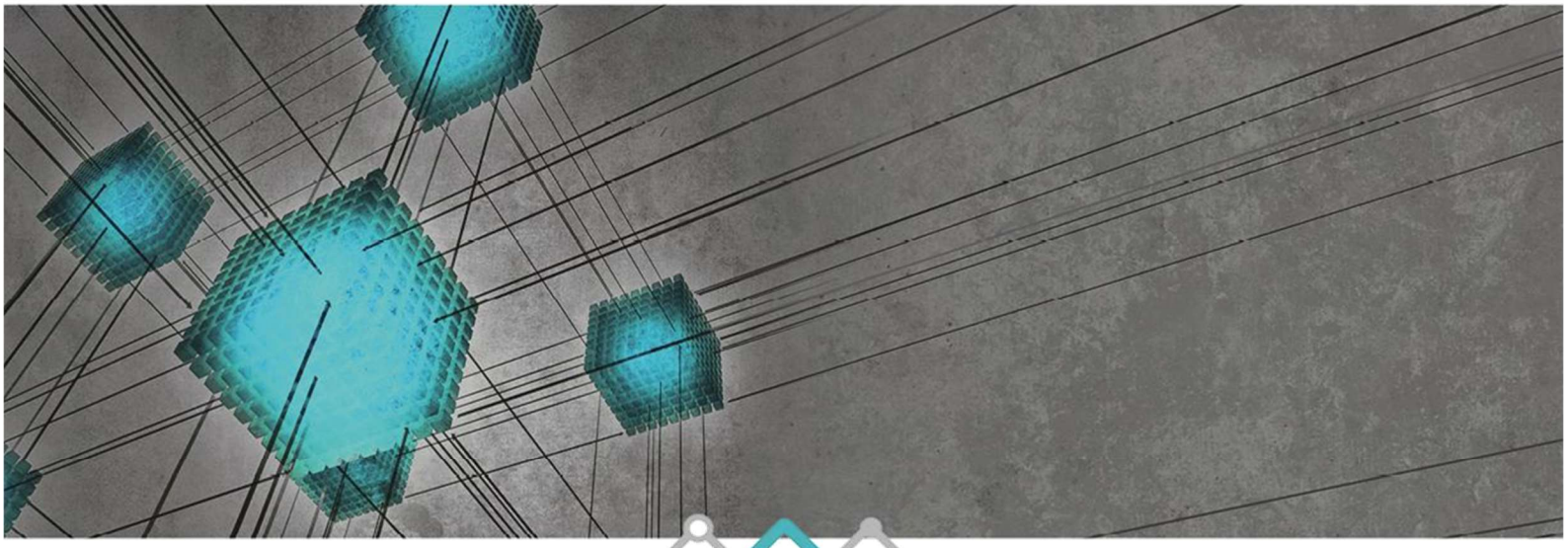

interiot

INTEROPERABILITY
OF HETEREOGENEUS
IOT PLATFORMS.

D7.1.

Evaluation Plan.

March 2018

INTER-IoT

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

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

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

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

INTER-IoT

Evaluation Plan.

Version: 1.5

Security: Public

March 31, 2018

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

Disclaimer

Executive Summary

The Deliverable D7.1 aims to provide evaluation plan for assessment of INTER-IoT both from the standpoint of its users and stakeholders, as well as its developers. It concerns itself with evaluation of technical functioning and interoperability of INTER-IoT components, as well as their performance, usability (including stakeholders' assessment), general project's results, business design, impact creation and its final exploitation.

In D7.1 the methodology is introduced first, partitioning INTER-IoT into five different dimensions of assessment. These include: exploitation, pilots, impact, interoperability as well as ethical, societal, gender and legal evaluation. Dimensions are then further subdivided into fields that group together related Key Performance Indicators.

Evaluation plan is subdivided into three separate plans. First of these is the technical evaluation plan, which assesses INTER-IoT from a technical standpoint. Aim of this evaluation is not only to assess INTER-IoT technical capabilities and performance, but also assess how much it improves the stakeholders' organisations performance (e.g., staff usage, time per task, financial gain). It evaluates all three main INTER-IoT development areas: INTER-Layer, INTER-FW and INTER-METH. The second evaluation plan assesses INTER-IoT from the standpoint of the pilots, measuring impact of using INTER-IoT, including users' and stakeholders' satisfaction. Third evaluation plan is the process evaluation plan, which is the most encompassing of all three. It considers project's stakeholders and users, their interest in the project and their potential gain from the project, as well as also project's legal, gender, societal and ethical aspects, etc. It will deliver a comprehensive picture of the expectable benefits from implementing the system as well as of the modalities required for its successful implementation.

Evaluation plans are going to be executed in Tasks T7.2, T7.3 and T7.4, each evaluation plan per task.

List of Authors

Organisation	Authors	Main organisations' contributions
VPF	Pablo Gimenez	Relation with requirements; Pilot KPIs; Pilots evaluation;
UPV	Jara Suárez de Puga	Relation with requirements; Impact KPIs; Interoperability KPIs; technical evaluation;
UNICAL	Giancarlo Fortino, Claudio Savaglio	Interoperability KPIs; Process evaluation (INTER-METH)
PRO	Amelia del Rey, Miguel A. Llorente	Relation with other WPs; Exploitation KPIs; Interoperability KPIs; Technical evaluation;
XLAB	Marija Gorenc Novak, Flavio Fuart, Matevž Markovič, Joao Pita Costa	T7.1/D7.1 coordination; Methodology selection; Objectives and definition of dimensions; Exploitation KPIs; Interoperability KPIs; Technical evaluation;
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RINICOM	Eric Carlson	Methodology selection; Objectives and definition of dimensions; Exploitation KPIs; Pilots Evaluation; Ethics section;
NOATUM	Toni Broseta	Exploitation and Pilots KPIs; Pilots Evaluation;
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ABC	Alessandro Bassi	Use of results and communication of evaluation findings; Interoperability KPIs;
SABIEN	Gema Ibáñez	Pilots KPIs; Pilots Evaluation;

Change control datasheet

Version	Changes	Chapters	Pages
0.1	TOC, methodology selection	All	10
0.2	Methodology explained, final list of dimensions and draft list of fields created	1, 2	21
0.3	Chapters assigned to partners, request for input inserted in document	All	25
0.4	Integration round 1 - KPIs	2, 3	40
0.5	Integration round 2 – Evaluation plan	2, 4	58
0.6	Ethics	5	60
1.0	Consolidated draft	All	66
1.1	XALB review	All	68
1.2	Inserted KPI tables	3 and annexes	70
1.3	Ready for internal review	All	70
1.4	Internal reviews with corrections	All	70
1.5	Integrated internal reviews, formatting tables	All	68

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Acronyms

AIOTI	Alliance for the Internet of Things Innovation
API	Application Programming Interface
AS2AS	Application services layer interoperability solution, result of INTER-IoT T3.4
ATA	Actual Time of Arrival
BC	BodyCloud IoT platform
BMI	Body Mass Index
CASE	Computer-Aided Software Engineering
CREATE-IoT	H2020 project
D2D	Device layer interoperability solution, result of INTER-IoT T3.1
Dn.m	Deliverable number, as in D2.1 (deliverable 1 of work package 2)
DoW	INTER-IoT Description of Work
ETA	Estimated Time of Arrival
ETR	Estimated amount of Time of Resolution
FIWARE	An IoT platform for the development of smart applications
H2020	Horizon 2020 Programme for Research and Innovation
ICT	Information and Communication Technologies
INTER-DOMAIN	INTER-IoT cross-domain pilot
INTER-FW	INTER-IoT IoT interoperability framework
INTER-Health	INTER-IoT eHealth pilot
INTER-IoT	Interoperability of Heterogeneous IoT Platforms
INTER-Layer	INTER-IoT layer interoperability
INTER-LogP	INTER-IoT transportation pilot
INTER-METH	INTER-IoT methodology for the integration of IoT platforms
INTER-MW	Middleware layer interoperability solution, result of INTER-IoT T3.3
IoT	Internet of Things
IPR	Intellectual Property Rights
IPSM	Inter-Platform Semantic Mediator
JSON-LD	JavaScript Object Notation for Linked Data
KPI	Key Performance Indicator
Mn	n^{th} month of the project (M1=January 2016)
N2N	Network layer interoperability solution, result of INTER-IoT T3.2
PWT	Professional Wen Tool
RDF	Resource Description Framework
REST	REpresentational State Transfer
Rn	n^{th} requirement
SDK	Software Development Kit
SDN	Software Defined Network
SME	Small or Medium-sized Enterprise
Tn,m	Task number, as in T2.1 task 1 of work package 2
W3C	World Wide Web Consortium
WP	Work Package

1 Introduction

The Evaluation work package (WP7) defines and oversees the project's comprehensive evaluation by means of Key Performance Indicators (KPIs). KPI[1] is a type of performance measurement used to evaluate the success of an organization or of a particular activity in which it engages. A good understanding of "what is important" is needed in the process of KPI selection. In order to gain this understanding, the authors of Evaluation plan have revisited the documentation created at the beginning of the project, especially the original DoW, requirements and system specifications. KPIs are important for the project self-assessment, thus for identifying the level of success, but also to identify gaps between the original target and the achievements. KPIs are also important when communicating with stakeholders and other external actors, as they provide confidence that the project is well-managed and achieving its goals.

Different aspects of INTER-IoT are concerned with this evaluation process: IoT interoperability, stakeholders' assessment, business design, impact creation, exploitation of results, but also considers project's ethical, societal, gender and legal aspects. Work package seven addresses also the process evaluation that assesses information related to the deployment and usage of INTER-IoT in pilots, results from which will be used for helping other application domains in adopting INTER-IoT solutions.

The aim of deliverable D7.1 is to provide a basis for a quantitative assessment of INTER-IoT both from the standpoint of its users and stakeholders, as well as its developers. Its essential output is an evaluation plan, which is based upon an internally developed evaluation methodology that uses quantitative models[2]. Most notable of these are the provisional KPIs, whose purpose is to measure the impact and success of the INTER-IoT project, as well as to provide the basis for internal assessment of INTER-IoT progress. The aim of the evaluation is not only to assess the INTER-IoT technical capabilities and performance, but also how much it improves the stakeholder organisation performance (e.g., staff usage, time per task, financial gain). Although we are concerned mainly with collecting quantitative data and defining a rigorous process of evaluating (calculating) KPIs, the number of covered evaluation areas and heterogeneity of evaluation data sources, will allow as to get some qualitative insights as well.

The main inspiration and source of ideas for construction of the evaluation methodology and specification of KPIs in this deliverable is the publicly available *Deliverable 01.04* of the *H2020–CREATE- IoT Project*[3]. Moreover, adequate metrics and KPIs have been constructed based on earlier project outcomes, such as user requirements, business models and legal regulatory from WP2; joint and individual exploitation actions from WP8; design/implementation results from WP3, WP4 and WP5 and WP6. Therefore, in this evaluation plan (D7.1) we also incorporate KPIs for impact creation reported in WP8.

This deliverable is divided into five main sections. In the Introduction we present the objectives of the deliverable, we outline the relation to other WP7 tasks and other INTER-IoT work packages. In the Methodology section, we present the evaluation methodology, which forms the backbone of the whole evaluation process, performed in WP7. In this section we introduce the evaluation methodology, define dimensions (main areas of measurement) that are further broken down in

[1] https://en.wikipedia.org/wiki/Performance_indicator

[2] https://hal.inria.fr/hal-01055929/document

[3] https://european-iot-pilots.eu/wp-content/uploads/2017/10/D01_04_WP01_H2020_CREATE-IoT_Final.pdf

fields of measurement. Further, fields are collections of KPIs. In the same section we explain data collection and management, as well as how we are going to communicate evaluation findings internally and externally. In the third section we introduce the notion of KPIs and we partition them into dimensions, introduced in the previous section. The evaluation plan of INTER-IoT, consisting of three separate evaluation plans, is described in the fourth section. First, the technical evaluation of INTER-IoT itself, the second one is the evaluation of the results of the pilots (impacts while using INTER-IoT, including users' and stakeholders' satisfaction), and the third is the process evaluation, where we consider work done in INTER-IoT both from the standpoint of its developers as well as users and stakeholders regarding its quality, how hard it is for other people to build upon it and other similar matters. The fifth section elaborates on ethical issues related to the execution of the evaluation. The final section is reserved for conclusions.

1.1 Overview

1.1.1 Objectives

Main objective of the deliverable D7.1 is to define the evaluation methodology and use it to create evaluation plans for subsequent tasks in this work package. Definition of the evaluation methodology encompasses design of the evaluation framework and definitions of fields of measurement, which further build upon Key Performance Indicators (KPIs).

D7.1 will thus provide methodology, approach to data collection and processing, evaluation targets and detailed plan for the following evaluation areas:

- technical evaluation of INTER-IoT,
- evaluation of the results of Large Scale Trials (thus including also open call projects),
- process evaluation, including assessment of ethical, societal, gender and legal aspects of the project.

These are going to be fed directly into other three tasks of WP7, where actual project's evaluation is going to be performed. Each of the subsequent tasks is going to perform this evaluation from a different standpoint and using a subset of the evaluation methodology and KPIs, as developed in this deliverable.

In task T7.2 "Technical Evaluation and Assessment" a purely technical evaluation of specifications and developed interoperability components is performed: interoperability capabilities, framework usability (e.g., APIs), and system performance. Evaluation that requires user input and subjective feedback through surveys and interviews is part of T7.3 and T7.4.

Task T7.3," Evaluation of Results from Large Scale Trials", will build upon KPIs and subsections of evaluation methodology connected with project's performance in large scale trials (pilots) of INTER-IoT. In this task the project team will perform data collection from both surveys (by questionnaire, interviews, focus group, etc.) and technical data sources (e.g., system logs). The obtained data will be used to define KPI metrics and assess the project success as what relates to application of INTER-IoT in real-world environments.

Final task T7.4 will be the most thorough one, as it is going to do a complete process evaluation of INTER-IoT, thus improving project's usability and ease of use beyond the two pilots executed in the project. This task will also aid further INTER-IoT developments.

Tasks are going to be executed separately and independently from one another.

1.1.2 Relation with other WPs

As it has been previously commented, WP7 addresses the INTER-IoT project evaluation by considering five main dimensions such as exploitation, pilots, impact, interoperability and ethical, societal, gender and legal evaluation.

The following figure shows the relation of WP7 with the results that have been so far obtained in the other work packages of INTER-IoT.

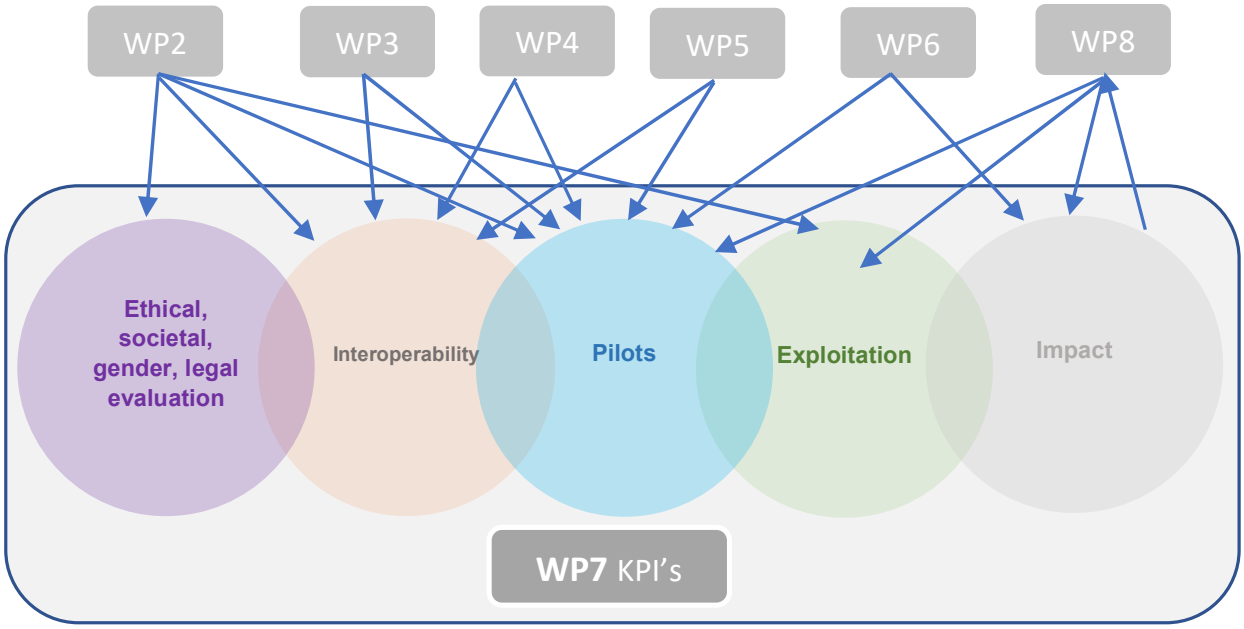

Figure 1 Relation of WP7 with other WPs

Regarding pilot's usability and legal and regulatory aspects, the WP7 will take into account the results of the analyses carried out in *WP2: Requirements and uses cases* through the results from the task *T2.4. Legal and Regulatory* (M1-M12).

The activities dealing with business analyses and impact creation for further exploitation are part of WP2 through the execution of *T2.1 Stakeholders and market analysis* and (M1-M3), *T2.2 Business Model design* (M1-M6), and from tasks of *WP8: Impact Creation*, like *T8.3 Business and marketing Operation* (M1 -M36) and *T8.4 Exploitation* (M1 -M36).

WP7 has a bidirectional relationship with the tasks *T8.4 Exploitation* and *T8.3 Business and marketing operations*. On one hand, in an early stage of the project an initial Exploitation Plan was defined and included in the deliverable *D8.3 Impact creation* (M4 and M12), that contemplated the inputs of the Evaluation and Assessment Plan from WP7 (M25-M36) based on the evaluation of the large-scale trials (transport and logistics and m-Health), during its second iteration of the joint and individual Exploitation Plans (M18-M32) and Go to market (M33-M26) phases.

For instance, aspects such as stakeholders/users satisfaction will help to improve the definition of the value proposition of on-going INTER-IoT products, to satisfy the market demands. The measure of other KPIs related with economic, societal, gender and legal aspects will provide information about barriers to put the products into the market. These inputs will help to better define the current effective business plans to build individual and joint go-to market strategies.

On the other hand, the deliverable *D8.3 Impact creation* also proposed some initial threefold impact KPIs: academic and research, communication and exploitation, to measure the impact creation of

INTER-IoT during the whole project. These initial KPIs were measured and reported in the deliverable *D8.5 Report on Impact Creation* (M18) and are going to be part of the KPIs included in section 3 of this deliverable.

KPIs related to interoperability are addressed by activities performed in WPs 2, 3, 4 and 5 (technical development work packages). These KPIs are identified is several activities of the project, which are not necessarily triggered by these work packages, however, WP leaders and task leaders are involved in the identification and definition of the indicators.

Some of these indicators for the areas of exploitation, interoperability, impact and pilots were initially proposed for the review in Athens, held in M21. These KPIs are also related with the output of task *T2.3 Requirement and Business Analyses (M1-M9),* which identified interoperability requirements which are the base to measure the different technical aspects reached by the development activities. Technical tasks that are more remarkably contributed to KPIs are all the tasks from *WP3. Layer Interoperability*, *T3.1-T3.6* (M7-M30), and *T4.1 Design of a Reference meta-Architecture for Interoperable IoT Platforms* (M7-M24), *T4.3 Design of an Interoperable Framework (INTER-FW) for Interoperable IoT Platforms* (M13-M30) from *WP4: Interoperability Framework API* and *T5.2 Definition of a Full-Fledged Methodology for IoT Platforms Integration* (M9-M24) from *WP5: Methodology for Integration of IoT Platform.*

Regarding pilots, user experience and user acceptance, KPIs are mainly identified in *WP6: Integration and Pilot Deployment* with tasks *T6.2 Transportation Pilot* (M22-M36), *T6.3 Mobile Health Pilot* (M22-M36) and *T6.4 Cross use Case Pilot* (M25-M36), which are focused in the development of the different pilot activities. KPIs related with pilots are important since they assess the combination of technical and exploitation requirements in real scenarios.

2 Methodology

In this section we describe the methodology for evaluation of the INTER-IoT project and specification of guidelines to evaluate the impact of INTER-IoT. We first prepare the groundwork in the form of dimensions and fields of measurement that we will use in the next section when we introduce specific KPIs. These will provide us with a better, more tangible assessment of the project's success factors, next to information gained from questionnaires and other such means. KPIs are derived mainly from the INTER-IoT Description of Work (DoW) and requirements gathered in WP2, as well as initial set of KPIs defined during the project review. This process will allow us to measure the project success with respect to the DoW (thus original project proposal); requirement coverage (accomplished, not accomplished, partially accomplished.), gap analysis, system potential bottlenecks, partners and stakeholders feedback and recommendations.

We have decided to build our evaluation methodology upon ideas, derived from the Deliverable 01.04 of the H2020 CREATE-IoT Project. We made this decision since this deliverable addresses the analysis of large scale IoT pilots, spread through more focus areas and application domains. It is thus very similar to the structure of INTER-IoT, where we have two large scale pilots in addition to several Open Call projects, in various application domains and thus also focus areas. However, in WP7, in contrast to the above-mentioned deliverable, we perform only validation, as testing is done in WP6.

First, we design the methodology, then define dimensions and fields of measurement, in accordance with project aspects presented above. Data collection management, use and communication of evaluation findings are considered at the end of this section. The actual evaluation procedure is based on INTER-IoT project requirements.

2.1 Dimensions and fields of measurement

Measurement of INTER-IoT performance and progress is done via the usage KPIs. Technically, a KPI is a type of performance measurement, which is done against a predefined set of values, called indicators. In this deliverable, we use only quantitative indicators, meaning that each KPI's value is going to be a number. For example, if we were to define a KPI for user's satisfaction with performance of INTER-IoT, we would choose a value for it from the set of numbers from 1 to 5, where 1 would represent complete dissatisfaction and 5 would represent complete satisfaction.

KPIs are grouped into fields. These join KPIs that are semantically similar, for example, KPIs that deal with system performance from the user's standpoint are grouped together, and in a different field we would have KPIs that deal with user's satisfaction with INTER-IoT.

Related fields are further coupled together into dimensions, which represent different aspects of progress measurement in the INTER-IoT project. We have decided to define these five main dimensions, which are further worked upon in section 3:

1 Exploitation (see Table 2)
2 Pilots (see Table 3)
3 Impact (see Table 4)
4 Interoperability (see Table 5)
5 Ethical, societal, gender and legal evaluation (see Table 6)

The Evaluation Plan of using different evaluation methodologies and their presence in different evaluation areas is shown in Table 1. Each of the dimensions is assigned to one or more evaluation

areas, which also represent three different methodologies by which we will measure the overall impact of INTER-IoT. As an example, the interoperability will be part of all evaluation areas and thus there will be measured: interoperability capabilities in technical evaluation area, interoperability capabilities in pilot projects as well as in the process evaluation.

Table 1 Evaluation plan for each evaluation area

	Dimension Filed of evaluation	Technical evaluation (Task 7.2)	Pilot evaluation (Task 7.3)	Process evaluation (Task 7.4)
1	**Exploitation**			
	Field 1.1 Stakeholders' engagement		X	
	Field 1.2 Impact on SMEs, start-ups and young entrepreneurs		X	
	Field 1.3 Business models			X
	Field 1.4 Market readiness and monetization mechanisms			X
	Field 1.5 Inclusiveness and participation of third parties			X
	Field 1.6 Exploitation of products			X
2	**Pilots**			
	Field 2.1 INTER-LogP pilot		X	
	Field 2.2 INTER-Health pilot		X	
	Field 2.3 INTER-DOMAIN pilot		X	
3	**Impact**			
	Field 3.1 Dissemination approach			X
	Field 3.2 Educational Effectiveness			X
	Field 3.3 Promotion of resources & Openness			X
	Field 3.4 Community engagement			X
4	**Interoperability**			
	Field 4.1 IoT devices and INTER-IoT modules	X		
	Field 4.2 IoT platforms	X		
	Field 4.3 IoT system functional design	X		
	Field 4.4 Use of open technology devices and platforms	X		
	Field 4.5 Use of supported standards	X		
	Field 4.6 Scalability	X		
	Field 4.7 Supportability			X
	Field 4.8 Configuration and monitoring	X		
5	**Ethical, societal, gender and legal evaluation**			
	Field 5.1 Legal issues			X
	Field 5.2 Holistic innovation			X
	Field 5.3 User worktime/life impact			X
	Field 5.4 Targeted social groups			X
	Field 5.5 Trusted, safe, secure IoT environment promotion			X
	Field 5.6 Community engagement			X

Within each dimension we further partition KPIs into the fields, as described in the following tables. Some of the fields were taken from the CREATE-IoT deliverable mentioned above.

Fields within the first KPI dimension deal with the topic of exploitation of project results.

Table 2 Dimension 1 - Exploitation fields

Name	Short description	Long description
Field 1.1	Stakeholders' engagement	Ability to reach out to the appropriate stakeholders and ability to engage them.
Field 1.2	Impact on SMEs, start-ups and young entrepreneurs	How is INTER-IoT impacting start-ups, young entrepreneurs and SMEs? How does it engage with them, how does it encourage disruptive innovation, etc.
Field 1.3	Business models	Ability to support diversified business models, includes capability of understanding their different features, how to serve their needs, how to adapt to their mechanisms, etc.
Field 1.4	Market readiness and monetization mechanisms	Mechanisms for billing and accounting that allow stakeholders to extract revenue streams.
Field 1.5	Inclusiveness and participation of third parties	What is the effective ability of third parties to expand the products and services, as well as with which rights?
Field 1.6	Exploitation of products	What is the effective ability of third parties to use the products and services, as well as with which rights?

Fields within the second KPI dimension deal with the topic of pilots.

Table 3 Dimension 2 - Fields connected with pilots

Name	Short description	Long description
Field 2.1	INTER-LogP pilot	KPIs connected with the INTER-LogP pilot.
Field 2.2	INTER-Health pilot	KPIs connected with the INTER-Health pilot.
Field 2.3	INTER-DOMAIN pilot	KPIs connected with the INTER-DOMAIN pilot.

Fields within the third KPI dimension deal with the topic of impact.

Table 4 Dimension 3 - Impact fields

Name	Short description	Long description
Field 3.1	Dissemination approach	KPIs related to dissemination channels and verticals.
Field 3.2	Educational Effectiveness	KPIs pertaining to INTER-IoT role in academia and educational sphere as well as events connected to it.
Field 3.3	Promotion of resources & Openness	Project's ability to being open, support standards and contribute to other research projects.
Field 3.4	Community engagement	Ability of the project to engage with the community.

Fields within the fourth KPI dimension deal with interoperability.

Table 5 Dimension 4 - Interoperability fields

Name	Short description	Long description
Field 4.1	IoT devices and INTER-IoT modules	KPIs related to software development and software running allowing to measure complexity and heterogeneity of proposed solutions.
Field 4.2	IoT platforms	KPIs related to types and characteristics of IoT platforms integrated using INTER-IoT as well as coverage of IoT platforms available on the market for which integration was evaluated.

Field 4.3	IoT system functional design	KPIs related to methodologies to optimize performance, data exchange, adaptation and extension of INTER-IoT ecosystem.
Field 4.4	Use of open technology devices and platforms	KPIs related to integration of (and integration with) existing and widespread technologies, devices and platforms.
Field 4.5	Use of supported standards	KPIs related to the ability to count on existing, well-renowned and commonly adopted standards.
Field 4.6	Scalability	KPIs related to non-functional requirements used to evaluate the performance of a system e.g. the ability to expand IoT platforms ecosystem integrated using INTER-IoT.
Field 4.7	Supportability	KPIs related to non-functional requirements used to evaluate the level of support provided to the user during the process of integration.
Field 4.8	Configuration and monitoring	KPIs related to the ability to configure and monitor INTER-IoT components.

Fields within the fifth KPI dimension that deal with ethical, societal, gender and legal evaluation.

Table 6 Dimension 5 - Fields connected with ethical, societal, gender and legal evaluation

Name	Short description	Long description
Field 5.1	Legal issues	KPIs pertaining to legislation.
Field 5.2	Holistic innovation	KPIs pertaining to INTER-IoT ability to conceive new products, services and processes that are putting human in the centre.
Field 5.3	User worktime/life impact	KPIs connected with extent to which INTER-IoT supports and enhances user's quality of life.
Field 5.4	Targeted social groups	Ability of INTER-IoT to target more vulnerable social groups' needs.
Field 5.5	Trusted, safe, secure IoT environment promotion	KPIs linked to the promotion of the safeness of IoT environment.
Field 5.6	Community engagement	Ability of INTER-IoT to engage directly with citizens, via public community events and activities.

2.2 Data collection management

Evaluation method of INTER-IoT embeds the intention to ensure ease of use and maximization of stakeholders' and users' gains. Thus, the core of the INTER-IoT evaluation methodology is formed through direct contact with the stakeholders and users. One of the points of contact are going to be through one-to-one interviews. These will be conducted with coordinators of both pilots, as well as work package leaders of tasks pertaining to the specific pilot. Next to one-to-one interviews, desk research, secondary research and on-line questionnaires are also going to be employed.

Ways for obtaining the evaluation data for the INTER-IoT project are as follows:

1. desk research will be performed to investigate the existing material (documentation),
2. face-to-face interviews/online questionnaires with different stakeholders (open call projects, WP/Task leaders, end users, businesses, software developers and researchers) are going to be performed,
3. questionnaires will be organized and conducted to obtain feedback from wider IoT community.

To be able to assess INTER-IoT progress in a more objective manner, obtained findings will be assigned a numerical value, a KPI.

To allow comparison of KPIs and calculation of overall scores for fields and dimensions of measurement, each KPI will be assigned a number, which will denote the percentage (completeness) of achievement of the target set for that KPI. Thus, 0% will mean that none of the INTER-IoT activities have managed to contribute to the KPI and 100% will mean that the target set in this evaluation plan has been reached. Moreover, values exceeding 100% mean that for that KPI, INTER-IoT has achieved more than initially planned.

The **KPI value** will be measured directly (for example messages/second, user satisfaction on the Likert scale). Then, the **KPI score,** expressed in percentages in relation to the KPI target, is going to be calculated for each KPI.

Thus, the steps in defining the KPI score are as follows:

1. Define the KPI unit of measure
2. Define the KPI target value
3. Define the function to transform the KPI value into the KPI score. The function must implement the following rules:
    a. KPI value = no achievement → KPI score = 0%
    b. no achievement < KPI value < target → 0% < KPI score < 100%
    c. KPI value = target → KPI score = 100%
    d. KPI value > target → KPI score > 100%

This approach allows us to, at the indicator level:

1. show the current value of an indicator,
2. define the performance function of an indicator where, for example, higher value means higher performance, lower value means lower performance and non-numerical values are transformed to a score,
3. interpret the value of an indicator against the original target set by INTER-IoT.

Then, KPI scores are used to calculate **Field scores**, which are calculated as average of all KPI scores for that field. These are expressed in percentages as well.

Formula for computation of the Field score is expressed in Figure 2. If all KPIs reach the target, which would manifest as all KPI scores being 100%, then Field score is also going to be 100%.

$$FieldScore = \frac{\sum_{i=1...N} KPIscore_i}{N}$$

Figure 2 Formula for computation of the Field score

Field scores are then further combined into a **Dimension score**, which is defined as the average of Field scores for that dimension.

On field and dimension level we thus calculate a score by taking into account the performance values of corresponding KPIs. This approach would provide an indication of achievements for specific indicators, as well as overall results obtained by INTER-IoT.

2.3 Use and communication of evaluation findings

Once we obtain and process information gained in the evaluation, we will have a much deeper insight into where INTER-IoT stands both regarding its internal development as well as regarding its connection to the outside world via its users and stakeholders. Clearly, all evaluations are fundamental. Within INTER-IoT, while we as partners might have an idea on the best path for technology development and commercial exploitation, these “feelings” can be strengthened and/or corrected by a proper evaluation phase.

Evaluation findings will be initially used by all partners of the consortium in different ways. As our talents are different, industrial partners will consider the evaluation to confirm that commercialisation plans are solid and the technology development going towards what is needed form the market. The research institutions will get the feeling on which technologies need improvement and how to plan future developments in the scientific domain.

In more details, the first dimension (Exploitation) will be used first and foremost by both marketing and technology officers of the different commercial entities participating into the project, for the direct exploitation of results. The evaluation results will also be used at large by the Support Actions, to drive more in general the exploitation of EU-funded projects, providing clearer and less bias roadmaps and therefore increasing the effectiveness of the actions.

For what concerns the second dimension (Pilots), evaluation will show the maturity of our specific solution towards those markets and, conversely, the readiness for those domains to the IoT technologies in general and to our solution in particular. Again, these findings can be used by both research partners to see which scientific developments are most needed, and to the commercial ones, to focus on specific market segments and to specific actions to provide mature solutions to them.

The third dimension will have a similar use by both the participants of different EU-funded projects and project partners, as it will have an impact on more general issues such as business models to use and community engagement. As such, it can drive current exploitation plans of different actions. In a sense, the fifth dimension has a very similar breadth, as it will appeal to a larger public and will show how societal issues are dealt with and how can the technology development respond to them.

The fourth dimension, as will look more into technology issues, will be more used by technology-related actors, therefore scientific partners and technology officers of industrial ones, and will show how far our work did, and how much is left to develop a suitable solution for industry.

The fifth dimension is important for all involved parties, as it provides confidence that project results are compliant with legal and ethical standards.

3 Key performance indicators (KPI)

In this section we present the Key Performance Indicators (KPIs) divided into five main dimensions of measurement: impact, exploitation, interoperability, pilots as well as ethical, societal, gender and legal aspects. Actual design of KPIs is based on the requirements of the INTER-IoT project, which are presented in section 3.1, while KPIs themselves are grouped into fields and thus dimensions in section 3.2.

3.1 Requirements for KPIs

Based on the requirements defined in the first stage of the project and improved throughout the project, some indicators can be extracted to measure the success of the project. That is the main reason why some of the KPIs can be directly related to the defined requirements.

Requirements were taken from deliverable *D2.3 Requirements and business analysis*.

In Table 7, the KPIs that arise from the requirements are listed. These KPIs are further described in the following sections.

Table 7 Key Performance Indicators derived from Requirements

KPI	Related requirements
Scalability of semantic translation	R2: Scalability. Design
Alignment with IoT architectures	R4: Alignment with other IoT architectures, especially with AIOTI
Device to device protocol integration in gateway southbound	R39: Heterogeneous gateway R245: Legacy gateway integration
IoT platforms integrated	R234: Provide connectors to middleware standards R236: Support of main Internet of Things platforms
Alignment with IoT ontologies Syntactic translators between different data formats and RDF	R178: Inter Platform Semantic Mediator provides data and semantic interoperability functionality R180: Syntactic and semantics interoperability - Data format and semantics translation R220: Ontology mapping among most prominent standards
Real-time access to medical applications	R71: Application response time
API offered	R226: API for network services R237: API Middleware for interoperability between different platforms R243: Gateway access API
Software defined network frameworks integrated	R17: Dynamic network support R229: SDN capabilities
Security mechanism in place	R27: System security R65: Communication channel security
Usability of the configuration and administration tools	R110: Usability
Standards supported	R123: Use of standards

3.2 KPIs grouped by dimensions

This section details, for each KPI dimension, how KPIs are grouped into fields within this dimension and what are the properties of these KPIs. This is done via two consecutive tables per dimension – the first one specifying the grouping of KPIs into fields and the latter one specifying KPI properties. The list has been compiled by INTER-IoT partners based on best-practises in similar domains and then further refined to reflect the specifics of this project.

The following KPI properties are provided:

- ID: unique identifier of the KPI,
- Name: short unique KPI name,
- Description: description of the KPI,
- Metric: a standard or dimension of measurement in which the KPI's value is expressed,
- Target: a value against which to benchmark the KPI. It is obtained either from the literature or from INTER-IoT partner's experience.

Further details about each KPI are provided in the annexes. They contain the following additional information about each KPI:

- Dimension: into which of five INTER-IoT dimensions (Exploitation, Pilots, Impact, …) the KPI belongs,
- Fields: into which field within the above selected field the KPI belongs,
- Target (T): target of the KPI, described above,
- KPI score calculation: each KPI is assigned a score, which is computed from KPI value and target T in accordance with the rules set in Section 2.2. This column provides the function which is used to obtain this KPI score,
- Comments: any additional comments about the KPI.

3.2.1 Exploitation

This section describes the KPIs designed to evaluate the success of the exploitation. These aim to ensure a high degree of participation and dissemination of the scope and objectives of the project.

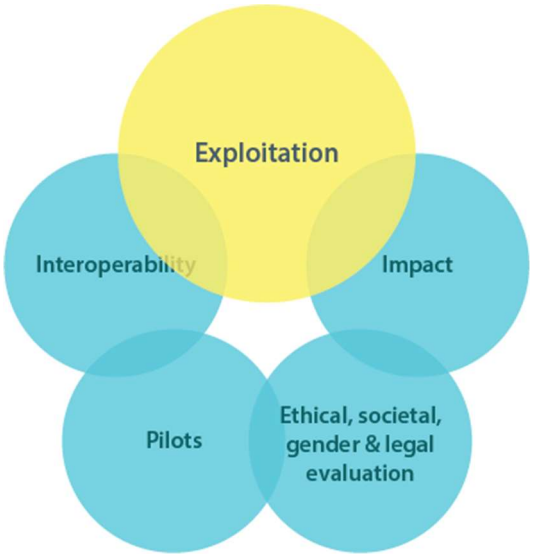

Figure 3 KPIs for exploitation

KPIs presented below are partitioned into fields, as described in Section 2.2.

Table 8 Dimension 1 - Exploitation; distribution of KPIs

Field id	Field Name	KPI id	Name
Field 1.1	**Stakeholders' engagement**	KPI.1.01	Stakeholders involved
		KPI.1.02	Stakeholders analysed
		KPI.1.19	Partners involved in joint exploitation
Field 1.2	**Impact on SMEs, start-ups and young entrepreneurs**	KPI.1.03	Open Calls launched
		KPI.1.04	Received proposals in Open Call
		KPI.1.05	Accepted proposals in the Open Call
		KPI.1.14	Spin-offs created
Field 1.3	**Business models**	KPI.1.06	Business models proposed
		KPI.1.11	Business model flexibility
		KPI.1.20	Openness in business models
		KPI.1.22	Channels selected
Field 1.4	**Market readiness and monetization mechanisms**	KPI.1.07	Monetizable products
		KPI.1.10	Open-source readiness
		KPI.1.15	Time to go-to-market
		KPI.1.16	Commercial presentations
		KPI.1.17	Commercial leads
		KPI.1.18	Commercial industrial events
		KPI.1.23	Effective business model design
		KPI.1.24	Competitors
Field 1.5	**Inclusiveness and participation of third parties**	KPI.1.08	Private companies using INTER-IoT products (estimate)
		KPI.1.09	Public institutions using INTER-IoT components (estimate)
		KPI.1.21	External partnerships and collaborations
Field 1.6	**Exploitation of products**	KPI.1.12	Derived products
		KPI.1.13	Existing products influenced by INTER-IoT developments
		KPI.1.25	IPR

Table 9 Dimension 1 - Exploitation KPIs

KPI id	Name	Description	Metric	Target
KPI.1.01	Stakeholders involved	Determine how many stakeholders were involved	Number	90
KPI.1.02	Stakeholders analysed	Determine how many stakeholders were analysed	Number	75% of the involved stakeholders
KPI.1.03	Open Calls launched	To prepare and organize an Open Call activity to provide the opportunity to SME and academia of participate in the project with their collaborations enriching the features already provided by INTER-IoT	Number	1
KPI.1.04	Received proposals in Open Call	Once the Open Call has been closed we count the number of received proposals that met the basic requirements.	Number	50
KPI.1.05	Accepted proposals in the Open Call	Number of proposals that are going to be funded by INTER-IoT.	Number	12
KPI.1.06	Business models proposed	Business models used to exploit INTER-IoT products	Number	4
KPI.1.07	Monetizable products	INTER-IoT technologies and combinations of technologies which can be exploited.	Number	5

KPI id	Name	Description	Metric	Target
KPI.1.08	Private companies using INTER-IoT products (estimate)	Once the products obtained from INTER-IoT are released, those can be acquired by private companies to be installed in their facilities.	Number	5
KPI.1.09	Public institutions using INTER-IoT components (estimate)	Once the products obtained from INTER-IoT are released, those can be acquired by public institutions to be installed in their facilities.	Number	4
KPI.1.10	Open-source readiness	Code/Pieces of code is/are published in one or more public repositories with detailed documentation.	Number	4
KPI.1.11	Business model flexibility	Business model flexibility represents those business models that can be used for more than one product.	Number	3
KPI.1.12	Derived products	Number of individual products (unique selling proposition) released by the end of the project containing a significant part of INTER-IoT technologies	Number	3
KPI.1.13	Existing products influenced by INTER-IoT developments	Number of individual products (unique selling proposition) released containing a part of INTER-IoT technologies	Number	8
KPI.1.14	Spin-offs created	Number of spin-off created to exploit INTER-IOT products	Number	1
KPI.1.15	Time to go-to-market	Time in months needed to place the INTER-IoT product/service on the market	Number	6
KPI.1.16	Commercial presentations	Number of commercial presentations/demos done to potential customers	Number	30
KPI.1.17	Commercial leads	Number of commercial leads detected	Number	20
KPI.1.18	Commercial industrial events	Commercial industrial events where the INTER-IoT partners have participated	Number	80
KPI.1.19	Partners involved in joint exploitation	Partners involved in INTER-IoT joint exploitation plans	Number	12
KPI.1.20	Openness in business models	Number of partners of INTER-IoT and third parties (Open Calls) that base their business models in an open source model	Number	15
KPI.1.21	External partnerships and collaborations	Number of recorded formal or informal agreements between the partners of the consortium and other external companies	Number	3
KPI.1.22	Channels selected	Channels selected by the partners for INTER-IoT product/service go-to market activities	Number/List	5
KPI.1.23	Effective business model design	Number of solid LLAVA Matrices Produced to go-to-market strategy by INTER-IoT partners	Number	7
KPI.1.24	Competitors	List of competitors of the marked oriented products derived from INTER-IoT	Number/List	-
KPI.1.25	IPR	Number of partners and third parties who are planning to exploit the intellectual property from the results their own.	Number	13

3.2.2 Pilots

In this section are described the KPIs designed to assess the success of the pilot deployments. By using the INTER-IoT components, the efficiency and productivity is going to be improved. The defined KPIs analyse how much these parameters can be enhanced.

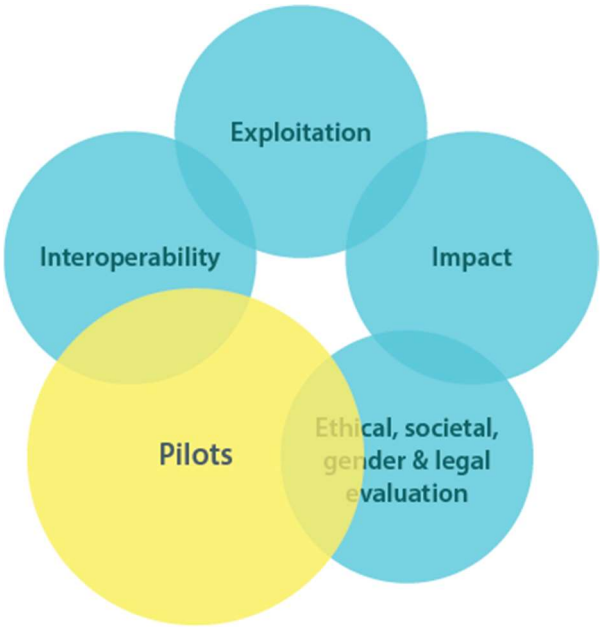

Figure 4 KPIs for pilots

KPIs presented below are partitioned into fields related with pilots.

Table 10 Dimension 2 - Pilots; distribution of KPIs

Field id	Field Name	KPI id	Name
Field 2.1	**INTER-LogP pilot**	KPI.2.03	Number of objects connected to INTER-LogP
		KPI.2.04	Accuracy ETA vs ATA
		KPI.2.05	Activity detected in the railway area
		KPI.2.06	Trucks detected by system
		KPI.2.07	Global events detected by system
Field 2.2	**IINTER-Health pilot**	KPI.2.02	Number of patients connected to INTER-Health
		KPI.2.08	Average BMI improvement
		KPI.2.09	Average waist circumference improvement
		KPI.2.10	Chronic diseases risk reduction
		KPI.2.11	Physical activity (steps) improvement
		KPI.2.12	Physical activity (minutes of activity) improvement
		KPI.2.13	Average eating habit improvement
		KPI.2.14	Dropout rate
		KPI.2.15	Performance of the Professional Web Tool
		KPI.2.16	Number of minutes in one screen in BC app
		KPI.2.17	Number of minutes in one screen in the PWT app
Field 2.3	**INTER-DOMAIN pilot**	KPI.2.01	Use cases

Table 11 Dimension 2 – Pilots

KPI id	Name	Description	Metric	Target
KPI.2.01	Use cases	Use cases defined and deployed to test different developments	Number	4
KPI.2.02	Number of patients connected to INTER-Health	Nutritional Counselling Data record on Professional Web Tool through smartphone application Measurements: weight, height, BMI, waist circumference, blood pressure, eating habit, physical activity practice	Number of patients	100
KPI.2.03	Number of objects connected to INTER-LogP	Number of devices and sensors connected to the different IoT platforms in INTER-LogP	Number	250
KPI.2.04	Accuracy ETA vs ATA	Measurement about the accuracy between estimated time of arrival, versus actual time of arrival.	Minutes	5''
KPI.2.05	Activity detected in the railway area	Percentage of trains correctly detected by system (Arrival and Departure trains) Rai zone. Validates NOATUM interoperability towards port authority	%	0,8
KPI.2.06	Trucks detected by system	Percentage of trucks correctly detected by system (Arrival and departure trucks) APV Zone. Validates port authority interoperability towards NOATUM	%	0,8
KPI.2.07	Global events detected by system	Percentage of events correctly detected by system. GLOBAL to the pilot	%	0,8
KPI.2.08	Average BMI improvement	Percentage of all persons' BMI improvements, that is, how their BMI has changed for better during the pilot.	% of Patients	0,6
KPI.2.09	Average waist circumference improvement	Percentage of all persons' waist circumference improvements during the pilot.	% of Patients	0,6
KPI.2.10	Chronic diseases risk reduction	For how many people the risk for developing chronic disease has decreased during the pilot.	% of Patients	1
KPI.2.11	Physical activity (steps) improvement	Average physical activity level improvement	Number of steps	10000 steps
KPI.2.12	Physical activity (minutes of activity) improvement	Average physical activity duration improvement	Minutes	21 minutes
KPI.2.13	Average eating habit improvement	Indicator of people's lifestyle improvement during the pilot	% of Patients	0,7
KPI.2.14	Dropout rate	Evaluate the effectiveness of Experimental Nutritional Counselling respect the traditional Nutritional Counselling	% of Patients	<25%
KPI.2.15	Performance of the Professional Web Tool	Medical data should be accessible for professionals	seconds	< 5s
KPI.2.16	Number of minutes in one screen in BC app	It indicates how long takes for a patient to use the app	Minutes	>10 minutes
KPI.2.17	Number of minutes in one screen in the PWT app	It indicates how much time a HP spends in a screen of the PWT	Minutes	>60 minutes

During the execution of pilot trials lot of information will be produced. This data will be analysed in the evaluation process. The result of the evaluation will be compared with the estimated target, to measure the effectiveness of the INTER-IoT products.

3.2.3 Impact

During the development of the project and, moreover, at last stages of this period, the repercussion of the tasks carried out inside the INTER-IoT framework will be measured and analysed. INTER-IoT will spread its knowledge and results, by means of standardization, information, support or product, to reach all groups of the scientific, academic and industrial community involved in IoT. This will benefit the community helping to improve the current situation of non-interoperability in the IoT systems and platforms. For that reason, with the aim of contribute positively the community and future activities based on INTER-IoT, we will accomplish a series of tasks that will provide the desired impact of the project. To define and quantify this 'desired impact' a series of KPIs activity-related have been defined with a minimum effect to be fulfilled. Achieving these objectives can be understood that INTER-IoT have reached the desired impact on the IoT environment for the scientific, academic and industrial areas.

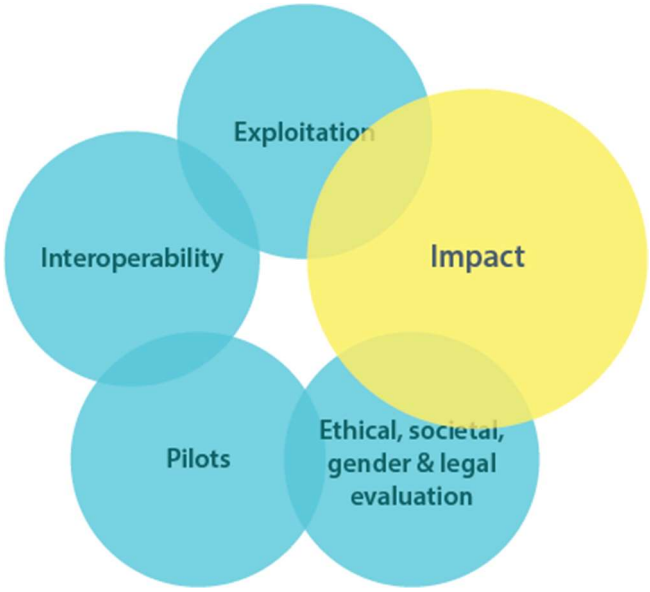

Figure 5 KPIs for impact

KPIs are presented below in the table and partitioned into the fields (connected with impact) as depicted in Section 2.2.1

Table 12 Dimension 3 - Impact; distribution of KPIs

Field id	Field Name	KPI id	Name
Field 3.1	**Dissemination approach**	KPI.3.01	Dissemination channels
		KPI.3.03	Verticals involved
		KPI.3.12	Business or commercial meetings to present the project
Field 3.2	**Educational Effectiveness**	KPI.3.04	Publication actions generated
		KPI.3.05	Organisation of Scientific events
		KPI.3.06	Academic impact (PhD and MSc Thesis)
		KPI.3.07	Participation in industrial dissemination actions
		KPI.3.08	Industrial demos development
Field 3.3	**Promotion of resources & Openness**	KPI.3.02	Initiatives to support standardization
		KPI.3.09	Research projects identified for Cross Dissemination
		KPI.3.14	Collaboration in Free and Open projects

Field id	Field Name	KPI id	Name
Field 3.4	**Community engagement**	KPI.3.10	Social network followers
		KPI.3.11	Number of individual addressed through different communication channels
		KPI.3.13	Participation in technological forums/discussions

Table 13 Table 3.6: Dimension 3 - Impact

KPI id	Name	Description	Metric	Target
KPI.3.01	Dissemination channels	Number of dissemination mediums to spread INTER-IoT actions and results including; multimedia platforms, events, social networks, industrial/academic environments or means, etc.	Number	20
KPI.3.02	Initiatives to support standardization	The inclusion of the project team in open initiatives to improve or create standardization in the IoT interoperability area using the results obtained during the lifecycle of the project	Number	4
KPI.3.03	Verticals involved	Number of IoT vertical markets in which the results obtained from the project are involved (eHealth, Logistics, Smart Home, etc.)	Number	3
KPI.3.04	Publication actions generated	A publication action is one submitted scientific or technical article to journals, conferences, workshops and business events.	Number	45
KPI.3.05	Organisation of Scientific events	Organization of events involved in the scientific area with a minimum range of impact and participation (50+ people)	Number	6
KPI.3.06	Academic impact (PhD and MSc Thesis)	Number of parallel work that can create a line of research to be perform by a PhD or MSc student.	Number	5
KPI.3.07	Participation in industrial dissemination actions	Getting involved in different tasks carried out by the industrial community	Number	8
KPI.3.08	Industrial demos development	The implementation of a well-defined demo to be shown in an industrial event as conference, meeting, fair, etc.	Number	3
KPI.3.09	Research projects identified for Cross Dissemination	To be involved in different projects that include dissemination in the IoT area not being restricted uniquely to this one.	Number	4
KPI.3.10	Social network followers	During the project duration different social networks have been created to follow the progresses and to be updated with the events that are being organized by INTER-IoT. These social networks include a web page, a Twitter account, a Facebook page and a LinkedIn Group.	Number	1000
KPI.3.11	Number of individual addressed through different communication channels	In addition to social networks and other public dissemination channels created by INTER-IoT, other private means of communication have been created with specific purposes, such as Slack and mailing lists.	Number	2000
KPI.3.12	Business or commercial meetings to present the project	To have private or semi-public meetings and presentations to show INTER-IoT to prospective customers.	Number	15
KPI.3.13	Participation in technological forums/discussions	Participation in technological forums on the internet to talk about INTER-IoT and related subjects.	Number	5
KPI.3.14	Collaboration in Free and Open projects	To be involved with other Open Source projects. The involvement is either by contributing to other projects or involving others to contribute to INTER-IoT.	Number	2

Having listed and explained the KPIs Impact-related, an evaluation of completion status will be done to determine how far INTER-IoT is to reach the success threshold. Based on this, future activities will be defined to complete the minimum values required per KPI.

3.2.4 Interoperability

The KPIs defined within the interoperability dimension should allow to measure to what extent solutions proposed in INTER-IoT project reached one of project's goals i.e. to propose mechanisms to achieve interoperability between heterogeneous IoT artefacts. This dimension addresses both functional aspects related to development, deployment and architecture of INTER-IoT components, and alignment to existing standards and open technologies. KPIs defined here, should allow to evaluate technologies used, their maturity and readiness level. Moreover, they should allow to assess how this technology has been integrated and is performing.

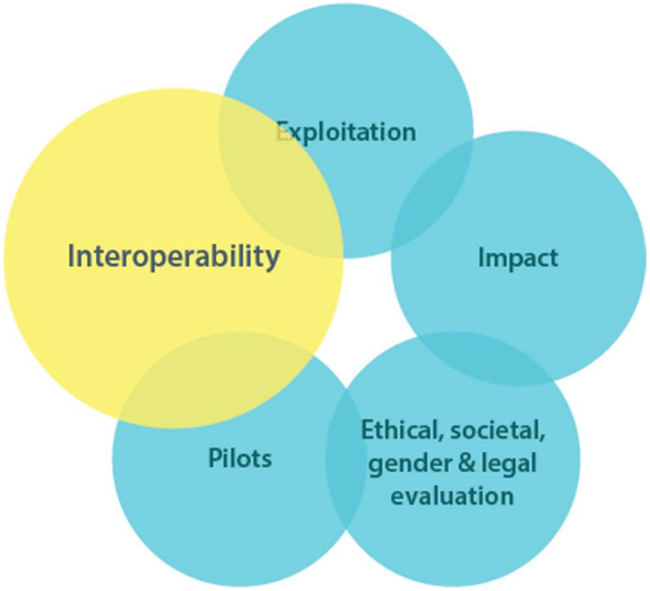

Figure 6 KPIs for interoperability

KPIs presented below are partitioned into fields (connected with interoperability) as follows.

Table 14 Dimension 4 - Interoperability; distribution of KPIs

Field id	Field Name	KPI id	Name
Field 4.1	**IoT devices and INTER-IoT modules**	KPI.4.01	APIs offered by INTER-IoT layer-specific solutions.
		KPI.4.02	Issue tracking
		KPI.4.25	Security mechanism in place
Field 4.2	**IoT platforms**	KPI.4.03	IoT platforms integrated on MW2MW layer
		KPI.4.04	IoT platforms integrated on AS2A layer
		KPI.4.05	Syntactic translators between different data formats and RDF
		KPI.4.06	Ontology alignments
		KPI.4.07	IoT platforms assets integrated in INTER-AS2AS
Field 4.3	**IoT system functional design**	KPI.4.08	Identified Patterns for Layer-oriented Integration
		KPI.4.09	Methodology and guidelines for integrating a new platform into INTER-IoT ecosystem
		KPI.4.10	Documented deployment and update procedures
		KPI.4.26	Documentation availability
Field 4.4	**Use of open technology devices and platforms**	KPI.4.11	Open source platforms integrated
		KPI.4.12	Software defined network frameworks integrated
		KPI.4.13	Device to device protocol integration in gateway

Field id	Field Name	KPI id	Name
		KPI.4.43	Standard open ontologies referred by GIoTP ontology
Field 4.5	**Use of supported standards**	KPI.4.14	Standards supported
		KPI.4.15	Alignment with IoT architectures
		KPI.4.16	Alignments between GIoTP and known standards
Field 4.6	**Scalability**	KPI.4.17	Scalability of semantic translation
		KPI.4.18	Scalability of INTER-MW
		KPI.4.19	D2D scalability
		KPI.4.20	N2N scalability
		KPI.4.21	AS2AS scalability
Field 4.7	**Supportability**	KPI.4.27	Longevity/stability of INTER-METH
		KPI.4.28	Usability of INTER-METH
		KPI.4.29	Extensibility of INTER-METH
		KPI.4.30	Generality of INTER-METH
		KPI.4.31	Coverage/completeness of INTER-METH (per-layer)
		KPI.4.32	Availability of CASE tool supporting the process of integration
		KPI.4.33	User satisfaction with CASE tool
		KPI.4.34	Speed up/productivity increase when using CASE tool
		KPI.4.35	Usability of CASE tool
		KPI.4.36	Collaborative work support in CASE tool
		KPI.4.37	Compliance of CASE tool to INTER-IoT approach
		KPI.4.38	Extent of End User Involvement
		KPI.4.39	Coverage, completeness and consistency (per-phase)
Field 4.8	**Configuration and monitoring**	KPI.4.22	Availability of the configuration and administration tools
		KPI.4.23	Components supporting monitoring over the lifetime of IoT application deployment
		KPI.4.24	Failover mechanisms
		KPI.4.40	System uptime
		KPI.4.41	INTER-MW Latency
		KPI.4.42	Loss rate
		KPI.4.44	INTER-N2N Latency

Table 15 Dimension 4 - Interoperability

KPI id	Name	Description	Metric	Target
KPI.4.01	APIs offered by INTER-IoT layer-specific solutions.	Number of standard interfaces offered by INTER-IoT components.	Number	5
KPI.4.02	Issue tracking	Number of issues resolved on time to issues reported/known by INTER-IoT component in a predefined period e.g. month.	Percentage	0,5
KPI.4.03	IoT platforms integrated on MW2MW layer	Number of IoT platforms integrated on MW2MW layer - number of bridges implemented within INTER-IoT works and open calls collaboration	Number	4
KPI.4.04	IoT platforms integrated on AS2A layer	Number of IoT platforms with dedicated nodes included in the INTER-AS2AS solution.	Number	4
KPI.4.05	Syntactic translators between different data formats and RDF	Number of implemented syntactic translators for different data formats and RDF used in INTER-IoT JSON-LD messages.	Number	3
KPI.4.06	Ontology alignments	Number of alignments prepared in the scope of pilot application and open call project to test the semantic translation mechanism.	Number	10

KPI id	Name	Description	Metric	Target
KPI.4.07	IoT platforms assets integrated in INTER-AS2AS	Number of services exposed by different IoT platforms that have dedicated nodes in INTER-AS2AS solution.	Number	10
KPI.4.08	Identified Patterns for Layer-oriented Integration	Number of design patterns for integration of heterogeneous IoT platforms identified.	Number	10
KPI.4.09	Methodology and guidelines for integrating a new platform into INTER-IoT ecosystem	Inclusion in INTER-METH a clear methodology with guidelines on how to approach the task of integrating a new platform into the INTER-IoT ecosystem.	Yes/No	Yes
KPI.4.10	Documented deployment and update procedures	Availability of procedures for deploying and upgrading different INTER-IoT components.	Yes/No	Yes
KPI.4.11	Open source platforms integrated	The percentage of open source standards implemented against the total number of IoT platforms integrated.	Percentage	0,5
KPI.4.12	Software defined network frameworks integrated	Number of SDN frameworks integrated in INTER-N2N.	Number	3
KPI.4.13	Device to device protocol integration in gateway	Number of communication protocols integrated in a single D2D gateway deployment (southbound interfaces)	Number	3
KPI.4.14	Standards supported	Number of supported/applied existing, well-renowned and market-applied standards.	Number	3
KPI.4.15	Alignment with IoT architectures	Alignment with existing IoT reference architecture standards.	Number	1
KPI.4.16	Alignments between GIoTP and known standards	Number of existing alignments between GIoTP and other existing ontologies.	Number	2
KPI.4.17	Scalability of semantic translation	Average number of messages translated per ms using realistic size alignments.	msg/ms	10
KPI.4.18	Scalability of INTER-MW	Number of messages per ms that can be handled by INTER-MW.	msg/ms	5
KPI.4.19	D2D scalability	Number of devices that can be connected to one INTER-IoT gateway instance.	Number	50
KPI.4.20	N2N scalability	Number of messages that can be routed per ms.	msg/ms	100
KPI.4.21	AS2AS scalability	Average number of messages that are handled per ms for demonstration workflows prepared in INTER-IoT.	msg/s	50
KPI.4.22	Availability of the configuration and administration tools	Number of tools for configuration and administration of INTER-IoT environment. Specifically, registration of components and their management using e.g. INTER-API.	Number	1
KPI.4.23	Components supporting monitoring over the lifetime of IoT application deployment	Percentage of INTER-IoT components that can be monitored.	Percentage	0,7
KPI.4.24	Failover mechanisms	Availability of failover mechanisms.	Number	5
KPI.4.25	Security mechanism in place	E.g. authentication, authorization, unique identification, role-based access.	Number	3
KPI.4.26	Documentation availability	Documentation should be continuously drafted and targeted to different kind of users/stakeholders.	Number	3
KPI.4.27	Longevity/stability of INTER-METH	Much of the main concepts, models and processes of Interoperability will be stable over time and will not need changes.	Number	3
KPI.4.28	Usability of INTER-METH	How difficult it will be to learn and operate the methodology.	Number	3
KPI.4.29	Extensibility of INTER-METH	Methodology results easy to be customized according to integration needs.	Number	3
KPI.4.30	Generality of INTER-METH	Methodology is not strictly technology-scenario-vendor dependent.	Number	3
KPI.4.31	Coverage/completeness of INTER-METH (per-layer)	Support for systematic IoT platforms integration, considering integration process on device, network, middleware, application, data and semantics layers.	Number	3

KPI id	Name	Description	Metric	Target
KPI.4.32	Availability of CASE tool supporting the process of integration	A CASE-tool can support the developers all over the integration process.	Number	3
KPI.4.33	User satisfaction with CASE tool	CASE-tool achieves the expected results in systematically guiding the integration process.	Number	3
KPI.4.34	Speed up/productivity increase when using CASE tool	How provided CASE-tool functionalities related to (i) integration guidelines management, (ii) graphical facilities, and (iii) project data repositories) improve productivity by reducing the time required for integration.	Number	3
KPI.4.35	Usability of CASE tool	How difficult it will be to learn and operate the CASE-tool.	Number	3
KPI.4.36	Collaborative work support in CASE tool	CASE-tool results easy to be exploited by multiple integrators working on the same project.	Number	3
KPI.4.37	Compliance of CASE tool to INTER-IoT approach	CASE-tool is compliant to the INTER-IoT integration philosophy, its architecture and its products.	Number	3
KPI.4.38	Extent of End User Involvement	The end-user is involved throughout the integration process, which increases the likelihood of client acceptance of the final implementation.	Number	3
KPI.4.39	Coverage, completeness and consistency (per-phase).	Support for systematic IoT platforms integration, considering integration process at analysis, design, implementation, test and maintenance phases.	Number	3
KPI.4.40	System uptime	Average time of system availability and uptime during a 7 days period.	h	168
KPI.4.41	INTER-MW Latency	Average time between the moment when message is created in bridge component and reaches the artefact consuming the message. (Generic; a time delay between the delivery of a message and its arrival to the desired destination in the system being observed)	ms	10ms
KPI.4.42	Loss rate	Transmission quality - number of messages lost over a period for a given application.	Number	0
KPI.4.43	Standard open ontologies referred by GIoTP ontology	Number of standard open ontologies taken into consideration in GIoTP ontology design (referred in different modules).	Number	25
KPI.4.44	INTER-N2N Latency	A time delay between the delivery of a message and its arrival to the desired destination in the system being observed	ms	10ms

3.2.5 Ethical, societal, gender and legal evaluation

This dimension measures the societal impacts of developed technologies that may affect quality of working and personal life. The measurements are mainly obtained through online questionnaires. Other legal or ethical issues are exposed here, like security, privacy, safety, efficiency.

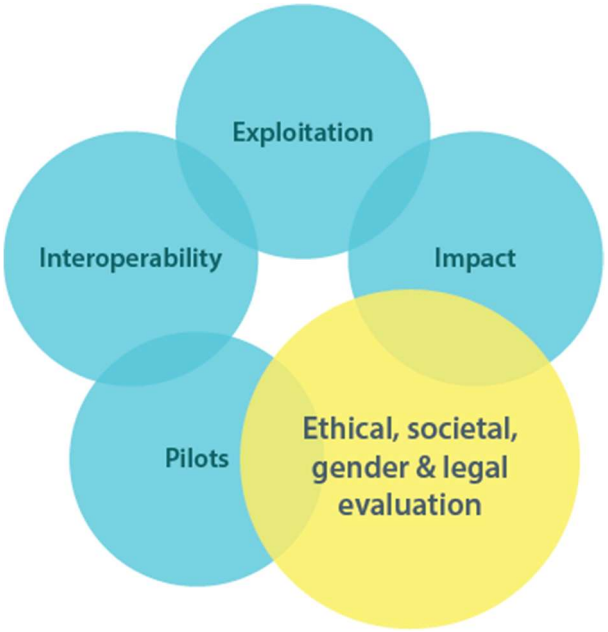

Figure 7 KPIs for Ethical, societal, gender and legal evaluation

KPIs presented below are partitioned into fields (connected with ethical, societal, gender and legal evaluation), as depicted in Section 2.2.1.

Table 16 Dimension 5 - Ethical, societal, gender and legal evaluation; distribution of KPIs

Field id	Field Name	KPI id	Name
Field 5.1	**Legal issues**	KPI 5.13	Publicity of data for research
		KPI.5.01	Legalisation assessment
		KPI.5.08	Number of identified regulations and public policies
Field 5.2	**Holistic innovation**	KPI.5.02	Human-centred innovations
		KPI.5.03	Connections and trust
Field 5.3	**User worktime/life impact**	KPI 5.10	Threat on the labour demand
		KPI 5.11	Help on disabled people's lives
		KPI.5.04	Worktime - Time Saving
		KPI.5.05	Life - Social inclusion
Field 5.4	**Targeted social groups**	KPI 5.12	Accessibility of INTER-IoT tech
		KPI.5.06	Socially excluded groups Elderly / Disabled
Field 5.5	**Trusted, safe, secure IoT environment promotion**	KPI 5.09	Trusted, safe, secure IoT environment promotion
Field 5.6	**Community engagement**	KPI.5.07	Citizens' involvement

Table 17 Dimension 5 - Ethical, societal, gender and legal evaluation

KPI id	Name	Description	Metric	Target
KPI 5.09	Trusted, safe, secure IoT environment promotion	Do you feel like the promotion of trust, safeness and security has been done properly? Were the means of this promotion sufficient?	numbers	100 answers, positive results > 75%
KPI 5.10	Threat on the labour demand	Do you believe that the INTER-IoT platform can be a threat to the labour force, since it might replace some human intervention?	numbers	100 answers, positive results > 75%
KPI 5.11	Help on disabled people's lives	Do you feel like INTER-IoT will help improving disabled persons life?	numbers	100 answers, positive results > 75%
KPI 5.12	Accessibility of INTER-IoT technology	Do you think the INTER-IoT platform will only benefit to people/companies considered as "rich"?	numbers	100 answers, positive results > 75%
KPI 5.13	Publicity of data for research	Should the data collected in the INTER-IoT platform be accessible for research?	numbers	100 answers, positive results > 75%
KPI.5.01	Legalisation assessment	Do you feel safe about the collected data? Do you think Intellectual Property is properly managed?	numbers	100 answers, positive results > 75%
KPI.5.02	Human-centred innovations	Do you feel that the INTER-IoT project will allow to improve people lives? Will the project have an impact on people, more than companies?	numbers	100 answers, positive results > 75%
KPI.5.03	Connections and trust	Do you think the connections between different IoT platforms are working well? Do you feel safe in those connections?	numbers	100 answers, positive results > 75%
KPI.5.04	Worktime - Time Saving	Do you think that an INTER-IoT platform can be saving work time? Do you think that an INTER-IoT platform will improve business?	numbers	100 answers, positive results > 75%
KPI.5.05	Life - Social inclusion	Will the INTER-IoT system have an impact on your life (private or professional)? Do you feel that the INTER-IoT platform will help social inclusion?	numbers	100 answers, positive results > 75%
KPI.5.06	Socially excluded groups Elderly / Disabled	Do you believe that the platform will help to prevent incidents (elderly, disabled people)? Do you believe that such platform will help to preserve people's health?	numbers	100 answers, positive results > 75%
KPI.5.07	Citizens' involvement	Do you feel that citizens have sufficiently been involved in the project development? Do you believe that citizens should be involved for further development?	numbers	100 answers, positive results > 75%
KPI.5.08	Number of identified regulations and public policies	Number of legislations (regulation and public policies) from at least 2 countries that are compliant with INTER-IoT.	Value (Number)	T1 >= 4 from at least T2 >=2 countries

4 Evaluation Plan

In this section we present the INTER-IoT evaluation plan. It consists of three separate evaluations, each presented in its own subsection. First one considers INTER-IoT from a technical perspective, including interoperability capabilities, framework usability (e.g. APIs), system performance (KPIs) and usability. The second one considers INTER-IoT from the viewpoint of its pilots, while the third one presents the INTER-IoT process evaluation.

4.1 Technical evaluation of INTER-IoT

The technical evaluation of INTER-IoT encompasses the demonstration of technical features that the different products of the project provide. INTER-IoT developments are divided in three main components: INTER-Layer, INTER-FW and INTER-METH. Furthermore, these three components can be subdivided in smaller pieces of software that will be tested and evaluated from a technical point of view. Also, each component follows a different development methodology that has been described in previous deliverables of the project and that will be analysed in this one by providing information on methods and timelines for accomplishing them.

4.1.1 Introduction

4.1.1.1 Evaluation Purpose

The purpose of this evaluation is to address the existence, functionality and availability of the technical components and features defined by the requirements in the INTER-IoT products. We document the methodology to evaluate these components and describe the results of this evaluation that will be summarized in future deliverables of this WP. The tests that will be included in this evaluation involve: validation of functionality, performance assessment, troubleshooting tests, software module tests and validation of KPIs.

The technical objectives proposed at the beginning of the project will be reviewed to assess the degree of compliance. To analyse the technical parameters, the assessment will use the results and outcomes from integration, testing and pilot activities. Concretely, the following will be evaluated:

- requirement coverage (accomplished, not accomplished, partially accomplished) and gap analysis;
- system performance (via KPIs and associated success criteria);
- overall interoperability methodology and identification of potential bottlenecks;
- partners and stakeholders feedback and recommendations.

These technical aspects will be analysed over all modules that compose INTER-IoT. The main software modules that were developed or integrated to be tested are the following:

- From INTER-Layer:
  - Device-to-device solution
  - Network-to-network solution
  - Middleware-to-middleware solution
  - Application and services-to-Application and services solution
  - Data and Semantics-to-Data and Semantics solution
- From INTER-FW:
  - API manager
  - INTER-FW Platform
  - INTER-FW SDK

Each of these modules is going to be tested and evaluated separately. Furthermore, the integration between some of the modules will be also evaluated and finally, some of the modules will be tested altogether, as in case of the pilots.

The findings from the evaluation will be used for measuring the level of maturity of the system and identifying its strong and weak points. Furthermore, fulfilment of the original requirements, set at the begging of the project is going to be verified.

4.1.1.2 Stakeholders

In this concrete evaluation our aim is to objectively measure the technical parameters and characteristics of the INTER-IoT proposal. Furthermore, usability and conformance testing for the obtained products is also going to be performed, and the opinion and feedback from the stakeholders will be added in future deliverables. Direct beneficiaries of INTER-IoT are the following;

- future users of INTER-IoT (Pilot section),
- administrations of systems that use INTER-IoT,
- developers of INTER-IoT modules/solutions.

Moreover, the outcomes of this evaluation will be used for future users of INTER-IoT to decide if the system meets their expectations.

Depending on the user's role, their interests in different parameters will vary. For example, interests of final users with non-technical knowledge will be oriented to cost-effective trade-offs, ease-of-use and performance. For administrators and integrators of INTER-IoT systems, their main interest will be oriented towards scalability, ease of integration and the existence of documentation, APIs and Interfaces. And finally, for developers who are going to extend the capabilities of the current system, their interests will be close to the ones of the administrators but with more focus on development helper tools, internal interfaces, modularity of the software and understanding of the code.

Any in the subsequent subsections presented lists of stakeholders, who will benefit from the system, are not directly involved in the evaluation part.

4.1.1.3 Description of the evaluation approach/system setup

The main need for INTER-IoT solutions is to cover the interoperability gap between systems (more concretely, devices, platforms, networks, applications and data) that have been developed in a divergent path and now they cannot communicate with each other. As IoT technology is applied to different markets or areas with specific requirements, systems have been created focused on specific use cases or fields, being unable to be reused or adapted to other application domains. INTER-IoT main developments aim at breaking this rigidity and creates interoperability at each level between heterogeneous components.

INTER-IoT main functional components are INTER-Layer, INTER-FW and INTER-METH. Each of

them are going to be evaluated separately as they do not need each other to work.

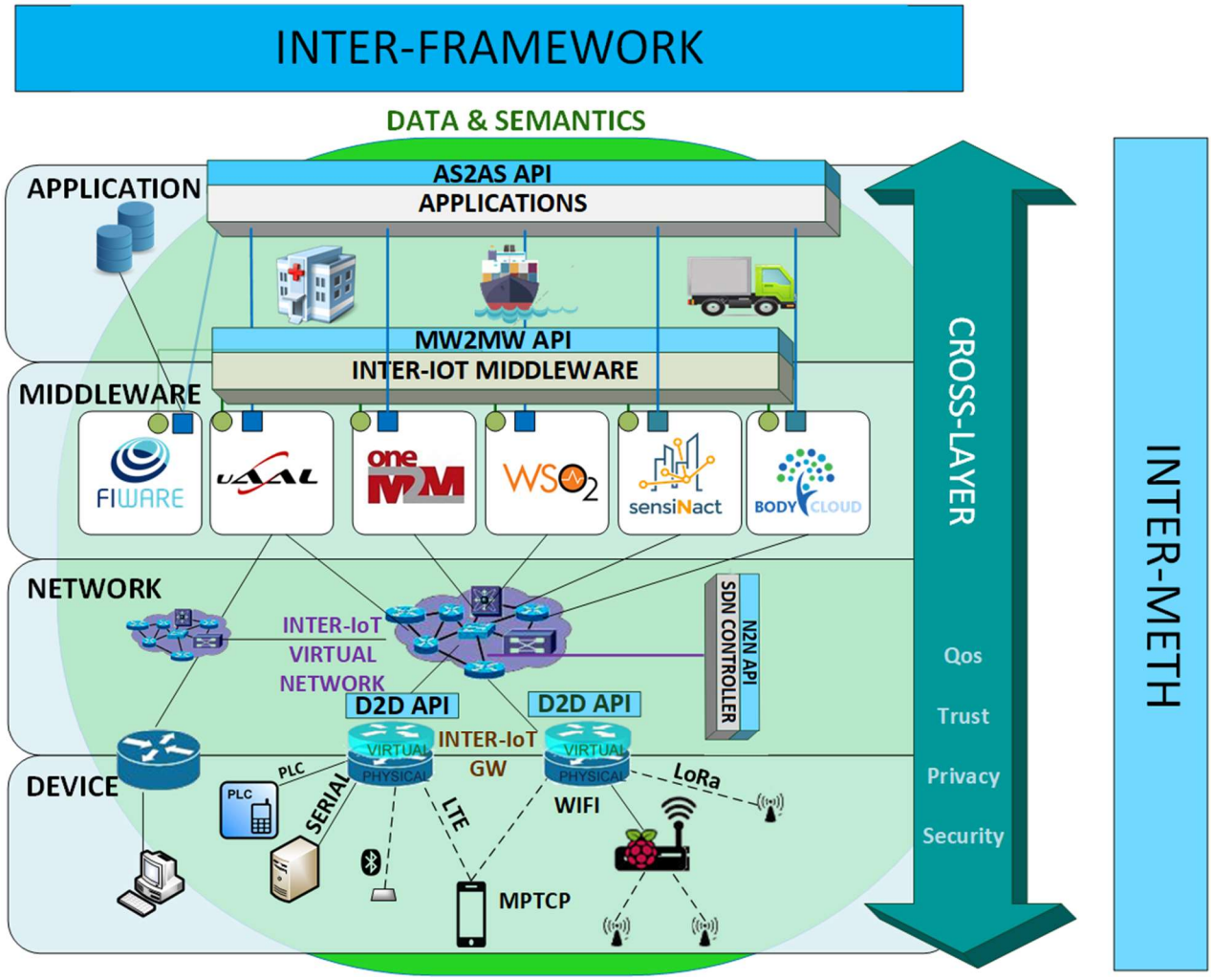

Figure 8 INTER-IoT architecture

To evaluate them we select a list of KPIs, mainly the interoperability ones that will compose the evaluation of INTER-Layer and INTER-FW components. Furthermore, the evaluation of INTER-METH will be based in questionnaires and usability test for users to define the quality of the component.

4.1.2 Selected KPIs

For the Technical Evaluation the KPIs selected are directly related with technical features of the modules. Hence, these KPI belong mainly to the area of Interoperability. As defined in Table 2.1, the selected KPIs are from the following fields of dimension “4. Interoperability”:

- Field 4.1 IoT devices and INTER-IoT modules
- Field 4.2 IoT platforms
- Field 4.3 IoT system functional design
- Field 4.4 Use of open technology devices and platforms
- Field 4.5 Use of supported standards
- Field 4.6 Scalability
- Field 4.8 Configuration and monitoring

As Interoperability is the main technical objective of the project, the KPIs selected for the evaluation

mainly address the area of interoperability. However, other technical KPIs can be derived from this basis.

Note that as the Field 4.7 Supportability is not strictly technically-oriented, but more user-oriented and requires input from external stakeholders, it will be evaluated in Task 7.4, thus described in section 4.3.

4.1.3 Data Collection and Measurement

KPI.4.01 APIs offered by INTER-IoT layer-specific solutions

For this KPI the number of exposed API collections, per layer, is counted. In principle, we expect to provide one REST API endpoint for each layer.

Several conditions should be met to make an API interface eligible for this KPI:

- API must be implemented according to a widely accepted standard (e.g. REST, Java interface);
- API must be well documented in accordance to conventions in use for that specific interface (e.g. Swagger for REST, Javadoc for Java interfaces);
- Versioning of provided APIs is in place.

Reliability, scalability and availability are not part of this measure, as these indicators are measured elsewhere in this section.

KPI.4.02 Issue tracking

Number of issues and resolved issues reported/known by INTER-IoT components in a predefined period e.g. month.

To measure this KPI, the included issue tracking of our self-hosted git service (Gogs) is used. For each ticket opened in a repository, the estimated amount of time of resolution (ETR) required by this issue is calculated. Once that issue is marked as solved (changes tag from “Opened” to “Closed”) the amount of time required to close the issue is measured.

At any point of time, this KPI can be calculated as the % of issues solved on time (resolution time below ETR). As a reference value, 50% of issues resolved on time is considered healthy.

KPI.4.03 IoT platforms integrated on INTER-MW layer

For this KPI the number of fully developed platform bridges is counted. A bridge to be eligible should have been successfully tested with at least one platform deployment, syntactic translator and semantic alignment.

KPI.4.04 IoT platforms integrated on AS2A layer

For this KPI the number of fully integrated platforms that have at least one service node developed is counted. An IoT platform developed node to be eligible should have been successfully tested and documented. It must validate that all its functions operate correctly with its IoT platform and that they can be integrated into an interoperability flow to interact with other nodes.

KPI.4.05 Syntactic translators between different data formats and RDF

For this KPI the number of implemented syntactic translators for different data formats and RDF used in INTER-IoT JSON-LD messages is counted. Syntactic translator functionality is part of the INTER-MW bridge. Therefore this KPI is related to number of integrated IoT platforms (KPI 4.03). The syntactic translator is eligible if it was tested with at least one bridge deployment.

KPI.4.06 Ontology alignments

For this KPI the number of alignments prepared in the scope of a pilot application and open call project to test the semantic translation mechanism is counted. An alignment is eligible if it has been successfully tested with at least one bridge deployment.

KPI.4.07 IoT platforms assets integrated in INTER-AS2AS

For this KPI the number of services from an IoT platform that have at least one node developed is counted. For an IoT platform service developed node to be eligible it should be successfully tested and documented. It must validate that all its functions operate correctly with its IoT platform and that they can be integrated into an interoperability flow to interact with other nodes.

KPI.4.08 Identified Patterns for Layer-oriented Integration

For this KPI the number of design patterns for integration of heterogeneous IoT platforms identified is counted. Designed patterns have been collected and published in Deliverable 5.1. Each of them has a realization in INTER-IoT therefore counting them directly gives the value for this KPI.

KPI.4.09 Methodology and guidelines for integrating a new platform into INTER-IoT ecosystem

Effectiveness of INTER-METH in driving the integration of new platforms into INTER-IoT ecosystem is measured through a set of KPIs mostly involving questionnaires and interviews with final-users and integrators.

KPI.4.10 Documented deployment and update procedures

For this KPI we count the number of deployment/update procedures for each INTER-Layer, INTER-FW and INTER-API component. Documentation, to be eligible for counting, should be: available online on the INTER-IoT documentation server and tested by a project partner or 3rd party not involved in the creation of the documentation.

KPI.4.11 Open source platforms integrated

This KPI is calculated via the count of the Open Source Platforms directly available in a new installation from the INTER-IoT official repositories. Open Source Platform is defined for this KPI as any platform whose license is contained in the following list (extracted from https://opensource.org/licenses):

- Apache License 2.0
- BSD 3-Clause "New" or "Revised" license
- BSD 2-Clause "Simplified" or "FreeBSD" license
- GNU General Public License (GPL)
- GNU Library or "Lesser" General Public License (LGPL)
- MIT license
- Mozilla Public License 2.0
- Common Development and Distribution License
- Eclipse Public License

The total count is calculated as the aggregation of different OS Platforms that have an *adapter* component to at least one Interoperability Layer in the architecture of INTER-IoT, so that data that flows from the platform can get from one platform A to another B without the intervention of extra components different than these adapters, the INTER-IoT Interoperability Infrastructure and the components under testing. To calculate this test, a fixed platform, integrated at middleware (INTER-

MW) level will be used as a destination platform, this way, all platforms will be plugged as data sources and the KPI will be measured as the number of different OS Platforms that, connected to any INTER-IoT infrastructure, can produce data and this is stored/reflected in the standard destination. This standard destination will be FIWARE Orion, chosen for general availability and knowledge among the partners.

KPI.4.12 Software defined network frameworks integrated

This KPI contains the number of technologies integrated in the SDN. Different frameworks can be exchanged to make the function of controllers in the SDN network. These should be OpenFlow and OpenVSwitch compliance (Understanding other protocols as OVSDB). Even though, in INTER-IoT a controller has been customized for the project purpose, the framework can be replaced to obtain some similar (not the same) characteristics as the one we wanted to obtain in the network layer interoperability.

KPI.4.13 Device to device protocol integration in gateway

This KPI measures the number of simultaneous communication protocols supported by the southbound interfaces of the gateway. Ideally many different D2D protocols will be developed (during and after the duration of the project) for the physical part of the gateway; but this physical part of the gateway will be deployed in constrained systems, so it is important to establish a minimum number of different protocols that a single instance of the gateway can support at the same time.

A minimum number of 3 different device controllers running smoothly at the same time should be supported to consider that a physical gateway deployment is behaving correctly for a target platform.

KPI.4.14 Standards supported

This KPI measures the number of supported/applied existing, well-renowned and market-applied standards in the different components of INTER-IoT. To identify the compliance of this KPI a list of INTER-IoT should be conformed, including in this one each of the standards supported by the component. Thus, having this list we can extract a final set of applied standards, without repetition, in INTER-IoT.

Is considered the fulfilment of this KPI, when the number of standards supported by all software components is over 3.

KPI.4.15 Alignment with IoT architectures

Interoperability will be almost impossible to achieve if INTER-IoT architecture will be substantially different from the IoT platforms supposed to be connected. Therefore, this KPI is about the distance between INTER-IoT Reference Architecture and a target Reference Architecture, where the target one is an IoT system or platform we are planning to bridge. Typically, this can be a Reference Architecture coming out of standards (such as OneM2M, ITU-T Y 2060, IIC RA 1.8, or FIWARE) or a de-facto Reference Architecture (such as AWS or Microsoft Azure). In this context, by distance we mean the number of functionalities that can be mapped seamlessly between two different Reference Architectures.

KPI.4.16 Alignments between GIoTP and known standards

For this KPI the number of existing alignments between GIoTP and other existing ontologies is counted. Other ontologies to be considered need to be publicly available and documented e.g. as W3C standards or as other standardization bodies products. They should be included as sides of alignments considered in KPI4.06.

KPI.4.17 Semantic translation scalability

For this KPI the average number of messages translated per ms using realistic size alignments is calculated. By a realistic size alignment an alignment prepared e.g. for pilot deployment is meant. The measure this KPI the benchmark tests are performed using messages generator and standalone IPSM deployment.

KPI.4.18 INTER-MW scalability

Scalability of INTER-MW will be measured using a deployment on a typical server HW with at least four platforms and three API clients attached to INTER-MW. To minimise the influence of external factors, the following approach will be used:

1. Platform emulators will be used to generate several OBSERVATION messages with increasing frequency.
2. API clients will subscribe to those device readings and consume (pull) messages with maximum frequency.
3. IPSM will be excluded and identity alignments used.
4. The number and frequency of messages will be verified through the RabbitMQ UI.

KPI.4.19 D2D scalability

Scalability defines the number of devices that each instance of the physical gateway can manage. It heavily depends on the system capacity and JVM configuration, as well as the rate and size of the measurements. To measure this KPI all the other factors must be set, so the following configuration will be used:

- Hardware: Raspberry PI 3 Model B
- OS: Raspbian Stretch Lite (Kernel 4.9)
- JVM: Oracle jdk-1.8.162 (initial heap size: 64MB, max heap size: 512MB)
- Device specs: Simulated (1 thread per device), 1 measurement every 5 seconds (each measurement contains 4 values: a random Boolean, string, integer and float)
- The physical and virtual part are connected through a single switch and with a wired connection to avoid any restraining factor based on the network.

The scalability KPI will be measured as the number of devices that can be processed (i.e. successfully received by the virtual part of the gateway) within the following constraints:

- Receiving a measurement with a delay more than 5s (each measurement is timestamped and the received time is also recorded).
- Getting an out-of-memory error by the JVM.

KPI.4.20 N2N scalability

The scalability at network layer defines the number of nodes virtually connected in the network. Thus, for a good scalability the inclusion of a new node in the network must have a very low impact in the performance of the whole system and should be a straightforward task. The measurement of this KPI will be base in the measurement of the data rate in t0.

KPI.4.21 AS2AS scalability

Scalability of INTER-AS2AS consists in the average number of messages that are handled per second for demonstration workflows prepared in INTER-IoT. It will be measured using a Docker container deployment that implements an instance of the AS2AS interoperability solution. The test flow of this instance contains at least four nodes belonging at least to two different IoT platforms.

To minimize the influence of external factors some test emulators will be implemented. Firstly, define and create a set of test data similar to the real data. Secondly, a node that implements a temporal trigger will be used to generate a set of messages flows with increasing frequency. Finally, the number and frequency of messages will be verified through a node that stores the log of this process.

KPI.4.22 Availability of the configuration and administration tools

This KPI is calculated as the number of independent configuration and/or administration tools available in INTER-IoT public repositories and accessible in the official online deployments. An independent configuration/administration tool is defined as a tool that can accomplish administration (add/modify/delete) or configuration actions over IoT entities (platform, devices, services) connected to interoperability mechanisms of INTER-IoT. A list of components will be prepared and then, the KPI calculated.

KPI.4.23 Components supporting monitoring over the lifetime of IoT application deployment

Percentage of INTER-IoT components that can be monitored. Value of this KPI is computed from the INTER-IoT technical specification.

KPI.4.24 Failover mechanisms

We understand Failover as a backup operational mode in which the functions of any INTER-IoT component are assisted by secondary system components when the primary one becomes unavailable due to failure or scheduled down time. This used to make the system more fault-tolerant and reliable. This procedure also involves the ability to restart the component itself when this unavailability occurs and restore the last known system state.

The mechanisms involved in the failover system include the automatically offloading of tasks in a seamless manner, for that reason is needed the redundancy of the components.

To meet the fulfilment of this KPI the components of INTER-IoT should implement this redundant component or mechanism to provide failover. In these mechanisms behaves as expected and the result of its implementation is successful, the positive answer is obtained (*Yes*) and the KPI is covered.

KPI.4.25 Security mechanism in place

Number of different security mechanisms are configured in the different communication endpoints of the INTER-IoT infrastructure. The KPI will be measured by identifying the potential security hazards points (API, entry point of the layers, INTER-FW) and listing and verifying the proper working of the security measures adopted. The KPI will be applied to the public deployment of INTER-IoT.

KPI.4.26 Documentation availability

This KPI focuses on the availability and the quality of the documentation. As code itself is barely understandable, and without being supported by a comprehensive documentation is practically impossible to use, it's necessary to produce a high-quality documentation to support it. The ways to measure the quality of the documentation are essentially two:

- The spectrum covered by the documentation (no function is left out),
- The easiness and completeness in the description (no further questions are needed).

The metric that can be used are therefore two: one more objective (number of functions documented / number of functions developed), which should be as close as possible to 1, and another more subjective (number of questions that are received concerning understanding of the proper behaviour of the functions).

KPI.4.40 System uptime

The uptime of a system is a measure of the time a component or machine is available and working with a normal behaviour. This time represents the period system can be left unattended without crashing, or needing to be rebooted for administrative or maintenance purposes. This autonomy is basic in case of pilots for the independence of the system with the administrators and the proper execution of the whole deployment.

INTER-IoT will measure its average time availability and uptime when the pilot applications are logged in the system. This measurement will be presented in time (hours) and it will be needed a minimum of 168 h to complete the KPI compliance.

Uptime >= 168 h of autonomy.

Different tools can be used for measuring this uptime, we present the most popular ones in the following list, awaiting to choose the most suitable for the final system implemented at the pilots.

For Windows:

- Using simple commands as *systeminfo* to check the system uptime
- Using net statistics for server
- Using Uptime.exe a utility indicator.
- Using Windows management Instrumentation tool
- Or even using Windows Task Manager

For Linux:

- Using *uptime* command
- Using logs registered in /proc/uptime
- Using scripts running on the system to measure the parameters.

KPI.4.41 INTER-MW Latency

Average time between the moment when message is created in the bridge component and when it reaches the REST server, being queued.

This value will be obtained by subtracting message send time (as contained within the message's metadata) from message receive time (when the message was queued in the REST server). Platform emulators will be used to generate several messages, and the computed average latency will be written in the log file.

KPI.4.42 Loss rate

The loss rate, that measures the message transmission quality in the different solutions of INTER-IoT, is going to be measured as the number of messages lost during each transmission. So, we can establish a relation between the numbers of packets lost over total number of messages sent. Also, this number of messages lost are measured over a period for a given application.

$$Number\ of\ messages\ loss\ /\ number\ of\ total\ message\ *\ sec$$

So that, we can obtain a ratio of the number of lost messages that must be near to 0 to fulfil the compliance with this KPI.

KPI.4.43 Standard open ontologies referred by GIoTP ontology

For this KPI the number of standard open ontologies taken into consideration in design of GIoTP ontology is counted. GIoTP is a modular ontology that reuses some of the publicly available

ontologies published by standardization bodies like W3C. This KPI is evaluated by analysing D4.2 deliverable in which GIoTP is documented, or GIoTP documentation directly.

KPI.4.44 INTER-N2N Latency

A time delay between the delivery of a message and its arrival to the desired destination in the system is observed. To quantify this latency, a time stamp will be logged for the delivery of a message and the arrival at its destination.

Time stamp of arrival at the destination - Time stamp of delivery to the N2N layer ≤ 10ms

4.2 Evaluation of the results of the pilots

The main products developed throughout the project are going to be tested and evaluated during the pilot operations. The results of the evaluation process are very important for the continuous improvement of the different developments. In this section is described how the evaluation will be managed and implemented during the pilots. For each pilot are described the objectives, status of the developments, list of KPIs, etc.

4.2.1 Introduction

4.2.1.1 Evaluation Purpose

INTER-LogP

INTER-LogP is the result of using INTER-IoT in a specific application domain providing support to public and private companies, with the main goal of improving different indicators through the exchange of data among interoperable platforms. The data coming from these platforms refers to machinery, containers, trucks, environmental platforms, gate access, etc.

INTER-LogP pilot illustrates the need to seamlessly enable IoT platforms interoperation within port premises e.g. container terminal, transportation companies, warehouses, road hauliers, port authorities, customs, border protection agencies, and outside the port.

Therefore, the objective of the evaluation is to test the functionality of the different components developed in INTER-IoT, with the aim of improving efficiency and creating new business models.

The INTER-IoT components to be deployed in the transport pilot are the INTER-MW, the IPSM, the gateway, as well as INTER-FW, the purpose of which is to manage all of them.

INTER-Health

As INTER-LogP, INTER-Health is the result of using INTER-IoT in a specific domain providing support, in this case, to public entities.

INTER-Health is designed in a way that the current platforms integrated could be substituted by others, or added new ones. INTER-Health is focused on fostering healthy lifestyle to prevent chronic diseases, but could cover other use cases, enriching existing.

The INTER-IoT components to be deployed in the health pilot are INTER-MW and IPSM with respective platform specific components (bridges, semantic alignments).

Therefore, the objective of the evaluation is to test the functionality of the different components developed in INTER-IoT, with the aim of demonstrating that to interconnect different health IoT platforms with already existing ICT systems at hospitals is possible and how INTER-IoT helps on that.

4.2.1.2 Stakeholders

INTER-LogP

There are different companies in the logistic and transport business in a port, and most of them must share information at least with the port authority. In addition, there are many opportunities for improvement and new business models that could occur if they had data from other companies. Therefore, most of the companies in the port environment are interested in a common system to share data in a controlled way.

For instance, a container terminal could improve the efficiency in the organization of the yard if they had real time information of the arrival of the trucks in advance. Nowadays, the haulier companies are customers of the terminals and they have the information, but they don't have a procedure to send the data.

INTER-Health

The health pilot will be tested in a health institution in Italy. The system implemented is tailored to prevent obesity, being this a world-wide extended problem. Other health institutions such as hospitals may be interested in the outcomes of this evaluation, meaning that INTER-IoT is a good solution for facilitating interoperability between different systems. These potential stakeholders may adopt the same solution as it is, or modify it slightly and incorporate new applications or services, with the main objective of having a common system to share data in a controlled way.

4.2.1.3 Description of the evaluation approach/system setup

INTER-LogP

The architecture high level view is shown in the below figure. As it mentioned above, there are three IoT platforms that need to share data among them. Currently two of them are ready: the port authority and the container terminal platforms.

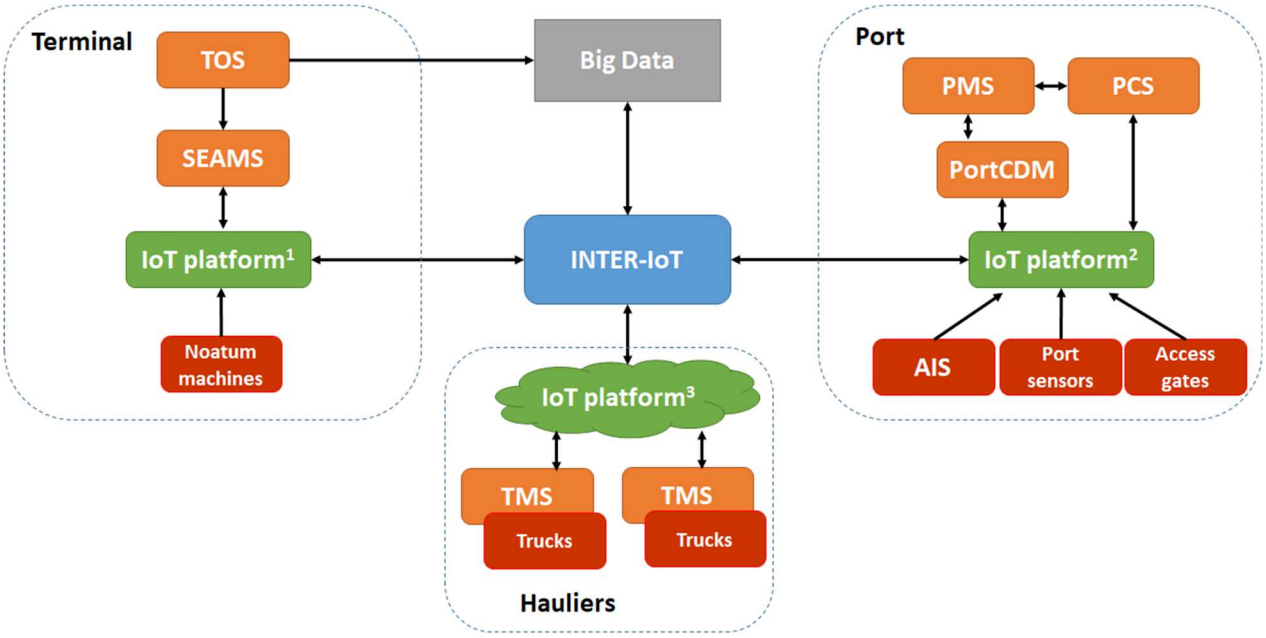

Figure 9 INTER-LogP pilot setup

The next activities planned are the integration of these two platforms through the INTER-MW component and the semantic translation of their ontologies. For that some developments must be finished in the middleware.

The result of these activities will be the exchange of data on gate access and the environment.

INTER-Health

INTER-Health pilot is composed by functionality from two IoT platforms: BodyCloud and universAAL, which are interconnected thanks to INTER-IoT components. We followed a co-creation methodology with clinicians to identify main functionalities needed. From the result of this process, new modules were implemented. The first phase of development is aimed to implement these specific modules and do modifications to set up the basic functionality of the pilot. In the second phase will be done additional developments for adopting security mechanisms arisen from INTER-IoT. Right now, the pilot is at the final of phase 1, being tested. In the next weeks will start with real patients. Phase 2 will start as soon as security mechanisms are ready in INTER-IoT.

The pilot execution will have a duration of around 10 months.

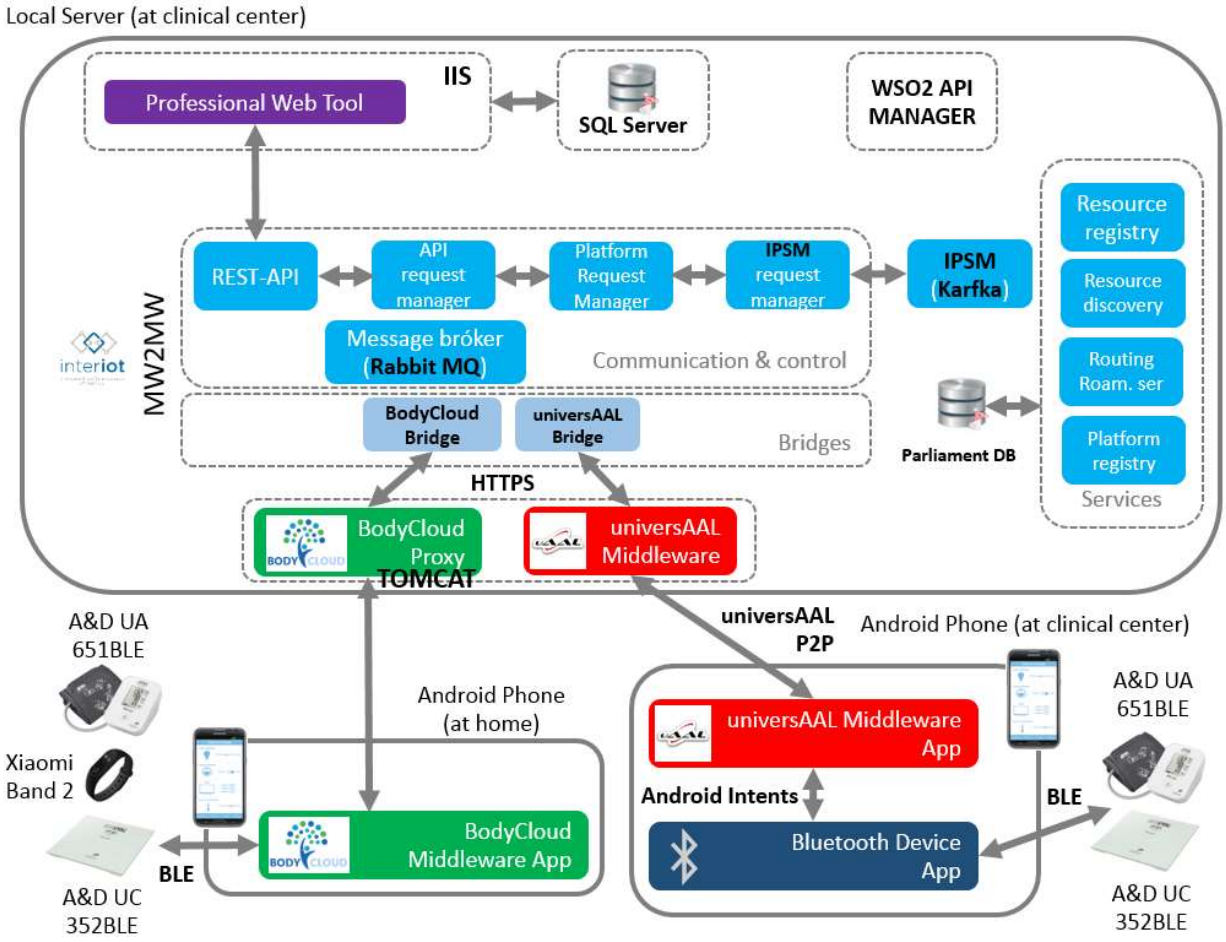

Figure 10 INTER-Health pilot setup

4.2.2 Selected KPIs

For the Pilot evaluation we select fields from both the dimension 1. Exploitation and 2. Pilots, as they are directly related to the technical execution of the pilots and engaged stakeholders:

- Field 1.1 Stakeholders' engagement
- Field 1.2 Impact on SMEs, start-ups and young entrepreneurs
- Field 2.1 INTER-LogP pilot

- Field 2.2 INTER-Health pilot
- Field 2.3 INTER-DOMAIN pilot

4.2.3 Data Collection and Measurement

In the previous sections we have identified some KPIs that will measure the success of the project during the pilot test. In this section is described how these KPIs are going to be measured and presented.

KPI.1.01 Stakeholders involved

Several stakeholders were interviewed in the first stage of the project to gather ideas and requirements from the final users of the products. Most of these requirements were included in the deliverable D2.3. Furthermore, some of these stakeholders will be part of the final pilots. For evaluating this KPI we count all project stakeholders that have been involved either actively of passively in the project. Passive involvement means, that INTER-IoT project partners gathered stakeholders data through desk research or similar, while active involvement is defined as actively providing information to the project consortium (needs, requirements, recommendations).

KPI.1.02 Stakeholders analysed

The objective of this KPI is to determine, out of the number of stakeholders involved at the beginning of the project, how many were analysed. A stakeholder has been successfully analysed when their request, most often in the form of need or requirement, has been assessed and formally acknowledged as relevant to INTER-IoT.

KPI.1.03 Open Calls launched

As INTER-IoT belongs to the IoT-EPI framework a mandatory requirement for the success of the project the organization of, at least one participative Open Call. To complete this KPI INTER-IoT had to prepare and organize all the infrastructure, system and mechanisms to carry-out a complete Open Call process. This KPI is assessing the quality, from the formal perspective, of the execution of this Open Call. The following parameter are taken into consideration: preparation of the open call, successful launch, efficiency of the ICT infrastructure for submitting and processing the proposals, engagement of external evaluators, involvement of the Project Coordination Committee in the decision-making process.

KPI.1.04 Received proposals in Open Call

Following the Open Call, a number of proposals have been submitted. The number and quality of received proposals reflect the quality and efficiency of the open call itself and dissemination activities to reach the desired audience. For this KPI, we count the proposals that meet the quality threshold set by the consortium.

KPI.1.05 Accepted proposals in the Open Call

Proposals that meet the basic requirements have been reviewed by a group of external reviewers against the Open Call text. Each proposal received points for several areas relevant to INTER-IoT, as predefined at the beginning. Based on these points, a subset of accepted proposals is created.

The target was to fund 10 small scale and 2 large scale projects and integrate their work in INTER-IoT.

KPI.1.14 Spin-offs created

Face-to-face interviews will be conducted with project partners, mainly universities and SMEs, to detect how many spin-offs are going to be set up within the framework of the INTER-IoT project.

This information will also be collected by the Joint and Individual Exploitation Questionnaires that will be included in D8.7.

KPI.1.19 Partners involved in joint exploitation

Face-to-face interviews will be conducted with project partners to better understand their role in a Joint Exploitation Plan. This information will be collected by the Joint Exploitation Questionnaires and the definition on how this will be done is already included in D8.7. With this KPI we count the number of partners that are committed to aspects of joint exploitation.

KPI.2.01 Use cases

During the first stage of the project, several use cases where defined to test the different developments. Some of these use cases have been analysed in depth to be later deployed in the two INTER-IoT pilots. After the Open Call, other use cases arose. This KPI will contain the number of all use cases tested in the final pilot operations.

KPI.2.02 Number of patients connected to INTER-Health

INTER-Health pilot will be tested at least with 100 real patients. KPI value will be obtained by observing the number of patients registered in the health platform that actually use the mobile application.

KPI.2.03 Number of objects connected to INTER-LogP

There are different companies involved in the development of the pilots, so to know the total number of objects connected to INTER-LogP we need a discovery process across involved IoT platforms. For that, we will use the INTER-MW registry service to count all registered devices. Thus, for this KPI we simply count the number of registered devices, while we are not concerned about their activity level.

KPI.2.04 Accuracy ETA vs ATA

The Estimated Time of Arrival (ETA) is when the terminal expects the truck to arrive to the terminal, and this data is used to manage the internal resources. Unfortunately, nowadays they are not aware of this data. With the interoperability with the port authority gates, this data can be received 15 or 20 minutes before the arrival of the truck. Value of this KPI is going to be obtained by subtracting ETA from ATA and taking the absolute value of the result.

KPI.2.05 Activity detected in the railway area

In the dynamic lighting pilot, the level of light will increase when a train arrives to the terminal or when there is machinery working in the railway area. The KPI will measure the percentage of times that there is activity in the railway area but the level of light does not increase. This can be checked through the recorded videos of the terminal.

KPI.2.06 Trucks detected by system

In the dynamic lighting pilots, the trucks are detected in the road before accessing the terminal through PIR sensors, to increase the level of light. As it is important to detect the 100% of the trucks on the road, the KPI measures the percentage of success in the truck detection.

KPI.2.07 Global events detected by system

It is determined based on a weekly sample of 2 days, 8 hours of viewing of recorded videos, which allow to see the global operation of the areas affected by the pilot. KPI value is obtained by computing the percentage of all successfully detected events.

KPI.2.08 Average BMI improvement

For this KPI we count the ratio of all patients that reached the BMI value between 18,5 and 24,5 against the total number of patients involved in the pilot. The target will be calculated separately for the control and trial groups. Here we report the trial group results. Additionally, a comparison will be made to verify which group performed better.

KPI.2.09 Average waist circumference improvement

Waist circumference improvement detected during outpatient nutritional counselling, measured in cm. For this KPI we count the ratio of all patients that reached the waist circumference value that is less than 94 cm for males and less than 80 cm for females against the total number of patients involved in the pilot. The target will be calculated separately for the control and trial groups. Here we report the trial group results. Additionally, a comparison will be made to verify which group performed better.

KPI.2.10 Chronic diseases risk reduction

During outpatient nutritional counselling a subjective assessment will be made to assess if the risk for chronic disease for a patient has decreased during the trial period. For this KPI we count the ratio of all patients for which the risk decreased against the total number of patients involved in the pilot. The target will be calculated separately for the control and trial groups. Here we report the trial group results. Additionally, a comparison will be made to verify which group performed better.

Based on questionnaires filled on the smartphone application and processed by the pilot system, an assessment will be performed to verify if eating habits of involved patients have improved.

KPI.2.11 Physical activity (steps) improvement

This KPI value will be obtained from the pilot system. Physical activity level (number of steps) of each patient is detected by the bracelet. The target is that all patients using the pilot system make at least 10.000 steps per day.

KPI.2.12 Physical activity (minutes of activity) improvement

This value will be obtained from the pilot system. Physical activity duration (number of minutes) of each patient is detected by the bracelet. The target is that all patients using the pilot system are active at least 21 minutes per day.

KPI.2.13 Average eating habit improvement

Based on questionnaires filled on the smartphone application and processed by the pilot system and nutritionists, an assessment will be performed to verify if eating habits of involved patients have improved.

KPI.2.14 Dropout rate

Study Effectiveness is evaluated through the relative Dropout Rate. Value of this KPI is obtained in the following manner:

- **Absolute dropout rate:** Drop-Out = number of patients who give up by choice from the study / Study duration;
- **Relative dropout rate:** Drop-Out rate = n * number of patients who give up by choice from the study / study duration /n of patients of the study.

KPI2.15 Performance of the Professional Web Tool

This KPI measures the technical performance of the pilot system as perceived by professional users. The responsiveness of the PWT will be measured indirectly through the analysis of system log files. Parameters such as speed of SQL queries execution or HTTP response times will be considered.

KPI.2.16 Body Cloud mobile app usage

It is important to measure the total amount of time spent by a patient in each screen of the mobile app. It will indicate how long takes for a patient to use the app. Being more than 10 minutes per functionality and day may be that the adherence to the app is good but not much user friendly as expected.

Value of this KPI is obtained by addition of time spent in each screen of the app. Measured in the app itself. Measurement per day and functionality.

KPI.2.17 Professional Web Toll application usage

As in the case of the patient, the time spent by the health professionals in the Professional Web Tool is also important to measure the adherence to the tool. It may be around 90 minutes.

Value of this KPI is obtained by addition of time spent in each screen of the app. Measured in the app itself. Measurement per patient.

4.3 Process evaluation

4.3.1 Introduction

4.3.1.1 Evaluation Purpose

The process evaluation of INTER-IoT encompasses evaluation of the process & tools that are used to successfully run the project within its boundaries, resulting in the technical results (as are being evaluated in the Chapter 4.1) and following the project approach as also is reflected in the definition of the work packages from WP1 up to WP8 in the project.

The used project approach or methodology is in line with the widespread standard development approach according the ‘V-model’, where you start with a requirements & use case definition (WP2), continuing into an architecture phase, detailing out your architecture in to a development phase (WP3/4/5), verify & test your design implementation in a pilot phase (WP6) and rolling out your solution/process/product onto the market (WP8).

Overall activities as project & risk management are gathered in WP1 and the evaluation of the project in WP7. To keep each process step manageable, a detailed work plan consisting of 8 Work packages and 36 Tasks has been defined in the INTER-IoT DoW.

The object of this evaluation is to verify that the process used was the applied correctly in the project, guaranteeing that all project targets are achieved and no gaps are left in the project and that the use project process approach is indeed a good method to be used in similar projects.

4.3.1.2 Stakeholders

In this process evaluation, our aim is to objectively measure the quality of the used project process and its characteristics as is applied for the INTER-IoT proposal.

Furthermore, (re-)usability of the used process is also going to be evaluated.

Direct beneficiaries of INTER-IoT project process are the following:

- future users of INTER-IoT results, entities that want to reuse, modify or expand the INTER-IoT architecture, approach or results,

- companies, consortiums, governments that want to develop in a structured way an IoT application in a multi-site or multi-national environment,
- public entities, universities, companies, consortium that want to apply for a future IoT (Open Call) project,
- developers of INTER-IoT modules/solutions.

Moreover, the outcomes of this evaluation can be used by future stakeholders to decide if the development-/project-process meets their expectations.

Depending on the stakeholders' role, knowledge domain, project target and geographical location, their goal or scope of using the INTER-IoT process will vary.

For example, a large scale multinational consortium which intent to develop a large scale INTER-IoT derived application, shall use the complete flow with all details & general process flow topics to control & guide the project; while a single PhD student who intends to develop a single INTER-IoT derived implementation only shall use some parts of the process as a guideline.

4.3.1.3 Description of the evaluation approach

INTER-IoT process evaluation primarily covers the interaction between project partners, open calls, stakeholders, future users and the public in general. It helps to align and synchronise the operation in such a way that it facilitates, supports and aligns the project flow, used approach and way of working to achieve, within time and budget, long term impact and sustainability of project results.

4.3.2 Selected KPIs

For the Process Evaluation the selected KPIs are directly related with different processes related to IoT interoperability. Hence, for the process evaluation relevant KPI's are distributed over several dimensions and evaluation areas. As defined in Table 1, the selected KPIs are from the following fields and dimensions:

- Exploitation
  - Field 1.3 Business models
  - Field 1.4 Market readiness and monetization mechanisms
  - Field 1.5 Inclusiveness and participation of third parties
  - Field 1.6 Exploitation of products
- Impact
  - Field 3.1 Dissemination approach
  - Field 3.2 Educational Effectiveness
  - Field 3.3 Promotion of resources & Openness
  - Field 3.4 Community engagement
- Interoperability
  - Field 4.7 Supportability
- Ethical, societal, gender and legal evaluation
  - Field 5.1 Legal issues
  - Field 5.2 Holistic innovation
  - Field 5.3 User worktime/life impact
  - Field 5.4 Targeted social groups
  - Field 5.5 Trusted, safe, secure IoT environment promotion

As 'The process' is a supporting feature for the project the KPIs selected for the evaluation are distributed over the several areas. However, other KPIs can be derived from this basis as well.

4.3.3 Data Collection and Measurement

KPI.1.06 Business models proposed

Business models are extracted from interviews with partners. The exact method on how this is done is described in D8.7. For this KPI we count the number of business models defined.

KPI.1.07 Monetizable products

Interviews will be conducted with project partners to better understand the products developed utilizing INTER-IoT technologies. The exact definition of a “monetizable product” and the full list of those products will be documented in D8.7. I this task we merely re-use the results reported there.

KPI.1.08 Private companies using INTER-IoT products (estimate)

Once the products obtained from INTER-IoT are released, those can be acquired by private companies to be installed in their facilities. As the definition of products and the market approach are being defined in WP8 tasks parallel to this evaluation, the list of users is not going to be available by the end of this tasks. Therefore, to collect the data for this KPI, we will first list the companies that already use INTER-IoT products at the time of evaluation. To this number, we will add a list of prospective users that may have shown interest in finalised products. Furthermore, using the results of Individual and Joint Exploitation questionnaires these estimates may further corrected.

KPI.1.09 Public institutions using INTER-IoT components (estimate)

Once the products obtained from INTER-IoT are released, those can be acquired by public institutions to be installed in their facilities. As the definition of products and the market approach are being defined in WP8 tasks parallel to this evaluation, the list of users is not going to be available by the end of this tasks. Therefore, to collect the data for this KPI, we will first list the companies that already use INTER-IoT products at the time of evaluation. To this number, we will add a list of prospective users that may have shown interest in finalised products. Furthermore, using the results of Individual and Joint Exploitation questionnaires these estimates may further corrected.

KPI.1.10 Open-source readiness

This KPI checks the open source readiness by identifying pieces of code that are published in one or more public repositories with detailed documentation. To collect the data for this KPI, a list of publicly available modules will be prepared and the licensing information verified.

KPI.1.11 Business model flexibility

Business models may be applicable to one or more products. We define a business model as “flexible” when it can be used for more than one product. During interviews with consortium partners, a map of relationships between products and business models will be developed. This way we will know what is the relation among business models and products. For this KPI, we count only those business models that qualify as “flexible”.

KPI.1.12 Derived products

This KPI represents the number of products (unique selling propositions) that are released and are containing a significant part of INTER-IoT technologies. To collect the data for this KPI, we count the number of products incorporating at least one INTER-IoT solution/module.

KPI.1.13 Existing products influenced by INTER-IoT developments

This KPI represents the number of products (unique selling propositions) that are released and are incorporating some INTER-IoT technologies. To collect the data for this KPI, a count of the number of products with some code (min 15%) base in INTER-IoT will be done.

KPI.1.15 Time to go-to-market

This KPI is the time in months needed to place the INTER-IoT product/service on the market. To collect the data for this KPI, joint and individual exploitation questionnaires, including face-to-face interviews with partners will be done. These results (including questionnaires) are an integral part of D8.7.

KPI.1.16 Commercial presentations

This KPI represents the number of commercial presentations/demos done to potential customers. To collect the data for this KPI, joint and individual exploitation questionnaires, including face-to-face interviews with partners will be done. These results (including questionnaires) are an integral part of D8.7.

KPI.1.17 Commercial leads

This KPI represents the number of commercial leads that are detected. To collect the data for this KPI, individual Exploitation Questionnaire and face-to-face interview with partners will be done. These results (including questionnaires) are an integral part of D8.7.

KPI.1.18 Commercial industrial events

This KPI counts the commercial & industrial events to which the INTER-IoT partners have participated. To collect the data for this KPI, joint and individual exploitation questionnaires, including face-to-face interviews with partners will be done. These results (including questionnaires) are an integral part of D8.7.

KPI.1.20 Openness in business models

This KPI represents the number of partners of INTER-IoT and third parties that base it business models in an open source model. To collect the data for this KPI, joint and individual exploitation questionnaires, including face to face interviews with partners and open call third parties will be organized. These results (including questionnaires) are an integral part of D8.7.

KPI.1.21 External partnerships and collaborations

This KPI represents the number of recorded formal or informal agreements between the partners of the consortium and other external companies. To collect the data for this KPI, joint and individual exploitation questionnaires, including face-to-face Interviews with partners will be held. These results (including questionnaires) are an integral part of D8.7.

KPI.1.22 Channels selected

This KPI represents the number of channels that are selected and used by the partners for INTER-IoT product/service go-to market activities. To collect the data for this KPI, an online questionnaire (list of multiple options) will be organized.

KPI.1.23 Effective business model design

This KPI represents the number of solid LLAVA matrices that are produced for the go-to-market strategy by INTER-IoT partners. To collect the data for this KPI, an elaboration of LLava Matrix and face-to-face Interview with partners will be organized.

KPI.1.24 Competitors

This KPI represents a list of competitors of the oriented marked products derived from INTER-IoT. To collect the data for this KPI, face-to-face interviews with partners will be held. Although this KPI does not measure the success of INTER-IoT, it will provide us a valuable insight into the

competiveness of the market, thus helping SMEs to assess the level of effort needed if they want to operate in the IoT interoperability market.

KPI.1.25 IPR

This KPI represents the number of partners and third parties who are planning to exploit the intellectual property from their own results. To collect the data for this KPI, an individual exploitation questionnaire, including face-to-face interviews with partners will be organized. These results (including questionnaires) are an integral part of D8.7. Several exploitation models are foreseen: Licensing, Assignment, Joint Venture, pay-per-service (consultancy), spin-off, none. With this KPI we estimate the innovation potential of project results.

KPI.3.01 Dissemination channels

This KPI represents the number of dissemination mediums to spread INTER-IoT actions and results including; multimedia platforms, events, social networks, industrial/academic environments or means, etc. To collect the data for this KPI, a list with all the channels that has been used by INTER-IoT will be elaborated to provide information in a public or private scope.

KPI.3.02 Initiatives to support standardization

To collect the data for this KPI all standardization bodies that INTER-IoT has collaborated with will be counted.

KPI.3.03 Verticals involved

This KPI represents the number of IoT vertical markets in which the results obtained from the project are involved. To collect the data for this KPI, the use cases where INTER-IoT product can be applied will be evaluated, including elaborating a list of markets.

KPI.3.04 Publication actions generated

To collect the data for this KPI, a list with all publications submitted to scientific, technical or business events will be created. Also, a list with all scientific/technical articles submitted to journals and other printed/on-line media will be created. Publications that have already been rejected at the time of evaluation are not counted.

KPI.3.05 Organisation of Scientific events

This KPI represents the number of organized events involved in the scientific area with a minimum range of impact and participation (50+ people). To collect the data for this KPI, a list of all events organized by partners or the project itself will be created and filtered to get all projects that have achieved the threshold of requirement in terms of impact and participation.

KPI.3.06 Academic impact (PhD and MSc Thesis)

To collect the data for this KPI, a list with all students performing a PhD or MSc work based in the project will be generated, for whom results can be fed back into the project flow.

KPI.3.07 Participation in industrial dissemination actions

This KPI contains the number of different events, projects, curses, meetings, etc. performed by the industry where INTER-IoT has participated.

KPI.3.08 Industrial demos development

To collect the data for this KPI, we will count the number of INTER-IoT participations in different industrial events.

KPI.3.09 Research projects identified for Cross Dissemination

Cross Dissemination is defined as exchange of information about project results with other research projects. To collect the data for this KPI, projects identified for cross dissemination where INTER-IoT has been involved in are going to be counted.

KPI.3.10 Social network followers

During the project duration different social networks have been created to follow the progress and are updated with the events that are being organized by INTER-IoT. This is represented by this KPI. These social networks include a web page, a Twitter account, a Facebook page and a LinkedIn and ResearchGate Groups. Value of this KPI is obtained by counting followers of all INTER-IoT social networks, and leaving out all the duplicated ones.

KPI.3.11 Number of individual addressed through different communication channels

This KPI represents the number of social network and public dissemination channels created by INTER-IoT. To collect the data for this KPI, all people reached by INTER-IoT to collaborate, solve problems or doubts and inform about events will be counted. Sources of these people will include social networks and public dissemination channels created by INTER-IoT, other private means of communication that have been created with specific purposes such as Slack, mailing lists, etc.

KPI.3.12 Business or commercial meetings to present the project

This KPI represents the number of private or semi-public meetings and presentations to show INTER-IoT to prospective customers. To collect the data for this KPI will be done by creating a list with the number of meetings and presentations of business character in which INTER-IoT has been presented.

KPI.3.13 Participation in technological forums/discussions

This KPI represents the participation in technological forums on the internet to discuss about IoT Interoperability issues. To collect the data for this KPI, a summary of all technological forums and meetings that INTER-IoT has participated in will be created. This will also include meetings and presentations to show INTER-IoT to prospective customers.

KPI.3.14 Collaboration in Free and Open projects

This KPI represents the involvement with other Open Source projects. The involvement is either by contributing to other project or involving others to contribute to INTER-IoT. To collect the data for this KPI, all OPEN projects in which the participants of INTER-IoT have collaborated actively will be counted.

KPI.4.29 Longevity/stability of INTER-METH

This KPI is an indication of stability over time of the main concepts, models and processes of interoperability. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Main concepts for interoperability are stable; Main concepts and models of interoperability are stable; Main concepts, models and processes of interoperability are stable.

KPI.4.28 Usability of INTER-METH

This KPI is an indication of the learning curve to start using the methodology. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Methodology is suitable only for experts; Methodology is suitable also for non-

experts but requires a long training; Methodology is suitable also for non-experts and does not requires a long training.

KPI.4.29 Extensibility of INTER-METH

This KPI represents the complexity level of the methodology customisation for integration needs. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Methodology is not customizable; Methodology is hard to be customized; Methodology is customizable.

KPI.4.30 Generality of INTER-METH

This KPI check if the methodology is not strictly technology-scenario-vendor dependent. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Methodology is vendor, technology and scenario dependent; Methodology is technology- and vendor-dependent but scenario independent; Methodology is technology-, scenario-, and vendor -independent.

KPI.4.31 Coverage/completeness of INTER-METH (per-layer)

This KPI represents the support for systematic IoT platforms integration, considering integration process on device, network, middleware, application, data and semantics layers. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Methodology focuses only on one layer; Methodology focuses only on some layers; Methodology focuses on all the layers.

KPI.4.32 Availability of CASE tool supporting the process of integration

This KPI represents how a CASE-tool can support the developers all over the integration process. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: CASE-tool not presented; CASE-tool supports for some phase of the process; CASE-tool supports all phases of the process.

KPI.4.33 User satisfaction with the CASE tool

This KPI represents how a CASE-tool achieves the expected results in systematically guiding the integration process. To collect the data for this KPI, interviews with end-users will be held. The following options will be available to end users: CASE-tool does not provide the expected results- guidelines insufficient; CASE-tool partially provides the expected results- guidelines partially satisfactory; CASE-tool fully provides the expected results- guidelines fully satisfactory.

KPI.4.34 Speed up/productivity increase when using CASE tool

This KPI represents how the provided CASE-tool functionalities (related to (i) integration guidelines management, (ii) graphical facilities, and (iii) project data repositories) improve productivity by reducing the time required for integration. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Provided CASE-tool functionalities do not impact the time required for integration; Provided CASE-tool functionalities slightly impact the time required for integration; Provided CASE-tool functionalities notably reduce the time required for integration.

KPI.4.35 Usability of CASE tool

This KPI indicates how difficult it will be to learn and operate the CASE-tool. To collect the data for this KPI, interviews with end-users will be held. The following options will be available to end users: CASE-tool is suitable only for experts; CASE-tool is suitable also for non-experts but requires a long training; CASE-tool is suitable also for non-experts and does not requires a long training.

KPI.4.36 Collaborative work support in CASE tool

This KPI measures how easy it is for a team of IoT system integrators to use the CASE-tool on the same project. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: CASE-tool does not support collaborative work; CASE-tool scarcely supports collaborative work; CASE-tool fully supports collaborative work.

KPI.4.37 Compliance of CASE tool to INTER-IoT approach

This KPI represents how a CASE-tool is compliant with the INTER-IoT integration philosophy, its architecture and its products. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: CASE-tool is not compliant to INTER-IoT approach; CASE-tool is scarcely compliant to INTER-IoT approach; CASE-tool is fully compliant to INTER-IoT approach.

KPI.4.38 Extent of End User Involvement.

The end-user is involved throughout the integration process, which increases the likelihood of client acceptance of the final implementation. To collect the data for this KPI, interviewers with end users will be held. The following options will be available to end users: End-users barely involved; End-users participate in all the incremental releases; End-users participate through both releases and reports.

KPI.4.39 Coverage, completeness and consistency (per-phase)

Support for systematic IoT platforms integration, considering integration process at analysis, design, implementation, test and maintenance phases. To collect the data for this KPI, interviewers with IoT system integrators will be held. The following options will be available to the integrator: Methodology focuses only on one phase; Methodology focuses only on some phases; Methodology focuses on all the phases.

KPI.5.01 Legalisation assessment

In the context of this KPI, we assess how INTER-IoT users and stakeholders feel about legal and IPR issues related to IoT interoperability. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you feel safe about the collected data? Do you think Intellectual Property is properly managed?*

KPI.5.02 Human-centred innovations

In the context of this KPI, we assess how INTER-IoT users and stakeholders perceive the social impact of INTERT-IoT innovation results. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you feel that the INTER-IoT project will allow to improve people lives? Will the project have an impact on people, more than companies?*

KPI.5.03 Connections and trust

In the context of this KPI, we assess how INTER-IoT users and stakeholders trust to INTER-IoT interoperability solutions. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you think the connections between different IoT systems are working well? Do you feel safe in using those solutions?*

KPI.5.04 Worktime - Time Saving

In the context of this KPI, we assess how INTER-IoT users and stakeholders believe INTER-IoT solutions will improve their efficiency and contribute their business output. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you think that an*

INTER-IoT platform can be saving work time? Do you think that an INTER-IoT platform will improve business output?

KPI.5.05 Life - Social inclusion

In the context of this KPI, we assess how INTER-IoT users and stakeholders believe INTER-IoT solutions will contribute to social inclusion and have a positive impact on wellbeing in general. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Will the INTER-IoT system have an impact on your life (private or professional)? Do you feel that the INTER-IoT platform will improve social inclusion?*

KPI.5.06 Socially excluded groups Elderly / Disabled

In the context of this KPI, we assess how INTER-IoT users and stakeholders feel about impact of INTER-IoT solutions to socially vulnerable groups. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you believe that the platform will help to prevent incidents (elderly, disabled people)? Do you believe that such platform will help to preserve people's health?*

KPI.5.07 Citizens' involvement

In the context of this KPI, we assess how INTER-IoT users and stakeholders believe the public has been engaged during development of INTER-IoT solutions. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: "*Do you feel that citizens have sufficiently been involved in the project development? Do you believe that citizens should be involved for further development?*" To collect the data for this KPI, filling an internet survey with binary yes/no questions will be requested.

KPI.5.08 Number of identified regulations and public policies

This KPI measures the number of legislations (regulation and public policies) from different countries that have been considered during INTER-IoT developments. Collecting data for this KPI will be done by listing the number of regulations and policies that have been considered during the project lifetime. This KPI will be mostly obtained through work done for the preparation of pilot deployments as well as T2.5, "Legal and Regulatory Requirement Analysis and Specification".

KPI.5.09 Trusted, safe, secure IoT environment promotion

In the context of this KPI, we assess how INTER-IoT users and stakeholders estimate the promotion of security-related issues during INTER-IoT developments. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you feel like the promotion of trust, safeness and security has been done properly? Were the means of this promotion sufficient?*

KPI.5.10 Threat on the labour demand

In the context of this KPI, we assess how INTER-IoT users and stakeholders estimate the impact of INTER-IoT technologies on the labour market. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you believe that the INTER-IoT platform can be a threat to the la labour force, since it might replace some human intervention?*

KPI.5.11 Help on disabled people's lives

In the context of this KPI, we assess how INTER-IoT users and stakeholders estimate the impact of INTER-IoT technologies on the improvement of quality of life of disabled persons. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you feel like INTER-IoT will help improving disabled persons life?*

KPI.5.12 Accessibility of INTER-IoT tech

In the context of this KPI, we assess how INTER-IoT users and stakeholders feel about the accessibility of INTER-IoT technology. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Do you think the INTER-IoT platform will only benefit to people/companies considered as "rich"?*

KPI.5.13 Publicity of data for research

In the context of this KPI, we assess if INTER-IoT users and stakeholders are willing to publicly release collected datasets for research purposes. To collect the data for this KPI, filling an internet survey with binary yes/no questions will be carried on: *Should the data collected in the INTER-IoT platform be accessible for research?*

5 Ethics of the INTER-IoT evaluation plan

As a consortium, INTER-IoT partners are committed to the standards of ethics outlined in the participant portal H2020 online manual. We have an internal ethical committee which has been meeting regularly for the second half of the project to discuss best practice and address new and existing ethical issues that arise as the project progresses. The evaluation of project results raises relevant ethical issues.

For any evaluation, there needs to be a clear plan so that the quality and ethical nature of the evaluation is designed into the process. This document sets out the INTER-IoT plan for evaluating the technology, use cases, and the processes involved in producing and using INTER-IoT technology and solutions. The United Nations Development Programme (UNDP) says that an evaluation should be independent, intentional, transparent, ethical, impartial, of high quality, timely and used. This section will consider the ethical issues surrounding evaluation.

Evaluation should not reflect personal or sectoral interests. Evaluators must have professional integrity, respect the rights of institutions and individuals to provide information in confidence, and be sensitive to the beliefs and customs of local social and cultural environments. A survey from the AEA identified the following ethical issues that we have considered as potentially relevant to the INTER-IoT project and WP7 while developing this plan:

- Pressure from stakeholders to alter findings prior to release
- Pre-evaluation decisions about results
- Suppression or ignoring findings
- Less than 100% disclosure of findings
- Objectivity of evaluators
- Stakeholders are omitted from the planning process
- Certain areas are declared “off limits”

Having a concrete plan written for the evaluation process available to the reviewers prior to the evaluation helps to address many of the above concerns. This plan must include well defined KPI, clear success criteria for each KPI and outcome measurement methodology. Knowing which specific KPIs will be measured removes some opportunity for the suppression of unwanted results.

Key steps taken to address ethical issues for this plan were:

- The completion of this document where the process and KPIs are clearly defined and available to all partners for review prior to the start of the evaluation process
- Ensure transparency and honesty in reporting by involving multiple partners in the process. Specific partners involved in the development of each KPI and its measurement are documented so the results are fully auditable down to the people involved in the process.
- Review of process by the INTER-IoT ethical committee.
- The involvement of all project partners in the evaluation process.

There are still issues that can arise since the evaluation is taking place internally. Becoming biased toward sections of the project that individuals are involved in can be difficult to avoid. For this reason, all partners were involved in the preparation phase of the evaluation plan and all partners will be involved in the review of the results on some level to ensure the results are reflective of the actual state of the project. However, at some point, we must rely on the integrity of the project partners.

6 Conclusion

This document presents the basis for rigorous assessment of the INTER-IoT success. In it we have first established the methodology of gathering data that we will use in the assessment of project's success. To complement the methodology, we have defined indicators that score this data, and thus enable us to judge success of individual parts of the project.

In the evaluation methodology, we have defined five orthogonal dimensions of measurement (exploitation, pilots, impact, interoperability and ethical, societal, gender and legal evaluation), and partitioned these dimensions of measurement into fields. For each filed we further define a list of KPIs with their description, target and data collection methods. Majority of these were taken from INTER-IoT project requirements (WP2), as well as design/implementation tasks (WP3 - WP5) from earlier project stages. We have based the evaluation of KPIs on the notion of KPI targets, which provide benchmarking values against which to judge individual KPI's success. To assign scores to KPIs, functions have been defined in the Annex of this deliverable, which are based on predefined constraints, presented in this document. Using KPI scores, we can calculate Field scores and later also Dimension scores. We have thus established a rigorous assessment of project's success, as well as success of individual project parts.

Based on all this work we have defined three different evaluation plans. In them we have described in detail how and when evaluation activities are going to be carried out, as well as who will accomplish them.

Technical evaluation plan was written so that it will assess INTER-IoT from a technical perspective, assessing its interoperability capabilities, usability of its framework, its performance and usability as per user's and stakeholder's judgment. It also judges whether the project has met its requirements and performs gap analysis. Technical evaluation shall be performed in task T7.2, judging all three main INTER-IoT development areas: INTER-Layer, INTER-FW and INTER-METH. Its results shall be fed back to the development team, driving further INTER-IoT development, while they will also benefit future INTER-IoT users in the pilots and administrators of systems who will use INTER-IoT.

The plan for evaluation of the results of the pilots will assess main products developed through the project from the standpoint of INTER-IoT pilots, thus aiding developers in improvement of project's efficiency in real-life scenarios as well as creating new business models for INTER-IoT deployment and usage in the future. It will be executed in the task T7.3.

Process evaluation plan was designed as being the most encompassing of all three evaluation plans. It considers project's stakeholders and users, their interest in the project and their potential gain from the project, as well as also project's legal, gender, societal and ethical aspects, etc. It will therefore deliver a comprehensive picture of the expectable benefits from implementing the system as well as of the modalities required for its successful implementation. Its results will feed back into the INTER-IoT development process.

7 Annexes

7.1 Annex 1 - KPI score calculation

KPI id	Name	Metric	Target (T)	KPI score calculation (%)
KPI.1.01	Stakeholders involved	Number	90	KPI_score = KPI_value / T * 100
KPI.1.02	Stakeholders analysed	Number	75% of the involved stakeholders	KPI_score = KPI_value / T * 100
KPI.1.03	Open Calls launched	Number	1	KPI_score = KPI_value / T * 100
KPI.1.04	Received proposals in Open Call	Number	50	KPI_score = KPI_value / T * 100
KPI.1.05	Accepted proposals in the Open Call	Number	12	KPI_score = KPI_value / T * 100
KPI.1.06	Business models proposed	Number	4	KPI_score = KPI_value / T * 100
KPI.1.07	Monetizable products	Number	5	KPI_score = KPI_value / T * 100
KPI.1.08	Private companies using INTER-IoT products (estimate)	Number	5	KPI_score = KPI_value / T * 100
KPI.1.09	Public institutions using INTER-IoT components (estimate)	Number	4	KPI_score = KPI_value / T * 100
KPI.1.10	Open-source readiness	Number	4	KPI_score = KPI_value / T * 100
KPI.1.11	Business model flexibility	Number	3	KPI_score = BMs with more than one product / T * 100
KPI.1.12	Derived products	Number	3	KPI_score = KPI_value / T * 100
KPI.1.13	Existing products influenced by INTER-IoT developments	Number	8	KPI_score = KPI_value / T * 100
KPI.1.14	Spin-offs created	Number	1	KPI_score = KPI_value / T * 100
KPI.1.15	Time to go-to-market	Number	6	KPI_score = KPI_value / T * 100
KPI.1.16	Commercial presentations	Number	30	KPI_score = KPI_value / T * 100
KPI.1.17	Commercial leads	Number	20	KPI_score = KPI_value / T * 100
KPI.1.18	Commercial industrial events	Number	80	KPI_score = KPI_value / T * 100
KPI.1.19	Partners involved in joint exploitation	Number	12	KPI_score = KPI_value / T * 100
KPI.1.20	Openness in business models	Number	15	KPI_score = KPI_value / T * 100
KPI.1.21	External partnerships and collaborations	Number	3	KPI_score = KPI_value / T * 100
KPI.1.22	Channels selected	Number/List	5	KPI_score = KPI_value / T * 100
KPI.1.23	Effective business model design	Number	7	KPI_score = KPI_value / T * 100
KPI.1.24	Competitors	Number/List	-	if KPI_value ==0 then KPI_score=100% else KPI_score = 1/ (KPI_value + 1) * 100
KPI.1.25	IPR	Number	13	KPI_score = KPI_value / T * 100
KPI.2.01	Use cases	Number	4	KPI_score = KPI_value / T * 100
KPI.2.02	Number of patients connected to INTER-Health	Number of patients	100	KPI_score = KPI_value / T * 100
KPI.2.03	Number of objects connected to INTER-LogP	Number	250	KPI_score = KPI_value / T * 100
KPI.2.04	Accuracy ETA vs ATA	Minutes	5	KPI_score = KPI_value / T * 100
KPI.2.05	Activity detected in the railway area	%	0,8	KPI_score = KPI_value / T * 100
KPI.2.06	Trucks detected by system	%	0,8	KPI_score = KPI_value / T * 100
KPI.2.07	Global events detected by system	%	0,8	KPI_score = KPI_value / T * 100
KPI.2.08	Average BMI improvement	% of Patients	0,6	KPI_score = KPI_value / T * 100
KPI.2.09	Average waist circumference improvement	% of Patients	0,6	KPI_score = KPI_value / T * 100
KPI.2.10	Chronic diseases risk reduction	% of Patients	1	KPI_score = KPI_value / T * 100
KPI.2.11	Physical activity (steps) improvement	Number of steps	10000 steps	KPI_score = KPI_value / T * 100
KPI.2.12	Physical activity (minutes of activity) improvement	Minutes	21 minutes	KPI_score = KPI_value / T * 100
KPI.2.13	Average eating habit improvement	% of Patients	0,7	KPI_score = KPI_value / T * 100
KPI.2.14	Dropout rate	% of Patients	<25%	KPI_score = 1 / (KPI_value + 1) * 100
KPI.2.15	Performance of the Professional Web Tool	seconds	< 5s	KPI_score = 100% if KPI_value < T else KPI_score= 1/(log(KPI_value)/log(T)) *100
KPI.2.16	Body Cloud mobile app usage	Minutes	>10 minutes	KPI_score = KPI_value / T * 100
KPI.2.17	Professional Web Toll application usage	Minutes	>60 minutes	KPI_score = KPI_value / T * 100
KPI.3.01	Dissemination channels	Number	20	KPI_score = KPI_value / T * 100
KPI.3.02	Initiatives to support standardization	Number	4	KPI_score = KPI_value / T * 100
KPI.3.03	Verticals involved	Number	3	KPI_score = KPI_value / T * 100
KPI.3.04	Publication actions generated	Number	45	KPI_score = KPI_value / T * 100
KPI.3.05	Organisation of Scientific events	Number	6	KPI_score = KPI_value / T * 100

KPI id	Name	Metric	Target (T)	KPI score calculation (%)
KPI.3.06	Academic impact (PhD and MSc Thesis)	Number	5	KPI_score = KPI_value / T * 100
KPI.3.07	Participation in industrial dissemination actions	Number	8	KPI_score = KPI_value / T * 100
KPI.3.08	Industrial demos development	Number	3	KPI_score = KPI_value / T * 100
KPI.3.09	Research projects identified for Cross Dissemination	Number	4	KPI_score = KPI_value / T * 100
KPI.3.10	Social network followers	Number	1000	KPI_score = KPI_value / T * 100
KPI.3.11	Number of individual addressed through different communication channels	Number	2000	KPI_score = KPI_value / T * 100
KPI.3.12	Business or commercial meetings to present the project	Number	15	KPI_score = KPI_value / T * 100
KPI.3.13	Participation in technological forums/discussions	Number	5	KPI_score = KPI_value / T * 100
KPI.3.14	Collaboration in Free and Open projects	Number	2	KPI_score = KPI_value / T * 100
KPI.4.01	APIs offered by INTER-IoT layer-specific solutions.	Number	5	KPI_score = KPI_value / T * 100
KPI.4.02	Issue tracking	Percentage	0,5	KPI_score = KPI_value / T * 100
KPI.4.03	IoT platforms integrated on MW2MW layer	Number	4	KPI_score = KPI_value / T * 100
KPI.4.04	IoT platforms integrated on AS2A layer	Number	4	KPI_score = KPI_value / T * 100
KPI.4.05	Syntactic translators between different data formats and RDF	Number	3	KPI_score = KPI_value / T * 100
KPI.4.06	Ontology alignments	Number	10	KPI_score = KPI_value / T * 100
KPI.4.07	IoT platforms assets integrated in INTER-AS2AS	Number	10	KPI_score = KPI_value / T * 100
KPI.4.08	Identified Patterns for Layer-oriented Integration	Number	10	KPI_score = KPI_value / T * 100
KPI.4.09	Methodology and guidelines for integrating a new platform into INTER-IoT ecosystem	Yes/No	Yes	KPI_score = 100 if YES else 0
KPI.4.10	Documented deployment and update procedures	Yes/No	Yes	KPI_score = 100 if YES else 0
KPI.4.11	Open source platforms integrated	Percentage	0,5	KPI_score = KPI_value / T * 100
KPI.4.12	Software defined network frameworks integrated	Number	3	KPI_score = KPI_value / T * 100
KPI.4.13	Device to device protocol integration in gateway	Number	3	KPI_score = KPI_value / T * 100
KPI.4.14	Standards supported	Number	3	KPI_score = KPI_value / T * 100
KPI.4.15	Alignment with IoT architectures	Number	1	KPI_score = KPI_value / T * 100
KPI.4.16	Alignments between GIoTP and known standards	Number	2	KPI_score = KPI_value / T * 100
KPI.4.17	Semantic translation scalability	msg/ms	10	KPI_score = KPI_value / T * 100
KPI.4.18	INTER-MW scalability	msg/s	50	KPI_score = KPI_value / T * 100
KPI.4.19	D2D scalability	Number	50	KPI_score = KPI_value / T * 100
KPI.4.20	N2N scalability	msg/ms	100	KPI_score = KPI_value / T * 100
KPI.4.21	AS2AS scalability	msg/s	50	KPI_score = KPI_value / T * 100
KPI.4.22	Availability of the configuration and administration tools	Number	1	KPI_score = 100 if KPI_value>=1 else 0
KPI.4.23	Components supporting monitoring over the lifetime of IoT application deployment	Percentage	0,7	KPI_score = KPI_value / T * 100
KPI.4.24	Failover mechanisms	Number	5	KPI_score = KPI_value / T * 100
KPI.4.25	Security mechanism in place	Number	3	KPI_score = KPI_value / T * 100
KPI.4.26	Documentation availability	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.27	Longevity/stability of INTER-METH	Number	3	KPI_score = 33% if (1) 66% if (2) 100% if (3)
KPI.4.28	Usability of INTER-METH	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.29	Extensibility of INTER-METH	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.30	Generality of INTER-METH	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.31	Coverage/completeness of INTER-METH (per-layer)	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.32	Availability of CASE tool supporting the process of integration	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.33	User satisfaction with the CASE tool	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.34	Speed up/productivity increase when using CASE tool	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)

KPI id	Name	Metric	Target (T)	KPI score calculation (%)
KPI.4.35	Usability of CASE tool	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.36	Collaborative work support in CASE tool	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.37	Compliance of CASE tool to INTER-IoT approach	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.38	Extent of End User Involvement	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.39	Coverage, completeness and consistency (per-phase)	Number	3	KPI_score = 0% if (1) 50% if (2) 100% if (3)
KPI.4.40	System uptime	h	168	KPI_score = KPI_value / T * 100
KPI.4.41	INTER-MW Latency	ms	100	KPI_score = 100% if KPI_value < T else KPI_score= 1/(log(KPI_value)/log(T)) *100
KPI.4.42	Loss rate	Number	0	KPI_score = 100% if KPI_value=0 else 0%
KPI.4.43	Standard open ontologies referred by GIoTP ontology	Number	25	KPI_score = KPI_value / T * 100
KPI.4.44	INTER-N2N Latency	ms	<10ms	KPI_score = 100% if KPI_value < T else KPI_score= 1/(log(KPI_value)/log(T)) *100
KPI.5.01	Legalisation assessment	numbers	T1=100 answers T2 = positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.02	Human-centred innovations	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.03	Connections and trust	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.04	Worktime - Time Saving	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.05	Life - Social inclusion	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.06	Socially excluded groups Elderly / Disabled	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.07	Citizens' involvement	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.08	Number of identified regulations and public policies	Value (Number)	T1 >= 4 from at least T2 >=2 countries	KPI_score = min (regulations/T1; 1) * (log(countries)/log(T2)) * 100
KPI.5.09	Trusted, safe, secure IoT environment promotion	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.10	Threat on the labour demand	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.11	Help on disabled people's lives	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.12	Accessibility of INTER-IoT tech	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100
KPI.5.13	Publicity of data for research	numbers	100 answers, positive results > 75%	KPI_score = (min(answers/T1;1) * (positive_results/ (answers* T2))) * 100

7.2 Annex 2 KPI leading partners

KPI id	Name	Responsible
KPI.1.01	Stakeholders involved	RINI
KPI.1.02	Stakeholders analysed	RINI
KPI.1.03	Open Calls launched	UPV
KPI.1.04	Received proposals in Open Call	UPV
KPI.1.05	Accepted proposals in the Open Call	UPV
KPI.1.06	Business models proposed	PRO
KPI.1.07	Monetizable products	PRO
KPI.1.08	Private companies using INTER-IoT products (estimate)	UPV
KPI.1.09	Public institutions using INTER-IoT components (estimate)	UPV
KPI.1.10	Open-source readiness	PRO
KPI.1.11	Business model flexibility	NPV
KPI.1.12	Derived products	PRO
KPI.1.13	Existing products influenced by INTER-IoT developments	PRO
KPI.1.14	Spin-offs created	RINI
KPI.1.15	Time to go-to-market	NPV
KPI.1.16	Commercial presentations	NEWAYS
KPI.1.17	Commercial leads	NEWAYS
KPI.1.18	Commercial industrial events	NEWAYS
KPI.1.19	Partners involved in joint exploitation	RINI
KPI.1.20	Openness in business models	NPV
KPI.1.21	External partnerships and collaborations	NEWAYS
KPI.1.22	Channels selected	NPV
KPI.1.23	Effective business model design	NPV
KPI.1.24	Competitors	NEWAYS
KPI.1.25	IPR	SABIEN
KPI.2.01	Use cases	VPF
KPI.2.02	Number of patients connected to INTER-Health	SABIEN
KPI.2.03	Number of objects connected to INTER-LogP	VPF
KPI.2.04	Accuracy ETA vs ATA	NPV
KPI.2.05	Activity detected in the railway area	NPV
KPI.2.06	Trucks detected by system	NPV
KPI.2.07	Global events detected by system	ASLTO5
KPI.2.08	Average BMI improvement	ASLTO5
KPI.2.09	Average waist circumference improvement	ASLTO5
KPI.2.10	Chronic diseases risk reduction	ASLTO5
KPI.2.11	Physical activity (steps) improvement	ASLTO5
KPI.2.12	Physical activity (minutes of activity) improvement	ASLTO5
KPI.2.13	Average eating habit improvement	ASLTO5
KPI.2.14	Dropout rate	ASLTO5
KPI.2.15	Performance of the Professional Web Tool	SABIEN
KPI.2.16	Body Cloud mobile app usage	SABIEN
KPI.2.17	Professional Web Toll application usage	SABIEN
KPI.3.01	Dissemination channels	UPV
KPI.3.02	Initiatives to support standardization	UPV
KPI.3.03	Verticals involved	UPV
KPI.3.04	Publication actions generated	UPV
KPI.3.05	Organisation of Scientific events	UPV
KPI.3.06	Academic impact (PhD and MSc Thesis)	UPV
KPI.3.07	Participation in industrial dissemination actions	NEWAYS
KPI.3.08	Industrial demos development	NEWAYS
KPI.3.09	Research projects identified for Cross Dissemination	UPV
KPI.3.10	Social network followers	UPV
KPI.3.11	Number of individual addressed through different communication channels	UPV
KPI.3.12	Business or commercial meetings to present the project	UPV
KPI.3.13	Participation in technological forums/discussions	UPV
KPI.3.14	Collaboration in Free and Open projects	PRO
KPI.4.01	APIs offered by INTER-IoT layer-specific solutions.	XLAB
KPI.4.02	Issue tracking	UPV
KPI.4.03	IoT platforms integrated on MW2MW layer	XLAB
KPI.4.04	IoT platforms integrated on AS2A layer	UPV
KPI.4.05	Syntactic translators between different data formats and RDF	SRIPAS
KPI.4.06	Ontology alignments	SRIPAS
KPI.4.07	IoT platforms assets integrated in INTER-AS2AS	UPV
KPI.4.08	Identified Patterns for Layer-oriented Integration	SRIPAS
KPI.4.09	Methodology and guidelines for integrating a new platform into INTER-IoT ecosystem	UNICAL
KPI.4.10	Documented deployment and update procedures	XLAB
KPI.4.11	Open source platforms integrated	PRO

KPI id	Name	Responsible
KPI.4.12	Software defined network frameworks integrated	RINI
KPI.4.13	Device to device protocol integration in gateway	NEWAYS
KPI.4.14	Standards supported	RINI
KPI.4.15	Alignment with IoT architectures	ABC
KPI.4.16	Alignments between GIoTP and known standards	SRIPAS
KPI.4.17	Semantic translation scalability	SRIPAS
KPI.4.18	INTER-MW scalability	XLAB
KPI.4.19	D2D scalability	NEWAYS
KPI.4.20	N2N scalability	TUE
KPI.4.21	AS2AS scalability	UPV
KPI.4.22	Availability of the configuration and administration tools	PRO
KPI.4.23	Components supporting monitoring over the lifetime of IoT application deployment	PRO
KPI.4.24	Failover mechanisms	UPV
KPI.4.25	Security mechanism in place	UPV
KPI.4.26	Documentation availability	ABC
KPI.4.27	Longevity/stability of INTER-METH	UNICAL
KPI.4.28	Usability of INTER-METH	UNICAL
KPI.4.29	Extensibility of INTER-METH	UNICAL
KPI.4.30	Generality of INTER-METH	UNICAL
KPI.4.31	Coverage/completeness of INTER-METH (per-layer)	UNICAL
KPI.4.32	Availability of CASE tool supporting the process of integration	UNICAL
KPI.4.33	User satisfaction with the CASE tool	UNICAL
KPI.4.34	Speed up/productivity increase when using CASE tool	UNICAL
KPI.4.35	Usability of CASE tool	UNICAL
KPI.4.36	Collaborative work support in CASE tool	UNICAL
KPI.4.37	Compliance of CASE tool to INTER-IoT approach	UNICAL
KPI.4.38	Extent of End User Involvement	UNICAL
KPI.4.39	Coverage, completeness and consistency (per-phase)	UNICAL
KPI.4.40	System uptime	PRO
KPI.4.41	INTER-MW Latency	XLAB
KPI.4.42	Loss rate	RINI
KPI.4.43	Standard open ontologies referred by GIoTP ontology	SRIPAS
KPI.4.44	INTER-N2N Latency	RINI
KPI.5.01	Legalisation assessment	AFT
KPI.5.02	Human-centred innovations	AFT
KPI.5.03	Connections and trust	AFT
KPI.5.04	Worktime - Time Saving	AFT
KPI.5.05	Life - Social inclusion	AFT
KPI.5.06	Socially excluded groups Elderly / Disabled	AFT
KPI.5.07	Citizens' involvement	AFT
KPI.5.08	Number of identified regulations and public policies	NEWAYS
KPI.5.09	Trusted, safe, secure IoT environment promotion	NEWAYS
KPI.5.10	Threat on the labour demand	NEWAYS
KPI.5.11	Help on disabled people's lives	AFT
KPI.5.12	Accessibility of INTER-IoT tech	NEWAYS
KPI.5.13	Publicity of data for research	UPV