a more detailed classification, the stakeholders can be divided into the following categories:

Table 77. Stakeholders by company type (INTER-Health)

University	Napier University – Scotland University of Calabria Turin University SRIPAS
University hospital	North Manchester University Hospital South Manchester University Hospital
Non-profit organization	Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), Consiglio Nazionale delle Ricerche (CNR) Inria Lille Nord Europe OpenEHR AIOTI-UPV
Public Authorities	Azienda Sanitaria Locale TO5 DG CONNECT – European Commission Vinovo Municipality
Projects	ICT30 Agile ICT30 Vicinity
Private Consulting and training company	4MOVE S.R.L.
HealthCare SME	Rinicare Ltd Slingcare
Private technology and solutions supplier company	Alkemy Tech Consoft Sistemi S.p.a. Embiq SP z.o.o. Engineering Ingegneria Informatica SpA ISECO S.L. Instituto de Tecnología Informática (ITI) SenSysCal S.R.L. TeleTransfusion XLAB d.o.o.

	NEWAYS Orange Polska S.A. Telecom Italia

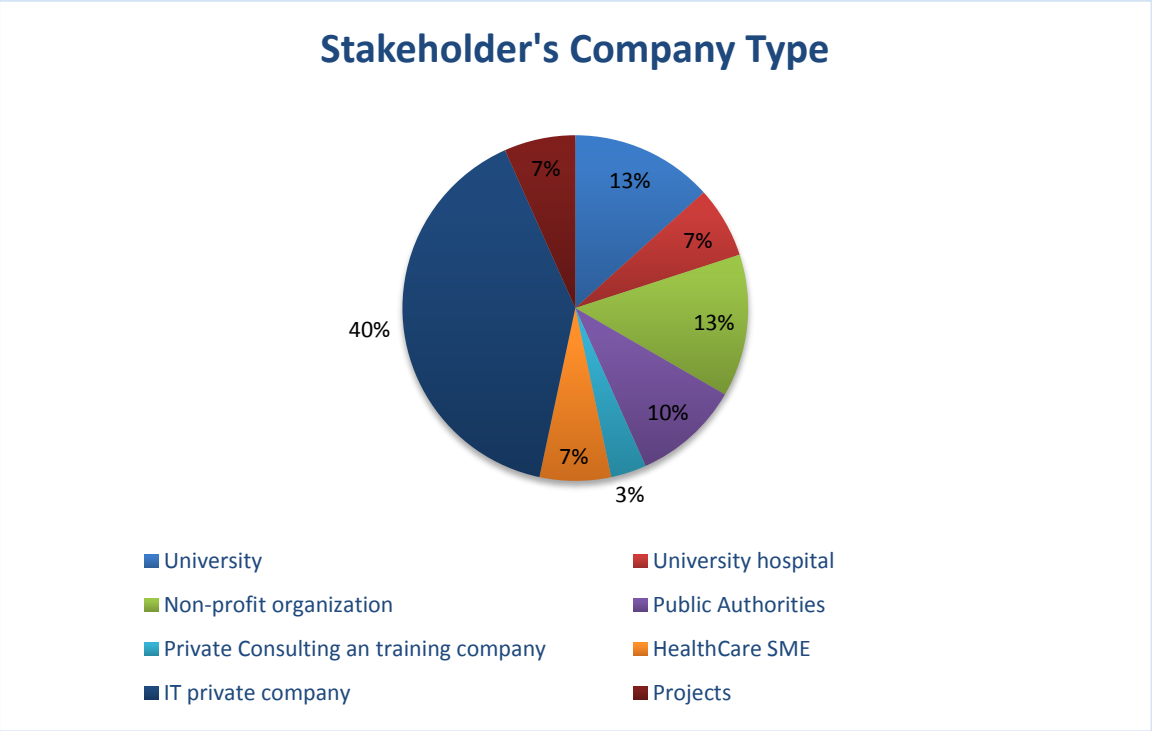

Figure 36 INTER-HEALTH Stakeholder's Company Types

At the graph we can observed that half of the identified stakeholders are from private companies (Private Company 40% and HealthCare SME 7%), followed by University (University 13% and University Hospital 7%), non-profit organization (13%), public Authorities (10%), related projects (7%) and Health operators (University Hospital 7%).

3.5.4 Stakeholders by country

Stakeholders can be differentiated by their country.

Table 78. Stakeholders by country (INTER-Health)

Spain	AIOTI-UPV ISECO S.L. Instituto de Tecnología Informática (ITI)
Italy	Alkemy Tech ASL TO5 Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), Consiglio Nazionale delle Ricerche (CNR)

	Consoft Sistemi S.p.A. Engineering Ingegneria Informatica SpA SenSysCal S.R.L. Telecom Italia Turin University University of Calabria Vinovo Municipality 4MOVE S.R.L.
France	Inria Lille Nord Europe
Nederland	NEWAYS Slingcare
UK	Napier University – Scotland North Manchester University Hospital Rinicare Ltd South Manchester University Hospital
Poland	Embiq SP z.o.o. OpenEHR Orange Polska S.A. SRIPAS
Slovenia	TeleTransfusion XLAB d.o.o.
Belgium	DG CONNECT – European Commission ICT-30 Agile ICT30 Vicinity

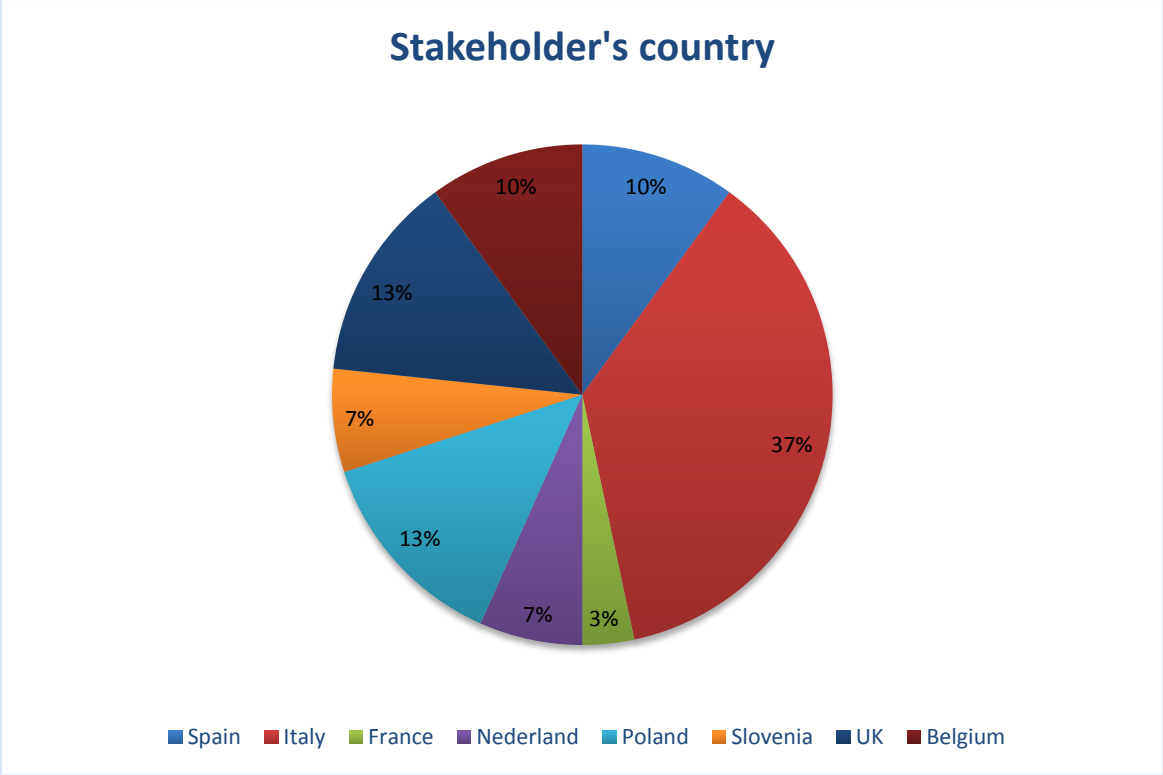

Figure 37 INTER-HEALTH Stakeholder's country

Most of the identified stakeholders are Italians, but this is probably because the project will use a pilot in the health sector in Italy.

3.5.5 Stakeholders map

Following the Volere methodology, the stakeholder's map for the INTER-HEALTH product is shown below.

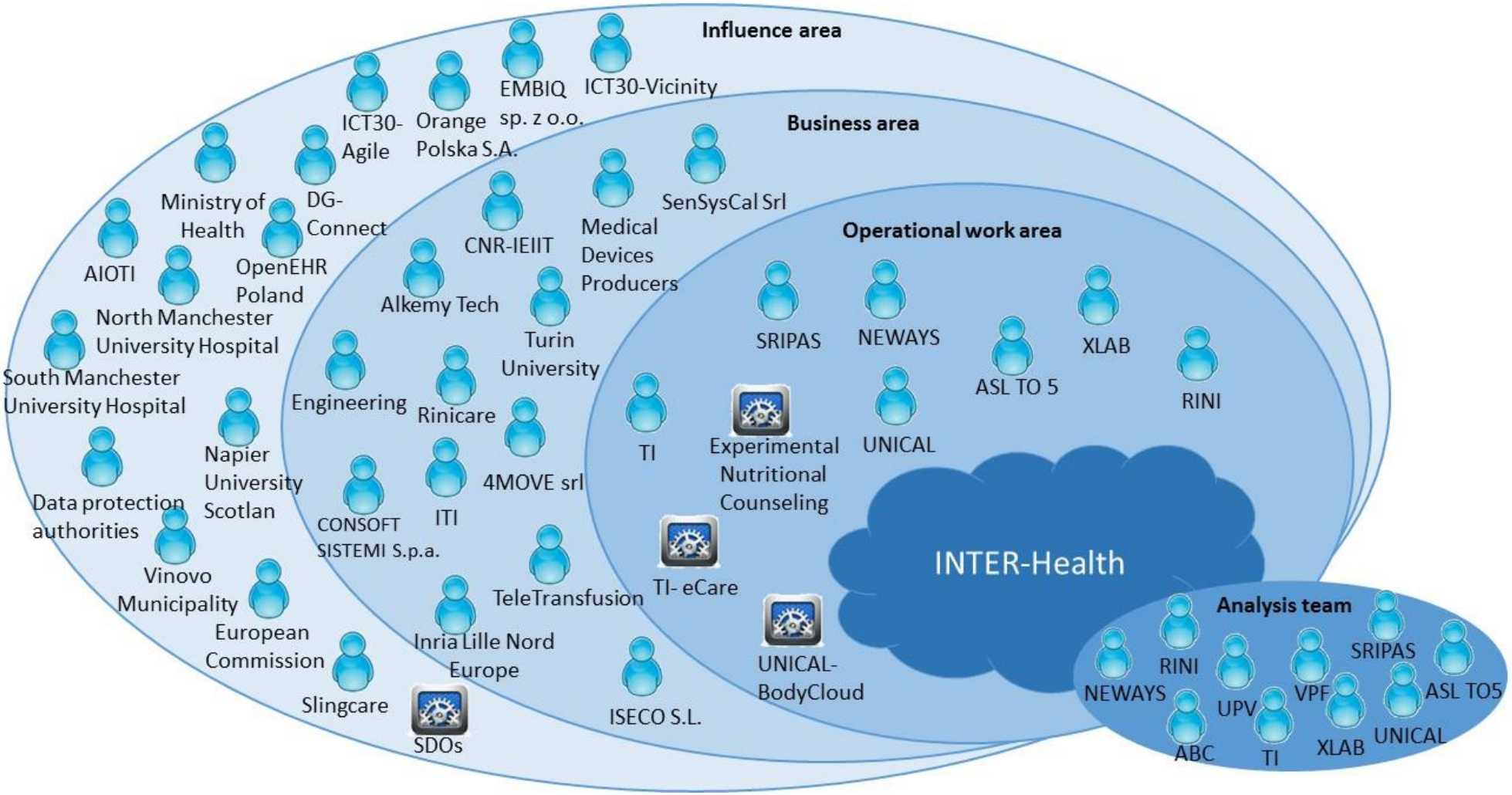

Figure 38 INTER-HEALTH Stakeholder's map

The **analysis team** is composed of all the project partners depending on their expertise and role have contributed to identify the stakeholder.

Surrounding the intended product is a ring representing the operational work area stakeholders who will have some direct contact with the product inhabit this space.

In the **operational work area** have been included: the existing platforms that need to be integrated to build the INTER-Health product (eCare, BodyCloud, Experimental Nutritional Counselling); the project partners that will be involved in the INTER-Health development and the partners that will be involved into the "decentralized and mobile monitoring of assisted livings' lifestyle" pilot.

In the next ring, **the business area**, you find stakeholders who benefit from the product in some way. They can be supplier or other companies that could provide new services or products (e.g. medical devices, localization service, new features, call center service, ...) to be added to the initial one.

The outer ring, **the influence area**, contains other stakeholders who have an influence on or an interest in the product: the health authorities (Ministry of health, Data protection authorities, European Commission); the standard organizations, the universities, the non-profit organization interested in technologies and innovation related to IoT and Mobile Health sectors; the health operators that could use the INTER–Health product to offer a service to patients/ citizens (Hospitals).

3.5.6 Stakeholders by class

Following the Volere methodology, the stakeholders can be classified according to the role they will play in the INTER-Health product. Therefore they can be distinguished the following classes.

Table 79. Stakeholders by class

Client	Citizen /Patient
Customer	HealthCare Operators
Political beneficiary	DG CONNECT – European Commission
Domain experts	ICT30 Agile ICT30 Vicinity
Clinical Experts	South Manchester University Hospital North Manchester University Hospital Azienda Sanitaria Locale TO5
Government	Vinovo Municipality

Representative of external Association	OpenEHR
Subject-matter experts	Azienda Sanitaria Locale TO5 Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), Consiglio Nazionale delle Ricerche (CNR) Consoft Sistemi S.p.A. Embiq SP z.o.o. Orange Polska S.A. Telecom Italia Turin University
Technology experts	4MOVE S.R.L. Rinicare Ltd
Usability experts	Slingcare
Research and Development Expert	University of Calabria
Big Data Expert	Instituto de Tecnología Informática (ITI)
System integrator	Alkemy Tech ISECO S.L. NEWAYS AIOTI-UPV SenSysCal S.R.L.
Designers and developers	Inria Lille Nord Europe TeleTransfusion XLAB d.o.o. SRIPAS Engineering Ingegneria Informatica SpA

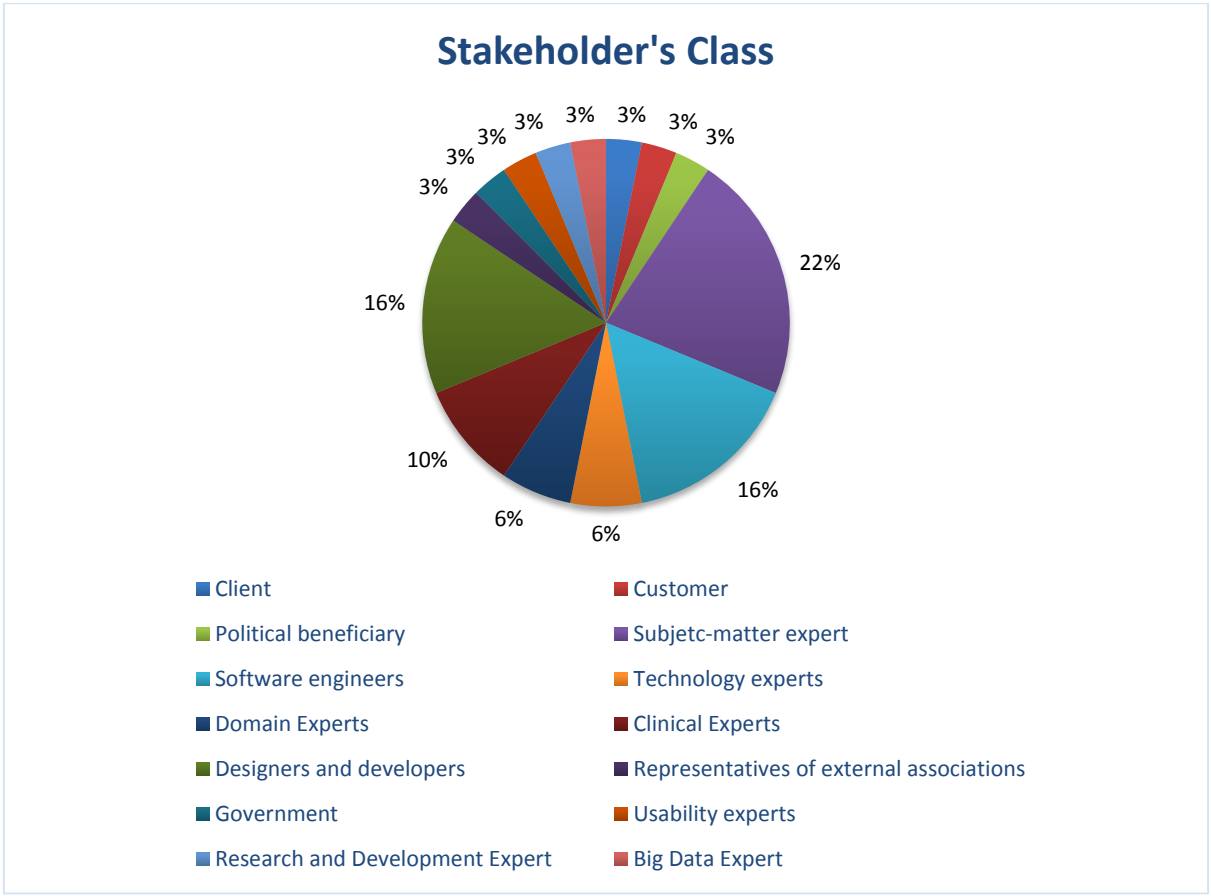

Figure 39 INTER-HEALTH Stakeholder's class

The graph shows that the majority of respondent stakeholders is "e-health matter experts" regardless whether it is a private company that offers services or health care operator who provides the services to patients and citizens. Their opinion and needs together to the ones of the clinical and domain experts will be indeed representative for our purpose.

Another important aspect are the classes of system integrators (17%) and designer and developer (17%), in fact among the stakeholders interviewed there are companies that offer telemedicine solutions.

3.5.7 Stakeholders by IoT Demand/Supply

In the field of internet of things each of the stakeholders can provide (Supply side) or receive (Demand side) information. On the supply side the majority of the stakeholder are development companies that offer e-health solutions, on the demand side it has been identified final users such as health operators (e.g. Hospitals).

Nevertheless, some stakeholders are present in both classes highlighting the interest is to offer you receive, an expression of the need to work together and integrate to get new services.

Table 80. Stakeholders by IoT Demand/Supply (INTER-Health)

IoT Demand side	IoT Supply side
DG CONNECT – European Commission	4MOVE S.R.L.
Napier University – Scotland	ICT-30 Agile
North Manchester University Hospital	AIOTI-UPV
OpenEHR	Alkemy Tech
South Manchester University Hospital	Azienda Sanitaria Locale TO5
TeleTransfusion	Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), Consiglio Nazionale delle Ricerche (CNR)
Turin University	Consoft Sistemi S.p.a.
Vinovo Municipality	Engineering Ingegneria Informatica SpA
Embiq SP z.o.o.	Inria Lille Nord Europe
	ISECO S.L.
	Instituto de Tecnología Informática (ITI)
	NEWAYS
	Orange Polska S.A.
	Rinicare Ltd
	Slingcare
	SenSysCal S.R.L.
	Telecom Italia
	University of Calabria
	ICT30 Vicinity
	XLAB d.o.o.

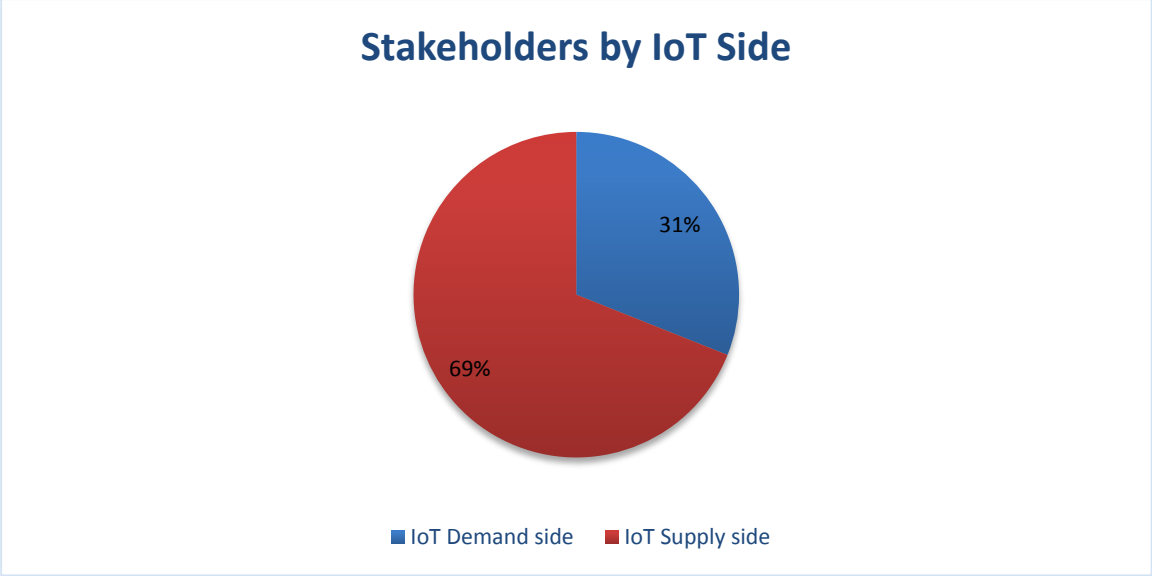

Figure 40 INTER-HEALTH Stakeholder's by IoT side

3.5.8 Stakeholders with interest in Open Call participation

Within the project INTER-IoT, an open call will carry out. All those stakeholders who meet the stated requirements can apply it. Stakeholders who have shown some interest are the following.

Table 81. Stakeholders with interest in Open Call (INTER-Health)

Interested in participating in open calls	Not interested in participating in open calls
4MOVE S.R.L.	ICT-30 Agile
AIOTI-UPV	Azienda Sanitaria Locale TO5
Alkemy Tech	DG CONNECT – European Commission
Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), Consiglio Nazionale delle Ricerche (CNR)	Instituto de Tecnología Informática (ITI)
Consoft Sistemi S.p.A.	NEWAYS
Embiq SP z.o.o.	North Manchester University Hospital
Engineering Ingegneria Informatica SpA	OpenEHR
Inria Lille Nord Europe	Slingcare
ISECO S.L.	South Manchester University Hospital
Napier University – Scotland	SRIPAS

Orange Polska S.A.	SenSysCal S.R.L.
Rinicare Ltd	Telecom Italia
Turin University	TeleTransfusion
Vinovo Municipality	University of Calabria
	ICT30 Vicinity
	XLAB d.o.o.

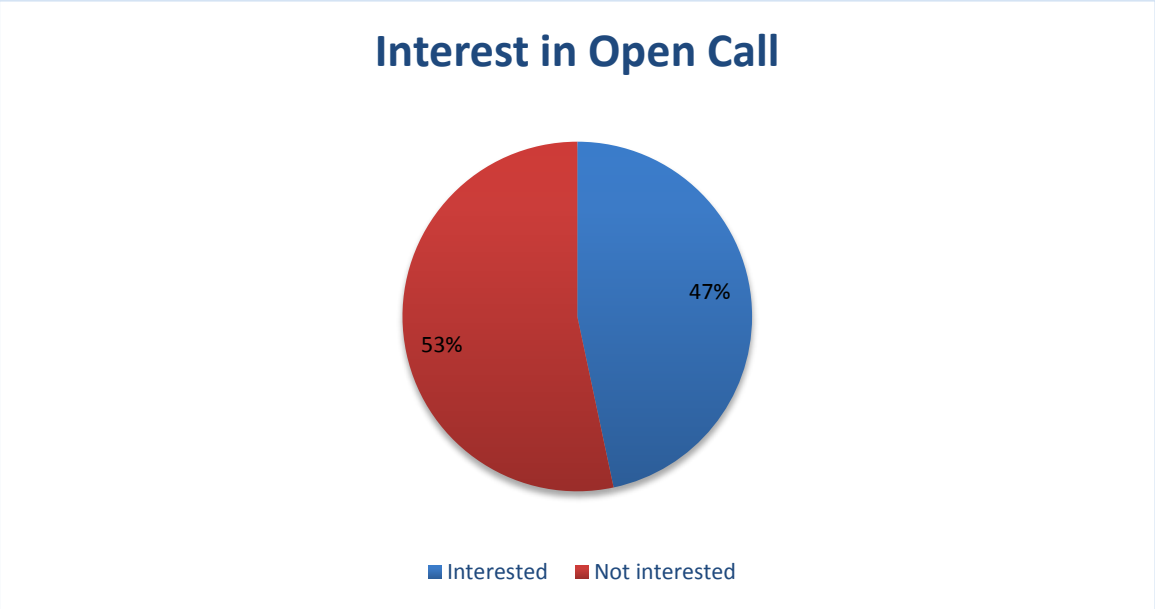

Figure 41 INTER-HEALTH Stakeholder's interest in the open call

3.5.9 Products involved by Stakeholders

In this section the products of interest for the stakeholder per INTER-Health area were grouped by classes. These products are also representative of what it is present on the market for the INTER-Health domain.

The most numerous is the class of e-health / telemedicine services that are available both at the local / national and at European and international level.

It follows the class of devices and sensors: medical, wearable, smart. Of particular interest are those certified according to the national, European and international laws.

Equally important is the set of reference standards, of which a good part allows to facilitate the integration and interoperability between systems.

Other products are then identified those relating to platforms and development framework and integration, communication usable in general for ICT services and therefore also for the e-health services.

eHealth Software Platform and services

- BodyCloud
- Butler - uBiquitous, secUre inTernet-of-things with Location and contEx-awaReness
- C-Health (prototype service)
- CoXnico (Nousmed)
- Digital Hospital
- e-Care (prototype service)
- EMC Healthcare Integration Portfolio
- Giraff+
- iMedOne® Mobile
- iMedOne® Hospital Information System
- INDRA Health
- Nutritional Folder
- PRIME
- Remote Patient Monitoring
- Self Care and Connected Care
- Seymour by Cellscope
- TelbiosConnect (commercial service)
- TELCOMED

Service

- Experimental Nutritional Counselling

Smart city Platform (for the ehealth services)

- VLCi (Valencia Open City)

Other Platforms

IoT Platforms

- Sofia2
- Libelium
- Open IOT – the Open source Internet of Things
- Thingworx

IoT Framework

- IOTIVITY

Development Platform

- Arduino only USA / Genuino outside USA

IoT Communication

- Sigfox

Sensors and devices

Hardware (sensors, devices, etc.)

- CITYSENSORs
- Thingsee One

Medical Devices

- Diamond Cuff BP - Blood Pressure monitor
- DigiO2ETH-301 – wireless thermometer
- Electronic Stethoscope Model 3200
- Onyx II 9560 - Wireless finger pulse Oximeter
- Stabil-O-Graph Blood pressure monitor (IEM)
- Wireless ECG

Wearable device

- FitBit Charge - activity tracker
- M&T (Wearable metabolic and sleep & activity monitoring)
- JawBone UP 3 – activity tracker
- Withings Activitè – activity tracker

Smart tools

- Fedex Senseaware
- ThinFilm

Standard and project results

Standards

- Anatomic Therapeutic Chemical Classification of Drugs (ATC)
- CEN/ISO EN13606
- Current Procedural Terminology (4th Edition) (CPT 4)
- HL7

- International Classification of Functioning, Disability and Health (ICF)
- International Classification of Disease (ICDx)
- ISO/IEEE 11073
- Logical Observations Identifiers Names and Codes (LOINC)
- Open Biomedical Ontologies
- OpenEHR
- SNOMED CT

Project results

- SemanticHealthNet – Semantic Interoperability for Health Network

3.5.10 Stakeholders needs

To effectively introduce IoT in ports, logistics and freight and container transport environments it is necessary to take into account the needs of all stakeholders:

Public authorities

European Commission

Public authorities may have different needs depending on the context they are. The needs will be different for a stakeholder at European and national health level.

At European health level the stakeholders want to break the gap between the application areas (e.g. health, home) and technologies such as IoT, Cloud, Big Data, in particular, preparing the ground for Large-scale Pilots.

INTER-HEALTH scenario for Decentralized and Mobile Monitoring of Assisted Livings' Lifestyle, aims at developing an integrated IoT system for monitoring humans' lifestyle in a decentralized way and in mobility, to prevent health issues mainly resulting from food and physical activity disorders.

The European Commission, that finances research projects, to develop this health use case, wants to create a high impact of the action through a visible and strategic program based on sustainability beyond the project life time. In particular, the coordination and synergies across projects will be the basis for making progress on available IoT ecosystems.

The EU goals to the Digital Age contributing to human advancement, fairness, jobs and growth, in this way shows an accessible and positive digital experience for every European citizen not forgetting about trust, security, ethics, etc. (IoT preparing the hyper-connected society)

At national health level the stakeholder's needs are dual, and they are related to the National Health System according to guarantee privacy respect and to defend the health status of people.

Data Protection Authority

In particular regarding the Privacy Authority, according to current national legislature, any kind of data treatment including: collection, recording, organization, storage, consulting, development, modification, selection, extraction, comparison, use, interconnection, blocking, communication, diffusion, cancellation and destruction must be controlled. So in this case the stakeholder need is to create an open IoT platform able to share a large amount of heterogeneous aggregate health data while ensuring a high level of security and protection of data.

During the pilot deployment the subjects recruited will be informed about the type of observational study and devices that will use, reading an information sheet and signing an informed consent, in particular by using a specific identification code and password they can check the data recorded from mobile devices and collected on platforms. This data will be made anonymous in accordance with national regulations concerning the handling and data protection.

Ministry of Health

The changes taking place in our society, first of all, the aging population and the increase in the development of chronic diseases, involve the need for a new response from the institutions

It is necessary to rethink the social health system digitally to create more efficient and transparent services, new models of care to patient-friendly and long-term savings for the health system; so investing in a market that can do as a driving force for economic development of the country.

There is therefore the need to program an appropriate level of assistance to a society with more elderly and chronically ill people: the "technological assistance". The digital health could save about 6 billion euro a year, gaining in terms of services rendered to citizens.

One of the needs of the stakeholders at this level would standardize processes: to have the data and be able to compare and analyse at national level so that the citizen is the protagonist and not passive users of health services.

M-health (mobile health) and "technological assistance", technologies and solutions for the remote monitoring of patients, will help the elderly and chronically ill people to live independently in their homes, even alone.

Piemonte Region

In Italy in the field of "protection of health" the general and common provisions belong to the exclusive competence of the state and the planning and organization of health services is ascribed to the regional jurisdiction.

In particular the Piemonte Region is responsible for: the analysis and determination of the health and social needs; the management of the hospital network and specialized outpatient services; planning of hospital construction investment and health technology equipment; programming and interventions on social health area; development of the primary care system; organization of service networks; waiting lists; health promotion; intervention and prevention programs; definition of standard costs and requirements of the services and the social and socio-health services. Therefore if from the point of view of the citizen notes the importance of creating a new IoT ecosystem to increase the efficiency of the health care system and to reduce costs, as public authority, the region has the need to contribute to institutional and macroscopic level the promotion and implementation of the 'use of devices in healthcare, responding to the new need for interoperability in health prevention centers and in people's homes.

Health operators

The Health Operator necessities are more related to the health operation and allow to improve the health scenario at several level: assistance service provider, involving family doctors and local authorities, and clinics.

Assistance service provider

The ASL TO5 will develop the mobile health use case decentralizing ambulatory activity from the health care center to users home using devices that allow to collected directly on platforms e-Care the users objective measures and monitoring in mobility users through wearable mobile devices by which the users objective measure are directly collected on Bodycloud platforms.

This stakeholder needs are related to the assistance service on citizens.

In the health care center is used a Nutritional Record, where the data subjects will be collected (by traditional and experimental methodology with the use of the devices). A future development could be the creation of a Computerized Nutritional Folder so that a subject can be controlled at several levels by the National Health System. The real-time collection of health data would provide a more efficient service.

The interoperability of these two platforms will create a new integrated ecosystem monitored at multiple levels; in this way the various stakeholders according to their skills will be able to work together to achieve the same goal: using the devices and preventive action

The development of quantitative benefits (public wideness) and qualitative (objective measurements) will lead to a greater efficiency of the system.

Creating new standards for the management of nutritional outpatient (tested during an "experimental nutritional counselling") to assist more efficiently the citizen, allowing them to extend the preventive action with the same resources to a wider group of people.

Will be used the health status indicators, and the dropout rate, to evaluate the effectiveness of the IoT during a nutrition counselling and the experimentation effectiveness in health scenario.

Ethics Committee

The Bioethics Committee needs to define the type of study and the research protocol, in accordance with local regulations for the treatment and protection of health data with evaluation of the study's effects on the population's health status, ensuring the protection of rights, safety and well-being of the subjects involved in the trials. In particular the committee may issue favourable or unfavourable opinions to the conduct of a trial based on the examination of the protocol of the study, the suitability of the investigators and structures where the trial should take place and on the methods and documents to be used to inform individuals the type of experimentation.

Family Doctors

The network of family doctors act at two levels: at the microscopic level by checking the health status of an individual user/ citizen through quantitative indicators can assess more precisely the 'effectiveness of actions carried out by the National Health System in preventive sphere; at the macro level by acting on the health status promotion of the 'entire population can more efficiently evaluate the morbidity and morbidity of major chronic degenerative diseases.

Municipality

Lastly at local health level the stakeholders want to act on the social health promotion, interacting with citizens and cultural and sporting associations. The local intervention will help the Pilot deployment and will show the real impact on the new health IoT ecosystem.

Private clinics

On the clinic level the developed Inter HEALTH solution will enhance the quality of care provided by the hospital and allow more efficient use of the resources by transferring non-critical hospital care to home care.

In particular the North Manchester University Hospital that provides care to elderly and dementia patients and with aging population, it is apparent that existing methods of provision of care will not meet the ever growing demand. Therefore, Hospital is looking for new methods and technologies for provision of care and Inter Heath product promises to address this problem.

Research Institutions & Projects

Universities

Universities are important research centres, and therefore has an important role in the development of this project. For the universities the INTER-HEALTH product is a scenario with different QoS requirements in which they can effectively test INTER -Layer, INTER -FW and INTER –Meth, and test if the previously identified requirements are fulfilled or not.

The universities should also develop a semantic model of the application domain which integrate data from identified IoT platforms so that they can be analysed together by the end user. All data exchange standards used in IoT platforms should be considered and the mapping of common concepts should be developed.

Universities need to test models upon health data management within interoperability environment and should meet safety regulations and satisfy the necessary medical certifications.

Implementation tools should be available to connect IoT technology with legacy systems. It is unlikely that health care legacy systems will be replaced in the short or midterm. For the health domain it would also be interesting to consider software to data strategies for things meaning that “mobile agents” would be able to visit especially more complex things in order to harvest information (not necessarily data). One of the biggest challenges is certainly the interoperability between different devices in the health domain.

The developed Inter HEALTH solution will enhance the quality of care provided by the hospital and allow more efficient use of the resources by transferring non-critical hospital care to home care

Non-profit organizations

There are several non-profit research groups and associations, collaborating in the project development. Some are more related to the health environment, and therefore their goal is to improve the functioning of health processes. But other organizations are more focused on the development of new technologies.

It is important that the non-profit research organizations introduce IoT platforms to handle the interoperable heterogeneous smart objects they want introduce and they want manage in the ecosystem.

One of the main features of an IoT platform is that it is able to gather information from all elements that interact. So medical devices, patients, doctors, become IoT entities enabled capable to be identifiable and smart, capturing data coming from sensors using different devices and communicating these data through IoT protocols and standards.

These IoT platforms have to be connected to enterprise and operational business platforms so smart objects are tightly linked with the operations and the stakeholders linked to those operations. So heterogeneous IoT platforms should be able to interoperate.

A smart object in motion (i.e. wearable device) should be able to interact and communicate with different heterogeneous IoT platforms in a secure and trusted environment (i.e. using a type of roaming service) according to the associated business operation, to its location or to some predefined business rules (i.e. specified at IoT application level). A smart object in motion is also able to interact and communication with other IoT platforms thanks to the communication or interaction with other fixed (i.e. non portable medical devices) or in motion (i.e. on the body user/patient) smart objects managed by other IoT platforms.

The data provided by a smart object could be different depending whether the IoT platform belongs, for example, to the owner, a partner, a customer, a service provider or a controller of the smart object. So we should have a common format that allows interoperability between different platforms.

Stakeholders ask that domain ontologies developed within Inter-IoT project should be compliant with their clinical models. Especially archetypes related to health parameters monitoring (e.g. temperature) should be considered in common Inter-IoT ontologies specification. Inter-IoT should enable analysis of data from stakeholder-based systems with data from other platforms, possibly from other domains. Inter-IoT should provide methodology for conversion between stakeholders-data and their ontological representation. Semantic model for the application domain should be developed and pilot in the application domain should integrate data from several IoT platforms so that they can be analysed together by the end user. All data exchange standards used within IoT platforms should be considered and mapping of common concepts should be developed.

Projects

There are several projects that must work together to achieve a framework that allows interoperability between IoT platforms. The needs of these projects are similar to those of INTER-IoT, as they share the same objectives.

These projects can benefit from the compatibility, integration and complementation with INTER-HEALTH. They can use it to take advantage to an existing interoperable open platform, lowering market entry barriers for IoT ecosystem, in the health domain, and allowing interweaving of platforms, things, and users.

Private research and development companies

The main needs expressed by private companies in various capacities operating in e-health area are:

- chance to be part of the ecosystems in which the various actors are present so you can offer your services by integrating them with those of other partners or with services already in use
- be part of a large initiative on IoT, which can be used as leverage toward our customers to propose new offering and solutions
- extension of existing solution with new features, new services, monitoring devices, analytics and user interfaces integrating existing solutions
- ability to analyse health data from different sources. The domain of HealthCare is interesting because the data analysis of a large set of healthcare or wellness data can open a number of new products or services related to personal assistants, care and prevention applications.
- tools for supporting different eHealth communication and data standards
- methods, tools and interfaces to integrate e-health platforms and services in accordance with safety regulations and privacy.

Collecting and summarising the main stakeholder's needs into a single table can offer an overall view of what the stakeholders have identified and they're looking in INTER-Health. We have processed the common needs scoring the number of times each need arises for the different stakeholders. The table below is ordered in descendant way with the number of occurrences of each stakeholder need.

Table 82. Stakeholders needs (INTER-Health)

Stakeholder needs	No	Public authorities	Health operators	Private research and development company	Research institution and non profit organizations	R&D projects
Interoperability platform to platform	12		X	X	X	X
Improve existing e-Health Platform	10			X	X	X
Interoperability device to platform	10			X	X	X
Create new e-Health platforms	7			X	X	X
Compliance to privacy regulations	4	X	X	X	X	
Compliance to safety regulations	4		X	X	X	
INTER-Health product	4		X			
Improve existing e-Health services	3			X	X	
Methods and tools to easily create new services	3			X		
Semantic model to integrate data (health domain)	3			X	X	
Create new e-Health services	2			X		
ehealth data standard supporting tools	2			X	X	

Interconnection with legacy systems	2			X			X
Access control to data collected	1				X		
Benchmarking tools	1				X		
Break the silos between application areas	1	X					
Case study on needs of customer	1				X		
Communication layer interoperability	1						X
Compliance of ontologies to OpenEHR	1						X
Compliance to medical certification	1						X
Computer Nutrizional Record service	1			X			
Coordination among projects	1	X					
Data presentation	1			X			
Device data access	1						X
Device integration tools /standard	1				X		
Distributed and cooperative inference methods	1						X
ehealth communication standard supporting tools	1				X		
Ethics	1	X					
Health data access	1				X		
Health pilot deployment	1				X		
Health processes standardition	1	X					
Health status indicators	1			X			
Improvement and customization of devices	1				X		
Innovation	1	X					
Innovative solutions for social health promotion	1			X			
Interconnection with other partners	1				X		
Interconnection with public structure	1				X		
Interoperability device to device	1						X
Interoperability in health prevention centers	1	X					
IoT ecosystem to increase efficiency of the health care	1	X					
IoT large initiative	1				X		
IoT platforms based on real ecosystem	1	X					
Large-scale Pilots	1	X					
Methodology for use of OpenEHR	1						X
m-health and e-health services for remote monitoring	1	X					

Open Platform architecture	1				X	
Open platform developing	1	X				
Open standard device protocol	1					X
Personalized health Care service	1					X
Pilot for extensive test on volounteers	1					X
Prediction algorithms	1				X	
Prevention of chronic desease services	1			X		
Products traceability and maintenance	1				X	
Rapid prototyping tools	1				X	
Raw health data access	1				X	
Re-design signal processing and statistic learning tools	1					X
Reliable communication platform	1				X	
Reliable data collection	1				X	
Scenarios testing	1				X	
Secure data transfer	1				X	
Security	1	X				
Solution for elderly and dementia patients	1			X		
Solution for Home-care	1			X		
Solution for Hospital quality care	1			X		
Standards for the management of nutritional outpatient	1			X		
Sustainability beyond the project life time	1	X				
Testing model upon interoperability environment	1					X
Testing models upon data management	1					X
Tools for data tracking	1				X	
Trust	1	X				
Use of standard protocols	1					X

We have categorized the stakeholder's needs for INTER-Health into the following ten groups:

Table 83. Stakeholders' needs categories (INTER-Health)

Category
Interoperability
Framework
Legal regulations
Methods and tools
Semantics
Standards
Protocol
Policy

Security
APIs & Tools

Each need has been assigned a specific category:

Table 84. Stakeholders' needs categorization (INTER-Health)

Stakeholder needs	Category
Interoperability platform to platform	Interoperability
Improve existing e-Health Platform	Framework
Interoperability device to platform	Interoperability
Create new e-Health platforms	Framework
Compliance to privacy regulations	Legal regulations
Compliance to safety regulations	Legal regulations
INTER-Health product	Framework
Improve existing e-Health services	APIs & Tools
Methods and tools to easily create new services	Methods and tools
Semantic model to integrate data (health domain)	Semantics
Create new e-Health services	APIs & Tools
ehealth data standard supporting tools	Standards
Interconnection with legacy systems	Protocol
Access control to data collected	Protocol
Benchmarking tools	Methods and tools
Break the silos between application areas	Policy
Case study on needs of customer	Policy
Communication layer interoperability	Interoperability
Compliance of ontologies to OpenEHR	Semantics
Compliance to medical certification	Legal regulations
Computer Nutrizional Record service	APIs & Tools
Coordination among projects	Policy
Data presentation	APIs & Tools
Device data access	Protocol
Device integration tools /standard	Protocol
Distributed and cooperative inference methods	Framework
ehealth communication standard supporting tools	Standard
Ethics	Policy
Health data access	Interoperability
Health pilot deployment	Policy
Health processes standardition	Standard
Health status indicators	APIs & Tools
Improvement and customization of devices	Framework
Innovation	Policy
Innovative solutions for social health promotion	Policy
Interconnection with other partners	Policy
Interconnection with public structure	Policy
Interoperability device to device	Interoperability
Interoperability in health prevention centers	Policy
IoT ecosystem to increase efficiency of the health care	Policy
IoT large initiative	Policy

IoT platforms based on real ecosystem	Policy
Large-scale Pilots	Policy
Methodology for use of OpenEHR	Methods and tools
m-health and e-health services for remote monitoring	APIs & Tools
Open Platform architecture	Policy
Open platform developing	Policy
Open standard device protocol	Standard
Personalized health Care service	APIs & Tools
Pilot for extensive test on volounteers	Policy
Prediction algorithms	Semantics
Prevention of chronic desease services	APIs & Tools
Products traceability and maintenance	APIs & Tools
Rapid prototyping tools	Methods and tools
Raw health data access	Interoperability
Re-design signal processing and statistic learning tools	APIs & Tools
Reliable communication platform	Framework
Reliable data collection	Framework
Scenarios testing	Methods and tools
Secure data transfer	Security
Security	Security
Solution for elderly and dementia patients	APIs & Tools
Solution for Home-care	APIs & Tools
Solution for Hospital quality care	APIs & Tools
Standards for the management of nutritional outpatient	Standard
Sustainability beyond the project life time	Policy
Testing model upon interoperability environment	Methods and tools
Testing models upon data management	Methods and tools
Tools for data tracking	Methods and tools
Trust	Security
Use of standard protocols	Protocol

Counting the number of times that each need appears for every category and summarizing per category leads to this distribution of stakeholder's needs:

Figure 42 INTER-HEALTH Stakeholder's needs by category

3.5.11 Conclusions

The main conclusion from this market analysis for INTER Health, is a real need to create a new health approach in which the healthy citizen or the citizen with known disorders can control their own health status in real time, both at home and at health centers.

The urgency of creating a new health IoT ecosystem is the growth of people with chronic diseases and rising senior class of society.

Since it increased the average life expectancy is necessary to ensure, for the same resources of the national health system (NHS) more efficient and effective system for the primary prevention of major chronic degenerative diseases.

The medical world is ready for the IoT testing at several levels and involving different actors: from the homes of the subjects to the health care center and to the NHS; from the citizen, to the medical staff, the family doctor, with local regional and national involvement.

The development of interoperability through the dissemination and communication of the results still presents obstacles including the processing of sensitive health data and the involvement of the most disadvantaged class of society. So INTER Health will need to overcome these barriers.

By comparing different stakeholder's offers and requests, it could differentiate a competitive market at the business level that allows real savings in costs to the national health level by integrating interoperability will decline in a country's economic growth.

From the analysis performed, we can assume that for the INTER-Health product the Industry of Mobile Health and ehealth in general is strongly interested in the IoT interoperability; the great heterogeneity of the proposal made of: devices (stand alone or connected) gateways (fixed, mobile, M2M) and platforms, and the growing need for expanding services using different kinds of devices and measures, makes harder and harder to build an all-embracing system; but the needs of completeness can't be ignored; so INTER-IoT approach will be the right choice enabling customers to integrate and make interoperable different objects in different ways (inter o intra layer), without always starting from zero.

The definition and implementation of a Methodology through a Case software could be useful even in presence of already integrated platforms as instrument of standardization to enable the service exposure for other potential clients.

The difficulty in disseminating this approach and make it become a standard could arise if top players in ICT world wouldn't adopt this approach or if they propose solutions that could become a defacto standard. To make know and demonstrate the importance and utility of the project results, trials and their real results would be very important: the presentation and publication and marketing of the outcomes could be the trump card.

4 MARKET ANALYSIS

4.1 Introduction

The main aim of the market analysis is to provide a clear overview of the characteristics of the products relevant to INTER-IoT. The products studied herein are those products that have been initially identified by partners, well aware of the overall interoperability goals of the project. A market analysis provides a clear description of the typology of products to which INTER-IoT will need to apply.

As it has been explained in the methodology section, the products considered in this anlysis are related with the project in one of the following ways: (i) as a component or module of the solution; (ii) as a complementary product; (iii) as a beneficiary, client or consumer of the solution or (iv) as a concurrent product. The process undertaken has been quite relevant as we have identified that many existing products are not yet prepared to participate in an interoperable IoT environment and they need to be transformed and complemented with other components like IoT gateways and platforms to meet the interoperability requirements. This represents a new market niche as there do not exist yet a wide adoption of IoT aware solutions and interoperable IoT products. The market analysis will also help us to identify relevant standards and protocols that these products are supporting and that INTER-IoT products would need to assess.

The maket analysis have been articulated around four perspectives to provide a clearer understanding of the market at hand. These perspectives are: identification of products at hand and classification of these products by class, context and access mode. The market analysis has been structured in a funnel form that provides a holistic picture at a first stage, and afterwards narrowing the understanding of the market into key perspectives allowing for a better assessment of the market conditions in which the identified products are available.

4.1.1 Products studied

The first step is to list all the products studied so as to provide a holistic view of the market where each individual product is described. This facilitates the understanding of each individual product's operational usefulness to be further analysed afterwards. The complete templates of the products studied is available in the annex of the deliverable and in the JIRA server, as the different products will be used during the requirements gathering phase. This list will be updated during the whole project lifetime.

Table 85. Studied products

Product	Description
ValenciaportPCS	ValenciaportPCS is an open, neutral electronic platform that enables smart and secure exchanges to be made between public and private agents with the aim of improving the competitive position of the port community of Valencia. ValenciaportPCS optimises, manages and automates efficient port and logistic processes through one single data transfer, connecting transport and logistics chains. Several ports in Europe already have a PCS in place or are planning to have one to create an ecosystem where different organisations participating in the logistics hub can collaborate and synchronize operations. Airports are also starting to create PCS for their airfreight operations. Today there is not yet any PCS that is IoT enabled or able to interoperate with IoT platforms although this is seen as the next step in the evoulution of a PCS.
Automated Gate System (AGS)	An Automated Gate System (AGS) is a gate operating system (GOS) for real time remote management and completely automated operations of an access control point. AGS improves the performance and land access by centralising the control of multi-lane gate events and incidents, with minimal operator presence required. When this system is used in ports, the system is able to to automatically identify ISO containers' numbers, truck plate numbers and, some of them, even drivers. The system includes Optical Container Readers (OCRs), vehicle license plate readers, capturing of still images and videos for control. Although AGS have been fulfilled with many sensors for different purposes they are not yet IoT enabled and prepared to interact with other devices that are outside the domain of the AGS, like devices carried out by drivers or attached to the trucks or containers. The capacity to have an open and interoperable IoT framework on AGS that enables the connectivity with external devices can provide many advantages.
PortCDM	PortCDM is an on-going initiative and product development which is being carried out in the STM (Sea Traffic Management) Action of the Connecting Europe Facilities programme. The goal of this initiative is sharing real-time information about the port call process of a vessel in order to speed up port calls, optimize vessel arrival time, operational efficiency and to ensure environmentally sustainable operations. This IT tool intends to boost closer information exchange between several port actors such as port authorities, terminals and vessels for key events in the process to minimize idle time or unnecessary waiting times. PortCDM plans to equip vehicles, boats and to use AIS data from vessels but it is not considering an IoT approach. The use of an interoperable IoT framework in the product is an interesting option for the initiative.

AIS	The Automatic Identification System (AIS) is an automatic tracking system used on ships and by vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites. AIS information supplements marine radar (VTS), which continues to be the primary method of collision avoidance for water transport. Vessels fitted with AIS transceivers can be tracked by AIS base stations located along coast lines or, when out of range of terrestrial networks, through a growing number of satellites that are fitted with special AIS receivers which are capable of deconflicting a large number of signatures. As all large vessels around the world are equipped with AIS devices and the data broadcasted can be received with coatal reception devices, the handling of AIS data is seen as an interesting element in the INTER-LogP product that will be created in the project.
SCADA	SCADA (supervisory control and data acquisition) is a system for remote monitoring and control that operates with coded signals over communication channels (using typically one communication channel per remote station). The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions. SCADA systems are widely spread over industrial system networks controlling, supervising and acquiring data from multiple devices (both sensors ans controllers). Achieving interoperability between SCADA systems and IoT platforms is a very interesting option to connect the consolidated market of the SCADA systems with the emerging market of IoT.
Azure IoT Suite	The Azure IoT Suite is an integrated offering that takes advantage of all the relevant Azure capabilities to connect devices and other assets (i.e. “things”), capture the diverse and voluminous data they generate, integrate and orchestrate the flow of that data, and manage, analyse and present it as usable information to the people who need it to make better decisions as well as intelligently automate operations. It allows: • Enhance the security of IoT solutions • Support a broad set of operating systems and protocols • Easily connect millions of devices • Analyse and visualize large quantities of operational data • Integrate with existing systems and applications • Scale from proof of concept to broad deployment Azure IoT Suite is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.

Google Cloud Platform	Google Cloud Platform is a cloud computing platform by Google that offers hosting on the same supporting infrastructure that Google uses internally. Google Cloud Platform provides developer products to build a range of programs such as scale connections, gather and make sense of data, and provide the reliable customer experiences that hardware devices require. The new IoT Platform within Google Cloud Platform is Brillo. Brillo brings the simplicity and speed of software development to hardware for IoT with an embedded OS, core services, developer kit, and developer console. Build on Brillo with an embedded OS based on Android, core services built-in, a developer kit, and a developer console. Choose from a variety of hardware capabilities and customization options, quickly move from prototype to production, and manage at scale with OTA updates, metrics, and crash reporting. Brillo is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Kii Could	Kii Cloud is an MBaaS (Mobile Backend as a Service) provided by Kii Corporation. The Kii Cloud service allows mobile app developers to add cloud services to their apps without writing server software. It provides various server-side features for mobile application development with common APIs. By leveraging these APIs, you can develop your mobile applications without worrying about the server-side implementations and operations. Kii Cloud is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Sofia2	SOFIA2 is a middleware that allows the interoperability of multiple systems and devices, offering a semantic platform to make real world information available to smart applications (Internet of Things). It is multi-language and multi-protocol, enabling the interconnection of heterogeneous devices. It provides publishing and subscription mechanisms, facilitating the orchestration of sensors and actuators in order to monitor and act on the environment. SOFIA2 is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Movildata	Movildata is an advanced fleet management systems for industrial and light vehicles. It provides information about vehicle use and maintenance, creates routes with stops to make and receive alerts if the vehicle has not reached the destination. MovilData is a product widely used by road hauliers in the port of Valencia where the INTER-LogP pilot case will take place. The product already

	considers devices as GPS, fuel consumption, digital tachograph, on-board unit connections and theft prevention devices, among others. MovilData is a platform which may not be fully IoT enabled that need to be considered for the interoperability of heterogeneous IoT platforms in this project.
Dynafleet	Dynafleet is a fleet management telematics based service provided by Volvo Truck Corporation to support end customers with performance follow up on vehicles and drivers to optimize the fleet performance. This tool provides users with the exact location and status of their trucks and drivers at any given time, but also shows what areas to improve in order to reach better profitability. Dynafleet is an interesting product for the INTER-LogP pilot case and it is a platform which may not be fully IoT enabled that could be considered for the interoperability of heterogeneous IoT platforms in this project.
VDO Digital tachograph	A digital tachograph is a device fitted to a vehicle that digitally records its speed and distance, together with the driver's activity selected from a choice of modes. In Europe, as a result of European Union regulation 1360/2002 digital tachographs are mandatory for all relevant vehicles manufactured after August 1, 2005. VDO Digital tachograph is an interesting device for the INTER-LogP pilot case and it could be considered for the interoperability at device level in the project.
CITYSENSORs	CITYSENSOR consists of Micro Autonomous Datalogger that allow the collection of data from the environment, processes, etc. The information is stored and then transmitted. These devices are able to monitor different parameters (air quality, toxic gases, noise, position, temperature, speed, motion, height, humidity, etc.) and have been designed to get their energy from solar cells. The data collected is transmitted via radio for its analysis to any handheld device, computer or cloud server. CITYSENSOR is an interesting device for the INTER-IoT pilot cases and it could be considered for the interoperability at device level in the project
Thingsee One	Thingsee One is a smart developer device for Internet of Things (IoT) application and solution development. The device is designed for the easier and faster deployment of new IoT applications and services at a fraction of the current cost. Thanks to its robust structure, wide variety of fully programmable sensors and extensive cellular connectivity, Thingsee One is an ideal host for a multitude of different applications. With a battery life lasting up to one year, the device's capabilities are extensive. Thingsee One is an interesting device for the INTER-IoT pilot cases and it could be considered for the interoperability at device level in the project

SEAMS	Smart, Energy-Efficient and Adaptive Management Platform (SEAMS). The SEAMS system connects the different machines of a Port Container Terminal with a database being able to acquire all the information related with the operative and energy dimensions in real time gathered from the diversity of sensors attached to the machine. The SEAMS make uses of a black box prototype (PLC and DGPS) connected to each machine which makes the function of a gateway. The information is stored into a database and then post-processed and evaluated by the port operators. SEAMS is a product created by NOATUM for receiving and processing the information coming from the sensors of their machines. NOATUM is a container terminal, partner of the project, and based in the port of Valencia where the INTER-LogP pilot case will take place. SEAMS is a platform which may not be fully IoT enabled that need to be considered for the interoperability of heterogeneous IoT platforms in this project.
OpenGate	Platform to create and manage complete M2M processes and move towards industrial solutions applying the Internet of Things. This platform is focused on the collection of data and BigData analysis of the data produced by the internet of thing solutions. This platform is able to escalate the information and able to process large amount of data. This solution is able to reduce implementation and maintenance costs for this kind of solutions. OpenGate is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
CATOS	A Terminal Operating System, or TOS, is a key part of cargo handling operations at ports and it is an important element for the efficiency of the supply chain. This system primarily aims to control the movement and storage of various types of Cargo in and around a Container terminal or Port. The systems also enables you to make better use of your assets, labour and equipment, plan your workload, and get up to the minute information which allows for timelier and cost-effective decision making. NOATUM uses as a TOS, the product CATOS (Computer Automated Terminal Operating System) from the Korean company Total Soft Bank Co., Ltd. This system can benefit and use the services offered by the INTER-LogP use case for improving operations at the terminal.
OpenIoT	OpenIOT provides an open source IoT platform that enables the semantic interoperability of IoT services in the cloud. OpenIoT is perceived as a natural extension to cloud computing implementations, which allow access to additional and increasingly important IoT based resources and capabilities. OpenIoT platform applies the W3C Semantic Sensor Networks (SSN) ontology, which provides a common standards-based model for representing physical and virtual sensors. Also it includes sensor

	middleware that eases the collection of data from virtually any sensor, ensuring their proper semantic annotation. OpenIoT is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Kura	Eclipse Kura is an Eclipse IoT project that provides a platform for building IoT gateways. It is a smart application container that enables remote management of such gateways and provides a wide range of APIs for allowing writing and deploying IoT applications. These applications leverage OSGi, a dynamic component system for Java, and Kura API to facilitate access to the underlying hardware (serial port, GPIOs, etc.), to communicate with an IoT server backend, to manage the runtime settings, etc. Eclipse Kura is a product which can be considered in the creation of gateways within the interoperability framework.
IoTivity	IoTivity is an open source software framework enabling seamless device-to-device connectivity to address the emerging needs of the Internet of Things. The IoTivity project is hosted by the Linux Foundation, as a Collaborative Project, and sponsored by the Open Interconnect Consortium. OIC is a group of technology companies such as Samsung Electronics and Intel who are developing a standard specification and certification program to enable the Internet of Things. IoTivity is a product which can be considered in the interoperability device-to-device layer.
NEXCOM IoT GATEWAY	NEXCOM IoT gateway is an intelligent IoT gateway based on Intel Quark/Intel IoT Gateway platform (Moon Island). It is designed to connect to sensor networks and provide flexible connections between sensor nodes and customer's cloud for enabling intelligent big data analysis and data-driven decision making. This smart gateway integrates technologies and protocols for networking, embedded control, security and manageability on which third-party applications can run. NEXCOM IoT Gateway is a product which can be considered in the creation of gateways within the interoperability framework.
Libelium	Libelium designs and manufactures hardware and a complete software development kit (SDK) for wireless sensor networks so that system integrators, engineering, and consultancy companies can deliver reliable Internet of Things (IoT), M2M, and Smart Cities solutions with minimum time to market. Libelium has its own versatile IoT platform that allows implementation of any Wireless Sensor Network, from Smart Parking to Smart Irrigation solutions. Libelium platform, named 'Waspmote', is open source, horizontal, modular and accessible to help developers design and deploy sensor applications on top, easily and within the minimum time to market. Waspmote provides a compact and highly reliable framework for

	developing IoT applications. Waspmote is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project. Libelium's manufactured devices could be also interesting for the INTER-IoT pilot cases and they could be considered for the interoperability at device level in the project
OM2M	The OM2M project, initiated by LAAS-CNRS, is an open source implementation of oneM2M and SmartM2M standard. It provides a horizontal M2M service platform for developing services independently of the underlying network, with the aim to facilitate the deployment of vertical applications and heterogeneous devices. OM2M follows a RESTful approach with open interfaces to enable developing services and applications with M2M interoperability. It proposes a modular architecture running on top of an OSGi layer. OM2M is based on the ETSI-M2M standard. It provides a horizontal Service Common Entity (CSE) that can be deployed in an M2M server, a gateway, or a device. OM2M is a product which can be considered in the interoperability at device and network layers and for building gateways in INTER-IoT project.
VLCi (Valencia Open City)	VLCi -smart city platform for Valencia- was launched in February, 2015. As a result, Valencia was the first fully integrated smart city in Spain. VLCi improves the services available for citizens and reduces public spending through efficient management of public resources. Valencia has merged 45 different city services into its open standard digital platform, VLCI, which are now managed centrally keeping citizens well informed in one single always-available access point. Valencia City Council designed Telefonica as the technological partner in charge of the creation of VLCi. . The Polytechnic University of Valencia (UPVLC) partnered in the project, delivering technology through 350 sensors that keep connected services under control, improving previous management systems. VLCi is one an IoT smart city platform which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
FIWARE	FI-WARE is a European Union driven open initiative aiming to create a sustainable ecosystem in order to offer a new wave of digitization services based on the integration of components and technologies of the Internet of Things through open standards that create a low-cost, open-data environment that benefits all. FIWARE is supported by the Future Internet Public-Private Partnership (FI-PPP) project of the European Union. The objective of FIWARE is to facilitate a cost-effective creation and delivery of Future Internet applications and services in a variety of areas, including smart cities, sustainable transport, logistics, renewable energy, and

	environmental sustainability. The API specification of FIWARE is open and royalty-free. FIWARE is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Intel Intelligent Systems Framework	Intel Intelligent Systems Framework is a set of interoperable solutions designed to address connecting, managing, and securing devices in a consistent and scalable manner. ISF provides solutions to allow smart objects to Connect, Share and Drive value from the Data. The Intelligent Systems Framework enables OEMs to shift their investments from achieving interoperability to unlocking the value of data. ISF allows faster-time-to-Market, as enables innovative services – as a consequence of exploiting the unlocked value of the data-, and lower development and deployment costs. The framework features fundamental capabilities, delivered by components from Intel and ecosystem partners that address connectivity, manageability, and security including software and middleware from Wind River and McAfee. ISF is a product which can be considered in the interoperability device-to-device layer.
MIHINI	Mihini is an open source incubator project under the Eclipse Technology umbrella. The Mihini project creates an application environment for the Things in the IoT, providing a framework that allows device interoperability. The Mihini project is still under development. Mihini is based on the programming language Lua, a lightweight scripting language, specifically defined for M2M applications on embedded systems, with a very powerful expressiveness which results in compact and efficient code. The main goal of Mihini is to deliver an embedded runtime running on top of Linux that exposes high-level API for building M2M applications. Mihini aims at enabling easy and portable development, by facilitating access to the I/Os of an M2M system, providing a communication layer, etc. Mihini is a product which can be considered in the device and network interoperability layers.
Contiki	Contiki is an open source operating system for the Internet of Things. Contiki connects tiny low-cost, low-power microcontrollers to the Internet. The operating system supports a wide range of networking protocols (L2 and L3) and allows for fast development of applications. It also supports a variety of hardware platforms from various manufacturers. It is the de-facto industrial standard of operating systems for low-power IoT devices. Mihini is a product which can be considered in the device interoperability layer.
Cooja	Devising, debugging, testing and prototyping algorithms running on contiki

	devices is a non-trivial process especially when the size of the network increases. Yet, simulating those conditions and those algorithms often generates results and drives conclusions far from the reality. Cooja, the Contiki network simulator, makes this tremendously easier by providing a simulation environment that allows developers to both see their applications run in large-scale networks or in extreme detail on fully emulated hardware devices. Cooja is a product which can be considered in the device and network interoperability layers.
JN516x	Low-power devices with running cycles in the range of years are important for industrial IoT applications. JN516x is a series of NXP low-power wireless IEEE802.15.4-compatible devices designed for this purpose. Besides power-efficiency, they support transmission power scaling. Contiki OS supports those devices. JN516X is a product which can be considered in the device and network interoperability layers.
Philips Hue	Philips Hue is a personal wireless lighting system, designed for real life and all its potential. It combines brilliant and energy-efficient LED light with intuitive technology. The Hue lights can be easy controlled via ZigBee. The bridge is the heart of the Philips Hue system that connects your smart device to your Hue lights. You can add up to 50 Philips Hue lights and accessories to one bridge. Philips Hue is a product which can be considered in the device and network interoperability layers.
Samsung RF28HMELBSR/AA	The Samsung 4-Door refrigerator with 8" Wi-Fi Enabled LCD will allow you to browse the web, access apps and connect to other Samsung smart devices – opening up a world of interactive communication and entertainment. Samsung RF28HMELBSR/AA is a product which can be considered in the device and network interoperability layers.
LG WT6001HV	LG Smart ThinQ™ Refrigerators, Ranges, Washers and Dryers do more than any appliance you've owned before. They integrate seamlessly with your busy schedule – whether you're home or miles away – offering a new world of connectivity, customization and efficiency. Smart ThinQ™ technology is stay connected with features like Smart Access and Smart Adapt, which allow you to monitor your laundry remotely and download new and improved cycles. LG WT6001HV is a product which can be considered in the device and network interoperability layers.
AR Drone 2.0	AR.FreeFlight is the primary application used to fly and pilot the AR.Drone. Pilot with or without the accelerometer and switch from the frontal camera to the vertical camera.

	Record pictures, nav data & videos and upload them instantly right from the application. AR Drone 2.0 is a product which can be considered in the device and network interoperability layers.
Flytrex Sky	Flytrex Sky is the first multipurpose drone. Use the different Sky apps for the task you need. Flytrex Sky is the world's first drone that operates over the cloud. All Sky flights are automatically logged to your personal Flytrex profile and are available to you via our web-site or mobile apps, built-in 3G tracking guarantees you'll never lose your expensive equipment, range-free connectivity keeps you worry free even when flying long distances or in urban areas. Flytrex Sky is a product which can be considered in the device and network interoperability layers.
Roomba 980	The Roomba 980 is iRobot's a robotic vacuum, adding Wi-Fi and app control for even easier home cleaning. Uses a high-efficiency cleaning pattern and a full suite of sensors to map and adapt to real world clutter and furniture for thorough coverage. Roomba 980 is a product which can be considered in the device and network interoperability layers.
Samsung Gear	The intuitive circular face and bezel let you navigate effortlessly to get to what you need. And with access to important notifications at a glance, you can get more out of every moment of your day with the Samsung Gear S2. Once paired with a compatible Android™ phone, 3G or 4G2 network connectivity lets you call, text, email and receive notifications directly from your wrist. Samsung Gear is a product which can be considered in the device and network interoperability layers.
Globe Tracker Communications Unit	Globe Tracker Communications Unit (GT Comm. Unit) is a real time tracking, monitoring and communications device. The GT Comm unit can be installed in cargo containers, truck trailers, railway cars and more. The unit tracks the position and condition of assets. Optional sensors can also monitor events with one of the optional sensors, such as g-force, motion, temperature, humidity, light, gasses, and door open/closed. The unit transmits the data via either WiFi (when it can connect to a WiFi access point) or via GSM network. The sensor data is stored in a personal database, in which the consumer can track its cargo. Globe Tracker Communications Unit is an interesting device for the INTER-LogP pilot case and it could be considered for the interoperability at device and network layers in the project.
Confidex	Confidex makes RFID tags and labels for products and transport system

	(warehousing) for CC-containers and bus, tram and train tickets. Confidex is an interesting device for the INTER-LogP pilot case and it could be considered for the interoperability at device and network layers in the project.
1 stop	1-stop is an online system to improve truck trafficking in and out of a port to avoid congestions. It is used to plan cargo freight. Different terminals can plan in their resources. The information can be shared among different terminals, making it a more integrated system. And enabling a more adequate planning. This system is operating in Australia and it can be further analysed for the assessment and applicability of its functionalities in the INTER-LogP use case.
Fraunhofer, FhG IMS	Wireless sensors for Agricultural Applications such as temperature and sunlight sensing in greenhouses, monitoring micro-climates in fields (temperature, humidity and soil moisture) and livestock measurement (measuring the pH and temperature inside the cow's rumen). IMS is a product which can be considered in the device and network interoperability layers.
Autonomous tractors	A system that makes an agricultural tractor autonomous. With a Laser Radio Navigation System the tractor can position itself with sub-inch precision. The route the tractor has to drive can be trained in the tractor. When during autonomous drive the autonomous tractor encounters a problem the owner will be notified by a text. The first stage is an upgrade kit for a normal tractor, the second stage is still under development and is a fully autonomous tractor-robot that has no room for a driver/passenger anymore. Autonomous tractors is an interesting solution which can have also applicability in INTER-LogP, specially the laser radio navigation system device which can be considered in the device and network interoperability layers.
Smart thermostat	Smart thermostat that combines heater control with extra functionality. With Geo-fencing (of smartphone) the thermostat can see if there is someone at home, or returning home, setting the thermostat on the desired heat level. The thermostat can learn your day to day routine, making sure that the home is at the desired temperature. Toon and the "energieassistent" can be monitoring the amount of energy used by appliances enabling you to reduce your energy consumption. Smart thermostat is a product which can be considered in the device and network interoperability layers.
ACOSO Meth	ACOSO Meth is a novel software engineering approach aiming to support a systematic and full-fledged development of SOs-based IoT systems.

	ACOSO Meth is based on metamodels that are defined at different levels of abstraction to support the development phases of analysis, design and implementation. Every phase introduces new features and a higher degree of detail in the metamodels, maintaining at the same time strong relations with the higher levels metamodels. Following the ACOSO Meth, the ACOSO middleware has been specifically conceived for the full management of cooperating and agent-oriented smart objects. ACOSO Meth is a product which can be considered in INTER-METH and the ACOSO Middleware is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
ÁGATA	AGATA is the name of a product created and commercialized by the company ÁGATA TECHNOLOGY, based in Spain. AGATA is a Smart multi-platform that is focused in the integration of any environment with complex and diversified technological systems: cities, ports, industries, universities, trade in consumer or any complex environment, where many people converge, resources and actions. It is the Smart platform used in Smart Port projects of Vigo and A Coruña. AGATA is a product which can be considered as a platform for the interoperability of heterogeneous IoT platforms in this project and in INTER-LogP taking into account its implementation in two ports.
AREAS	AREAS® is the specific ERP (Healthcare Enterprise Resource Planning) platform for healthcare developed by Engineering, chosen and used each day by dozens of local healthcare facilities and hospitals. AREAS® is a complete, customizable web solution, to support the carrying out and integration of the clinical and administrative processes in the company-based or supra-company healthcare organizations. In Engineering's architectural vision, the single applications are bricks in the Hospital Information System, integrated into a common platform for connection and exchange of data. The AREAS® platform, with the combination of its 68 certified profiles/IHE actors, is the national leader in terms of international tests certifying interoperability according to the sector's reference standards. AREAS is a product which can be considered in the INTER-Health pilot case of the project.
Butler - uBiquitous, secUre inTernet-of-things with Location and contEx-awaReness	The main objective of BUTLER is to support the construction of pervasive applications that make use of heterogeneous devices (SmartObjects in BUTLER parlance), based on different protocols and standards. Said pervasive applications aim to improve daily user activities in different domains taking into account contextual information (user needs,

	preferences and location, status of the physical entities the user interacts with and so on). To enable applications implement their functionality, BUTLER takes the raw information generated by users and devices and shuffle it to create rich contextual information, to calculate precise location information, or to predict user behaviour. BUTLER has to be also able to provide efficient ways to declare and compute contextual and location information, as well as predict user behaviour. BUTLER is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
COSM	COSM Agile Framework is Herzum Software's widely used approach for enterprise architecture and agile software manufacturing. COSM analyses 7-levels of interoperability protocol model: development lifecycle interfaces, functional reference model, semantics, functional interfaces, application infrastructure, technical infrastructure, and technical interfaces. These levels include: technology selections, technical infrastructure, integrations points in the application infrastructure, functional reference model and semantic specifications, functional reference models. Business Component Model consists of five dimensions: Architectural Viewpoints, Component Granularity, Development Process, Distribution Tier, and Functional Categories. COSM is a product which can be considered in INTER-METH.
EldaMeth	ELDAMeth (Event-driven Lightweight Distilled StateCharts-based Agents Methodology) is a methodology specifically designed for the simulation-based prototyping of distributed agent systems (DAS). It is based on an iterative development process covering modelling, simulation and implementation phases of DAS. ELDAMeth can be used both stand-alone for the modelling and evaluation of DAS and coupled with other agent-oriented methodologies for enhancing them with simulation-based validation. In particular, the proposed methodology, which is based on the ELDA (Event-driven Lightweight Distilled StateCharts-based Agents) agent model, provides key programming abstractions (event-driven computation, multi-coordination, and coarse-grained strong mobility) very suitable for highly dynamic distributed scenario and is supported by a CASE tool-driven iterative process, seamlessly covering the detailed design, simulation, and implementation phases of DAS. ELDAMeth is a product which can be considered in INTER-METH.
Giraff+	GiraffPlus is a complex system which can monitor activities in the home using a network of sensors, both in and around the home as well as on the

	body. The sensors can measure e.g. blood pressure or detect e.g. whether somebody falls down. Different services, depending on the individual's needs, can be pre-selected and tailored to the requirements of both the older adults and health care professionals. At the heart of the system is a unique telepresence robot, Giraff, which lends its name to the project. The robot uses a Skype-like interface to allow e.g. relatives or caregivers to virtually visit an elderly person in the home. Giraff+ is a product which can be considered in INTER-Health.
Home Manager	Home Manager is a prototype application for the control of an intelligent home, designed as a multi-agent system via the SODA methodology, and implemented on top of the TuCSoN coordination infrastructure. The system considers a house with independent devices (air conditioners, lights, etc.), each equipped with an agent to participate to the agent society. The coordination infrastructure, programmable via tuple centres, embeds the coordination laws required both to mediate among the different user's preferences and to pursue the overall system. Home Manager is a product which can be considered in INTER-FW.
Intoino	Intoino is an Arduino based educational and prototyping platform for the Internet of Things that provides with customized boards and plug-and-play sensors and actuators that allow to easily program and connect events to produce smart-things behaviour such as watering plants when their soil is too dry, or send an alarm every time the fridge is opened. The accompanying iOS and Android applications allows the users to program their Intoino but also to interact with it to receive alerts and monitor programmable events. Intoino is a product which can be considered in INTER-FW.
Kukua	Kukua's vision is to close Africa's weather information gap by leveraging new weather station technology and mutually beneficial partnerships. The sustainable solution will provide accurate weather data and forecasts to smallholder farmers, commercial farmers and other stakeholders throughout Africa. This system is operating in Africa and it can be further analysed in INTER-FW.
Oracle IoT	Oracle IoT Cloud Service is like a fast and simple on-ramp for merging IoT into your business. Work in the cloud to minimize your costs and time to market. Connect your existing sensors and devices to powerful analytics and business intelligence engines in the cloud. Customize your software intelligence on the device side and the cloud side to meet your business needs. Use friendly interfaces to set up monitoring of your IoT data. Oracle IoT Cloud Service security protects your network and data. Whether your business data comes from simple sensors or complex programmable devices, you can connect your data sources to Oracle IoT

	Cloud Service. Oracle IoT is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
PASSI (Process for Agent Societies Specification and Implementation)	PASSI is a step-by-step requirement-to-code methodology for developing multi-agent software that integrates design models and philosophies from both object-oriented software engineering and MAS using (more properly extending) the UML notation (OMG, 2003b). Because of the specific needs of agent design, the UML semantics and notation will be used as reference points, but they will be extended, and UML diagrams will be often used to represent concepts that are not considered in UML and/or the notation will be modified to better represent what should be modelled in the specific artefact. The PASSI process is composed of five process components: System Requirements, Agent Society, Agent Implementation, Code, and Deployment, and several distinct work definitions within each of them. PASSI is a product which can be considered in INTER-METH.
Posidonia Operations	Posidonia Operations is a product that is part of the Posidonia Port Solution Suite© developed by PRODEVELOP, S.L. Posidonia Operations is an Integrated Port Operation Management System highly customizable that allows a port to optimize its maritime operational activities related to the flow of vessels in the port service area, integrating all the relevant stakeholders and computer systems. It has been designed to meet all the phases of vessel traffic: berth planning, authorization, port approach, entry in port's service area, berthing, unberthing, berth change, anchorage, bunkering, exit from port, waypoint/zone pass-through control, etc. Posidonia Operations is a product which can benefit and use the services offered by the INTER-LogP use case for improving its functionalities related with the flow of vessels in the port service area.
Sentinel	Sentinel is a hardware and software solution for the monitoring of private boats and vessel fleets. It is composed of a set of sensors connected to a local smart hub, which in turn processes and sends the information via GSM or Wi-Fi to a central service, and user front-ends for the communication and monitoring of such values. The services includes a set of standard sensors which include humidity, temperature, battery level, location (GPS), acceleration, and intrusion, but additional ones can be connected to the smart-hub via Bluetooth or the NMEA2000 wired standard. All this information is then transmitted to the Sentinel service, stored, processed and analysed in order to detect potential problems such as collisions, and trigger alarms to the users. Sentinel is a solution which may not be fully IoT enabled that can be considered for the interoperability of heterogeneous IoT platforms in this

	project.
Smart Cites and open data. UNE 178301:2015 (AENOR)	AENOR is a Spanish Association for Standardization and Certification is a private non-profit organization that was founded in 1986. AENOR offers a proven track record and information on standards, products and services connected with organizations from all over the world, performing major work in the field of international cooperation. The standard: Smart Cites and open data. UNE 178301:2015 (Last version 2015-07-29 has been produced by the Committee AEN/CTN 178 - CIUDADES INTELIGENTES. Publication date: 21/01/2015. There are a set of standards that are being released named 178GXX, being G a specific working group for these interest fields: 1-Infraestructures, 2: KPIs and semantics, 3: Govern and mobility, 4: Energy and Environment, 5: Tourism. UNE 178301:2015 (AENOR) is a product which can be considered in INTER-METH.
SODA (Societies in Open and Distributed Agent spaces)	SODA (Societies in Open and Distributed Agent spaces) is a methodology for the analysis and design of complex agent-based systems. SODA is not concerned with intra-agent issues: designing a multi-agent system with SODA leads to defining agents in terms of their required observable behaviour and their role in the multi-agent system. Instead, SODA concentrated on inter-agent issues, like the engineering of societies and infrastructures for multi-agent systems. SODA is a product which can be considered in INTER-METH.
ConLock	ConLock is a GPS container tracking device embedded in a proprietary IoT platform used by haulage companies in France that deliver transport services in connection with container terminals in ports. The device features several sensors that can operate simultaneously, allowing for remote protection of the container. It comes ready to work the “mytrackingdevices.com GPS tracking platform”. But integration with existing enterprise application platforms is also possible as API and integration support can also be provided. ConLock is a product which can be considered in the device and network interoperability layers.
Arduino only USA / Genuino outside USA	Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Arduino is a product which can be considered in the device and network interoperability layers.

BodyCloud	BodyCloud is a distributed software framework for the rapid prototyping of large-scale BSN applications. It is designed as a SaaS architecture to support the storage and management of sensor data streams and the processing and analysis of the stored data using software services hosted in the Cloud. In particular, BodyCloud endeavours to support several cross-disciplinary applications and specialized processing tasks. It enables large-scale data sharing and collaborations among users and applications in the Cloud, and delivers Cloud services via sensor-rich mobile devices. BodyCloud also offers decision support services to take further actions based on the analysed BSN data. BodyCloud is a product which will be used in the INTER-Health use case.
CEN/ISO EN13606	Health informatics – Electronic health record communication, is a European norm designed to achieve semantic interoperability in the Electronic Health Record communication. CEN/ISO EN13606 is a product which can be considered in the INTER-Health use case.
C-Health (prototype service)	C-Health is a data platform designed to gather data and information supporting monitoring services and clinical trials. It can be used either by citizens who want to check their own health status or by professional stakeholder providing care services. As a matter of fact, both sensor based measurements, clinical reports and e-CRF (electronics Case Report Form) may be managed. Sensor based measurements are transferred to the data platform by means of dedicated home gateways. It is possible to upload the following information: activity monitoring, health monitoring, wearable device activity, and environmental monitoring. Clinical information (clinical reports and e-CRF) is transferred to the platform by means of the integration of dedicated software interfaces, thus integrating dedicated web based applications and archives. C-Health is a product which can be considered in the INTER-Health use case.
CoXnico	Telemedicine system, which uses as a gateway device with integrated SIM (CoXnico Lab) that connect both wired and wireless several medical devices (very wide of the glucometers wired) and send the information by means of mobile connection to the platform. It offers consulting services for data collected to various web users / profiles. CoXnico is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
Current Procedural Terminology (4th Edition) (CPT 4)	Current Procedural Terminology (4th Edition), is a taxonomy developed by American Medical Association that describes medical procedures and services CPT4 is a product which can be considered in the INTER-Health use case.
Diamond Cuff BP	Diamond BP cuff device is a Bluetooth enabled blood pressure cuff that

	allows for automatic monitoring of blood pressure with minimal patient intervention required. Readings are stored on the device or if connected to the target application can be loaded straight to the platform in use such as the PRIME system. A clinically validated BP cuff this device has advanced blood pressure monitoring technology to take accurate readings and raise potential problems using Irregular Rapid Beat (IRB) technology. Diamond Cuff BP is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
DigiO2ETH-301	This thermometer is designed to allow users to take temperature readings as quickly and easily as possible. Temperature can be taken without contact from the forehead, and readings take only a second to display on a large and easy to read screen. All readings taken on the device can be saved on the internal memory and are transmitted live when connected to an external device for remote viewing. DigiO2ETH-301 is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
Digital Hospital	Digital Hospital is a suite of IT and communication Telefonica services designed to improve the efficiency of healthcare providers, empowering professionals by providing access to the right information, in the right place and at the right time, and improving patient demand management by offering new digital channels and multichannel platforms for medical appointments, triage, health advice and emergencies. Digital Hospital is a product which can be considered in the INTER-Health use case.
Wireless Stethoscope	The 3M Littmann Electronic Stethoscope Model 3200 combines ambient Noise Reduction technology and frictional noise dampening features with amplification, Bluetooth technology and an all-new user interface, for the next level of performance and ease of use. Wireless Stethoscope is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
e-Care (prototype service)	e-Care is a Telemonitoring service that could be used by chronic pathology patients or simply by citizens that want to monitor their health status for prevention. It is made of two modules: the first one regards quantitative measures management (collection and analysis of physiological parameters) while the second one regards the qualitative measure management (lifestyle analysis through questionnaires). Patients or Citizens could perform measurements of many physiological parameters using the following medical devices: weight scale, blood pressure monitor, INR monitor, oxymeter, spirometer, ECG, glucometer, body temperature, etc. The medical devices are connected to the platform with a Bluetooth wireless connection. Measures are sent to a medical platform via a gateway installed on a smartphone or a tablet. Doctors have at their disposal the instruments to evaluate the exams results (by web access to the medical platform) and,

	on the basis of patient's condition, are able to interact with him and modify their treatments. Patients may receive, depending on the treatment laid down by his doctor, SMS reminder about therapies to follow. e-Care is a product which will be used in the INTER-Health use case.
EMC Healthcare Integration Portfolio	The EMC Information Intelligence Group's (IIG) HIP is a new suite of products specifically designed to help simplify the management and sharing of all forms of patient-related content. HIP provides support for healthcare IT standards such as XDS, HL7 and DICOM, and enhances the value of an EMR, enabling the rich content management services of Documentum to be applied seamlessly to the management of patient-related content throughout its lifecycle, from capture to disposition or retention. EMC works with industry EMR, medical imaging, and VNA application partners, system integrators, and service providers to integrate, test, and certify EMC infrastructure with partner applications for enhanced clinical workflow and provider productivity. EMC HIP is a product which can be considered in the INTER-Health use case.
Experimental Nutritional Counselling	The nutritional outpatient of the ASL TO5 prevention department proposes to clinically healthy subjects a nutritional counselling, with the aim to reduce the occurrence of major chronic degenerative diseases. For the development of this product, they will be monitored on a qualitative and quantitative level two types of measures: objective, such as weight, height, body mass index (BMI), blood pressure (BP), and subjective such as eating habits and physical activity practice. During the experimental nutritional counselling (year: month 0, month 6, month 12), the subjects recruited will be monitored in a decentralized way from the health care center to their homes, through the use of medical devices and wearable mobile devices. In particular through the use of medical devices will be monitored and recorded the objective measures (the BP will be monitored on a daily basis only in individuals at hypertension risk) while the use of wearable mobile devices will be monitored and recorded the practice of daily physical activity, so that such a subjective measure can be assessed objectively by using the number of routes distance, elapsed time and Kcal consumed; for a more effective evaluation, the subjects will be divided into "classes of physical activity." Experimental Nutritional Counselling is a product which will be used in the INTER-Health use case.
Fedex Senseaware	SenseAwareSM powered by FedEx provides enhanced visibility during shipping, allowing taking control of supply chain. SenseAware helps heighten security, improve efficiency and productivity, and gain confidence from business partners and clients. Using a multi-sensor device, SenseAware collects and transmits data from inside packages, pallets, trailers, and warehouses using wireless

	communication. The data is sent in near real-time to a powerful online application for monitoring and analysis. SenseAwareSM is a product which can be considered in the INTER-LogP use case and INTER-LAYER device interoperability.
FitBit Charge	FitBit Charge is a smartwatch that permits the monitoring of daily activity, sleep and share this data with friends. Charge connects to the APP on the smartphone with a Bluetooth LE link and transfers data with a property communication protocol. FitBit Charge is a product which can be considered in INTER-LAYER device interoperability.
HL7	HL7 is an international standards development organization in the area of healthcare information technology. HL7 and its members provide a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information. HL7 is a product which can be considered in the INTER-Health use case.
iMedOne® Mobile	iMedOne® Mobile is an app for an hospital information system. By using mobile applications and smartphones and tablets it is possible to optimize work processes at your hospital. Relieve the burden on doctors and nursing staff and improve your patients' quality of healthcare at the same. iMedOne® Mobile is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
iMedOne® Hospital Information System	iMedOne® support processes in hospitals in a wide range of ways. They both contribute substantially toward profitability and quality improvement because they make the work of doctors and nursing staff much easier. iMedOne® supports the user not only by drawing up the statutory quality assurance documentation, but also ensures transparency in target statistics and in-house data evaluation iMedOne® Mobile is a product which can be considered in the INTER-Health use case.
INDRA Health	INDRA Health solution integrates advanced telemedicine and remote assistance services, improving quality for patients in rehabilitation or with chronic diseases without the need for patients to leave their homes INDRA Health is a product which can be considered in the INTER-Health use case
International Classification of Functioning, Disability and Health (ICF)	The International Classification of Functioning, Disability and Health developed by World Health Organization is a classification of health and health-related domains structured around main components: body functions, body structures, activities and participation, environmental factors. ICF is a product which can be considered in the INTER-Health use case

International Classification of Disease (ICDx)	The International Classification of Disease coding standard is a classification of diagnosis developed by the World Health Organization. ICDx is a product which can be considered in the INTER-Health use case
M&T (Wearable metabolic and sleep & activity monitoring)	M&T is a real time analysis system of lifestyle that allows to easily and intuitively collecting key data to achieve the objectives of athletes / patients. Thanks to the ease of use and fit that M & T can become a daily companion for the evaluation of user's lifestyle. In a tiny plastic wrap (6 × 5.5 × 1 cm) weighing only 80g, M&T embodies years of development technological and scientific researches that allow the recording of data with an average error less than 10%: completely negligible error due to the complexity of the nature of the extracted data and the non-invasiveness of the method. M&T is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
ISO/IEEE 11073	Health informatics – Point-of-care medical device communication, is a European norm describing low level communication standards between medical, health care and wellness devices (e.g. weight scale, pulse oximeter) and with external computer systems. ISO/IEEE 11073 is a product which can be considered in the INTER-Health use case and INTER-LAYER device and network interoperability.
JawBone UP 3	JawBone Up 3 is an activity tracker that permits the monitoring of daily activity, sleep, heart rate and share this data with friends. UP3 connects to the APP on the smartphone with a Bluetooth LE link and transfers data with a property communication protocol. JawBone UP 3 is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
Logical Observations Identifiers Names and Codes (LOINC)	Logical Observations Identifiers Names and Codes, is an ontology providing a universal code system for tests, measurements, and observations related to electronic health records. LOINC is a product which can be considered in the INTER-Health use case and INTER-LAYER semantics interoperability.
Onyx II 9560	The Nonin 9560 was the world's first wireless finger pulse oximeter and supports Bluetooth®. This device allows clinicians to remotely monitor a patient's oxygen saturation level, pulse rate and pulse wave. As a wireless device it allows for greater patient freedom (up to 100m range) and ease of logging results to a patient's electronic patient record. Onyx II 9560 is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
Nutritional Folder	During the traditional nutritional counselling the ASL TO5 dietitian records data of subjects who arrive to nutritional outpatient on a "nutritional folder." This type of nutritional folder is an off line folder managed with EPI

	INFO software creating pages in excel format. It is used to record health and sensitive data of subjects such as: personal data (name, surname, age), anthropometric data (weight, height, BMI, waist circumference), blood pressure, eating habits and physical activity. The data collected is protected under national law "Code regarding the protection of personal data". Nutritional folder is a product which can be considered in the INTER-Health use case.
Open Biomedical Ontologies	The goal of the OBO Foundry is to develop a family of interoperable ontologies that are both logically well-formed and scientifically accurate. Nutritional folder is a product which can be considered in the INTER-Health use case and INTER-LAYER semantic interoperability.
OpenEHR	OpenEHR is a community working on interoperability and computability in the eHealth domain, with the main focus being the EHR that has developed an open domain-driven platform for developing flexible e-health systems. It includes a set of specifications defining a health information reference model, a language for building clinical models, or archetypes. OpenEHR is a product which can be considered in the INTER-Health use case.
PRIME	PRIME is a mobile health information and monitoring platform aimed to optimise patient pathways in pre-hospital healthcare and ambulance services' efficient performance. It creates intuitive and rich patient electronic forms (eForms) that integrates real-time continuous recordings of patients' vital signs and multimedia (written and audio notes, images and high-definition video), considering NHS requirements and the paramedics' mobile environment, procedures and workflow. PRIME eForms can be seamlessly shared with remote specialists (telehealth) to assist early and accurate assessment of patients' condition and the provision of treatment advice to paramedics on site and in the ambulance. PRIME is a product which can be considered in the INTER-Health use case.
Remote Patient Monitoring	Remote Patient Monitoring is a Telefonica telemedicine service for operators, professionals and patients which optimise healthcare provision by adapting it to the needs and level of risk of each patient. This approach supports the development of a new care model which is more efficient and cost-effective, and ensures that patients and their families, health professionals and organisations are more connected. It is an end-to-end service which facilitates efficient communication between patients and health professionals. Remote Patient Monitoring is a product which can be considered in the INTER-Health use case.
Self Care and Connected Care	Selfcare and Connected Care are selfcare programmes and well-being Telefonica services that enable prevention, greater self-control and peace of mind by giving the whole population better access to doctors and health contents. This is a totally new market where the company has invested in a

	disruptive Internet startup which connects users and doctors online: Saluspot. Saluspot is an online community where users can engage with thousands of doctors about any health doubt or concern they may have and have online consultations. Self Care and Connected Care is a product which can be considered in the INTER-Health use case.
Stabil-O-Graph Blood pressure monitor (IEM)	Stabil-O-Graph® is a blood pressure and pulse monitor for self-measurement at home. Measured values can be transmitted automatically via a Bluetooth transmission (proprietary protocol). Stabil-O-Graph is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
Seymour by Cellscope	Seymour is the smarter way to care for your family's health. It offers around-the-clock access to a doctor's opinion for kids' health concerns. Using in-app guidance and phone attachments, can share images of ear and skin concerns and get a doctor's opinion and recommendation plan in under 2 hours right to the phone. Seymour is a product which can be considered in the INTER-Health use case.
SemanticHealthNet – Semantic Interoperability for Health Network	Project focused on semantic interoperability of clinical and biomedical knowledge, in order to ensure efficiency of EHR systems. Semantic interoperability mechanisms and domain models were prepared with ontologies. The focus of that project was put on chronic heart failure as patient care exemplar and cardiovascular prevention as public health exemplar. SemanticHealthNet is a product which can be considered in the INTER-Health use case and INTER-LAYER semantic interoperability.
Sigfox	SIGFOX is an operated telecommunication network, dedicated to the Internet of Things. It is an operated network, meaning you do not have to handle any installation or maintenance operations. SIGFOX is seamless and out-of-the box, allowing you to forget about communication and keep focused on the core of your project. It is a LPWA (Low-Power Wide-Area) network, currently deployed in Western Europe, San Francisco, and with ongoing tests in South America & Asia. It allows a bidirectional communication, both from & to the device. The communication is always initiated by the device. The SIGFOX network is designed for small messages sent every now and then. It is not appropriate for high-bandwith usages (multimedia, permanent broadcast). Its focus on energy efficiency allows you to build connected devices able to last years on a standard battery. SIGFOX is a product which can be considered in the INTER-LAYER network interoperability.
SNOMED CT	SNOMED CT is the most comprehensive and precise clinical health terminology product in the world, owned and distributed around the world

	by The International Health Terminology Standards Development Organisation (IHTSDO). SNOMED CT is the multilingual clinical healthcare terminology that enables consistent, processable representation of clinical content in electronic health records and can be mapped to other international standards SNOMED CT is a product which can be considered in the INTER-Health use case and INTER-LAYER semantic interoperability.
TelbiosConnect (commercial service)	TelbiosConnect is a Telemonitoring platform that can be used by patients at home; different kits (for diabetes, bronchitis, heart failure and Hypertension) include different medical devices and the Telbios Station, a device aggregator, which is the gateway to send data to the server platform. Kits don't need a patient involvement in the configuration; patients don't need neither a network connection. Data recorded on TelbiosConnect platform can be read by specialized personnel (Nurses, Physicians) in the medical Service Center provided by Telbios as part of its Services. A specialized pool of cardiologists is also available for patients affected by heart disease. TelbiosConnect platform is a certified medical device according to 93/42/ce medical device directive class IIa. TelbiosConnect is a product which can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
TELCOMED	The Medic4All Technology Platform consists of miniaturized, wearable, wireless medical monitoring peripherals and gateways, medical call center software and protocols. Located in the patient's home, Medic4all's telemedicine system, is designed to automatically and wirelessly send its collected data to the medical monitoring center server without the patient's or medical monitoring center operator interaction. Uses several medical devices including the multi WristClinic device able to measure - Wrist Blood Pressure Monitor, Heart Rate, Heart Rhythm Regularity, Single Lead ECG, Breathing Rate, Body Temperature, and Blood saturation - SpO2. TELCOMED products can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
ThinFilm	ThinFilm is an Oslo based company looking to use printed electronic techniques to add intelligence to objects that have not been possible (or cost prohibitive) to connect in the past using traditional electronics. Using roll-to-roll printing Thinfilm can produce electronic labels with built-in rewritable memory (up to 100,000 times), sensors, a display, and embedded wireless communications including RFID and NFC capabilities. These printed smart labels promise to open up a range of new types applications: food packages that can provide a freshness indicator; product pricing that can adjust itself dynamically over time; medical labels that can track their products lifetime safety and authenticity.

	The creation of labels that can monitor and record other environmental data (light, pressure, humidity, even toxic gases) or other physical properties to be accessed by a consumer using their smartphone or displayed directly on the packaging. ThinFilm is a product which can be considered in the INTER-Health and INTER-LogP use cases and INTER-LAYER device interoperability.
Thingworx	ThingWorx is the industry's leading Internet of Things (IoT) technology platform. It enables innovators to rapidly create and deploy game-changing applications, solutions and experiences for today's smart, connected world. The IoT Platform enables users to connect, create, analyse and experience "things" in new ways. With ThingWorx, users can: • Connect any device in the ecosystem to the platform • Remove complexity and develop IoT applications and solutions without limits • Quickly and easily automate complex big data analytics using integrated machine learning Thingworx is one of the several IoT platforms which has the potential to be considered for the interoperability of heterogeneous IoT platforms in this project.
Withings Activitè	Withings Activitè is a smartwatch that permits the monitoring of daily activity, sleep and swim. Activitè connects to the APP on the smartphone with a Bluetooth LE link and transfers data with a property communication protocol. Withings Activitè is a product which can be considered in INTER-LAYER device interoperability.
Wireless ECG	Wireless ECG is a clinical grade 12-lead ECG sensor operating over BLUETOOTH wireless link. It offers reliable ECG reading with easy monitoring, with a broad scope of applications, ranging from clinical to sport to personal health monitoring. The system also incorporates data analytics software, allowing prediction mitigation of risk factors, such as heart attack and cardiac arrest. Wireless ECG is a product wich can be considered in the INTER-Health use case and INTER-LAYER device interoperability.
iCargo	Intelligent Cargo in Efficient and Sustainable Global Logistics Operations (iCargo) will build an open affordable information architecture that allows real world objects, existing systems, and new applications to efficiently co-operate, enabling more cost effective and lower-CO2 logistics through improved synchronisation and load factors across all transport modes. iCargo is a product which can be considered in the INTER-LogP use case and INTER-LAYER semantic interoperability.
iGPS	Intelligent Global Pooling Systems (iGPS) is the world's first RFID-tagged, all-plastic pallet pool. iGPS is dedicated to being the industry leader of

	innovative, world-class supply chain solutions leveraging sustainable, intelligent shipping platforms while achieving unmatched value for our customers, investors, and employees. iGPS is a product which can be considered in the INTER-LogP use case and INTER-LAYER device interoperability.
Numerex	Single-Source Provider of IoT Solutions. Numerex's fleet management solutions can track any high value moving asset - including large and small fleets - adding vehicle management and driver behaviour capabilities as well. Numerex is a product which can be considered in the INTER-LogP use case and INTER-LAYER semantic interoperability.
Smart Port Logistics	Collaboration between smartPort Hamburg, Deutsche Telekom, SAP. smartPORT logistics is synonymous for smart traffic and trade flow solutions in the Port of Hamburg, taking account of both economic and ecological aspects. A special focus of the project lies on infrastructure, traffic flows and trade flows. Smart Port Logistics is a product which can be considered in the INTER-LogP use case.
Smart Port Barcelona	The Port promotes information technology as a way of improving the services it offers to its customers: automatic lighting management, automating terminal entry and exit controls, removing the need for paper documents in container deliveries and collection. Smart Port Barcelona is a product which can be considered in the INTER-LogP use case.
BestFact	The objective of BESTFACT is to develop, disseminate and enhance the utilisation of best practices and innovations in freight transport that contribute to meeting European transport policy objectives with regard to competitiveness and environmental impact. BESTFACT is a product which can be considered in the INTER-LogP use case.
NEC Smart Cities	NEC supports smart city scalability with first live deployment of the new oneM2M standard NEC is the first company in the world to deploy the new oneM2M service layer standard in a live smart city control center deployment. NEC's use of the open oneM2M specification makes it possible to collect data from a diversity of sensors in a consistent and secure way for statistical and billing purposes and use robust data management models to enable cities to make informed day-to-day management decisions. Smart Port Logistics is a product which can be considered in INTER-FW.
SensorThings API	The OGC (Open Geospatial Consortium) SensorThings API provides an open and unified way to interconnect the Internet of Things devices, data and applications over the Web. The SensorThings API is an open standard, builds on Web protocols and the OGC Sensor Web Enablement standards, and applies an easy-to-use REST-like style.

	SensorThings API is a product which can be considered in INTER-FW.
oneM2M	Standards for M2M and the Internet of Things. The purpose and goal of oneM2M is to develop technical specifications which address the need for a common M2M Service Layer that can be readily embedded within various hardware and software, and relied upon to connect the myriad of devices in the field with M2M application servers worldwide. oneM2M is a product which can be considered in INTER-FW.
HyperCat	The HyperCat specification allows Internet of Things clients to discover what data an IoT server has available. It is built on the same Web standards that are now common for that interface, i.e. HTTPS, REST/HATEOAS, and JSON. With HyperCat, developers can write apps that will work across many servers, which helps to break down the walls between today's vertical silos. HyperCat is a product which can be considered in INTER-FW.
W3C SSN Ontology	This ontology describes sensors and observations, and related concepts. W3C SSN Ontology is a product which can be considered in INTER-LAYER semantic interoperability.
INTEL IoT Gateway	Intel IoT Gateways securely connect legacy industrial devices and next-generation intelligent infrastructure to the IoT. They integrate technologies and protocols for networking, embedded control, security and manageability on which third-party applications can run. The Intel IoT Platform is an end-to-end reference model and family of products from Intel. An Intel IoT Gateway is a critical component within this framework. INTEL IoT Gateway is a product which can be considered in INTER-LAYER network and device interoperability and in INTER-FW.
The Anatomic Therapeutic Chemical Classification of Drugs (ATC)	The ATC/DDD system classifies therapeutic drugs. The purpose of the ATC/DDD system is to serve as a tool for drug utilization research in order to improve quality of drug use. ATC is a product wich can be considered in the INTER-Health use case.

4.1.2 Products by class

Once a wide set of products at hand related with the project have been identified, this section present the product by class perspective where each product is classified by its class (*e.g.* management platform, standard, software, IoT platform etc.) so as to enable a deeper insight with regard to the category of products at hand, which in turn will facilitate a more focused perspective when placing the INTER-IoT products approach (INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP and INTER-Health) in line with each individual product identified by partners.

Table 86. Market products by class

Port System	ValenciaportPCS Automated Gate System (AGS) PortCDM AIS SCADA SEAMS CATOS 1 Stop Sentinel Fedex Senseaware Posidonia Operations Smart Port Logistics Smart Port Barcelona
IoT Platform	Azure IoT Suite Google Cloud Platform Kii Could Sofia2 OpenGate OpenIoT OM2M FIWARE Oracle IoT ÁGATA Libelium Thingworx VLCi (Valencia Open City) NEC Smart Cities INTEL IoT Gateway
Management Platform	Movildata Dynafleet Conlock Philips Hue AR Drone 2.0 Autonomous tractors AREAS Home Manager

	Arduino only USA / Genuino outside USA iGPS Numerex
Hardware (sensors, devices, etc.)	VDO Digital tachograph CITYSENSORs Thingsee One Roomba 980 Samsung Gear Globe Tracker Communications Unit Samsung RF28HMELBSR/AA LG WT6001HV Flytrex Sky Smart thermostat Diamond Cuff BP - Blood Pressure monitor DigiO2ETH-301 – wireless thermometer Electronic Stethoscope Model 3200 Onyx II 9560 - Wireless finger pulse Oximeter Stabil-O-Graph Blood pressure monitor (IEM) Wireless ECG ThinFilm JN516x Confidex Fraunhofer, FhG IMS FitBit Charge - activity tracker M&T (Wearable metabolic and sleep & activity monitoring) JawBone UP 3 – activity tracker Withings Activitè – activity tracker
Software	Contiki OS Google Brillo
Standards	AENOR. UNE 178301:2015 Anatomic Therapeutic Chemical Classification of Drugs (ATC) CEN/ISO EN13606 Current Procedural Terminology (4th Edition) (CPT 4) HL7 International Classification of Functioning, Disability and Health (ICF) International Classification of Disease (ICDx) ISO/IEEE 11073

	OpenEHR SensorThings API oneM2M HyperCat
Ontology	Logical Observations Identifiers Names and Codes (LOINC) Open Biomedical Ontologies SemanticHealthNet – Semantic Interoperability for Health Network SNOMED CT W3C SSN Ontology
IoT framework	Kura IoTivity Intel Intelligent Systems Framework MIHINI Sigfox FIWARE NEXCOM IOT GATEWAY COSM
IoT Simulators	Cooja
IoT Methodology	ACOSO Meth ELDAMeth PASSI SODA
eHealth	Butler Giraff+ BodyCloud C-Health (prototype service) CoXnico (Nousmed) Digital Hospital e-Care (prototype service) EMC Healthcare Integration Portfolio iMedOne® Mobile iMedOne® Hospital Information System INDRA Health Nutritional Folder PRIME

	Remote Patient Monitoring Self Care and Connected Care Seymour by Cellscope TelbiosConnect (commercial service) TELCOMED
Education	Intoino
Weather	Kukua
Medical Devices	Diamond Cuff BP - Blood Pressure monitor DigiO2ETH-301 – wireless thermometer Electronic Stethoscope Model 3200 Onyx II 9560 - Wireless finger pulse Oximeter Stabil-O-Graph Blood pressure monitor (IEM) Wireless ECG
Service	Experimental Nutritional Counselling
Project	BestFact iCargo

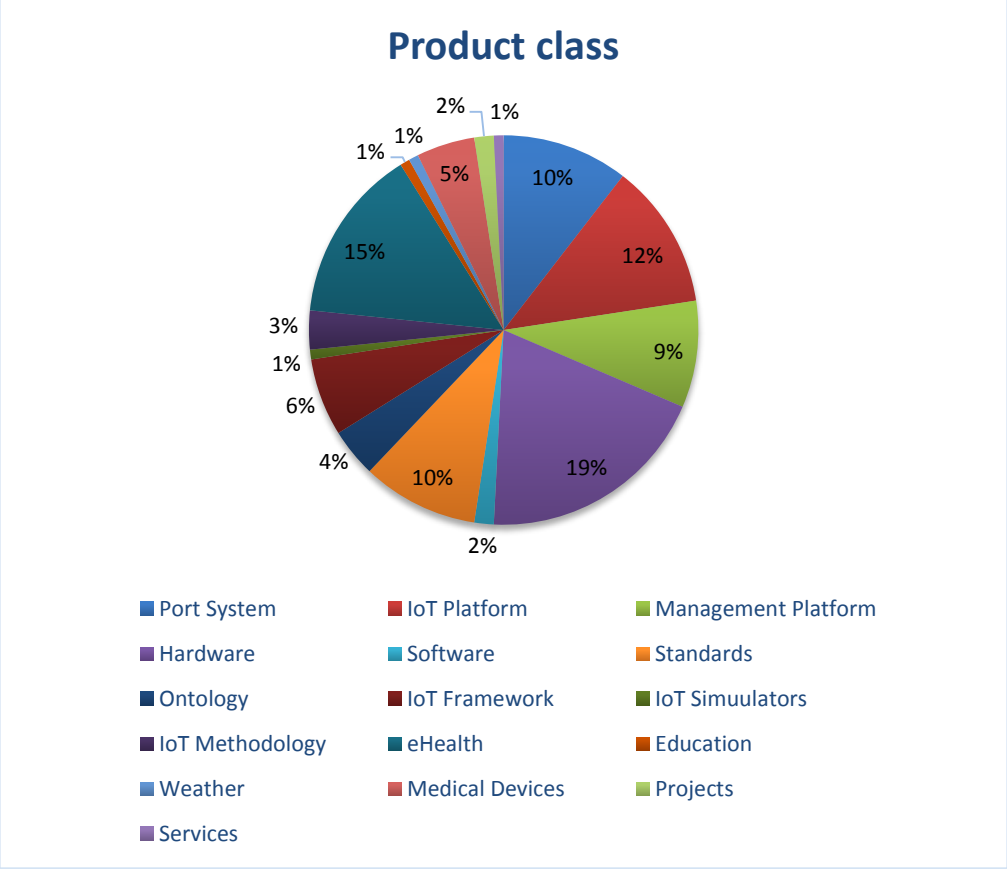

Figure 43 Products by class

The most prominent effect of this figure is the fact it shows a high level of heterogeneity, with many product classes accounting for very low portions of the overall product class spread (e.g. hardware, standards, simulators, IoT platforms etc.). There is no general rule that can emerge from this view though other than the fact that IoT educated stakeholders' awareness of existing products is quite scattered.

However, another interesting fact emerges, showing that the quantity of known products can be closely tied to domain specific classes. The figure above indeed shows that 20% of products identified are linked to either the medical sector (15% to eHealth, 5% to medical devices) or to port systems (10%). This observation enables us to assume there is a high level of domain application specialization of the products being identified.

4.1.3 Products by context

At a third stage, the products identified are classified by context in order for the reader to gain a clearer picture of the level of geographic openness of the market, whether products to which stakeholders resort to are operated locally, or at a national, European or international level.

Table 87. Market products by context

Local	ValenciaportPCS Automated Gate System (AGS) SCADA SEAMS VLCi (Valencia Open City) Butler Giraff+ Intoino Kukua Sentinel Posidonia Operations OpenGate contEx-awaReness Diamond Cuff BP - Blood Pressure monitor DigiO2ETH-301 – wireless thermometer Electronic Stethoscope Model 3200 Nutritional Folder PRIME Wireless ECG Smart Port Logistics Smart Port Barcelona

National	Movildata *Libelium* Autonomous tractors Smart thermostat AENOR. UNE 178301:2015 ÁGATA CoXnico (Nousmed) Digital Hospital e-Care (prototype service) Experimental Nutritional Counselling iMedOne® Mobile iMedOne® Hospital Information System M&T (Wearable metabolic and sleep & activity monitoring) Remote Patient Monitoring Self Care and Connected Care TelbiosConnect (commercial service)
European	Sofia2 OpenGate OpenIoT FIWARE Fraunhofer, FhG IMS C-Health (prototype service) INDRA Health SemanticHealthNet – Semantic Interoperability for Health Network iCargo BestFact
International	PortCDM AIS Azure IoT Suite Google Cloud Platform Kii Cloud Dynafleet VDO Digital tachograph CITYSENSORs Thingsee One CATOS Conlock

	Kura IoTivity NEXCOM IOT GATEWAY OM2M Intel Intelligent Systems Framework MIHINI Contiki OS CoojaJN516X Philips Hue Samsung RF28HMELBSR/AA LG WT6001HV AR Drone 2.0 Flytrex Sky Roomba 980 Samsung Gear Globe Tracker Communications Unit Confidex 1 stop ACOSO Meth AREAS Home Manager OpenIoT Eclipse Kura OM2M FIWARE Google Brillo PASSI Oracle IoT Kii Cloud SODA COSM ELDAMeth Anatomic Therapeutic Chemical Classification of Drugs (ATC) Arduino only USA / Genuino outside USA BodyCloud CEN/ISO EN13606

	Current Procedural Terminology (4th Edition) (CPT 4) EMC Healthcare Integration Portfolio Fedex Senseaware FitBit Charge - acitivity tracker HL7 International Classification of Functioning, Disability and Health (ICF) International Classification of Disease (ICDx) IOTIVITY ISO/IEEE 11073 JawBone UP 3 – activity tracker Libelium Logical Observations Identifiers Names and Codes (LOINC) Onyx II 9560 - Wireless finger pulse Oximeter Open Biomedical Ontologies OpenEHR Open IOT – the Open source Internet of Things Stabil-O-Graph Blood pressure monitor (IEM) Seymour by Cellscope Sigfox SNOMED CT TELCOMED ThinFilm Thingworx Withings Activitè – activity tracker iGPS Numerex NEC Smart Cities SensorThings API HyperCat W3C SSN Ontology oneM2M INTEL IoT Gateway

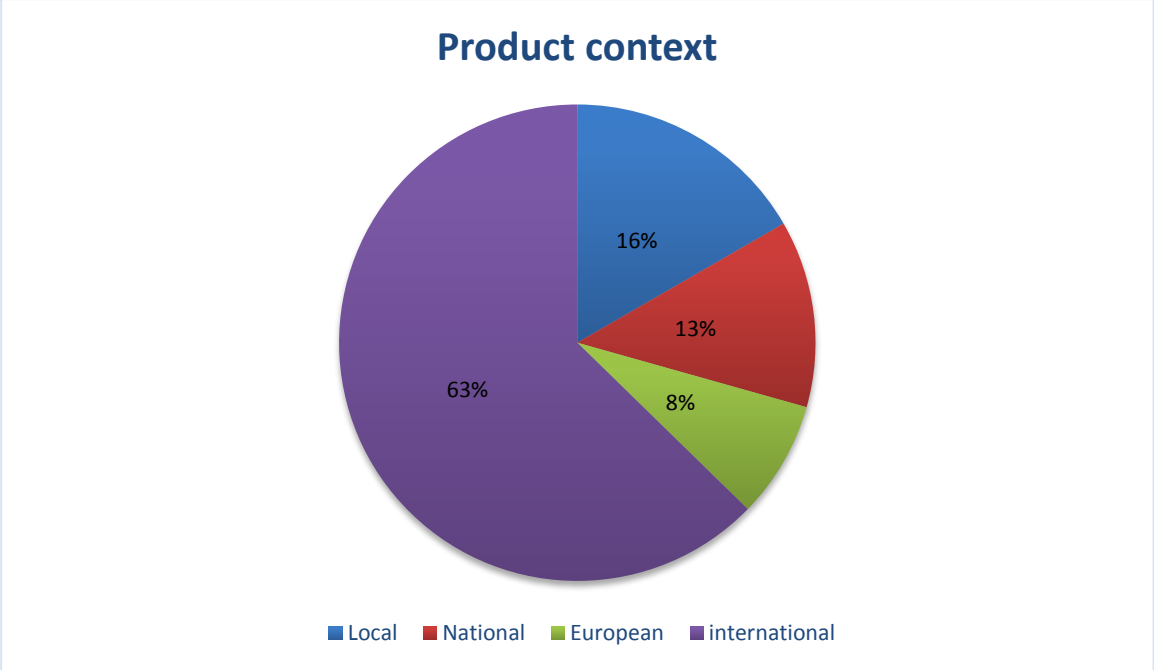

Figure 44 Products by context

The figure above hints that IoT products are available on a geographically widely open market, since 71 % are operated abroad, either at a European level (8 %) or at an international level (63 %), while 13 % are operated in a country level. And this case, it is worth noting that IoT products seem to be operating locally at a comparable level to those products that are operated nationally.

4.1.4 Products by access mode

Finally, the products are classified by access mode which allows to a certain degree to acquire a clearer idea of the economic and administrative constraints to overcome in order to be able to use the products. The access mode also provides a certain indication as to the structural interoperability the products bear.

Table 88. Market products by access mode

Open	AIS Sofia2 OpenIoT Kura IoTivity NEXCOM IOT GATEWAY Libelium OM2M VLCi (Valencia Open City)

	FIWARE Intel Intelligent Systems Framework MIHINI Contiki OS Cooja Phillips HUE RF28HMELBSR/AA LG Smart ThinQ Flytrex Sky Roomba 980 Samsung Gear AR Drone 2.0 Globe Tracker Communications Unit Fraunhofer FhG IMS Sigfox PASSI SODA ELDAMeth Anatomic Therapeutic Chemical Classification of Drugs (ATC) Arduino only USA / Genuino outside USA BodyCloud CEN/ISO EN13606 Current Procedural Terminology (4th Edition) (CPT 4) Experimental Nutritional Counselling HL7 International Classification of Functioning, Disability and Health (ICF) International Classification of Disease (ICDx) IOTIVITY ISO/IEEE 11073 Logical Observations Identifiers Names and Codes (LOINC) Open Biomedical Ontologies OpenEHR Open IOT – the Open source Internet of Things SemanticHealthNet – Semantic Interoperability for Health Network SNOMED CT Thingworx

	iCargo BestFact oneM2M SensorThings API HyperCat W3C SSN Ontology
Closed	ValenciaportPCS Automated Gate System (AGS) SCADA Movildata Dynafleet VDO Digital tachograph CITYSENSORs Thingsee One SEAMS CATOS Conlock JN516x Confidex 1 stop Autonomous tractors Smart thermostat ACOSO Meth AREAS Butler Giraff+ Sentinel Google Brillo Oracle IoT Intoino Kukua OpenGate COSM contEx-awaReness Diamond Cuff BP - Blood Pressure monitor DigiO2ETH-301 – wireless thermometer Electronic Stethoscope Model 3200

	Fedex Senseaware FitBit Charge - acitivity tracker M&T (Wearable metabolic and sleep & activity monitoring) JawBone UP 3 – activity tracker Onyx II 9560 - Wireless finger pulse Oximeter Nutritional Folder Stabil-O-Graph Blood pressure monitor (IEM) Seymour by Cellscope ThinFilm Withings Activitè – activity tracker Wireless ECG iGPS Numerex Smart Port Logistics Smart Port Barcelona NEC Smart Cities INTEL IoT Gateway
Subscription	Azure IoT Suite Google Cloud Platform Kii Cloud C-Health (prototype service) CoXnico (Nousmed) Digital Hospital e-Care (prototype service) EMC Healthcare Integration Portfolio MedOne® Mobile iMedOne® Hospital Information System INDRA Health PRIME Remote Patient Monitoring Self Care and Connected Care TelbiosConnect (commercial service) TELCOMED
License	AENOR. UNE 178301:2015 ÁGATA Posidonia Operations
TBD	PortCDM

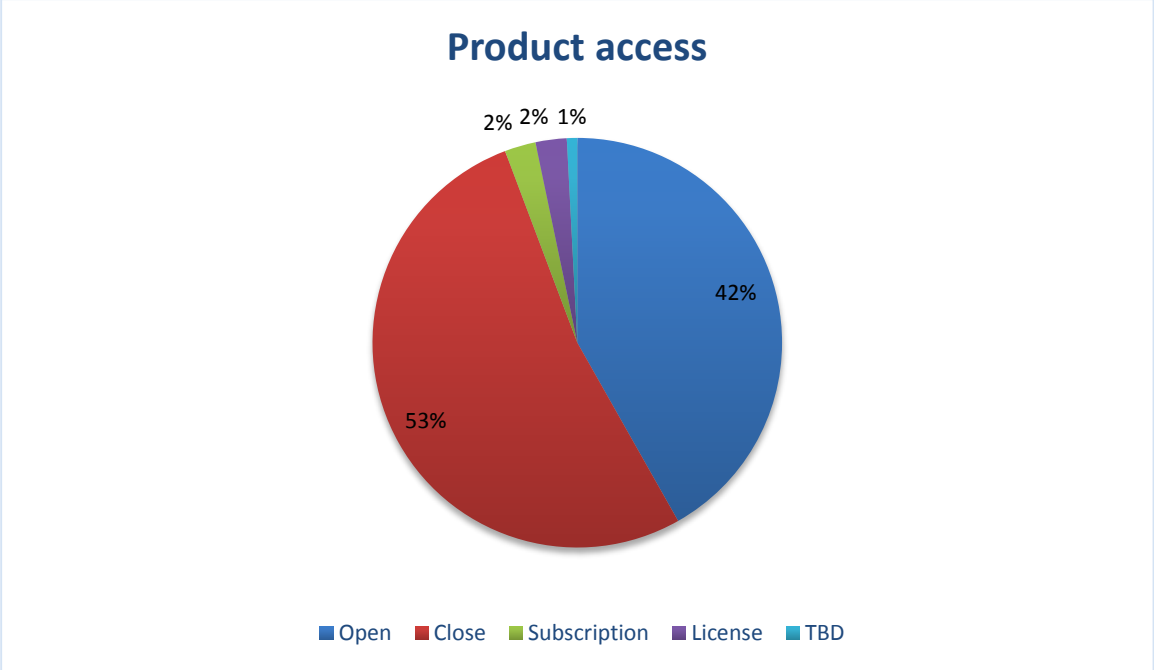

Figure 45 Products by access policy

This figure confirms the need for INTER-IoT solutions as over half of the identified products are used in a closed environment mode, thus hindering the economic efficiency and competitive advantages that could be gained by fostering interoperability. Luckily, among those products that can theoretically be accessed more openly, few require to overcome additional hurdles such as subscription or licensing.

4.2 SWOT analyses

In order to provide a more discerning view of the IoT market with regard to the five products relevant to the INTER-IoT project (INTER-LAYER, INTER-FW, INTER-METH, INTER-LogP and INTER-HEALTH) a simple SWOT analysis has been carried out. The objective of this analysis is to provide accurate and useful information to partners that will help them identify some of the crucial market challenges to which INTER-IoT needs to respond when developing its products.

The term SWOT is an initialism standing for Strengths, Weaknesses, Opportunities and Threats. Hence it is organised around two sets of factors:

- Internal factors comprised of the strengths and weaknesses stemmed from the identification of stakeholders, of their needs and of existing products has revealed. These internal characteristics can either facilitate or constrain the interoperability objective fixed by the project.

- And the external factors the market analysis points to in terms of threats and opportunities that INTER-IoT can, respectively, prepare to overcome or exploit to its advantage in order to achieve interoperability of IoT.

A SWOT analysis is to be objective-oriented in the sense that the analysist should always have in mind the intended product(s) and the intended usefulness of the product(s), as some characteristics may be viewed as strengths or opportunities when pursuing one objective, or as weaknesses or threats when pursuing another. In the INTER-IoT framework, it is understood that the analysis of the market is carried out with the intent to provide INTER-IoT products destined to achieve interoperability of existing IoT solutions.

Figure 46: SWOT analysis scheme

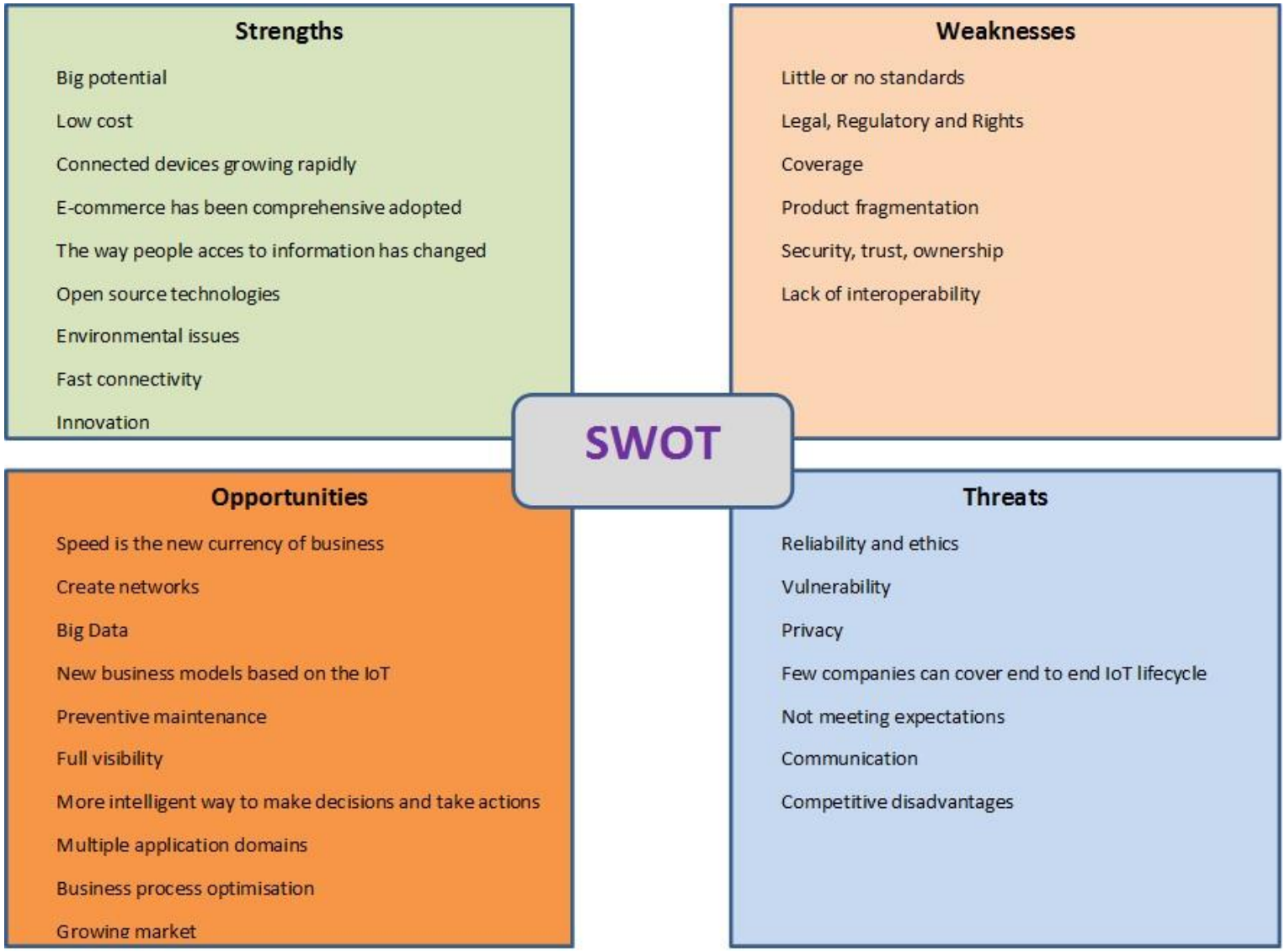

Figure 47: INTER-IoT SWOT analysis

Strengths

- **Big potential:** Using Internet of Things solutions such as the ones provided by the INTER-IoT products has an enourmous potential for those organizations that create value from information. In fact, a new McKinsey Global Institute report estimates that the IoT has a total potential economic impact of $3.9 trillion to $11.1 trillion a year by 2025. Additionaly, the connection of IoT with other current technologies like BigData and 5G will increase the potential for many different application environments. With regard to this, interoperability is the corner stone for the spread of IoT.
- **Low cost:** The use of IoT instead of current procedures can automate business processes to eliminate manual interventions, improve quality, and lower costs. Reduction in the cost of hardware devices, and the introduction of virtual cloud based platforms and also the economy of scale, will reduce the cost of deploying and exploiting IoT. Interoperability mechanisms will eliminate duplicities and may reduce of this deployment.
- **Connected devices growing rapidly:** According to industry forecasts, the number of networked devices overtook the global population in 2011 and will reach 50 billion by 2020 (Ericsson's prediction, dating from 2010). Therefore, INTER-IoT products could be used for allowing these devices to talk to each other, and through interoperability at any layer, allow roaming, secure transfer of information and avoidance of duplicities.
- **E-commerce has been comprehensive adopted:** as the consumer market becomes more digitalised and the e-commerce is forecast to continue to grow fast, the IoT can play a vital role in reshaping the way how goods and services are consumed in the future. As an example, with IoT, a smart phone application can recommend where you buy your gas, by understanding your drive journey, availability of gas stations, pricing on-demand discounts, and gas station commission. IoT can transform e-commerce from awareness, to intent, to purchase.
- **The way people acces to information has changed:** the use of mobile devices for accessing information is growing at very high pace. An explosion of mobile data traffic is expected in the coming years and, therefore, the use of IoT to give specific access to mobile users is expected to be imperative. Usability of information and integration of several devices in a single application (e.g. weather sensors integrated with travel information applications) provide a new and more efficient access and distribution of information. INTER-IoT aims to provide this usability in order to create a development ecosystem around it.
- **Open source technologies:** open source technologies such as the ones developed by Google, Facebook and Amazon is also playing a role in wider adoption of IoT. Now people can build devices and applications that can work across a wider range of vendors. The INTER-IoT products, as open source solutions, are expected to have a very good acceptance, at the same time INTER-IoT products will integrate and interoperate with other open platforms and also with legacy systems. Participation in open source initiatives and communities will be a strength for INTER-IoT.

- **Environmental issues:** the Internet of Things can make our world a greener place. Environmental sensors can detect pollution, smart thermostats can help us save money on our electric bills and agriculture technologies based on IoT can save water by giving exactly the amount they need and no more. Interoperability amongst IoT platforms may reduce extra deployments and through this reduction in the number of sensors performing the same activity and measuring the same values, this will lead to less electricity consumption as a whole. At the same time the three proposed use cases in the INTER-IoT project include environmental KPIs mainly addressed to reduce CO2 emisions, in transport and logistics or in smart e-health environments reducing the traveling times to the health centers. Other application domains could be benefited from interoperability and benefits can be associated to environmental issues.
- **Fast connectivity:** one of the most important strengths of the IoT is the instantaneous connection that it allows. The INTER-IoT project covers interoperability and connectivity at different layers from device to data and services, provided by INTER-LAYER product. Fast connectivity includes security and device discovery both provided by INTER-IoT.
- **Innovation:** the development of the INTER-IoT products essentially consists in developing innovative solutions making IoT evermore interoperable. In this sense, it is an innovation well in line with the current market trend to constantly innovate in order to allow for new business services, new management capabilities, new process tools etc. Innovation is coated with a positive value making INTER-IoT solutions most welcome.
- **Public interest:** There is a clear need, not only from industry operators, but also from public authorities (EU Commission) and users/customers to address the growing number of IoT devices and solutions in an optimised way. Any endeavour to support the interconnection of IoT solutions is welcome in a favourable way by the general public as it is viewed as way of expanding the technological capabilities of the interconnected world everyone has grown fond of. In this sense INTER-IoT will be introducing its products with a favourable eye.
- **Cost reduction:** Stakeholders view the INTER-IoT products as enabling greater efficiency in regular work processes, as the interoperability aimed at by INTER-IoT also leads to implementing these processes or delivering services in a smarter and faster way by processing data from fragmented sources without necessarily having to acquire additional costly IoT solutions in order to access the needed data.
- **Domain applications:** the market analysis has revealed the tendency of many IoT solutions to cluster around specific domain applications. Such is the case for port logistics-related IoT products and for those related to healthcare for instance. Although other specific domain applications were not in the scope of this analysis, it appears safe to assume that economic domains generally tend to “attract” sets of dedicated IoT applications. This strengthens the INTER-IoT approach by confirming the

appropriateness of developing domain-specific applications and developing cross-domain interoperability.

Weaknesses

- **Little or no standards:** a fragmented environment of proprietary stand-alone systems hinders the communication among objects. There is no reference standard for IoT platform technology and we do not foresee one in the near future. INTER-IoT will provide tools, methods, libraries and mechanisms in order to solve the proliferation of standards. INTER-IoT will need to cope with all the new standards appearing and at the same time keep operativity. Industrial and academical interest will exist during the lifetime of the project and will influence the market and developments. INTER-IoT will depend but will have to influence somehow existing and new standards.
- **Legal, Regulatory and Rights:** the use of IoT devices raises many new regulatory and legal questions as well as amplifies existing legal issues around the Internet. The questions are wide in scope, and the rapid rate of change in IoT technology frequently outpaces the ability of the associated policy, legal, and regulatory structures to adapt. Depending on the application domains privacy legislation and regulation may require extra development and configuration activity. The country of deployment will have to be considered, so extendability of the solution depending on the country will have to be considered. Interoperability in terms of virtualization, data transfer through non-trusted networks and countries will have to be considered. And additionally in the future new regulations and legal aspects related with IoT interoperability will come out.
- **Coverage:** The knowledge provided by the stakeholders has allowed us to realise that networks that were designed from the ground up for IoT don't yet provide enough coverage. Additionally, mobile and satellite networks have great coverage, but they weren't designed for the IoT. Thus, communication issues, despite major efforts from different entities (e.g SIGFOX), telecom operators or even research projects (e.g. 5G programme) will always face the problem of scalability and coverage of wireless access. Not having a device, smart object or platform connected reduce the availability of data and globally the IoT. INTER-IoT faces the same problem, but allowing at D2D and N2N layers different protocols and standars may reduce the weakness.
- **Product fragmentation:** the main weakness of the studied market that has redundantly been confirmed through all partner investigations on existing products is that of fragmentation. There is a wide variety of products available on the market and the supply of these products originates from a wide variety of actors. Moreover, these products cover different technology sectors associated with the IoT industry. As a result, the interoperability feature that has been set as a fundamental goal for the INTER-IoT products will be harder – though not impossible – to reach as this heterogeneity will force us to focus the specific interoperable features to be developed

by re-using existing technology rather than trying to develop new IoT features starting from scratch. This weakness is partially related to the existence of different standards and industrial groups pressing to use their products.

- **Security, trust & ownership:** contacts with stakeholders combined with the analysis of products show that the fragmentation of the market is made even more complex by the level of openness of existing products. Interoperability will overcome the proprietary barrier of certain existing solutions and has the potential to put the data and information accessed at risk. The risk burdens weights not only on industry operators who voice concerns over competition settings but may also affect ordinary citizens when sensitive information such as health data becomes accessible. In other words, making IoT interoperable also generates a new challenge of security that necessarily needs to be tackled by INTER-IoT outputs in view of successful marketing.

Opportunities

- **Speed is the new currency of business:** the importance of speed in productivity challenge organisations to adopt IoT as a solution for their needs. Using INTER-IoT products to create a network of physical things that are connected to the Internet could allow automation, improved productivity, reduced downtime and enhanced knowledge. At the same time context-aware virtualization of things in the cloud, may allow better and faster transfer of objects, and depending on the situation more calculation and execution power.
- **Create networks:** the Internet of Things is a good opportunity for different firms to join forces with hardware, networking, and software companies, and with a number of industry associations and academic consortiums, to develop synergetic solutions for Internet of Things. INTER-IoT consortium is a good example of these opportunities derived from the Internet of Things. Interoperability between platforms, multihoming, secure network transfer and resources discovery that will be services included within INTER-IoT will allow to create new networks and extend the development ecosystem.
- **Big Data:** the concepts of Big Data and IoT are converging. With the Internet of Things a whole new world of intelligent equipment has been opened and, as more devices generate more information, its analysis through Big Data applications is enabling several companies to improve their services and increase efficiency which leads to higher productivity and, in turn, lower costs for its customers.
- **Preventive maintenance:** Using IoT solutions could allow maintenance managers to monitor machinery and equipment more closely with less effort by compiling all data in one easy place. The INTER-IoT solutions pretend to make the world smarter and safer through better reporting and data collection. One of the needs highlighted by the stakeholders in the analysis is the deployment of management tools to configure the interoperability platform. At the same time INTER-IoT will include self-* features in order to

- **New business models based on the IoT:** In a connected world, products are no longer the most important thing to be sold. Companies could obtain more benefits by selling new features and functionality to the customer on a regular basis. The INTER-IoT Project will show in D2.2 deliverable how IoT is changing traditional business models. IoT and other new vibrant environments like Future Internet will bring new business models to deal with devices, interoperability, data, security, new applications and services,…
- **Full visibility:** one area that will play a prominent role in the future supply chain is in its wider and deeper visibility. The IoT enable locating, monitoring, and handling different transport and cargo equipment in real time. As an example from INTER-IoT INTER-LogP product could help logistic companies to obtain full visibility of their cargo and equipment. However full visibility os extendable to other application domains, like Smart cities, e-health even defence and security.
- **More intelligent way to make decisions and take actions:** the Internet of Things allow companies to obtain massive data over time. Once this data is converted into valuable knowledge and useful insight, firms can make things better, improve their decision-making and improve their service quality. For a correct situational awareness events, data from sensors and adequate correlation using Big Data techniques or complex event processing may support the decision making process.
- **Multiple application domains:** the interoperability provided by the INTER-IoT solutions can be applied to many different applications domains (health, logistics, cities, transportation, agriculture, retail, home, energy, etc.). INTER-IoT will be application domain agnostic, although during the validation and evaluation phases of the project two application domainshave been chosen. On the other hand, cross-domain environments like the one proposed provide an opportunity to merge different IoT platforms and allow them to interoperate.
- **Business process optimisation:** according to our investigations, the use given by stakeholders to the IoT solutions they resort to, the growing IoT economy has been successful primarily because it enhances business processes and enables service providers to offer new or better features for which there is a demand. If isolated IoT solutions have had the market success the variety of existing IoT products point to, one can only deduce that making these products interoperable can only be as successfully acclaimed by the demand side of the market, thus promising a positive environment for the INTER-IoT outcomes.
- **Growing market:** the market analysis shows that IoT solution developers, manufacturers and providers are always marketing an increasing number of products for which stakeholders' needs show that the demand will not stop growing until these needs are all satisfied. By proposing interoperable solutions that will precisely enable many of these needs to be met, cost-effectively and often seamlessly, INTER-IoT will be introducing its products in a competitive market where demand is on a rise.

- **Investment opportunities:** the EU Commission funding the INTER-IoT project is a clear indicator enhancing IoT interoperability is a worthwhile investment. The wide variety of products also show tremendous levels of investments have been devoted to developing an IoT economy. In light of these two facts, it is logical that developing products that will provide cost-effective and process enhancing IoT interoperability will likely spur new investments to help service the application of INTER-IoT products into existing frameworks. Additionally, different investment funds consider IoT and interoperability as one promising area for the next years together with other technologies that could interact.
- **Cross-area deployments:** use of information between different application domains, e.g. weather and logistics in order to select the most adequate transport mean in inter-modality and syncro-modality transportation models; using the power of big-data and IoT information sources is a clear opportunity foreseen by the stakeholders that open new business and service development opportunities. An example is the potential integration of INTER-Health and/or INTER-LogP with the new platforms coming from the open call to develop the cross-domain scenarios.

Threats

- **Reliability and ethics:** one major concern with IoT is public trust in the solutions that IoT products could provide. The IoT adoption will require a new level of trust among partners that will be key for the successfull implementation of the INTER-IoT solutions. The INTER-IoT Project, aware of this reality, will evaluate if the platform fully respects ethical, societal, gender and legal aspects. Additionally, trust between platforms in terms of interoperability is a major issue that may reduce interest interoperability, e.g. pollution and contamination measuring application using IoT platforms of different industrial areas owned by different stakeholders, if measured data is not good the operator of the platform may avoid to provide real-time data to other stakeholders.
- **Vulnerability:** IoT users could be seriously hurt if vulnerable devices are sold in the market. The INTER-IoT Project will ensure that security is included by design in the whole framework and at every layer. Cyber security and protection of infrastructures like IoT platforms will be a major issue relaed with interoperability and connectivity of IoT platforms to the Internet. Stakeholders, operators and interoperability providers (i.e. INTER-IoT) have to consider security by design in every deployment.
- **Privacy:** Internet of Things privacy is one of the major fears that could slow down the adoption of IoT solutions. Being able to protect sensitive information of individuals from exposure is key to deploy INTER-IoT products. Different application domains may have different privacy requirements, but despite open data philosophy some data will remain private (e.g. people positioning or sensitive medical data).
- **Few companies can cover end to end IoT lifecycle:** some of the analysed stakeholders indicate that not every company addresses and covers the whole IoT lifecycle. Some companies are focused on hardware, on services or in infrastructure provision. This

indicate that interoperability and SLA agreements between entities is a must. The weakness is related with the difficulties in arriving to such agreements, that could block interoperability and secure access to data and platforms.

- **Not meeting expectations:** some of the needs expressed by stakeholders do not directly match the interoperability objective of INTER-IoT, as they are more focused on IoT features (e.g. support push notifications, minimize sensor transmissions etc.). This hints to the fact the IoT market is yearning for many innovative evolutions of different nature, without necessarily having hierarchized the awaited new products. INTER-IoT will thus be developing products addressing specific issues (interoperability) but in a market context where expectations are high and broad.
- **Communication:** the necessity to address market expectations places a heavy burden on the communication and dissemination challenges of the INTER-IoT project as will be critical to raise awareness on the exact scope of benefits provided by project products and if possible enable stakeholders to measure relative importance of interoperability with other expected IoT improvements that are not in the scope of INTER-IoT
- **Competitive disadvantages:** the strengths (cost efficiency) of the IoT market somewhat bear their threatening counter-part. If there is a demand for the INTER-IoT products with the view of benefitting from the underlying cost-efficiency, service enhancement and process optimisation, there is a risk that not appropriately addressing some of the stakeholders' concerns may lead to competitive drawbacks. Such would be the case if security and trust issues are not addressed as expected. The market is sustained by the willingness to continuously maintain and –whenever possible- extend industry stakeholders' competitive edge. Fears exist that achieving interoperability may lead to competitors accessing economically strategic information. INTER-IoT will hence be introducing its products in market characterised by a strong willingness to make IoT solutions interoperable but not transparent.

5 CONCLUSIONS

The stakeholder and market analysis contained in this report has targeted a large variety of stakeholders and products. The stakeholders identified cover different classes (public stakeholders, software engineers, technological experts, customers, etc.) as well as different technology sectors (software developers, integrators, hardware manufacturers, application domains users etc.) and the products listed reveal a very fragmented market in which many different products and systems, with different levels of openness, that show often overlapping features and are available from many different actors.

This fragmentation of the market, combined with the needs expressed by stakeholders when interviewed confirms on the fundamental goals of the INTER-IoT project that is the interoperability of different IoT objects, platforms, systems etc. Interoperability is well understood as a characteristic that not only enhances the efficiency of IoT in the first place, but can also help providing some added value on existing systems by overcoming current existing communication gaps between industries, linked stakeholders and processes.

Among the interoperability features INTER-IoT will have to tackle, one chief dimension has emerged as being critical: that of developing a semantic interoperability so as to facilitate IoT integration and allowing for information and data re-use in various IoT ecosystems. Such semantic interoperability is considered as critical feature due to the current fragmentation of IoT products – and its prolific and continuous growth – make it impossible to develop all-embracing IoT solutions and inevitably lead INTER-IoT partners to consider reusing existing technologies rather than developing new ones.

One major issue all INTER-IoT products will need to address is related to security and trust. Stakeholders, though they welcome the interoperable potential of INTER-IoT, clearly express fear over the risk proprietary and/or sensitive data interoperability – with regard to competitive risk at stake and the sensitivity of the personal data health-related products bear – may expose them to. It will be therefore important for INTER-IoT outcomes to specifically integrate security challenges while, in addition, to clearly communicate toward all categories of stakeholders with the objective, explaining how INTER-IoT solutions will allow facilitating interoperability without jeopardizing the security of business and personal data exchanges.

The market analysis and review of stakeholders also provide justification to the future testing phase of INTER-IoT, as in both INTER-LogP and INTER-Health areas, all across the respective domain industry chains, stakeholders are ready for testing new IoT paradigms and expect from them to overcome current process inefficiencies, communication gaps and to help producing added value. The use of the different products may allow the generation of an ecosystem of entities using INTER-IoT and extending the value generated within the project. Additionally, the interaction with other projects of the same H2020 call (H20202-ICT30-2015) through IoT-EPI; previous IoT projects through AIOTI and IERC; and other international projects (e.g. USA, Japan, Korea or Brazil) will improve possibilities of having a clearer landscape of the market and related stakeholders.

The market analysis has provided some interesting outcomes in associating IoT initiatives and mainly interoperability with other current technological programs and developments like Big Data or 5G. The first one requires interoperability in order to have more data sources available at the service layer, and the second one will be considered in INTER-LAYER as a component for interoperability. Advances in IoT will come together with these and other technological areas so a clear dependency exists.

The information analysis from stakeholders and producst will play a major role in the requirements process as they will be inputs specified directly from stakeholders and the market itself. The different needs will be grouped and indicate the main services and components to be developed in WP3, WP4 and WP5. And in a later stage be considered during the evaluation phase. The stakeholders and products will be updated during the whole life of the project, this is the reason of selecting JIRA as a tool to manage WP2 process and keep the information generated by the partners during the execution of T2.1 and WP2 as a whole.

To conclude, there is clearly a demand in the market for the interoperable solutions INTER-IoT intends on producing. Partners have now a clearer understanding of the market configuration as well as of the contents and expectations of stakeholders. By associating these stakeholders to project developments, through continuous dissemination of project evolution, by tackling the challenges identified in this market evolution and by demonstrating the convergence of INTER-IoT solutions with stakeholder expectations – especially with regard to overcoming the risks they fear- the INTER-LAYER, INTER-FW, INTER-METH, INTER-logP and INTER-Health products will likely be successful in the market.