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Architecture for Scalable, Self-human-centric, Intelligent, Secure, and Tactile next generation IoT

D9.6 Business Models and Marketing Operations – First Version

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Executive Summary

The objective of T9.4 is to analyse and explore the commercial opportunities in order to validate and exploit the business model on which the technological platform developed in the framework of ASSIST-IoT project is based.

This document is the first deliverable of the T9.4, which will be updated accordingly by the end of the project. Therefore, this report aims at building the basis for the business opportunities of the exploitable results of ASSIST-IoT. It provides an analysis of those expected results based on a careful IPR management that will allow the Consortium to track and monitor the progress of the technological developments and their commercial availability. Moreover, the report also considers the business perspective of the Consortium partners, updated through individual and joint exploitation plans in D9.2, which will serve to improve the early business model for D9.7.

To increase the chances of success of the commercial strategy, an agile development and Lean (start-up) methodology has been followed for customer discovery and validation of the value proposition based on a series of iterations whose core has been the target customer, whose needs are not currently met by any commercial solution existing today. To do so, new useful business development tools have been considered for the generation of this document, including a detailed evaluation process of the value proposition. Based on this, we construct the business model of ASSIST-IoT that updates the Lean Business Model Canvas to a version of it focusing the lean methodology, and a detailed look at the project's innovation management, including mapping of the relationship between the background and foreground IP elements developed by the various partners.

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List of acronyms

Acronym	Explanation	Acronym	Explanation
AI	Artificial Intelligence	**GWEN**	Gateway/Edge Node
API	Application Programming Interface	**HLR**	Home Location Register
APN	Access Point Name	**HPA**	Horizontal Pod Autoscaling
AR	Augmented Reality	**HTML**	Hypertext Markup Language
ARM	Advanced RISC Machine	**HTTP**	Hypertext Transfer Protocol
ASANF	ASSIST-IoT Advanced Network Configuration features	**HW**	Hardware
ASDO	ASSIST-IoT service deployment orchestration	**ICCID**	International Circuit Card ID
ASFL	ASSIST-IoT Federated Learning framework	**ICE**	Internal Combustion Engine
ASGT	ASSIST-IoT Semantic Governance Tools	**IDM**	Identity Manager
ASHA	ASSIST-IoT Horizontal Autoscaling	**IE**	Innovation Elements
ATGUI	Auto-truck guiding	**IMEI**	International Mobile Equipment Identity
AV	Audio-Visual	**IMSI**	International Mobile Subscriber Identity
AVROUT	AV Router	**IoT**	Internet of Things
B2B	Business-2-Business	**IP**	Intellectual Property
BIM	Building Information Modelling	**IPR**	Intellectual Property Rights
BIP	Background IP	**ISC**	In-Service Conformity
BMC	Business Model Canvas	**ISM**	Industrial, Scientific, and Medical
CAPEX	Capital Expenditure	**ISO**	International Organization for Standardization
CD	Continuous Development	**IT**	Information Technology
CDR	Call Detail Record	**ITH**	Head of IT department
CHE	Container Handling Equipment	**JSON**	JavaScript Object Notation
CI	Continuous Integration	**KPI**	Key Performance Indicator
CM	Crane Manufacturer	**LAC**	Location Area Code
CMS	Content Management Service	**LED**	Light Emitting Diode
CPU	Central Processing Unit	**LIDAR**	Light Detection and Ranging
CS	Companies providing OSH services	**LTE**	Long Term Evolution
CST	Customer Service Team	**LTSE**	Long-Term Storage Enabler
CT	Container Terminal	**M2M**	Machine-2-Machine
DLT	Distributed Ledger Technology	**MANO**	Management and Orchestration
EU	European Union	**ML**	Machine Learning
FAIR	Findable Accessible Interoperable Reusable	**MMS**	Multimedia Message Service
FF	Freight Forwarder	**MQTT**	Message Queuing Telemetry Transport
FIFO	First-In First-Out	**MR**	Mixed Reality
FIP	Foreground IP	**MSISDN**	Mobile Station International Subscriber Directory Number
FL	Federated Learning	**MVP**	Minimum Viable Product
GC	General contractor	**NB**	Narrowband
GDPR	General Data Protection Regulation	**NG**	Next Generation
GIS	Geographical Information System	**NOx**	Nitrous Oxide
GMLC	Gateway Mobile Location Centre	**OEM**	Original Equipment Manufacturer
GPU	Graphical Processing Unit	**OGC**	Open Geospatial Consortium
GUI	Graphical User Interface	**OS**	Operating System
GW	Gateway	**OSH**	Occupational Safety and Health

Acronym	Explanation	Acronym	Explanation
OSM	Open-Source MANO	**SOAR**	Security Orchestration Automation and Response
OT	Operational technology	**SOC**	Security Operation Centre
PCM	Power-train Control Module	**SOM**	System on Module
PCS	Port Community System	**SPA**	Single Page Application
PDS	Positioning Detecting System	**SQL**	Structured Query Language
PLC	Programmable Logic Controller	**SW**	Software
RAM	Random Access Memory	**TD**	Truck Driver
RDF	Resource Description Framework	**TI**	Threat Intelligence
REST	Representational State Transfer	**TOS**	Terminal OS
RF	Radio Frequency	**TP**	Technology providers
ROS	Remote Operating System	**UI**	User Interface
RPC	Remote Procedure Call	**UNIX**	Uniplexed Information and Computing System
RSS	Received Signal Strength	**URL**	Uniform Resource Locator
RTG	Rubber Tyred Gantry	**USSD**	Unstructured Supplementary Service Data
RTLS	Real-time locating system	**UV**	Ultraviolet
SCENT	Smart Toolbox for Engaging Citizens into a People-Centric Observation Web	**UWB**	Ultra-Wide Band
SDN	Software Defined Networking	**UX**	User Experience
SD-WAN	Software-Defined Wide Area Network	**VEI**	Vehicle Exterior Inspector
SGSN	Serving GPRS Support Node	**VMT**	Vehicle Mount Terminal
SIEM	Security Information and Event Management	**VO**	Vehicle Owner
SIM	Subscriber Identity Module	**VPN**	Virtual Private Network
SME	Small Medium Enterprise	**VR**	Virtual Reality
SMS	Short Message Service	**XML**	Extensible Markup Language

1. About this document

This deliverable will provide a follow-up to D9.2, reporting on the progress of exploitation and innovation activities of ASSIST-IoT. D9.6 provides reporting of execution and results of the market analysis into a live market monitoring. It includes global business models to be adopted at ASSIST-IoT, developing: (i) the planning and (ii) expected outcomes of market adoption, (iii) further business models to achieve and (iv) actions to perform in the project related to ASSIST-IoT exploitable products. It shall be followed by a final version in D9.7 at the end of the project (i.e., M36).

While communication activities are paramount parts which will enable us to reach out masses and organizations in order to spreading the project views in industry, standards, and academia, there are specific deliverables to describe such vision, strategy and expected goals so please assume that this deliverable (i.e., the one that you are reading) is (deliberately) out of the scope of dissemination activities.

1.1. Deliverable context

Keywords	**Lead Editor**
Objectives	To describe the whole process followed by the Consortium to generate a Minimum Viable Product (MVP) and iterate over it, as many times as necessary, according to the feedback obtained from interviews and working sessions held with the target customers from the early stages of the project, bearing in mind a clear value proposition which fulfil some underserved customer needs and maximizing the opportunities that guarantee a commercial exploitation beyond the end of the ASSIST-IoT project
Work plan	This deliverable belongs to the set of WP9 deliverables, and it is directly linked to all WP9 innovation activities. The ASSIST-IoT project, through this deliverable, compile results of market analysis, implications (e.g., financial, industrial/manufacturing, regulatory, environmental, socioeconomic aspects) and business models to adopt by partners for ASSIST-IoT.
Milestones	This deliverable does not mark any specific milestone completion. However, it contributes towards MS8 – Feedback in M36.
Deliverables	D9.6 is directly linked to two previous WP9 deliverables since it provides the initial and current status of partners' exploitation plans. It is also considered as the starting point of the innovation activities of the project, which will be further updated in final version at the end of the project: • D9.2 Impact Creation Roadmap (M6) • D9.5 Report on Impact Creation Achievements and Plan for the First Period (M18) • D9.8 Business Models and Marketing Operations – Final (M36)

1.2. The rationale behind the structure

This deliverable begins with the main tools and considerations that we have considered, the main one being the fact of having involved a real potential customer from the early stages of the project (which required, in the first instance, the identification of this target). In addition, a state of the art of the main commercial alternatives currently existing that could pose a significant threat to a possible commercial exploitation of the results of ASSIST-IoT is carried out, and sufficiently innovative ways or points that highlight the value propositions are envisaged. Finally, the business model is defined, specifying the value proposition, as well as the underserved customer needs and the problem (i.e., pain) to be solved.

1.3. Outcomes of the deliverable

The most important outcome of this deliverable is that the Consortium has gathered evidence enough that the technological stack developed over the ASSIST-IoT will solve worth and real problems for potentials users and clients. One of the biggest mistakes for start-ups and companies when developing new businesses is writing a business plan, creating lengthy financial projections, and then immediately diving first into executing on their plans. This only maximizes the risk of failure since in many cases, entrepreneurs and researchers launch a product or service that customers do not want and that their business models cannot support. Building something nobody wants is the number one reason for new business failure [1]. According to the literature [2], as a Consortium we should always be striving to achieve three kinds of fit before beginning any tasks related to execution oriented to business and marketing. To sum up: problem/solution fit, product/market fit, and business model fit. Achieving these three kinds of fit will help minimize the risk of failure. The objective pursued by this deliverable (i.e., Business Models and Marketing Operations – First Version) is to describe the process followed by the Consortium in order to try to reach the problem/solution fit (i.e., this occurs when you have evidence that customers care about certain jobs, pains, and gains. At this stage the Consortium proved the existence of a problem and have designed a value proposition that addresses identified customers' jobs, pains and gains. It is important to mention that, unfortunately, the Consortium still does not have clear evidence about care level of potential customers about ASSIST-IoT's value proposition or whether it is enough to buy the product. This will be clarified along the way during the second half of the project.

1.4. Lessons learnt

From all the work carried out throughout the first half of the project, the following insights have been extracted with regards to innovation activities:

- **Lesson 1:** Before creating innovative stuff of software is important to ensure that such developments make sense (i.e., they are important for a potential user and client)
- **Lesson 2:** Less is more so it is important to reach a well-balanced agreement between the technological and the business-oriented staff in the Consortium. Otherwise, there is a risk to carry out more developments than required
- **Lesson 3:** It is critical to involve potential users and clients since the very beginning of the Project. Otherwise, we will have the risk as a Consortium to start creating things from scratch based in our assumptions and hunts (not tested, neither validated).
- **Lesson 4:** Related with the previous lesson, ASSIST-IoT partners have postponed the competence analysis and cost structure of the different MVPs identified for the second term of the project, once their feature sets are well established.

1.5. Deviation and corrective actions

There is no important deviation neither corrective action regarding the content of this deliverable. This document is a first version of the information regarding business operations and marketing which will be populated with a second version before the Project ends. This first approach is focused on problem/solution fit for ensuring that the things we are going to deliver are important for someone (i.e., user persona and potential customers) whereas the second one will be oriented to answer the product/market fit. It is on this second version of the deliverable where the business model canvases will be described per each of the exploitable results.

2. Introduction, Scope

Starting up a commercially successful (technology) product from scratch is tremendously complex and difficult. For every commercial success, there are countless companies that are forced to close because their projects have not been as profitable as originally estimated. Just looking at statistics and figures in the specialized media, it is more than enough to find out the high death rate of start-ups and SMEs. A well-known fact in the business literature finds that 90% of start-ups do not reach two years of life because their business model fails to take off [3] (i.e., their product does not meet a real need for which customers are willing to pay). For every Google, Facebook, Instagram, etc. there are thousands of small or medium companies that run out of resources and are therefore forced to close before reaching the product/market fit[1]. The main reasons include, to cite some of the most recurrent and representative ones, the following: (i) the market does not demand this type of solution, (ii) the needs covered by our product are not as important as previously envisaged and therefore do not represent a real pain for users, (iii) not involving potential target customers in the creation of the product, price, offering, etc. In short, although there is often no single reason why a product does not reach the break even, what cannot be disputed is that the solution created does not satisfy any need that stands out (e.g., in cost, ease of use, time savings, etc.) compared to currently existing alternatives.

At its genesis, nothing about an eventual innovation is new. To get started, all you need is a hunch about a real-world problem that matters; a set of parts and access to a community of people to render the problem tangible; a strategy to engage in trial and error; and an appetite to learn by being productively wrong. You learn about the problem as you bring together those people and parts [4]. The pathway is full of choices and the potential outcomes endless. ASSIST-IoT, through its WP9 (i.e., Impact Creation), is the engine which nurtures the conditions for innovating from a pragmatical point of view that yields impact and prepare it to produce new products, services, and companies, while developing industrial and academic innovations as well as fulfil both scientific and commercial goals. ASSIST-IoT innovations and outcomes will create a pathway for contributing to the creation of a FAIR (Findable, Accessible, Interoperable, Reusable) and decentralized reference architecture for building scalable, self-*, human-centric, intelligent, secure, and tactile next generation of enablers, services, and tools, to assist human-centric applications from an agnostic point of view (i.e., to be used in multiple verticals like automotive, construction and maritime, for instance).

Traditional R&D Projects try to quantify and measure social impact as an academic exercise of assessment separate from business operations (i.e., things like product/market fit, customer development or sales funnels, to name only a few, are outside of their scope and ambition plans). On the other hand, start-ups or industrial companies when developing new businesses, talk about value and growth as the two most important achievements to chase for entrepreneurs to validate assumptions and reach the desired problem/solution fit. Besides that, in businesses it is common that the end-user is also the one who will purchase the goods and services delivered by the company so both value and growth are 100% aligned but when the project is aiming to outcome a social innovation, like ASSIST-IoT, getting a better understanding of our beneficiaries (i.e., users in the social sector like disadvantaged populations, for instance) is even more important because social change is far more complicated than building a new framework or application. It requires more listening, more care, more empathy, and more stakeholders. To make a lasting difference, solutions must be embraced by beneficiaries, address root causes, and include an engine that can accelerate growth to reach the scale of the need while setting up a repeatable, scalable, referenceable, and profitable growth process of entrepreneurship.

[1] Achieving the product/market fit is a critical point as it confirms that the business model we have chosen is the right one and therefore we have exceeded the break-even point, i.e. the profitability threshold that a company needs to sell so that the profit at that moment is zero. That is, when total costs equal total sales revenue

3. The Innovation process methodology

3.1. State of the art of Lean Start-up methodologies

The Lean Start-up movement originated by Eric Ries in 2008 [5] popularised the idea of chasing as a milestone the desired product/market fit in a fast and agile way, with the aim of guaranteeing the business viability of companies before they run out of resources. The fact that there are countless bibliographic references describing methodologies and workflows, although they reduce uncertainty and the possibility of making mistakes, do not guarantee commercial success. However, it is highly advisable to take advantage of all this knowledge in order to promote the technological results of the developments carried out within the outcomes of the ASSIST-IoT project, so that they can be commercially exploited in real production environments. The following is a list of the methodologies and tools on which the Consortium has relied when validating and creating a business model whose expectations are that it should be profitable, repeatable, and scalable. Specifically:

- **Lean Startup** (Eric Ries [5]) is a methodology for developing businesses and products. The methodology aims to shorten development cycles by adopting a combination of hypothesis-driven experimentation to measure progress, iterative product launches to gain customer feedback and validated learning to measure how much has been learned in each iteration. The central hypothesis of the methodology is that if start-ups invest their time in iteratively building products or services to meet early customer needs, they can reduce market risks and avoid the need for large amounts of seed funding or large expenditures to launch a product.
- **Lean Manufacturing** (Kiichiro Toyoda [6]) is a simple, profound, and effective work methodology that originated in Japan, focused on increasing production efficiency in all processes by implementing the kaizen management philosophy of continuous improvement in time, space, waste, inventory, and defects, involving the worker, and generating a sense of belonging by allowing them to participate in the process of proposing their ideas on how to do things better. Therefore, it is a management model that focuses on minimising losses in production systems while maximising value creation for the end customer. It does this by using the minimum number of resources, i.e., those strictly necessary for growth.
- **Customer Development** (Steve Blank [7]) is a methodology for creating new businesses. The process is based on the idea that new businesses have a series of unconfirmed hypotheses about their business model (for example: who are the customers, what characteristics do they want, what channels should we use to reach them, etc.). The way to validate hypotheses is like the scientific method: create a hypothesis about the business model, design an experiment to confirm it, go out there and test the hypothesis. A start-up operates very differently from a large company and therefore must employ different methods and tools. Companies execute known, tested and validated business strategies, but start-ups have to look for new business models in a completely hostile and unknown environment.
- **Blue Ocean Strategy** (W. Chan Kim and Renée Mauborgne [8]) is a strategy for designing and creating business models (and/or finding opportunities in niche markets). The blue ocean represents that space in the market that has not yet been exploited by any existing solution and will therefore generate an opportunity for sustainable and profitable growth. The four basic pillars on which this strategy is based are: (1) creating new consumer space, (2) focusing on the big picture, not the numbers, (3) knowing beyond existing demand, and (4) ensuring the viability of the strategy.

Although they are not methodologies *per se*, the following are the main tools and frameworks that have also helped to design, validate, and create a business plan that captures the validated learning from the ASSIST-IoT project:

- **Business Model Canvas** (Alexander Osterwalder [9]) is a strategic management template for developing new business models or documenting existing ones. It is a visual chart with elements describing product or value propositions of the company, infrastructure, customers, and finances. It helps companies to align their activities by illustrating possible trade-offs.
- **Running Lean: Iterate from Plan A to a Plan That Works** (Ash Maurya [10]) is an adaptation of the business model canvas created by Alexander Osterwalder that is more oriented towards Internet-based

projects or services. The Lean Canvas is fundamentally focused on understanding the customer's problem or need and then putting the focus on the design of the product. For the author, Alex Osterwalder's canvas lacked factors that would show the riskiest hypotheses and others, such as key activities or alliances, seemed dispensable for the business model of a start-up (or new creation company). So, he remodelled Alex Osterwalder's canvas and added these four elements: problem, solution, key metrics, and unique competitive advantage.

- **The Mom Test: How to talk to customers & learn if your business is a good idea when everyone is lying to you** (Rob Fitzpatrick [11]) is a methodology that helps entrepreneurs to conduct interviews with potential customers in a way that provides evidence that we are pursuing a problem that is really worth solving (and therefore, they might be willing to pay for such a solution in the future) with certain guarantees.
- **The Lean Product Playbook: The how-to guide for creating products that customers love** (Dan Olsen [12]) is a step-by-step user's guide to creating products that fit the market and that consumers love. The methodology covers the entire process and culminates in the desired product/market fit).

3.2. ASSIST-IoT innovation methodology

3.2.1. Vision

The aim of this section is to describe the complete work process followed by the Consortium throughout the project. The approach we have followed is a variation of the traditional Lean Start-up methodology (Build - Measure - Learn) proposed by Dan Olsen [12] to create an MVP based on certain validated learning thanks to real feedback from users as a result of the work sessions and iterations. The innovation methodology of ASSIST-IoT is accordingly described in the following four stages, as shown in Figure 1.

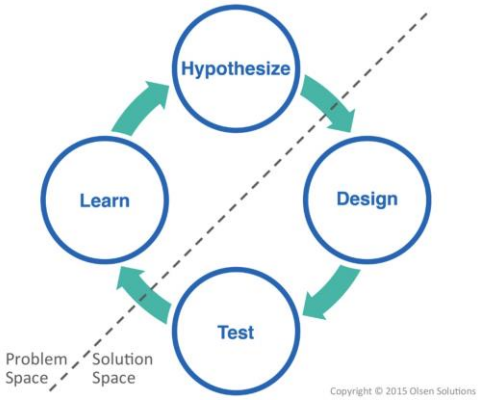

Figure 1. **Lean Start-up Methodology**

1. **Hypothesize stage**: According to the author, the whole process is triggered by hypotheses (business, market, technical, value proposition, etc.) that the work team has and must validate in an agile way to create a product that fits the needs of customers before running out of resources or reaching the end of the process to discover that the result of our work does not meet any expectations.
2. **Design stage**: It is important to mention that the design phase does not require us to build a complete and fully functional solution, but rather to have something interactive that allows future potential customers to get an idea of the product we are creating and for us to validate the hypotheses of the previous step. The objective is to create something that allows us to validate, quantitatively and/or qualitatively, certain hypotheses and therefore move forward firmly through the next iteration (test via pilots).
3. **Test stage**: Although, as we have mentioned in this phase, it is not an essential requirement to have the complete solution (in fact, it is something that we will create over time as the iterations evolve), it is essential to present our solution to the client to validate, by means of observation, whether we are really facing a problem that is worth solving for this type of client.
4. **Learn stage**: The last phase of the work cycle consists precisely in taking advantage of the results and conclusions obtained from these experiments to modify our initial working hypotheses (validate, invalidate, add new hypotheses, etc.), modify the solution and then present it again to customers.

3.2.2. Strategy

Based on the aforementioned phases, and since innovating is a highly nonlinear process, this Consortium is going to turn that nonlinearity into our advantage systematically exploring a space of opportunities. The key to the process is to iterate quickly as many times as necessary to provide (measurable) value and reduce the uncertainty of achieving the desired product/market fit. In more detail and going deeper into the work process we have followed in ASSIST-IoT, the cycle described above is based on six fundamental pillars on which we iterate until the break-even point is reached, consisting in the following process sequencing:

1. Determine who is (or who are) our target customer(s)
2. Identify currently unmet needs that are important to our potential target customers (i.e., different customers choose different business alternatives to satisfy their current needs).
3. Defining our value proposition
4. Specify the minimum set of functionalities that will make up our Minimum Viable Product (MVP).
5. Designing and implementing our MVP.
6. Test and validate our MVP with target customers

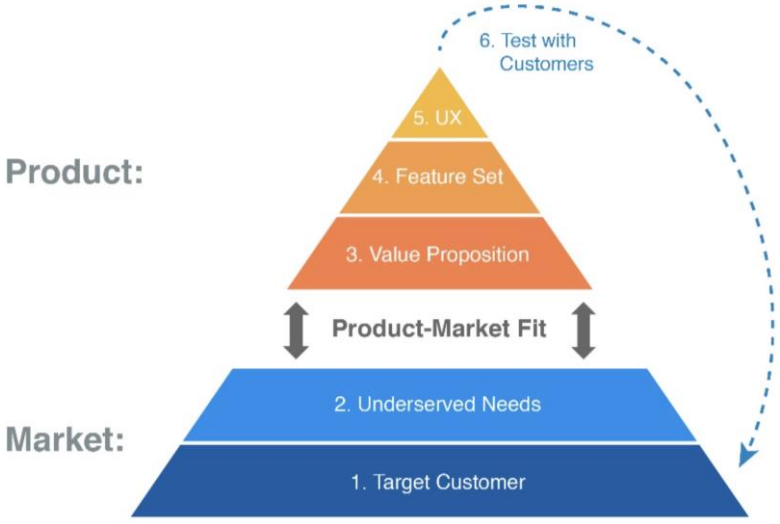

Figure 2. Pillars of the Lean process.

3.2.3. Tactics

The next sections define the tactics for addressing the previous strategy in detail, that will make possible to reach at the end of the project a reasonable business model, based on a clear unique value proposition and a set of functionalities validated with our main target customers.

3.2.3.1. Spin-in group for customer development and product discovery

In today's competitive marketplace, innovative companies and start-ups seek for agility and resourcefulness. Although in the past they used to take advantage of the spin-out philosophy in order to speed up the innovation, another approach quite popular nowadays is basically the opposite: to set up a **spin-in group** of involved staff. Spin-in has several advantages for a business, being the most important inside a Consortium like ASSIST-IoT the ability to be more agile thanks to a solid infrastructure of a cross-marketing group of very focused (in business) people. For that reason, the Consortium led by its Innovation Manager decided to set up a spin-in team based on a reduced number of staff very market-driven and business oriented. This team, which meets every two weeks, has the goal to stress hypotheses and transform them into facts which could be materialized into tangible results.

3.2.3.2. Target customer(s) identification

There is a traditional tendency in R&D projects to directly jump straight forward to defining a bunch of metrics for performance without talking to people. Since the beginning of this project until M36 the Consortium will start asking open ended questions about users and beneficiaries lived experiences. **Ambition**: Identify target customers, users, and beneficiaries for whom our hypothetical business model may create sustainability change. Then, improve our hunch, refine our problem, and help us reconceive what we are going to prototype for impact.

Table 1. Target customer identification template.

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
Target customer #1			
Target customer #2			
…			

3.2.3.3. Underserved customer needs identification

Once the target customers are well identified, the next stage leads to a proper identification of their underserved needs. The main recommendation from the Innovation team is to be pragmatical and focus on what matters the most to those target customers. To do so, the following two templates are used sequentially. While the first one is mainly focused on determining customer and their needs, the second one aims at developing the User Persona for any target customer envisaged in the previous step. The User Persona will ensure that everyone working in the same pilot (at least) is focused on the same customer, so that all involved partners are on the same page regarding exploitable outcomes. Therefore, it will allow to have a better understanding about our main target (potential) customers which in turn will help us to improve our solutions and the offering we will carry out.

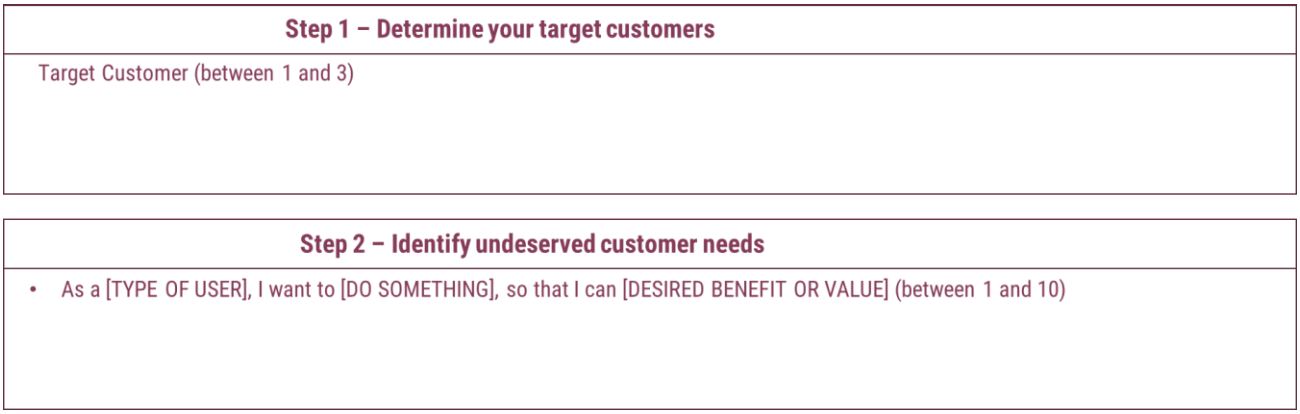

Figure 3. Target customer identification and needs

3.2.3.4. Value proposition definition

At the end of this stage, the Consortium will be able to know what our vision about the goal is for creating a product in the scope of an MVP. To do so, the first stage starts by the definition of all the involved different ASSIST-IoT partners of a clear value proposition that should fulfil customers' challenges, i.e., becoming their problem-solver. A value proposition is defined in this deliverable as a simple list of statements that summarize why the previously identified target customers would choose the ASSIST-IoT product or service in the form of an Innovation Element. **Ambition:** Communicate the clearest benefits that customers can receive by relying on ASSIST-IoT product for their business. Although a great value proposition must highlight what makes ASSIST-IoT Innovation Elements different from competitors, given the still lack of clear path for exploitation well defined, the scope of the value proposition definition in this deliverable has been focused on how customers can clearly identify our values.

3.2.3.5. MVP feature set and low fidelity prototype

Also, it is usual that in R&D projects technological partners do not start producing results until M30 or M33. Therefore, the Innovation Elements developed in the project are not able to be stressed in real conditions or pilots until (almost) the end of the project, when there is no chance to pivot with considerable planning and thoughtful execution. ASSIST-IoT Consortium is aimed to start innovating right away since the second term of the project, just assembling some parts we already have or can be produced easily (as a prototype and growing from bottom to top) using those parts to make the problem(s) tangible(s), even the solution(s), enabling us systematically reasoning about it with our minds and our hearts. **Ambition**: Specify our Minimum Viable Product(s) feature set(s) and create them according to the categories: must-have, nice to have, and delightful to have. This analysis will allow to smoothly move from MVP feature set to low fidelity prototype coding decisions in the second term of the project.

3.2.3.6. MVP validation with target customers

Even though the strong expertise and background of the ASSIST-IoT Consortium, partners accept that the trial-and-error approach reveals the innovations needed, so project's pathway towards impact has been designed putting a lot of emphasis interrogating our ideas/prototypes/developments with parts and with insights the Consortium will get from people, making our innovations practical, robust, and scalable. **Ambition:** once the MVP prototype is well grounded in the early phase of the second term of the project, the different partners will need to stress the project outcomes (ideas, assumptions, prototypes, and developments) with real users and potential clients and beneficiaries in a quantitative and qualitative way (in-person, remote and unmoderated user working sessions), in order to validate or invalidate hypothesis and implicit assumptions which will enable build up from a solid foundation.

3.3. Summary

The following table summarizes the ASSIST-IoT Innovation methodology that is being used in the project in order to support a long-term sustainability of ASSIST-IoT project outcomes, reaching the market with enough guarantees for success.

Table 1. ASSIST-IoT Innovation Methodology summary

Vision
• Create technological products (i.e., ASSIST-IoT enablers, framework, etc.) customers love • Develop and release the ASSIST-IoT innovation process (i.e., a reliable methodology for innovating continually starting from a hunch while being productively wrong), which is a crystal-clear step by step guidance to help future researchers build successful products
Strategy
• Logical sequence of testable hypothesis which will help the Consortium to reach the product/market fit • Iterate recursively through the Product/Market fit pyramid, which is break down into five layers.
Tactics

• Set up a reduced group of people very focused on business and market exploitation
• Experts on automotive, construction and logistics/maritime sectors as well as IoT and communication fields
• Expertise on industrial environments and very close to the industry
• Meet every two weeks to share ideas, discuss tactics and stress out every testable hypothesis we have in the ASSIST-IoT Consortium
• Iterate through the product/market fit pyramid:
  ○ Determine your target customers
  ○ Identify underserved customer needs
  ○ Define your value proposition
  ○ Specify your minimum viable product (MVP) feature set
  ○ Create your MVP prototype

- Test your MVP with customers
- Ensure the problem/solution fit first which means that ASSIST-IoT solves a problem worth solving
- Feed the ASSIST-IoT staff with comments and feedback to prioritise developments and put the focus on the bunch of functionalities which are the most important ones

4. Customer and product development per Consortium – solution as a whole (UPV, PRO, INF)

This section is dedicated to the progress of business development at ASSIST-IoT solution as a whole. In it, we will be presenting the new version of the value proposition defined for the project platform. The section revisits the target market segments that will help the project outcomes to encode the market coverage of competitors and compare them with ASSIST-IoT main features.

4.1. Target customers identification

ASSIST-IoT, as a Next Generation IoT enabler, takes advantage of the pros of both domains (i.e., the academic and the industrial ones) with the strong foundational belief of working through innovations that are good for the business (profit), good for the payers (customer value) as well as good for the wider system solving social and environmental challenges. The scope of this project is to design, implement and validate, in a realistic, measurable, and replicable way, a unified innovative multi-plane (semi-)autonomous decentralized edge-cloud reference architecture. Besides that, ASSIST-IoT results are expected to make a difference in terms of impact, not only during the project timeframe but also beyond, thanks to the application of the following methodology that underpin the foundation engine of innovation of the Silicon Valley Product Group [13].

Table 2. Target customers identification – ASSIST-IoT Solution as a whole

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
IT Head	Head of IT department of a –medium/big- company (whichever sector).	Maintain the computing infrastructure of a company: keep services working optimising efficiency, cost, maintenance, etc. In addition, renewal of equipment adhering to the most modern standards is one of their duties.	Obsolescence of equipment, interoperability among different servers and devices, size and capacities of their diverse computing equipment made (usually) the management of the services and the infrastructure a difficult task. In addition, being able to manage all services (natively) from a single system, interpreting all underlying machines as a continuum would allow them a finer and more optimal control.
Head of innovation	Head of Innovation Department of a –medium/big- company or a Research Center/Uni	For private companies: elaborate over the current trending technologies in IoT/edge/Cloud computing leveraging them to offer better services to their clients. For research teams / Unis: test modern IoT-related equipment in a testbed and to introduce my own developments in an easy way.	Cost uses to be a barrier here. Some tools are open source only to a certain extent (then a more privative licenses is required and fees to be paid). Time and resources availability for testing those technologies, altogether with a stem learning curve for an unclear RoI are also issues here. Finally, incompatibility of those solutions with their already-in-place equipment is an entry barrier that prevents this "persona" to digging deeper in such systems.
Smart City head	Smart City responsible / Head of Development department of a medium/big- city	(1) Delivering a platform / tool or set of tools to the citizens for consulting heterogeneous data owned by various stakeholders.	Addition of new IoT equipment like sensors or other devices is usually a barrier (economically and operationally), as current solutions are vendor-lock, and interoperability among them is not easy. In addition, applying ser-

		(2) Managed diverse equipment, including IoT sensors and edge devices (e.g., cameras) that capture data of the city. (3) Agile, robust backend servers to manage infrastructure and servers to provide (1) and (2).	vices over those devices/sensors gets complicated without a compatible/interoperable manageability system.
Universities - IT schools of departments	Universities and Research Centres are organisations whose main goal is to educate generations and promote science	To provide new educational means and UpToDate experimentation platforms	Not unified technological solutions could be a barrier. IoT ecosystem can offer new experimentation platforms which assist in the teaching and experimentation procedures. Furthermore, the combination of IoT and AI, engineering and architecture lessons give the chance to students to study and test in simulation mechanisms and mixed reality events

The three previous personae have in common:

- All of them have *admin* access to computing resources of the company/entity.
- All of them manage the network equipment of the company/entity.
- All of them have the capacity to purchase new ad-hoc or off-the-shelf computing equipment.
- All of them participate in the network design.

4.2. Underserved customer needs identification

Head of IT department of a –medium/big- company (whichever sector) - ITH

1. As an ITH, I want to CONTROL IN A UNIFIED PLATFORM ALL THE SERVICES INSTALLED IN MY COMPUTING EQUIPMENT, BEING THIS INSTALLATION RATHER CHANGING AND FLEXIBLE.
2. As an ITH, I am USING THE COMPUTING EQUIPMENT TO PROVIDE SERVICES TO MY CUSTOMERS AND I CAN IMPROVE THE USER SATISFACTION OF MY PRODUCTS
3. As an ITH, I want to INTRODUCE NEW INTERFACES IN MY INDUSTRY LINE AND CONTROL THE APPLICATIONS RUN BY THOSE NEW INTERFACES ACCORDING TO THE NEEDS OF MY BUSINESS.
4. As an ITH, I want to MAKE MY NETWORK REDUNDANT AND CAPABLE TO INCORPORATE NEW EQUIPMENT EASILY

Head of Innovation Department of a –medium/big- company or a Research Center/Uni - HID

1. As a HID, I want to BE ABLE TO TEST MODERN IOT-RELATED EQUIPMENT IN A TESTBED AND TO INTRODUCE MY OWN DEVELOPMENTS IN AN EASY WAY.
2. As a HID, I want to ESTABLISH NEW BUSINESS/RESEARCH LINES FOR MY COMPANY AND TO BASE THOSE IN A SET OF MODERN EQUIPMENT OVER WHICH I CAN DEPLOY NEW SERVICES RELATED TO IoT.

Smart City responsible / Head of Development department of a –medium/big- city - SCR

5. As a SCR, I want to HOST A PLATFORM WHERE CITIZENS CAN CONNECT AND HAVE INFORMATION OF THEIR SURROUNDING WITH MINIMAL LATENCY AND MÁXIMUM QUALITY OF SERVICE.
6. As a SCR, I want to EASILY ADD NEW IOT PLAFORMS, DEVICES, SENSORS AND DATASETS INTO MY CURRENT DISTRIBUTED COMPUTING EQUIPMENT INFRASTRUCTURE
7. As a SCR, I want to DEPLOY A NEW NETWORK OF EQUIPMENT WITH MODERN STANDARDS AND BE ABLE TO EASILY MIGRATE MY SERVICES

Universities - IT schools of departments - UNI

1. As a UNI, I need an IoT PLATFORM than can ASSIST TEACHING AND EXPERIMENTATION methods to STUDENTS.
2. As a UNI, I want A SIMULATION AND MIXED REALITY PLATFORM for specific scientific disciplines.

4.3. ASSIST-IoT value proposition definition

The ASSIST-IoT solution as a whole aim at delivering a reference architecture for the NG-IoT deployments. The project, with this result, however, does not only aim at generating a series of recommendations and methodologies, but go further. As a matter of fact, the project will create a "platform" based on such architecture, composed of actual technology that will help pilots (WP7) develop innovative use-cases using it.

In particular, the delivered platform has the aim of covering most modern IoT deployment needs, ranging from devices connectivity, network, data forwarding, data processing, storage, application, virtualization, flexible deployment, monitoring, manageability, user interfaces, AR/VR and others.

To cover the "expressed needs" by the personae described in the previous section, ASSIST-IoT as a whole root its value proposition in the following principles:

1. Offering a unified management interface (single window like) where to manage the deployment of different services.
2. Possibility to modify parameters/configuration of the services "on-the-fly" to adjust to end users requirements.
3. Bring flexibility to: create UI interfaces (over an open framework), control the data flow and interact with devices in real time.
4. Have control on the topology of the IoT deployment network, being able to deploy network functions and policies and rules defined by software (SDN) to create a dynamic, flexible environment.
5. An easy (close to zero-touch) deployment of new equipment (assuming Linux-based OS) so that it is visible and interactive from ASSIST-IoT manageability interface.
6. Capacity to insert own developments of the user (i.e., an AI model, a new storage system, a web server) and be able to distribute them via ASSIST-IoT to diverse equipment. This is possible thanks to the encapsulation methodology built in the project.
7. Allowing a company providing IT services to use ASSIST-IoT as the single platform to manage services (offered to clients) according to modern technologies for orchestration (enhanced OSM), deployment (k8s and variants), storage (SQL and NoSQL), etc.
8. Availability to expose the services via an attracting interface.
9. Allowing external people to the hosting company/entity to make use of the equipment/services and also accessing to the data persisted in the system (thanks to an OpenAPI).
10. Boosting interoperability with platforms operating at various levels (device, network, middleware, application) based on well-documented, template-guided REST APIs which all enablers are equipped with.
11. An evolving ecosystem that will permit the incorporation of new technologies as long as the encapsulation principles and the equipment capabilities allow it.
12. Create new platforms to support students and researchers.
13. Provide simulation and mixed reality environments for closest to reality practice.

4.4. MVP feature set and low fidelity prototype

Based on the aforementioned value propositions for ASSIST-IoT as a whole solution, six main Innovation Elements have been devised, leading to the following three MVP feature sets:

1. ASSIST-IoT service deployment orchestration (**ASDO**): A product able to deploy different functionalities over k8s-compatible equipment controlled over the same orchestrator, tagging the tiers and levels of the infrastructure and with a unified, clearly defined structure of software packaging and deployment.

2. ASSIST-IoT Advanced Network Configuration features (**ASANF**): A set of advanced functionalities related to network capacities/capabilities.
3. ASSIST-IoT Federated Learning framework (**ASFL**): Framework able to be deployed over an ASSIST-IoT compliant system that will allow heterogeneous devices and equipment to partially train and fully leverage ML models that take advantage of various nodes without the need of sharing information (it remains local to each edge node.
4. Edge Node IoT Gateway (**GWEN**): A hardware node that will be natively equipped with connectivity, configuration, etc. to be ready to act as a functional node of ASSIST-IoT.
5. ASSIST-IoT Semantic Governance Tools (**ASGT**): A suite of novel, advanced software functionalities to ensure semantic interoperability, sovereignty of data and other data-related capabilities following ASSIST-IoT Data View, pipelines and recommendations.
6. ASSIST-IoT Horizontal Autoscaling (**ASHA**): A software functionality belonging to the self-* knowledge domain that will allow k8s-assimilable nodes to auto-scale their resources depending on historic values (based on ML) to optimise resources usage.

Table 3. ASSIST-IoT as a whole – ASDO MVP feature set

ASSIST-IoT service deployment orchestration (**ASDO**)	
Type of feature	**Description**
Must Have	
Automation	The MVP must be able to, automatedly, order and achieve the actual deployment of that functionality (represented in a Helm chart) in the ASSIST-IoT ecosystem.
Heterogeneity of equipment and services	The MVP must be able to interact with different underlying technologies for deployment (k8s, k3s, microk8s) so that diverse equipment will be able to run ASSIST-IoT functionalities.
Interactivity	The MVP must feed the user back with any relevant information about the success or failure of the deployment of the service/functionality-
Nice to Have	
Automated selection	The MVP may include the automatic selection of the optimal spot in the edge-cloud continuum (i.e., all the tiers of equipment available in different parts of the network-topology/computing-hierarchy)
Usability	The MVP may include additional usability traits like virtual aid for selecting the charts to be deployed.
Delighters	
Templating	The MVP would stand out with a “wizard” for creating Helm charts for functionalities that could be afterwards deployed.
Configuration	The MVP would be able to configure parameters (like number max. of replicas) both during the initial deployment and on-the-fly.

Table 4. ASSIST-IoT as a whole – ASANF MVP feature set

ASSIST-IoT Advanced Network Configuration features (ASANF):	
Type of feature	**Description**

Must Have	
VPN connection	The MVP must be able to allow different hosts connected to a remote network to join a k8s (or similar) cluster of ASSIST-IoT via a VPN connection.
SD-WAN option	The MVP must be able to allow SD-WAN connectivity, defining software rules for network behavior between two remote networks.
Traffic classification	The MVP must be able to classify the traffic using prediction AI techniques to help improve the performance of a network segment.
Nice to Have	
Dynamic configuration	The MVP may allow the configuration of parameters (e.g., bandwidth, VLANs, etc.) of k8s (or related) clusters in a dynamic way thanks to ASSIST-IoT.
Delighters	
Wide multi-link compatibility	The MVP would stand out with adding several technologies in a multi-link connection (e.g, Fluidmesh, Ethernet, Wifi, 4G).

Table 5. ASSIST-IoT as a whole – ASFL MVP feature set

ASSIST-IoT Federated Learning framework (ASFL):	
Type of feature	**Description**
Must Have	
Increase of nodes	The MVP must be able to accept the introduction of new computing elements (devices, servers, computers) as nodes of the federation to contributed to the learning.
Configuration of learning parameters	The MVP must be able to configure some hyperparameters for the learning (epochs, target function, etc.)-
Access to improved models	The MVP must be able to share models in a secured and private way.
Nice to Have	
Accuracy reporting	The MVP may be able to proactively report the accuracy achieved of the learning in the centralized location, spreading it to the underlying nodes and also to other enablers of the system (or external entities).
Configuration UI	The MVP may allow the aforementioned configuration via a user interface.
Delighters	
Adaptation of models	The MVP would stand out if it would be able to adapt the inference model to be used in each device/end node depending on their computing capacities.

Table 6. ASSIST-IoT as a whole – GWEN MVP feature set

Edge Node IoT Gateway (GWEN):	
Type of feature	**Description**
Must Have	

Connectivity	The MVP must be able to communicate southbound and northbound using various communication protocols (at least, the most used in NGIoT) – 4G, 5G, Bluetooth, WiFi, NBIoT, etc.
Natively equipped for ASSIST-IoT ecosystem	The MVP must equip a compatible version of k8s or similar so that the incorporation as a node/cluster to the ASSIST-IoT ecosystem will be straightforward. This way, the orchestrator will be able to easily interact with the GWEN.
Computation capacity	The MVP must be able to run UNIX-based programs and functionalities. In addition, accessibility for managing the device is needed.
Nice to Have	
Top-in modularity	The MVP may allow the incorporation of other modules on top of its hardware.
GPU capacity	The MVP may include enough GPU capacity to perform AI operations (inference and even learning) in a local environment (fostering edge approach of ASSIST-IoT).
Delighters	
Certified industrial envelope	The MVP would stand out with a certification of Industrial-accepted ISO or other normatives so that the device will be able to be used in operative conditions.
Powering options	The MVP would be able to

Table 7. ASSIST-IoT as a whole – ASGT MVP feature set

ASSIST-IoT Semantic Governance Tools (ASGT):	
Type of feature	**Description**
Must Have	
Data diversity support	The MVP must be able to accept different data in different formats using different ontologies, data models and schemas. The MVP should also be able to keep a record and register of such information to guarantee posterior sovereignty.
Automated interoperability	The MVP must interoperate diverse information following alignment rules so that varying stakeholders with different goals and data provisions will be able to take advantage of all the data being gathered in the ASSIST-IoT ecosystem.
Pipelines definition	The MVP must allow syntactic conversion from JSON to RDF in a lightweight manner so that data pipelines can be established for the linked functioning of enablers.
Nice to Have	
Supporting wide variety of formats	The MVP will be more innovative and interesting as more formats will be accepted for the annotation and transformation.
Delighters	
Pipelines UI	The MVP would stand out if the data pipelines connecting different formats (involving annotation and then, transformation) could be configured via a user interface.

Table 8. ASSIST-IoT as a whole – ASHA MVP feature set

ASSIST-IoT Horizontal Autoscaling (ASHA):	
Type of feature	**Description**
Must Have	
Adapt to the demand	The MVP must be able to appoint internal resources to services/pods in an automated way, without the need of human intervention and depending on the required computing workload.
Optimise resources usage	The MVP must have as its main goal the resources optimization, allowing the equipment to consume as less as possible RAM (and other capacities) while still performing the assigned work.
Nice to Have	
Act in advance to the demand	The MVP may not react only to current changes but also learn from historic values (finding patterns, trends, etc.) to adapt the resources allocated in advance, preventing bottlenecks or mis-functioning to happen.
Reporting	The MVP may include reporting functionality (beyond API for querying logs registers), shifting into an active approach.
Delighters	
Broader awareness	The MVP would stand out if, in addition to reaction and prediction of workload to be processed by that host (self-*), it would add monitoring of other elements in the eco-system (e.g., other enablers, load of the system as a whole, etc.) to apply horizontal allocation policies based on that information.

5. Specific customer and product development per Pilot

5.1. Pilot 1: Port Automation

5.1.1. Motivation

The main problem to solve from a container terminal operator is to enable traceability of containers within the port to avoid losing them, and to enhance the operational efficiency of terminal operators (including internal-external drivers). To achieve this, the positions of all CHEs within the yard are willing to be tracked. All this information is combined in the Terminal Operating System in order to link the location of all CHEs with the job orders, i.e., containers handled in the yard.

5.1.2. Target customers identification

Table 9. Target customer identification – per pilot – Port Automation

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
Container Terminal (CT)	Logistics (private) enterprises whose core business is to manage and tranship cargo containers between several modes of transportation. They are physically located in harbours and their most important clients are shipping lines (i.e., there are SLAs signed-off in terms of performance between the container terminal and the shipping line so that cargo low-level productivity is not an option)	Improve performance managing cargo operations, as well as reduce IDLE and waiting times (in both arrival/departure) of vessels to the terminal	Data is captive inside the Terminal Operating System (TOS), which is not shared, reachable neither standardized so involved partners in the supply chain do not have access to them. Besides that, there are a lot of processes which require human intervention (mistakes, safety-risk and low performance) and there is not compatibility between different IoT vendors and software providers
Crane Manufacturer (CM)	Cranes play a vital role in the world of transport and maritime industries. They are utilized on a daily basis not only for managing cargo operations but also for performing daily duties enabling yard storage and maintenance. They carry huge amount (~10 times the size of a human being) from water or land. They are responsible for installing the cranes as well as the rest of the CHE (Container Handling Equipment) available in the infrastructure of the container terminal. CHE equipment is the assets for the terminal staff	Ensure the use of the assets and machinery (any type of crane) without outages and reducing the IDLE times, which are the higher operational cost	In any terminal there is a different stock of assets available which are vendor dependent so that the expertise of such machinery is not within the reach of the terminal staff. Depending of the manufacturer, cranes and CHEs are most of the time black boxes. Besides that, the performance and the IDLE time of the machinery is directly related with the performance of the terminal staff who is managing the asset
Freight Forwarder (FF)	A freight forwarder or forwarding agent is a company that organizes shipments for individuals or corporations to get goods from the manufacturer or producer to a market, customer, or final point of distribution. Forwarders contract with a carrier or often multiple carriers to move the goods from one country to another. It is the intermediary which moves the cargo to/from the vessel from/to the final destination	Ensure there is not IDLE times in the movement of the cargo so that there will not be waiting times and the trucks are most of the time on the go	Freight forwarders are external companies. In order to access to the terminal to pick up cargo goods, they need to cross several security checks points which delays the process, while increases waiting and IDLE time. Besides that, the truck driver normally does not know how to directly reach the destiny where the good is waiting to be picked up and there are delays managing cargo operations which are not shared with them
Truck Driver (TD)	A truck driver is the human being in charge of delivering or collecting containers to/from container terminals, based on contractual agreements. They perform the cargo operations that allow	Perform their daily routines in the minimum time without uncertainties, so that	Truck drivers, and especially external truck drivers from freight forwarders do not have access to IT systems and data of Container terminals due to security reasons, so that they are not aware of which

	the maritime logistics to move from sea areas to inland areas	they are not wasting time	is their area of operation until they are lost in the terminal environment

5.1.3. Underserved customer needs identification

Container terminal (CT)

1. As a CT, I want to REDUCE IDLE TIME IN THE YARD, so that I can IMPROVE PERFORMANCE.
2. As a CT, I want to REDUCE TRUCK TRAFFIC JAMS, so that I can REDUCE IDLE TIME IN THE YARD
3. As a CT, I want to SECURELY EXPOSE MY DATA, so that I can SPEED UP INTEGRATION WITH EXTERNALS Devices.
4. As a CT, I want to REDUCE IDLE TIME OF RTG CRANES, so that I can IMPROVE PERFORMANCE.
5. As a CT, I want to REMOTELY OPERATE RTG CRANES, so that I can REDUCE IDLE TIME OF RTG CRANES.
6. As a CT, I want to ENABLE M2M COMMUNICATIONS, so that I can MINIMIZE HUMAN ERRORS AND INCREASE SAFETY
7. As a CT, I want to MANAGE AND CONTROL MY OT AND IOT DEVICES EASILY: supervision, upgrade, security.
8. As a CT, I want to IMPROVE MY NETWORK RESILIENCE WITH WiFi+5G+4G
9. As a CT, I want to REPLACE MY NETWORK (USUALLY WIRELESS) WITH A NEW TECHNOLOGY, BUT I IN A SMOOTH WAY, so that I can SPREAD THE INVESTMENT DURING SEVERAL YEARS, RUNNING BOTH NETWORKS SIMULTANEOUSLY, KEEPING THE 100% COVERAGE AND SERVICE QUALITY.
10. As a CT, I want to RUN AS MANY IOT SERVICES (FROM DIFFERENT PROVIDERS) AS POSSIBLE (TELEMETRIC, PDS, VMT, AI, PREDICTIVE MAINTENANCE, KPIS) IN JUST ONE UNIQUE HARDWARE AND MANAGEMENT SYSTEM so that I can control the security.

Crane manufacturer (CM)

1. As a CM, I want to IMPROVE UX OF REMOTE OPERATION, so that I can IMPROVE REMOTE CRANE DRIVERS' PERFORMANCE
2. As a CM, I want to SUPPORT WIRELESS CONNECTIVITY, so that I can REDUCE CAPEX FOR REMOTE INSTALLATION

Freight forwarder (FF)

1. As an FF, I want to HAVE REAL-TIME INFO OF THE PORT TERMINAL, so that I can LIMIT DRIVERS' INEFFICIENCIES
2. As an FF, I want to REDUCE PAPERWORK, so that I can HELP MY DRIVERS' DAILY ROUTINES
3. As an FF, I want to HAVE ACCESS TO TERMINAL CARTOGRAPHY GUIDANCE, so that I can HELP MY DRIVERS NOT BEING LOST

Truck driver (TD)

1. As a TD, I want to HAVE REAL-TIME INFO OF THE PORT TERMINAL, so that I can REDUCE MY STRESS knowing where and when my cargo is going to be loaded discharge. I can use the time expected time in other duties or just relax.
2. As a TD, I want to BE ABLE TO COMMUNICATE WITH THE TERMINAL, ESPECIALLY WITH THE CHE DRIVER IF SOMETHING GOES WRONG.
3. As a TD, I want to BE ABLE TO ABORT THE LOADING-DISCHARGING OPERATION IN CASE OF EMERGENCY.
4. As a TD, I want to REDUCE PAPERWORK, so that I can DO EVERYTHING WITH MY CELL PHONE.

5. As a TD, I want to HAVE ACCESS TO TERMINAL CARTOGRAPHY GUIDANCE, so that I can SAVE TIME AND STRESS FINDING THE RIGHT LOADING-DISCHARGING SLOT.
6. As a TD, I want to HAVE A SIMPLE APP TO DO MY APPOINT IN ADVANCE AND USE THE SAME APP FOR CHECK-IN-CHECKOUT, EMERGENCY CALL, REGISTER MY KPIS AND PRESENT A CLAIM.

5.1.4. ASSIST-IoT value proposition definition

The ASSIST-IoT port automation pilot aims at addressing the most of the underserved customer needs identified above. To do so, the ASSIST-IoT value proposition will:

1. Reduce uncertainties for external truck drivers when they enter into a container terminal.
2. Digitalize the delivery of assigned working instructions to internal and external terminal operators (i.e., remove the use of paperwork at the entrance gates to the terminal).
3. Boost active collaboration among stakeholders which is the basis of the digital transformation for achieving automation
4. Reduce human intervention in order to accept working instructions from the terminal staff
5. One source of truth so that the different stakeholders involved in the whole supply chain will share operational data in real time with no risk in terms of security and privacy
6. An out-of-the-box platform that will help with the integration of Next Generation IoT vendor-agnostic devices and services.
7. Provide secure and reliable mechanisms for not exposing container terminal valuable information outside the agreed terms with their external customers.
8. Reduce capital and operational expenditure of deploying remote services over cranes.
9. Enhance the user experiences with remote cranes' maneuverability

5.1.5. MVP feature set and low fidelity prototype

Based on the aforementioned value propositions for Pilot 1, three main Innovation Elements have been devised, leading to the following three MVP feature sets:

1. Truck GUI mobile app
2. UWB geofencing
3. eROS

Table 10. Pilot 1 – Truck GUI MVP feature set

Truck GUI	
Type of feature	**Description**
Must Have	
Real-time access	The MVP must be able to collect, retrieve, and expose in real-time the location of all the cranes and trucks involved in the cargo operations of a terminal environment by means of the Edge Data Broker Enabler
Mobile compatibility	The MVP must be provided over both desktop-based web apps (by making use of Tactile Dashboard) as well as native mobile-app (being compatible with mobile operating systems like iOS and Android)
Access rights management	The MVP must be able to support several user roles, which will be able to obtain more privileged information depending on their access rights, by means of the IDM and Authorization enablers

Nice to Have	
Operational statistics	The MVP may include operational KPIs of each logged user, based on historical data collected in the LTSE, such as number of movement/days, elapsed time on last work instruction, average elapsed time per work instruction, etc.
Alarm buttons	The MVP may include access to alert buttons when an unexpected or wrong location is identified during the reaching phase
Delighters	
Guiding navigations	The MVP will provide recommended guiding routes with the aim of avoiding traffic jams
GIS reference information	The MVP will integrate GIS mechanisms in order to allow CT operators to easily modify their yard schemas, if some yard replanning or refactoring occurred in the terminal.

Table 11. Pilot 1 – UWB Geofencing MVP feature set

UWB Geofencing	
Type of feature	**Description**
Must Have	
Secure M2M communication	The MVP must provide a secure and very accurate Machine-to-Machine communication by means of the Edge Data Broker Enabler embedded in the cranes, which will communicate with the services installed over the smartphones/tablets of the invicinity trucks
Short-range coverage	The MVP must provide a short-range coverage by means of UWB technology in order to guarantee that the exposed information from the CT to TD is not subject of hacking attacks
Mobile compatibility	The MVP must be integrated with the native mobile app Truck GUI (i.e., being compatible with mobile operating systems like iOS and Android)
Nice to Have	
Alignment recommendations	The MVP should connect with the LIDAR and PLC systems installed on a crane allowing the integration of alignment recommendations
Delighters	
Operational statistics	The MVP collects historical data in the LTSE, with the aim of showing to CT operators, the operational KPIs of each truck-crane interaction, such as number of crane/truck interactions in the operating day, elapsed time for aligning

Table 12. Pilot 1 – eROS MVP feature set

eROS	
Type of feature	**Description**

Must Have	
Wireless functionalities	The MVP must provide a reliable wireless service over the current Remote Operation System that fulfils the required bandwidth, and latency demands.
Multi-link	The MVP must provide at least one primary connection, and in case of failing, a secondary access networks, such as FluidMesh, 4G, and WiFi
Nice to Have	
Human-to-Machine Interface	The MVP may include operational KPIs of each logged user, based on historical data collected in the LTSE, such as number of movement/days, elapsed time on last work instruction, average elapsed time per work instruction, etc.
Delighters	
Visuals guidelines	The MVP eases the operational routine of remote crane drivers by highlighting by means of computer vision functionalities the container over which he/she has to work with.

5.2. Pilot 2: Smart safety of workers

5.2.1. Motivation

A primary concern for general contractors is the safety of workers on construction sites, where the construction sector experiences some of the highest injury and fatality rates in Europe. Recording accurate and timely data, that lead to faster and more effective responses, while minimizing the potential impact on work, will result in an overall safer work environment. The goal is to utilize the tools provided by ASSIST-IoT in order to create a safer construction site.

5.2.2. Target customers identification

Table 13. Target customer identification – per pilot – Smart Safety of Workers

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
General contractor (GC)	The party responsible for delivering a completed building or other built structure. The company is directly responsible for safety on the construction site.	Maintaining a safe working environment that minimizes the potential for lost productivity resulting from a potential injury or fatality.	The ever-changing nature and scope of construction sites produces many unknown variables in terms of worker health and safety. It may be difficult for OSH managers to monitor individual workers at all places and times. The workers themselves might not be aware of possible dangers to themselves or others.
Companies providing OSH services (CS)	Companies that provide consultancy services for construction sites, they provide general contractors with advice, find potential hazards, and perform inspections.	Find potential safety hazards and find potential systematic or technological solutions for safety issues that arise on a construction site.	Companies providing OSH services must maximize safety without hampering construction progress in order to meet the needs of both the worker and general contractors. These companies cannot impose unproven technologies on construction sites.
Technology providers (TP)	Technology providers are the developers and manufacturers of equipment and technologies.	The goal of technology providers is to find markets that have the potential for innovative solutions to be implemented.	Technology providers must be able to design a product that minimizes interference with construction works. In order to convince general contractors to implement innovative solutions, the technology providers must prove reliability as well as ensure contractors that the solution

			can be easily implemented without hindering work on the site.

5.2.3. Underserved customer needs identification

General contractor (GC)

1. As a GC, I want to ELIMINATE fatal accidents, in order to create a safe working environment and reduce the risk of delaying construction works.
2. As a GC, I want to REDUCE the number of hazardous situations, so that I can IMPROVE SAFETY at the construction site and reduce the possibility of causing temporary worker shortages
3. As a GC, I want to GUARANTEE access control of the construction site, so that I can PREVENT unauthorized persons from entering the construction site.
4. As a GC, I want to PROVIDE an innovative Health and Safety platform, so that I can have more CONTROL of safety at the construction site.
5. As a GC, I want to IMPROVE SAFETY on my construction site and on future sites by COLLECTING DATA on safety incidents and learning from them.

Companies providing OSH services (CS)

1. As a CS, I want to INCREASE competitiveness, so that I can OFFER an innovative service on construction sites.
2. As a CS, I want to INCREASE the efficiency of the OSH inspector by OFFERING a platform to support them in daily tasks.

Technology providers (TP)

1. As a TP, I want to INCREASE sales and the competitiveness of my equipment, by INTEGRATING with the ASSIST-IoT platform.

5.2.4. ASSIST-IoT value proposition definition

The ASSIST-IoT Pilot 2 aims at addressing the most of the underserved customer needs identified above. To do so, the ASSIST-IoT value proposition will:

1. Actively monitor the physiological parameters of each construction worker and detect abnormalities that are potentially threatening to their health and safety.
2. Securely process and send data in a decentralized fashion.
3. Track construction worker's location and motion patterns, preventing their access to unauthorized areas as well as to the construction site as a whole.
4. Assist the OSH manager by alerting them to incidents and life-threatening events.
5. Protect construction workers in the vicinity of operating Construction Equipment
6. Verify that construction workers have permission to enter based on medical tests and safety trainings.
7. Detect falls or immobility based on location and acceleration measurements.
8. Notify OSH manager when a construction worker is suspended by their fall arrest equipment, or first aid is needed due to a fall onto the ground or immobility (loss of consciousness)
9. Manage and distribute updated information about safe walking routes within the construction site
10. Provide the OSH inspector with up-to-date information about workers, construction site activities, and site risks and hazards.

5.2.5. MVP feature set and low fidelity prototype

Based on the aforementioned value propositions for Pilot 3A, three main Innovation Elements have been devised, leading to the following three MVP feature sets:

1. Occupational safety and health monitoring
2. Fall-related incident identification
3. Health and safety inspection support

Table 14. Pilot 2 Occupational safety and health monitoring

Occupational safety and health monitoring	
Type of feature	**Description**
Must Have	
Personal location tracking	The MVP must be able to track the location of workers on the construction site within an accuracy of 1 m. The Building Information Model will be used to infer which floor a worker is located on using elevation information.
Monitoring the weather conditions at the construction site	The MVP will monitor weather conditions at the construction site such as temperature, wind velocity, humidity, UV radiation, and precipitation.
Geofencing	The MVP will use the tracking feature to monitor the location of workers and constantly assess whether or not they are authorised to be at that location, which depends on their training and role. They are also notified if they are within a hazardous area. Authorisation and hazards are indicated on the Building Information Model.
Smart wristband for construction workers	The MVP must include smart wristbands for workers that will be used to track the worker's location and physical state as well as to be used for identification purposes.
Wireless coverage	The MVP must be able to cover all construction site areas both indoors and outdoors, ensuring the connectivity among the devices via central getaways without affecting by signal obstacles
Temporary storage	The MVP must include local temporary storage where critical information is stored, given the chance of a network disruption It shall be integrated in the worker's processing unit.
Personal cooling systems	The MVP will include an active cooling feature that each worker will be equipped with individually in response to their needs and preferences.
Alerts and notification MR visualization	Alerts and notifications are used to notify the OSH inspector for incidents such as hazardous physiological and environmental parameters, unauthorized access, or when a worker is approaching of dangerous zones. The alerts and notification will be transmitted to the MR device through the edge data broker or other systems.
Nice to Have	
Device number minimisation	The MVP should minimize the number of separate sensors and integrate them as much as possible.
Device Reliability and Durability	The MVP should be reliable and durable, suitable for the demands of a construction site and the outdoor environment.
Alerts and notifications minimization	The MVP should make sure that alerts and notifications are not unnecessarily intrusive and that they correspond to the risk level. The alert level of the notification received by the construction worker will be communicated to the OSH manager and the information will be recorded.
Delighters	

Continuous authentication for wristband	The MVP could ensure that wearables are used by the person they were assigned to. Authentication could be continuous and achieved via biometrics or through a third party, e.g., the OSH manager.
Assessment of Personal Exposure to UV Radiation	The MVP could estimate the exposure of each worker to UV radiation based on data about ambient UV radiation and their location and clothing.
Monitoring distance to operating construction plant	The MVP could track both the state and location of operating construction plants and alert workers and OSH managers if the workers approach the construction plants.

Table 15. Pilot 2 Fall-related incident identification

Fall-related incident identification	
Type of feature	**Description**
Must Have	
Fall and immobility detection	The MVP will be able to identify fall-related events by detecting the fall arrests by the protective equipment, slips/trips, as well as the immobility.
Wireless coverage	The MVP must be able to cover all construction site areas both indoors and outdoors, especially for employees working at heights, ensuring the connectivity among the devices via central getaways without affecting by signal obstacles
Alerts and notification MR visualization	Alerts and notifications are used to notify the OSH inspector for incidents such as a falling or other accident detection. The alerts and notification will be transmitted to the MR device through the edge data broker or other systems.
Nice to Have	
Device Reliability and Durability	The MVP should be reliable and durable, suitable for the demands of a construction site and the outdoor environment.
Alerts and notifications minimization	The MVP should make sure that alerts and notifications are not unnecessarily intrusive and that they correspond to the risk level. The alert level of the notification received by the construction worker will be communicated to the OSH manager and the information will be recorded.
Delighters	

Table 16. Pilot 2 Health and safety inspection support

Health and safety inspection support	
Type of feature	**Description**
Must Have	
BIM data models and interoperability compliance	The MVP will be able to produce and consume BIM data in standard interoperable formats.
Wireless coverage	The MVP must be able to cover all construction site areas both indoors and outdoors, ensuring the connectivity among the devices via central getaways without affecting by signal obstacles

OSH Reporting	The MVP will provide OSH inspectors with data relating to worker safety and potential OSH violations that will aide in generating reports that include photos and other relevant information that will be saved to the LTSE.
Nice to Have	
Device Reliability and Durability	The MVP should be reliable and durable, suitable for the demands of a construction site and the outdoor environment.
Delighters	
Evacuation instructions	The MVP will enable the safe evacuation of the construction workers in case of emergency by providing safe evacuation routes that can be displayed over a BIM model.

5.3. Pilot 3A: Vehicle in-service emission diagnostics

5.3.1. Motivation

The main task to solve from vehicle OEM perspective is to address challenging emission regulations in a rapidly evolving legal landscape on the one hand and at the same time serve rightfully high customer expectations on the other hand. While these goals are partially in sync also from OEM perspective, like meeting emission regulations throughout vehicle life, which is something all beforementioned parties expect, other goals are hardly matching, like high precision emission measurement capabilities without adding additional cost to the vehicle, which the customer would have to pay. The same applies to the discrepancy of running enhanced diagnostic methods to identify vehicle defects in an early stage to minimize vehicle downtime, while valuing driver privacy aspects at the same time. Within Pilot 3A we are aiming to solve these challenging discrepancies with the help of ASSIST-IoT.

5.3.2. Target customers identification

Table 17. Target customer identification – per pilot – Vehicle in-service emission diagnostics

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
Vehicle OEM	Usually a private enterprise, whose core business is to develop, sell and maintain passenger and/or commercial vehicles. In Pilot 3A especially vehicles with internal combustion engines (ICE) are addressed.	• Monitoring vehicle emissions on fleet level and ensuring the vehicle fleet is meeting all emission related legal requirements and thus increasing vehicle owner trust. • Getting a detailed understanding of potential issues seen in the field. • Addressing potential issues in an early stage and thus creating vehicle owner satisfaction. • Reducing vehicle down time to a minimum.	Currently a cost-efficient yet precise way to measure emissions on fleet level over vehicle lifetime is not available. Also, a statistical evaluation of fleet level emissions is not possible, due to missing evaluation capabilities, which at the same time protect private data of the driver. Vehicle diagnostic capabilities are limited, detailed measurements of potential issues for later analysis are not foreseen. Therefore, an on-the-edge / Cloud-solution is envisioned.
Vehicle owner / driver	Either a private person or a company, owning or leasing one of the OEMs passenger cars or commercial vehicles.	• Having trust in the capabilities of their vehicles, that it is meeting emission regulation thresholds over vehicle lifetime. • Getting informed early if a vehicle sees a potential defect. • Reducing vehicle downtime to a minimum. • Improving communication with the mechanic in the garage. • Protection of their private data according to GDPR.	In addition to Target Customer #1: Currently there is no solution to allow logging the driving situation triggered by the driver in case an unforeseen event is noticed in the vehicle. Communication with the mechanic is therefore sometimes difficult.

5.3.3. Underserved customer needs identification

Vehicle OEM

1. As an OEM, I want ACCESS TO VEHICLE DATA, WHILE RESPECTING GDPR.
2. As an OEM, I want to MONITOR THE EMISSION LEVEL OF MY VEHICLE FLEET DURING OPERATION, AND NOT JUST BY TESTING SINGLE VEHICLES.
3. As an OEM, I want to ENSURE MY IN-VEHICLE NOX SENSOR MEASUREMENTS ARE ACCURATE THROUGHOUT VEHICLE LIFE, WITHOUT ADDING COSTLY NEW SENSOR SOLUTIONS.
4. As an OEM, I want to HAVE THE TOOLS TO ENSURE EMISSION LEVELS ARE ALWAYS BELOW LEGAL THRESHOLDS, BY MODIFYING THE PCM CALIBRATION.
5. As an OEM, I want to MEASURE EMISSION LEVELS AS PRECISE AS POSSIBLE, so that I DO NOT HAVE TO CONSIDER PROPHYLACTICAL COSTLY HARDWARE AND SOFTWARE SOLUTIONS.
6. As an OEM, I want to HAVE A CERTAIN FLEXIBILITY TO ADJUST CALIBRATION so that I can ADJUST TO POTENTIALLY STRICTER EMISSION REGULATIONS IN THE FUTURE.
7. As an OEM, I WANT TO MONITOR IF THE PREVIOUS ADJUSTMENTS WERE SUCCESSFUL
8. As an OEM, I want to IDENTIFY SINGLE VEHICLES, WHICH ARE OUTLIERS AND NEED TO BE REPAIRED IN THE GARAGE.
9. As an OEM, I want to NOTIFY THE DRIVER OF OUTLIER VEHICLES TO TRIGGER A REPAIR ACTION.
10. As an OEM, I want A DETAILED UNDERSTANDING OF FAILURES IN MY VEHICLES, so that I can REDUCE THE DOWNTIME OF VEHICLES TO A MINIMUM.
11. As an OEM, I want to LOG DETAILED VEHICLE DATA IN A FLEXIBLE WAY, e.g., by adding / removing data channels so that THE UNDERLYING ISSUE CAN BE ANALYZED.
12. As an OEM, I want TRUST AND A GOOD REPUTATION FROM PUBLIC, LEGISLATIVE AND VEHICLE OWNER SIDE.

Vehicle Owner / Driver (VO)

1. As a VO, I want to TRUST THE EMISSION LEVELS ADVERTISED BY THE VEHICLE OEM.
2. As a VO, I want MY VEHICLE DOWNTIME REDUCED TO A MINIMUM, ideally close to zero.
3. As a VO, I want POTENTIAL FAULTS TO BE DETECTED AS EARLY AS POSSIBLE, so that I POTENTIAL COSTLY REPAIRS CAN BE AVOIDED.
4. As a VO, I want SMOOTH REPAIRS, e.g., by already ordered and available spare parts when I come to the garage.
5. As a VO, I want to EASILY COMMUNICATE WITH THE MECHANIC IN THE GARAGE, sit that I can TRIGGER A MEASUREMENT IF I DETECT FAILURES DURING VEHICLE OPERATION, WHICH I CAN LATER SHARE WITH THE MECHANIC.
6. As a VO, I want A RELIABLE AND EMISSION PERFORMANCE THAT MEETS LEGAL THRESHOLDS, WITHOUT PAYING COSTLY HARDWARE OR SOFTWARE SOLUTIONS.

5.3.4. ASSIST-IoT value proposition definition

Pilot 3A aims at addressing the most underserved customer needs identified above. To do so, the ASSIST-IoT value proposition will be:

1. Give access to vehicle data while respecting GDPR
2. Precisely monitor emissions on vehicle fleet level during operation

3. Ensure accuracy of in-vehicle NOx sensor measurements throughout vehicle life
4. Develop tools to ensure emission levels are always below legal thresholds or react to future changes in emission regulations
5. Allow identification of emission outlier vehicles and trigger repair actions if needed
6. Provide a detailed understanding of previously unknown failures
7. Logging of detailed data on demand by utilizing enhanced diagnostic methods on the edge

5.3.5. MVP feature set and low fidelity prototype

Based on the aforementioned value propositions for Pilot 3A, three main Innovation Elements have been devised, leading to the following three MVP feature sets:

4. Fleet in-service emission verification
5. Addressing emission outlier vehicles outside of the desired emission distribution
6. Deploying enhanced diagnostic methods out of a method pool to the edge

Table 18. Pilot 3A – Fleet in-service emission verification

Fleet in-service emission verification	
Type of feature	**Description**
Must Have	
Precise emission measurements throughout vehicle life	The MVP must be able to measure emissions precise enough to meet legal requirements throughout vehicle life. Therefore, so called HiFi sensors are added to a statistically relevant number of vehicles. These additional sensors are frequently maintained within standard service intervals to allow this functionality over vehicle lifetime.
Compression of relevant raw data	The MVP must be able to filter and compress the large quantity of raw data being generated in the vehicle, to allow cost efficient close to real-time communication with the cloud.
Edge-Cloud communication to allow calculation of fleet emission distribution	The MVP must be able to allow communication between vehicle edge nodes and the cloud, so an overview about the fleet emission distribution can be calculated.
No costly hardware development	The MVP must allow precise emission measurements with existing standard sensors, i.e., without the development of costly new hardware.
Nice to Have	
Graphical UI	The MVP may include a graphical UI to allow an easier evaluation of the fleet emission distribution in less time.
Delighters	
Automatic evaluation and reports	The MVP will provide the option to generate frequent automatic status evaluations and reports.

Table 19: Addressing emission outlier vehicles outside of the desired emission distribution

Addressing emission outlier vehicles outside of the desired emission distribution

Type of feature	Description
Must Have	
Ability to upload updated PCM calibrations	The MVP must be able to upload an updated PCM calibration to vehicle edge nodes, to ensure emission regulations are met throughout the vehicle life, for example if NOx sensors are seeing increased sensor drift, which would compromise internal combustion engine control strategies.
Safe and secure upload	The MVP must ensure, that uploads are only allowed from trustworthy sources. In parallel software uploads have to be signed and calibration updates must match the underlying PCM software. Also, updates must be delayed until the vehicle is in a safe driving situation to always ensure driver safety.
Driver information	The MVP must allow sending messages to the driver, if PCM calibration updates are not addressing defects seen in a certain vehicle and the vehicle has to be fixed in the garage instead.
Nice to Have	
Selections of sub-fleets	The MVP should be able to allow the selection of fleets, sub-fleets and single vehicles, based on filter settings done by the OEM software engineer.
Edge-Cloud communication to verify update process	The MVP should be able to monitor the effectiveness of the updated calibration, by monitoring the emission models of the previously selected sub-fleet.
Delighters	
Driver information about scheduled updates and remaining time to finish operation	The MVP should provide a UI to inform the driver about any scheduled updates, potentially also offering the option to delay an update to increase driver convenience. Also, the UI should inform the driver about the remaining time, which is needed to complete the update, once it has been started

Table 20: Deploying enhanced diagnostic methods out of a method pool to the edge

Deploying enhanced diagnostic methods out of a method pool to the edge	
Type of feature	**Description**
Must Have	
Methods pool	The MVP must have the capability for a growing database for enhanced diagnostic methods. These methods will be developed over time and can be deployed on demand if a vehicle shows a potential defect, e.g., by increased emission values.
Ability to identify defect vehicles while respecting GDPR	In order to allow the upload of enhanced diagnostic methods to defect vehicles, these vehicles have to be identified first. It has to be ensured that identification can be achieved without interfering with any GDPR related requirements.
Upload of enhanced diagnostics methods to identified defect vehicles	After a defect vehicle was identified, the MVP needs to allow the upload of one or more appropriate enhanced diagnostic methods to the edge node.

Active Monitoring capabilities	The MVP must allow high frequency logging in the vicinity of a suspected defect module, to allow a detailed analysis of the failure situation, so the underlying root cause can be understood and fixed.
Nice to Have	
Active Monitoring triggered by driver	The MVP may provide the option for the driver to trigger the Active Monitoring feature via an in-vehicle menu within a short time after an unexpected event was noticed.
Delighters	
Utilise a large ring buffer to allow a delayed Active Monitoring, after an unexpected event was noticed in the vehicle	In order to simplify the activation of the Active Monitoring feature, a large ring buffer could be envisioned, so the activation by the driver can be triggered for events which happened a significant time ago (Though the driver would need to specify the exact time when the incident happened)

5.4. Pilot 3B: Vehicle exterior condition inspection and documentation

5.4.1. Target customers identification

Table 21. Target customer identification – per pilot – Vehicle exterior condition inspection and documentation

Target Customer	Who are they?	What is their main goal?	What is their main barrier to achieving this goal?
Customer service team member at a car garage / automotive branch (CST)	In the automotive branch several OEM brands but also privately owned SME-garages qualified teams are receiving the car owners as consumers and determine together with them the necessary technical repair or service actions for their vehicle and close the final contract as base for the services given at this time	• Document the vehicle´s actual status for later uses in a digital form • Determine the actual status of the vehicle´s exterior to potentially define with the customer small repairs to keep the vehicle safe or maintain its asset value • Protect his organisation from later, costly claims of the customer about new surface damages, allegedly conducted after the vehicle takeover from the garage-team • Minimize the time of vehicle physical inspection, foreseen by the typical take-over procedures of the garages • Do above tasks in the most effective way	Customer service team member at a car garage / automotive branch
Vehicle exterior inspector at fleet management services, transport branch and rent-a-car companies (VEI)	Persons with the responsibility to check the vehicles exterior conditions every time a vehicle leaves or returns to the fleet base station, to a specific transport location, or a rental station	• Document the vehicle´s actual status for later uses in a digital form • Determine in pace with the running every-day operations and at reasonable costs the actual vehicle exterior status • Claim in time and in a justifiable & fair manner asset devaluations (damages of various categories at the exterior surface)	High volume and dynamically changing traffic of incoming or upgoing vehicles make a use-case suitable documentation and inspection challenging due to the manual nature of processes so far. Low level of digitalisation processes in these markets due to the lack of adequate image acquisition and communication possibilities prohibits the building of inside- & intime-realisations for efficient, business justifiable so far. The proposal of a well-balanced, hybrid communication and decision-oriented architecture opens the door to restructure conventional processes with more dedicated information flow between the various levels and different stakeholders of the organisations

5.4.2. Underserved customer needs identification

Customer service team member (CST)

1. As a CST, I want to OPTIMISE MY INTERNAL PROCESSES BY DIGITALISING THE DOCUMENTATION OF THE EXTERNAL CONDITION OF VEHICLES, so that I can REVIEW THEIR STATUS VIA HIGH QUALITY PICTURES AND SAVE THE TIME NEEDED TO PHYSICALLY VISIT THE VEHICLES.
2. As a CST, I want to DOCUMENT THE ACTUAL VEHICLE CONDITION UPON THE TIME OF THEIR ARRIVAL IN MY GARAGE SHOP, so that I can PROTECT MY ORGANISATION AGAINST UNJUSTIFIED CUSTOMER CLAIMS FOR NEW VEHICLE DAMAGES DURING THEIR GARAGE STAY and avert costly goodwill settlements with the customers.
3. As a CST, I want to BE AUTOMATICALLY INFORMED ABOUT VEHICLE CONDITION UPON AT THEIR ARRIVAL, so that I can CREATE ADDITIONAL UPSELLING BUSINESS WITH THESE VEHICLES, like smart surface repairs, rim repairs, new tyres, etc.
4. As a CST, I want to BE SUPPORTED BY AN AUTOMATED INSPECTION ENGINE, proposing me its potential vehicle exterior damages, so I can ACT PROPERLY IN TIME.
5. As a CST, I want to BE SUPPORTED BY AN ERGONOMICALLY OPERATING USER INTERFACING SYSTEM (UI) so that I can EFFECTIVELY MANAGE THE ADMINISTRATION, VISUALISATION, AND RETRIEVAL OF THE VAST NUMBER OF IMAGES TAKEN BY THE SCANNED VEHICLES OVER THE TIME.
6. As a CST, I want access to VEHICLE DATA WON, WHILE RESPECTING THE GDPR RULES FOR MY CUSTOMERS.

Vehicle exterior inspector (VEI)

1. As a VEI in various market applications, I want to OPTIMISE MY INTERNAL PROCESSES BY DIGITALISING THE DOCUMENTATION PROCESS OF THE EXTERNAL CONDITION OF INCOMING VEHICLES, so that I can REVIEW THEIR STATUS VIA HIGH QUALITY PICTURES AND SAVE THE TIME NEEDED TO PHYSICALLY VISIT THE VEHICLES IN THE PARKING AREA and MANUALLY MAKE PICTURES AND NOTES as well as to DOCUMENT / ENTRY ALL THOSE CASES BY A MANUALLY BASED WAY IN MY BUSINESS INTELLIGENCE IT-WORLD.
2. As a VEI, I want to DOCUMENT THE NEWLY PRODUCED DAMAGES OF MY FLEET VEHICLES ON A DAILY OR WEEKLY BASE, so that I can REDUCE MY REPAIR COSTS OF MY FLEET BY OPTIMISING THE LOGISTIC AND REPAIR PLANS OF MY FLEET OPERATIONS and HAVE AN ACTUAL, COST-EFFECTIVE EVALUATION OF MY FLEET ASSETS.
3. As a VEI, I want to BE ABLE TO COMPARE THE STATUS OF MY FLEET VEHICLES IN DIFFERENT TIME MOMENTS, so that I can SUPPORT THE ANALYSIS FOR THE DAMAGE'S REASONS AND CIRCUMSTANCES as well as INCREASE THE QUALITY AND DECREASING THE COSTS OF MY SERVICES.
4. As a VEI in the role of a mobility manager at rent-a-car companies, I want to DETERMINE THE DIFFERENCE AUTOMATICALLY AND VERY FAST IN EXTERIOR CONDITIONS OF MY RENTED VEHICLES WHEN THEY ARE DROPPED OFF AND RETURNED, so that I can DETERMINE DAMAGE CLAIMS ACCORDING TO THE INSURANCE CONDITIONS AGREED.
5. As a VEI in the role of a mobility manager at rent-a-car companies, I want to BE ABLE TO PROVIDE TO MY INSPECTORS THE POSSIBILITY TO ERGONOMICALLY DOCUMENT VEHICLE DAMAGES BY SMART DEVICES WITH OPTIONAL CUSTOMER DIALOGUE, so that I can OPTIMIZE THE DIGITALISATION OF THE WHOLE PROCESSES
6. As a VEI, I want to ACCESS TO VEHICLE DATA WON, WHILE RESPECTING THE GDPR RULES FOR MY CUSTOMERS AND MY TEAM MEMBERS OF THE SERVICING COMPANY.

5.4.3. ASSIST-IoT value proposition definition

The ASSIST-IoT Vehicle exterior condition inspection and documentation pilot evaluates the architectural proposal of the project for most of the underserved customer needs above. To address it, the targeted value proposition will include:

1. Provision of a well-balanced architecture between edge and cloud individual functionalities implementation to investigate various scenarios of possible configurations adapted to various requirements of the different end-user applications using the scanner ecosystem.
2. Support to a cost-efficient acquisition, management, communication, storage, processing, and visualisation of the data of the scanned vehicles (images and their meta data) in a flexible and human-centred manner.
3. Development of advance visualisation techniques to ergonomically visualise the documented vehicles exterior condition on user-demand and in fast ways.
4. Development of novel automatic, AI-based inspection of the vehicle's exterior inspection, where the advantages and disadvantages between edge- and cloud-oriented approaches will be also studied. Suggestions for future implementations of the various realisation possibilities depending on the end-user application will be formulated. Federated learning AI-methodologies can be validated, whether they can provide sufficient recognition performance, whilst reducing communication volumes and providing additional data privacy by keeping the training vehicle data on the user edge of the network.
5. Access to the interesting vehicle images and their meta data while respecting GDPR rules

5.4.4. MVP feature set and low fidelity prototype

On the base of the above-described value propositions, two main Innovation Elements have been identified for the Pilot 3 B with the following MVP features:

1. Hybrid architecture: a well-balanced implementation framework with smart multigrid processing and multi-level communications among the system actors allowing a scalable system configuration per system realisation to provide the necessary acquisition, communication, storage, retrieval, and visualisation functionalities from the vehicle scan till to the end-users' information exploitation with adapted costs according to the use case.
2. Automated, AI-based surface inspection of the user-defined damage classes with sufficient performance for the various use cases, to provide the necessary added-value towards more productive digitalisation.

Table 22. Pilot 3 B - First MVP feature

Hybrid architecture	
Type of feature	**Description**
Must Have	
Fast & intelligent edge computing	The MVP architecture must allow the configuration of suitably strong computing capabilities on the edge to pre-process the high-resolution, coloured vehicle images to cope in real-time with the changing arrival sequences of the vehicles.
Compression of relevant raw data	The MVP must be able to filter and compress the large quantity of images being generated during the scan of the vehicle with the result to reduce the data volume to be transmitted to the outside world of the scanner.
Temporary, very fast edge storage	The MVP architecture must facilitate in the scanner computing system the configuration of smart, temporary edge storage for intelligent buffering of scanned images and scan meta data, prioritised communication capabilities and different interfaces to the local business intelligence IT-system as well as to the cloud.

Edge-Cloud communication to provide the scanned images to the outside world	The MVP must be able to allow communication with sufficient bandwidth and between the scanner computing system vehicle edge nodes and the cloud, so an overview about the fleet emission distribution can be calculated. Mobile networks like LTE or 5G but also cable-based solutions incl. fibre optics must be included in the existing options. The whole communication system must offer a cost-balanced proposal of needed data volumes and associated operational costs, as many SME-oriented garages are very cost-sensitive.
No costly hardware development	The MVP must prioritise the possibilities to use components-of-the-shelf to implement the overall architecture, providing a significant contribution to a cost-sensitive application.
Strong cloud server	The MVP architecture must include the possibility to also configure a strong cloud server, who stores the vast data volume of the scanned vehicles for a longer period of up to two years and who can support the interaction of several scanners installed in various locations and the corresponding end-users in an ergonomic and fast interactive way (User interface and fast data access with advanced visualisation)
Option for edge AI-computing	The MVP must provide the possibility to include either on the edge or on the cloud, scalable, cost-effective (edge), expandable (cloud), dedicated computing power to execute in time the AI-algorithms, in case that this option is required by scanner application case.
User Interface	The MVP must provide means for an efficient image retrieval, visualisation, and review for the users, demanding the review of the documented vehicles. It also must support the export of selectable sets of the acquired data (images and other meta data) at least in pdf- or jpeg-format (human-oriented reporting or computer-needed format for further processing)
System interface	The MVP must provide fast and flexible interfaces to
Nice to Have	
Additional intelligent storage	The MVP can provide enough local storage within the scanner-computing system to temporarily store and manage all edge-gathered information over an extended period supporting more sophisticated upload policies and on-spot visualisation possibilities for non-regular usage, like system installation & maintenance or dedicate scanner usage for specific vehicles additionally to the regular scanning customer processes
Minimal graphical UI on the edge	The MVP can include a minimal graphical UI running on the scanner itself to visualise scanned pictures, supporting a user edge-interaction needed for special purposes, like system installation & maintenance or dedicate scanner usage for vehicles outside the regular organisation processes.
Fraud-secured pictures documentation	Each picture of the scanned vehicles receives via the MVP a DLT-derived "stamp" to ensure the originality of the scanned picture
Delighters	
Automatic recognition of vehicle model	The MVP will offer the option to automatically recognize the specific model of the scanned vehicle
Manual image acquisition support	The MVP supports the acquisition of additional, manually taken vehicle images, taken after the vehicle scanning or as an alternative process. Smart visualisation techniques, like advanced overlaying or Augmented Reality can support the user.

Automated, AI-based surface inspection

Type of feature	Description
Must Have	
Efficient creation of ground truth annotations	The MVP must support the creation of the needed AI-training data in an efficient time with a minimized time frame. A dedicated annotation team for vehicle exterior inspection is needed to mark the usual surface damages in sufficient amount but also highlight individual patterns sparely occurring in specific vehicle characteristic in the automotive market and may irritate the basic ML algorithms.
AI-training	The MVP must provide appropriate the necessary process and resources for appropriate AI-training using recent AI-technologies with centralized training methodologies or Federated Learning approaches.
AI-engines	The MVP must provide appropriate AI-technologies to do the automated exterior inspection based on the scanned vehicle images. Typically, compact graphics cards are used to run the AI-algorithms at both edge- or cloud- or even hybrid computing
AI-annotation task support	The MVP architecture must include the possibility to also configure a strong cloud server, which allows to a remote annotation team to work on the scanned images, review them and manually mark the vehicle exterior defects found with very effective interactive techniques. These annotations are saved together with the associated images and form the very valuable asset of the database for the necessary AI-training for the automated surface inspection.
Nice to Have	
Automatic recognition of vehicle parts	The MVP can offer to automatically recognize the standard parts of a vehicle, like doors, booth, fenders, tyres, windscreen etc, thus supporting a faster user interaction or support automatic documentation with advanced functionality.
Delighters	
Automatic recognition of vehicle model	The MVP will offer the option to automatically recognize the specific model of the scanned vehicle
Smartphone GUI	The MVP visualises the found AI-proposals of a given vehicle in real time with AR-methodologies, when the user reviews the vehicle using its smartphone

6. Lean Business Model Canvas

The Business Model Canvas (BMC) is a useful tool used in the business sector to represent the most important aspects for the exploitation of a product [9]: market segment, customers, value proposition, channels, revenue streams, etc. In the case of ASSIST-IoT, a first exercise to define a BMC was done during the proposal stage, redounding in a single BMC (encompassing the ASSIST-IoT solution as a whole) that is being improved during the course of the project.

For this deliverable, an updated BMC has been elaborated. Drawing from the initial model, the worked performed in the task T9.4 (reported in previous sections) has served as input to enhance the BMC of ASSIST-IoT. In particular, the Lean spin-in methodology that is being carried out has shown itself a very good activity to complete the different boxes of the model.

In this version of the BMC (M18), only one model has been completed (encompassing, again, the whole solution). However, it is expected that for forthcoming deliveries (D9.7), every MVP will have its own BMC. Therefore, from ASSIST-IoT perspective, each MVP will be considered a "potential product" and the BMC analysis will be performed accordingly.

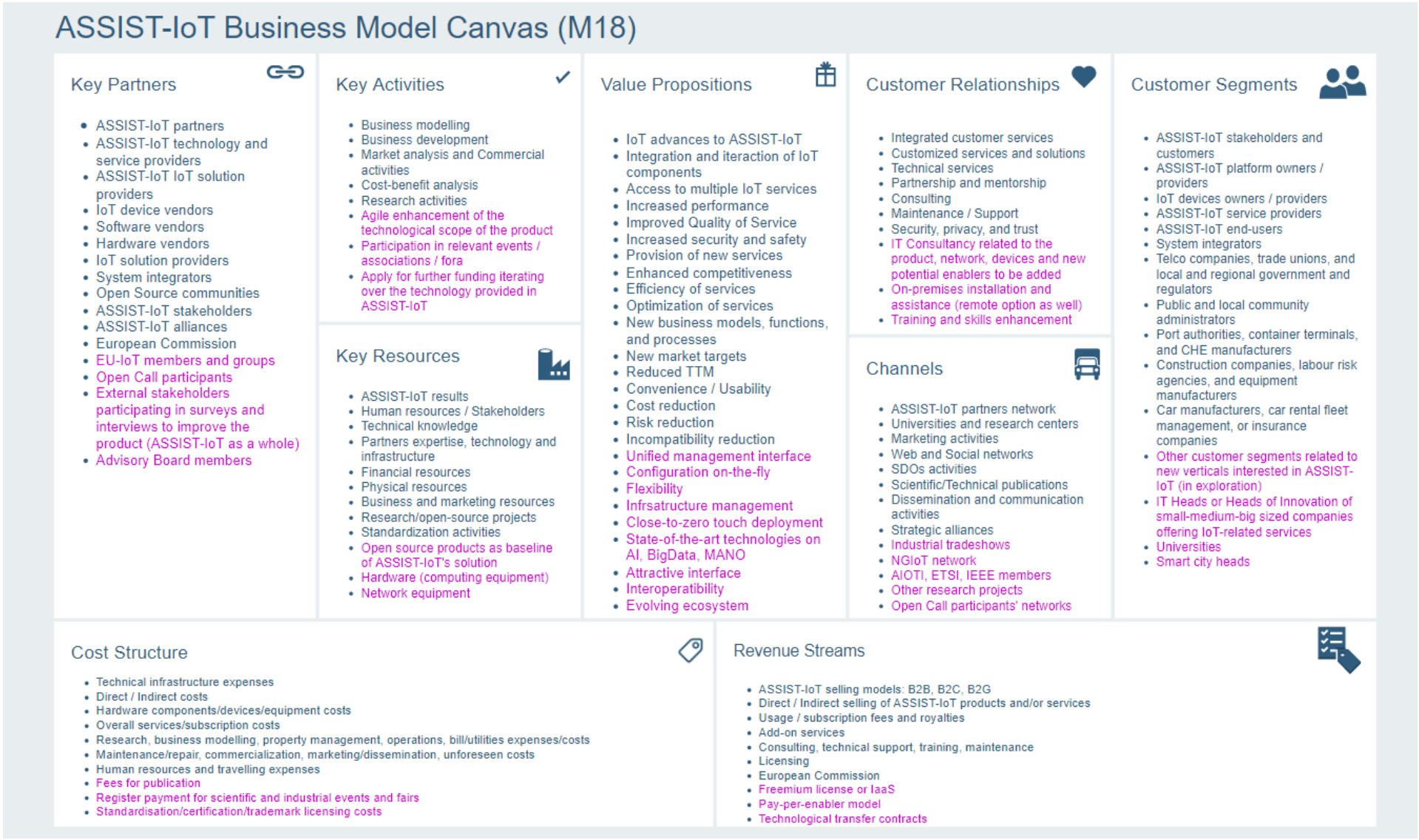

Figure 4. ASSIST-IoT Lean Business Model Canvas

7. IPR and Consortium Agreement surveillance

The main purpose of the Innovation Management activity is to track the innovations generated in the project, analysing, and formalizing their relationship with the Background and Foreground Intellectual Property (IP) elements brought and developed by the various partners.

This section provides a preliminary product definition based on the expected IPR results collected from the background IPR identified on the Consortium Agreement, from the WP4, WP5 and WP7 deliverables, and from the different discussion maintained within the Spin-in customer group meetings.

Two relevant clarifications should be highlighted:

- It should be noticed that in this deliverable, we are referring to technology-related IPR results, not marketing-related IPR results that do not contribute to product development but go-to-market strategy.
- It should also be noticed that it is not expected to extensively modify or change the source code of most of new ASSIST-IoT technology enablers. Instead, we are developing them with several underlying dependencies/inner modules, which will remain working according to their licenses. Therefore, the technological IPR results will be mostly private, but some of them are potentially public, planning for an Apache 2.0 Open-Source license[2].

7.1. Innovation management methodology

The starting assumption is that a given Foreground Intellectual Property element (FIP) is made by one or more "Innovation Elements" (in the form of ideas, concepts, design patterns, or pieces of hardware/software). Therefore, innovation elements (IEs) do not have, by themselves, the "legal" independence to be regarded as IP elements. They are just the fundamental bricks of a Foreground IP element.

In all IP management framework, Foreground IP elements might depend (or be based on) one or more Background IP elements (BIPs). Each Background IP elements is brought to the project by one single participant. Each Foreground IP element is then owned by one or more participants (1: N relationship). The focus is moved on the relationship between Background IP elements and Innovation Elements: an IE can depend on one or more BIPs, and one BIP can contribute to one or more IEs.

[2] In the specific case of generating FIWARE-based components, we would be obliged to produce it with AGPLv3.0.

7.2. Background IPR Results

Table 23. ASSIST-IoT Background IP elements

BIP id	BIP name	BIP element type	Ownership	Access conditions
BIP-01	Posidonia Terminal	SW Platform	PRO	On request
BIP-02	Blockchain as a Service	SW Platform	CERTH	On request
BIP-03	BIM models	Dataset	MOW	On request
BIP-04	GW board	HW	NEW	On request
BIP-05	SCENT data management	SW Platform	ICCS	On request
BIP-06	NextGen AR	SW Platform	ICCS	On request
BIP-07	(1) Auto-truck guiding (ATGUI), (2) Remote Control (ROS), (3) AV Router (AVROUT)	HW / SW Platform	KONE	On request
BIP-08	(1) In-service conformity strategies, (2) Production level engine control strategies	Know-how	FORD	On request
BIP-09	Security Operation Center (SOC) and Threat Intelligence (TI) platform	SW Platform	S21SEC	On request
BIP-10	Secure DevOps platform	SW Platform	S21SEC	On request
BIP-11	Vehicle scanner system	HW / SW platform	TWOT	On request
BIP-12	Live Objects platform for IoT	SW Platform	OPL	On request
BIP-13	Orange datasets	Dataset	OPL	On request
BIP-14	PUI9 framework	SW Platform	PRO	Open source
BIP-15	Personal Cooling System	HW / SW platform	CIOP	On request

The following subsections provide a brief description for each BIP listed in the table.

7.2.1. BIP-01: Posidonia Terminal

Posidonia Terminal 4.0 is a real-time big data system that offers the possibility of discovering, exploring and analysing data from equipment, devices and other systems deployed in a container terminal (such as the Terminal Operating System), enabling data comparison between multi-source data and exploratory analysis in different timespans (from seconds to months). Posidonia Terminal is a tool for:

- **Observe and measure the reality**: measuring what is happening in the terminal by connecting to the source of the data and not simply leveraging reported data.
- **Detect problems**: With the KPIs, costs and bottleneck algorithms, it can spot problems that can cause inefficiencies, wasted time or improvement needs in the terminal operations.
- **Support decision making:** Based on real data and simple and visual data analysis, it helps to prioritize and make decisions based on data.
- **Establish continuous improvement**: it comprises a complete framework for continuous improvement, and the foundation to connect systems and expand the unified vision of a terminal. It enables a continuous process of problems detection, fixes, and results validation.

All these aspects are supported by some platform features, such as (i) Data collection (data is acquired from multiple heterogeneous sources in an automatic fashion, including edge data gathering from PLCs), (ii) Edge computing (several business rules, KPI calculation, 'data cleaning' are performed in the edge), (iii) Data fusion (the heterogeneous data is combined in real time as the data is generated in the different systems), (iv) Data visualization (data is represented in charts, tables, etc. but also providing analytical tools).

7.2.2. BIP-02: Blockchain as a Service

Blockchain as a Service contains a properly configured network containing the peers who store the ledger and validate transactions before their submission to the network, the ordering service that decides on the order of transactions and include the transactions into newly created blocks, and the Certificate Authorities that verify the identities of the network participants before they can submit transactions to the network. This whole infrastructure can be used to build services offered to clients. These services are encoded as business logic within the chain code that is deployed to the Blockchain network and are available to eligible clients.

7.2.3. BIP-03: BIM models

BIM (Building Information Modelling) models used in ASSIST-IoT project are not only a geometric representation of a demonstration building but are parameterized models which present the detailed execution design. In addition, models with danger zones will be created. Although the models are created by MOW, the Investor is the owner of the project. Therefore, the use of the models and the image of the demonstration building must be made with the agreement of MOW. The use of models outside the ASSIST-IoT project is prohibited.

7.2.4. BIP-04: GW board

Recognizing the need for an integrated approach, Neways Electronics International participated in the European Inter-IoT project, which ran from 2016 to 2019. Continuously expanding its IoT capabilities, Neways has developed its IoT gateway to serve both as a technology showcase and as a prototyping platform with which it can quickly react to customer wishes. The gateway implements the most common wired and wireless interfaces. These are combined with an on-board processing unit and expansion possibilities. These are the Hardware specifications: ARM Cortex M4 Controller, 4G LTE Cat. 1, Cat. M1, Cat. NB, WiFi, Bluetooth, LoRa, RF ISM 868MHz, RS232, Micro-SD Card, Multi peripheral extension.

The gateway stack is protocol agnostic. At one end, it has a strict interface that the IoT devices need to implement and at the other, it has an interface to implement for connection to the middleware running in the cloud. It supports the following software frameworks. For Device interfaces: SWAP, and LoRa; for Middleware interfaces: REST, and MWNW; for Maintenance interface: RPC.

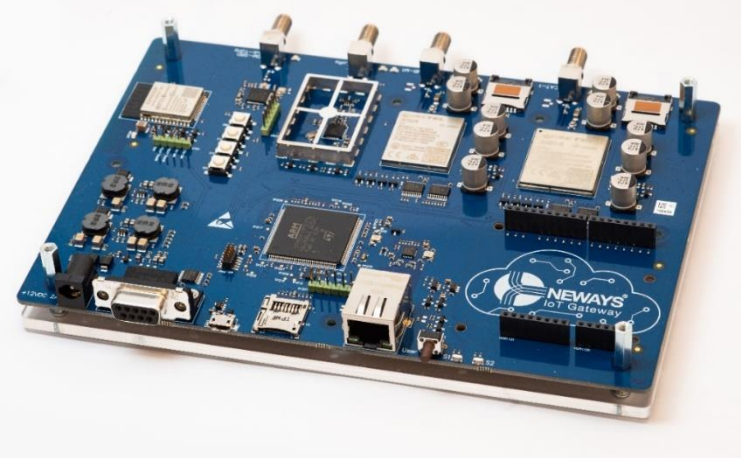

Figure 5. INTER-IoT Gateway by Neways

The SCENT Authoring Tool, is a web-based application, targeted to policy makers and flood managers or civil protection units. Through this, the relevant authorities are able to create campaigns targeted on specific areas where images and sensor measurements are requested while defining the scope of the campaigns (e.g. measuring parameters of the river, taking photos of urban obstacles etc). Moreover, the platform has the capacity to store, retrieve and visualize citizen generated content (images), raw measurements and processed data, such as flood hazard maps, according to the O&M OGC standard.

7.2.5. BIP-06: NextGen AR

The NextGen AR is a two-part solution consisting of two core components to support both the addition and editing of the content and its visualization and demonstration. The AR Content Management Service (AR-CMS) is a web-based application that allows the administrators to create campaigns and add content to the platform, and the AR mobile application (CirculAR) is designed to provide the generated experiences to the end users. The AR-CMS consists of two distinct parts; the back end which stores the resources in the database and provides the APIs, and the front-end which retrieves resources through the APIs so as to display the interface in the browser. The AR-CMS provides a user-friendly web interface, with a series of functionalities supporting the insertion of data to be displayed in the mobile AR app. CirculAR is developed in the Unity game engine using ARCore and Mapbox and supports both marker and location-based applications to overlay the digital data.

7.2.6. BIP-07: Auto-truck guiding (ATGUI), Remote Control (ROS), AV Router (AVROUT)

ATGUI: Konecranes Auto-Truck Guiding system is aimed to help the truck driver to stop the trailer in the correct position so that the RTG can pick up or place down a container with minimum gantry movements. The system is implemented with a laser scanner mounted between the crane legs on the truck lane side. Laser scanner measures the profile of the truck underneath, detects whether it is loaded, partly loaded or empty. TOS provides information about which position in the truck is to be handled. Auto-Truck Guiding system then signals the truck driver to park the truck in desired location using indicator lights.

ROS: Konecranes Remote RTG is a concept where the crane operators are moved from the crane cabins to an office environment and the container handling is performed fully remotely. Remote RTG provides increased work safety and makes the work environment more ergonomic and comfortable. It also increases the overall productivity because in this operating model the crane and the operator are decoupled which makes it possible to decrease the idling time of the operators. The operator is not anymore bound to a single crane, but instead can freely connect to any RTG in the yard depending on the existing situation and truck traffic. The operators have the same crane controls at the Remote Operating Stations (ROS) as they would have in the crane cabin. Instead of looking out of the cabin window, the operators get the required visibility through video views that are optimized especially for manual RTG use case.

AVROUT: The Audio-Visual System (A/V system) oversees audio and video streaming across the entire system. It streams low latency audio and video from the Remote RTGs to the ROSs and displays data from the crane to the remote operator through a graphical user interface.

7.2.7. BIP-08: In-service conformity and production level engine strategies

In the vehicle emission regulation landscape, the In-Service Conformity (ISC) mechanism is set to test a sample of vehicles in operation, to ensure vehicle emission compliance with according to regulations even after the vehicle production has started. A negative outcome of the ISC testing procedure forces corrective actions from the OEM in order to restore initial fleet emission levels, with negative cost impact on OEM side. In modern vehicles, emission In-Service Conformity efforts and production level Internal Combustion Engine (ICE) control strategies go hand in hand – or in other words: Meeting emission regulations on national and EU level isn't possible without sophisticated ICE control strategies, which need to find a well-balanced compromise between high engine performance on the one hand, and long-term low vehicle emissions on the other hand.

7.2.8. BIP-09: Security Operation Centre (SOC) and Threat Intelligence (TI) platform

S21Sec provides SOC services compiling manually by soc operators information from several sources depending. Information gathering relies on different tools such as SIEM and SOAR tools interconnected to deliver security incident detection and incident response services. Additionally advanced services on S21Sec also provides Threat Intelligence services compiling manually by security analysts information from several sources.

7.2.9. BIP-10: Secure DevOps platform

S21Sec deploy and operate software for managed security services operated by the SOC using a DevSecOps approach. DevOps and DevSecOps methodologies rely on DevOps principles and DevOps practices as long as a set of software tools like distributed version control tools, CI tools, CD tools, Configuration Automation tools, Container orchestration tools to produce software used in SOC services.

7.2.10. BIP-11: Vehicle scanner system

The current TwoTronic server covers the actual market needs with a robust, over years - evolved and modular system architecture. The same basic elements allow the realisation of scanners with various vehicle sizes (from passenger cars to whole lorries) and support a unified indoor or outdoor version. The system includes the patented rotating pilar-based acquisition system with its high-resolution colour industrial cameras, the corresponding LED-based illumination system with its adaptive illumination offering constant image acquisition conditions, several smart electromechanical implementations resulting into very cost-effective but efficient implementation proposals as well as an embedded real-time control unit coordinating the whole scanning process and the delivery of the won data (images + scan meta data) to the outside IT-world.

7.2.11. BIP-12: Live Objects platform for IoT

Live Objects (https://liveobjects.orange-business.com) is IoT platform offered by Orange telecommunication service provider as software as a service (SaaS). Platform provides a set of tools dedicated for Machine to Machine (M2M) and Internet of Things (IoT). Main features provided by Live Object are:

- Advanced management of connected devices (provisioning, supervision, configuration, firmware update, campaign...)
- Application programming interfaces (API) to connect devices and business applications, and manage all Live Objects features
- Messages routing
- Data management (event/state processing, data search, data message enrichment)

- Data storage

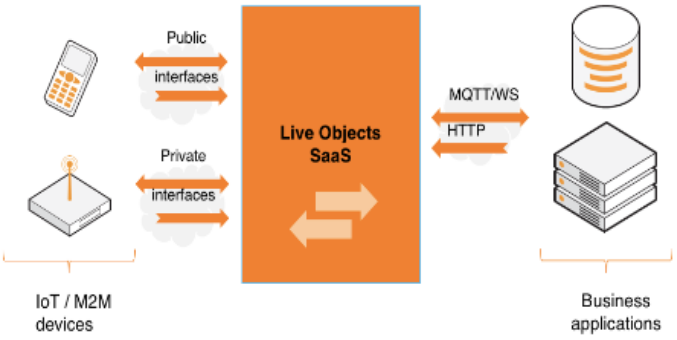

Figure 6. Live Objects IoT platform concept

The SaaS allows multiple tenants on the same instance without possible interactions across tenant accounts (i.e. isolation, for example a device belonging to one tenant could not communicate with a device belonging to another tenant). A web portal provides a UI to administration functions like manage the messages and events, supervise your devices and control access to the tenant.

The main advantages of Live Objects platform are as follows:

- Integrated support for USSD, SMS and Data channels within one IoT platform
- Worldwide coverage - over 200 countries / 560 roaming agreements for 2G / 3G / 4G /5G networks
- Supporting IoT communication using the MQTT protocol, also with the use of FIFO queuing mechanisms
- Dedicated API for connection management (portal, API) to manage and monitor the IoT solution
- Extended IoT data analytics based on Big Data environment
- Searching IoT data based on Elasticsearch mechanisms
- Safe handling of traffic in the Data channel as part of dedicated private APN IoT Orange
- Supporting mechanisms:
    - Data Management (storage and flexible data search)
    - Device Management (supervision, configuration, software change, device repository)
    - Message Routing between devices and applications

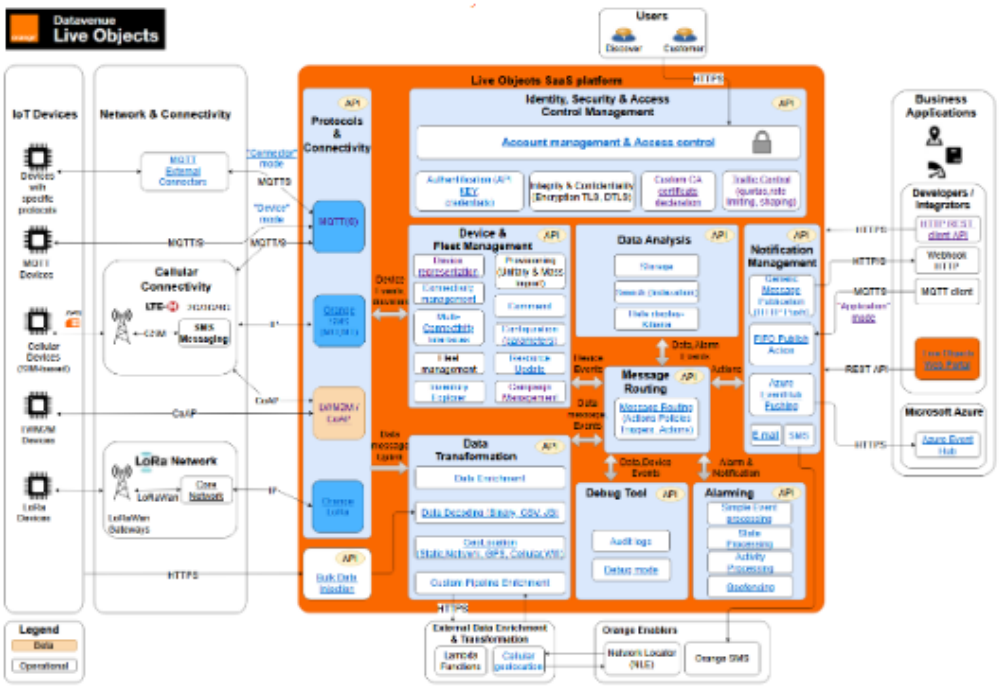

Figure 7. Live Objects architecture

Live Objects SaaS architecture is composed of two complementary layers:

- Connectivity layer: manages the communications with the client devices and applications,
- Service layer: various modules supporting the high-level functions (device management, data processing and storage, etc.).

Connectivity layer exposes a set of standard and public interfaces supporting following standards and protocols: MQTT(S), LoRa®, SMS and REST/HTTPS.

Service layer consists of following components:

- **Device management** - Live Objects offers functions dedicated to device operators: supervise devices, manage connectivity, manage devices configuration parameters, send command to devices, monitor the status executed commands, send configuration and loadware files (any binary files are supported) to devices and monitor the status of this operation.
- **Data management** – Platform allows to store the collected data from any connectivity interfaces. These data could be then retrieved by using HTTPS REST interface. A full-text search engine based on Elastic search is provided in order to analyze the data stored. The Live Objects platform has built-in data indexing capabilities that allow users to search and extract a wide variety of data using a wide range of search functions. This service is also exposed through HTTPS REST interface. The Live Objects platform allows users to view the collected data with a variety of graphical presentations, including pie charts, graphs, or maps.
- **Messages and Events Processing** – Live Objects platform has been developed using Events based architecture approach. Implemented event processing service is aimed at detecting notable single event from the flow of data messages. Based on processing rules defined by tenant administrator, it generates fired events that your business application can consume to initiate downstream action(s) like alarming, execute a business process, etc. The FIFO mode communication is based on the usage of topics to publish a message with ensuring no message loss. It can forward or route messages to recipients without data loss using FIFO Publication and FIFO subscription. You can also use the HTTP push forwarding after the message is processed by event processing service or message routing service. Those services give a notification or give an alarm to the recipients on purpose.
- **Access control** – this layer consists of two major blocks: API keys and user management. API keys are used to control the access to the SaaS platform for devices, application and users to authenticate. Users

management function is used for users account creation. The user with administration privileges (tenant admin) can add other users to the account and set their privileges. These privileges are defined by a set of roles. The users can connect to the Live Objects web portal.

Based on Live Objects platform, Orange addresses many business verticals by build on the top IoT platform following application and services:

- **Smart Tracking** - monitoring vehicles and other resources both outside and inside the building
- **Smart Metering** - measurement of utilities consumption (water metering, energy metering)
- **Smart Light** – management of intelligent street lighting
- **Smart sensors** - measurement of various environmental parameters such as: temperature, humidity, pressure, luminosity, air quality (Particulate Matter), carbon dioxide (CO2)
- **Smart Bins** - smart trash bins with geolocation and occupancy monitoring
- **Smart bike** - city rental bikes
- **Smart noise** - noise monitoring (e.g., in cities or near highways)
- **Live Button** - intelligent programmable button with various functions depending on the customer's requirements (calling for service in a restaurant, ordering goods and services, etc.)

The customer can access free technical support through two Orange Support Forums, available at: https://developer.orange.com/apis/datavenue

ASSIST-IoT will allow to extend the platform with new capabilities and IoT services (business cases), especially with the safety workers use case.

7.2.12. BIP-13: Orange datasets

In the first step it must be emphasized that telecommunication service providers data are well protected in the Polish telecommunications law, and it is not possible to share or process any data without the consent of the end customer. Therefore, this chapter focuses more than on data on presenting the API to the operator's network that enables the use of Orange network functions (enablers) in external applications.

Orange Polska is exposing large set of APIs divided into following segments (https://api.orange.pl):

- M2M – Machine to machine communications
- B2B – APIs for business customers
- IoT – Internet of Thigs oriented enablers (under development)

The full list of Orange API's is presented in the tables bellow:

Table 24. Orange M2M APIs

API	Description
Access Type	Information on the current access used by the SIM card
Activity Control	Checking the availability of the SIM card in the network (paging). In case of a failed paging procedure, the last value saved in the HLR is returned.
Activity Info	Notifications about changes in the location or availability of the SIM card. On-line data sent to the application / client server.
Cell ID	Information about the current operator location data: LAC and Cell_ID, in which the SIM card (paging) is supported. In case of a failed paging procedure, the last saved data from HLR is returned.
Geolocation	Location of the SIM card based on GMLC Orange
IMEI	Information about the IMEI number - identification of the terminal in which the SIM card is operated. The data for the service comes from the IMEI Tracking application installed on the SIM

Reset Location	Removal of SIM card data from Orange network registers (HLR / SGSN). Refresh an entry in HLR (location update).
Roaming Country	Information about the current country in which the SIM card is attached
Signal Strength	Information on the level of RSS signal received by the terminal with the SIM card
SMS Receive	Receiving an SMS to the indicated by the Customer number and redirecting to the URL
SMS Send	Sending SMS to MSISDN M2M numbers from the indicated M2M contract
Status HLR	Information about the status of the SIM card in the HLR. If the SIM card is not active, the status in the HLR is updated every 1.5 hours. - periodic location updates
USSD Receive	Receipt of USSD sent from MSISDN at defined client URL (* 139 * xxxx *…. #)
USSD Send	USSD sending to MSISDN number

Table 25 Orange B2B APIs

API	Description
Geolocalization	Location of the SIM card based on GMLC Orange
CheckIfOrange	Checking if the SIM card belongs to the Orange network
SMSOnnet	Sending SMS to MSISDN numbers in the Orange network
ReceiveSMS	Gateway for receiving SMS. Messages from the client's number will be redirected to the indicated client's URL
SMSOffnetNat	Sending SMS to MSISDN numbers to all mobile networks in the country
SMSOffnetInt	Sending SMS to MSISDN numbers outside the country
SMSDeliveryStatus	A method of checking the delivery status of an SMS
EventsForMSISDN	Selected on-line data in the field of network activity of the monitored SIM card. On-line data is sent to the client's application / server.
MSISDNContractType	Method of checking contract data based on SIM
IPAddressAPN	Method of checking the card's IP address with private APN
MMSOnnet	Sending MMS to MSISDN numbers in the Orange network
MMSOffnetNat	Sending MMS to MSISDN numbers to all mobile networks in the country
MMSDeliveryStatus	Method for checking the delivery status of an MMS
USSDNotify	USSD sending to MSISDN number
StatusHLR	Information about the status of the SIM card in the HLR. If the SIM card is not active, the status in the HLR is updated every 1.5 hours
CDREventsReport	CDR records of successful and unsuccessful Voice / SMS / MMS / Data events
USSD Send IP	Sending the USSD to the MSISDN number by addressing the APN and IP pair from the M2M contract
DetailedSIMProfile	Information about the SIM card in Orange (services, APN, IP). Query by MSISDN, IMSI, ICCID, APN; IP, IMEI

SmartSMS	SMS sending. Automatic distribution of SMS to the Orange, Country and World networks

Table 26. Orange IoT APIs

API	Description
SmartLights V2	Reading of measurement data reported by lamps, reading of alarms and data collection start reports

7.2.13. BIP-14: PUI9 framework

The PUI9 framework is based on the VueJS framework. This framework allows the creation of fully reusable web components that can be used to create web pages (SPA) or complex web APPs. In addition, new applications using PUI9 framework have a basic layout with a login screen and a fully configurable menu. The advantages of the new PUI9 framework are (i) modern, responsive and in some cases adaptive design, (ii) very good performance, (iii) based on web components (own components + Vuetify components), (iv) responsive components, (v) each component has its own HTML template, internal Javascript code, styles, and translations, (vi) a general model is enabled for the whole application based on Vuex, and (vii) a routing system is enabled based on Vue Router. Thanks to being based on VueJS, it has a very gentle learning curve, so it is very easy and quick to start being productive in the generation of web applications.

7.2.14. BIP-15: Personal Cooling System

Active personal cooling system with thermoelectric coolers (Peltier modules) integrated with clothing used to reduce thermal discomfort. The idea behind the system is to adjust the cooling power to the individual needs of the user based on the desired temperature in the undergarment microclimate to ensure thermal comfort. The applied system controlling the operation of the PCS enables automatic adjustment of the cooling power to the set temperature level with the possibility of additional adjustment of the cooling power depending on the individual preferences of the user. Controlling the cooling power on the basis of the temperature set by the user is possible because the system is equipped with a temperature sensor for its measurement in the undergarment microclimate. The user adjusts the cooling power by selecting the appropriate cooling level using the "decrease" / "increase" cooling buttons. The active cooling system is able to reduce the local skin temperature by up to 3 °C in the sixth hour of the system operation during little physical activity of the user.

7.3. Foreground IPR Results

In the following, we discuss the expected results deriving from the active IPR management at ASSIST-IoT. At the moment we account with 15 BIP results in total, with 15 expected FIP results deriving from the technological development.

Table 27 lists the initial set of Innovation Elements identified so far by the ASSIST-IoT consortium. This has to be considered as a preliminary list of Innovation Elements. Indeed, the Innovation Management activities will be continuing in the second half of the project and will aim at identifying further Innovation Elements as result of activities carried out in the technical WPs.

Table 27. ASSIST-IoT Innovation Elements and Foreground IP results

IE id	IE description	IE type	Task item(s)	BIPs	FIP associated	Partners involved	Access conditions
IE-01	TruckGUI app	SW Platform	T7.1	BIP-01	FIP-01	PRO	Yearly license
IE-02	UWB Geofencing	HW / SW Platform	T7.1	-	FIP-01	PRO	On request
IE-03	Multiwireless ROS	HW / SW Platform	T7.1 + T4.2	BIP-07	TBD	UPV, KONE	On request
IE-04	eGuided ROS	SW Platform	T7.1 + T4.4	BIP-07	FIP-04	PRO	On request
IE-05	Workers safety system	SW Platform	T7.2	BIP-03	TBD	MOW, SRIPAS	On request
IE-06	MR-based inspection support system	SW source code	T4.4	BIP-05 BIP-06	FIP-06	ICCS	On request
IE-07	In-Service emission diagnostic	HW / SW Platform	T7.3	BIP-08	TBD	FORD, UPV	TBD
IE-08	Enhanced scanner	SW Platform	T7.3	BIP-02, BIP-11, IE-11	TBD	TWOT, CERTH, SRIPAS	On request
IE-09	GWEN	HW	T4.1	BIP-04	FIP-09	NEW	On request
IE-10	ASSIST-IoT service deployment orchestration (ASDO)	SW source code	T4.2	-	TBD	UPV	Open source
IE-11	FL System	SW Platform	T5.2	-	FIP-11	PRO, SRIPAS	Open source
IE-12	Enhanced Security Center	SW Platform	T5.3	BIP-09	TBD	S21SEC	On request
IE-13	ASSIST-IoT Horizontal Autoscaling (ASHA)	SW Platform	T5.1	-	FIP-13	UPV	Open source
IE-14	Edge data broker	SW source code	T4.3	BIP-05	FIP14	ICCS	On request
IE-15	Enhanced Blockchain as a Service	SW source code	T5.4	BIP-02	FIP-15	CERTH	On request

The following subsections provide a brief description for each Innovation Element listed in the table.

7.3.1. IE-01: TruckGUI App

It will be a modern Graphical User Interface (GUI) created for Truck operator in their either Vehicle Mounted Terminals (VMTs) such as the Honeywell VM1A tablets available for the project, or on the truck drivers own smartphones. TruckGUI will make the work of truck drivers (internal and external) easier and error prone, by means of automation and decision helpers. The benefits and capabilities of such solution generates more efficiency productivity and safety to terminal operation.

7.3.2. IE-02: UWB Geofencing

It will be a joint HW and SW platform that will allow defining virtual fences or perimeters around a real-world physical location by making use of a RTLS (Real-time Location System) based on UWB technology. In principle, the first use case foreseen for this Innovation Element is to detect when an object (a truck) enters or leaves a virtual zone (RTG crane area). When this happens, it will be possible to trigger different events or actions (such as providing access to classified information only available when the two CHEs are closed to each other). Advanced logic for triggers may be included in later stages, such as the minimum duration that the tagged object is within the given geofenced zone, etc.

7.3.3. IE-03: MultiWireless ROS

Currently, the system that allow the remote management of cranes (ROS) has a wireless connectivity based on a single technology. This means that only one "physical connectivity link" exists, risking to unavailability or down scenarios. ASSIST-IoT is developing an enabler (multi-link enabler) that will allow nodes (of the ASSIST-IoT manage equipment environment) to successfully apply the so-called "interfaces bonding" so that various links are active and usable at the same time to communicate two points of a network. This will eventually enable the ROS to have two active communication channels (e.g., WiFi and 4G/5G), thus if one goes down or misbehaves, the other could take over, making the system much more robust and sounder. From an exploitation perspective, this Innovation Element will be tightly linked to the eGuided ROS, hence a further analysis of the ownership, business plan and exploitation routes will be performed within task T9.4 and will be detailed in further deliverables.

7.3.4. IE-04: eGuided ROS

The eGuided ROS will provide, based on Deep Learning and neural networks, an easy to install computer vision solution for remotely managed cranes. Thanks to the collaboration with Konecranes, the system will be able to connect to any (pre-existing) Remote Operating Systems integrated into RTG cranes. The eGuided ROS solution processes the video streams captured from the ROS cameras, and by simultaneously connecting to the TOS, highlights the containers involved in the current work instruction assigned to the operator. It will then help on improving operational by reducing manoeuvres uncertainties thanks of achieving maximum accuracy detection.

7.3.5. IE-05: Workers safety system

Worker's safety system will be a comprehensive service that allows better control of safety on the construction site. It will focus on three main areas: occupational safety and health monitoring, fall-related incident identification and health and safety inspection support based on augmented reality.

7.3.6. IE-06: MR-based Inspection support system

The MR-based Inspection support system is a 2-part solution. The first component is a web interface allowing the configuration of parameters defining how and where the MR application must connect to communicate with the other components/layers. Upon successful connection to the IE-14, the MR-based Inspection support system starts receiving data and translates it in a format suitable for visualization through the second component, an MR application on the head-mounted devices (Microsoft HoloLens 2). Data, from historical databases or real-time data streams, are requested according to its relevance to the user at a specific time and location (such as BIM models or time-series parameters). The MR-based Inspection support system will support a variety of

functionalities, starting from ASSIST-IoT use cases worker identification, BIM 3D model and dangerous zones visualization and manipulation, as well as alerting and reporting functions.

7.3.7. IE-07: In-Service emission diagnostic

As described in the BIP section above, In-Service Conformity focuses on a limited number of vehicles. While the selection of vehicles should allow a representative overview about the vehicle fleet in total, the true amount of emission outliers is neither detected nor addressed by effort. Therefore, the innovative idea developed in Pilot 3A shifts the focus away from testing single vehicles, to monitoring the fleet as such. In the highly cost-sensitive automotive environment, this strategy is accomplished without costly, newly developed additional hardware. Instead, available production level sensors are used on a fraction of the produced vehicles in a smart way, allowing a statistically relevant fleet emission overview, even for aging vehicles.

Additionally, an enhanced diagnostic methods pool is developed in Pilot 3A, which gives insight to unknown field issues, which previously would have triggered a laborious measuring and analysis process on OEM side. With the help of ASSIST-IoT, the beforementioned enhanced diagnostic methods can now be deployed from the pool solely to affected vehicles, generating detailed high-frequency logfiles once the issues occur, making it much easier for the OEM engineers to analyse and finally correct the underlying cause.

7.3.8. IE-08: enhanced scanner

Beyond the current system architecture supporting an excellent price-performance ratio (vehicle image quality - price) and a extended flexibility of installations with minimal space requirements in both indoor or outdoor places, the software platform of the scanner will be massively enhanced by getting a hybrid and modular software structure (allowing to confection the edge or cloud system implementation properties according to the many individual market needs of the various use cases, and supporting a multi-level interfacing with simple, yet effective user interaction systems or with complex, location-depending business intelligence IT-systems of the organisations, where the scanners are installed). Additionally, the innovative Federated Learning AI-approach promises a good, automated surface inspection without the necessity to continuously share the scanned pictures of various scanners, installed in physically different locations and / or separate organisations, for training purposes with each other or with a centralized training system, which results into decreased communication bandwidth- and data volume- requirements (cheaper, easier). Additionally, and in conjunction with the DLT-approach a more trustful operation mode can be achieve for business-critical cases, like the legal insurance procedures or asset evaluation applications.

7.3.9. IE-09: GWEN

The GWEN is a universal gateway with a modular design. The GWEN has compute power to operate AI algorithms at the edge, memory physical network interfaces and Smart IoT device interfaces. The GWEN is modular in the sense that a system on module (SOM) is used for the compute power which can be replaced by different versions with different memory sizes and different amount of CPU cores. An industry standardized SOM interface is used. This SOM is mounted at a carrier board. This carrier board has several fixed interfaces available, e.g., 1Gbps Ethernet, USB3, WiFi6 and 5G. Besides these fixed interfaces add-on modules can be plugged-in at the carrier board to implement dedicated interfaces, e.g., UWB for localization purposes. Linux is used as operating system with docker as container runtime.

7.3.10. IE-10: ASSIST-IoT service deployment orchestration

A product able to deploy different functionalities over k8s-compatible equipment controlled over the same orchestrator, tagging the tiers and levels of the infrastructure and with a unified, clearly defined structure of software packaging and deployment. This Innovation Element has custom developments over a technological baseline counting with OSM MANO [14] as its main core component. Up to now, it does not exist an orchestrator with the capabilities and the IoT-orientation proposed by ASSIST-IoT's **ASDO**. This "product" will be able to provide added value to adopters whether or not they will use it in a context of ASSIST-IoT, becoming a product itself as long as the underlying equipment could run k8s (or similar) technologies for

deployment. The exploitation of this product will be analysed during forthcoming deliverables, which will include the study of appropriate licensing.

7.3.11. IE-11: FL System

Since several use cases of the project require the use of federated learning, PRO and SRIPAS partners are developing a standalone FL system. However, due to the still infancy of federated learning into the AI/ML research ecosystem, it should be noticed that the expectations of our FL system will be in principle provided as a research-oriented platform. In that sense, the ASSIST-IoT FL system is conceived as a lightweight FL system like Flower [15], which at the end is seen as a competitive advantage with respect to other more sophisticated FL systems, such as FedAI [16], TensorFlow Federated [17], whose learning curve is very steep. In addition, the ASSIST-IoT FL system is expected to be able to be fully operational over Kubernetes environment, which up to the involved parties' knowledge, is still not provided by any other FL system available in the market.

7.3.12. IE-12: enhanced Security Centre

The enhanced Security Center will make use of an enhanced methodology for applying DevSecOps integrated in SOC services when deploying managed security services. In particular, it will be an advanced configuration tool needed to deploy SOC services and apply orchestrated security automated incident response in the platform, innovating and standardizing the way to offer Service Operation Center Services.

7.3.13. IE-13: ASSIST-IoT Horizontal Autoscaling

A software functionality belonging to the self-* knowledge domain that will allow k8s-assimilable nodes to auto-scale their resources depending on historic values (based on ML) to optimise resources usage. This product comes directly from the results of the enabler T51E5, that includes the usage of the HPA functionality of k8s clusters in addition to custom developments and auxiliary components to create an autonomous solution that gathers information and interacts with the HPA option to improve resources usage. It improves the frequency update (currently 15 mins with HPA) and enhances the original functionality, that just establishes a maximum threshold (% of RAM usage) from which horizontal replicas are created. Thanks to the development of this product, more intelligence will be included. It is expected that this product will be growing in scope during the project duration and also beyond. The exploitation of this product will be analysed during forthcoming deliverables.

7.3.14. IE-14: Edge data broker

The edge data broker is a high-performance, distributed MQTT message broker that has the capability to scale horizontally and vertically on edge gateway devices. It can support a large number of clients that consume and produce data through a pub/sub mechanism. The Edge Data Broker enables the efficient management of data demand and data supply among edge nodes based on a publish/subscribe schema, taking account load balancing criteria. It distributes data where it is needed for application, services and further analysis while considered essential only in those deployments that involve IoT architectures. A group of innovative features are provided by the Edge Data Broker, which facilitates creation of pipelines, in which data flow can be controlled. Control over the conditional paths is achieved through scriptable broker nodes, while data may be analysed to cause alert events, directed to specific sinks depending on pre-set conditions. The data broker is scriptable with a highly expressive language to enable a wide range of uses

7.3.15. IE-15: Enhanced Blockchain as a Service

Enhanced Blockchain as a Service leverages the infrastructure provided by the Blockchain as a Service (BIP-02) and builds on top of it a set of services that improve the security, privacy, and trust of the interactions done via IoT devices / gateways. Those services are, (i) the immutable logging of critical interactions to ensure accountability, (ii) the data integrity verification of any data at question, (iii) the distributed broker which serves as a registry of all the data sources containing indexing and querying services that facilitate the efficient irretrievability of the stored (meta)data, and (iv) the integration with FL platforms providing a decentralised

exchange of ML models and a local model verification mechanism that tackles with the training dataset skewness and biases with an aim to diminish model poisoning.

7.4. Innovation maps

The BIP and IE plus FIP tables allow to derive a number of innovation maps, where each IE, FIP and BIP will be cross-linked among themselves, and with the partners owning them.

These maps will constitute the basic information to analyse IPR interdependencies among the various IP elements entering the project and being generated during the project. As such, these maps are also the basic information needed for the potential legal and commercial agreements among the partners, after the end of the project.

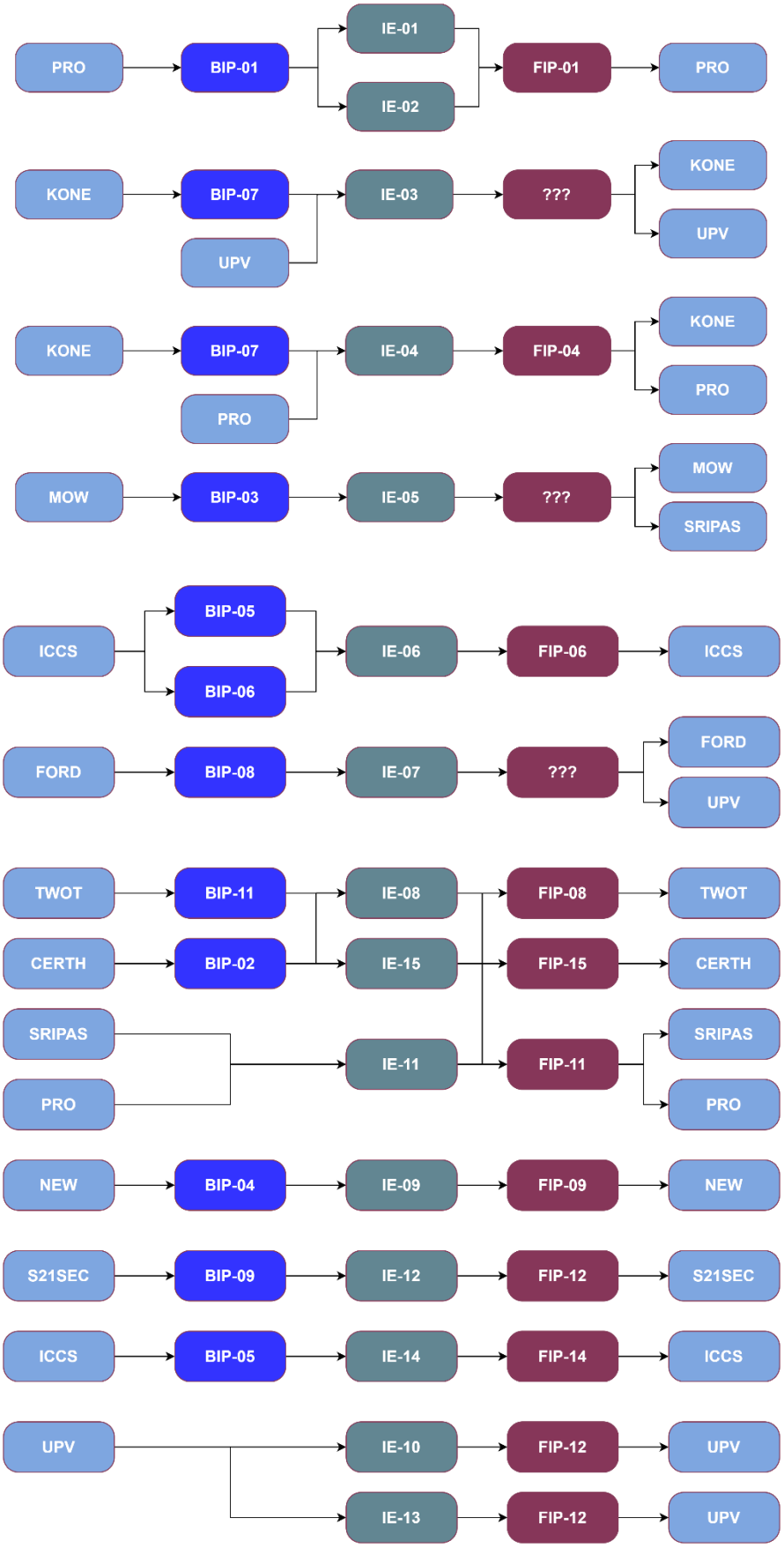

Figure 8. ASSIST-IoT Innovation maps

7.5. Next steps

The results of the Innovation Management provide a preliminary mid-term overview of the Innovation Elements and Foreground IP envisaged in ASSIST-IoT so far. The methodology followed will be further used during the second half of the project with the aim of fostering and assisting the identification of additional project innovations. Moreover, as part of the Innovation Management duties, ASSIST-IoT will consider contributing to the EC Innovation Radar initiative [18]. In this context, relevant project Innovation Elements will be selected to be part of the Innovation Radar platform, and thus ease greater access to the ASSIST-IoT innovations information, facilitating their potential introduction in the market through its dynamic ecosystem of incubators, entrepreneurs, funding agencies and investors.

8. Conclusions

At its genesis, nothing about an eventual innovation is new. To get started, all you need is a hunch about a real-world problem that matters; a set of parts and access to a community of people to render the problem tangible; a strategy to engage in trial and error; and an appetite to learn by being productively wrong. You learn about the problem as you bring together those people and parts. The pathway is full of choices and the potential outcomes endless. This deliverable (i.e., D9.6 – Business Models and Marketing Operations First Version) is the engine which nurtures the conditions for innovating that yields impact, strategic insight into new challenges, and increased efficiency, and prepare it to produce new products, companies, causes, policies, inventions, innovation kits and resources, while develop both industrial and academic innovations into the ASSIST-IoT domain (i.e., open, decentralized reference architecture, associated enablers, services and tools, to assist human-centric applications in multiple verticals starting up, but not limited to, construction, building and maritime sector). While traditional R&D Projects try to quantify and measure social impact as an academic exercise of assessment separate from business operations (i.e., things like product/market fit, customer development or sales funnels, to name only a few, are outside of their scope and ambition plans), during this first stage of the Project the ASSIST-IoT Consortium is getting a better understanding of our beneficiaries (i.e., potential users and clients, for instance) since it is even more important because is far more complicated than building a new framework or application. It requires more listening, more care, more empathy, and more stakeholders. To make a lasting difference, solutions must be embraced by beneficiaries, address root causes, and include an engine that can accelerate growth to reach the scale of the need while setting up a repeatable, scalable, referenceable, and profitable growth process of entrepreneurship.

ASSIST-IoT takes advantage of the pros of both domains (i.e., the academic and the industrial ones) with the strong foundational belief of working through innovations that are good for the business (profit), good for the payers (customer value) as well as good for the wider system solving social and environmental challenges. The scope of this project is not only to provide *an innovative multi-plane (semi-)autonomous decentralized edge-cloud reference architecture, supplemented by cross-cutting digital enablers* especially in the context of the Next Generation IoT but also dispelling the notion of trade-offs between what seem to be competing goals: performance versus impact, profit versus purpose and human wellbeing versus environmental protection. ASSIST-IoT through its spin-in for customer development and product discovery will deliver results which are expected to make a difference in terms of impact, not only during the project timeframe but also beyond the immediate scope and duration of it thanks to the application of the aforementioned methodology (i.e., please see Section 1) that underpin the dramatic engine of innovation of Silicon Valley Product Group for the more challenging realities of social impact becoming a more responsive Consortium that creates value together providing practical, robust and scalable tools to improve the interoperability, quality, and integrity of data (in the IoT domain).

As it has been said before, there's a traditional tendency in R&D projects to directly jump straight forward to defining a bunch of metrics for performance without talking to people. Since the very beginning of ASSIST-IoT until M36 the Consortium have started a measurement journey embracing qualitative approaches, asking open ended questions about users and beneficiaries lived experiences. This action has enabled the Consortium to identify how our business model could create a sustainable change and for whom (beneficiaries, users, and clients) and analyse the specific changes the Project outcomes will generate for them. From this point onwards, the lessons learned carried out on this deliverable will enable the Consortium to improve our hunch, refine our problem, and help us reconceive what we are going to prototype for reaching the desired impact. To sum up, the work carried out through this innovation journey has given us the opportunity to identify our target customers, users and beneficiaries, their underserved needs as our unique value proposition (which obviously fulfils the pain highlighted by the users). Next period of the Project and thanks to the technological results produced, the Consortium will be able to stress them in real conditions or pilots until (almost) the end of the project (avoiding the risk to have no chance to pivot with considerable planning and thoughtful execution). Then, move from idea to prototype tested under real conditions will give us the opportunity to specify our Minimum Viable Product(s) feature set(s) and create them (according to the categories: functional, reliable, usable and delightful) as well as to validate or invalidate hypothesis and implicit assumptions releasing a realistic BMC.

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