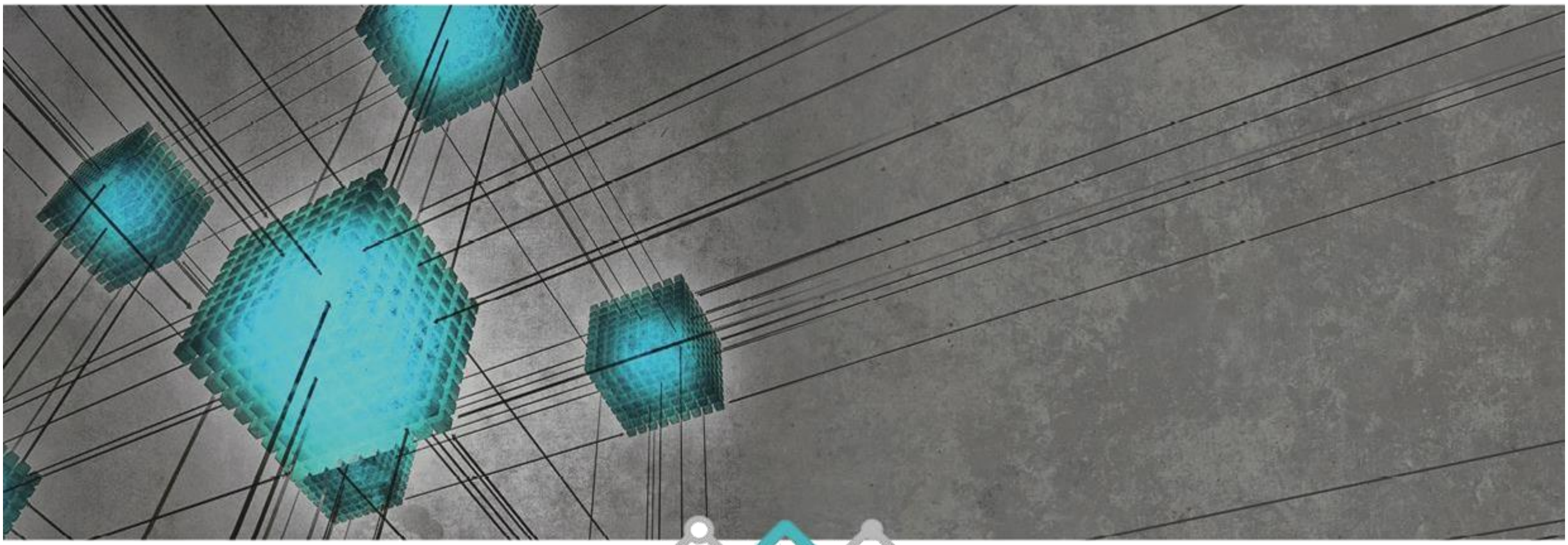

interiot

INTEROPERABILITY
OF HETEREOGENEUS
IOT PLATFORMS.

D2.4

Use cases manual

December 2016

INTER-IoT

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

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

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

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

interiot

INTER-IoT

Use cases manual

Version: Final

Security: Public

December 26. 2016

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

Disclaimer

Executive Summary

This deliverable presents the work carried out regarding business scenarios and use cases considered in the INTER-IoT project. It comprises the different stakeholder's goals and the interactions of the components considered for an interoperability of heterogeneous platforms. This deliverable is the result of the activity developed on the task 2.4 "Use Cases and Scenarios definition".

Business scenarios or scenario for short, describes a real-world example of how one or more people or organizations interact with a system. They describe the steps, events, and/or actions which occur during the interaction. On the other hand, the term **use case** is a way to describe an interaction between a system and a user of that system.

Based on these definitions, we have conducted a work to identify first a set of business scenarios related with the application domains considered in the project (transportation, mobile health and cross domain). These business scenarios have been afterwards decomposed in different use cases. As a result of this exercise, we have identified several commonalities for the interoperability of heterogeneous IoT platforms in those business applications that are based on the mobility of physical entities. The characterisation of use cases has helped us to better address the requirements of the different components of the project: INTER-METH, INTER-LAYER and INTER-FW.

For each business scenario, it has been analysed and described the interoperability role (in term of main possible system/services involved and interoperability requirements for the different layers: Data & Semantics, Application Services, Middleware, Networking, and Device).

A further level of analysis was performed for each scenario detailing the description of the business scenarios by means of use case diagrams. Use case diagrams represent basic interoperability functions extracted from each scenario. In addition to the initial work carried out on the technical packages, it has been identified and analysed more use cases that are going to be needed in the scope of the project.

The iterative analysis performed on the real business scenarios in specific application domains has come to identify the integration and interoperability scenarios that can be generalized and used to design the INTER-LAYER, INTER-FW and INTER-METH products. On the basis of this result some general use cases description for the INTER-FW, INTER-LAYER and INTER-METH products were defined.

The approach followed for the definition and description of the business scenarios and use cases is based on the VOLERE methodology.

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Change control datasheet

Version	Changes	Chapters	Pages
0.1	Creation, index and introduction	All	16
0.2	Methodology	2	25
0.3	Business scenarios analysis	3	66
0.4	Use case diagrams	4	88
0.5	Use cases analysis	5	115
0.6	Conclusions	6	117
1.0	Final version	All	118
1.1	Internal review 1	All	118
1.2	Internal review 2	All	118
1.3	Final version to upload	All	123

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Acronyms

AIOTI	Alliance for Internet of Things Innovation
BIP	Best Ideas and Projects
EC	European Commission
IERC	European Research Cluster on the Internet of Things
INTER-LAYER	INTER-IoT Layer integration tools
INTER-FW	INTER-IoT Interoperable IoT Framework
INTER-METH	INTER-IoT Engineering Methodology
INTER-LogP	INTER-IoT Platform for Transport and Logistics
INTER-Health	INTER-IoT Platform for Health monitoring
INTER-META-ARCH	INTER-IoT Architectural meta-model for IoT interoperable platforms
INTER-META-DATA	INTER-IoT Metadata-model for IoT interoperable semantics
INTER-API	INTER-IoT Programming library
INTER-CASE	INTER-IoT Computer Aided Software Engineering tool for integration
IoT	Internet of Things
ITU	International Communications Union
SOLAS	Safety Of Life At Sea
PCS	Port Community System
PMIS	Project Management Information System
SEAMS	Smart Energy-efficient and Adaptive Management System
TOS	Terminal Operating System
SCADA	Supervisory Control And Data Acquisition
API	Application Programming Interface
HMI	Human Machine Interface
IDE	Integrated Development Environment
ECG	Electrocardiography
SPO2	Blood oxygen saturation level
ACL	Access Control List
GSM	Global System for Mobile communications
Port CDM	Port Collaborative Decision Making

1 Introduction

1.1 Internet of Things

The connection of intelligent devices, equipped with a growing number of electronic sensors and/or actuators, via the Internet, is known as the ‘Internet of Things’ (IoT). With the IoT, every physical and virtual object can be 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. All of them seamlessly integrated into the information network.

The design of the Internet and specifically the extension of the Internet to the IoT, rely 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. 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 overlay associations between smart connected objects (physical and virtual), that are able to exchange information by using an agreed method (including protocols) and a data scheme. IoT deployments are increasing, the same applies to standards, alliances and interest for homogenization. All of this is giving a strong push to the IoT domain to be 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 sensor networks to a most clear description and definition referring to objects and the virtual representations of these objects on the Internet and associated infrastructures. It defines how the physical things and virtual objects will be connected through the Internet and their interaction. And how they communicate with other systems and platforms, in order to expose their capabilities and functionalities in terms of services and accessibility through open APIs and frameworks. IoT is not only linking connected devices through 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.

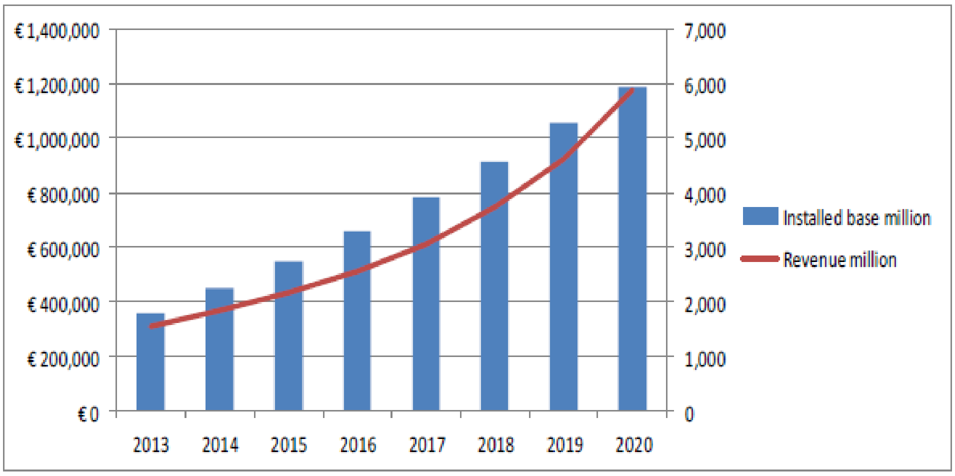

Figure 1: IoT Installed Base and Revenues in EU 28 2013-2018

There are several challenges associated with IoT and its evolution, but one major issue is related with interoperability. 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 further 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 the development of 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 overcome. The 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 and user dissatisfaction. Current research in IoT is focused on providing integrated solutions and primarily on the feature that enables convergence or what is known 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 utmost importance.

Interoperability can be generalized as the feature for providing seamless exchange of information to, for example, customize services automatically or simply exchanging information in a way that other systems can use it for improving performance, enabling and creating services, controlling operations and processing information. 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. Ensuring 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 Centre 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 APIs 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 relies 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 by the stakeholders.

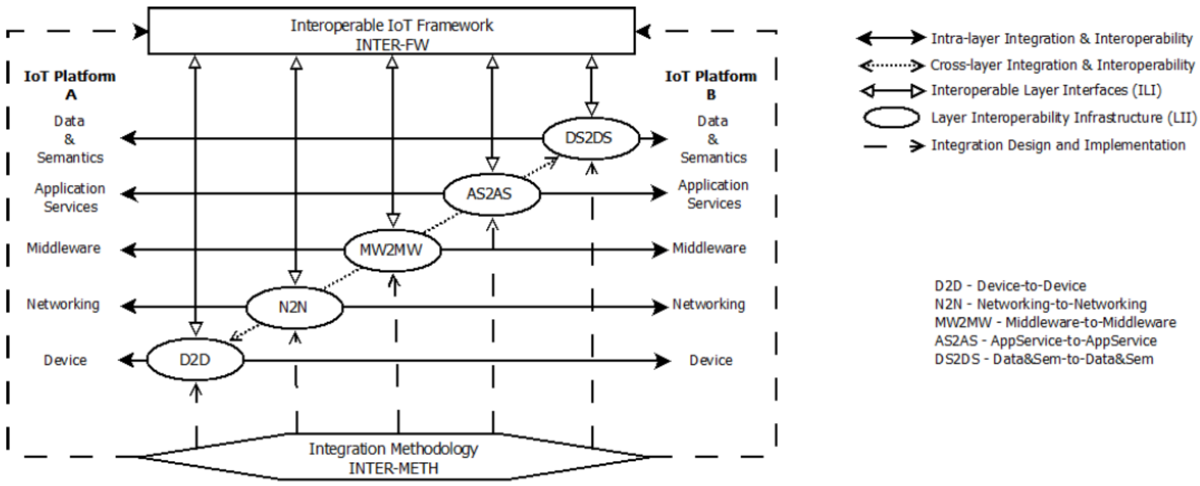

Figure 2: INTER-IoT approach abstract schema

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 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 allowing global-level management of the integrated IoT platforms.

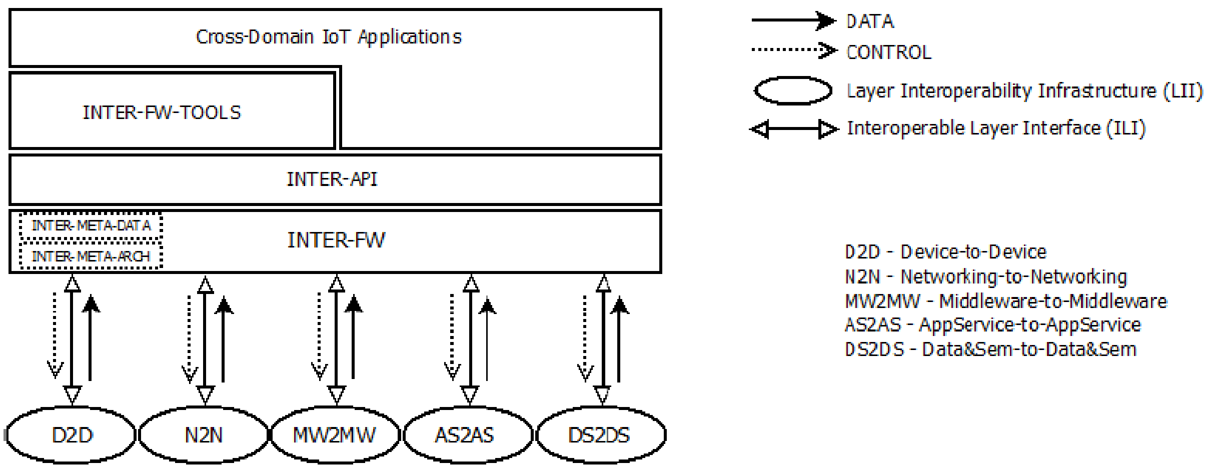

Figure 3: Abstract schema of the INTER-FW

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 and trust. In particular, INTER-FW will thoroughly address privacy and security-related risks and challenges resulting from the 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 so allowing implementation and deployment of IoT applications at the 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 is supported by a Computer Aided Software Engineering (CASE) tool for driving IoT platforms/systems 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 centre 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.

1.4 Scope of the document

The objective of the document is to introduce a set of business scenarios and use cases to attend the needs of different stakeholders and the interactions required by the different components of INTER-IoT that will be developed in the scope of the project.

Business scenarios have initially been focused in two domains: Transport & Logistics and m-Health, highlighting those scenarios that require the connection of different IoT platforms and services, and that can be used both as examples for the preparation of requirements and test beds for the project achievements.

Each business scenario is composed of several use cases that define the usage of the main components of the INTER-IoT system. Use cases are analysed and related with the requirements gathered earlier from stakeholders and partner's expertise, and they have also been used to focus and enhance the description of these requirements.

The document is organized as follows:

- Chapter 1 introduces the project and the environment in which it is developed. This is a common introduction included in every WP2 deliverable so the reader is able to understand the objectives and scope of the project without any previous knowledge. One of the goals the consortium has with the deliverable is that they are self-contained.
- Chapter 2 describes the methodology used to characterise business scenarios and use cases. This chapter includes the templates and the ways to describe and represent business scenarios and use cases. Both scenarios and use cases are stored in Jira, a repository for easy consultation and refinement on a collaborative environment.
- Chapter 3 presents the Business scenarios highlighting the requirements on interoperability.
- Chapter 4 includes the use case diagrams and how they are related in the different business scenarios, detailing the main actors and systems involved.
- Chapter 5 describes in detail each of the use cases identified in the previous chapter. Moreover some general use cases useful to detail interoperability aspects and not tied to a particular domain are presented.
- In Chapter 6 are reported the conclusions of the business scenarios and use cases.

The deliverable includes an appendix that contains the complete description of the business scenarios and use cases.

2 Methodology

The description of business scenarios and use cases has followed the Volere[1] methodology with the objective to examine how real-world examples would interact with the project products. This methodology has already been used to represent the requirements.

Particular emphasis has been placed on interoperability issues arising in the business scenarios of the application domains (INTER-LogP to INTER-Health) where different platforms / components have to interact.

2.1 Business Scenarios and Uses Cases

The Business Scenario tells the story of a set of business use cases. The scenario is a neutral medium, both simple and understandable, to describe how a system is to be used.

A scenario helps to reach an agreement on what to do. Once such agreement is achieved, the subsequent key question is how the product shall be designed to cover the different scenarios. This second aspect is dealt by the use cases.

Scenarios are used by analysts to describe and present business processes and present their understanding of the required functionality. Once scenarios are agreed with stakeholders, they become the foundation for the requirements.

A scenario describes a real-world example on how one or more people or organizations interact with a system. They describe the steps, events, and/or actions which occur during the interaction. Scenarios can be very detailed, indicating exactly how someone works with a user interface, or they can be reasonably high-level descriptions, showing critical business actions but not indicating how they are exactly carried out. Scenarios are applied in several development processes, often in different ways. In derivatives of the Unified Process (UP) they are useful to derive sequence diagrams.[2]

On the other hand, the term use case was coined by Ivar Jacobson back in 1987 as a way to describe an interaction between a system and a user of that system. Jacobson needed to break the system into smaller units, as he felt that object models were not scalable. Thus, to conquer the complexity and largeness of modern systems, he said it was first necessary to partition them into convenient chunks, and that these chunks should be based on the user's view of the system.[3]

Based on these definitions, the methodology agreed on this task has consisted in identifying first a set of business scenarios related with the application domains considered in the project (transportation, m-health and cross domain) and to decompose afterwards these scenarios in different use cases. As a result of this exercise, we have identified several commonalities for the interoperability of heterogeneous IoT platforms in those applications based on the mobility of physical entities. The characterisation of use cases has helped us to better address the requirements of different components of the project: INTER-METH, INTER-LAYER and INTER-FW.

[1] Volere Web Page. [Online] http://www.volere.co.uk/

[2] Agile Modelling (AM) Home Page. [Online] http://agilemodeling.com

[3] Robertson S. Robertson J. Mastering the Requirements Process. S.l.: Addison Wesley, 2013

2.1.1 Business Scenarios description

Business scenarios have been described as in the template shown in Table 1. All the scenarios compiled have been written as a history observed by an external viewer. These scenarios describe what would be the interoperability of IoT platforms in specific situations and what would be the flow of events, the actors involved and the main interactions.

Table 1. Business Scenarios template

Business Scenario		
Scenario ID ***#1***	**Scenario Name** *Self-explanatory. Choose short, catching title*	
Illustration of system's behaviour in a specific situation, flow of events	*Write here the scenario: description of users' interaction with a system in users' perspective, covering a short story of an individual user(s), interacting with a system, to achieve a specific outcome, under specific circumstances over a certain time interval. Check that the scenario covers at least the following elements.*	
	User/users:	*What are the characteristics of the user(s)? (e.g. age, gender, education, technical skills) Are they producer or consumer with respect to the system/service?*
	Setting / context	*What is the physical environment? (e.g. place, location, other persons involved).*
	Interacting system	*Give an overview of the technical environment if possible. (e.g. devices and network, services and platform, etc.)*
	Users' goals	*What the user(s) wants to achieve?*
	Interaction	*How the user(s) interacts with the system? (in addition a schematics of the interacting system, if relevant, could be helpful)*
	Initial status	*What is the initial condition of the interacting system or initial situation of the actors?*
	Data	*Which are the information (data) produced and /or consumed?*
	Motivation	*Why to choose the particular way to act?*
	Time	*When? How long? At what frequency?*
Interoperability Role	**General description**: *Short description of the interoperability scenario that enables the required functionalities in the business scenario shown above starting from at least one platform or existing service* **Interoperability requirements**: *description of requirements for each layer involved by the integration* Data & Semantics: Application Services: Middleware:	

	Networking: Device:		
Market and usage data available	*If you own or know any market research studies related to the scenario, please, mention the source and tell if the source is available to the consortium.*		
Business model	*Indicate what are the potential business model*		
Missing technical know how / input	*If you lack some technical knowledge / know how which could be received from other international partners in the project, please, specify.*		
Partner specific interests	*Please, enumerate the aspects you intend to contribute / develop in the project.* *You can also underline in the text of the scenario description above, the aspects you are interested in.*		
Product: *INTER-LogP, INTER-Health*	**Identified by:** *Partner who has identified the requirement*	**Registration Date:** *Date of registration* *Date of update*	

2.1.2 Use Cases description

To describe a use case the “use cases diagrams” and the “description template” are used. A use case diagram is a diagram that shows the relationships among actors and use cases within a system. The use case diagram is a tool to give a preliminary overview of the functionality that the system should have, and discover the various actors involved. The initial results of this analysis leads to the definition of Actors and Use Cases that describe the high-level functional requirements of a business scenario in general terms. This information brings the limits and purposes of the system to be developed.

The full functionality of the system is represented by the set of all use cases. In each use case a specific functionality over the system or its service is presented. In the graphic representation, a symbol is used especially for an actor (e.g. a user or another system). An actor is the entity that interacts with a use case by starting the sequence of actions described by the use case itself and, possibly, receiving precise answers from the system.

The sequence of events described in each use case is started by a person, by another system, by a hardware or even by the passage of time. Graphically a use case is drawn as a horizontal ellipse and actors are typically drawn as stick figures. The actor that begins the sequence of the events of a use-case is inserted to the left of the use case while, on the contrary, the actor that receives the effects caused by the sequence triggered by the use case itself, is drawn to the right.

Figure 4: Generic use case diagram

The name of the actor appears just below the picture of the same actor, while the name of the use case appears inside the ellipse (or just below it). An association between an actor and a use case representing a communication between actor and use case is drawn as a line connecting the two modelling elements. The name of a Use Case is a sentence with the verb in active form.

Use cases can also be re-used, there are four ways of doing it:

- Extension: with this method a new use-case can be created simply by adding steps to an existing use case. A dotted line with arrow end is used to represent the extension, along with a stereotype that shows the word << extend >>.
- Inheritance: a use case can inherit the behaviour and meaning from his father and in addition adds its specific characteristics. The inheritance is represented with a continuous line that has a triangle that points to the father. The relation inheritance can exist also between actors.
- Grouping: in some use case diagram, many use cases can be included and the diagram has to be organised in a better way. Such a situation may occur when a designed system consists of several subsystems. The easiest way is to organize groups of use cases that are somehow related.

Note that:

<< extend >> means a use case that can be performed under certain circumstances the use case to the tip of the arrow.

<<specialize>> means a use case created from the use case to the tip of the arrow.

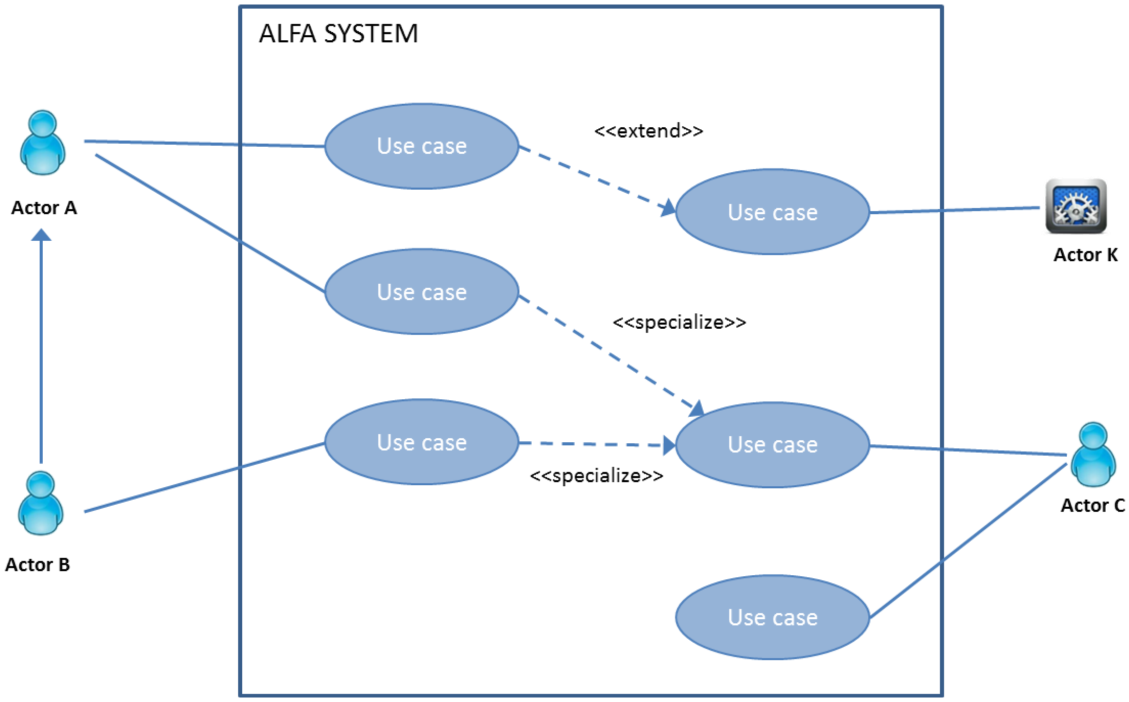

Figure 5: Generic Use Case diagram example

The following template allows to describe the use case and the possible execution scenarios.

Table 2. Use Case template

Use Case		
ID #N	**Name** Self-explanatory. Choose short, catching title	
Description	*Description of the use case (2 lines)*	
Reference Scenario	*Name of the scenarios referred to by the use case*	
Level	*Semantics, Service, Middleware, Network, Device*	
Objectives	*Objectives of the use case*	
Actors (system actor or natural persons)	*Enumerate (primary and secondary) actors/systems involved in the execution of the use case. Primary Actors often coincide with the actors that trigger the execution of the use case or those who benefit directly of the result.*	
Pre-conditions	*What there must be already*	
Trigger	*Which action triggers this use case*	
Expected results	*What the user will see/obtain*	
Design choices	*Optional. Enumerate potential technological approaches and/or methodologies*	
Extends the use case (if applicable)	*Name of the "base" use case that can be extended by this use case*	
Specializes the use case (if applicable)	*Name of the "generic" use case of which this use case is a specialization*	
Notes and issues	*Enumerate aspects to be considered such as special requirements, assumptions or issues.*	
Main execution	*The sequence of actions (steps) that describe the execution of "normal" use case* *1. STEP 1* *2. STEP 2* *3. STEP 3* *4. …*	
Alternative execution (if applicable)	*2.1 STEP 1* *2.2 STEP 2* *2.3 STEP 3* *2.4 …*	
Exceptions (if applicable)	*List of actions of exceptions to the use case.*	
Requirements involved	*List of requirements involved*	
Product: INTER-LogP, INTER-Health	**Identified by:** Partner who has identified the requirement	**Registration Date:** Date of registration Date of update

2.2 JIRA Repository

All scenarios and use cases descriptions are maintained into the Jira Repository (jira.inter-iot.eu). Following the same approach that has been used for the requirements. Using the tool the periodic update and maintenance of the use cases is easily implemented.

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 6 illustrates Inter-IoT Project on JIRA home page.

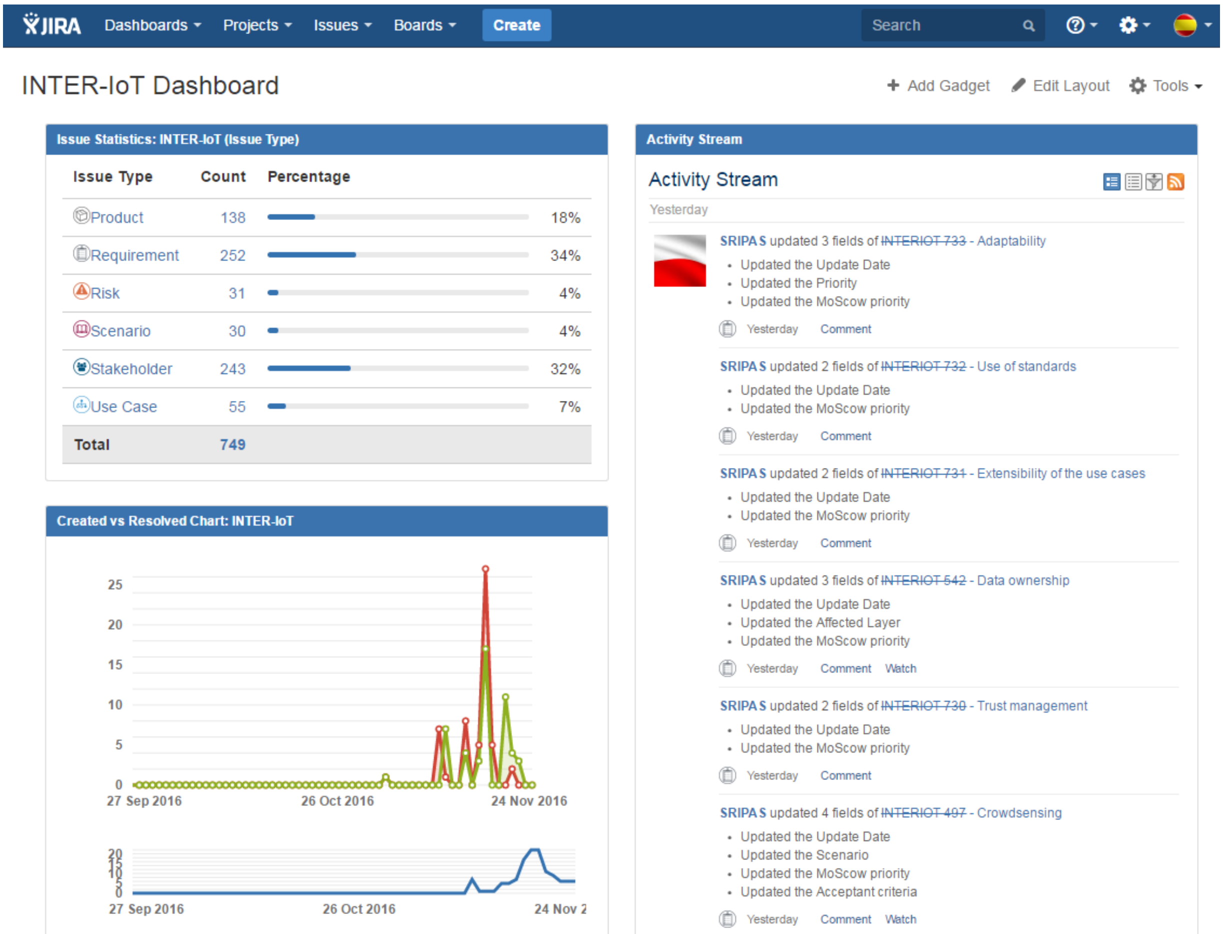

Figure 6: JIRA home page of the INTER-IoT project

Once in the application the user can access all stored information and can filter by type of issue (e.g. stakeholder, product, risk, scenario, requirement, or use case) or by any field or metadata of the form (as shown in Figure 7).

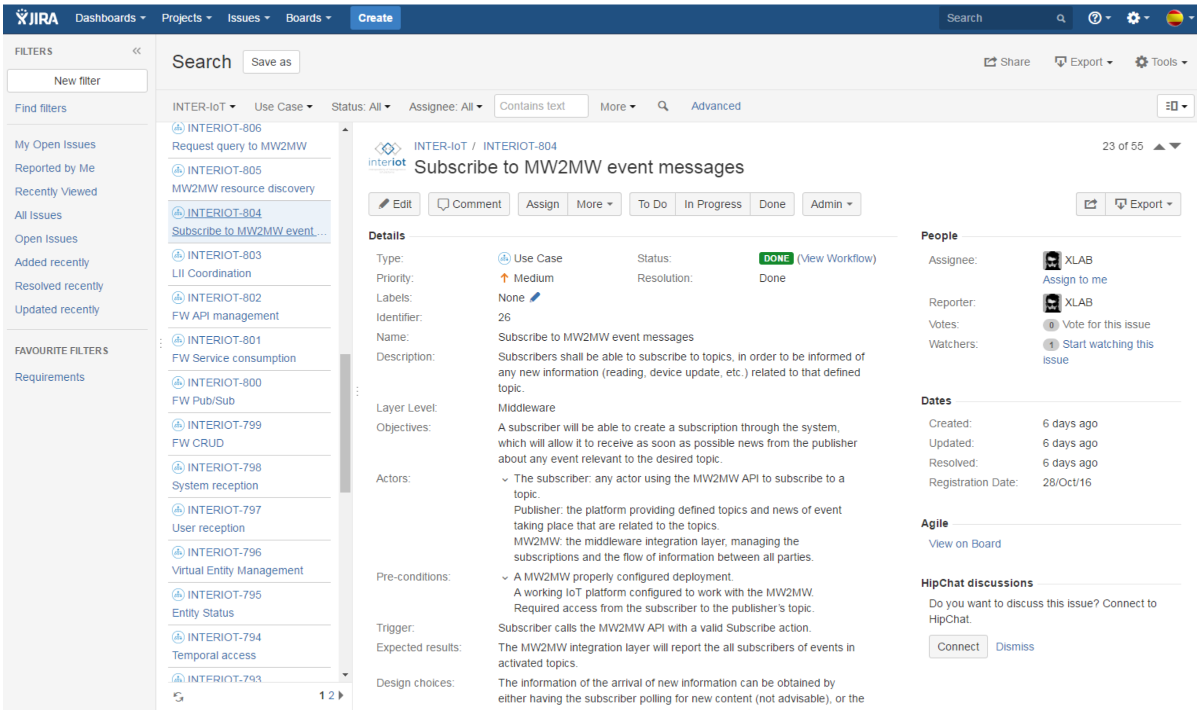

Figure 7: View issues

To create new issues, the user can execute the *create button* option at the top menu as it can be seen in Figure 8. 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 above, following the methodology.

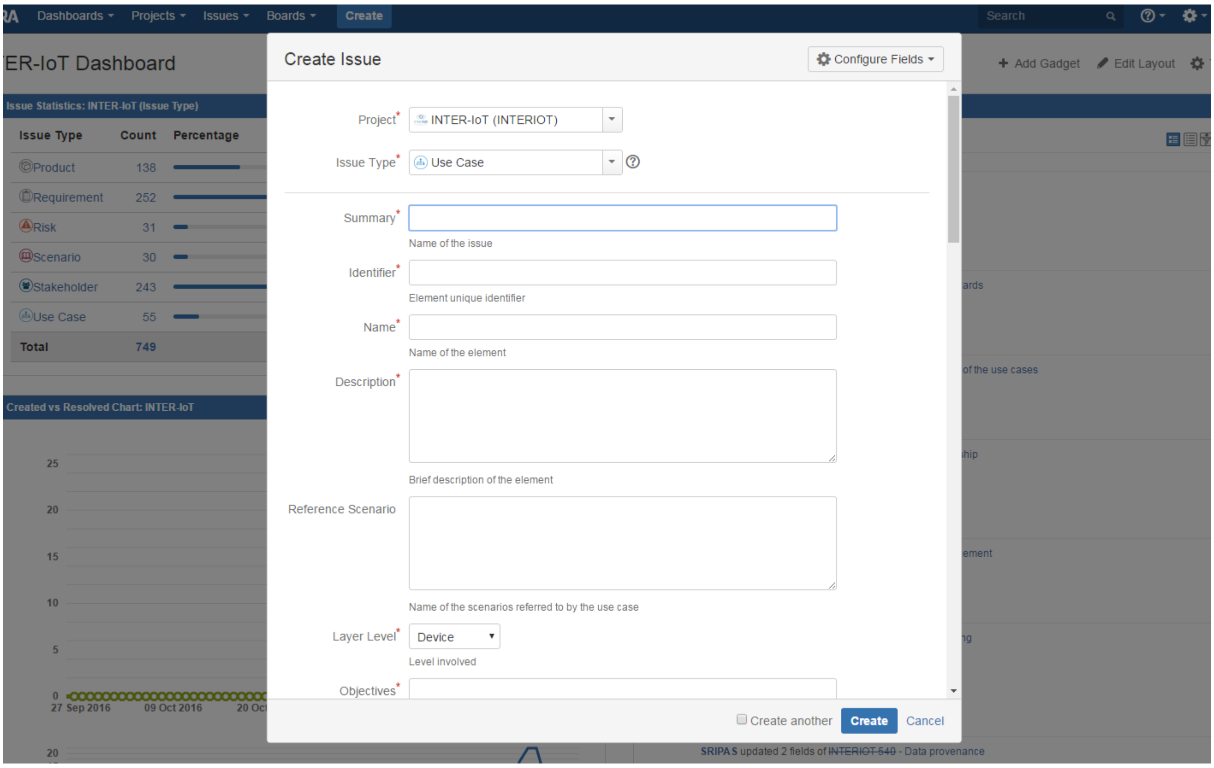

Figure 8: Create new issue

3 Business scenarios

In order to assess the functionality of the INTER-IoT identified products to be designed and implemented, it is necessary to have real scenarios in which to perform tests. This is why this section comprehends different scenarios that have been identified and analysed.

Additionally, for the definition of the final pilots (i.e. activity developed in WP6), several scenarios defined in this section will be selected. The selection of the scenarios to be tested will depend on the feasibility to achieve sound results based on time and resource constraints, and existing environments in the pilot locations.

Once the main technical functionalities of each product have been defined, specific scenarios will be further defined to demonstrate them. These scenarios will be included in the technical deliverables, and will be used to evaluate the performance of the INTER-IoT products in the framework of WP7.

The complete template of each business scenario is on Jira, in order to keep the information updated. The current version of the business scenarios at the time of writing this deliverable is in the Annex document.

The following business scenarios have been identified for the different products:

Table 3. List of Business Scenarios

Id	Scenario name	Product
1	Chronic disease prevention	Health
2	IoT support for transport planning and execution	LogP
3	IoT Weighbridges	LogP
4	Monitoring reefer container	LogP
5	Monitoring of containers carrying sensitive goods	LogP
6	Dynamic lighting in the port	LogP
7	SCADA port sensor system integration with IoT platforms	LogP
8	SEAMS integration with IoT platforms	LogP
9	Accident at the port area	LogP/Health
10	Health monitoring system with passengers aboard a ferry	LogP/Health
11	Primary prevention of cognitive decline	Health
12	Health failure disease and mild Alzheimer disease	Health
13	IoT interoperability for Vessel Arrivals	LogP
15	Surveillance systems for prevention programs	Health
16	Elderly monitoring	Health
17	Health monitoring system with passengers aboard a train	LogP/Health
18	Containership is entering the harbour region	LogP
19	Transport on truck breaks down or is hijacked	LogP
20	Damage or problems to the container during shipment	LogP
21	Low risk of developing chronic diseases.	Health
22	Increased risk of developing chronic diseases	Health
23	High risk of developing chronic diseases	Health

24	Very high risk of developing chronic diseases	Health
25	Extremely high risk of developing chronic diseases	Health
26	Alcohol / Drug testing for truck/ bus drivers	LogP/Health
27	Vitamins intake analyser	Health
28	Calories / nutrition mixer / cookware counter	Health
29	Reliable control of robotic cranes and trucks in port terminals	LogP
30	IoT access control, traffic and operational assistance	LogP

As seen in the figure, there is a well-distributed number of scenarios between the health and port logistics domains. In order to test the interoperability between domains, there are also some scenarios covering both domains. In appendix A, we have included the detailed description of all the scenarios at the time of writing the report.

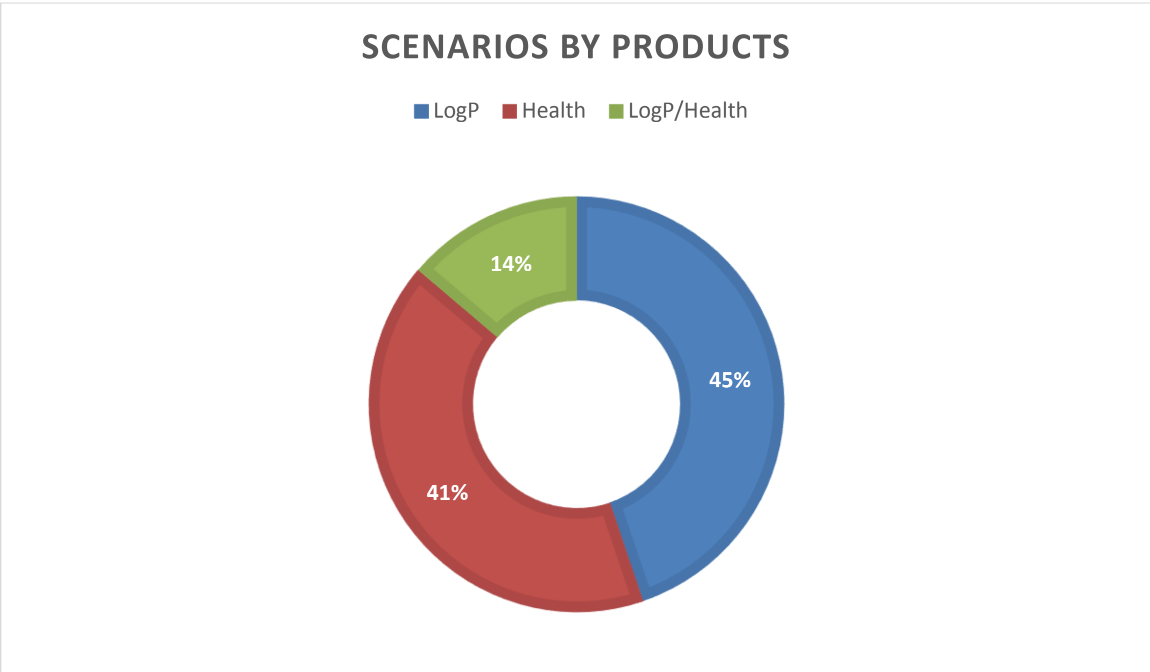

Figure 9. scenarios by products

3.1 INTER-LogP scenarios

Logistics and transport has a very high potential of taking advantage of IoT solutions through an enhancement of the interoperability among the people and objects that are continuously interacting while the freight is moving along its route. Although the stakeholders involved in the project are mainly related with the transport of goods, in many circumstances, the transport of people can also benefit from the scenarios identified in INTER-LogP.

3.1.1 Business scenarios description

This section introduces a brief description of the scenarios identified during this activity, while the complete scenarios described as user stories are included as an annex to facilitate the reading. We encourage the reader to review the complete scenario on those he can be more interested.

IoT support for transport planning and execution [2]
The objective of this scenario is to develop and integrate an IoT cloud platform that is able to manage different devices connected to the trucks by interfacing with the IoT entities of the truck and devices installed. Moreover, this IoT cloud platform is able to communicate with different IoT platforms in order to estimate the ETA (estimated time of arrivals) from trucks to the port terminal or port gates, exchanging the information or data whenever the authorised parties agree. The resulting service will be obtained by the integration of: • A platform for monitoring trucks of in haulier company • A platform of the destination company
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives to subscribe to changes in the attributes of a virtual entity in other IoT platforms under a subscription and Authorisation basis. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: - Device: There should be primitives to associate a new device to a virtual entity and provide information to the IoT platform. The association could be temporal.

IoT Weighbridges [3]
The objective is to build an automatic and unattended service for weighbridges dedicated to the port, therefore shippers, truck drivers and freight forwarders can use it to comply with new International Convention for the Safety of Life at Sea (SOLAS convention from now on). This means that verifying the gross mass of containers before being loaded onto the vessel is required, therefor the truck data will be available in the weighbridge service and in this scenario congestion parameters can also be measured to avoid congestion at gates and scales. The resulting service will be obtained by the integration of: • A platform for monitoring trucks by the haulier company able to interact with other platforms. • A platform for the Weighbridge
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms.

Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: - Device: There should be primitives for an IoT platform using tags or identifiers to identify physical entities registered in other IoT platforms. There should be primitives for an IoT platform to use the resources of a device registered in another IoT platform.

Monitoring reefer containers [4]
The objective of this scenario is to interoperate and use a shipping line's container IoT platform that is currently able to monitor reefer containers along its journey with the IoT platforms of the road hauliers or container terminals. This integration will allow a quick reaction in case of an alarm regarding the functioning of refrigerated goods and it will benefit container terminals and road haulier companies (drivers in this case) to avoid the periodic human inspection required for reefer containers. Interoperability in this scenario is required to connect the shipping lines, the container terminals and the road hauliers IoT platforms. The resulting service will be obtained by the integration of: • Carrier IoT platform who is owner of the container • Container terminal IoT platform • Road haulier cloud IoT platform
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an application to subscribe to the services offered by any IoT platform. There should be primitives to provide a business context to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms. Device: There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity.

Monitoring of containers carrying sensitive goods [5]
The objective of this scenario is to attach to containers carrying sensitive goods devices (i.e. electronic seals) that will integrate to an IoT platform to monitor containers along its journey. This platform will be open and connected with the IoT platform of the roads hauliers and of the storage facilities (i.e. container terminals). This integration will allow to monitor the transport of the container along its journey and provide to the container's devices network connectivity.

Interoperability in this scenario is required to connect the IoT platform of the devices attached to the container, the container terminal IoT platform and the road hauliers IoT platform. The resulting service will be obtained by the integration of: • IoT platform of the owner of the container • Container terminal IoT platform • Road haulier IoT platform
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an application to subscribe to the services offered by any IoT platform. There should be primitives to provide a business context to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms. Device: There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity.

Dynamic lighting in the port [6]
The objective of this scenario is to integrate different IoT platforms from the port, road haulier companies and port terminals to make more efficient the use of lighting inside the port, especially during night hours. The integration of the IoT platforms could rely on the position of a truck in order to adjust light levels while the truck is inside the port facilities (roads from the port, inside port container terminals, gate accesses, etc.), whenever trucks are not inside the port area the light levels will be reduced improving the overall energy efficiency of the port. Interoperability in this scenario is required to connect the terminal IoT platform, the road hauliers' IoT platforms for monitoring trucks, presence detectors and a dynamic lighting system. The resulting service will be obtained by the integration of: • Terminal IoT platform • A platform for monitoring trucks by haulier company • Dynamic Lighting system • Presence detectors
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a

geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform to connect to network resources to determine the presence of physical entities. Device: -

SCADA port sensor system integration with IoT platforms [7]
The objective of this scenario is to create an open and interoperable IoT platform using the existing SCADA system (supervisory control and data acquisition system) used to monitor different sensors, telemetry and actuators devices, such as marine buoys, navigation aids or pollution sensors) which are currently installed in the port. This system is not able to interoperate with applications other than those it was initially designed for. The support of SCADA based devices with a new open and interoperable IoT platforms will facilitate a smooth evolution of the existing situation in the port towards a future platform where everything will be connected. Interoperability in this scenario is required to connect different applications and systems with any IoT platform and to connect this platform with any new device and support legacy devices connected with the SCADA system. The resulting service will be obtained by the integration of: • SCADA port sensor system • Internal and External IoT platforms • Legacy and new devices
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: Connecting measurements captured in the SCADA system with new applications PMIS, PCS, etc. Middleware: There should be primitives for an IoT platform to subscribe to the services offered by legacy systems (i.e. SCADA). Networking: - Device: There should be primitives of an IoT platform support the connection of new devices. An open Industrial IoT platform will enable (i) an heterogeneous computing platform environment (e.g. Android, iOS, RTOS, Linux, Windows, machine controllers, sensors, gateways, cloud services, virtualization); (ii) enterprise wide data-connectivity for control analytics, monitoring, mobility, etc. wherever required to add business value; (iii) IDEs (for rapid new application development), edge device management, API management, edge (small data) and cloud-based (big data) analytics, etc. for generic applications and services; (iv) multiple and sophisticated end-to-end qualities-of-service (e.g. determinism, content-based prioritisation, data security, bandwidth efficiency, massive scalability, real-time peer-to-peer capability,

etc.); (v) integrating legacy systems via standards-based protocol gateways to free the data from proprietary constraints.

SEAMS Integration with IoT Platforms [8]
SEAMS is a platform that processes the data coming from the sensors of more than 200 machines. These machines are equipped with sensors and a PLC that compiles the information of the sensors and the position of the machine. A server is in charge to interrogate each PLC and capture the data. This platform only supports devices which are prepared to accept the internal communication protocol and it is not designed to share the information with other platforms. The objective of this scenario is to evolve SEAMS towards an interoperable IoT platform at the container terminal able to share and link data with other IoT platforms and applications owned by their customers, users and partners like road hauliers, shipping companies, rail companies, the port authority and customs. Currently SEAMS application is in charge of analysing the data coming from sensors installed on the terminal cranes ant tractors. Some of the improvements needed are mechanisms to decide the best network access point to transmit data or the support of other protocols to communicate the machines with the application servers to increase a more reliable and resilient system in front of temporary unavailability of communications. There is also an increasing need to manage external physical entities entering in the terminal like trucks. How to link different IoT platforms and dynamically access to physical entities entering in the terminal using virtualisation are some of the challenges of this scenario. The use of big data to handle in real time large quantities of data generated by the IoT platform merged with the operations managed by the TOS is another objective of the container terminal. Interoperability in this scenario is required to connect applications monitoring machines like SEAMS, new devices in the terminal, platforms operated by users, customers and partners of the terminal. This includes truck, rail, container and port IoT platforms. The resulting service will be obtained by the integration of: • Terminal IoT platform • Haulier cloud IoT platform • SEAMS
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures and physical entities; etc.). Application Services: There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms.

Device: There should be primitives for an IoT platform using tags or identifiers to identify physical entities registered in other IoT platforms. There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity. There should be primitives for an IoT platform to use the resources of a device registered in another IoT platform (i.e. print a document, show a message, show a map, produce a sound, or a voice message).

IoT interoperability for Vessel Arrivals [13]
The objective of this scenario is to build a service providing interoperability with existent and new IoT platforms to monitor vessels announced to arrive at the port. The intention is to merge this information with data provided from other platforms managed by tugboats, mooring services and the position of the ship to shore cranes at the container terminal. The data provided by different platforms will be shared to pilots or to the pilot coordinator (using a specific system named PortCDM) that is in charge of conducting the operations carried out by the pilots and coordinating them with other nautical and vessel supply services during the arrival and departure of the vessels at the port. Interoperability in this scenario is required for the connection of existing platforms for monitoring vessels, including readers receiving AIS signals owned by the Port Authority, to introduce and connect new devices installed on tugboats or carried by mooring staff and to use IoT platforms monitoring the handling equipment in the terminals. Currently, some container terminal have a platform to monitor cranes and tractors and the port authority has an AIS system. Tugboats and mooring services does not use any device connected to their management systems. Existing platforms are closed to the purposes they were initially designed and they do not share information with any other platform. The objective is to achieve open and interoperable IoT platforms able to share data produced by these stakeholders to provide new value added services. The resulting service will be obtained by the integration of: • Port authority IoT platform • Private IoT platforms in the port environment
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for temporarily linking virtual entities of different IoT platforms. Different devices are installed by different port and nautical service providers. These companies are interested in the first hand to use these devices to optimise their internal operations but they are open to share part of the data generated to other stakeholders to better coordinate the operations and reduce manual reporting obligations. Networking: -

Device: There should be primitives for an IoT platform using tags or identifiers to identify physical entities registered in other IoT platforms.

Containership is entering the harbour region [18]
This scenario focuses on the connectivity issues of embedded devices installed on containers that start transmitting data when they arrive at the harbour and acquire connectivity with the network. Nowadays this is not really an issue as most of the containers have not any embedded system willing to transmit data when it arrives at the harbour. This scenario would need a way that a device can detect and connect to different networks provided in different countries and places. The resulting service will be obtained by the integration of: • Port platform • Containers with a monitoring system
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: - Middleware: - Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms. There should be primitives for an IoT platforms manage large quantities of devices willing to connect at the same time. Device: There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity.

Transport on truck breaks down or is hijacked [19]
The objective of this scenario is to examine how devices and sensors installed in the truck can assist when it breaks down or when it is hijacked. These same sensors and devices can also be used for other purposes and be connected with the platforms monitoring the freight or the container being transported. Interoperability of this scenario is required to connect the road haulier IoT platform with the security alarm centre, the IoT container platform and other platforms so as to solve problems or alarms raised during the trucks' journey including the detection of theft or hijacking. The resulting service will be obtained by the integration of: • A platform for monitoring trucks of in haulier company
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.).

Application Services: There should be primitives for an application to subscribe to the services offered by any IoT platform. There should be primitives to provide a business context to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms. Device: There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity.

Damage or problems to the container during shipment [20]
The objective of this scenario is to integrate the container monitoring IoT platform with other platforms so as to solve problems or alarms during its journey. This scenario is complementary to the scenario described for monitoring containers carrying sensitive goods and it focus on the specific situation where the container is damaged or raise some kind of alarm during its transport. Interoperability of this scenario requires the integration of an additional platform to handle the alarms (i.e. logistic company platform) connected to the platforms described in the scenario of containers carrying sensitive goods. The resulting service will be obtained by the integration of: • Logistic company platform
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: - Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. Networking: There should be primitives for an IoT platform provide network connectivity to devices registered in other IoT platforms. Device: There should be primitives to associate two different virtual entities registered in different IoT platforms that represent the same physical entity.

Reliable control of robotic cranes and trucks in port terminals [29]
The objective of this scenario is to develop services able to locate and control cranes and machinery of a Port Terminal in a remote way. The IoT platforms are able to accurately locate people and elements that are located in unsafe or unauthorized areas, so operations may be immediately stopped automatically and by the terminal staff in the case of detection of any risk (i.e. detecting people moving on unauthorised or dangerous places by safety cameras or electronic fences installed at the terminal).

Using autonomous cranes and tractors inside the terminal yard is an interesting possibility to be assessed in the future, however at this moment this possibility is not yet feasible as there are still many aspects that would need to be considered, starting by labour regulations for environments where autonomous machines and people can work together. In the meantime, what can be assessed are the safety components running on an assisted operation mode instead of an autonomous mode. This scenario will require interoperable and resilient mechanisms between the terminal IoT platform, the cyber physical systems of cranes and trucks and several additional sensors installed in the terminal to establish safety conditions to operate autonomously. The resulting service will be obtained by the integration of: • Terminal platform • Cranes and trucks cyber physical systems
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.). Application Services: There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms. Middleware: There should be primitives for an IoT platform to access the virtual entities registered in other IoT platforms. This scenarios requires the Interoperability between different systems e.g. CCTV, Industrial IoT, cyber-physical systems. Networking: - Device: There should be primitives for an IoT platform to use the resources of a device registered in another IoT platform.

IoT access control, traffic and operational assistance [30]
The objective of this scenario is to build a new service to control access, monitor traffic and assist the operations at the port. Several IoT platforms will be able to identify trucks and drivers using different devices and they will share data under predefined rules through an interoperability of the platforms involved owned by the road hauliers, the port authority and container terminals. In this way, all parties concerned would have access to relevant information managed by different IoT platforms. The truck could be better monitored inside the port by the Port Authority platform through a connection with the road haulier platforms and it will also give information to the container terminal platform. More accurate, reliable and resilient information about trucks can be used for security and safety purposes inside the port as well as for operational and optimisation purposes inside the container terminal. The terminal operator will be able to follow up trucks entering to pick up or deliver containers in a similar way as they are monitoring their own machines. The container terminal platform could have even access to some devices installed in the truck (e.g. a screen or a printer so they can exchange documents and provide

instructions in real time). All the information required for the driver could be send through these platforms to improve job performance. Interoperability in this scenario is required for the connection of the platforms monitoring the trucks from different road hauliers and the platforms operated by the container terminals and by the port authority. Currently, some container terminals have a platform to monitor cranes and tractors and to automatically control the gates, and the port authority have a platform to control the gates. However these platforms cannot be yet considered as interoperable IoT platforms. Several road hauliers have fleet management systems and devices in the truck are connected to these systems although neither of these platforms are sharing data with other systems. The resulting service will be obtained by the integration of: • Road haulier IoT cloud platform • Port Gate System • Port Authority IoT platform • Container Terminal Gate System • Container Terminal IoT platform
Interoperability requirements: <u>Data & Semantics:</u> There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures and physical entities; etc.). <u>Application Services:</u> There should be primitives for an IoT platform to subscribe to the services offered by another IoT platform. There should be primitives to define a geo-fence to subscribe to attributes of virtual entities registered in other IoT platforms. <u>Middleware:</u> There should be primitives for temporarily linking virtual entities of different IoT platforms. The platform were the virtual entity is registered can terminate this connection with other platforms at any time. <u>Networking: -</u> <u>Device:</u> There should be primitives for an IoT platform using tags or identifiers to identify physical entities registered in other IoT platforms. There should be primitives for an IoT platform to use the resources of a device registered in another IoT platform.

3.1.2 Analysis

INTER-LogP scenarios demonstrate how interoperability of heterogeneous IoT platforms is needed when the physical entities (i.e. trucks) move through different areas and different stakeholders are interested in the information generated by or to communicate with these physical entities. However the same needs to access to data related with a physical entity along its route is something that it is not specific for ports, trucks and containers and it can be generalised to many situations and application domains.

Although there are different objectives in each scenario presented we observe that there exist several commonalities and complementarities among them that reinforce the foreseen advantages to prepare the IoT systems built by different organisations to be interoperable among them.

We also observe that the achievement of this scenarios requires a cultural change of the organisations to share information. Although initially there can be some initial opposition for sharing data, this resistance diminishes when the stakeholders feel that they can control the way that data is shared among different parties and there will exist tools that will support sharing and monitoring data.

We found also that there are scenarios where the pilot sites are ready to test but others that still need some time to be ready. The following table shows the degree of readiness to test the scenarios proposed within the project of INTER-IoT:

Table 4. Readiness of INTER-LogP Scenarios

Scenario name	Readiness	Reasons
IoT support for transport planning and execution	High	The consortium has involved road haulier companies to test this scenario and it is feasible to create a test environment.
IoT Weighbridges	Medium	Although the consortium can involve some weighbridges operators, the creation of a testing environment is not yet agreed with these operators.
Monitoring reefer container	Low	To test this environment it is required the involvement of the shipping line which has created the container monitoring network and his platform should be ready to interoperate. For the moment the willingness of this shipping line to participate in the experimentation is not known.
Monitoring of containers carrying sensitive goods	High	The consortium has involved several road hauliers to participate in the pilot. The containers could be monitored using specific devices installed on the containers by the terminal or by the road hauliers involved.
Dynamic lighting in the port	High	The container terminal already has acquired technologies to experiment with dynamic lighting inside the terminal. The identification of trucks could be also assessed during experimentation.
SCADA port sensor system integration with IoT platforms	Very High	Agreements with the port authority to start an experimentation with this scenario have already been started.
SEAMS integration with IoT platforms	Very High	The container terminal is member of the consortium and it has already sensors installed in more than 200 machines.
IoT interoperability for Vessel Arrivals	Very High	Agreements with the port authority to start an experimentation with this scenario have already been started.
Containership is entering the harbour region	Very Low	The existence of embedded smart devices in containers is not yet widespread among shipping lines. Only few container have today some kind of sensor.
Transport on truck breaks down or is hijacked	Medium	Agreements with road hauliers to experiment INTER-LogP have already started and the introduction of sensors to raise alarms when the truck breaks down or it is hijacked could be installed. The probability of a truck to be hijacked is very low.

Damage or problems to the container during shipment	Low	Currently, shipping lines didn't use containers able to detect if they have any kind of damage through specific sensors or devices. Only the most advanced case for detecting damages or problems is found in the scenario of the reefer containers. Reefer containers are a convenient case as they have easy access to power and they embed sophisticated equipment for controlling the temperature.
Reliable control of robotic cranes and trucks in port terminals	Very low	The use of autonomous machines in a container terminal substituting human driven machines is still very far to become a reality.
IoT access control, traffic and operational assistance	Very high	Agreements with the port authority to start an experimentation of this scenario have already started.

Scenarios by kind of users

The scenarios assessed are considering almost all type of users in the Port Logistics industry that are handling physical entities. It can be observed that road haulier companies are the most representative in almost all the scenarios analysed, followed by Container Terminals. The physical entities of major concern are trucks and containers. This result is quite logic as we have been focusing on transport and logistics operations in a port that is highly specialised in container transport. However, we can easily extrapolate and extend several of these scenarios to other logistics and transport situations, including the transport of people.

The scenarios presented have considered other users such as drivers (truckers), weighbridge operators, port authorities, shipping lines and agencies, traders, container depots, or truck owners. This users have been questioned and the expressed interest has been reflected in the scenarios. The different kind of users is relevant from the point of view of the different members of the transport community that will be interested in the use of INTER-IoT solutions and in which circumstances.

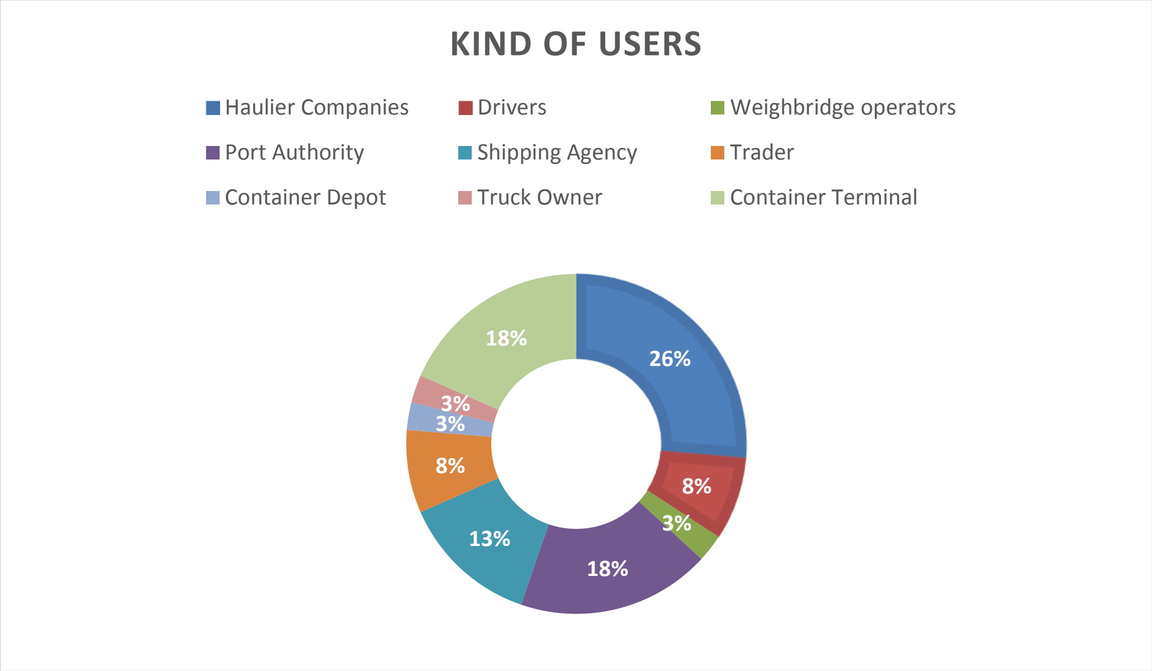

Figure 10: INTER-LogP scenarios by kind of users

Scenarios by Context

The context represents the physical environment where the scenario is defined. The predominant context of the scenarios is road transport followed by port container terminals and port areas. This is due to those scenarios where the physical entity, in this case the truck, is moving along a route where different IoT platforms are in operation and all of them are interesting in capturing information of this physical entity.

The scenarios considered also involve other contexts like the container yard, the port sensor network, the gates of the port or the terminal, the vessel voyage, the container route or the port operations.

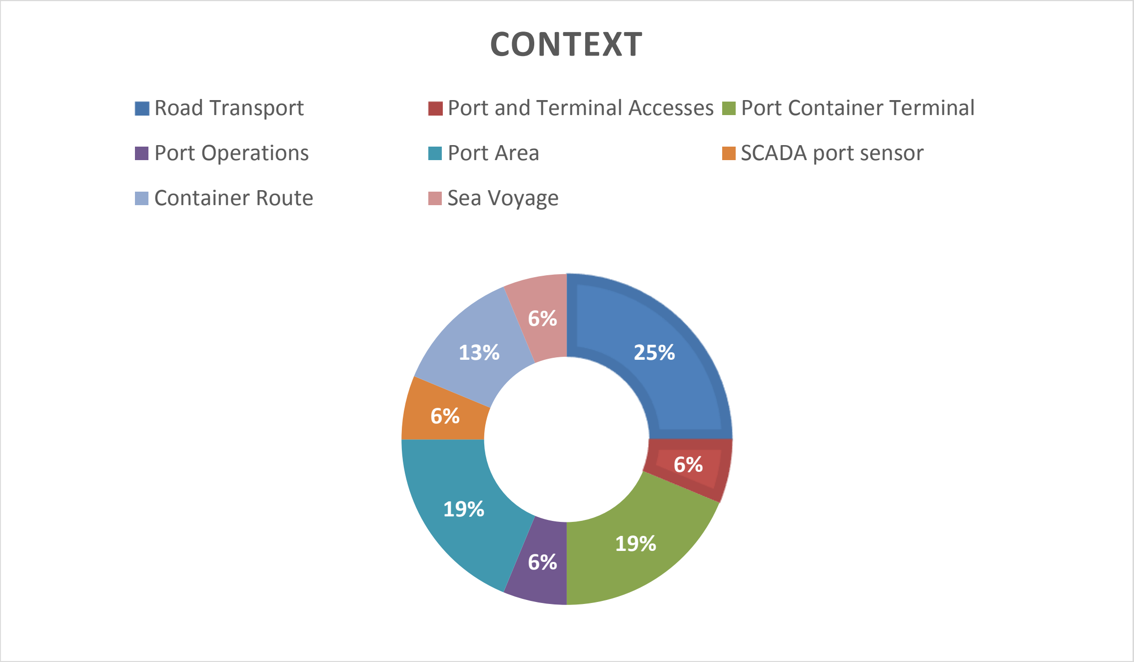

Figure 11: INTER-LogP scenarios by context

Scenarios by Interacting systems

In the description of the scenarios, the interacting systems give an overview of the technical environment. In most cases the identified scenarios foresee the integration of service platforms that use three-tier architecture: devices with connectivity (e.g. BT, BTLE, NFC), gateway hosted on terminal with mobile connectivity, or platforms on the internet. Most of these three tier platforms refer to existing monitoring services.

Most of the cases use hosted equipment such as on board computer units, smartphones or tablets, as well as geopositioning devices like GPS/Galileo or DGPS/EGNOS. This equipment influence the different requirements and extendibility of the scenarios.

Table 5. INTER-LogP Interacting systems

Scenario	Devices	Equipment	Connectivity	Platforms
[2] IoT Support for transport planning and execution	Printer. Identification devices on trucks Sensors on trucks CAN Bus	Smartphone Tachograph Tablet Beacons GPS.	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https NFC	Fleet Management system Valenciaport PCS SEAMS Platform Truck's owner IoT Platform Destination Company IoT Platform/ Container Terminal Platform
[3] IoT Weighbridges	Identification devices on trucks Weighbridge controller	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	IoT Weighbridge Platform Road Haulier IoT Platform
[4] Monitoring Reefer Containers	Reefer Containers	Smartphone Tablet Personal Computer Reefer Container sensors DGPS	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Carrier IoT Platform (RCM) Container Terminal IoT Platform (SEAMS) Road Haulier IoT Platform Terminal Operation System (TOS)
[5] Monitoring of containers carrying sensitive goods	Electronic seals	Smartphone Tablet Container sensors DGPS	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https RFID	Container Terminal IoT Platform (SEAMS) Haulier IoT cloud platform OMNIS
[6] Dynamic lighting in the port	Trucks Lighting system Presence sensors	DGPS Smartphones	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Port IoT Platform Haulier IoT cloud platform Dynamic Lighting System
[7] SCADA port sensor system integration with IoT Platform	Buoys Systems integrated into the SCADA	Smartphone Tablet SCADA port sensor systems	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	External IoT Platforms Port Management and Information System Interoperable port IoT Platform Port Community System
[8] SEAMS integration with IoT Platform	Trucks Machinery Ships	Personal Computer PLCs DGPS	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Container Terminal IoT Platform (SEAMS) Road Haulier IoT Platform Terminal Operation System (TOS) Shipping Company IoT platform

Scenario	Devices	Equipment	Connectivity	Platforms
[13] IoT Interoperability for Vessel Arrivals	Sea buoys Ships	PLCs DGPS	2G-3G-4G Internet https	Port Community System Port CDM Port IoT Platforms
[18] Containership is entering the Harbour region	Container Truck	Container Sensors	2G-3G-4G WiFi/ADSL Internet https	Road Haulier IoT Platform Port IoT Platform
[19] Transport on Truck breaks down or is hijacked	Truck	Smartphone Tablet Personal Computer	2G-3G-4G WiFi/ADSL Internet https	Road Haulier IoT Platform Port IoT Platform
[20] Damage or problems to the container during shipment	Container Truck	Container Sensors	2G-3G-4G WiFi/ADSL Internet https	Road Haulier IoT Platform Port IoT Platform
[29] Reliable control of robotic cranes and trucks in port terminals	Port Machinery Ships	PLCs	2G-3G-4G WiFi/ADSL Internet https	Container Terminal IoT Platform (SEAMS) Terminal Operation System (TOS) Shipping Company IoT platform Port CDM
[30] IoT access control, traffic and operational assistance	Truck Printer	Smartphone Truck sensors DGPS	NFC BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Road Haulier IoT Platform Port IoT Platform Port Community System

Scenarios by Users Interaction

The interaction parameter describes how the users of the scenarios interact with the system. In the INTER-LogP scenarios the main interactions are with:

- DEVICES (smartphones, DGPS for activity monitoring and localization, PLCs, container sensors, machine sensors or SCADA sensors). All the scenarios use one or more kinds of device. The different devices are used mainly by final users: road haulier companies, port terminals, port authorities or drivers.
- WEB INTERFACE (on tablet, personal computer on application): it is used in most scenarios,
- APP on smartphone / tablet / platform to collect measures and calculate variables such as Estimated Time of Arrival.

Scenarios by data

In this section are presented the main kinds of information produced and consumed by the different users.

<u>Device:</u> weight from the weighing station, data from sea buoys, data from lighting systems, container data (temperature, positioning, tracking of the goods, etc.), tachograph data.

Machine/vehicle: data from truck, driver identification, data from machinery (gantry cranes and yard machines), data from tugboats and other nautical services.

Platform: weighbridge platform data, interchange of documents, data from Port CDM (Collaborative Decision Making), data from PCS (Port Community System), data from container terminal IoT Platform, data from the SCADA system.

Scenarios by Business model

The creation of new services from the interoperability across platforms is one of the most common business model from the INTER-LogP scenarios [2], [3], [4], [5] and [8], for instance from SCADA data or the devices on board a truck.

Other specific service is the monitoring of the container along its route [4], [5], [18], [19], and [20]. Or use the monitoring of the truck and machines to improve performance [6], [8], [29] and [30].

Save energy and resources is one of the common objective across all the scenarios, considering that IoT environments may use constrained devices, and scalability is a key factor in the specification and deployment of such platforms.

Scenarios Motivations

The Inter-LogP scenarios are motivated by improving the added value of the container logistic chain by monitoring its route and different aspects such as security and safety, temperature and location (scenarios 4, 5, 18, 19, 20 and 30).

Also it is remarkable the focus on the interoperability of existing IoT platforms in the logistic chain such as scenarios 2, 3, 7, 8 and 13 providing more added value to the supply chain and creating new business models and services.

Finally two scenarios are focused on improving the efficiency of existing systems and machines by using interoperability such in scenarios 6 and 29.

[2] IoT support for transport planning and execution – connect truck services to plan and execute transport services through interoperable IoT platforms and devices.

[3] IoT Weighbridges is to connect truck services to plan and execute transport services through IoT platforms and attend a high quantity of truck weighs per day.

[4] Monitoring reefer container – motivating by monitoring the temperature of the container through its route and securing the supply chain of the reefer container.

[5] Monitoring of containers carrying sensitive goods – tracking and monitoring the security status of the container through the supply chain of sensitive goods.

[6] Dynamic lighting in the port – focus on reducing the energy demand from lighting at port infrastructures.

[7] SCADA port sensor system integration with IoT platforms – open access to relevant data from the SCADA system to enable new business models, new applications and to provide more added value to the port.

[8] SEAMS integration with IoT platforms – evolve and improve an existing platform to become and interoperable IoT platform.

[13] IoT Interoperability for Vessel Arrivals – provide IoT infrastructure and interoperability capabilities to enhance the coordination and decision making in vessel port arrivals.

[18] Containership is entering the harbour region – container monitoring

[19] Transport on truck breaks down or is hijacked – trucks and container monitoring

[20] Damage or problems to the container during shipment – Monitoring the container through its route in order to secure and manage problems during shipment.

[29] Reliable control of robotic cranes – improvement of the container terminal efficiency.

[30] IoT access control, traffic and operational assistance – provide new mechanisms for truck monitoring in restricted areas through interoperability of IoT platforms

Scenarios users' goals

The users' goals in the logistic services are

- From the point of view of the Haulier companies is to improve communication with different platforms and services to customers.
- From the point of view of Drivers improve the safety and efficiency in operations.
- From the point of view of Weighbridge operators interoperate with the truck and the driver.
- From the point of view of Port Authority giving more added value to the port.
- From the point of view of Shipping Line/Agency improve the traceability of the container route and improve the efficiency in operations.
- From the point of view of Trader to receive and ship the goods in time.
- From the point of view of Container Terminals is to improve the efficiency in operations of the container terminal in general.

Scenarios by Interoperability layers

For all the scenarios described the interoperability requirements and the layers involved are outlined. In particular the main requirements collected at the different layers are the following:

Data & Semantics:

- There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.).

Middleware:

- The truck virtual entities are linked to the IoT platform of the infrastructure.
- Virtual truck and driver entities are registered in the truck's owner IoT cloud platform. A semi-trailer and driver virtual entity can temporarily be linked to a truck to carry out work orders. When a truck accesses to the port, the virtual entities are linked to the IoT platform of this place. The virtual entities' owners can disconnect the links of other external virtual entities at any time.
- Interoperability between external systems e.g. CCTV.
- Different devices are installed by different port and nautical service providers. These companies are interested in the first hand to use these devices to optimise their internal operations and they are open to share part of the data they have generated to better coordinate the operations and reduce manual reporting obligations. Private IoT platforms can also share data with existing applications, like PortCDM, PCS and PMIS.

- The Terminal IoT platforms needs to access to relevant data managed by external IoT platform such as the truck position.
- Relevant data managed in the SCADA system is available in an Industrial IoT platform to interoperate with other IoT platforms.
- The position of the haulier company's truck is shared with the port IoT platform and terminal IoT platform.
- The container is monitored when is in the ship, in the terminal and in the truck, so the container virtual entity is share
- A virtual truck registered in the truck's owner IoT cloud platform can be discovered, linked and used by a different IoT cloud platform managed by the road haulier. An event registered in a linked virtual truck is transferred to other IoT platforms where the virtual truck is registered or linked.

<u>Application Services:</u>

- The road haulier IoT platform subscribes to the services of the location IoT platform. The infrastructure IoT platform defines a geo-fence and the mechanisms to share information with the road haulier IoT platform.
- The IoT platform of the location visited by the virtual entities can request and subscribe to data as well as to use some devices of the virtual entity (i.e. a screen, a printer).
- An IoT platform can notify changes in the properties of an object to other systems under a subscription basis. An IoT platform is able to interface with PortCDM in the same way as a software interfaces directly with a device.
- SEAMS accesses to the information of position of the trucks.
- The Dynamic Lighting system accesses to the information of position of the trucks.
- Whenever container data is obtained by the haulier, the terminal operator or the carrier, it can be share with the trader.
- An IoT platform can notify changes in the properties of an object to other systems under a subscription basis.

<u>Networking:</u>

- There should be a radio communication between the device and the app on the smartphone (e.g. BT).
- Devices should be able to select and find a communication line everywhere along the route.
- IoT platforms can provide different network connectivity to devices and they can access the more convenient communication channel.
- Different stakeholders handling the container can provide network connectivity to the container devices.
- Mobility will be handled by the use of the network layer, providing support for Mobile IP and roaming
- Support for network offloading and multi-homing, allowing devices to be connected to several access networks simultaneously (e.g. use of MPTCP)

<u>Device:</u>

- Automatic identification of the truck through passive sensors. The IoT platform of the infrastructure can request and subscribe to data as well as to use some devices of the virtual entity (i.e. a screen, a printer).
- Identification of the truck at a gates.
- Interoperability between nodes of different manufacturers (HW & SW).
- AIS data is automatically inserted in the port IoT platform.

- The SEAMS should communicate with external devices to get data from sensors and tags located in different physical entities and to provide certain interactions with actuators (i.e. print a document, show a message, show a map, and produce a sound or a voice message).
- All the sensor in the container send the data to the container virtual entity.
- A device is able to be introduced in a truck to provide information to the IoT platform for handling trucks.

The interoperability layers involved into the INTER-LogP scenarios are showed in the following diagram.

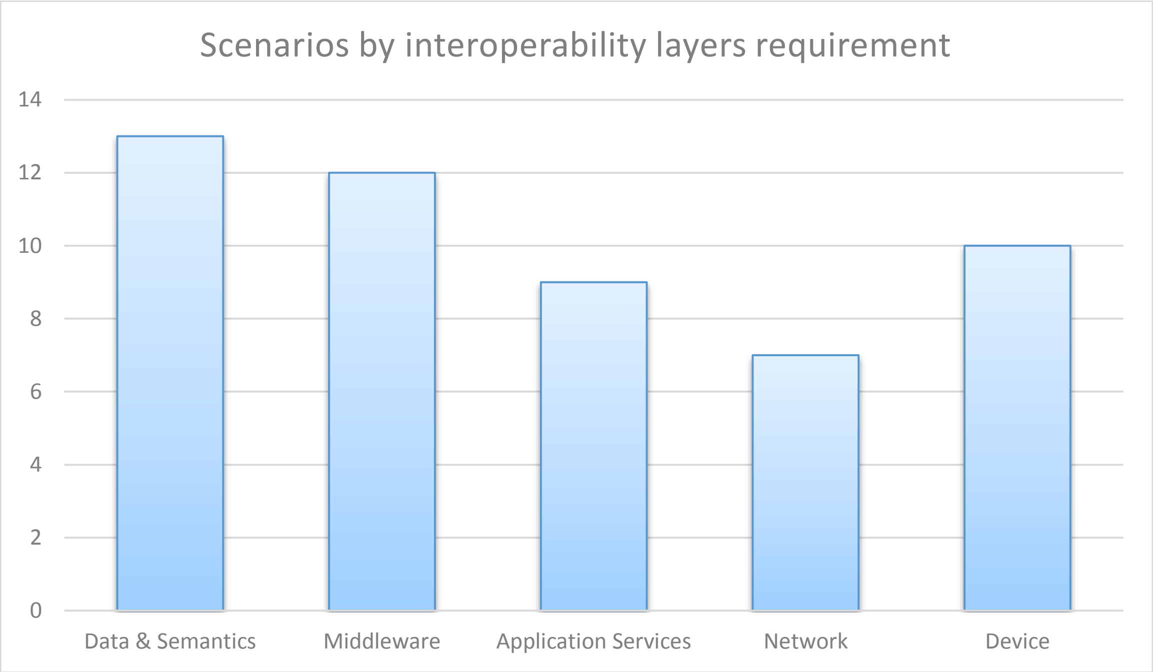

Figure 12. INTER-LogP scenarios by interoperability layers

3.2 INTER-Health scenarios

This section presents the scenarios collected to characterize the product INTER-Health. These scenarios show an overview of the expected services and the main requirements for interoperability for the monitoring of different diseases supporting the mobility of patients with the aid of different IoT devices.

3.2.1 Business scenarios description

This section introduces a brief description of the scenarios identified during this activity, while the complete scenarios described as user stories are included as an annex to facilitate the reading. We encourage the reader to review the complete scenario on those he can be more interested.

Chronic disease prevention [1]
The objective of this scenario is to build a service for the prevention of chronic diseases (e.g. hypertension, diabetes, cardiovascular disease, obesity, etc.) based on a remote monitoring of objective measures (weight, BMI, blood pressure, physical activity, etc.) and subjective parameters (on eating habits and physical activity) under the control of doctors. The resulting service will be obtained by the integration of: • A platform for monitoring subjective information (questionnaires) and medical measures (such as eCare platform) • A platform for continuous activity monitoring (such as BodyCloud)
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping between the user identities; correlation between citizen personal data like sex, age, tel. number; correlation between the same kind of measures; mapping between unit of measures Kg/g/lb) Application Services: There should be primitives for access to service data or already synthetized information (e.g. trend of measures, health status dashboard, fall events,..) of the integrated platforms Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices or user data into the different platforms integrated Networking: - Device: There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated

Primary prevention of cognitive decline [11]
This scenario presents a service thought for elderly people to prevent cognitive decline and it is based on a remote monitoring service under the control of doctors. The patient at home will perform different measures: weight, blood pressure, glycaemia, oximetry, physical activity following the doctor's prescriptions and fill periodically food and physical activity diary through a questionnaire. INTER-Health Integrated resulting service by use of:

• A platform for monitoring subjective information (questionnaires) and medical measures (such as eCare platform) • A platform for continuous activity monitoring (such as BodyCloud)
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping between the user identities; correlation between citizen personal data like sex, age, tel. number; correlation between the same kind of measures; mapping between unit of measures Kg/g/lb) Application Services: There should be primitives for access to service data or already synthetized information (e.g. trend of measures, health status dashboard, fall events,..) of the integrated platforms Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated Networking: - Device: There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated

Heart failure disease and mild Alzheimer disease [12]
This scenario presents a service for patients that suffer of mild Alzheimer's disease and other pathologies (e.g. heart disease, hypertension, diabetes) and it allows them to continue living at home while still maintaining a degree of autonomy and quality of life. The service allows to monitor the cardiac pathologies and the early symptoms of Alzheimer disease using a remote monitoring system under the doctor's control. The service offers also a geolocalization system that allow to control the position of the patients (through family or doctors in case of need). The patient at home should be able to perform different measures: weight, blood pressure, glycaemia, oximetry, physical activity, three-lead electrocardiogram, moreover the patient should wear some device for localization. The resulting service will be obtained by the integration of: • A platform for monitoring medical measures (such as eCare platform) • A platform for activity monitoring (such as BodyCloud) • Platform /service for geolocalization and related devices
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping between the user identities; correlation between citizen personal data like sex, age, tel. number; correlation between the same kind of measures; mapping between unit of measures Kg/g/lb) Application Services: There should be primitives for access to service data or already synthetized information (e.g. trend of measures, health status dashboard, fall events, localization data) of the integrated platforms Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated Networking: -

Device: There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated

Surveillance systems for prevention programs [15]
The objective of this scenario is to promote health in childhood and adolescence using a service for monitoring some measures like height, weight, fat mass, body mass index in the school environment, and to elaborate information collected in order to supply indicators and trends. On the basis of the indicators and trends, the territorial healthcare centre (ASL) in connection with the schools will promote ad hoc training campaigns for prevention. The resulting service could be obtained by means of use of health kiosks by the integration of: • A platform for monitoring subjective information (questionnaires) and medical measures through the use of health Kiosk (such as eCare platform). • A platform (to be identified) that offers data aggregation and anonymization, reporting and data analysis.
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping between the same user; correlation between the same kind of information: sex, age, physical parameters/ measures; unit of measures Kg/g/lb) Application Services: There should be primitives for access to service data or already synthetized information of the integrated platforms Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated Networking: - Device: -

Elderly monitoring [16]
This scenario presents a telemonitoring service is thought for elderly people with chronic disease (e.g. diabetes, COPD) and with lack of familiarity with the technology. For this reason, the service must allow the elderly person to carry out the medical measures, directly from his house, in such a way to allow doctors to remotely monitor his health status. Furthermore, the sending mode of the measures must be as simple as possible and require minimal interaction by the person. This objective could be reached by using a hub, always listening, able to collect measures from medical devices (oximeter, blood pressure monitor, spirometer, glucometer, weight scale) without interaction by the person. The resulting service could be obtained by the integration of: • A platform for medical measures monitoring (such as eCare) • Platform /service (to be identified e.g. coXnico) for gateway hub and related devices
Interoperability requirements:

Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping between the user identities; correlation between the same kind of measures; mapping between unit of measures Kg/g/lb) Application Services: - Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated Networking: Need of managing mobility elderly people, as they will be monitored at home or on the run using a mobile IoT Platorm Device: There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated

Low [21], Increased [22], High [23], Very High [24] or Extremely High [25] risk of developing chronic diseases
The objective is to use a service for patients with a low/medium/high/very high/extremely high risk of developing chronic disease to help them to follow a proper lifestyle and solve initial problems or improve their health status. The resulting scenarios will include interoperability between: a platform for telemonitoring of data recorded by the medical devices (weight scale) and online questionnaires for the physical activity and eating habits (such as e-Care Platform), and a platform for physical activity monitoring that contains the data recorded by mobile wearable devices (bracelets for the detection of physical activity) such as BodyCloud platform. Moreover all the data collected should be made available to the healthcare center into the computerized nutritional folder that will collect also measures performed periodically during visits by health operators.
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms and nutritional folder (e.g. mapping between the user identities; correlation between citizen personal data like sex, age, tel. number; correlation between the same kinds of measures; mapping between units of measures Kg/g/lb). The resulting INTER-Health service can demonstrate the efficacy of a complete health status monitoring. At this level objective and subjective measures collected at Nutritional outpatient and at home through heterogeneous device on heterogeneous platform, allow to overcome the traditional methods about the relationship with subject who come to Nutritional Outpatient. Application Services: There should be primitives for access to service data or already synthetized information (e.g. trend of measures, health status dashboard, fall events etc.) of the integrated platforms. Health operator periodically checks if the subject is following the given nutritional counselling and checks measures and activities on the INTER health platform. Middleware: There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated. Networking: - Device: There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated. Health operators and subjects using smartphone / tablet and web interfaces on personal

computer can collect and send measures, see reports and trends and setting information.

Vitamins and minerals intake analyser [27]
The objective of this scenario is to use a service for children for vitamin deficiency detection. The service is based on a device which is a cuddly bear that, besides behaving like a normal toy, is able to analyse if the child has symptoms of vitamin deficiency, The device is able to interact and communicates with a smartphone in case of detection of deficiencies of vitamins in order to alert the deficiency of vitamins. The resulting new service will include interoperability between: an app on a smartphone (to be identified) and a device (e.g. cuddly bear to be identified) and possibly a platform for telemonitoring of data recorded by the device (to be identified).
Interoperability requirements: <u>Data & Semantics</u>: There should be primitives for data interpretation between device, app on the smartphone and platform receiving data (e.g. mapping between the user identities; correlation between the same kind of measures or level of alert). <u>Application Services</u>: There should be primitives for access to service data (e.g. deficiency of vitamins, level of alert) of the integrated platform. <u>Middleware</u>: There should be primitives at the platform level for direct access to the collected data of the devices integrated into the platform. <u>Networking</u>: There should be primitives to provide radio communication between the wearable devices and apps in the smartphone (e.g. BT). <u>Device</u>: There should be primitives at the gateway level on the smartphone for direct access to the collected data of the device.

Calories/ nutrition mixer / cookware counter [28]
The objective of this scenario is to use a service for analyse calories and nutrition in the meal. The service is based on a cookware device which has a calories and nutrition analyser. The device is able to interact and communicates with a smartphone the list of calories. The resulting new service could include interoperability between: an app on a smartphone (to be identified) and a device (e.g. cookware to be identified) and possibly a platform for monitoring of data recorded by the device (to be identified).
interoperability requirements: <u>Data & Semantics</u>: There should be primitives for data interpretation between device, app on the smartphone and platform receiving data (e.g. mapping between the user identities; correlation between the same kind of measures). <u>Application Services</u>: There should be primitives for access to service data (e.g. list of calories by day, trend) of the integrated platform.

Middleware: There should be primitives at the platform level for direct access to the collected data of the devices integrated into the platform. Networking: There should be primitives to provide radio communication between the wearable devices and apps in the smartphone (e.g. BT). Device: There should be primitives at the gateway level on the smartphone for direct access to the collected data of the device.

3.2.2 Analysis

INTER-Health scenarios demonstrate how interoperability of heterogeneous IoT platforms is needed to support several remote monitoring, surveillance and prevention programmes with patients dealing with chronic diseases, cognitive decline or physical activities. Most of the scenarios presented pointed the need to interoperate a platform able to handle medical devices and questionnaires (such as e-Care) with a platform able to monitor certain aspects of the patient's physical activity through mobile wearable devices (such as BodyCloud platform).

We found also that there are scenarios where the pilot sites will be ready to test but others that still need some time to be ready. The following table shows the degree of readiness to test the scenarios proposed within the project of INTER-IoT:

Table 6. Readiness of INTER-Health Scenarios

Scenario name	Readiness	Reasons
Chronic disease prevention	Very High	This is one of the main scenarios introduced by ASL and the prevention focus for the experimentation provides less constraints in terms of dependability of the patients.
Primary prevention of cognitive decline	Very High	This is one of the main scenarios introduced by ASL and the prevention focus for the experimentation provides less constraints in terms of dependability of the patients.
Heart failure disease and mild Alzheimer disease	Medium	This is one of the main scenarios introduced by ASL, however the increased dependability of the patients may create some constraints that will be need to be assessed before the experimentation.
Surveillance systems for prevention programs	Medium	This is one of the main scenarios introduced by ASL and the prevention focus provides less constraints in terms of dependability of the patients. The fact that the patient is a minor may impose additional constraints.
Elderly monitoring	High	This is one of the main scenarios introduced by ASL and the monitoring focus provides less constraints in terms of dependability of the patients.
Low risk of developing chronic diseases.	High	This is one of the main scenarios introduced by ASL. The degree of risk in developing chronic diseases impose an increasing dependability degree for patients shall be taken into account for the experimentation.
Increased risk of developing chronic diseases	Medium	This is one of the main scenarios introduced by ASL. The degree of risk in developing chronic diseases impose an increasing dependability degree for patients shall be taken into account for the experimentation.

High risk of developing chronic diseases	Low	This is one of the main scenarios introduced by ASL. The degree of risk in developing chronic diseases impose an increasing dependability degree for patients shall be taken into account for the experimentation.
Very high risk of developing chronic diseases	Low	This is one of the main scenarios introduced by ASL. The degree of risk in developing chronic diseases impose an increasing dependability degree for patients shall be taken into account for the experimentation.
Extremely high risk of developing chronic diseases	Very low	This is one of the main scenarios introduced by ASL. The degree of risk in developing chronic diseases impose an increasing dependability degree for patients shall be taken into account for the experimentation.
Vitamins intake analzyer	Low	The lack of readiness of the devices presented in the scenario may avoid to include it in the pilot tests. The fact that the patient is a minor may impose additional constraints.
Calories / nutrition mixer / cookware counter	Low	The lack of readiness of the devices presented in the scenario may avoid to include it in the pilot tests.

Scenarios by kind of users

The majority of scenarios includes different type of users, such as the health operators. Health operators include: doctors, nurses, dieticians, nutritionist biologists, food technologists, health assistants. They operate actively on the system both in the initial phase by setting parameters of the healthy person/ patient on the basis of their needs and in the monitoring phase.

Depending on the kind of services (more oriented towards prevention or health care) the type of users involved could include healthy people or patients or both. In general, healthy users / patients can be of any age and have any level of culture and technical skill. As they interact actively with the systems in order to perform and send measures, the usability of the interfaces is a relevant aspect.

Only one scenario is thought for child (Vitamins and minerals intake analyser [27]) and one for young people at school (students) (Surveillance systems for prevention programs [15]).

One scenario is thought for elderly people with little familiarity with the technologies (Elderly monitoring [16]). This scenario will be linked with the H2020 IoT1 Large Scale Project ACTIVAGE, in which UPV and other members of IoT-EPI are involved.

In few cases, between the users there is a member of the family: consort or parent (Heart failure disease and mild Alzheimer disease [12]; Vitamins and minerals intake analyser [27]; Surveillance systems for prevention programs [15]).

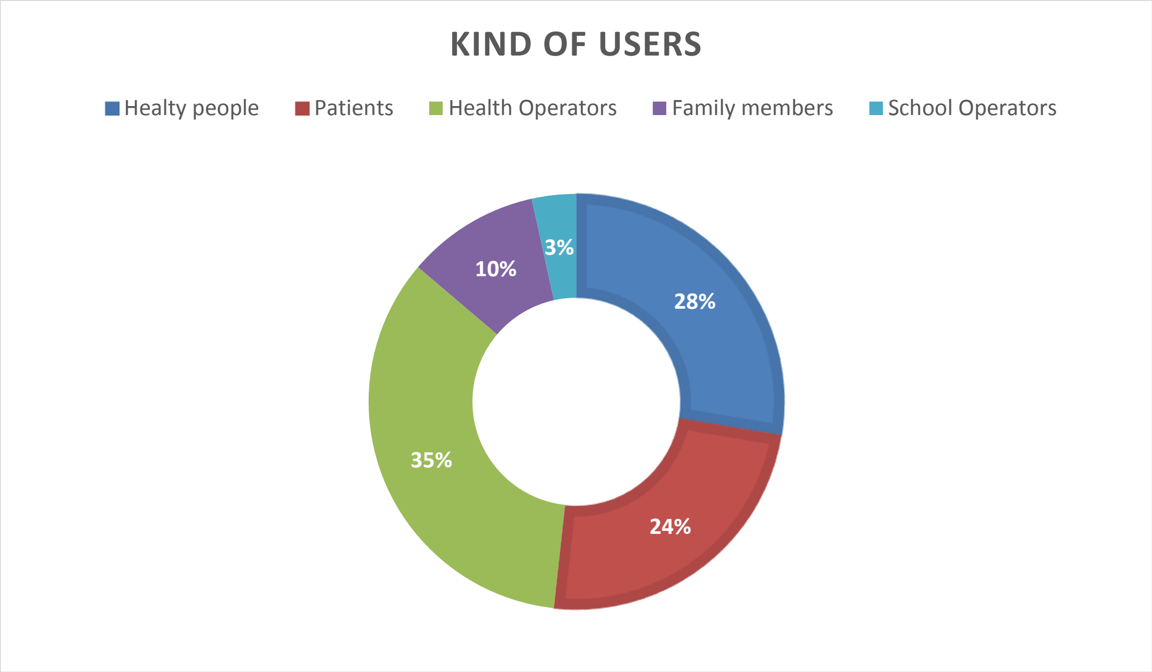

Figure 13: INTER-Health scenarios by kind of users

In what follows the scenarios are grouped by the kind of users:

Healthy people, Patients, Health Operators

- Chronic disease prevention [1]
- Primary prevention of cognitive decline [11]
- Low risk of developing chronic diseases [21]
- Increased risk of developing chronic diseases [22]
- High risk of developing chronic diseases[23]

Healthy people

- Calories/ nutrition mixer / cookware counter [28]

Healthy people, Patients, Family member

- Vitamins and minerals intake analyser [27]

Patients, Health Operators

- Elderly monitoring [27]
- Very high risk of developing chronic diseases [24]
- Extremely high risk of developing chronic diseases [25]

Healthy people, Health Operators, Family members, School operators

- Surveillance systems for prevention programs [15]

Patients, Health Operators, Family members

- Heart failure disease and mild Alzheimer disease [12]

Scenarios by Context

The context represents the physical environment where the scenario is developed.

The majority of the scenarios considered, are developed in the context where patient / healthy people use the services at home. Patients/ healthy people at home perform measures using medical devices and interacting with the system. In case of scenario: Surveillance systems for prevention programs [15] the students measures are collected at school while at home the parents can monitor the data of their sons.

For ten scenarios the setting context is a Health department, depending on the kind of service could be a Hospital, public Health ambulatory or an outpatient Family Doctor. In some cases there could be more health departments involved in order to cope with all the expertise required.

Only two scenarios that address end users services, the only context related is home: Vitamins and minerals intake analyser [27] and Calories/ nutrition mixer / cookware counter [28].

Finally, it should be noticed that in eight scenarios it is expected that the patients / healthy people can monitor physical activity or can be localized in an environment outside the predicted context (i.e. outside their home).

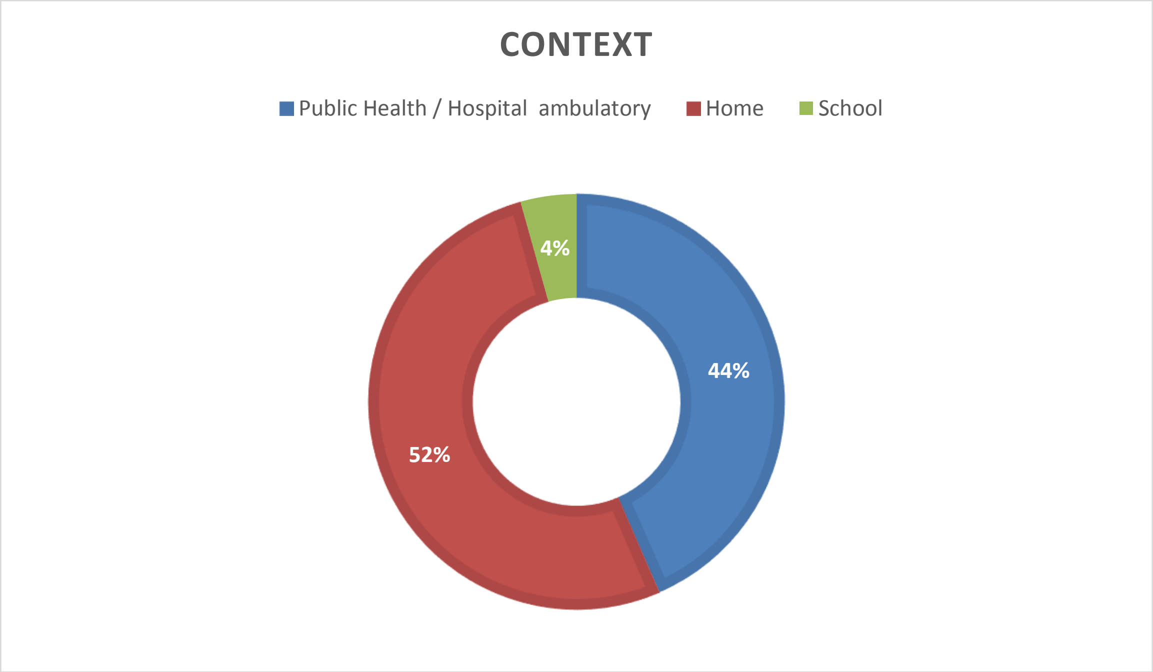

Figure 14. INTER-Health scenarios by context

Scenarios by Interacting systems

In the description of the scenario the interacting systems give an overview of the technical environment.

In most cases, the identified scenarios (nine) foresee the integration of service platforms that use three-tier architecture: devices with connectivity (e.g. BT, BTLE, NFC), gateway hosted on terminal with mobile connectivity, platform on the internet.

Most of these three tier platforms refer to existing monitoring services.

In two cases the scenarios foresee the integration of services /platforms that need to be identified (e.g. geolocalization platform and data analysis platform).

In three cases the scenarios need to identify a specific device that should be integrated in an existing platform (e.g. wearable for geolocalization, vitamin analyser, calories counter).

In the following table, it is summarized the devices and equipment involved for each scenario, the kind of connectivity (for device, gateway and platforms), and the interacting platforms.

Table 7. INTER-Health Interacting systems

Scenario	Devices	Equipment	Connectivity	Platforms
[1] Chronic disease prevention	Medical for weight and blood pressure. Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud)
[11] Primary prevention of cognitive decline	Medical for weight, blood pressure, blood glucose, pulse oximetry. Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud)
[12] Health failure disease and mild Alzheimer disease	Medical for weight, blood pressure, temperature, blood glucose, pulse oximetry, ECG. Wearable for activity monitoring Wearable for geolocalization (to identify)	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Geolocalization (to identify)
[15] Surveillance systems for prevention programs	Health Kiosk for height, weight, fat mass, body mass index	Tablet Personal Computer Smart card	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https RFID	Tele-monitoring (e.g. eCare) Data analysis (to identify)
[16] Elderly monitoring	Medical for weight, blood pressure, blood glucose, pulse oximetry.	Black box/ HUB Gateway (to identify e.g. coXnico) Personal Computer	USB , RS232 BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare)

Scenario	Devices	Equipment	Connectivity	Platforms
[21Low risk of developing chronic diseases	Medical for weight Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Nutritional folder
[22] Increased risk of developing chronic diseases	Medical for weight and blood pressure Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Nutritional folder
[23] High risk of developing chronic diseases	Medical for weight and blood pressure Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Nutritional folder
[24] Very high risk of developing chronic diseases	Medical for weight Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Nutritional folder
[25] Extremely high risk of developing chronic diseases	Medical for weight and blood pressure Wearable for activity monitoring	Smartphone Tablet Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Tele-monitoring (e.g. eCare) Continuous monitoring (e.g. BodyCloud) Nutritional folder
[27] Vitamins intake analzyer	Vitamins analyser (to identify)	Smartphone Tablet	BT? NFC?	Monitoring (to identify)
[28] Calories / nutrition mixer / cookware counter	Embedded device for calories counter/ Nutrition analysis (to identify)	Smartphone Tablet	BT? NFC?	Nutrition analysis system (to identify)

Scenarios by Users Interaction

The interaction parameter describes how the users of the scenarios interact with the system. In the INTER-Health scenarios the main interactions are with:

- DEVICES (medical, wearable for activity monitoring and localization, smart, Kiosk). All the scenarios use one or more kinds of devices. The different devices are used mainly by final users: patients and healthy people to measure parameters. In some cases they can be used by health operators (e.g. in the surgery) or by School operators (e.g. use of health kiosk at school).
- WEB INTERFACE (on tablet and on personal computer): it is used in all the scenarios, except the scenario 28, by all kind of users (with different profiles)
  - to monitor data (almost all scenarios)

  - to fill out questionnaires (scenarios number 23-24-25)

- APP on smartphone / tablet to collect measures: it is used in all the scenarios, except scenario 16 that uses a gateway hub. The app is used mainly by final users: patients and healthy people to collect measures. In some cases it can be used by health operators (e.g. in surgery) or by school operators (e.g. use of health kiosk) to collect the patients/healthy people measures in assisted mode.

Scenarios by data

This section presents the main kinds of information that are produced and consumed by different users.

Personal data: these data, depending on the kind of service, contain all information to identify a person (e.g. name, address, tel. number, age, sex, and ethnicity) and particular information on the health status (e.g. problems, diseases, therapies). This kind of information is in general collected by health operators to set the system with a new patient.

Protocol /setting parameters (frequency, type of measure, thresholds...): these data enable Health Operators to set the protocol (for the service that operates) according to the specific state of health of the person. These data can be the kind of measures (subjective and/or objectives) that should be monitored, the kind of devices and the way to transmit measures, the frequency, etc.

Health measures (weight, blood glucose, steps, calories...): the health measures correspond to all measures that a person performs using medical devices and wearable devices for physical activity and location.

Subjective measures (questionnaires): subjective measures corresponds to information that a person provides answering questions on his eating habits and physical activity practice, choosing generally the answer, using a pop up.

Reports (details and trend of health measures of patients /healthy people): reports are elaborated by the systems in order to allow health operators to monitor the health status of their patients. A similar report and/or the detailed measure is also available for the patient/healthy people.

Health measures analysis (e.g. out of threshold range, frequency): these analysis on the collected data are useful for health operators in order to monitor the behaviour and the health status of the patients.

Reports on subjective measures (questionnaires): like to the clinical reports, these reports on subjective measures allow health operators to have a more complete picture of the health status of the patients.

Dashboard on health status and trends: summary data are accessible both by the patients and by health operators.

Position and tracking: the location and tracking are information available to control patients with cognitive problems (or Alzheimer). The scenario is thought both for family members and for health operators.

Analysis of anonymised data and trend of measures: these analysis are based on big amounts of data and they are used by Health operators and school operators in order to put education on healthy lifestyles in schools.

The following table summarises the kind of data for the different scenarios, a “P” or a “C” in a cell means that the corresponding data can be produced or consumed by the corresponding type of user.

Table 8. INTER-Health Kind of data produced and consumed

Kind of data	Healthy people /Patients	Family members	Health Operators	School Operators
User personal data			**P** Scenarios 1, 11, 12, 16, 21, 22, 23, 24, 25	**P** Scenario 15
Protocol /setting parameters (frequency, type of measure, thresholds...)			**P** Scenarios 1, 11, 12, 15, 16, 21, 22, 23, 24, 25	
Health measures (weight, blood glucose, steps, calories...)	**P** Scenarios 1, 11, 12, 15, 16, 21, 22, 23, 24, 25, 27			
Subjective measures (questionnaires)	**P** Scenarios 1, 11, 12, 15, 21, 22, 23, 24, 25		**P** Scenarios 1, 11, 12, 15, 21, 22, 23, 24, 25	
Reports (details and trend of health measures of patients /healthy people	**C** All scenarios except 28	**C** All scenarios except 28	**C** All scenarios except 28	
Health measures analysis (e.g. out of threshold range, frequency)			**C** Scenarios 1, 11, 12, 15, 16, 21, 22, 23, 24, 25	
Reports on subjective measures (questionnaires)	**C** Scenarios 1, 11, 12, 15, 21, 22, 23, 24, 25		**C** Scenarios 1, 11, 12, 15, 21, 22, 23, 24, 25	
Dashboard on health status and trend	**C** Scenarios 1, 11, 12, 16, 21, 22, 23, 24, 25		**C** Scenarios 1, 11, 12, 16, 21, 22, 23, 24, 25	
Position and tracking		**C** Scenario 12	**C** Scenario 12	
Analysis of anonymised data and trend of measures			**C** Scenario 15	**C** Scenario 15

Scenarios by Business model

Most of the scenarios indicate B2B2C as possible business model in which the service provider (e.g. private or public health) uses ICT services to offer better quality and to reduce costs.

Depending on the kind of service and providers, part of the costs could be covered by the final users: patient or health person.

In this perspective the customer of the INTER-health system that enables, for example, a primary prevention (e.g. for cognitive decline or chronic disease with various degree of risks) or the care and monitoring of diseases (e.g. Heart failure/ chronic diseases / mild Alzheimer / elderly) could be a Health operator (hospital, public or private health operators) that uses it for patients.

Three scenarios address a B2B business mode, two of them ([27] Vitamins intake analyser and [28] Calories / nutrition mixer / cookware counter) are related to innovative smart devices that could be used in hospital, at doctor office or into work canteens.

One ([15] Surveillance systems for prevention programs) could be used for the prevention campaign at the schools. In this case the customer could be the government (e.g. the Regional government) in collaboration with the public health department.

The scenarios: [27] Vitamins intake analyser and [28] Calories / nutrition mixer / cookware counter, foresee in addition to the B2B model also the B2C model for home use.

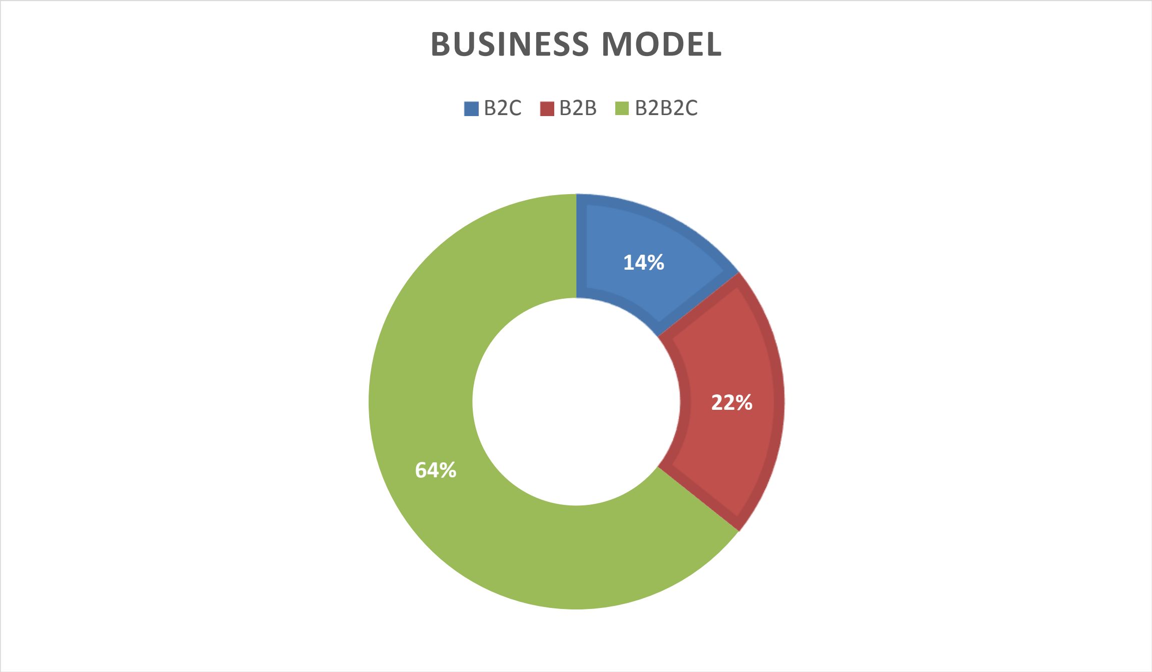

Figure 15. INTER-Health scenarios by Business model

Scenarios Motivations

The Inter-health scenarios address three main areas: **prevention** (scenarios 1, 11, 15, 21, 22, 23, 24, 25, 27, 28), **care** (scenarios 16) and **assistance** (scenario 12).

In the prevention services the main motivations are:

- The introduction of ICT in the healthcare environment allows the creation of a connection network between health staff and the afferent public, which in the preventive field and in terms of health is reflected in the health care cost savings.
- The decentralized and in mobility lifestyles monitoring allows to act on health products in terms of efficacy of treatment for health staff and the person involved.
- The use of mobile devices allow to record objectives measurements in real time and continuously.

In the care and assistance services there are additional reasons related to the quality of life of patients and their families

- Home monitoring can improve the efficacy in terms of response to the program by the patient, comfort and autonomy of the patient (the patient does not have to go to the ambulatory a can stay at home).

In general, the adoption of integrated IoT solutions to develop new services or to enrich existing ones is appealing since allows to benefit of already available services.

Scenarios users' goals

The users' goals in the prevention services are

- From the point of view of the people to improve their well-being, to feel good, to improve wellbeing of loved ones, to become the main players in their own health state.
    - From the point of view of Health Operators to promote the adoption of proper lifestyles for health, to improve and make more efficient the activity by monitoring lifestyles of remote users / citizens in their homes and in real time.

The users' goals in the care and assistance services are

- From the point of view of the patients: they want to be cared staying at home, they want to feel good and improve their well-being, they want to keep their autonomy and quality of life
- From the point of view of Health Operators they want to care their patients monitoring them at home reducing visits at home and hospitalizations.

Scenarios by Interoperability layers

For all the scenarios described the interoperability requirements and the layers involved are outlined.

In particular the main requirements collected at the different layers are the following:

Data & Semantics:

- There should be primitives for data interpretation in the different platforms (e.g. mapping between the user identities; correlation between citizen personal data such as: sex, age, tel. number; correlation between the same kind of measures; mapping between unit of measures Kg/g/lb)
- There should be primitives for data interpretation between devices, apps on the smartphone and platforms receiving data (e.g. mapping between the user identities; correlation between the same kind of measures or analysis results like for example alerts)
- There should be primitives for data interpretation in the different platforms and legacy system (e.g. nutritional folder)

Middleware:

- There should be primitives at the platform level for direct access to the collected data of the sensors /devices into the different platforms integrated

Application Services:

- There should be primitives for access to service data (e.g. trend of measures, health status dashboard, fall events, localization data) of the integrated platforms
- Health operators and subjects using smartphone / tablet and web interfaces on personal computer can collect and send measures, query reports and trends and setting information.

Networking:

- There should be a radio communication between the device and the app on the smartphone (e.g. BT)
- Need of managing mobility elderly people, as they will be monitored at home or on the run using a mobile IoT Platorm

Device:

- There should be primitives at the gateway level for direct access to the collected data of the sensors /devices into the different platforms integrated

The interoperability layers involved into the INTER-Health scenarios are showed in the following diagram.

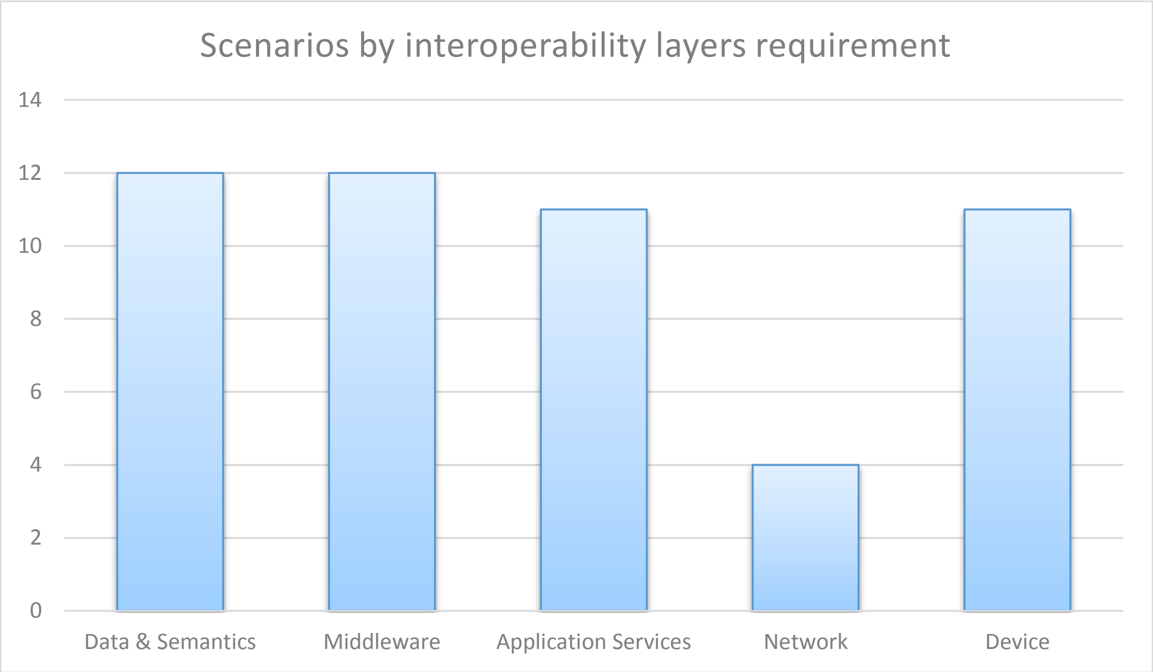

Figure 16. INTER-Health scenarios by interoperability layers

Since in the INTER-Health scenarios the final service is obtained in most cases integrating already existing platforms (comprehensive of devices, app/ gateway and final services) the requirements at the network layer occur only in two cases.

3.3 INTER-Health/LogP scenarios

In addition to the two application domains, the project also wants to test interoperability between different domains. Bringing together data from two different domains, allows to create many other services. This is the reason to identify scenarios combining health and logistic domains.

Additional scenarios related with the cross-domain INTER-Health/LogP scenarios and other extra scenarios for the INTER-Domain pilot will be brought to the project through the open call that will be closed in January 2017. The scenarios will be included in the deliverables associated with WP6 and WP7.

3.3.1 Business scenarios description

This section presents the business scenarios in the cross domain e-Health/logistics and port transport.

Accident at the port area [9]
The objective is to interoperate the wearable medical devices with IoT platforms such as the road haulier company and the port emergency control centre are able to react quickly, thus reducing time responses during accidents and health prevention.
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. medical data). Application Services: There should be primitives between the haulier IoT platform and the port IoT platform for sharing information about the driver. The haulier company monitors the health of their drivers at any times. The haulier IoT cloud platform and the port emergency control system share security and safety information. Middleware: The personal health device alerts the haulier IoT platform. Networking: There should be primitives to connect the truck to the port platform. Device: -

Health Monitoring System [10] [17]
The objective of these scenarios are to create an IoT cloud platform that will allow passengers of different transportation modes to connect their wearable devices that monitors their ECG, SPO2, blood pressure or temperature. This platform will be connected with their respective e-health or e-care platform and it will establish a new form of triage in order to detect and tackle health problems during long distance trips. The scenario can also be extended to truckers. A health IoT system will allow the addition of new medical sensors. It will also make healthcare borderless and facilitate collaborative care.
Interoperability requirements: Data & Semantics: There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.).

Application Services: It will also make healthcare borderless and facilitate collaborative care. Middleware: A health IoT system will allow the addition of new medical sensors. Networking: - Device: -

Alcohol / Drug testing protection system from driving for truck / bus drivers [26]
The objective is to develop platform or application that interoperates with the fleet management system of road haulier companies and detects information related to alcohol and drugs in the drivers' blood. The analysis would be done by a tube, where the driver exhales and this information is sent via GSM to the road haulier company IoT platform.
Interoperability requirements: Data & Semantics: Application Services: Middleware: Device: Integrate a device to measure the level of alcohol and drugs with the truck system.

3.3.2 Analysis

Cross domain INTER-LogP and INTER-Health operations explore the opportunities raised by the interconnection of IoT platforms designed for completely different application domains. In this case it demonstrate how e-Health and e-Care could use IoT platforms dedicated to transport to prevent the occurrence of accidents and to support evacuation or attention in case of emergency situations.

Some of these cross-domain scenarios could be considered in the pilot sites. The following table shows the degree of readiness to test the scenarios proposed:

Scenario name	Readiness	Reasons
Accident at the port area	High	The testing of this scenario could be part of emergency simulation exercises that are executed periodically at the port area.
Health monitoring system with passengers aboard a ferry	Medium	The testing of this scenario could be part of emergency simulation exercises that are executed periodically at the port area.
Health monitoring system with passengers aboard a train	Low	Testing this specific scenario requires the collaboration of passenger train undertakers.
Alcohol / Drug testing for truck/ bus drivers	Low	The execution of this scenarios requires an important cultural change by truckers and road hauliers.

Scenarios by kind of users

Since there are only three kind of scenarios the users are very diverse and do not repeat along the scenarios. The users are Haulier companies, drivers, train companies, port authorities and cruise companies ([10] ferry case).

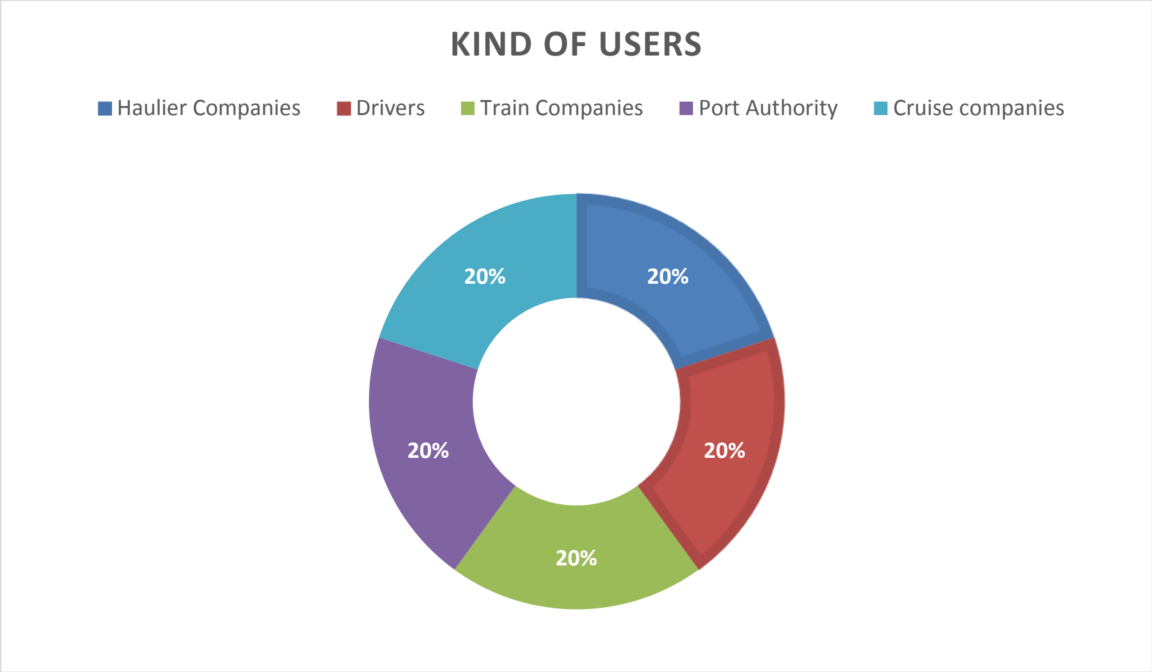

Figure 17: INTER-LogP/INTER-Health scenarios by kind of users

Scenarios by Context

Since there are three scenarios, only three context have been identify but in the case of Medical care in public transport it could be split into two contexts since it has been considered the train scenario [17] and ferry scenario [10].

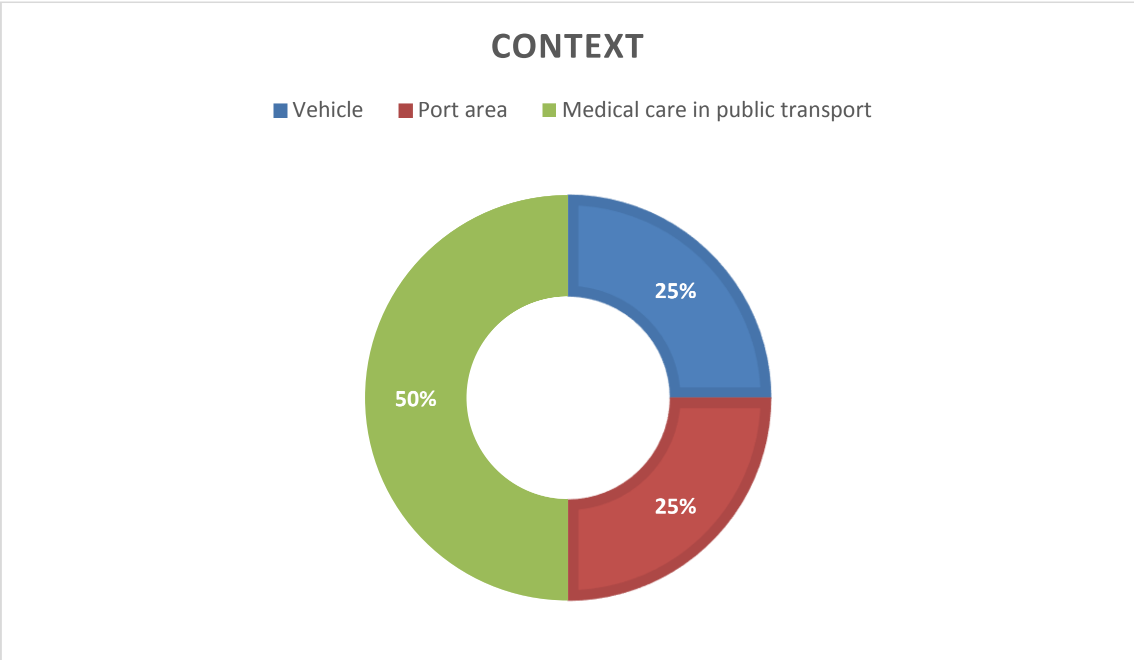

Figure 18. INTER-LogP/INTER-Health scenarios by context

Scenarios by Interacting systems

In the description of the scenario the interacting systems give an overview of the technical environment.

Table 9. INTER-LogP/INTER-Health Interacting systems

Scenario	Devices	Equipment	Connectivity	Platforms
[9] Accident at the port area	Medical device Truck	Pacemaker Tachograph GPS Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Fleet Management system Valenciaport PCS Truck's owner IoT Platform Port Control System Emergency Control Centre IoT platform
[26] alcohol / Drug testing protection system from driving for trucks / bus drivers	Alcohol tube machine sensor	Alcohol tube machine Truck/Bus Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https	Movildata Fleet Management System IoT Platform Driver IoT Platform
[17] Health monitoring system with passenger aboard a mod of public transport	Medical wearable devices	Personal Computer	BT / BTLE 2G-3G-4G WiFi/ADSL Internet https NFC	Train Company IoT Platform Cruise company IoT Platform Passenger IoT platform Health IoT platform

Scenarios by Users Interaction

The interaction parameter describes how the users of the scenarios interact with the system. In the INTER-Health/LogP scenarios the main interactions are with:

- DEVICES (smartphones, DGPS for activity monitoring and localization, medical wearable devices, alcohol sensors). All the scenarios use one or more kinds of devices. The different devices are used mainly by final users: drivers and passengers.
- WEB INTERFACE (personal computer on application): it is used in most scenarios,
- APP on platform to collect measures and calculate variables such as Alcohol on blood.

Scenarios by data

In this section are presented the main kinds of information that are produced and consumed by the different users.

Device: data produced from the level of drugs or alcohol in blood, from wearable devices, truck positioning.

Platform: platform and app data.

[26] Produced data are the levels of drugs or alcohol in blood.

[9] Produced: driver medical data, truck position.

Consumed: safety event.

[17] Produced: patient monitoring data

Consumed: data collected from IoT cloud platform

Scenarios by Business model

The creation of new services from the interoperability across platforms is one of the most common business model from the INTER-Health/LogP scenarios due to the communication of different platforms from the Logistic and Health Sector.

Scenarios Motivations

The Inter-Health/LogP are motivated by decreasing fatal accidents at the port and improving safety related to Health conditions accidents. This would be improved by the real time reaction. As well, introducing Health IoT systems in the public transport sector enables emergency medical personnel early access to data available for treatment and improving triage in case of emergencies.

[26] Decreasing fatal accidents

[9] The scenario is focused on improving safety within the port. It wants to react in real time when an accident happens.

[17] Having a health IoT systems in this environment enables emergency medical personnel early access to data pertinent in the treatment and triage of patients.

Scenarios users' goals

The users' goals in the heath/logistic services are

- From the point of view of the drivers to improve citizen protection from drivers under the influence of alcohol or drugs.
- From the point of view of Port Authority to detect accidents and react in real time
- From the point of view of haulier companies to improve the safety of their drivers and reduce accidents
- From the point of view of train and cruise companies to have a greater customer satisfaction by improving their assistance of medical staff triage.

[26] Citizen protection from drivers under influence.

[9] Port authority wants to detect accidents and react in real time.

Haulier company wants to improve the safety of their drivers.

[17] Greater customer satisfaction by assisting medical staff triage. Medical teams wants to start triage ASAP.

Scenarios by Interoperability layers

For all the scenarios described the interoperability requirements and the layers involved are outlined.

In particular the main requirements collected at the different layers are the following:

Data & Semantics:

- There should be primitives for data interpretation in the different platforms (e.g. medical data).
- There should be primitives for data interpretation in the different platforms (e.g. mapping objects among platforms; correlation between the same kinds of measures; etc.).

Middleware:

- The personal health device alerts the haulier IoT platform.
- A health IoT system will allow the addition of new medical sensors.

Application Services:

- There should be primitives between the haulier IoT platform and the port IoT platform for sharing information about the driver. The haulier company monitors the health of their drivers at any times. The haulier IoT cloud platform and the port emergency control system share security and safety information.
- It will also make healthcare borderless and facilitate collaborative care.

Networking:

- There should be primitives to connect the truck container to the port platform.

Device:

- Integrate a device to measure the level of alcohol and drugs with the truck system.

The interoperability layers involved into the INTER-Health/LogP scenarios are showed in the following diagram.

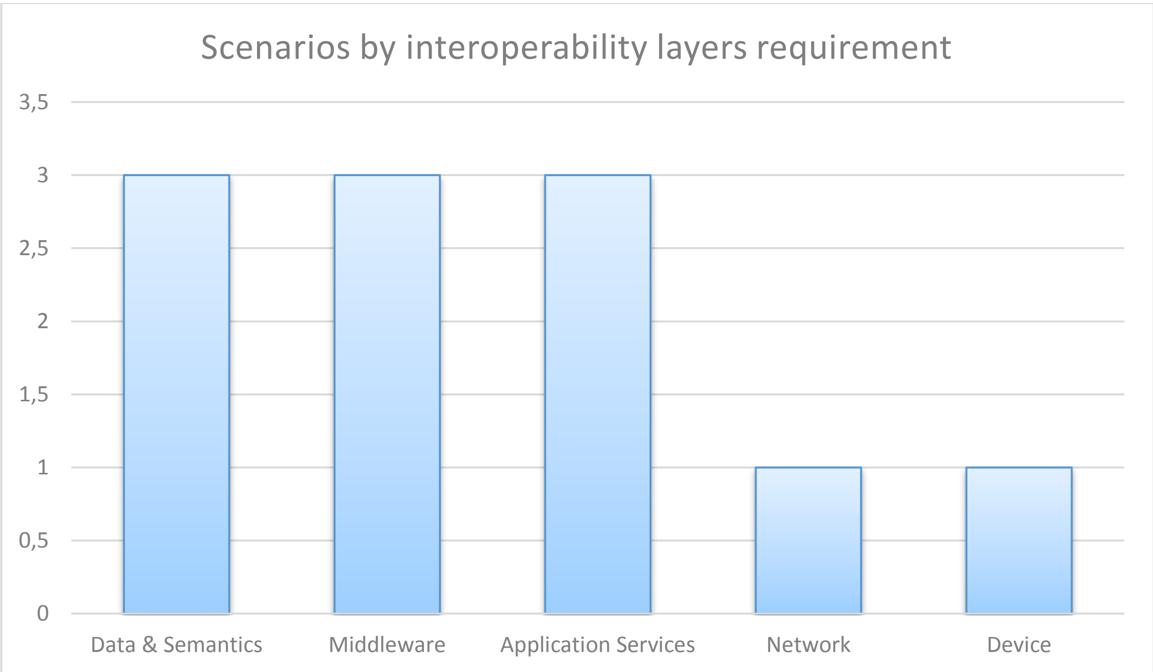

Figure 19. INTER-LogP/INTER-Health scenarios by interoperability layers

4 Scenario use cases

In this chapter, each of the scenarios is analysed to extract the use cases that will be considered in WP3, WP4 and WP5.

In particular, for each business scenario or group of scenarios, there is a diagram of use cases with the actors involved, the main functionalities offered to the final users and the integration and interoperability functionalities needed.

4.1 INTER-LogP scenario use cases

This section defines the use case diagrams for the INTER-LogP scenarios. Some scenarios have been merged in the same diagram as the operation is very similar. This is the case, for example, the scenarios about the monitoring reefer container and monitoring of containers carrying sensitive goods where the main difference is the actor who manages the container IoT platform and the use of embedded or attached devices to the container.

4.1.1 IoT support for transport planning and execution [2]

The scenario focuses on providing connected truck services to plan and execute transport services through interoperability of IoT platforms and devices.

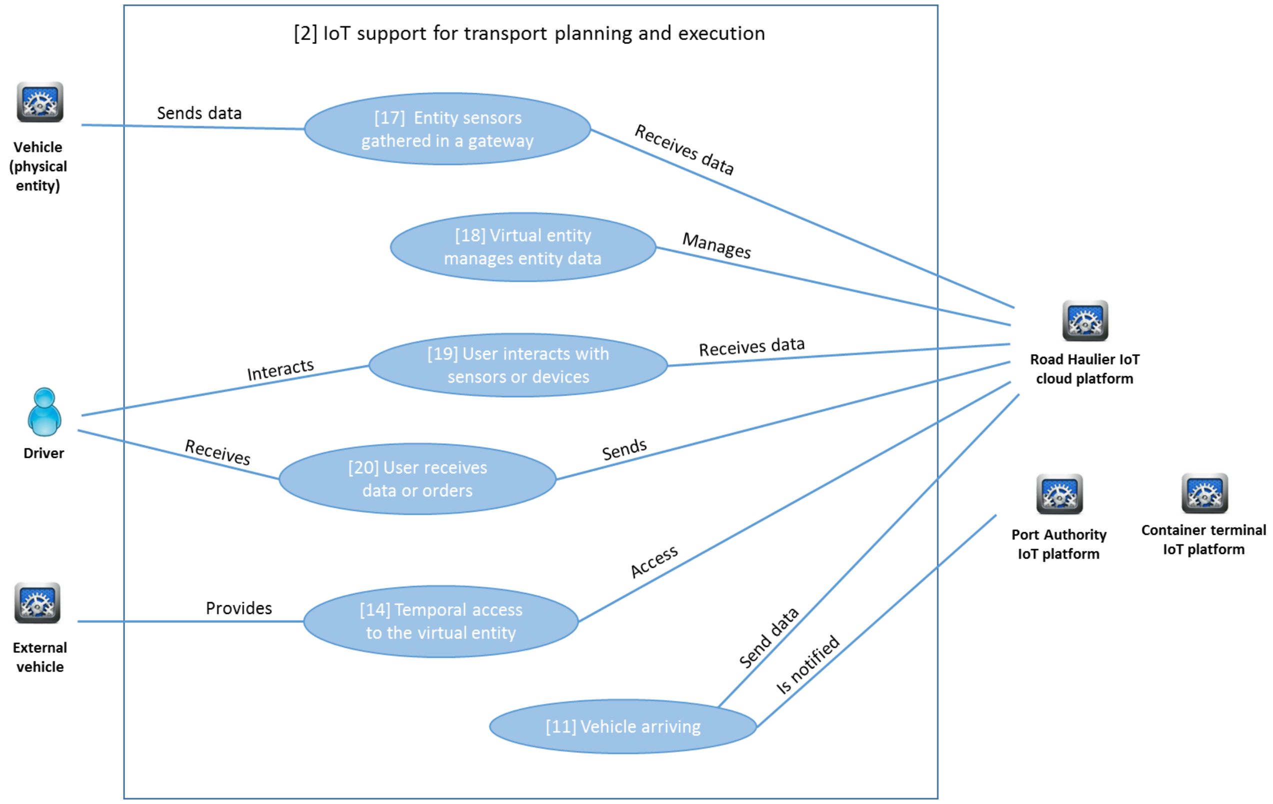

Figure 20. "IoT support for transport planning and execution" use case diagram

The main actors involved in the scenario are:

- Vehicle: It is the physical entity of the scenario. It contains multiple sensors and devices.
- Driver: It is the user who interacts with the devices and sensors of the truck.
- External vehicle: If the road haulier company don't have enough vehicles for the service, it can hire external vehicles that can be managed by his fleet management system.
- Road haulier IoT cloud platform: It's the IoT platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company. It can send orders to the driver and provide access to other IoT platforms and applications.
- Port authority IoT platform: It's the platform that manages all the systems of the port including the gates to control the arrival and departure of trucks.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal.

4.1.2 IoT Weighbridges [3]

The scenario is focused on attending a high quantity of truck weighs per day with the minimum delays for the transport. The weight information is automatically sent to the destination.

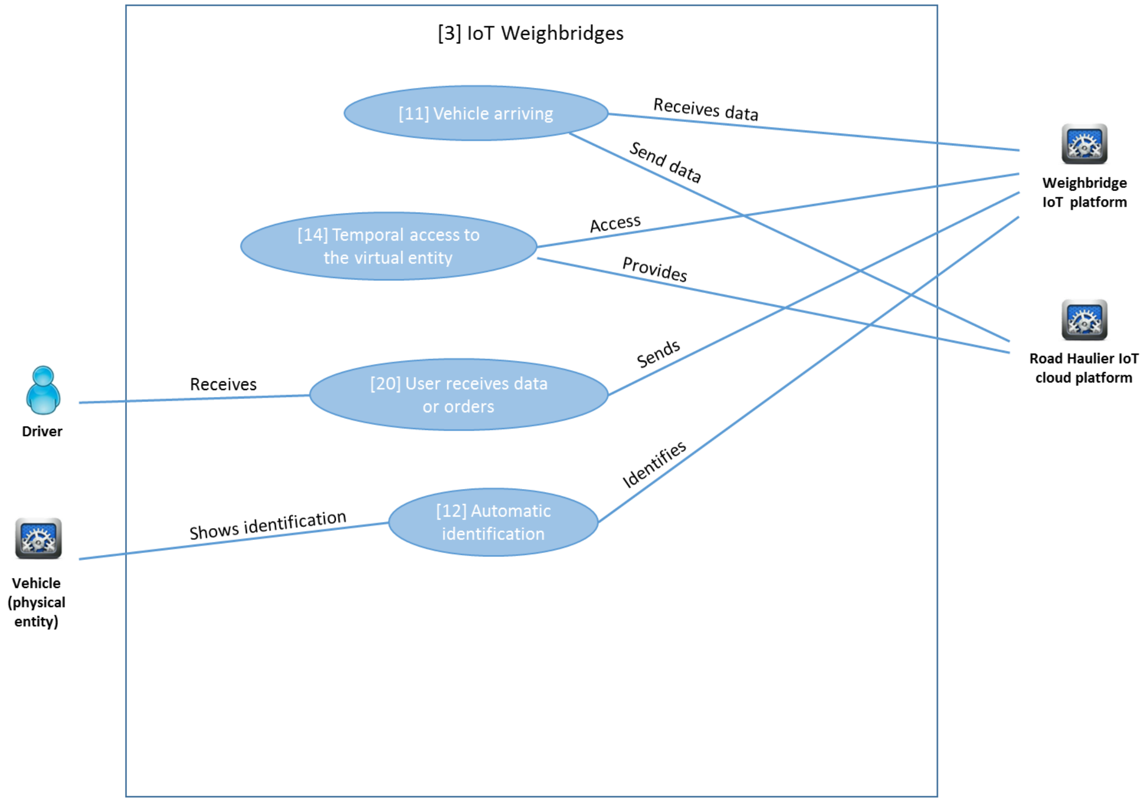

Figure 21. "IoT Weighbridges" use case diagram

The main actors involved in the scenario are:

- Vehicle: It is the physical entity of the scenario. It contains multiple sensors and devices.
- Driver: It is the user who interacts with the devices and sensors of the truck.
- Road haulier IoT cloud platform: It's the IoT platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company.
- Weighbridges IoT platform: It's the platform that manages all the systems of the weighbridge. It can send instructions to the driver.

4.1.3 Monitoring reefer container [4]

The scenario is focused on tracking and monitoring the temperature of the container through different operators along its route, and to obtain faster responses in front of any issue with the temperature of the container.

The process carried out in this scenario is the same as that in "Monitoring of containers carrying sensitive goods [5]", so the use case diagram is the same.

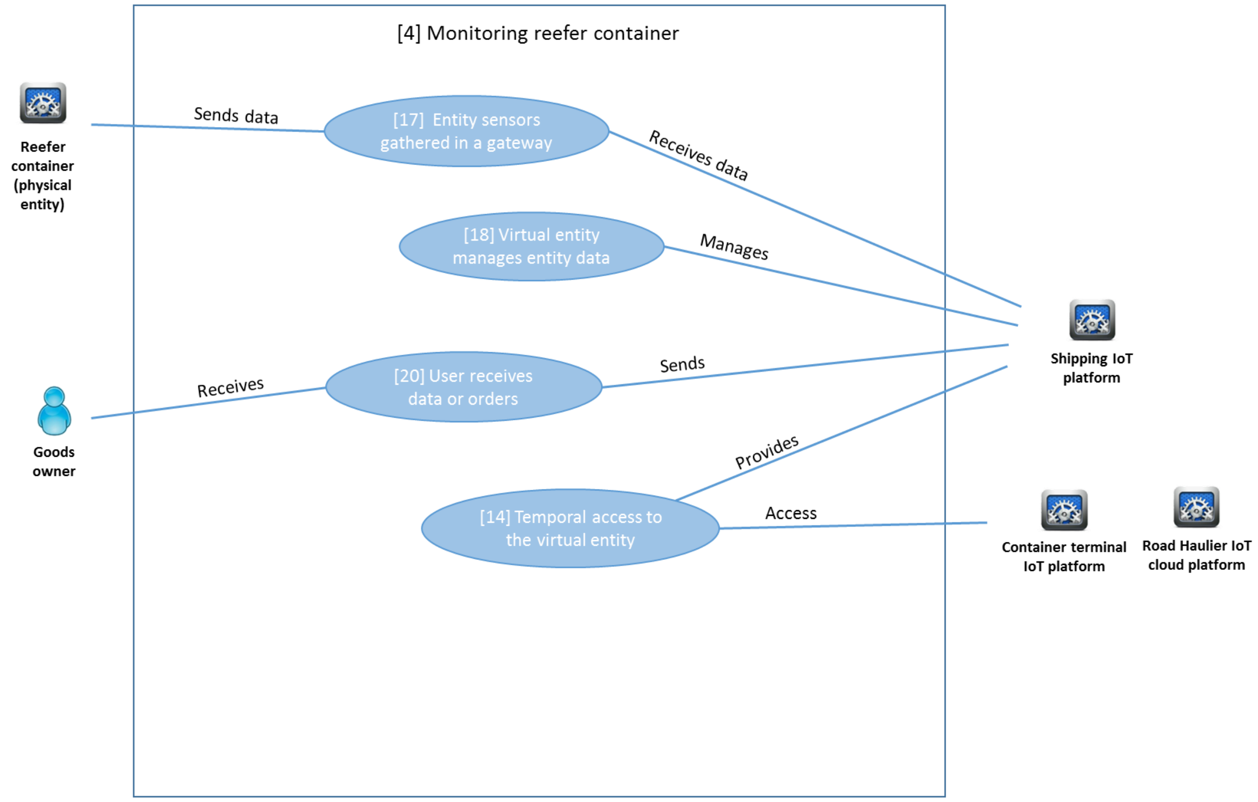

Figure 22. "Monitoring reefer container" use case diagram

The main actors involved in the scenario are:

- Reefer container: It is the physical entity of the scenario. It contains multiple sensors.
- Good owner: It is the company sending goods into the container.
- Shipping IoT cloud platform: It's the platform of the operator of the container and it is used to manage all the containers and vessels of the company. It informs the traders about the state of their goods.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. It manages the container data when it is in the terminal.
- Road haulier IoT cloud platform: It's the platform used to manage all the vehicles and drivers of the company. It manages the container data when it is on the truck.

4.1.4 Dynamic lighting in the port [6]

The scenario is focused on regulating the intensity of the lights needed depending on the position of internal machinery and external trucks, in order to save energy and thus reduce the carbon footprint derived from lighting usage.

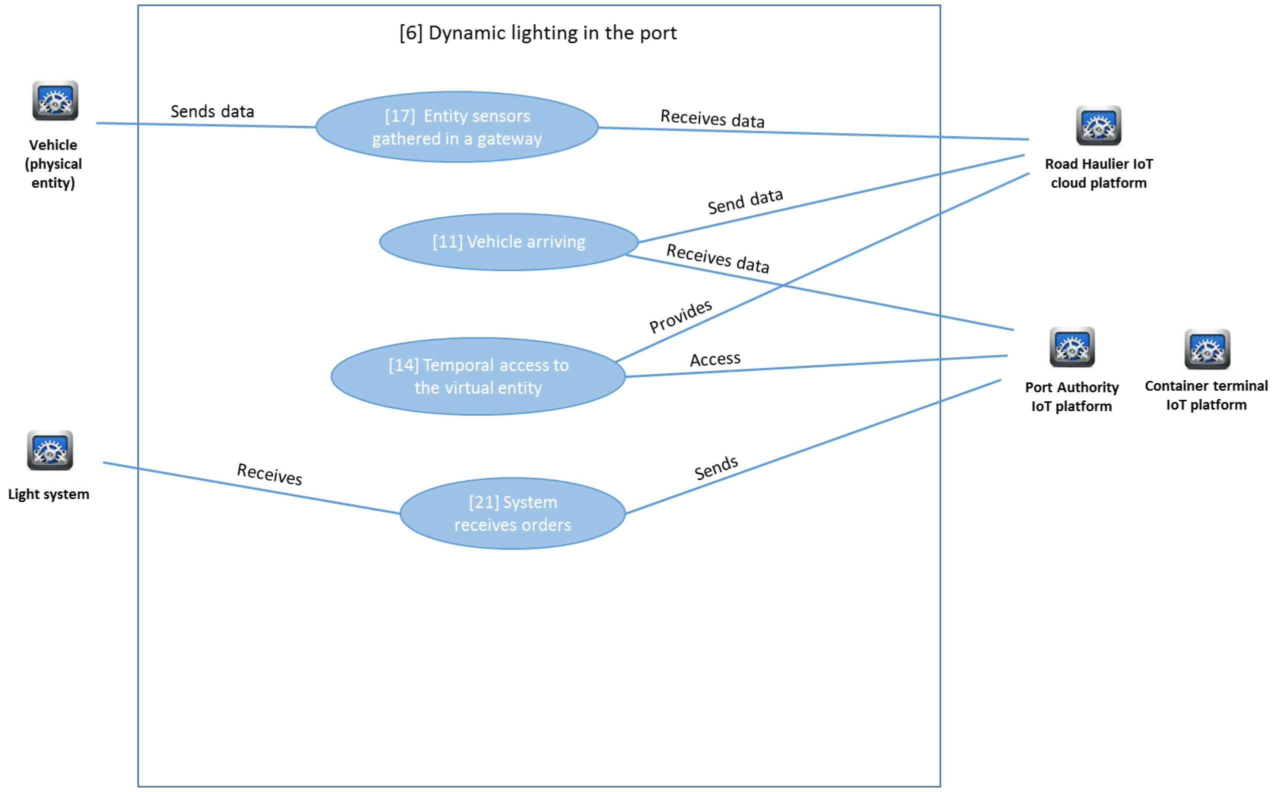

Figure 23. "Dynamic lighting in the port" use case diagram

The main actors involved in the scenario are:

- Vehicle: It is the physical entity of the scenario. It contains multiple sensors and devices.
- Light system: It is the system that manages all the lights, the light system of the port and of the terminal are different.
- Road haulier IoT cloud platform: It's the platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company.
- Port authority IoT platform: It's the platform that manages all the systems of the port. It can send orders to its light system.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. It can send orders to its light system.

4.1.5 SCADA port sensor system integration with IoT platforms [7]

The scenario is focused on opening access to relevant data that is managed by the SCADA system of the port, i.e. enabling new business models and applications therefore providing more added value to the port.

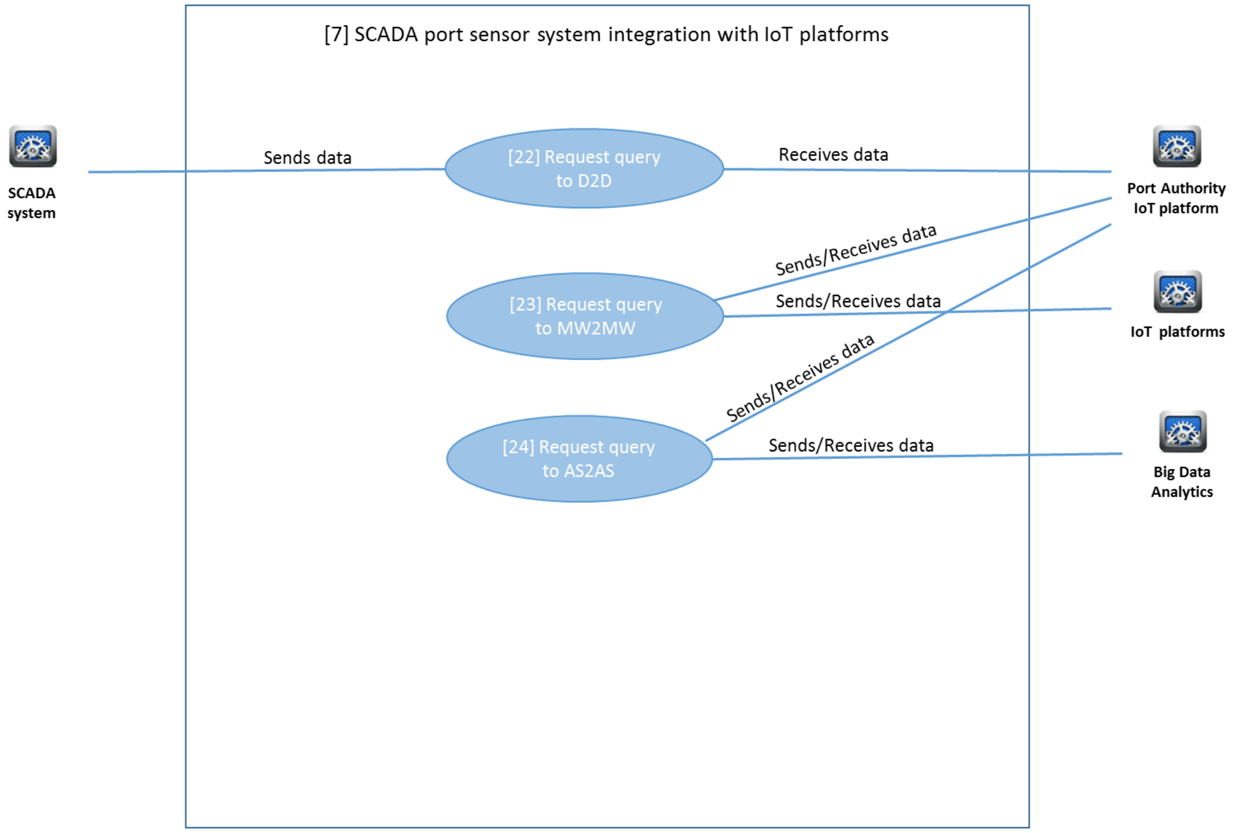

Figure 24. "SCADA port sensor system integration with IoT platforms" use case diagram

The main actors involved in the scenario are:

- SCADA system: It is the system that gathers the data from several sensors of the port.
- Port authority IoT platform: It's the platform that manages all the systems of the port.
- IoT platforms: They are all the external platforms that want to access to the data provided by the port authority.
- Big Data Analytics: It's the system that assess all the data of the port.

4.1.6 SEAMS integration with IoT Platforms [8]

The scenario is focused on improving the data collection of data from the Port Container Terminal machinery in order to exchange information with several systems and platforms in a pre-defined standard way.

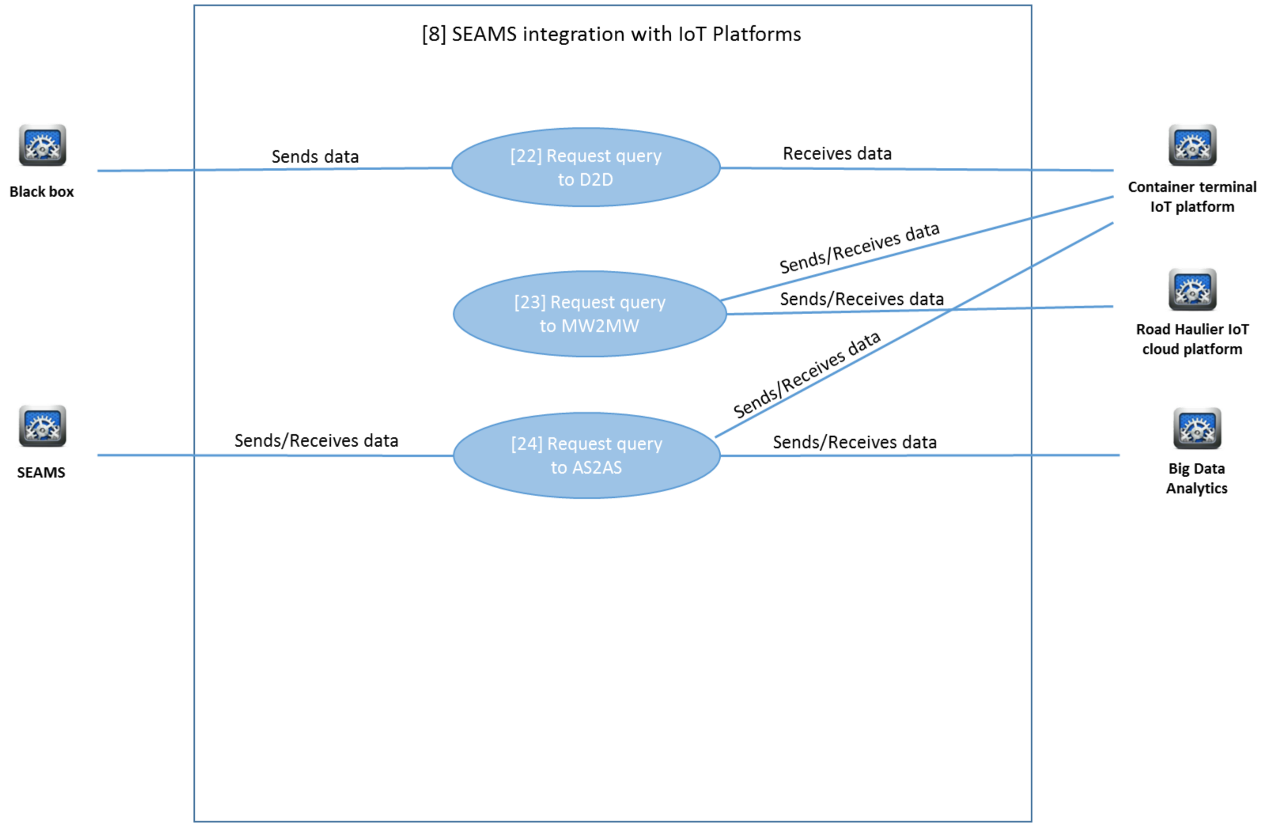

Figure 25. "SEAMS integration with IoT Platforms" use case diagram

The main actors involved in the scenario are:

- Black box: It is the system that gathers the data from all sensors from each machine in the container terminal.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal.
- Road haulier IoT cloud platform: It's the platform that manages all the vehicles and drivers of the company. It sends information about the position of the vehicles in the terminal.
- Big Data Analytics: It's the system that assess all the data of the terminal.
- SEAMS: It is an internal application of the terminal that access, manages and calculates data from the machinery.

4.1.7 IoT interoperability for Vessel Arrivals [13]

The scenario is focused on providing the IoT infrastructure and interoperability capabilities to enhance the coordination and decision making in vessel port arrivals.

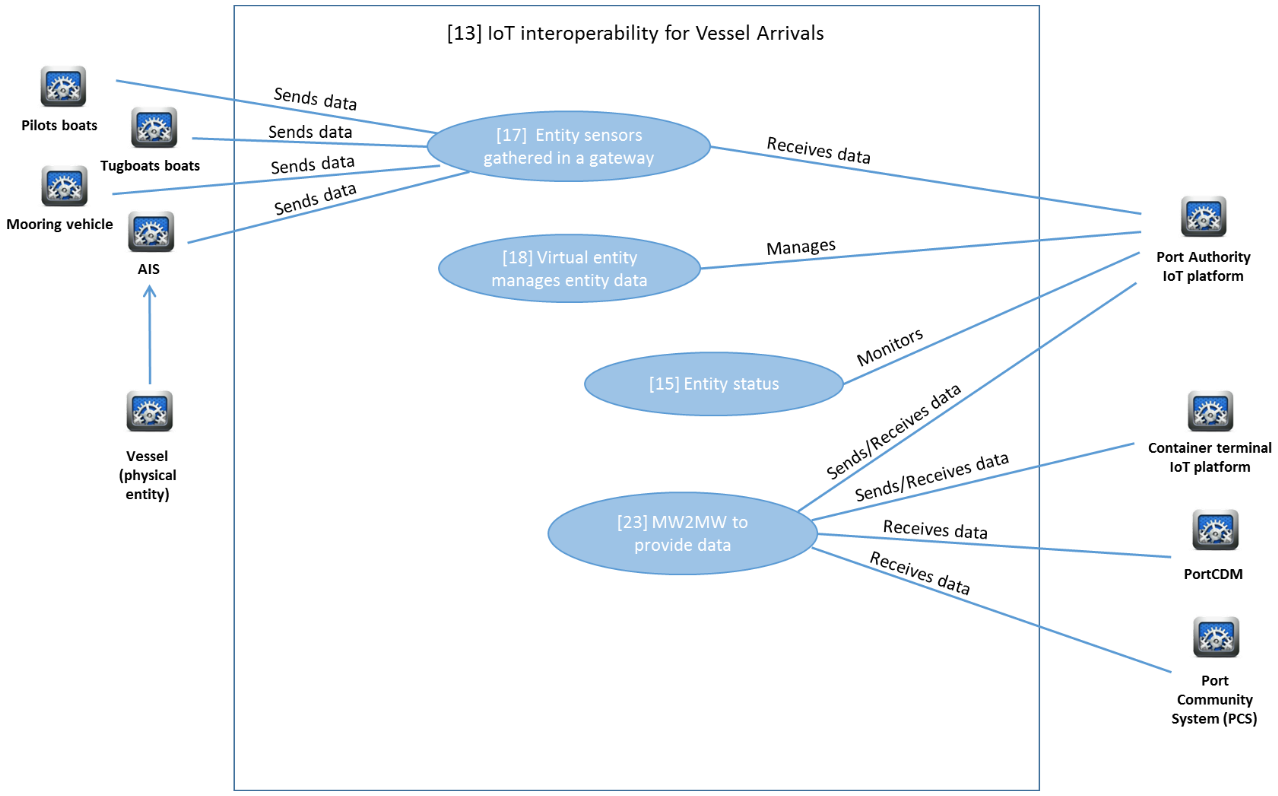

Figure 26. "IoT interoperability for Vessel Arrivals" use case diagram

The main actors involved in the scenario are:

- Vessel: It is the physical entity of the scenario. It access to the port facilities and sends its position through the AIS system.
- Port services: There are some services needed when a vessel arrives. Pilots' boats, tugboat boats and mooring vehicles send their position and some extra information.
- Port authority IoT platform: It's the platform that manages all the systems of the port.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal.
- Port CDM (Collaborative Decision Making): It is an internal system of the port that access to the data from the port services.
- PCS (Port Community System): It is an internal system of the port that access to the data from the port services.

4.1.8 Containership is entering the harbour region [18]

The scenario is focused on providing the container information to all the actors involved when it is accessing to the harbour facilities.

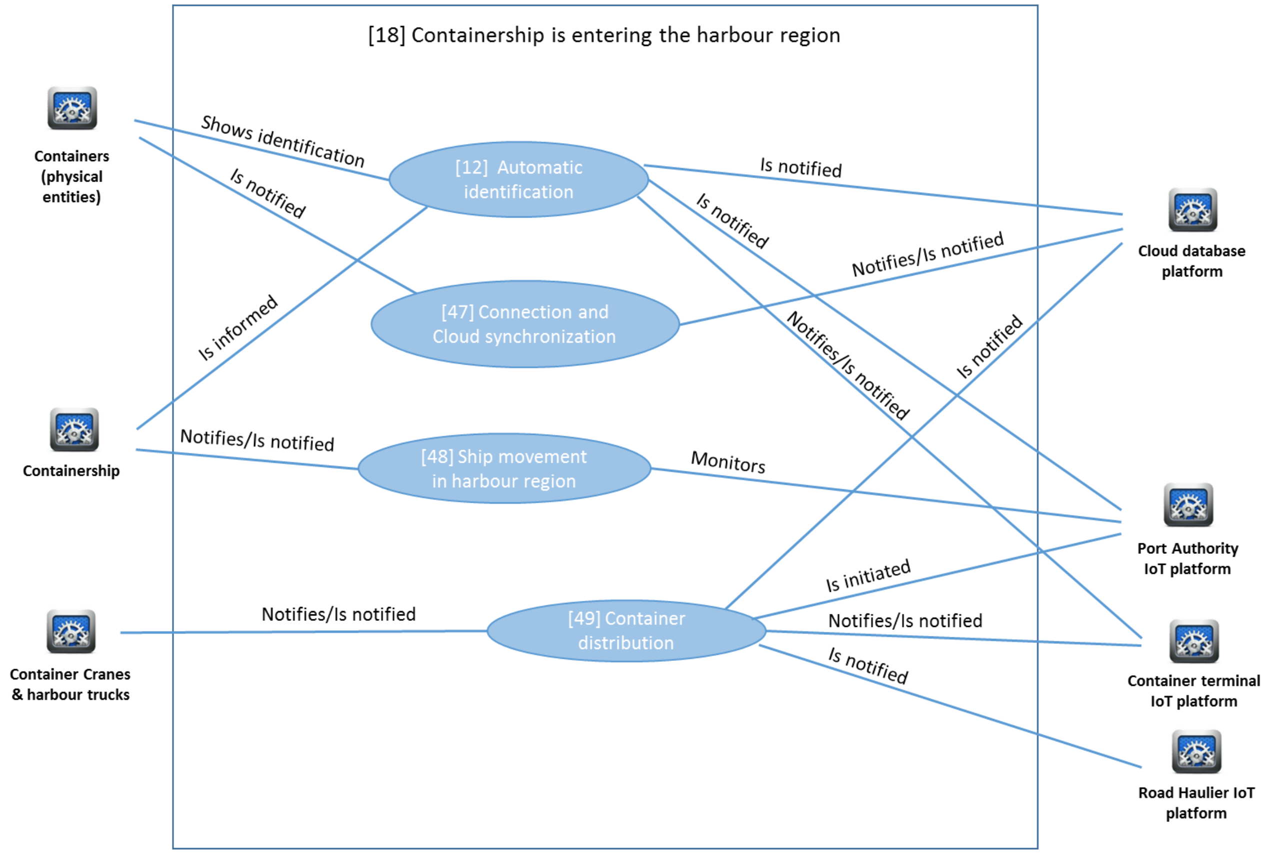

Figure 27. "Containership is entering the harbour region" use case diagram

The main actors involved in the scenario are:

- Container: It is the physical entity of the scenario. It access to the port facilities. The container has been on journey possibly without connection. The container will try to connect to GSM, WIFI, LoRa or other protocols when it is in the range of the networks to synchronize its databases.
- Containership: The containership will contact the harbour IoT system for its location and status.
- Container Cranes & harbour trucks: These have to be informed about time and place of the arriving containership to unload the ship. The Cranes need to know the order of unloading, the harbour trucks need to know where the container should go.
- Cloud database platform: The (virtual) IoT platform in which the main database is located for the containers. Each device will synchronize with this database when the device has internet connection.
- Port authority IoT platform: It's the platform that manages all the systems of the port such as traffic inside the port, safety inside the port, etc.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. This is the platform of the container terminal used for tracking of all containers inside the area as well as managing space in the terminal area.
- Road haulier IoT platform: This is the platform of the road haulier. This platform keeps track of the truck and the driver and it receives information from the port or container terminal about where to pick-up or deliver the container.

4.1.9 Transport on truck breaks down or is hijacked [19]

The scenario is focused on providing real time tracking of container/vehicle movements and monitoring the container status to maintain the cold chain.

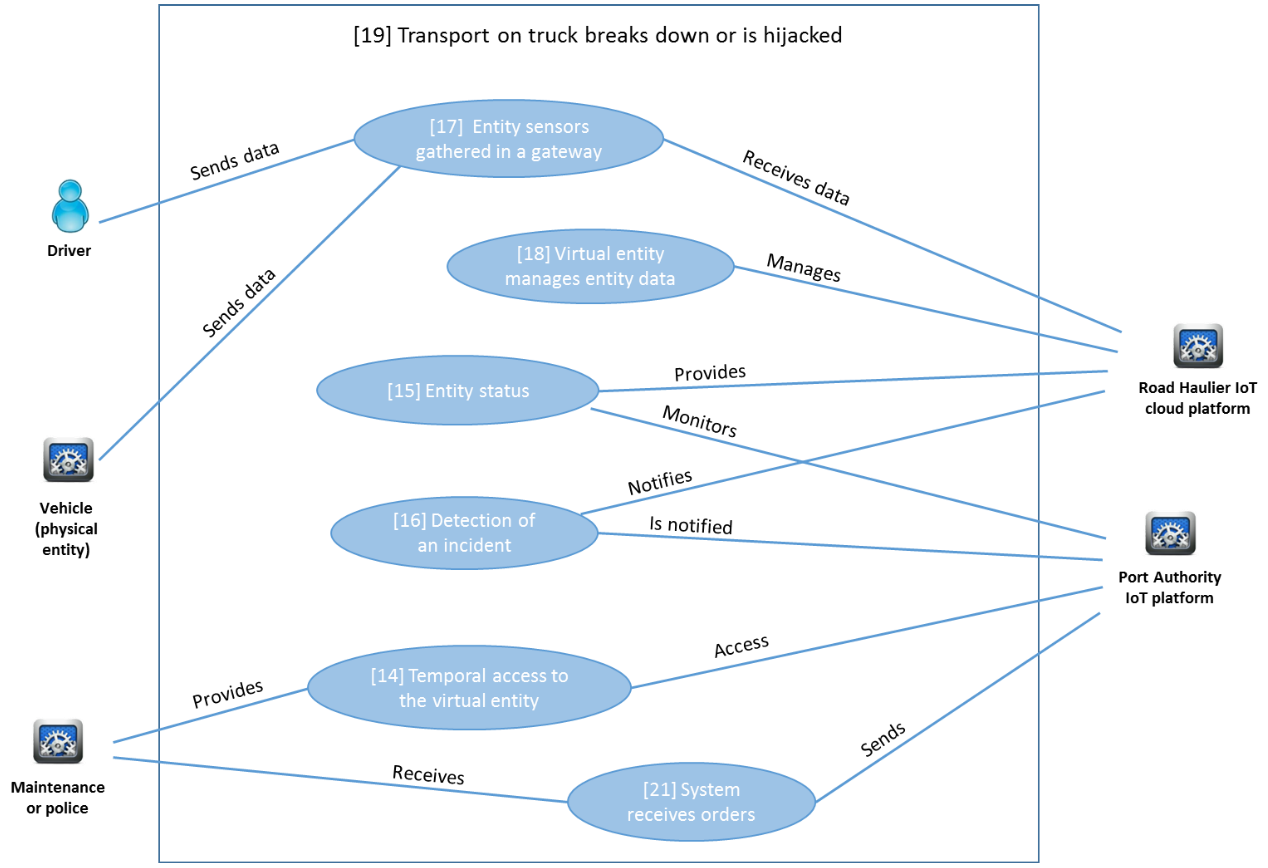

Figure 28. "Transport on truck breaks down or is hijacked" use case diagram

The main actors involved in the scenario are:

- Driver: The person operating the truck that has access to the IoT information through some device (i.e. laptop, tablet, smartphone, etc.) This access will be by means of an API.
- Vehicle: It is the physical entity of the scenario. Keeps track of the trucks location and parameters (gas usage, etc.). It can be accessed by the driver
- Maintenance or police: The party that handles/solves the problem. Maintenance is needed when the truck breaks down, so the truck can continue its delivery. The Police has to be notified in case of criminal activity.
- Road haulier IoT platform: This is the platform of the road haulier. This platform keeps track of the truck and the driver and it will get notifications/alarms from the devices of the truck in case of problems.
- Port authority IoT platform: It's the platform that manages all the systems of the port such as traffic inside the port, safety inside the port, etc.

4.1.10 Damage or problems to the container during shipment [20]

The scenario is focused on providing the IoT infrastructure and interoperability capabilities so as to enhance the coordination and facilitate the decision making process in vessel port arrivals.

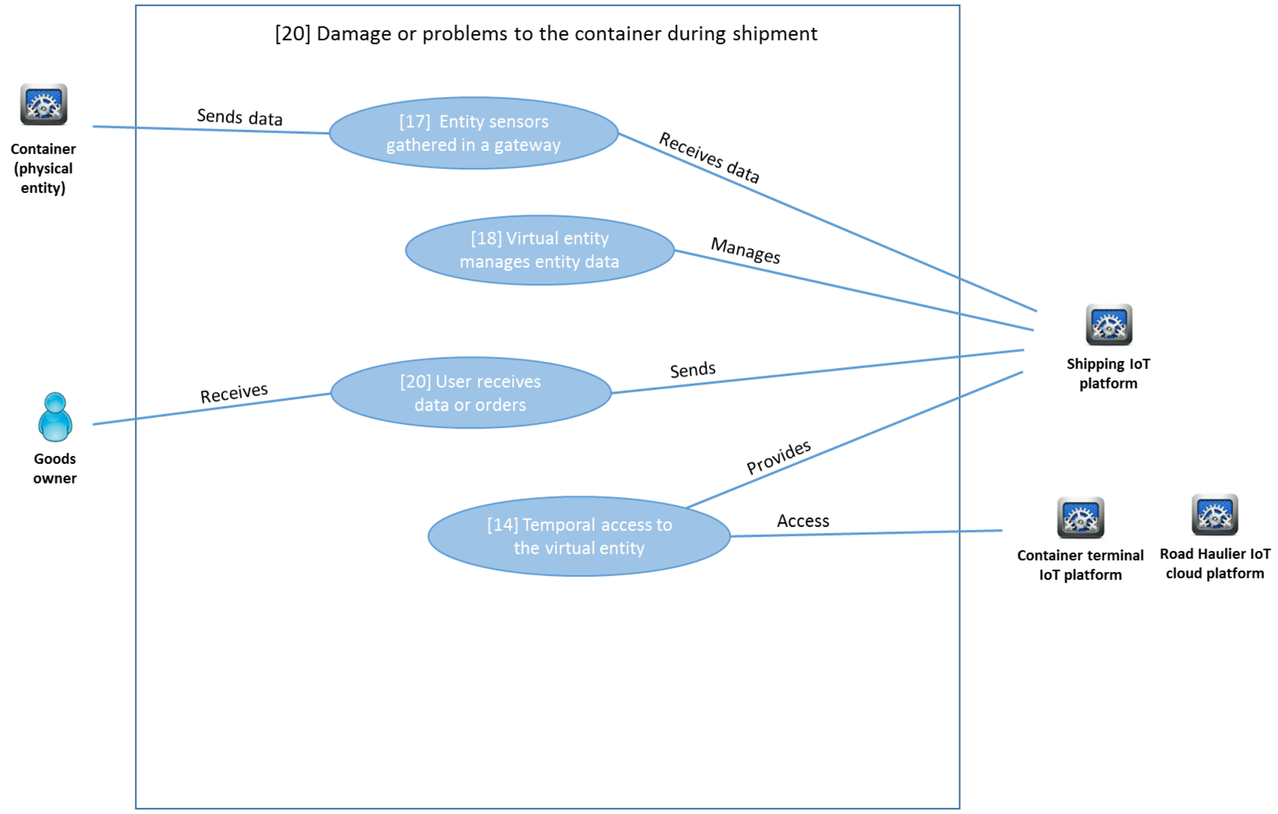

Figure 29. "Damage or problems to the container during shipment" use case diagram

The main actors involved in the scenario are:

- Reefer container: It is the physical entity of the scenario. It contains multiple sensors.
- Good owner: It is the company sending goods into the container.
- Shipping IoT cloud platform: It is the owner of the container and it is used to manage all the containers and vessels of the company. It informs the good owner about the state of the goods.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. It manages the container data when it is in the terminal.
- Road haulier IoT cloud platform: It's the platform used to manage all the vehicles and drivers of the company. It manages the container data when it is on the truck.

4.1.11 Reliable control of robotic cranes and trucks in port terminals [29]

The scenario is focused on providing new mechanisms for access controls and trucks monitoring in restricted areas through interoperability of IoT platforms and devices.

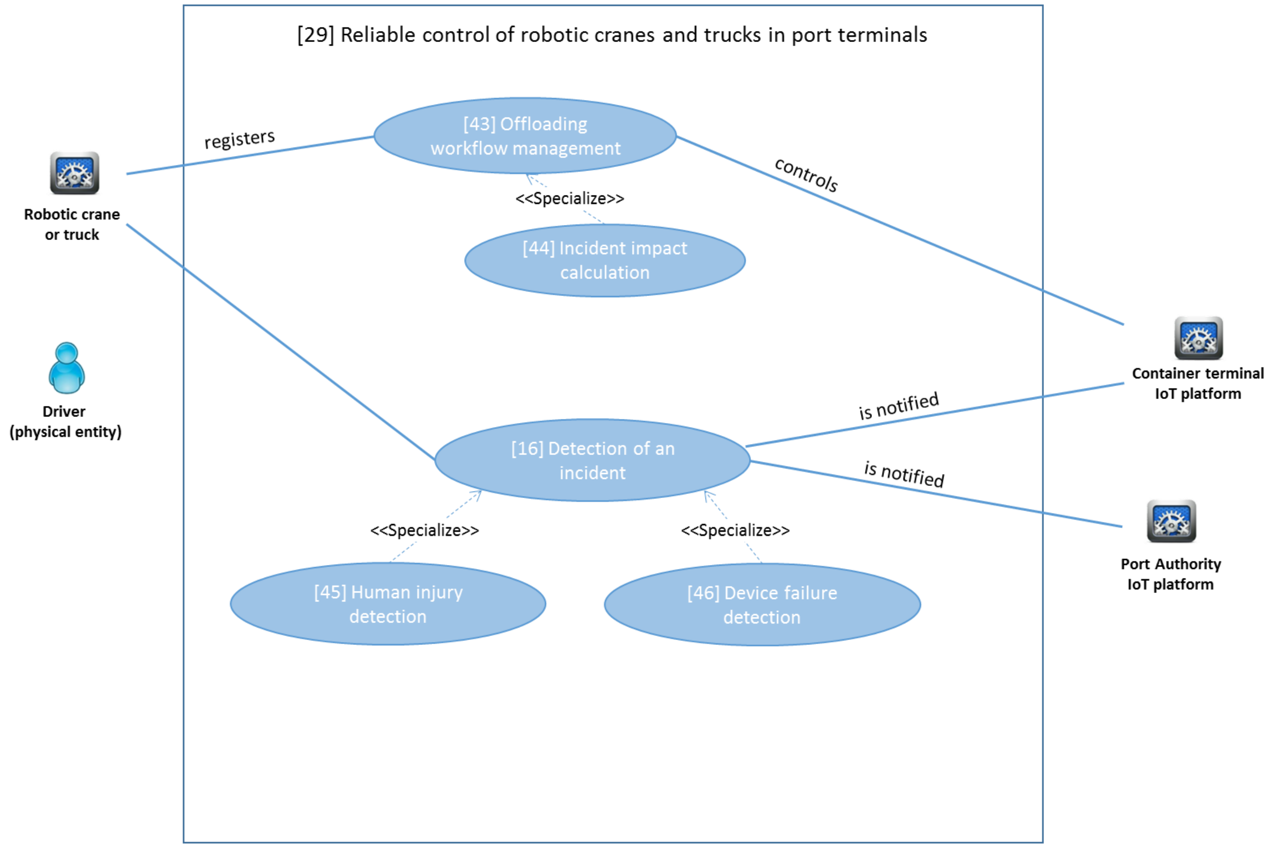

Figure 30. "Reliable control of robotic cranes and trucks in port terminals" use case diagram

The main actors involved in the scenario are:

- Driver: His position is monitored in real time to avoid accident.
- Robotic crane or truck: The machinery in the terminal has cameras and other devices to detect people in its route.
- Port authority IoT platform: It's the platform that manages all the systems of the port.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. It can send orders to the machinery.

4.1.12 IoT access control, traffic and operational assistance [30]

The scenario is focused on providing new mechanisms for access controls and trucks monitoring in restricted areas through interoperability of IoT platforms and devices.

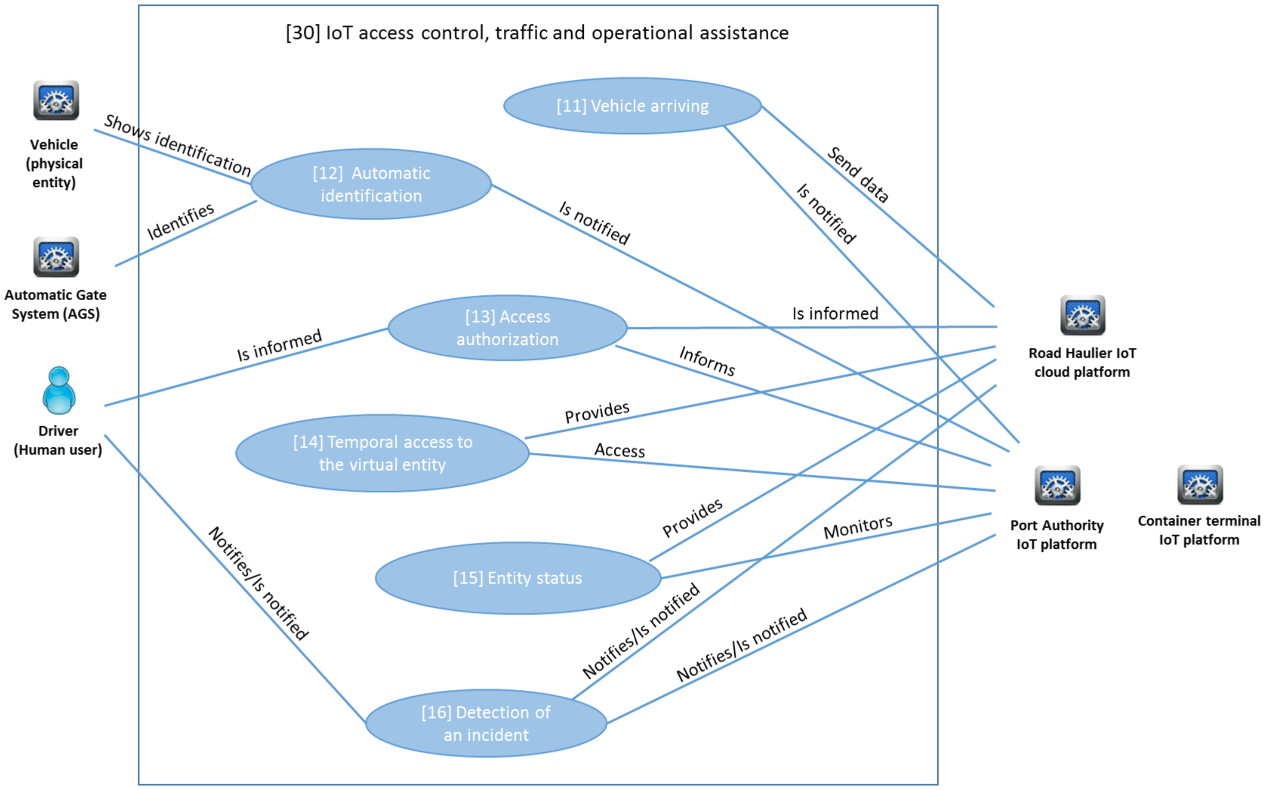

Figure 31. "IoT access control, traffic and operational assistance" use case diagram

The main actors involved in the scenario are:

- Vehicle: It is the physical entity of the scenario. It accesses to the port facilities.
- Driver: It is the user who interacts with the devices and sensors of the truck.
- Automatic system Gate: It is a port system that monitors and controls all the vehicles that want to access and leave the port.
- Road haulier IoT cloud platform: It's the owner of the vehicle and it is used to manage all the vehicles and drivers of the company.
- Port authority IoT platform: It's the platform that manages all the systems of the port. It can send orders to the driver.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal. It can send orders to the driver.

4.2 INTER-Health scenario use cases

In this section for each business scenario or aggregation of them (in case of scenarios with similar services and functionalities) a use case description of the main functionalities is given. The use case diagram allows to present a general overview of the system and of the main actors (users or systems) involved.

4.2.1 Chronic disease prevention [31]

The scenario is focused on providing prevention services for healthy people with different level of risk of developing chronic diseases based on a monitoring system helping to follow the prevention program to change their lifestyle.

The monitoring services are obtained by the interoperability between different platforms offering the overall needed features, medical and wearable devices and use of mobile phone with gateway applications.

The “chronic disease prevention scenario” is an aggregation of the following scenarios:

01 - Chronic disease prevention.
11 - Primary prevention of cognitive decline.
21 - Giulia, young teacher with a low risk of developing chronic diseases.
22 - Claudia, young housewife with increased risk of developing chronic diseases.
23 - Giorgio, unemployed electrician with high risk of developing chronic diseases.
24 - Rosa, employed with very high risk of developing chronic diseases.
25 - Umberto, nurses with extremely high risk of developing chronic diseases

All of these scenarios require similar services based on the integration of two main e-Health existing platforms and used to handle different health problems. In the appendix you can find the detailed scenarios descriptions as well as the aggregated ones (refer to scenario number 31).

The chronic disease prevention is based on four main use cases:

- Creates and operates users and associated services
- Sets Citizens/patients protocol parameters (kind of measures, thresholds, periodicity)
- Performs objective measures (e.g. weight, oximetry, activity) and subjective measures (lifestyle questionnaires)
- Monitoring measures and trends

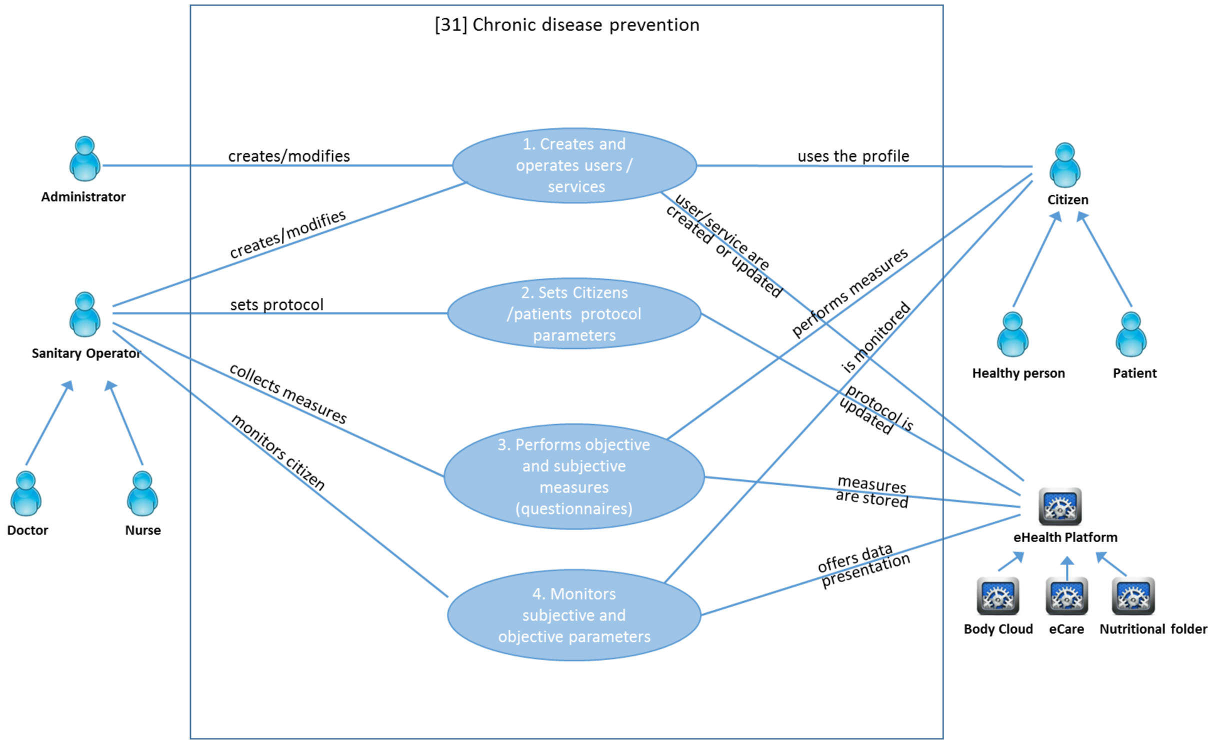

Figure 32: “Chronic disease prevention” use case diagram

The main actors involved are:

- Administrator: He is a user that manages (creates and operates users and services) the services and the users on the INTER-Health platform delivered to citizens and Health Operators
- Final Users that can be.

- Health Operators (i.e. doctors, healthcare assistant) that use the prevention service for their prevention program. Depending on the assigned profile they can:
  - create and modify services for users, set the protocol parameters that the citizen will follow by defining the kind of measures, the periodicity and, the questionnaires to be used,
  - collect the objective measures (e.g. weight, height, blood pressure) of citizens during ambulatory visits,
  - monitor the citizens measures and trends.
- Citizens (i.e. Healthy persons, patients) that use the services of prevention, they can be healthy people or patients with some diseases, they can:
  - use the created profile for access to the services,
  - perform all measures prescribed following the established periodicity using the medical devices and/or wearable devices, gateways (e.g. on mobile phone) and by filling the assigned questionnaires on lifestyle,
  - receive advices by the physicians that monitors them.

- e-Health Platforms: To obtain the prevention service available on the INTER-Health platform it is necessary to integrate different e-Health platforms through interoperability at different layers. Possible examples of platforms that could interoperate are: BodyCloud for continuous activity monitoring, eCare for subjective measures (questionnaires on lifestyle) and for objective measures (e.g. weight, blood pressure). The Nutritional folder is a system which aim to collect all patients' data of interest for Nutrition Hygiene Department to manage the prevention protocols (clinical history, measures, etc.).
  These platforms will store all the data produced/updated and, for each citizen, they will present the information collected (by means of reports, trend analysis, and punctual data) to the Health Operators authorized within the constraints of privacy.

4.2.2 Heart failure disease and mild Alzheimer disease [12]

The service is thought for patients that suffer of mild Alzheimer disease and other pathologies (e.g. heart disease, hypertension, diabetes) and it allows them to continue living at home while still maintaining a degree of autonomy and quality of life. It is based on the integration of measures monitoring platforms (like ones used into the scenario [31]) plus geo-localisation platform and devices that allow to control the position of the patients.

The "Heart failure disease and mild Alzheimer disease" scenario is based on the same use cases described for "Chronic disease prevention" scenario ([31]) plus three specific use cases addressing the functionalities related to geo-location. The uses case used are:

- Creates and operates users and associated services
- Sets Geolocation parameters for patients (e.g. safe area, alarm condition)
- Sets patients protocol parameters (kind of measures, thresholds, periodicity)
- Performs objective measures (e.g. weight, oximetry, activity, ECG, temperature)
- Detects and acquires patients positions
- Monitoring measures and trends
- Monitor patients position and manages alarms

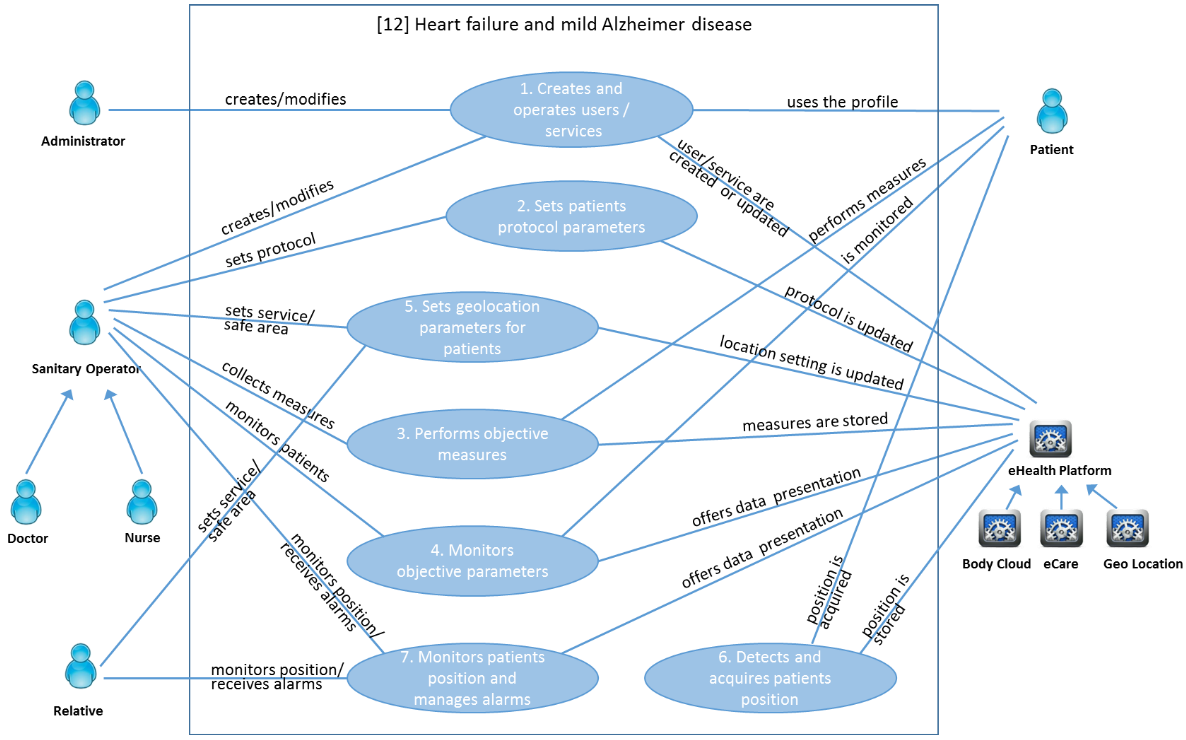

Figure 33: "Heart failure and mild Alzheimer disease" use case diagram

The main actors involved in the scenario are:

- Administrator: He is a user that manages (creates and operates users and services) the services and the users on the INTER-Health platform delivered to patients, their Relatives and Health Operators
- Health Operators (doctors, healthcare assistant): They use the telemonitoring and location services to support the patients at home. Depending on the assigned profile they can:
  - create and modify the services for users, set the protocol parameters that the patients will follow, by defining the kind of measures, the periodicity, and the devices to be used.
  - set the geo-location parameters for the patients (safe area, location frequency, alarm condition)
  - collect the objective measures (e.g. weight, ECG, blood pressure) of patients during ambulatory visits
  - monitor the citizens measures and trends
  - monitor the patients position and receive alarm (e.g. for safe area exit)
  - Patients: They use the services of monitoring at home, they can:
    - use the created profile for access to the services,
    - perform all measures prescribed following the established periodicity using the medical devices and/or wearable devices, gateways (e.g. on mobile phone),
    - receive advices by the physicians that monitor them,
    - be located periodically or upon request via the wearable tracking device.
  - Relatives: They control their families with diseases using the geo-location service.
  - e-Health Platforms: To obtain the Heart failure and mild Alzheimer disease service available on the INTER-Health platform, it is necessary to integrate different e-Health platforms through interoperability at the different layers. Possible examples of platforms that could interoperate are BodyCloud for continuous activity monitoring, eCare for objective measures (e.g. weight,

blood pressure) and a geo-location platform plus wearable devices for the localization services.

4.2.3 Surveillance systems for prevention programs [15]

The Surveillance systems for prevention programs is thought for health prevention in very young people, mainly focused on obesity prevention that could be introduced in schools.

The scenario is based on the following use cases:

- Creates and operates users' services to create and modify users and associated roles and services.
- Sets prevention program for students (e.g. thresholds for measures depending on age and gender).
- Detects and acquires students' measures (using at school multifunctional device healthy kiosk)
- Analyses students' measures and manages health feedback.

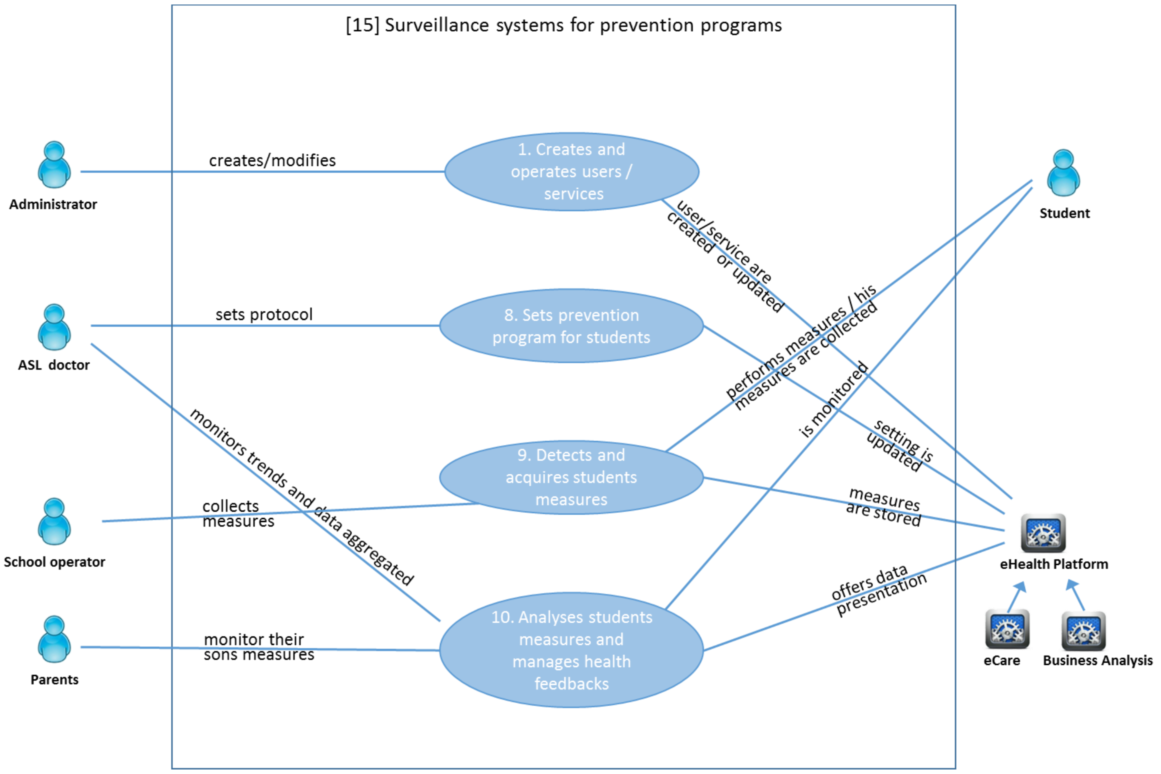

Figure 34: "Surveillance systems for prevention programs" use case diagram

The main actors involved are:

- Administrator: He is a user that manages the services and users on the INTER-Health platform
- School operators: They help students to perform measurements
- Health Operators (ASL Doctors): They set the protocols and analyse the students' measures and questionnaires and they give students and school educators feedback and suggestions.
- Students: They are periodically measured at school
- Parents: They can control only their children measures and trends.

- e-Health Platform: It provides telemonitoring services built on interoperability at the different layers. Possible examples of platforms that could interoperate are eCare and Business Analysis platform for reporting.

4.2.4 Elderly monitoring [16]

The Elderly monitoring scenario is thought for elderly people with lack of familiarity with the technology and that use smart gateways that doesn't need interaction to send measures.

It is based on four use cases describing the functionalities, typically used for Elderly People health monitoring.

The use cases of this scenario are:

- Creates and operates users/services.
- Sets Citizens /patients protocol parameters.
- Detects and acquires elderly people measures using the smart "gateway hub".
- Monitors objective parameters.

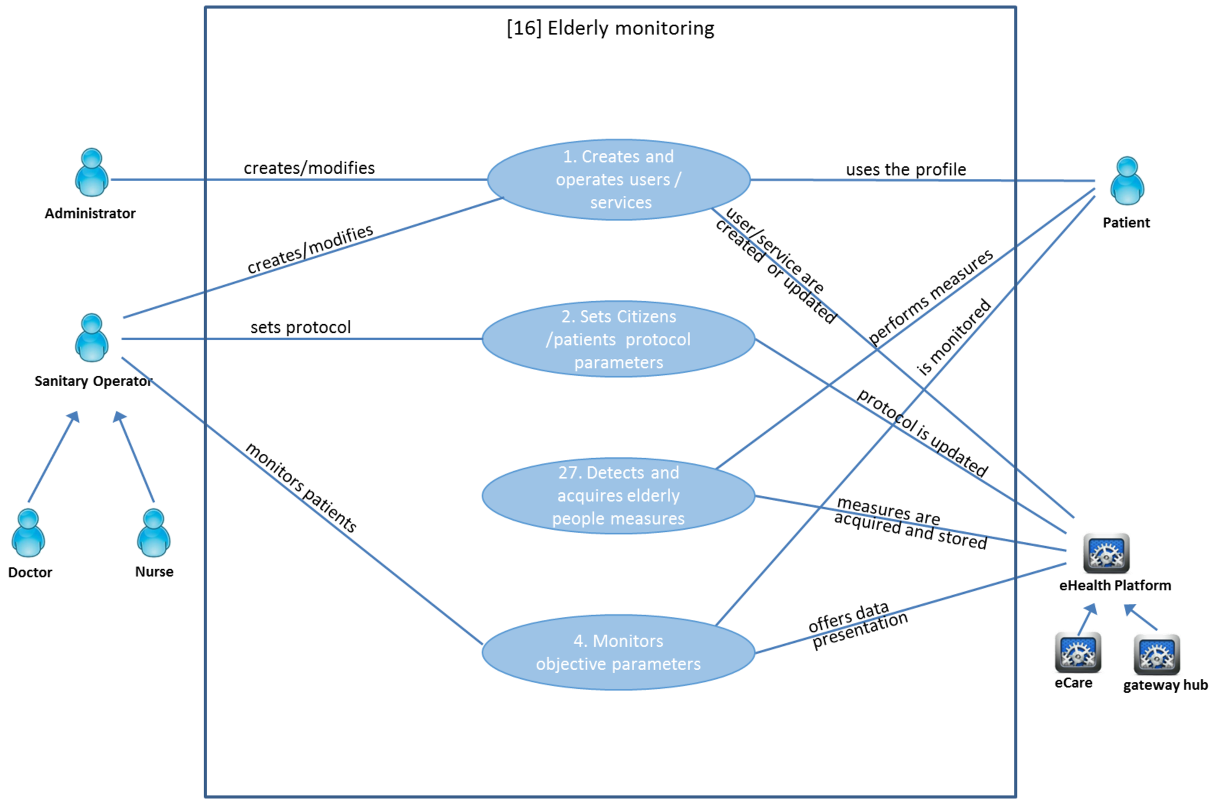

Figure 35: "Elderly monitoring" use case diagram

The main actors involved are:

- Administrator: He is a user that manages (creates and operates users and services) the services and the users on the INTER-Health platform delivered to patients and Health Operators.
- Health Operators (doctors, healthcare assistant): They use the monitoring service to control elderly people and depending on the assigned profile they can:
    - create and modify the users and services, set the protocol parameters that the citizen will follow, by defining the kind of measures and the periodicity to be used,

- monitor the citizens measures and trends.

- Patients: They use the services of elderly health monitoring services at home using the medical devices and a smart gateway hub that collects measures without interaction with the patient.
- e-Health Platform: To obtain the monitoring service available on the INTER-Health platform, it is necessary to integrate different e-health systems through interoperability at different layers. Possible examples of platforms that could interoperates are: eCare (server side) and CoXnico (device-gateway side).

4.2.5 Vitamins intake analyser [27]

The scenario describes a service for children for vitamin deficiency detection based on a smart device which is a cuddly bear able to interact and communicate with a smartphone in case of detection of deficiencies of vitamins.

The scenario is based on the following use cases:

- Users interacts with sensors or devices
- Parameter validation
- Alert Sending

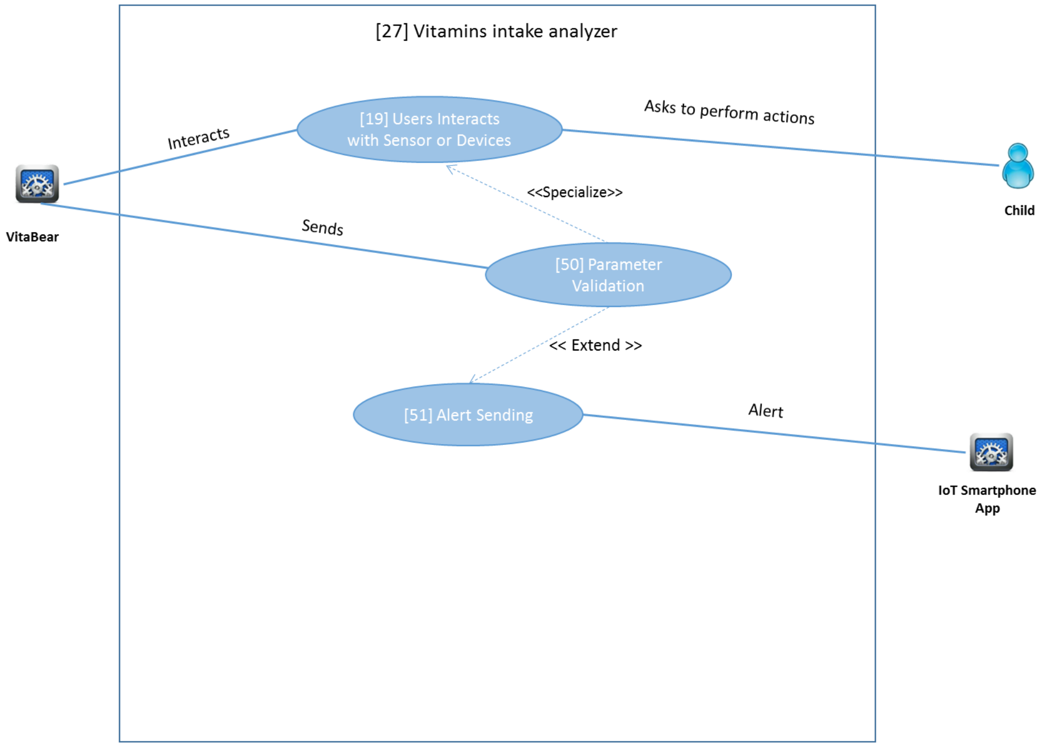

Figure 36: "Vitamins intake analyser" use case diagram

The main actors involved are:

- Child: He is a user that needs to be monitored and he uses the device as a toy
- Vitabear: A cuddly bear able to interact and communicate with a smartphone in case of detection of deficiencies of vitamins.
- IoT smartphone app of the children's parents that receive alerts from Vitabear device.

4.2.6 Calories / nutrition mixer / cookware counter [28]

The objective is to use a service to analyse calories and nutrition in the meal using a smart device to cook.

The scenario is based on the following use cases:

- Parameter validation
- Select cooking
- Add ingredients
- Perform cooking

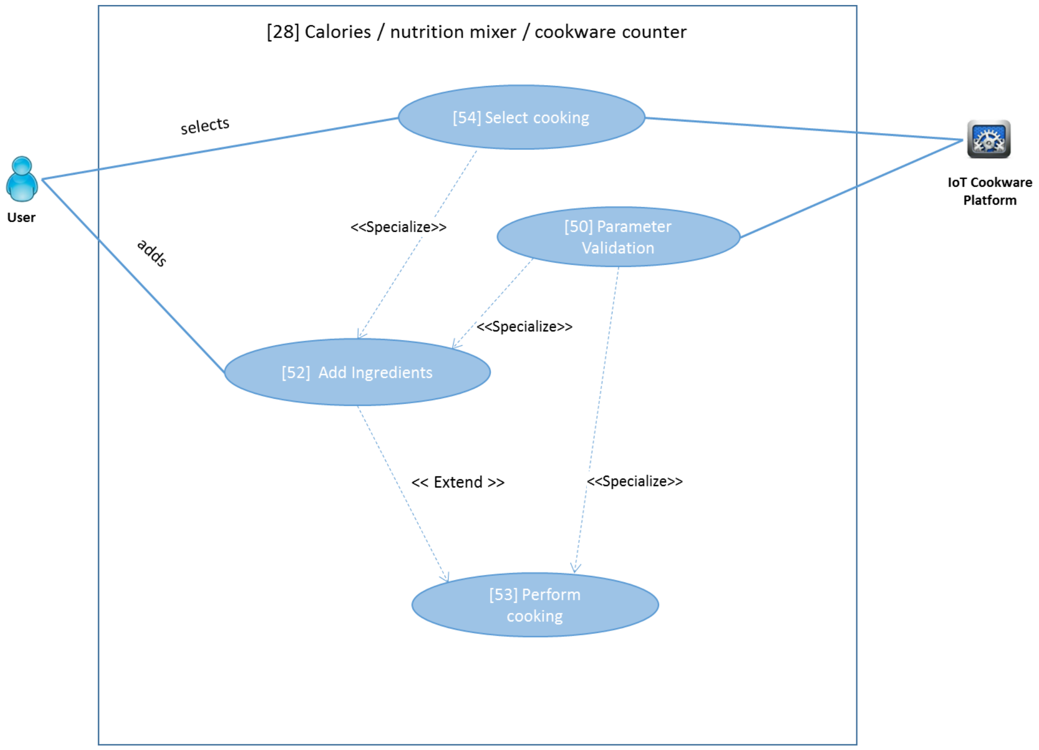

Figure 37: “Calories/nutrition mixer/cookware counter” use case diagram

The main actors involved are:

- User: He uses the smart device to cook and control the calories
- IoT Cookware Platform: It interacts with the device and analyse ingredients and calories

4.3 INTER-Health/LogP scenario use cases

This section define the use case diagrams for the cross-domain scenarios INTER-LogP and INTER-Health.

4.3.1 Accident at the port area [9]

The scenario is focused on improving safety within the port. The target is to support a faster reaction when an accident happens to a driver of a truck who wears several health sensors.

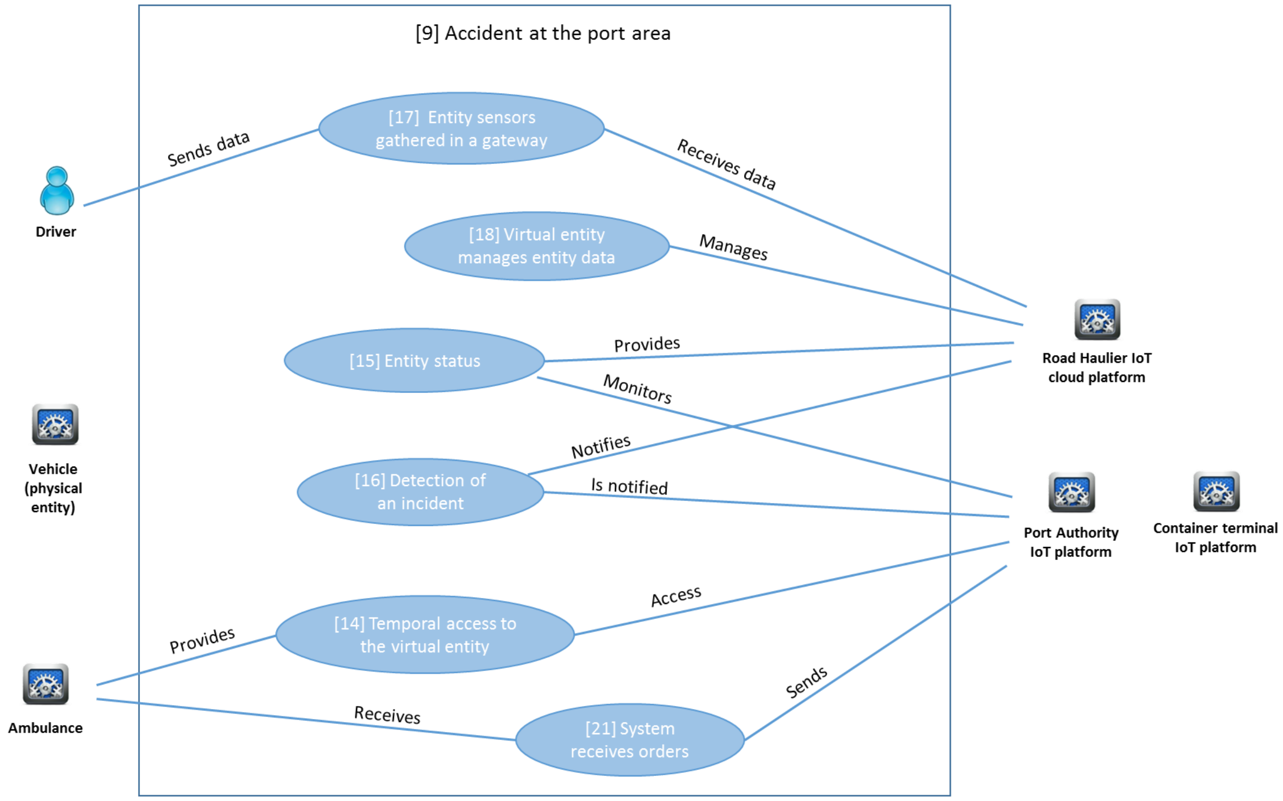

Figure 38. "Accident at the port area" use case diagram

The main actors involved in the scenario are:

- Vehicle: It is the physical entity of the scenario. It access to the port facilities.
- Driver: He is the user who is driving the vehicle and he has health sensors. He has a health issue or an accident inside the port.
- Ambulance: It is an external which that is guided by the emergency control centre of the port authority when it is inside the port facilities.
- Road haulier IoT cloud platform: It's the platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company. It monitors the health sensors of the driver.
- Port authority IoT platform: It's the platform that manages all the systems of the port.
- Container terminal IoT platform: It's the platform that manages all the systems of the container terminal.

4.3.2 Health monitoring system with passengers aboard a ferry [10]

The scenario is focused on improving early intervention services in places with difficult access to medical services as it can be either a train or ferry.

The process carried out in this scenario is the same as in "Health monitoring system with passengers aboard a train [17]", so the use case diagram is the same.

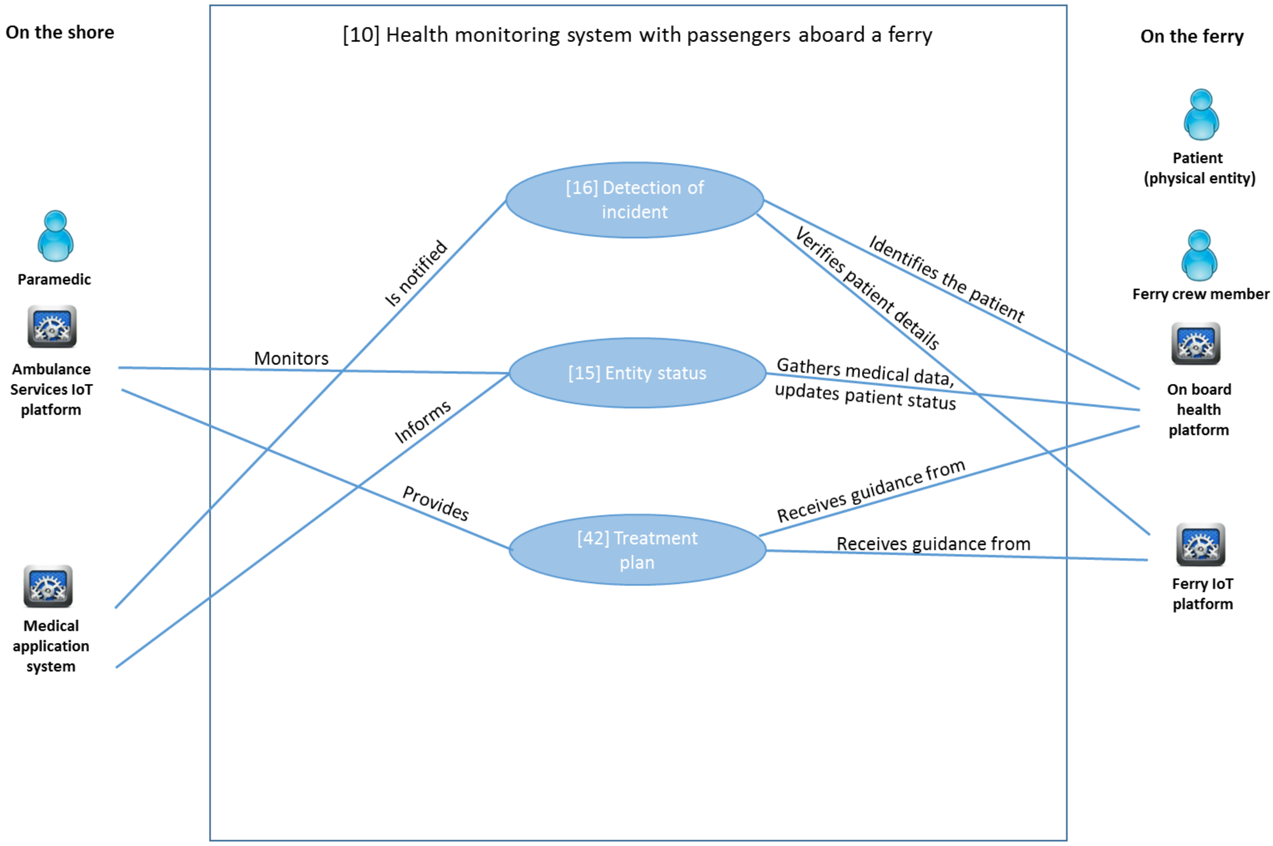

Figure 39. "Health monitoring system with passengers aboard a ferry" use case diagram

The main actors involved in the scenario are:

- Patient: He the physical entity of the scenario. He is on board a ferry when he has a health issue.
- Ambulance Services IoT platform: It is the system which is used by the paramedic to manage the patient status and provide a treatment.
- Medical application system: It is the system which is used by the crew member to gather and share the data from medical devices.
- On board health platform: It's the platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company. It monitors the health sensors of the driver.
- Ferry IoT platform: It's the platform that has information about the passengers (name, etc.).

4.3.3 Alcohol / Drug testing for truck/ bus drivers [26]

The scenario is focused on reducing road accidents by controlling the level of alcohol and drugs of drivers before starting the route.

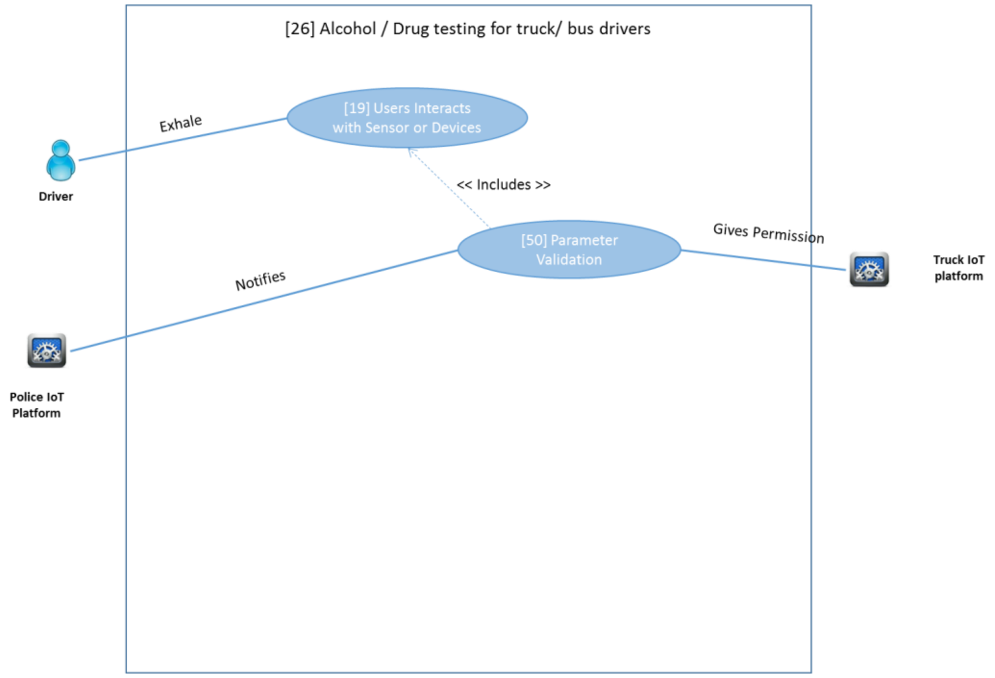

Figure 40. “Alcohol / Drug testing for truck/ bus drivers” use case diagram

The main actors involved in the scenario are:

- Driver: He is the physical entity in the scenario. He is on the truck and he is monitored to control the level of alcohol and drugs.
- Road haulier IoT platform: It’s the platform of the owner of the vehicle and it is used to manage all the vehicles and drivers of the company.
- Police IoT platform: It is the platform system which is used by the police to manage incidents. It is notified when a driver exceeds the limits of drugs or alcohol.

5 Product use cases

From the inputs of the previous two chapters, it has been possible to identify some use cases necessary to achieve the project. On the one hand, there are the use cases identified on the diagrams of each scenario. On the other hand, during the initial technical tasks carried out in WP3, WP4 and WP5, it can be extracted specific use cases needed for the different INTER-IoT products.

A deeper analysis is carried out in the corresponding tasks of WP3, WP4 and WP5, including a sequence diagram. The list and description of requirements can be found in D2.3[4].

The complete template for each use case is on Jira repository, in order to keep the information updated. The current version of the use cases is in the Annex of this document.

5.1 INTER-LAYER Use Cases

The following use cases have been identified for the INTER-LAYER product:

Table 10. List of INTER-LAYER Use Cases

Id	Use Case
19	User interacts with sensors or devices
23	Request query to MW2MW
24	Request query to AS2AS
25	MW2MW resource discovery
26	Subscribe to MW2MW event messages
28	AS2AS service cataloguing
29	AS2AS service discovery
30	AS2AS service composition
38	IPSM translation
40	Support to non-standard access networks
41	SDN communications: functions virtualization and central management
43	Offloading workflow management
44	Incident impact calculation
46	Device failure detection
47	Connection and Cloud synchronization
55	SDN communications: traffic routing
60	Device Registry
61	Platform Configuration on the Gateway
62	Device (sensor) triggers information

[4] Requirements numbering and description has been updated in a second version of D2.3. The numbering used in this deliverable corresponds to the second version of the deliverable. However as requirements and scenarios are considered a live component of the project, some of the numbering may evolve with time. The changes will be reflected in Deliverables associated with the pilot demonstration

63	Platform requests information from a device (sensor)
64	Platform sends information to device (actuator)
65	MW2MW sends information to a device (sensor or actuator)
66	IPSM alignment configuration
67	IPSM channel configuration

19	User interacts with sensors or devices

Description: Users can interact with sensors or devices in different contexts, for example a driver can send/receive data to/from a specific cloud platform by interacting with his smartphone or a patient can send medical data to his doctor by interacting with wireless medical devices.

Objectives: Provide an easy to use or even transparent interface for data communication between the generic user and sensors or devices.

Main execution:

1. The generic user interacts with his device to require/receive information on the next mission to be accomplished.
2. The generic user reads the requested information and execute the specific task.

Requirements: [19], [22], [65], [70]

23	Request query to MW2MW

Description: An MW2MW user will be able to request a list of values from [a set of]devices of the platforms it has access to with conditions regarding the geographical, temporal and other conditions as defined by the given set of filters.

Objectives: To let the inquirer to obtain a list of values of interest from a subset of devices.

Main execution:

1. Inquirer sends query and call-back point to API.
2. MW2MW creates and sends a request to all relevant platforms.
3. The Platforms responds to the MW2MW.
4. The MW2MW merges all obtained results.
5. The MW2MW call-back the calling party.

Requirements: [2], [6], [13], [72], [179], [234], [235], [236], [237], [255]

24	Request query to AS2AS

Description: An AS2AS user (IoT platform, application, person, etc.) will be able to exchange information between IoT platform services/applications through the AS2AS system.

Objectives: To let the inquirer exchange information of interest with services and applications allocated in another platform.

Main execution:

1. A user uses the Modeller GUI to create a query within available services. In this step the desired information exchange is defined.

2. The modeller performs a validation of the created design. 3. The validated design (query flow) is stored in the Flow Repository. 4. The API orchestrator runs the query flow. 5. The orchestrator module calls IoT platform services in the order indicated in the design to run the composite service. If everything has worked well there is an exchange of information between platform services. 6. The orchestrator informs the user of the correct execution of the flow. On the other hand, if there is any problem the user will be informed of any error in the execution of a service.
Requirements: [236], [239], [240], [241]

25 MW2MW resource discovery
Description: An MW2MW user will be able to obtain the list of devices throughout the integrated platform it has access to, which comply with a search query or filter.
Objectives: To let application and services to discover, whenever possible, what devices, and with which properties, are available to the system.
Main execution: 1. Inquirer sends query and call-back point to API. 2. MW2MW forwards request to all relevant platforms. 3. Platforms responds to the MW2MW. 4. MW2MW merges all obtained results. 5. MW2MW call-back the calling party.
Requirements: [2], [6], [13], [17], [43], [57], [72], [179], [234], [235], [236], [237], [238], [255]

26 Subscribe to MW2MW event messages
Description: Subscribers shall be able to subscribe to topics, in order to be informed of any new information (reading, device update, etc.) related to that defined topic.
Objectives: A subscriber will be able to create a subscription through the system, which will allow it to receive as soon as possible news from the publisher about any event relevant to the desired topic.
Main execution: The sequence of actions (steps) that describe the execution of "normal" use case 1. Subscriber issues a Subscribe call to the MW2MW API. 2. The MW2MW forwards the subscription to the underlying platform(s). 3. At least one platform reports a new related event. 4. The MW2MW informs the subscriber of the new information.
Requirements: [2], [6], [13], [72], [75], [179], [201], [234], [235], [236], [237], [255], [281], [282]

28	AS2AS service cataloguing

Description: An AS2AS user will be able to register the applications with their description or detailed information to make them discoverable.

Objectives: The following objectives are mainly pursued:
- Register the applications to make them discoverable.
- Offer a description or detailed information about the services/applications.

Main execution:
1. A user uses the GUI to register a service through Register Client.
2. The user fills the information and description of the service.
3. The catalog confirms that the service has not been previously registered.
4. The catalog confirms that the service has been successfully registered.
5. The new service becomes available in the modeller. So it can be used by the orchestrator.

Requirements: [180], [236], [238]

29	AS2AS service discovery

Description: An AS2AS user will be able to obtain the list of services throughout the integrated platform it has access to, which comply with a search query or filter.

Objectives: Main Objective: discover information about available IoT services from the IoT platforms, to provide the appropriate service to the user.
Objective in the short term: a searching mechanism that provides recommended results for queries that do not provide a perfect match of service features.

Main execution:
1. A user uses the Modeller GUI to discover a registered service/application which comply with a search query or filter.
2. The service discovery module forwards request to service catalog.
3. The service catalog responds to service discovery.
4. The service discovery processes the result of the query and sends it back to the graphical environment
5. A list of matching services and applications from the IoT platforms considered is available for the user.

Requirements: [180], [236], [238]

30	User interacts with sensors or devices

Description: An AS2AS user will be able to create added-value services, called composite services, from existing services.

Objectives: The main objective is wiring together APIs and Services from the IoT Platforms creating new composite services.

Main execution:
1. A user creates with the Modeller GUI a solution with the available services.
2. The modeller performs a validation of the created design.

3. The validated design (flow) is stored in the Flow Repository.
4. The API orchestrator runs the flow
5. The orchestrator module calls IoT platform services in the order indicated in the design to run the composite service.
6. The orchestrator informs the user of the correct execution of the flow. On the other hand, if there is any problem the user will be informed of any error in the execution of a service.

Requirements: [236], [239], [240], [241]

38 IPSM translation

Description: Data is exchanged between artifacts that use different semantics. The message should be translated from the semantics of the source artifact to the semantics of the target artifact.

Objectives: To establish communication between artifacts that use different semantics.

Main execution:
The sequence of action for IPSM translation:
1. Component(s) that supports interaction with IPSM prepare and send input data to the appropriate IPSM communication channel.
2. IPSM translation channel performs the semantic conversion based on alignments between source, central and target ontologies.

Component(s) that supports interaction with IPSM receive translated messages.

Requirements: [179], [180], [183], [220]

40 Support to non-standard access networks

Description: There is a class of sensors/actuators that use non-standard RF communication links. The reasons why this class of devices use non-standard RF links include the following:
- to improve the link range;
- to allow interoperability with legacy systems;
- to enhance the resilience to jamming and other kinds or interference;
- to enhance link security.

The Inter-IoT platform provides access to this class of devices, thus allowing the Inter-IoT user community to take advantage of the services provided by these sensors/actuators. To accomplish this the Inter-IoT GW comprises a bridge facility to perform the translation of the proprietary link into a standard IP based protocol usable by the Inter-IoT GW (e.g. Ethernet, WiFi).

Objectives: Allow sensors/actuators that use proprietary RF links to be accessible to the Inter-IoT community.

Main execution:
- The Inter-IoT bridge starts and is now ready
- The bridge establishes a link with the Inter-IoT GW
- The Inter-IoT GW reports to the Inter-IoT platform that the non-standard AN module is now active. Sensors of this class, if available, are now accessible to the Inter-IoT community.

Requirements: [17], [18], [170], [204]

41	SDN communications: functions virtualization and central management

Description: The implementation and use of the SDN paradigm to speed up IoT connections and centralize the management.

Objectives: The virtual network could be manage from a central point, using the API access to request topologies, statistics, historical, etc.

Main execution:
1. The user communicates with the controller through the access API, requesting information (about topology, statistics, etc.) or wants to modify a routing policy.
2. The controller calls the involved module or the light database to provide the requested information.
3. Or the controller checks the viability to the policy to be applied and, store the rule within the routing module.
4. Finally, the data flow continues being carried with the new policy installed.

Requirements: [17], [93], [226], [229], [231], [232], [233]

43	Offloading workflow management

Description: Discharging data traffic from more than one access network, simultaneously.

Objectives: Improve the speed of uploading or discharging data traffic from the device using more than one access network technology.

Main execution:
1. The device is connected to an access network (e.g. 4G), but he need more bandwidth to discharge data nimbler.
2. The device connects to another access network (e.g. WiFi).
3. The gateway registers these two connections and re-sends the information to the virtual network.
4. The network manages and drives properly the data flows until its destination.

Requirements: [227], [229]

44	Incident impact calculation

Description: When an incident occurs, it can impact the offloading workflow. This impact should be calculated in order to adapt the workflow accordingly.

Objectives: To calculate the incident impact and to inform the appropriate managing system.

Main execution:
1. An incident occurs in the platform.
2. Information about the incident is gathered.
3. The impact of the incident on the platform is computed.
4. Higher layers of the incident’s impact are informed.

Requirements: [205], [232]

46	Device failure detection
Description: A device suddenly experiences a technical issue, and shuts down. This failure should be detected in order to be reported.	
Objectives: To detect a device failure.	
Main execution: 1. Device unexpectedly does not respond anymore 2. Network detects this failure 3. Network adapts itself to guarantee quality of service	
Requirements: [84], [154], [168], [201], [205]	

47	Connection and Cloud synchronization
Description: A connection must be setup during primary use as well as a cloud connection for data storage and synchronization as well as user access (API).	
Objectives: Setup a communication with the cloud.	
Main execution: Whenever there is an active internet connection the system can have a synchronization action. This will originate from the device. The device will be aware that its database is updated recently and checks the cloud database to have the data synchronized.	
Requirements: [1], [6], [9], [11], [13], [16], [30], [45], [48], [53], [68], [73], [77], [92], [125], [126]	

55	SDN communications: traffic routing
Description: The implementation and use of the SDN paradigm to prioritize data flows using traffic engineering, having a general overview of the whole network at any time.	
Objectives: The data flows will travel through the software define network from the gateway to the IoT platform in a secure manner following the defined policies.	
Main execution: 1. The GW receive the information for one of his AN (out of this scope) and send the information over IP to a virtual GW switch in the v-net. 2. The data flow travels among the network following the rules implemented inside the virtual switches configured by the controller. 3. If a data flow does not match any of the fields of the routing table is sent to the controller that analyses and includes the adequate entry in the table to route the information. 4. Finally, the data flow is delivering to its destination, the IoT platform or another GW.	
Requirements: [11] ,[16], [18], [19], [20], [21], [55], [72], [89], [226], [229], [230], [233]	

60	Device Registry

Description: A device is registered within the gateway by a descriptive method with basic parameters needed for its addressability and understanding of data.

Objectives: To include the information about a device, sensor or actuator, in order to receive or send information from the device and to the gateway or to another system connected to the gateway.

Main execution:

1. The file is created by the user, and then the registry module reads the file with all the information referring the device.
2. The registry module sends this information to the device manager to be parsed and stored in a cache or light storage.
3. The device calls the AN and Protocol controllers to check the correct set-up of the connection.
4. Those as well invoke the relevant AN and Protocol module to test the connection.

Requirements: [15], [22], [39], [45], [57], [60], [93], [138], [242], [245]

61	Platform Configuration on the Gateway

Description: A device is registered within the gateway by a descriptive method with basic parameters needed for its addressability and understanding of data.

Objectives: To include the information about a device, sensor or actuator, in order to receive or send information from the device and to the gateway or to another system connected to the gateway.

Main execution:

1. The file is created by the user, and then the registry module reads the file with all the information referring the device.
2. The registry module sends this information to the device manager to be parsed and stored in a cache or light storage.
3. The device calls the AN and Protocol controllers to check the correct set-up of the connection.
4. Those as well invoke the relevant AN and Protocol module to test the connection.

Requirements: [15], [20], [39]

62	Device (sensor) triggers information

Description: A device, typically a sensor, triggers an event sending determined information to the gateway in order to be stored on the platform. Cloud or server or in order to generate a response for an actuator (being handled by the rules engine).

Objectives: To send data from the device side through the gateway to rise its destination (Local platform, cloud or other device) in an efficient way.

Main execution:

1. The sensor, previously connected, sends a data message to the gateway through its specific access network.
2. The AN module is in charge of receive this message and send it to the controller.

3. The controller with the message and the information about the physical direction of the device and the AN will contact the device manager.
4. The device manager will provide the protocols supported by the device and will call the protocol controller.
5. The protocol controller will start the protocol module in charge of parse the message and send it to it.
6. The protocol module will interpret the message and parse into a common message format to be sent to the dispatcher.
7. The dispatcher will receive the common format message and redirection it to the MW controller.
8. The middleware controller will call the MW module in charge of parse again the message, if needed, and connects with the IoT platform.

Requirements: [15], [21], [22], [23], [39], [45], [93], [138]

63 Platform requests information from a device (sensor)

Description: The gateway receives the request from the platform al re-direct it to the device, to obtain specific information.
If is no change on the value has been performed in a short period, the response will be provided directly from the measurements storage.

Objectives: To obtain a data requested by the platform from a concrete device.

Main execution:
1. The platform sends a request to the gateway.
2. The platform connector module that communicates with the platform receives the message and parse the information, send them to the platform controller.
3. The controller connects with the dispatcher and re-sends the parsed message.
4. The dispatcher carries the request to the protocol controller.
5. This controller sends the messages to be again parsed to the specific protocol supported by the device on the protocol module.
6. Once parsed the module retrieve the message to the controller and this asks the device manager for the AN in which the device is connected.
7. The message is handled by the relevant AN module and sent to the device.

Requirements: [15], [21], [22], [39], [45], [72], [93], [153], [283]

64 Platform sends information to device (actuator)

Description: The platform sends information, normally a change of state, to the device, typically an actuator.

Objectives: To change the state of an actuator connected to the gateway.

Main execution:
1. The platform sends a message to the gateway.
2. The platform connector module that communicates with the platform receives the message and parse the information, send them to the platform controller.

3. The controller connects with the dispatcher and re-sends the parsed message. 4. The dispatcher carries the request to the protocol controller. 5. This controller sends the messages to be again parsed to the specific protocol supported by the device on the protocol module. 6. Once parsed the module retrieve the message to the controller and this asks the device manager for the AN in which the device is connected. 7. The message is handled by the relevant AN module and sent to the actuator to change its state.
Requirements: [15], [21], [22], [25], [26], [39], [45], [56], [283]

65	**MW2MW sends information to a device (sensor or actuator)**
Description: The Middleware can access to a device (sensor or actuator) and send it orders or actions (e.g. change the configuration, activate/deactivate).	
Objectives: In order to manage a device, it is necessary to send orders to it, besides receiving data.	
Main execution: 1. A platform/application sends an order to the device through the MW2MW API. 2. The platform request manager to the corresponding platform's bridge. 3. The bridge translate to the proper format. 4. The order arrives to the device where it is located.	
Requirements: [2], [6], [13], [25], [89], [179], [234], [235], [236], [237], [255], [283]	

66	**IPSM alignment configuration**
Description: Alignment configuration enables operations, such as add, list and get, to be performed. Before utilizing IPSM translation services at least one alignment must be added to the Alignments Repository to become available to be used in the translation process.	
Objectives: IPSM needs configuration before being utilized.	
Main execution: The request is sent to the component that exposes a dedicated API. The request is forwarded to the alignment repository that returns result depending on operation executed.	
Requirements: [178], [179], [183], [184]	

67	**IPSM channel configuration**
Description: IPSM Channel configuration is required before establishing communication, between designated IoT artifacts, which involves semantic translation.	
Objectives: IPSM needs configuration before being utilized.	
Main execution:	

A request is sent to the component that exposes a dedicated API. The request is forwarded to the component responsible for channel configuration (with respect to input, output and alignment to be used) that completes the request.
Requirements: [178], [179], [183], [184]

5.2 INTER-FW Use Cases

The following use cases have been identified for the INTER-FW product:

Table 11. List of INTER-FW Use Case

Id	Use Case
14	Temporal access to the virtual entity
15	Entity status
18	Virtual entity manages entity data
20	User receives data or orders
21	System receives orders
31	FW CRUD
32	FW Publication/Subscription to middleware or gateway events
33	FW Service consumption
34	FW API management
35	Layer Interoperability Infrastructure (LII) coordination
36	FW Configuration tools
37	FW registration & discovery tools
39	Semantic repository management

14 Temporal access
Description: Subscribers shall be able to access virtual entities of the different platforms only for a specified time range, attribute, business or geographic based conditions. Time range defining the temporal access to a virtual entity will be able to be set from outside the INTER-FW by the corresponding API taking into account the virtual entity, its location and specific consumers.
Objectives: A platform owner will be able to specify a time range for the subscribers to be able to access measurements from the virtual entities. The possibilities will be the following ones: • Any virtual entities or for specific ones. • Daily allowed time range (for the 7 week days). • Geofencing: defining a polygon(s) so that only measurements with locations inside the polygon(s) will be made accessible from subscribers.
Main execution: 1. An integrator configures a subscription through INTER-FW to specific virtual entities. 2. The integrator specifies in INTER-FW a temporal filter (time periods or location based) for a set of entities. (Could be made at the same time than 1). 3. A subscriber requests to subscribe to some entities, some of them with temporal restrictions (this is unknown by the subscriber).

4. INTER-FW sends the subscriptions and the temporal restrictions to MW2MW for the specific platform and entities.
5. The MW2MW forwards the subscription to the underlying platform(s) with the subscription filters for entities and time/location restrictions.
6. At least one platform reports a new related event matching the temporal restriction.
7. The MW2MW informs the INTER-FW of the new measurement.
8. INTER-FW forwards the measurement to the subscriber.

Requirements: [2], [6], [14], [21], [28], [33], [37], [47], [50], [53], [61], [62], [64], [77], [94], [116], [121], [127], [195], [224], [266], [267], [270]

15 Entity Status

Description: A virtual entity is used to represent a physical entity with its related measurement. This virtual entity can store and provide its status to INTER-IoT users.

Objectives: The objective of this entity is to be a virtual representation of the physical object accessed through the gateway and virtualized in a cloud environment outside the scope of the physical sensor network. This virtual entity will be able to be updated with its current status and queried as well.

Main execution:

1. The gateway collects a new measurement from a sensor.
2. The measurement is processed locally at the gateway.
3. The measurement is submitted to the virtual representation, which is updated.
4. A consumer queries the latest measurement from the virtual entity.

Requirements: [23], [33], [39], [48], [50], [51], [55], [75], [127], [153], [194], [223], [238], [243], [244], [247], [267], [268], [270]

18 Virtual Entity Management

Description: A virtual entity is used to represent a physical entity with its related measurement. This virtual entity can be managed, being created, updated or destroyed.

Objectives: The objective of a virtual entity is to be a virtual representation of the physical object. It can be managed through the gateway, for adding new entities into the system, querying, updating or destroying them.

Main execution:

- Creation:
  1. The external component wants to create a new virtual entity for a physical thing accessible through a gateway, and sends a request to the gateway.
  2. The gateway creates a virtual entity and stores its latest measurement if available.
  3. The virtual entity reference is sent back to the external component.
- Access:
  1. The external component sends a request to the virtual entity.
  2. The virtual gateway accesses the virtual entity and sends the data back to the external component.
- Destruction:

1. The external component wants the system to stop using a virtual entity for a physical thing, and sends a request to the gateway.
2. The gateway destroys the virtual entity and stops collecting data.

Requirements: [23], [33], [39], [48], [50], [51], [55], [75], [127], [153], [194], [223], [238], [243], [244], [247], [267], [268], [270]

20 User reception

Description: A truck driver receives some data in the vehicle, containing instructions for a specific action to be done.

Objectives: To be able to send instructions to a truck driver so that he can perform an action.

Main execution:

1. The road haulier sends some data.
2. The App at the truck gets the data.
3. The data is presented in the App to the driver, confirming the lecture.
4. A confirmation is sent back to the road haulier company.

Requirements: [70], [103], [260]

21 System reception

Description: A port application or system receives some data containing instructions for a specific action to be done.

Objectives: To be able to send instructions to a port application or system so that it can perform an action.

Main execution:

1. The Port Authority IoT platform sends some order as an event.
2. The target system receives the data App at the truck gets the data.
3. The data is presented in the App to the driver, confirming the lecture.
4. A confirmation is sent back to the road haulier company.

Requirements: [27], [28]

31 FW CRUD

Description: Basic operations provided by INTER-FW to maintain things in INTER-IoT, with the possibility of creating or adding a new thing (C), reading or getting measurements from a thing (R), updating/inserting things measurements (U) and destroying or deleting the thing (D).

Objectives: To offer the basic handling operations for managing things.

Main execution:

Create:

1. The user requests to create a new thing into a specific IoT platform.
2. The FW checks for the right permissions of the user to access the platform.

3. The request is sent to the IoT platform.
4. A response with right/wrong result is returned from the IoT platform.

5. The response is forwarded to the user.

Read:

1. The user requests to read data about a thing from a specific IoT platform.
2. The FW checks for the right permissions of the user to access the platform.
3. The request is sent to the IoT platform.
4. A response with right/wrong result is returned from the IoT platform.

5. The data is sent back to the user.

Update:

1. The user requests to insert new data about a thing into a specific IoT platform.
2. The FW checks for the right permissions of the user to access the platform.
3. The measurement is sent to the IoT platform.
4. A response with right/wrong result is returned from the IoT platform.
5. The response is forwarded to the user.

Delete:

1. The user requests to delete and unregister new thing into a specific IoT platform.
2. The FW checks for the right permissions of the user to access the platform.
3. The request is sent to the IoT platform.
4. A response with right/wrong result is returned from the IoT platform.
5. The response is forwarded to the user.

Requirements: [23], [26], [27], [28], [33], [48], [50], [51], [52], [64], [74], [256], [267], [271]

32 FW Pub/Sub

Description: INTER-FW will provide the ability for an external user to subscribe to a middleware data stream from an IoT platform / gateway.

Objectives: To be able to continuously receive all the measurements of a thing from an IoT platform or gateway.

Main execution:

IoT platform

1. The external component requests a data subscription from a sensor.
2. The FW checks for appropriate permissions.
3. The MW2MW requests a sensor subscription from a platform.
4. The IoT platform begins sending data for each measurement.
5. Each measurement is sent to the FW and next to the external component.
6. Finally the external component requests to stop the subscription.
7. The subscription end is sent from the MW2MW to the IoT platform.

Gateway

1. The external component requests a data subscription from a sensor.
2. The FW checks for appropriate permissions.
3. The FW sends the requests for subscription to the gateway.
4. The gateway begins sending data for each measurement.
5. Each measurement is sent to the external component.
6. Finally the external component request to stop the subscription.
7. The subscription end is sent from the FW to the gateway.

Requirements: [27], [28], [33], [39], [47], [50], [52], [54], [64], [74], [115], [127], [242], [249], [256], [267], [270], [271]

33	FW Service consumption
Description: INTER-FW will provide the ability for an external user to consume a service offered by AS2AS layer which in turn makes use of IoT platform services.	
Objectives: To consume existing services from the different IoT platforms connected through INTER-IoT.	
Main execution: 1. The external system requests to consume a service. 2. The FW relays the request to AS2AS layer, which executes the requested service, making the necessary requests to specific IoT platform services. 3. The result of the service is sent back to the external request.	
Requirements: [239], [240], [241], [248]	

34	FW API management
Description: INTER-FW will offer an API for accessing all the capabilities of INTER-IoT. The API will be managed and protected through an API Manager.	
Objectives: The API Manager should be responsible for: • Controlling API versions and deployment. • Controlling user load. • Monitoring API usage. • Securing the API. • Using different communication protocols.	
Main execution: 1. The external system makes a request to the INTER-FW API. 2. The API Manager captures the request and handles it, with the specific security and load aspects. 3. If everything is OK, the request is relayed to the INTER-FW. 4. The response from INTER-FW is sent back to the external system.	
Requirements: [2], [27], [28], [37], [47], [52], [58], [68], [86], [95], [115], [116], [117], [199], [237], [265], [266], [267], [268], [270], [271]	

35	LII Coordination
Description: The INTER-FW is responsible for handling the requests it receives from external users and direct the request to the appropriate layer, controlling the answer and sending it back to the requestor.	
Objectives: To control the interaction between the external user and the different components of INTER-IoT.	

Main execution: 1. The external system makes a request to the INTER-FW API. 2. The INTER-FW captures the request and decides which layer is responsible for performing the requested action. 3. The INTER-FW sends the request to the specific layer through its API and receives the answer. 4. The response from INTER-FW is sent back to the external system.
Requirements: [14], [47], [52], [193], [198], [199], [201], [237], [249], [250]

36	FW Configuration tools
Description: The configuration tools are designed to be standalone software components and are used to support the configuration of the INTER-FW in deployment time and even in runtime.	
Objectives: Configuration tools support the use of the Inter-IoT interoperability stack in a harmonized, simple way.	
Main execution: 1. Run the specific configuration tool. 2. Set the desired configuration parameters. 3. Save the configuration. 4. Deploy and run INTER-FW.	
Requirements: [131], [140]	

37	FW Registration & discovery tools
Description: Considering different IoT platforms, the Inter-FW is able to connect, in a transparent way, the platforms in order to enable their interoperability. In this context, discovery of services and devices play a central role. For this reason, Inter-FW includes specific mechanisms of registration and discovery.	
Objectives: Services and devices belonging to different IoT platforms must be discovered and registered to be fully available to other platforms.	
Main execution: 1. A new device or service is discovered by a certain IoT Platform. 2. The IoT platform notifies to Inter-FW the activation of a new device or service. 3. Inter-FW registers the presence of the new device or service in a specific registry.	
Requirements: [23], [43], [256], [275], [276]	

39	Semantic repository management
Description: Semantic repository is a component dedicated to storage and sharing of semantic data.	

Objectives: There exists a component that provides access to semantic data necessary to add a platform to the INTER-IoT deployment and to perform a translation of data exchanged between artifacts.
Main execution: The following functionalities of semantic repository component can be considered: upload ontology, upload alignment, delete ontology, and delete alignment. The user uses a dedicated API to send requests to the repository and receive results.
Requirements: [23], [53], [223], [224], [225]

5.3 INTER-METH Use Cases

The following use cases have been identified for the INTER-METH product:

Table 12. List of INTER-METH Use Case

Id	Use Case
56	Requirements Analysis for IoT Platform Integration
57	IoT Platforms Integration Design
58	IoT Platforms Integration Implementation
59	IoT Platforms Integration Maintenance

56 Requirements Analysis for IoT Platform Integration
Description: Given two or more IoT platforms/systems to be integrated, the integration requirements need to be elicited. On the basis of the elicited requirements, the design of the IoT platforms integration could be then carried out.
Objectives: To elicit the requirements for the integration of IoT platforms/systems.
Main execution: 1. Each platform is analysed according to the functional and non-functional viewpoints of the five IoT platform layers (device, networking, middleware, application services, data&semantics) and of the cross-layering. 2. According to the Step 1, the requirements of integration among the layers of the platforms to be integrated, are defined according to an iterative process. The execution could be supported by the INTER-CASE tool.
Requirements: [74][159-162][108-120]

57 IoT Platforms Integration Design
Description: Given two or more IoT platforms/systems that have been analysed according to the use case IM1, design specifications have to be produced. On the basis of the design specifications, the implementation of the IoT platforms integration could then be carried out.

Objectives: To define the design specifications for the integration of IoT platforms/systems.

Main execution:
1. For each layer (and cross-layer), on the basis of the elicited requirements in IM1, an initial design specification is produced.
2. Each design specification produced in Step 1 is iteratively refined.
3. A global integration design is defined on the basis of the outcome of Step 2.

The execution could be supported by the INTER-CASE tool.

Requirements: [74][159-162][108-120]

58 IoT Platforms Integration Implementation

Description: Given two or more IoT platforms/systems, whose integration has been designed according to the use case IM2, the integration implementation (deployment and testing/validation) has to be performed. On the basis of the actual deployed and tested implementation, the maintenance of the integrated IoT platforms could then be realised.

Objectives: To integrated/interconnect, deploy and test the IoT platforms/systems to be integrated/interconnected.

Main execution:
1. For each layer (and cross-layer), the design specifications produced in IM2 are actually implemented.
2. On the basis of Step 1, a full-fledged integration (namely Integrated Platform) among the involved IoT platforms/system will be obtained.
3. The *Integrated Platform* is deployed.
4. The *Integrated Platform* is validated through testing.

The execution could be supported by the INTER-CASE tool.

Requirements: [74][159-162][108-120]

59 IoT Platforms Integration Maintenance

Description: Given an integrated platform obtained from the integration of two or more IoT platforms/systems, such platform needs to be maintained.

Objectives: To maintain an integrated IoT platform.

Main execution:
1. Identification of a list of bugs and/or a list of evolution points.
2. Correction of bugs and/or implementation of new functionalities.

The execution could be supported by the INTER-CASE tool.

Requirements: [74][159-162][108-120]

5.4 INTER-LogP Use Cases

The following use cases have been identified for the INTER-LogP product:

Table 13. List of INTER-LogP Use Case

Id	Use Case
11	Vehicle arriving
12	Automatic identification
13	Access authorization
16	Detection of an incident
48	Ship movement in harbour region
49	Container distribution

11	Vehicle arriving
Description: A vehicle IoT platform (P-IoT - publisher) keeps track, among other attributes, of the position, destination, distance to destination and estimated time of arrival. This platform provides information to other IoT platforms and applications (S-IoT - subscriber) informing when the vehicle is arriving. The virtual entity will consider an ACL (Access Control List) to identify to whom publish data.	
Objectives: A P-IoT publish certain attributes to authorised S-IoT previously registered and subscribed. Authorised subscribers establish the conditions for receiving notifications.	
Main execution: 1. INTER-IoT provides mechanisms to register IoT platforms and applications associated with their owners. 2. S-IoT previously subscribes to this service and they provide trigger conditions to be notified as, for example, the distance to destination. 3. The P-IoT only provides the information to those S-IoT owned by the companies included in the ACL. 4. The S-IoT receives the information published that met the conditions of the subscription.	
Requirements: [19], [201], [224], [253], [256], [257]	

12	Automatic identification
Description: A sensor identifies a physical object automatically through passive tags, video recognition, etc. and informs the owner about this event.	
Objectives: Publish the automatic identification of a physical entity to proper IoT platforms and applications.	
Main execution: 1. The identification system detects and identifies the entity. 2. The identification system platform publishes the event. 3. The S-IoT receives the information published.	
Requirements: [166], [197], [246], [201], [257]	

13	Access authorization
Description: The IoT platform that manages the identification system has to check whether the entity is authorized to access the facilities and report the result to and other related companies.	
Objectives: Check the authorization of a physical entity and publish the relevant data to authorised subscribed IoT platforms and applications.	
Main execution: 1. INTER-IoT provides mechanisms to register IoT platforms and applications associated with their owners. 2. The P-IoT localizes the VE to determine it access authorization and the owner and authorised companies. 3. The P-IoT platform publishes the information about the vehicle, access status, gate and lane. 4. The S-IoT platform receives the information published. 5. The driver's mobile app receives the information published.	
Requirements: [201], [224], [256], [257]	

16	Detection of an incident
Description: An incident is detected by the sensors of a system or by a user and is notified to all the relevant actors.	
Objectives: Detect, evaluate and publish an incident.	
Main execution: 1. An incident is detected by a sensor or process and the IoT platform is informed. 2. The P-IoT platform publishes the information about the incident. 3. The S-IoT platform receives the information published.	
Requirements: [84], [154], [168], [201], [205]	

48	Ship movement in harbour region
Description: A ship moves into the harbour region allowing all container monitoring systems, as well as the ship's own systems, to connect to the harbour IoT system.	
Objectives: All the containers and vessel systems can connect to the port IoT system and transmit the pending data.	
Main execution: 1. When the vessel is close to the port, it establish a connection with the port systems. 2. The data is sent first come first serve.	
Requirements: [1], [2], [13], [17], [18], [22], [115], [189], [193], [204], [207], [227], [253], [258], [275], [278]	

49	Container distribution
Description: A containership has arrived at the dock and is ready to be unloaded. The IoT system will give the crane operator instructions of which container should be picked up, the truck or container distribution system will be ready to bring the container to the reserved location or the truck will pick up the container for further transport.	
Objectives: Optimize container movement through the harbour.	
Main execution: 1. The vessel IoT platform sends information about the containers on board to be unloaded. 2. The terminal IoT platform calculates the optimal distribution of the containers on the yard for each container. 3. The terminal IoT platform sends the orders to each crane.	
Requirements: [1], [3], [17], [19], [84], [94], [142], [193], [196], [197], [198], [203], [223], [224], [241], [245], [246], [247], [248], [249], [275], [278]	

5.5 INTER-Health Use Cases

The following use cases have been identified for the INTER-Health product:

Table 14. List of INTER-Health Use Case

Id	Use Case
1	Creates and operates users /services
2	Sets Citizens /patients protocol parameters
3	Performs objective and subjective measures (questionnaires)
4	Monitors subjective and objective parameters
5	Sets geolocation parameters for patients
6	Detects and acquires patients position
7	Monitors patients position and manages alarms
8	Sets prevention program for students
9	Detects and acquires students measures
10	Analyses students measures and manages health feedbacks
27	Detects and acquires elderly people measures
42	Treatment plan
45	Human injury detection
50	Parameter Validation
51	Alert Sending
52	Add Ingredients
53	Perform cooking
54	Select cooking

1	Creates and operates users /services

Description: Administrators/ Health Operators (e.g. ASL TO 5) will be able to create and manage users (e.g. patients, doctors, healthcare assistant) and their information needed by the services.

Objectives:
• To create and modify users of the services, assigning roles and related permissions, enabling users the access to functionalities provided by different platforms in a cooperative way or using a platform as a master.
• To define a method to recognize a data entity identity and to map and group different instances of different platforms representing the same entity. For entity, we assume, for example, users or anthropometric information such as gender, etc.
• To access and synchronize data exchange among the involved platforms (databases, directories, file systems and so on, and applications).

Main execution:
The user (administrator or Health Operator) uses the INTER-Health web interface to handle the requirement to add /modify a new user to the specified service (e.g. chronic disease prevention of ASL TO 5).
The user performs the action requested for the specified user / service (creation of a new user or modification of same attribute of the specified user).

Requirements: [104], [106], [171], [174]

2	Sets Citizens /patients protocol parameters

Description: Health Operators will be able to choose and set patients protocols, devices, thresholds, measures scheduling to perform.

Objectives:
• To assign/de-assign due measures to patients, to define appropriate measures calendars and measures thresholds for their patients.
• To define a method to recognize a data entity identity and target values used in setting health protocols (e.g. thresholds for measures). For entity, we assume for example: type of measure, target reference (i.e. WHO: World Health Organization) for thresholds.

Main execution:
1. The user (Health Operator) uses the INTER-Health web interface to handle the requirement to add / remove a new measure, calendar or threshold
2. The patient profile will be updated; consequently he will perform the health monitoring using the new protocol defined.

Requirements: [173], [174]

3	Performs objective and subjective measures (questionnaires)

Description: Patients/ Citizens will be able to perform subjective measures compiling the assigned questionnaires. They will be able to perform also objective measures taken by medical and wearable devices.

Objectives: To associate medical devices to the gateway on smartphone (i.e. Bluetooth pairing), to perform measures in time as defined in the protocol and to send them to the platforms involved.
Main execution: 1. The final user (patient or health operator) uses the INTER-Health web interface to handle questionnaires and the INTER-Health gateway to handle objective measures (sent by wireless devices: e.g. via Bluetooth). 2. The user sends performed measures to the platform: updating the questionnaire or using the due gateway functions for objective measures.
Requirements: [101], [102], [172], [176], [177]

4 Monitors subjective and objective parameters
Description: Health Operators will be able to analyse in real time their patients' measures and monitor the healthy state.
Objectives: To access and deal subjective and objective measures using different filters and criteria to monitor the patients.
Main execution: 1. Data filtering in a period of time for the user under their control 2. Downloading in different file formats 3. Continuous time analysis of measure kept by wearable devices. Patients can auto-monitor themselves using or downloading only their own measures.
Requirements: [101], [102], [107], [172], [173]

5 Sets geolocation parameters for patients
Description: Doctors/Relatives shall be able to set geolocation parameters for the patients assigned to control patients' position and be informed about possible danger occasions.
Objectives: • To assign/de-assign location parameters (such as polling frequency and Safe Area radius) to patients. For Safe Area we mean a circle with the centre in the patient position (latitude and longitude) and pre-fixed radius. • To activate/deactivate localization functionalities: i.e. deactivating the localization during the night etc.).
Main execution: 1. Relatives/Location Operators change location parameters. 2. The new location parameters are sent to the location system. 3. The location system updates its settings and runs using new parameters.
Requirements: [173], [174]

6	Detects and acquires patients position
Description: Patients will be able to be localized wearing a geo location device that automatically sends measures to the target platform where they will be stored in the database.	
Objectives: • To detect patients position periodically at a fixed period of time. • To compute the position comparing it with the safe limits (within the Safe Area) and generate alarm events in case of a possible danger.	
Main execution: Periodic position detection. The gateway picks up measures in continuous, elaborates them and send them or a part of them automatically at fixed time to the target platform.	
Requirements: [101], [176], [177]	

7	Monitors patients position and manages alarms
Description: Doctors/Relatives will be able to monitor the position of the assigned patients and control and be informed about possible danger conditions.	
Objectives: • To monitor alarms (for Safe Area exits) using different filters and criteria. • To receive alarm notifications for patients going outside the Safe Area. • To define an algorithm for generation of alarms.	
Main execution: Doctors/Relatives can monitor measures. 1. Using synthetic information (alarms, events). 2. Accessing to detailed information or asking a real time localization.	
Requirements: [101], [107]	

8	Sets Prevention program for students
Description: ASL health operators shall be able to set parameters for a student healthy growth (growth percentiles) referred to children age.	
Objectives: • To assign/de-assign due measures to patients, to define appropriate measures for students and measures thresholds for obesity prevention. • To define a method to recognize a data entity identity and target values used in setting health protocols (e.g. thresholds for measures depending on age on gender, and so on). For entity, we assume for example: type of measure, target reference (i.e. WHO: World Health Organization) for thresholds. Calendars and reminders for measuring are not useful for this kind of massive measures taken at School at fixed time (twice a year).	
Main execution: 1. The ASL health operators use the INTER-Health web portal to add / remove a new measure or threshold.	

2. The students profile will be updated; consequently students will perform the health monitoring using the new protocol defined.
Requirements: [173], [174]

9 Detects and acquires students measures
Description: Students will be able to perform measures using at school multifunctional device (healthy kiosk) that sends measures to the target platform where they will be stored in the database.
Objectives: • Pairing between device and gateway: the association to the gateway is done once for all users; two main goals are: • Measure taking. o Measure detection for objective measures is done massively for all the students of the class. o Subjective Measures: at the same time students are requested to fill on the web portal questionnaires assigned to them by ASL health operators. • Measure Storing: o Questionnaires are immediately stored on the IINTER-Health database. o Objective measures can be temporarily stored on gateway and send to the target platform later.
Main execution: 1. The final user (student) uses the INTER-Health web interface to handle questionnaires. 2. The final user (school operator) uses the INTER-Health gateway to handle objective measures (sent by wireless devices: e.g. via Bluetooth). 3. The school operator sends performed measures to the target platform: updating the questionnaire or using the due gateway functions for objective measures. 4. Background updating of Business analysis database/data warehouse.
Requirements: [101], [102], [172], [177]

10 Analyses students' measures and manages health feedbacks
Description: ASL health operators or School Operators will be able to monitor, at fixed point in the school year, the students growth and control and be informed about possible obesity conditions.
Objectives: To define a multidimensional reporting to monitor measures; possible filters are: age, gender, and period of time.
Main execution: School operators /parents can monitor measures using: 1. Data filtering in a period of time for the user under their control. 2. Drill down and swap. 3. Downloading in different file formats.
Requirements: [107], [171], [173]

27	Detects and acquires elderly people measures
Description: Patients will be able to perform measures using a fixed gateway that collects and automatically send measures to the server (gateway hub). The service is studied for elderly people digitally inexperienced.	
Objectives: • User friendly measure detection without the need of user interaction. • Automatic and safe measure sending to the server platform. • No subjective measures are requested since users are already included in cure programs.	
Main execution: The final user (patient or Health operator) uses the INTER-Health fixed gateway to handle objective measures.	
Requirements: [62], [103], [176]	

42	Treatment plan
Description: Improving health services access, efficiency and quality of our nutritional outpatient using an experimental trial which allow health operator to give subject a continuous decentralized treatment plan.	
Objectives: The treatment plan aim to improve the quality of the health operator work through the use of technologies that could increase efficiency reducing time and resources and improving services. The treatment plan promotes, with the diffusion of electronic medical records, the concept of telemedicine, mHealth, and the decentralized monitoring for healthy subjects using Internet of Things, interoperability and standardization of devices.	
Main execution: 1. Bioethic Committee approval for clinical experimentation. 2. Information sheet reading by the subjects involved. 3. Informed consent reading and signing by recruited subjects. 4. Data treatment in respect of national and European laws.	
Requirements: [62], [101], [102], [103], [104], [105], [106], [107], [143], [144], [145], [146], [147], [148], [149], [150], [154], [155], [156], [157], [158], [171], [172], [173], [174], [175], [176], [177], [190], [191], [192], [208], [209], [210], [211], [212], [213], [217], [218]	

45	Human injury detection
Description: Decentralized monitoring and detection of objective (weight, height, BMI, waist circumference, blood pressure) and subjective measures (eating habit and physical activity practice) during the traditional and experimental nutritional counselling (in the outpatient and at home) through electromedical and wearable device to prevent chronic diseases.	
Objectives: Using electromedical and wearable device, all the detected measures become objective, in a real time mode for the mobile health system; this condition provides more effective and accurate instruments for the healthy prevention action.	

Main execution:

1. During the traditional nutritional counselling all the measures will be detected every 3 months in outpatient.
2. During the experimental nutritional counselling all the measures will be detected every 6 months in outpatient; the weight will be detected at home once a week; the eating habit and physical activity practice twice a months through online questionnaire; physical activity practice everyday.
3. All the data will be collected on Computerized Nutritional folder.
4. INTER-IoT (mobile health) provides mechanisms to register aggregate and anonymize data of healthy subjects.

Requirements: [62], [101], [102], [103], [104], [105], [106], [107], [143], [144], [145], [146], [147], [148], [149], [150], [154], [155], [156], [157], [158], [171], [172], [173], [174], [175], [176], [177], [190], [191], [192], [208], [209], [210], [211], [212], [213], [217], [218]

50 Parameter Validation

Description: Module should be used to validate parameters, if they belong to a certain range.

Objectives: A user of a system will be able to know if the parameters belong to a specific range.

Main execution:

1. Validation parameters are entered.
2. Data to be validated is entered.
3. IF parameter are within range THEN validation successful.

Requirements: [3], [9], [10], [11], [12], [13], [21], [192]

51 Alert Sending

Description: An alert is sent triggered by an event.

Objectives: To send an alert in case some parameters are out of range.

Main execution:

1. Call the module.
2. Publish the value.

Requirements: [12], [13], [44], [131], [154], [168], [193], [276]

52 Add Ingredients

Description: Adding ingredients to the mixer.

Objectives: To have all necessary ingredients added to the mixer in order to process the calories counter.

Main execution:

1. User adds ingredients.

Requirements: [12], [28], [147], [150], [190], [191]

53	Perform cooking
Description: Perform the selected cooking with the ingredients in the mixer.	
Objectives: Food is prepared as planned.	
Main execution: 1. Food is cooked.	
Requirements: [110], [188], [189], [190]	

54	Select cooking
Description: Selection of the cooking for the ingredients	
Objectives: To select the cooking	
Main execution: 1. Select cooking method	
Requirements: [13], [56], [168], [189], [190], [191]	

6 Conclusions

This deliverable analyzes the scenarios and use cases necessary to test the functionalities of the products developed in INTER-IoT.

Firstly, scenarios have been specified which reflect the main characteristics of the system, focusing on the port logistic domain (INTER-LogP) and mobile health (INTER-Health). These scenarios will be refined and further extended in WP6 in order to meet the integration requirements and needs and additionally will be evaluated in the framework of WP7.

Following the VOLERE methodology it have been defined 30 business scenarios into the selected domains (13 scenarios for the transportation and logistics in port environment, 12 for the m-health, 4 for the cross domain), which represent real examples of possible services that the interoperability of the internet of things could enhance in the context of the INTER-IoT project. For the definition of the final pilots, one or several scenarios will be selected, depending on the available resources and services /products.

For each domain, the set of scenarios has been analyzed and some key fields have been identified such as user types, context, interoperability with different systems, motivations or data type.

Furthermore, each scenario has been broken down into simpler actions so use cases are identified to be able to carry out the scenario. In this analysis we have established the actors that are involved and the relationship with each use case.

In addition to the use cases extracted from the scenarios, the technical use cases that have emerged from the work carried out in work packages 3, 4 and 5 have also been taken into account. For all of them, key areas have been identified such as objectives, actors, pre-conditions, triggers, main and alternative execution or requirements involved.

The business scenarios and use cases descriptions presented into the document have been analyzed in order to outline the interoperability requirements that could be further detailed into the activity of the design of the products INTER-LAYER, INTER-FW and INTER-METH.

These products will be used to develop the INTER-LogP and INTER-Health products as benchmark for the INTER-IoT approach and to verify the final results. Additionally several extra scenarios and use cases will be brought to the project by means of the new third parties accepted through the open call.