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

D2.13 – Risk Update and Status Report

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Description	Risk Update and Status Report [M36] - provide an update status of the project and the risks face. Deliverable inserted as a consequence of project extension		

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Executive Summary

This deliverable is written in the framework of WP2 – Project Coordination and Management of **ASSIST-IoT** project under Grant Agreement No. 957258. As a consequence of the project extension, the project Coordination team deemed convenient to include an extra deliverable in the framework of WP2, with two main goals: to avoid having more than 18 months without producing technical reports, and to update the management of risks, so that the periodicity of summarising it in steps of 9 months is kept (at the proposal phase, M9, M18, M27, and now, M36).

In the first part, the overall pace of the project in the reporting phase (M19-M36) is presented, followed by a list of the achievements towards fulfilling the initial objectives of the action and a dedicated summary per work package. It is not the intention of this summary to represent all the activities performed, but rather to provide an overall picture of the current situation. Overall, the project is in good shape to deliver the expected outcomes, with some outstanding results in many fields (communication and dissemination, number of technical outcomes produced, number of pilot-related activities, etc.) and entering into the last phase in which focus will be put into evaluation, impact and business-related efforts.

In the second part of the document, the risk management report is updated. Notes have been added in most of the risks, along with new mitigation measures in those that required additional ones. In this moment, 49 risks have been spotted along the action, with 3 new ones spotted in the last risks' reporting period (in this case, M28-M36), particularly related to the current unstable geopolitical situation, the potential difficulties in integrating legacy solution with the project security stack, and the risk related to the low adoption of project outcomes after the project conclusion.

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List of acronyms

Acronym	Explanation
AB	Advisory Board
AI	Artificial Intelligence
AIOTI	Alliance for the Internet of Things Innovation
API	Application Programming Interface
AR	Augmented Reality
BIM	Building Information Model
BKPI	Business KPI
BSD	Berkeley Software Distribution (license)
CA	Consortium Agreement

CI/CD	Continuous Integration / Continuous Delivery
CNI	Container Network Interface
CSA	Coordination and Support Action
DLT	Distributed Ledger Technology
EC	European Commission
EDB	Edge Data Broker
ENISA	European Network and Information Security Agency
ETSI	European Telecommunications Standards Institute
EUCEI	EUCloudEdgeIOT
FL	Federated Learning
GDPR	General Data Protection Regulation
GNU GPL	GNU General Public License
gRPC	Remote Procedure Calls
GWEN	GateWay and Edge Node
HBR	Horizon Booster Result
HTTP	Hypertext Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers
IdM	Identity Manager
IE	Innovation Elements
IoT	Internet of Things
ITU-T	International Telecommunication Union Telecommunication Standardization Sector
K8s	Kubernetes
KER	Key Exploitation Results
KPI	Key Performance Indicator
LTSE	Long-Term Storage Enabler
MANO	Management and Orchestration
MQTT	Message Queuing Telemetry Transport
MIT	Massachusetts Institute of Technology (license)
MR	Mixed Reality
MVP	Minimum Viable Product
NFV	Network Function Virtualization
NGIoT	Next-Generation IoT
NIS	Network and Information Systems
OC	Open Call
OSM	Open Source MANO

P2P	Peer to Peer
PC	Project Coordinator
PCC	Project Coordination Committee
PCS	Personal Cooling System
PIC	Project Implementation Committee
PoC	Proof of Concept
PUD	Performance and Usage Diagnosis enabler
PUI9	Prodevelop's User Interface
RDF	Resource Description Framework
ROS	Remote Operating Station
RTO	Research and Technology Organisations
SA	Standards Association (IEEE)
SAB	Standards Activity Board (IEEE)
SAST	Static Application Security Testing
SD card	Secure Digital card
SD-WAN	Software-Defined WAN
SDN	Software Defined Network
SDO	Standards Development Organizations
SG	Standardisation Group
SIEM	Security Information and Event Management
SOAR	Security Orchestration, Automation, and Response
SME	Small and Medium Enterprise
SNS	Smart Network and Services
TC	Technical Coordinator
UV	Ultraviolet
UWB	Ultrawideband
VPN	Virtual Private Network
WAN	Wide Area Network
Wasm	WebAssembly
WG	Working Group
WP	Work Package

1. About this document

Two are the main objectives of this document: to provide a summary of the progress of the project in the last execution period (M18-M36), and to update of all aspects of risk management. This deliverable was not in the initial plans, but it was deemed convenient because of the project extension, as a year and a half has passed since the last technical report.

1.1. Deliverable context

Table 1. Deliverable context

Item	Description
Objectives	The objective of this document is not related to the technical development of the project, but rather informative. Apart from the overall status of the action, this deliverable establishes and reports over the Risk Management Plan and the main procedures proposed to correctly manage the likelihood of risk materialisation in a continuous and timely manner.
Exploitable results	N/A
Work plan	This document is developed within the WP2 "Project Coordination and Management", being useful for the overall project planning and coordination. This document corresponds to the works carried out under the scope of tasks T2.1 - *Overall Project Planning, Coordination, Administrative & Financial Management* and T2.2 - *Technical coordination, quality assurance and risk management*.
Milestones	N/A
Deliverables	This deliverable is related to all those delivered between M19 and M36, as the status report feed partially from them. With respect to the risk section, current version can be seen as an update on risk assessment provided in the action proposal (last iteration D2.7 – M27). It is fed directly from the Project Management Handbook (D2.1). Furthermore, this document is semi-independent from D2.3 and D2.4, which cover all aspects of ethical risks. Hence, ethical risks are not considered here.
Risks	**Planning problems** – This deliverable establishes mechanisms to ensure the quality of the documentation and the processes, facilitating the correct interpretation by the partners so that they know the timing and responsibilities.
	Collaboration issues – This deliverable describes coordination mechanisms, communication tools, and procedures that allow correct decision-making and conflict resolution in the face of any situation that may arise throughout the project.

1.2. The rationale behind the structure

The content of the deliverable is organised in two sections with clearly separated objectives:

- **Section 2** summarises the progress performed on each one of the work packages between M19 and M36.
- **Section 3** provides an update on risk assessment, explaining the status of the different risks identified and the mitigation measures put in place.

2. Overview of the progress of ASSIST-IoT project

The second phase of the project started in M19, after the release of the deliverables of April 2022. At this moment, the reference architecture, the specifications of the enablers, the pilots' scenarios and use cases, the overall frameworks for ethics, privacy, enablers' delivery (testing, integration, packaging and documentation) and KPI reporting were set up. Additionally, the initial plans for the pilot, communication and dissemination activities were executed, and the project was ready to evolve towards the next phase.

The architecture was defined, however, the feedback from the activities of the technical work packages helped refining it a bit further, and hence the final formalisation of the reference architecture was delivered (M21). Also, at this moment only some set of enablers (including those defined as essential) had released their initial MVPs, and the project (WP4-WP5-WP6) focused from this moment onwards on working towards (i) the refinement of their specifications, (ii) the development of their features, (iii) the implementation of integration interfaces, when required, (iv) their testing, (v) their packaging, including their licensing strategy and (vi) their releasing into the project's private and public repositories (for code, images and Charts). All these activities, under the guidelines of WP6, following DevSecOps methodology previously defined and using the implemented staging servers as testing and integration environment. At this moment, all enablers have been finalised, packaged and documenting (except the three encapsulation exceptions), and there are started to be published in public repositories.

In parallel, pilots (WP7) continued with their pending procurement activities and their required development efforts, taking into account their respective business needs, legal and ethical frameworks. Enablers were started to be implemented in their use cases, and the project's gateway (i.e., the GWEN – WP4) was finally manufactured and delivered to the pilots to be used. With the KPI framework in place, partners continued the formalisation of the KPIs, including the methodologies to capture them (WP8). In addition, other activities targeting the overall evaluation – surveys, transferability analysis, were carried out. At this moment, pilot 2 has finalised its activities in-site, with only some minor pending validations to be performed in lab conditions; the rest of the pilots are ending the integration activities and moving towards the measuring of the missing KPIs.

At the same time, impact outreach activities have been tackled with very good result during the last period, Communication via social media and exposure through website and other channels is continuously addressed by specialised teams as well as by partners individually. This also applies to scientific dissemination events, which have shifted primarily towards face-to-face fashion, allowing better spread of ASSIST-IoT achievements. Also, the first round of Open Calls was completed while the second one is ongoing, with 15 participants (SMEs, RTOs and Universities included), receiving ASSIST-IoT funding to deliver innovative, single projects bringing added value to one of our pilots while validating (the entirety or part of) our architecture. Finally, exploitation is taking a more impactful work in this second phase. The project Key Exploitation Results (KERs) have been defined thanks to the work of the -in customer identification taskforce, and have entered into the Horizon Booster Programme to optimise their exploitation potential. In the next months, their business plans will be completed.

2.1. Research and innovation objectives

To meet its goals, above mentioned, ASSIST-IoT is structured in a set of specific research and innovation objectives (listed below). A review of the advances performed during this M19-M38 report to achieve each of them is also depicted in this sub-section.

It is worth mentioning that the list below does not reflect the total amount of tasks undertaken to meet the objectives. For simplicity and readability, the following **consists only of a compilation of the results obtained** during the M19-M36 period directly tackling the project objectives. For a full understanding of activities executed towards ASSIST-IoT completion the reader should review the rest of the sections of the document, as well as the deliverables generated that are uploaded on the official website: https://assist-iot.eu/deliverables. In addition, it is also worth noting that the lists below do not purposely list deliverables of each WP, as those can be considered by-products of the actual results.

Obj.1: Design, implementation and validation of an NGIoT Reference Architecture

ASSIST-IoT architecture will fully address issues not covered, or deficiently covered, by current IoT solutions. This includes (i) enhanced smart devices for sensing/actuation; (ii) algorithms offering centralized and decentralised human-centric AI; (iii) effective deployment of scalable interoperability on all levels, supported by semantics and DLT; (iv) self- mechanisms across IoT ecosystems; (v) smart networking and integration with NFV and SDN; and (vi) security, privacy and trust by design, supported by DLT. It will leverage existing components (e.g., from past research projects, open-source communities, SDOs, other research areas, e.g. 5G, AI, edge computing, and robotics), allowing new deployments, and providing tools and components to third parties. The latter will be based, in part, on the (very practical) guidelines formulated during pilot-based validation.*

The results obtained till M36 addressed to accomplish this objective have been:

- Last version of the architecture for ASSIST-IoT (deliverable D3.7).
- Final specifications of the templates and global design principles for: (i) development of enablers in WP4 and WP5, (iii) documenting and packaging in WP6, (iii) trial deployment schemas in WP7 and (iv) ground truth technological KPIs in WP8.
- Final version of the project enablers (WP4 & WP5), including testing, packaging, releasing and documentation (WP6).
- Announcement, publication, opening, closure, processing, awarding announcement and start of works of 8 projects as output of the second round of ASSIST-IoT Open Calls (WP2). This activity is expected to be very relevant to ASSIST-IoT architecture as the #1 technical eligibility criteria has been "validate (the entirety or parts of) the ASSIST-IoT architecture" (WP7).

Obj.2: Definition and implementation of distributed smart networking components

ASSIST-IoT will identify business drivers, technical requirements and best practices for adoption of smart networks, combining smart connectivity, decentralised edge nodes, AI-based data analytics, efficient distributed computing, and security by design. In other words, future cost-effective and sustainable communication systems and networks will be increasingly based on applied AI and growing softwarisation. Since connectivity between gateways and smart devices may virtualise some functions, ASSIST-IoT will use NFV to support scalability, broad deployments, and SDN to (i) improve performance of IoT deployments, (ii) use distributed AI near the edge of the network, and (iii) achieve better access to new communication technologies (e.g. NB-IoT or mesh).

The results obtained till M36 addressed to accomplish this objective have been:

- Final version (4.0.0) of the Smart Orchestrator enabler, the core component of the distributed networking components.
- Final implementation of SDN-related enablers, including SDN controller, Auto-configurable network, SD-WAN and WAN acceleration enabler.
- Design and development of other enablers related to network innovations: VPN enabler, traffic classification and multi-link enabler.
- Final manufacture of the GWEN (ASSIST-IoT Gateway Node), to perform the functions of IoT gateway in ASSIST-IoT deployments including network capabilities, supporting a wide variety of communication protocols. Delivered to pilots.
- The script developed to facilitate the deployment of a K8s cluster with the needed requirements to support the Smart Orchestrator and the Manageability enablers (joint effort with WP5 & WP6) has been updated. With them, the rest of the enablers can be deployed much easily.

Obj.3: Definition and implementation of decentralised security and privacy exploiting DLT

Security, privacy and data protection by design will be founding assumptions for the ASSIST-IoT to guarantee security, interoperability, confidentiality, integrity and availability. Thus, ASSIST-IoT will introduce a holistic

cross-plane solution for security, trust and privacy across NGIoT ecosystems. It will exploit DLT for strengthening data protection and privacy (e.g. GDPR and NIS Directive) across all planes but also ensuring integrity of data sharing through smart contracts. Appropriate mechanisms for establishing trust between cooperating Next Generation IoT artefacts, will support authentication, authorisation, logging, consent / ownership / permission / access-control of interoperable IoT assets and data will be supported. ASSIST-IoT will also contribute to the implementation of the EC Trustworthy AI Guidelines, in industrial contexts, which require edge computing and next generation IoT to guarantee data protection and security, while providing full control to the users. These components will be employed with security-by-design principles using DevSecOps, while common security protocols and standards (including standardised data encryption) will ensure interoperability.

The results obtained till M36 addressed to accomplish this objective have been:

- Final version of Authorisation, Identity Manager, Cybersecurity monitoring enabler and Cybersecurity monitoring agent enabler ready.
- All DLT enablers finalised, packaged and released.
- Enablers have been developed following the DevSecOps methodology envisioned in the project, including as key part of the process the use of GitLab pipelines so that security tests are executed during development, integration and testing stages.

Obj.4: Definition and implementation of smart distributed AI enablers

Develop an AI-based framework, by means of modular features (both hardware and software), dynamically deployable to heterogeneous IoT nodes (e.g., devices) in the edge-cloud continuum, combined with smart networking to instantiate applications explored within pilots. The objective is to provide an integrated intelligence framework for smart edge improvements, enriched and facilitated by distributed data processing, federated learning, virtualisation/aggregation of data/events/objects, resolution of mixed-criticality situations and conflicts, verification, and context-aware self-adaptation of connectivity and real-time event-oriented reactive approaches. All these aspects will be supported by comprehensive mutual fertilisation of semantic technologies and AI techniques. Moreover, boundaries of explainable AI in the context of IoT ecosystems will be studied. While the explainability is not an object of research as such, the issue of establishing which parts of the ecosystem depend on "unexplained AI" will be investigated, and obtained results brought into the ASSIST-IoT architecture.

- The results obtained till M36 addressed to accomplish this objective have been:
- Specification of the smart distributed AI enablers and their characteristics within the architecture finished, together within the different technologies to be used.
- Realisation of the 4 enablers involved in the Federated Learning (FL) suite – FL Orchestrator enabler, FL Training Collector enabler, FL Local Operations enabler and FL Repository enabler, packaged.
- Datasets from pilots 2 and 3B ready to be used in those pilots.

Obj.5: Definition and implementation of human-centric tools and interfaces

Enablers for implementation of semi-autonomous services, traditionally falling under human responsibility/liability will be developed. This will assist augmentation of workforce intelligence, via: visualisation; decision support; or control of work environment, by tightening collaboration of cyber-physical systems, human beings, and virtual services. This will aid human-friendly haptic and AR/MR interfaces, including tactile feedback, voice control, real-time data feedback and prediction, visual feedback, and data feed for AI models capable of identifying critical improvements, preventions and triggers in long-, short-term, or real-time. The goal is to synergistically enable both human and machine intelligence, to improve work safety and human-centricity, support supervision and quality, increasing level of automation of work-related tasks benefiting from this synergy.

The results obtained till M36 addressed to accomplish this objective have been:

- MR enabler (based on HoloLens) finalised and validated in Pilot 2. An alternative MR enabler in pilot 3a has been also tested, in conjunction with the video augmentation enabler.

- Video augmentation enabler ready, packaged and tested with real-life video from Pilot 1.
- Final version of the Tactile dashboard and Manageability enablers, so that pilots can leverage the use-case specific, the enablers' and the system-related dashboards prepared.
- Final versions of BKPI and PUD enablers integrated with Tactile dashboard.
- OpenAPI manager ready to allow the integration of external systems with ASSIST-IoT realisations.
- All project dashboards and OpenAPI manager integrated with the Identity management and authorisation enabler, for increase security.
- PUD enabler ready so that the performance of enablers (and the system) can be supervised by identified users with access, if metrics are exposed in the proper endpoint.

Obj.6: Definition, deployment and evaluation of real-life pilots.

Three industry-driven pilots will demonstrate the value of the architecture, as an innovation tool. Pilots will be validated using heterogeneous data sources in real-life settings and based on actual deployments. ASSIST-IoT outcomes will be validated from both technical and business perspective. Moreover, provided solutions will be analysed by relevant stakeholders, considering their benefits, requirements, and constraints. Stakeholders from other application domains will be involved, to evaluate the extendibility of results. Business validation will include the introduction and evaluation of business models for different verticals. ASSIST-IoT will extend and deploy sector-specific reference architecture implementations to allow testing, performance validation and business impact of proposed approaches. Pilot-oriented smart devices and specific human-centric applications, services and configurations will be developed. Pilots will be crucial for formulating real-world-experience based "lessons learned" and "best practices", which will be combined in a manual, as one of key results of the action.

The results obtained till M36 addressed to accomplish this objective have been:

- Pilots have finalised their procurement and development activities, and are working towards the final integration and KPI reporting activities.
- In the particular case of pilot 2, all activities in the construction site have been completed, with some minor laboratory validation efforts pending. Feedback gained have been of great utility to improve the enablers used.
- The first round of Open Calls executed their activities with the pilots, and the second one is ongoing.
- Transferability analysis of existing methodology is being carried out, to assess the transference of the pilot activities to other verticals.

Obj.7: Establishment of an innovative cooperation and business framework

ASSIST-IoT will define and validate credible, scalable business models, which will ensure wide and sustainable use of deployed solutions. Business modelling will be fully aligned with technical capabilities of results, ecosystem, and functionalities of deployed pilots. In addition to devising credible and viable business models, action will attempt at their generalisation, towards reusing them in the scope of IoT deployments in other application domains. Furthermore, action will introduce and validate best practices, including privacy, ethical aspects and AI explainability. This framework will be used in conjunction with the business models of the action, as part of a holistic approach to interoperable IoT and data governance. From the business perspective, use of ASSIST-IoT architecture will reduce costs, increase efficiency, lower customer frustration and, therefore, speedup IoT adoption in the NGI environment.

The results obtained till M36 addressed to accomplish this objective have been:

- Feedback from Consortium's experts (in the spin-in customer identification task force) and the AB to contribute to the definition of the business model.

- A total of 7 KERs (Key Exploitable Results) have been identified, and several actions (exploitation intentions summaries, risk assessment maps, elevator pitches, characterization tables) have been performed over them.
- Transferability analysis methodologies are being studied to adapt and use some of their approaches for ASISST-IoT results.
- Selection and participation in the Horizon Result Booster (HRB) programme to foster a better exploitation of the project outcomes.

Obj.8: Impact creation: Showcasing ASSIST-IoT and Disrupting the current market

Besides standard dissemination activities, e.g. presenting and promoting the approach and its results, at conferences, website, exhibitions, social media, publications and workshops, ASSIST-IoT will perform several showcases, including small demonstrations, to widely present main outcomes and to show concrete advantages of using ASSIST-IoT architecture and enabling technologies, to stakeholders and potential clients, targeting diverse verticals, mobilising key actors, including the security area. Furthermore, action will establish an Advisory Board with at least 4 key members from industry and academia associated with the different pillars and enabling technologies. Exploitation and business models are also meant to strengthen the impact, and they will be goals of ASSIST-IoT. Internationalisation will be achieved with support of key partners, and through networks of contacts of the members of the Consortium. Finally, ASSIST-IoT will track relevant standards bodies (Section 2.2.1.2) to be compliant with them and, at further stages of the project, provide influence to standards filling the gaps they may have, which the action identifies.

The results obtained till M36 addressed to accomplish this objective have been:

- Continuation with the formal meetings with the members with all partners. In the last meeting, a total of 9 recommendations (with already visible effects in ASSIST-IoT workplan) were obtained.
- Fostering the contribution from ASSIST-IoT in different standardisation initiatives (AIOTI, ITU-T, ETSI, IEEE SAM ENSO/ENISA, CEN).
- Relevant positioning with respect to different associated CSAs, like NGI4EU: EUCEI, NGIoT, EU-IoT, IEEE and other associations are being continuously interacted with like EUCloudeEdgeIoT, 6G-IA/SNS and Networld Eurorpe SME WG. More than 60 actions have been performed with regards to the collaboration with IoT community linked to the active engagement with NGIoT and EUCloudeEdgeIoT CSAs.
- A total of 80 active presentation activities at events/conferences and organisation/co-organisation of 16 webinars/workshops oriented to gather stakeholders' feedback and summoning Open Call applicants.

2.2. Explanation of the advances per WP

2.2.1.WP2

WP2 activities have focused on project coordination and management, including the management of the Open Calls and the communication with the European Commission (EC) and the Advisory Board (AB) members. Particularly, the main activities carried out are the following:

- Organisation of bi-weekly virtual plenary meetings, and in-site ones.
- Continuous project monitoring to ensure the optimal execution of the task, technically and financially, to ensure the best value for the funds received.
- Keep track of the potential risks of the project execution, as well as having mitigation measures in case they happen.
- Force that all regulation related to privacy and ethics is followed during the execution of the different tasks of the project.
- Ensure that feedback from the AB members is received and considered during the project execution.

- Provide a trusted framework for the Open call evaluation processes, as well as a clean execution of the Open Call projects.
- Formal preparation of two amendments, being the second one still in process.

Going more deeply into WP2 activities, during the reporting period (M19-M36), the Consortium has continue having virtual bi-weekly meetings, managed by UPV and using the MS Teams platform, aiming at controlling that the execution of the project goes according to the plan. Additionally, three physical meetings have taken place: Warsaw (19-21/Oct/2022), Thessaloniki (25-27/Apr/2023) and Malta (4-6/Oct/2023). Aiming at ensuring that integration among technical teams go smoothly, two physical code-camps have been conducted: in Bilbao (17-19/1/2023) and Eindhoven (26-27/7/2023).

Regarding risk management, the **live document has been kept updated by WP leaders**, who have been periodically reporting in the plenary meetings possible risks and ensuring that mitigation measures are in place in case they occur. As a result, Section 3 of this document has the list of risks updated, with the minitigations measures considered ready (during the reporting phase, D2.7 – Risk management v3 was also produced).

With respect to the Advisory board, the 3rd meeting with them was divided into two sub-meetings. The results were presented in D2.10, directly drawing from specific questions established by the Consortium and the answers by AB members, together with their genuine feedback provided by the latter. The meeting and the previous actions redounded in a set of recommendations and results that have already had an impact in the project. According to this document, a total of **9 new recommendations were drawn** (separated into 3 global management consideration, 3 global research direction, 2 technical additions and 2 exploitation points).

Finally, the first Open Call process finalised successfully, and the second one is still ongoing. The seven open callers from phase one have completed their activities and received their funds, whereas the eight open callers from the second phase are still in the execution phase. The selection processes of both phases were implemented in the same way, starting with a preparation phase with the CSA support, the execution of the communication strategy (using the communication channels, P2P meetings, webinars, etc.) to ensure that potential applicants have all the tools and material needed for submitting their proposals, the submission phase itself (with the tools in place so applicants can upload their proposals) and the evaluation procedure, which flow can be seen in the following figure. More details can be found in D2.11.

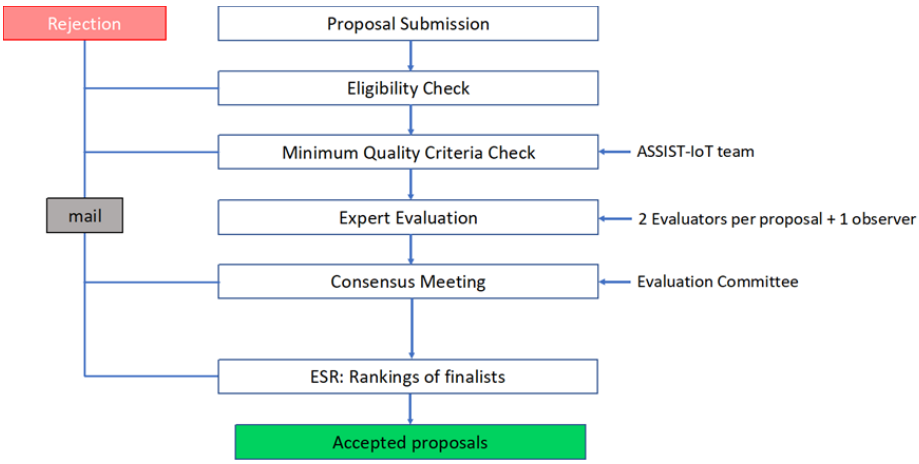

Figure 1. Open call evaluation procedure flow

2.2.2.WP3

The reporting period comprises the last three months of execution of WP3, in which T3.5 (ASSIST-IoT Architectural Design, Functional & Technical Specification) was still active. In particular, the Consortium worked towards:

- Delivering the final version of the ASSIST-IoT reference architecture (D3.7 – M21), enhancing the intermediate version presented 6 months before.
- Conducting fluid communication with technical work packages (WP4-WP5) to be aligned with the insights gained during their first period of execution.

The first significant modification included was about the concept of the *micro-application* concept. In former architecture iterations, enablers were expected to be composed by microservices. However, in the design phase of enablers, it was seen that it some cases it was better to leverage functional units larger than microservices. Hence, now enablers consist of a group of micro-applications, which might or might not be microservices, providing a specific functionality for the architecture.

Also, the architecture views were revisited. These are the most relevant changes:

- In the **Functional view**, where the four horizontal planes are depicted, the Device and edge plane was modified to clarify the scope of the enablers that it might involve. Particularly, its potential features are now classified into three functional blocks, namely: "edge intelligence", "pre-processing functions" and "communication capabilities" (from previous versions, analytics, AI capabilities and enhancement of IoT devices smartness have been grouped into a single block, i.e., edge intelligence). Also, a generalisation with respect of the hardware that could act as edge gateway/node was made, as previous iteration was too centred in the GWEN. The rest of the planes were slightly improved, being the fact that all functions related to the implementation of Distributed Ledger Technologies (DLT), because of their cross-cutting nature, should not be advertised as a set of plane functions, but rather as vertical capabilities.
- The **Node view** was extended, as it was seen that CPU and GPU processing architectures play a major role in the design and deployment of container, and thus it had to be better accounted for in the architecture. Particularly, it was deemed important as some enablers might not work in environments of the edge-cloud continuum if container images have not been prepared carefully, or might not have good performance without hardware acceleration capabilities enabled.
- The **Development view** was introduced in the architecture, aiming at providing some guidelines for designing enablers and to consider DevSecOps methodology to realise them, being thus an intrinsic part of the architecture realisation.
- Some guidelines of the **Deployment view** were somehow entangled in the previous architecture iteration, and therefore it was decided to arrange it into different subsections to add clarity. More options were presented to deploy enablers, aiming at not forcing a specific packaging and deployment tool and trying to be more agnostic to the architecture implementation.
- Finally, the information about the **Data view** was extended, including clear examples of how data pipelines should be formalised.

As Verticals were not directly addressed in the intermediate architecture version (D3.6), there was some room for improvement:

- Starting with the **self-* vertical**, the scope of the enablers defined was refined and contextualised with respect to self-* properties. In any case, the most important highlight made was that additional enablers bringing system autonomy or semi-autonomy (with a certain degree of intelligence) could belong to this vertical, not being limited to the ones under development within the project.
- **Interoperability and Scalability** are properties present in different parts of the architecture, however, any enabler was directly assigned to them at this point. In the final version, examples of interoperability in system realisations are depicted. With respect to scalability, this property is part of a Next Generation IoT system thanks partially to the modular characteristics of the considered hardware and software (e.g., Kubernetes). This version stresses that enablers can (and should) be developed with this property in mind, and an example of how Federated Learning enablers address it is provided.
- The **Security, Privacy and Trust** vertical was reviewed to include (a) aspects related to security identity and access management are discussed within the scope of decentralised ecosystem; (b) security considerations with respect to MQTT and third-party access; (c) detailed insights about Distributed Ledger Technologies are given: how they fit in decentralised environments, which data should be stored, process of assessment, how enablers are integrated with the ledger, etc.
- Finally, regarding **Manageability**, some refactor of the enablers and the features offered was performed. Specifically, (i) the features of two enablers were merged; (ii) the scope of the Composite services manager was slightly reduced to facilitate the realisation of data pipelines; and (iii) other manageability tools and mechanisms present in the rest of the Planes/Verticals were briefly depicted.

Additionally, several considerations for realising systems based on the ASSIST-IoT architecture were provided. Starting with the list of **essential enablers**, it was reduced and not the formerly identified ones were really needed in all cases. The c**ommon endpoints** were kept from previous iterations, with some refinement coming from practical insights gained during the execution of the technical work packages. The **monitoring and logging approaches** have been modified to be more scalable as well as technologically-agnostic, as the idea (as with the rest of the architecture) is not to force specific technologies. Finally, apart from the hardware-related **enablers exceptions** related to encapsulation infeasibility (or worthlessness) were explained, with two enablers fitting in this category (self-healing and cybersecurity monitoring agent), which should be installed over a node's Operating System.

2.2.3.WP4

In the reporting period (M19-M36), WP4 has focused on:

- Concrete the specifications of the project's devices, manufacturing and delivering them to the pilots (T4.1).
- Fine-tuning the specifications of the enablers, and complete their development (T4.2 – T4.4),
- Work in interfaces needed for further integration,
- Produce some technical videos to be published in the communication channels,

following the reference architecture guidelines (D3.5-D3.7) and receiving feedback from the pilots (WP7). All the activities related to the enablers' implementation have been completed, resulting in the release of D4.3 in this month (specifications + enabler code). This section will be reviewed task by task:

T4.1 (Device and edge plane)

As a result of this task, three devices have been designed, manufactured, and distributed to the pilots. In particular, the localisation tags and the fall arrest device were sent to Pilot 2, showing good performance results. These devices are based on the UWB transceiver Qorvo DWM1001c, with a microcontroller programmed to provide the features expected.

In any case, the higher effort has been put in the ASSIST-IoT Gateway and Edge Node, the GWEN, which suffered some delays related to the global chip shortage and also the specific needs for tailoring the operating system using Yocto. At this moment, Pilot 1, Pilot 2 and Pilot 3a have successfully tested the GWEN and deployed some of the enablers there, working great also in combination with other edge computing nodes.

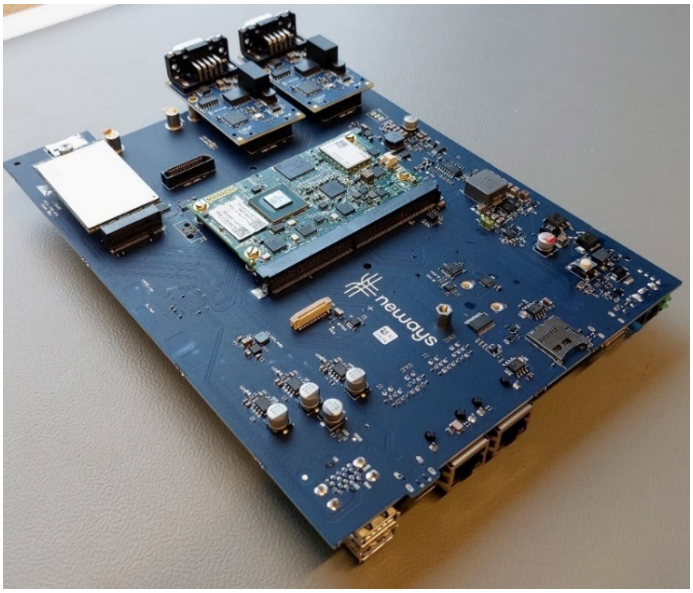

Figure 2. GWEN prototype developed

T4.2 (Smart network and control plane)

This task has delivered 8 enablers. Main effort has been put in delivering the edge-cloud Smart orchestrator, the main tool for managing the virtualised network and controlling the lifecycle of the enablers to manage. It has been designed considering **ETSI MANO specifications**, however, in the final version a **custom version of the MANO solution** was developed, as OSM technology formerly considered consumed many resources and was lacking some key features for containerisation workloads. The enabler has **AI policies** in case the user wants to let the system decide the workload placement in the edge-cloud continuum, and **manages the virtualized network**, ensuring enablers encapsulation is achieved. Its final architecture design can be seen in Figure 3.

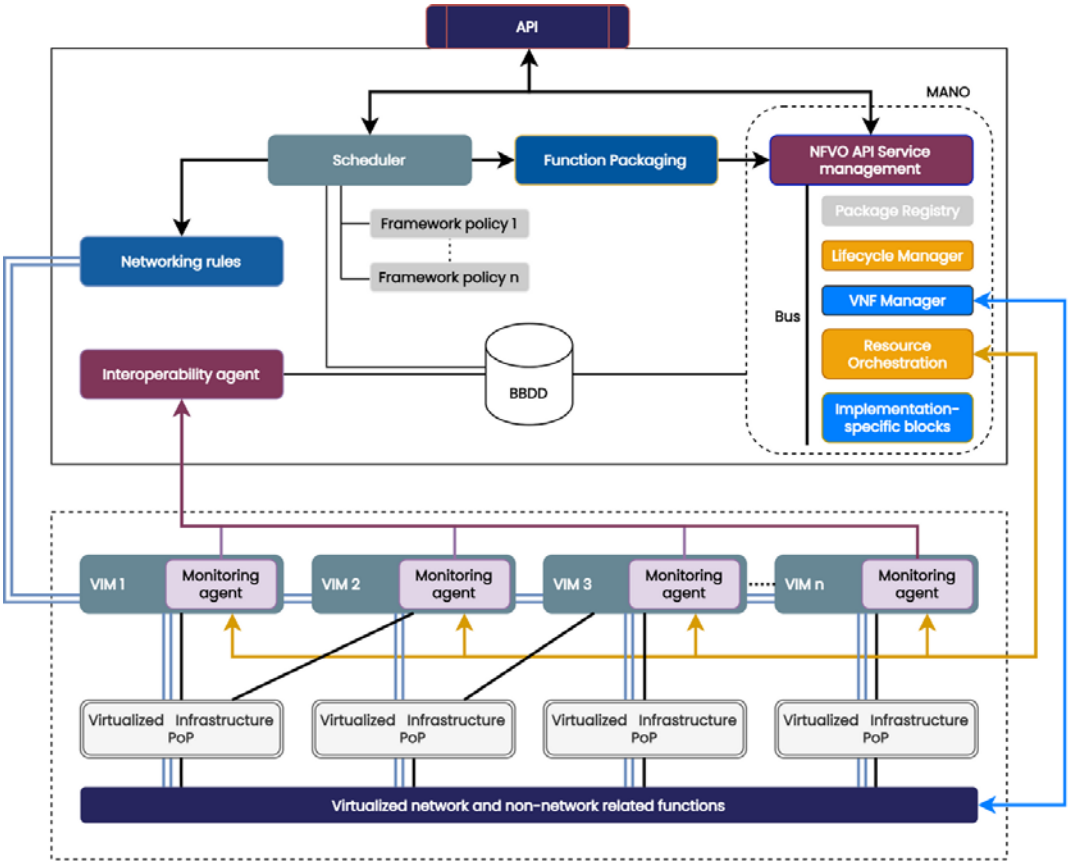

Figure 3. Architecture design of the Smart orchestrator

The next group of enablers designed are targeted for SDN networks: the SDN controller, the Auto-configurable network enabler, and the traffic classification enabler. These enablers have been developed, offering the following features: network topology configuration, monitoring of network elements (traffic load, data losses and latency), packet flows configuration, AI based policy rules generation, network resources optimisation for multidimensional KPI's, and packet classification.

The Multi-link enabler is able to manage different wireless access networks, so in case the configured primary link is down a second one is up without noticing (at least, not by the user) any kind of service disruption. The enabler offers the ability to be reconfigured in the meantime it is running. In the next figure, one can see an implementation of the Multi-link enabler between two hosts. In this case, there are two links (Ethernet and WiFi) combined by a bond in the client side and a bridge on the server side. The bond monitors the primary link (WiFi) and in case this link fails switch to the backup link (Ethernet). If the primary link connection is restored, it will switch to the primary link. In other words, the devices will be communicating all the time using the primary link except when the connection of the primary link is down.

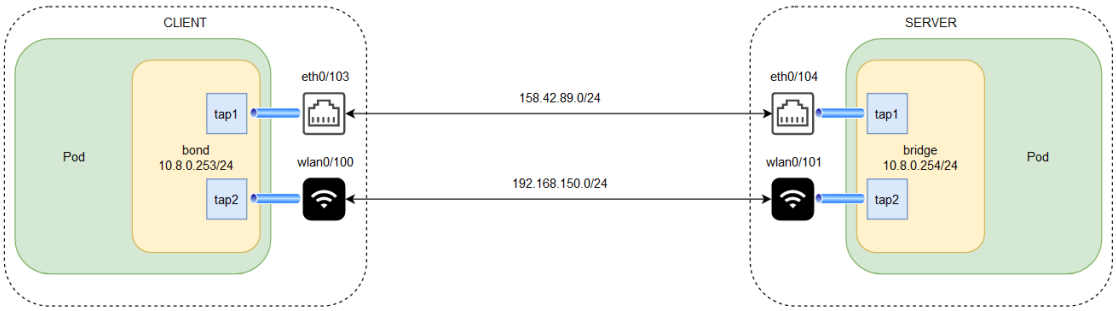

Figure 4. Exemplification of links available for a Multi-link realization

The VPN enabler was already finalised (only aspect under improvement was the use of LTSE from T4.3 to back up the peers' information), while the SD-WAN enablers (server and acceleration), based on open source software from Akraino community, have been completed. The final schema is the following:

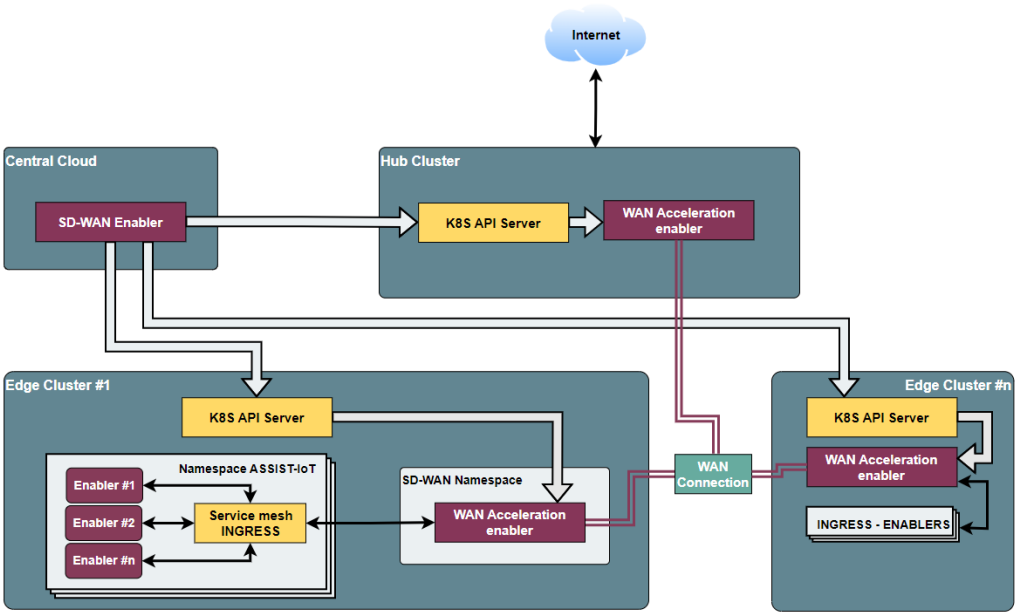

Figure 5. SD-WAN enablers working together

T4.3 (Data management plane)

This plane focused on the data semantic and governance enablers, delivering a total of 5 enablers. The semantic suite, composed of the Semantic annotator, translation and repository enablers, is finished. They use RDF as standard file format, and support annotations (considering several types of input formats) and translations both offline and via streaming (MQTT, Kafka), as well as dedicated graphical interfaces to manage them.

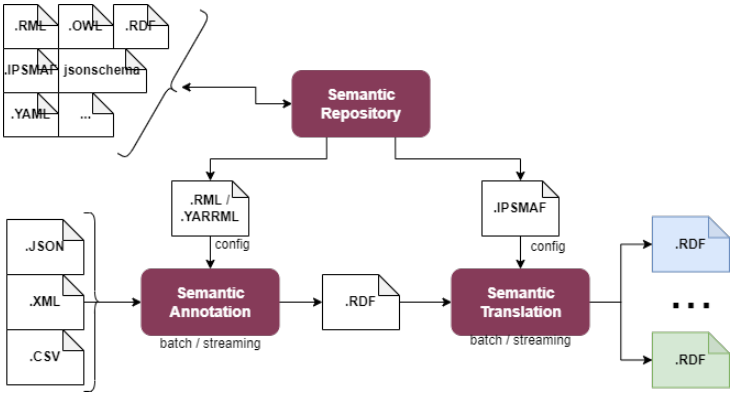

Figure 6. Semantic suite

Besides, the Edge data broker (EDB), which effectively works as a highly-scalable MQTT broker, has been completed after the implementation of the filtering and ruling capabilities, with a custom API interface developed with that purpose. Finally, the gateway component (i.e., API) from the Long-Term Storage Enabler (abbreviated as LTSE) has been extended to support a larger amount of calls to underlying SQL database, marking the finalisation of the enabler. It should be highlighted that its API has not been finally integrated to the IdM and Authz enablers from Task 5.3, as external access will be managed via OpenAPI.

T4.4 (Applications and services plane)

This task has delivered 6 enablers. Three of them aim at presenting data to users from different kind, including the Tactile Dashboard, the BKPI and the PUD. The efforts with respect to the Tactile Dashboard have been two-fold: (i) integrating it with the IdM and the Authz enabler (this is, the security stack) so access and allowable actions from users are managed through them; (ii) and allowing integration with other enablers, like BKPI and PUD dashboards, and manageability enablers. Different branches are available in the code repository, to have production-ready samples and for easing development activities. On the other hand, BKPI and PUD offer the possibility of collecting metrics and KPIs related to business and system/performance, respectively. Following SotA technologies, efforts have been done in ensuring that data from the environment and the system are properly gathered and processed, of special utility for the decisions of the Smart orchestrator, self-resource

provisioning and other enablers. Another interface for external users and applications is the OpenAPI manager – in this case, not graphical. The activities with respect to this enabler have been considered completed after being integrated with the IdM and Authz enablers, and implementing the ingress controller to proxy services by name also outside the scope of the Kubernetes cluster that hosts it.

The two remaining enablers are arguably the flashiest ones. The Video augmentation enabler was completed and successfully tested with video streams from Pilot 1, returning good results in terms of object identification and latency. Being an encapsulated exception, as Hololens glasses did not allow the same containerised environment as the rest of enablers, the MR enabler required some integration efforts to adapt it to the rest of the architecture, particularly, with the EDB and the PUD. Among its features, the visualisation of assets, customised alerting and report preparation (with additional text, voice, and pictures) can be highlighted.

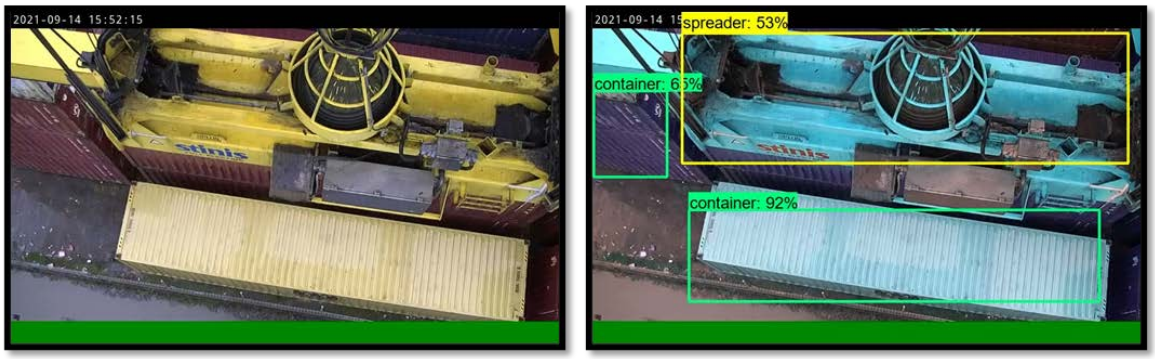

Figure 7. Video augmentation enabler inference example

Figure 8. Captures of the AR enabler

2.2.4.WP5

In the reporting period (M19-M36), WP5 has focused on:

- Fine-tuning the specifications of the enablers, and complete their development,
- Work in interfaces needed for further integration,
- Produce some technical videos to be published in the communication channels,

following the reference architecture guidelines (D3.5-D3.7) and receiving feedback from the pilots (WP7). All the activities related to the enablers' implementation have been completed, resulting in the release of D5.5 in this month (specifications + enabler code). This section will be reviewed task by task:

T5.1 (Self-* enablers)

The self-* enablers have been finalised. They are independent enablers that aim at providing autonomous features to the systems in which they are deployed and configured. The following features have been achieved:

- Self-healing device enabler: aims at providing to IoT devices with the capabilities of actively attempting to recover themselves from abnormal states, mainly divided in two categories: network security (lack of connection, jamming), and long-term resources (HW's end-of-life, HW unsupported capabilities), based on a pre-established routines schedule. It was deemed to be an encapsulation exception, as it was better to control the resources from the host level, and not from within the virtualisation one.

- Resource provisioning enabler: using forecasting ML techniques outcomes from monitoring data, it aims at adapting the auto-scaling of nodes and clusters more dynamically, achieving optimal use in relation to resource utilisation and general operation.
- Monitoring and notifying: responsible for monitoring the uninterrupted functionality of devices and notifying in case of malfunction incidents. Specifically, it has to ensure the departure of data, the arrival, the validity and its own self-monitoring functionality.
- Location processing enabler: provides highly configurable and flexible geofencing capabilities based on location data. It runs user-defined queries against the data storage. The enabler handles data updates and queries using both the HTTP-based request-response and streaming approach. It has been tested along with the outcomes of the location tracking enabler, which essentially is the firmware of the localisation tag from T4.1.
- Automated configuration enabler: it allows users to abstractly define requirements for functionalities and then to check whether those requirements are met by registered resources. The enabler can also automatically react to external actions based on predefined rules. Once configured, it performs automatic configuration over devices, based on the requirements and the reactions specified.

Overall, these enablers provide automatic capabilities to detect failures of the devices, correct them, automatically configure them, assign more resources to specific workloads in case they are expected to be needed and provide interoperable positioning context.

T5.2 (Cross-context Federated Machine Learning Enablers)

The FL stack is composed by 4 enablers, with additional support of one of the DLT enablers (FL-DLT). The overall FL architecture can be seen in the following figure:

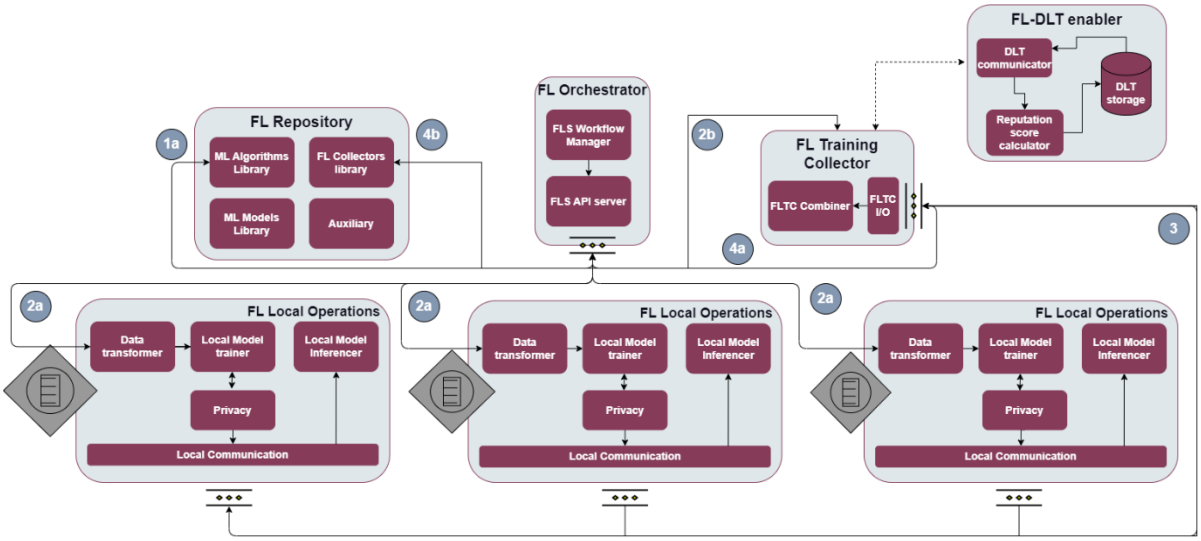

Figure 9. FL suite

All the enablers have been completed, supporting orchestration of the entire flow (via FL Orchestrator); model combination considering different aggregation strategies (e.g., FedAvg, via FL Training collector); remote training and inference (including easy-to-implement data transformation via FL Local operations), optionally supporting the use of privacy mechanisms such as homomorphic encryption and/or differential privacy; and providing storage for FL related data (via FL Repository) like: initial ML model weights and structure, the resulting training weights of specific ML models combined with stored metrics, aggregation strategies encapsulating different model weight averaging approaches, ML collectors for loading data of a certain format, or data transformations for reusable data pre-processing. Also, allowing communication among them via gRPC, web socket and REST API, and a dedicated dashboard to manage the training and distribution of the models in a simple way, as can be seen in the next figure:

Figure 10. FL Graphical user interface

T5.3 (Cybersecurity Components)

The cybersecurity stack has completed their development and integration efforts in time. Two types of enablers have been implemented:

- The IdM (Identity manager) and the Authorisation enablers, being the first one based on the KeyCloak solution and the second one developed from scratch, following the distributed nature of NGIoT systems. Main activities have been focused on (i) developing and packaging them, (ii) integrating them with other project enablers – so far, with Tactile dashboard and OpenAPI manager from T4.4, and (iii) providing **documentation and cookbooks** so developers – and pilots – can leverage them suitably. They were initially developed for protecting API endpoints, afterwards extended to applications.
- The cybersecurity monitoring enabler and its agents. An extensive API is available to former the first one, with SIEM and SOAR-related features (security analysis, intrusion detection, log data analysis, file integrity monitoring, vulnerability detection, configuration assessment, incident response, regulatory compliance, containers security – part of DevSecOps methodology, incident management and threat intelligence, among others). Apart from developing and packaging the solution, tailored for NGIoT environments, partners have focused on the agents as encapsulation exceptions. Although they could be packaged and deployed as enablers, it was deemed convenient to be deployed in the lower level, over the Operating System or at host level, as in this way their possibilities for monitoring the overall system are higher. Of course, container could have been deployed in privileged mode, but this would have opened some security breaches, thus contributing to security problems and not just focused on addressing them.

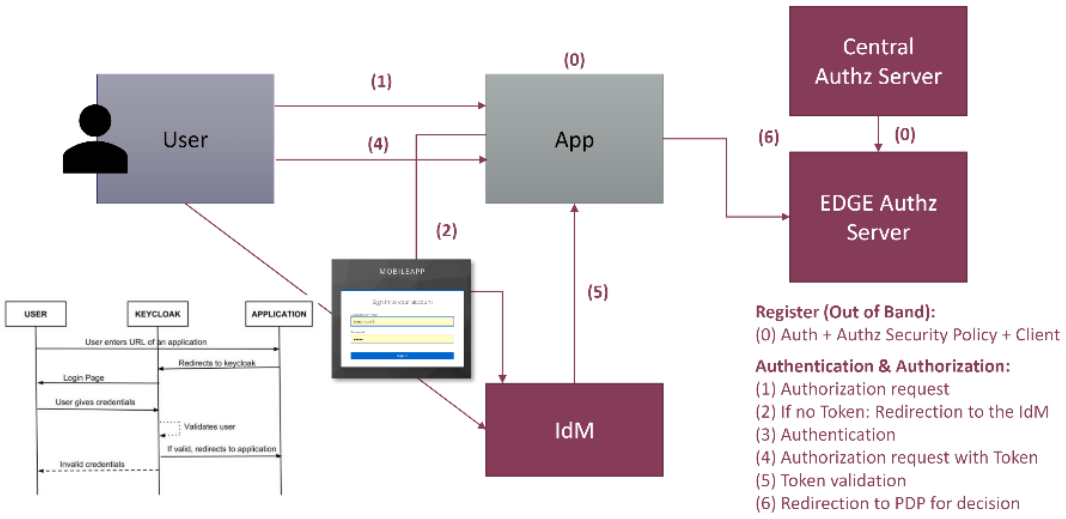

Figure 11. High-level architecture of the IdM and the Authorisation enablers

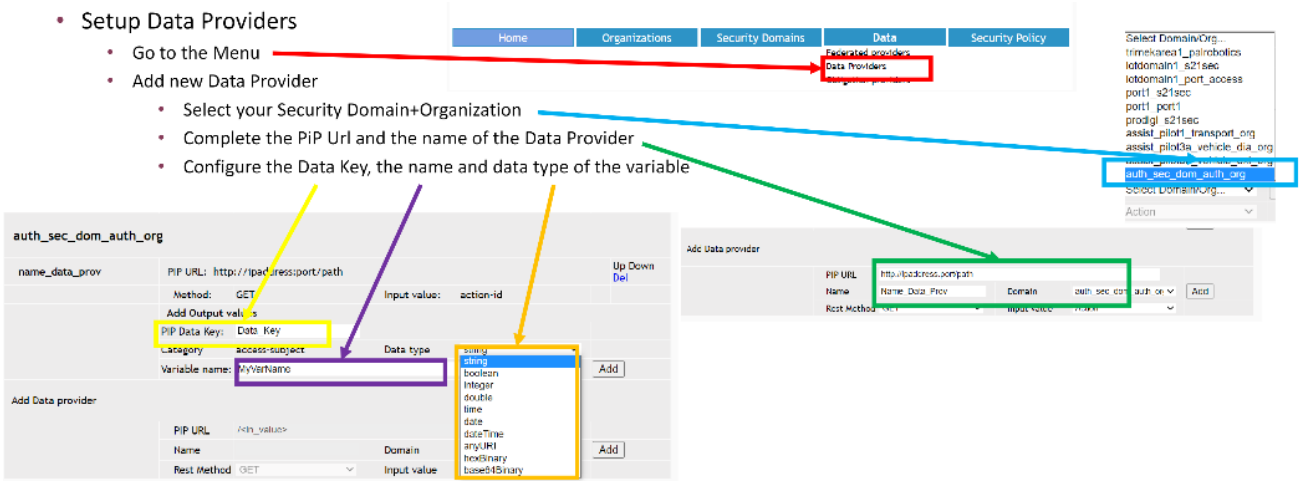

Figure 12. Capture taking from the cookbook to configure the Authorisation enabler

T5.4 (DLT Decentralised Infrastructure Privacy and Trust)

In this task, four enablers have been developed and packaged. They are very similar in the way in which they have been constructed, although the logic that governs them is different. These are specific objectives of each of them, and the high-level structure of the auditing and logging enabler can be seen in Figure 13:

- Logging and auditing enabler: logs critical actions that happen during the data exchange between ASSIST-IoT stakeholders to allow for transparency, auditing, non-repudiation and accountability of actions during the data exchange. Also, security events, if deemed appropriate.
- Data integrity verification enabler: data integrity verification mechanisms that allow data consumers to verify the integrity of any data at question, via comparison with stored hashed data in the ledger.
- Distributed broker enabler: data source metadata management and provide trustable, findable, and retrievable metadata for the data sources.
- DLT-based FL enabler: provides a secure reputation mechanism for all local operators in an FL system. The reputation mechanism serves as a safeguard against free-riders and malicious adversaries, ensuring that only reputable local operators can contribute to the global model (see Figure 9).

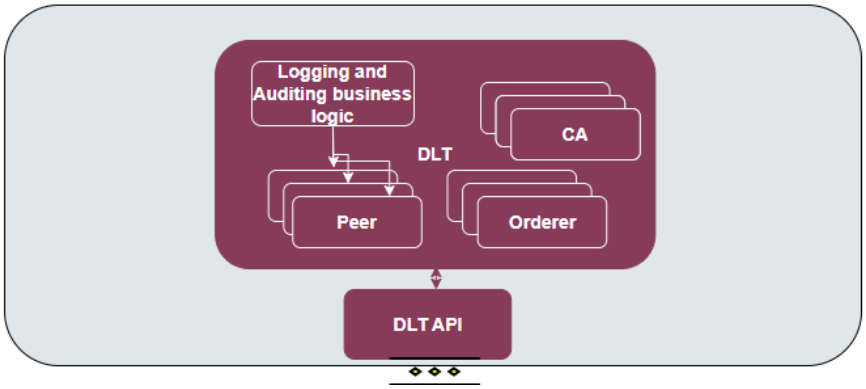

Figure 13. Structure of the logging and auditing enabler

T5.5 (Manageability and Control Enablers)

Three enablers have been completed: the Enablers manager, the Composite services manager, and the Cluster and topology manager. Each of them controls a specific part of the overall system, aiming at facilitating the interaction of external users with a deployed system based on the Smart orchestrator as main control element. These enablers are considered completed, after being integrated with the Tactile dashboard so that, effectively, user access and roles are managed by the security stack from T5.3. Additionally, a "flavour" of this stack has been developed specifically for Pilot 3a, as the number of edge nodes to manage was very large and a dedicated set of features were needed for that case.

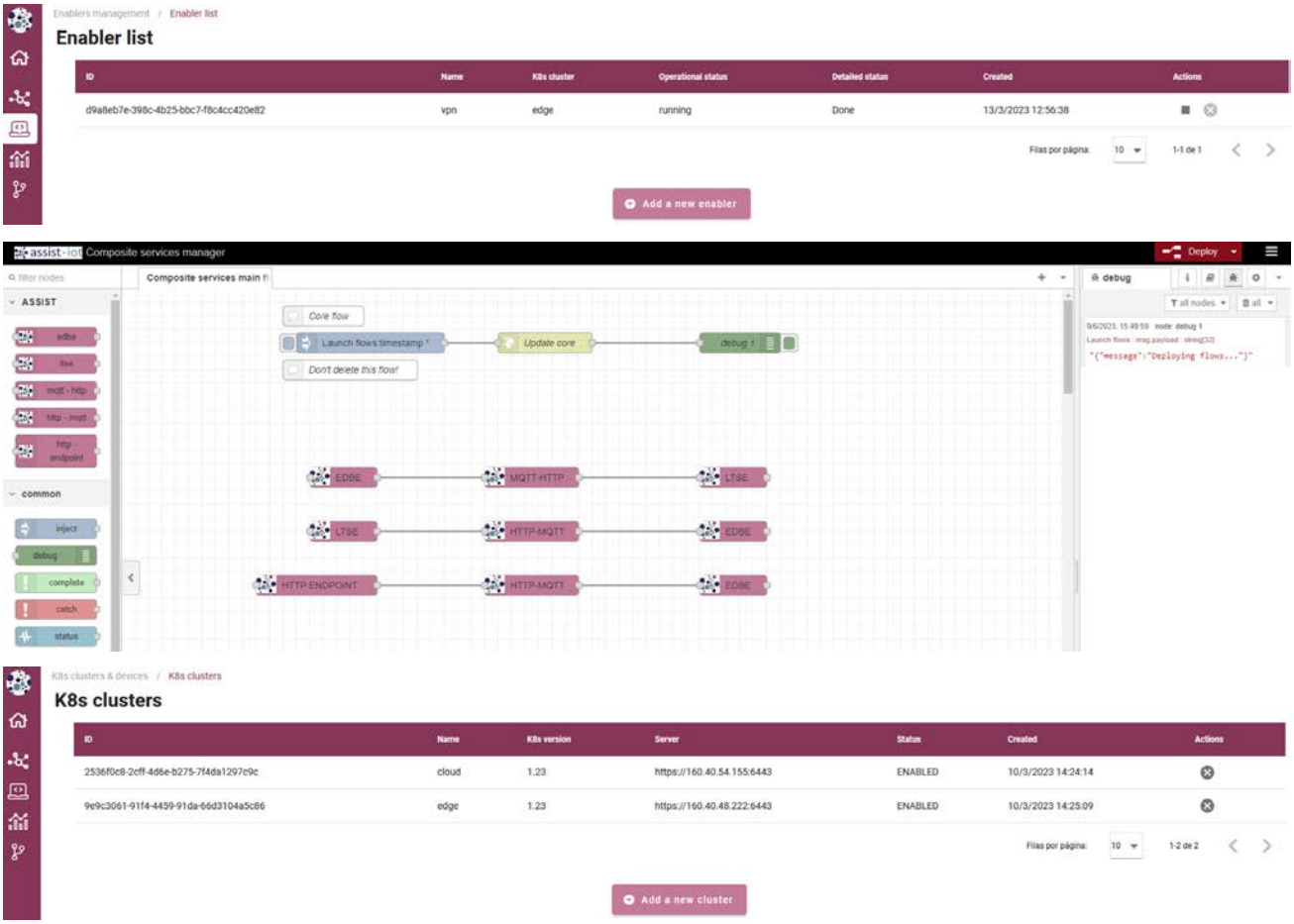

Figure 14. Manageability dashboards

2.2.5.WP6

This work package has been very active in the last months of the project. In the first phase of the project, the DevSecOps was defined (T6.1 - DevSecOps Methodology), to be followed in the development, integration, testing and releasing phases of the different enablers. This task has ensured that all the phases of DevOps are well implemented, and that security is an intrinsic part of them. In the reported period, key results have been:

- Creating a staging environment in which performing the testing and integration activities.
- Defining and implementing the key integrations between project enablers.
- Designing and executing the functional, integration and end-to-end tests envisioned for the project.
- Devising the releasing strategy of the enablers, including packaging, licensing, repository strategies and documentation. A Helm chart generator has been developed to help with packaging activities.
- All enablers have followed the strategy (the 3 encapsulation exceptions have not been packaged).

T6.2 (Testing and Integration)

As an outcome of this task, the testing and integration methodology were designed, depicting the testing environment and tools (GitLab CI/CD, GitLab Runner, Helm, and container registries) used in the project. The staging environment for testing and integration was prepared by partner CERTH, with partners allowed to access via VPN, comprising the elements presented in the Figure 15.

Several kinds of tests have been performed in the project, including functional (for the features of the enablers), integration (among enablers), and end-to-end (for the cases that will be required in the pilots), reported in D6.3 and D6.8. Regarding acceptance and performance, in many cases they are bound to the pilots' evolution, and therefore evaluation will be executed in the following months, to be reported in WP8 (D8.3, M41).

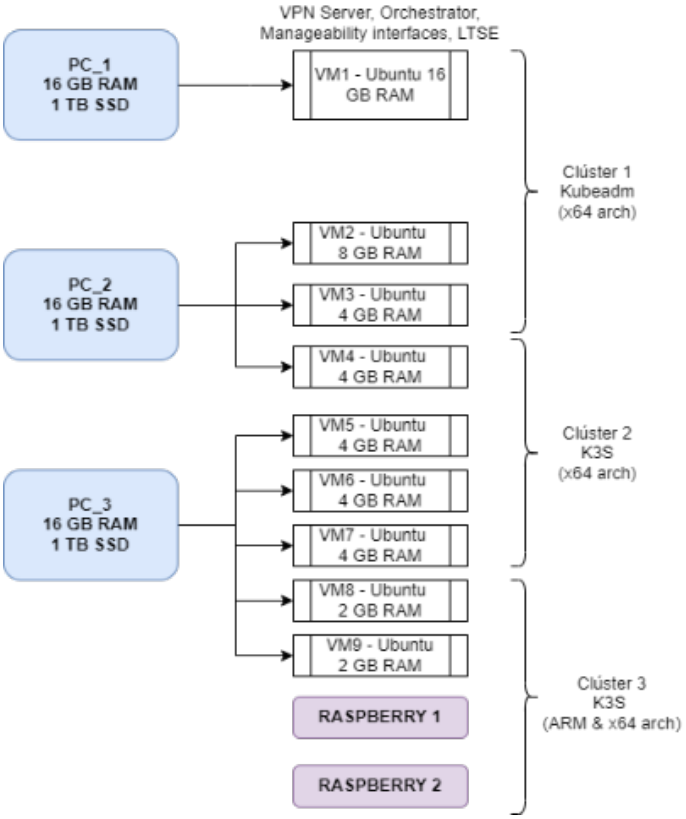

Figure 15. Test environment to simulate pilot site premises

T6.3 (Packaging and Releasing)

This task defined a release plan, a packaging methodology, and a strategy for publishing and licensing the outcomes, to be followed by the enablers of the project. The plan included three phases, aligned with the activities of WP4 and WP5:

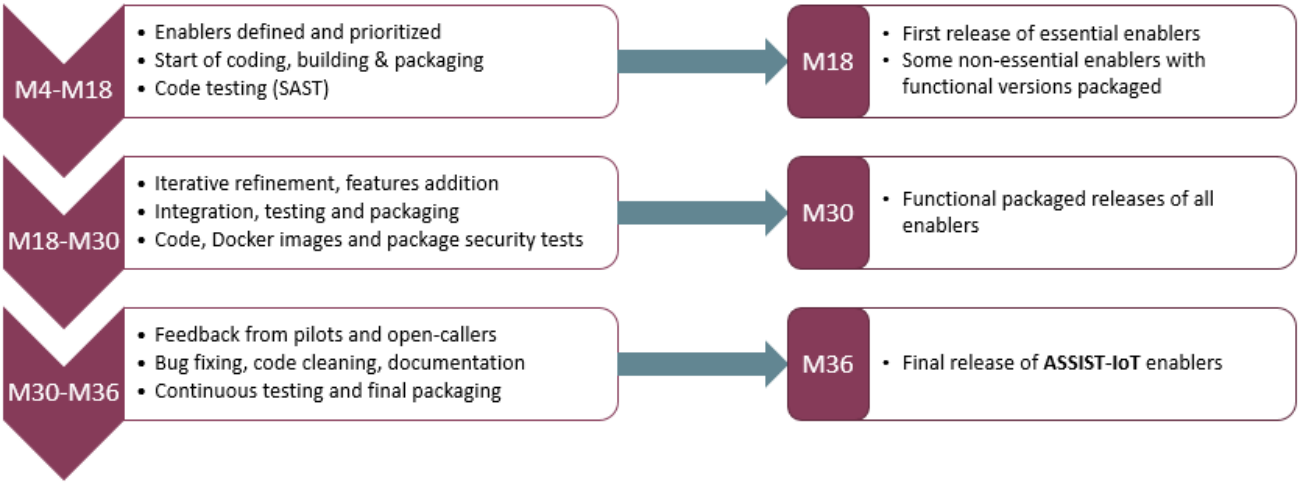

Figure 16. Release plan

Regarding packaging, naturally after considering containers and Kubernetes as key technologies for an architecture realisation, Helm was chosen to **wrap enablers** in a single file, and **ease configurations.** Charts of ASSIST-IoT follow the official conventions and best practices posed by Helm. Hence, the official structure is kept, considering the typical folders (*charts* – for the dependencies; templates – for the components' files; and *crds* – for the custom resources, when implemented) and files (*Chart.yaml* – with the main information of the chart, included sub-charts info; *values.yaml* – with configuration/deployment options applied to the templates to realise manifests at deployment time; and the typical *LICENSE* and *README* files). In addition, this structure is extended with two minor modifications: first, by **including a folder structure within the templates folder**, to separate the templates related to each components developed (not from third-parties, those are kept separately

in their respective charts, under the charts folder); and second, by including a *qa-values.yaml* for having configuration parameters for development phases (e.g., for the staging environment) separated to the official one. The structure proposed is presented in Figure 17 (left). A Helm chart generator has been specifically developed within the scope of the task in order to ease the packaging process.

With respect to licensing, ASSIST-IoT will work on the basis of delivering its results considering **Apache license 2.0 or licenses with similar nature** (MIT, GNU GPL and BSD). This particular license is one of the most popular open-source licenses and belongs in the permissive category, allowing users to do anything they want with the code, with very few exceptions. Partners reserve the right to apply different licenses and levels of code sharing in case of requiring additional protection (e.g., because of internal policies). Besides, all technical results from WP4 & WP5 will be make available for usage, even in the eventual case that code is not shared. **The following registries are already open to the community**: GitHub: link, DockerHub: link.

Figure 17. Proposed enablers' chart structure (left); registries considered (right)

Finally, in order to implement DevSecOps, security testing tools need to be automated and integrated with the development tools and processes. This allows for security testing to be done continuously and automatically as new code is committed, resulting in the integration of security testing as part of the CI/CD pipeline. In the packaging phase, **GitLab SAST and KubeLinter** have been the security testing tools implemented by default in the pipeline provided as baseline for the enablers' maintainers.

T6.4 (Technical and Support Documentation)

Finally, documentation in ASSIST-IoT has been delivered, considering the following aspects:

- Installation prerequisites (hardware, K8s, etc.).
- Steps for deploying a baseline system.
- High-level documentation for the architecture and enablers.
- Open calls feedback.

The main source of documentation is the **ReadTheDocs page** (link) This repository is used to document the main technical developments of the ASSIST-IoT Project, namely the enablers of the ASSIST-IoT architecture. This documentation will be used as a tool that will help technical personnel and third parties to integrate and use the capabilities of ASSIST-IoT technical outputs and solutions.

Each enabler has its dedicated wiki page organised following a general approach and consisting of the following sections: Introduction, Features, Place in Architecture, User Guide, Prerequisites, Installation, Configuration options, Developer guide, Version control and Release, License, Notice. It is important to stress that the ReadTheDocs Platform, chosen to host the documentation of ASSIST-IoT, supports continuous and dynamic integration and thus it will be the main public repository that will reflect the progress of the technical developments.

2.2.6.WP7

WP7 has continued fulfilling the work for performing the pilots' trials, aiming at both improving current technological systems thanks to ASSIST-IoT innovations, and to evaluate the latter within the context of T8.3. It should be noticed that the Pilot 2 construction site was entering into its final construction phase during Summer '23. Thus, all Pilot 2 in site activities were successfully completed in July '23. Overall, the implemented activities can be summarised into:

- Finalisation of procurement and of pilot-specific development activities.
- Integration of project enablers in the respective pilots' systems, as well as Open callers' developments.
- Initial evaluation of the pilot-related KPIs.

As reporting all the activities carried out in the last 18 months would require a dedicated deliverable, the current pilots' status (extracted from the minutes of the last physical plenary meeting in Malta on 4-6/Oct/2023) is summarised below.

Pilot 1 – Port automation pilot

With respect to Pilot 1, three trials are to be executed: tracking assets in terminal yard, automated CHE cooperation and RTG remote control with AR support. In this moment, all procurement and development activities have been completed, and with respect to integration activities, trial #1 has completed all the foreseen integrations, trial #2 is advancing on them, and trial #3 were just started due to the ROS commissioning delays. Key pilot effort has been done in developing tactile interfaces and dashboards for the different actors of the trials, as can be seen in the following pictures:

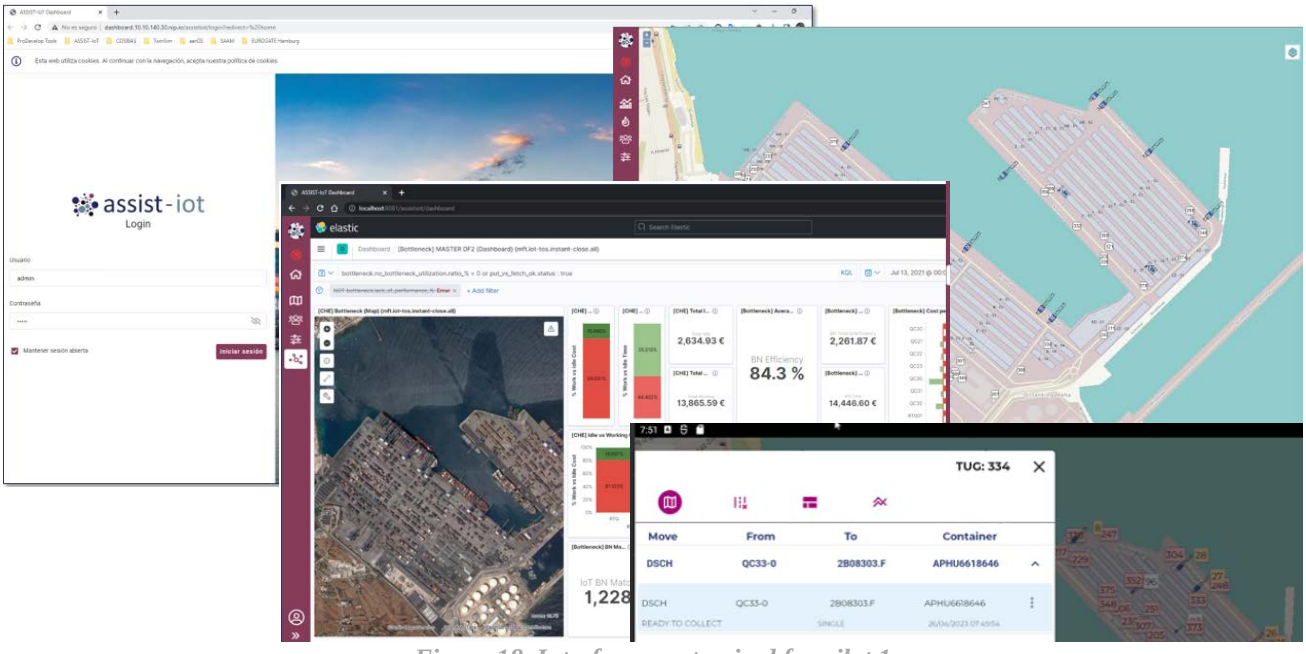

Figure 18. Interfaces customised for pilot 1

Pilot 2 - Smart safety of workers' pilot

Since the construction site used as pilot testbed was about to be finalised in Summer '23, Pilot 2 had to speed their development and integration activities with respect to the rest of the pilots. Three trials are in this case defined: Occupational safety and health monitoring, Fall-related incident identification, and Health and safety

inspection support. Regarding trial #1, the activities related to alarms when entering a danger zone, going to an area without permissions and UV exposure tracking were completed successfully in the pilot site. With respect to the trial #1, the fall detection experiments were also completed successfully, in lab conditions and in the construction site. Regarding trial #3, the activities related to BIM & worker data visualisation, reporting, danger zone restriction visualisation, and alerting were completed. In this case, the MR enabler played a key role.

All in all, it can be summarised that trials were a great success, considering the shorter time to implement all the effort in comparison to the rest of the pilots. There were some issues when integrating some of the WP4-5 enablers. The reported feedback to the rest of pilots is being crucial to have them ready for the final stages of the trials of the rest of the pilots. There are some remaining tasks, as integrating the Personal Cooling System's (PCS) communication with the GWEN, implementing the logic for controlling the PCS, and prepare for the last laboratory validation activities in CIOP (scheduled for November). As a result of the pilot activities, the following video can be consulted: https://www.youtube.com/watch?v=2dxT6Knj_L0

Pilot 3A - Vehicle in-service emission diagnostics Pilot

Pilot 3A has a main trial to perform, fleet in-service emission verification, which considers two trials: the verification itself, and the diagnostics phase. At this moment, all the procurement and almost all development activities have been carried out successfully, and current effort is being in integration and the development of specific web interfaces so that users (different roles in place) can manage the overall features. Among key features, one can highlight (i) the finalisation of all the hardware setup at the car under test, (ii) the fault-tolerance system deployed, as cars may easily suffer of disconnections, and (iii) the development of a scalable system that can support deploying enablers and retrieving data from a fleet of more than 100.000 edge nodes (i.e., cars). The architecture of the system being integrated is the following:

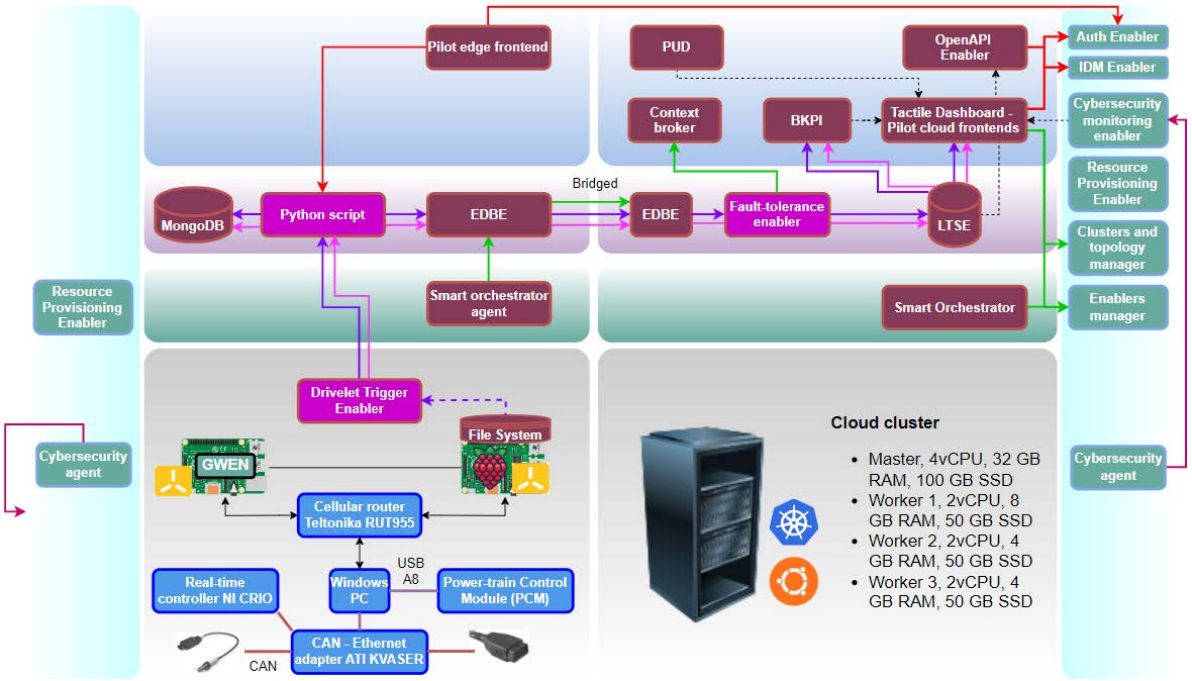

Figure 19. Architecture diagram for pilot 3a

Pilot 3B - Vehicle exterior condition inspection and documentation pilot

Pilot 3B has continued its activities towards the fulfilment of the two considered trials: (i) vehicle's exterior condition documentation, and (ii) visualisation with automated inspection via AI & FL training. Since some software artifacts for both trials had to work aligned, a single architecture diagram for addressing the pilot was made (see Figure 20). At the last period, the effort has been put in: finalising such architecture design, completing the procurement activities (i.e., access to real scanners data, provisioning of edge and cloud servers), developing specific enablers for the pilot, and integrating them with ASSIST-IoT enablers. At this moment, effort is being done in the latter, now that all hardware and software artifacts are in place. Additionally, an activity to integrate their business application dashboard with the project's Tactile dashboard is planned, so that users' access management is carried out by the latter.

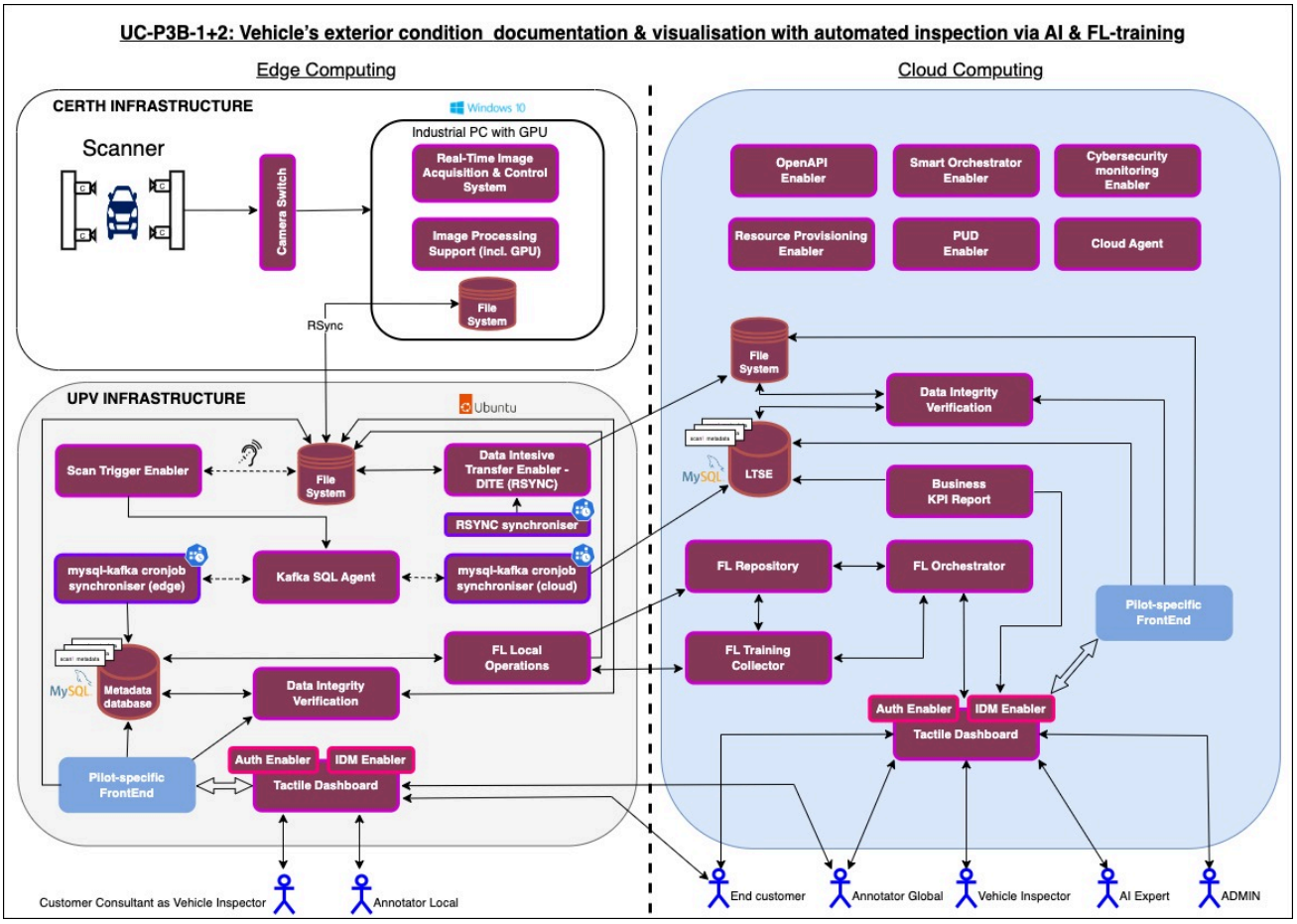

Figure 20. Architecture diagram for pilot 3b

2.2.7.WP8

The activities in WP8 can be grouped into two main streams:

- The definition, methodology preparation, and gathering of the project KPIs,
- The overall project evaluation.

In D8.2, the evaluation methodology was updated from D8.1, by providing more detail on the exact procedure and mechanisms to be used for the final evaluation of the identified KPIs. These KPIs have kept the partitioning into five different dimensions of assessment. Those include exploitation, impact, pilots, technology as well as ethical, societal, gender and legal evaluation. Dimensions are then further subdivided into fields that group together related Key Performance Indicators. Working towards the final version D8.3, a new template has been developed with the aim at reporting all KPIs in a homogenised way, with tailoring mostly in the tables/figures needed to presenting the outcomes. Additionally, partners have been already capturing many of the KPIs. The envisioned template is the following:

Table 2. Summary of KPI X.X.X

Name	***Name of the KPI***				
Description	*What is the KPI about.* ***Do not over explain****.*				
Motivation	*Why is it important to have/mention as KPI (added value). Try not to exceed 4-5 lines of text, unless needed.*				
Initial target		***Score****		***Achieved***	*Yes/No*
Rationale target selection	*Why the target number was selected. Try not to exceed 4-5 lines of text, unless needed.*				

Measurement period	
Partner/s responsible	

**** In case of several measurements, averaged.***

Measurement methodology

*Test/measurement procedure (what and where do we have to measure). Suggested to include a list of **steps**.*

*Include involved **actors**, **enablers**, and **data sources.***

Include how it is measured (tools, formulas, models, etc.). It can be also based on expert judgement, questionnaires, existing methodologies and other references. Regardless of the case, justify it.

Specify how the baseline is computed, in the cases needed.

Results and outlook

In this section, some templates for reporting the outputs are included (D8.3 in M41), as well as some considerations for reasoning the KPIs obtained.

In addition, a live excel is shared by the Consortium to track the current status of all the KPIs, aiming at detecting any possible deviation from the initial objectives. With respect to the process evaluation, some actions have been realised:

- An analysis of transferability methodologies is being carried out. Among the preliminary outcomes, the AIOTI's replicability tool will be used for characterising the project KERs.
- A general survey of adoption barriers for NGIoT systems has been conducted, to get more insights of the current situation.

Adoption Barriers of Next Generation IoT technologies

Purpose of the questionnaire

This survey is part of the project "Architecture for Scalable, Self-*, human-centric, Intelligent, Secure, and Tactile next generation IoT' - 'ASSIST-IoT'", funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 957258.

The Next Generation Internet of Things (NGIoT) leverages progress in enabling technologies such as 5G, cyber-security, computing continuum, AI, Augmented Reality and tactile internet, with the goal of building a competive ecosystem of European IoT technology while ensuring end-user trust, security and privacy by design.

Task T8.4 of ASSIST-IoT project has developed this questionnaire containing tables and heterogenous fields in order to understand the adoption and implementation barriers of NGIoT solutions (i.e., administrative, political, financial, technological, geographical, cultural related barriers/drivers). T8.4 relies on the exposed information on the developed deliverables of the project (https://assist-iot.eu) and spreads this questionnaire to selected experts and stakeholders with technical background to gain knowledge on such barriers and drivers.

The questionnaire is structured in five parts, starting with a profiling chapter to understand the responder background, followed by some sub-parts corresponding to the features that characterize the adoption barriers. The aims of the survey are:

- To collect experts' and stakeholders' opinions on the relevance of each barrier and specific aspect, to feed back the technical and exploitation approaches of the results of ASSIST-IoT.
- To understand the different views of the barriers depending on the respondent profiles.
- If necessary, to map additional barriers which had not been considered. This questionnaire is the first of a series of three surveys that are planned to be exerted by T8.4 of ASSIST-IoT.

Figure 21. First page of the adoption barriers survey

2.2.8.WP9

With respect to WP9, in the last reporting period the communication, dissemination, standardisation and innovation-related efforts have been intensified. In this section, we review the most relevant figures achieved so far. In Figure 22, one can see the outstanding results in terms of publications and outreach in the different communication channels. Among other activities, the communication task has been recently focused in other activities such as (i) communication of pilots' and enablers' videos, (ii) participation in EUCEI communication task force, (iii) the release of newsletters – one each 3 months, (iv) the promotion of ASSIST-IoT results in channels externals to those of the project, like the EUCEI newflashes and website, (v) promotion of project surveys and white papers, or (vi) contribution to Hipeac magazine. The ASSIST-IoT website and social media are the main communication channels used and where all the aforementioned activities/content are reported in more detail.

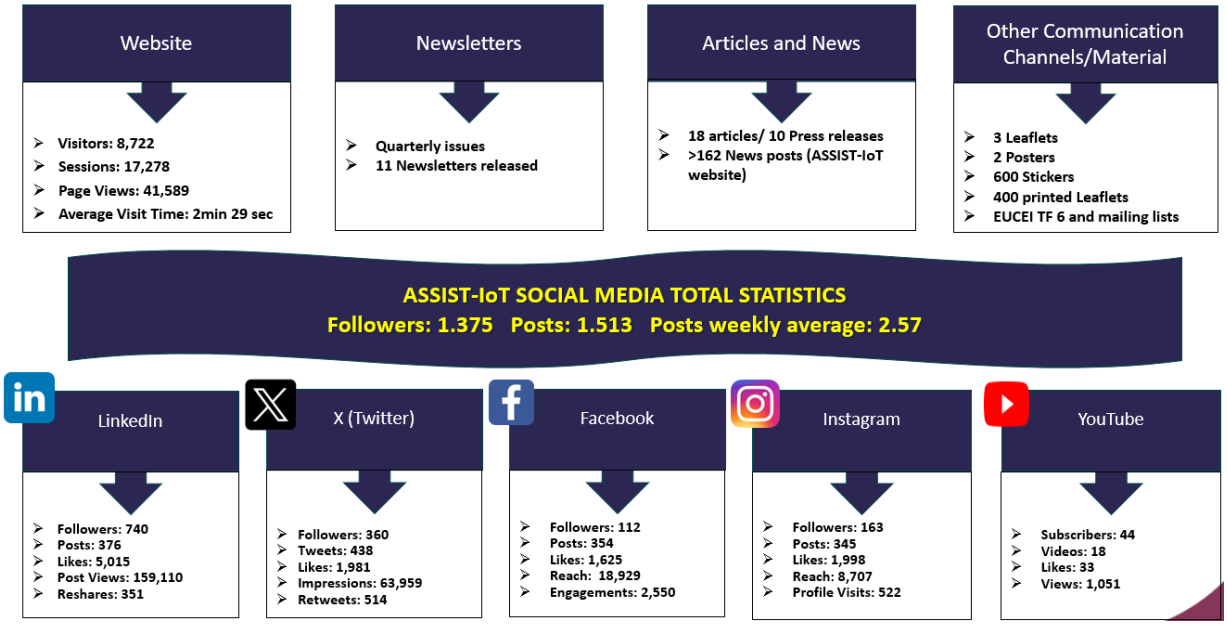

Figure 22. Statistics of the communication channels at M34 (August 2023)

With respect to scientific dissemination, 36 contributions out of the 38 defined at the beginning of the actions have been published, counting journal papers, conference workshops, contributions to book chapters and white papers. Also, some additional contributions have been submitted and/or pending to be released, and therefore the dissemination effort is considered in very good shape. In https://assist-iot.eu/publications/, one can see the total list of scientific dissemination actions carried out by the Consortium.

With respect to standardisation, the project is expected to meet the KPIs related to this task. Efforts is being made by the partners of the Consortium in different fields, including:

- OPL/UPV – AIOTI (in reports preparation, gaps analysis, High-level Architecture release, use of the replicability tool, etc.).
- OPL/partners – ITU-T, ETSI (in ITU-T SG-20, following specialist task forces, analysing potential areas of contribution).
- OPL/SRIPAS – IEEE SA (particularly, in the ontology standards working group).
- S21SEC – ENSO/ENISA (monitoring in security).
- CIOP-PIB CEN/TC248/WG 31 (proposal of technical standard or technical specification will be submitted)

Finally, with respect to innovation and exploitation, several actions have been carried out after the definition of the plan and the identification of the (15) Innovation Elements (IE) of the project. In this last reporting phase, thanks to the work of the **spin-in customer identification task force**, the project has identified the 7 Key Exploitable Results (KERs), including the Joint result:

1. TruckGUI app
2. Workers' safety system
3. In-service emission diagnostic
4. Enhanced scanner
5. GWEN
6. Enhanced security centre
7. ASSIST-IoT platform (joint result)

Q1 - How are we going to ensure we are fulfilling a worth-problem solving?

Q2 - How are we to ensure continuity of our project results beyond the end of the project?

These two questions about the KERs are being answered thanks to the participation of ASSIST-IoT in the **Horizon Booster Result (HBR) initiative**, aided by the preparation of supporting material such as exploitation intentions summaries, risk assessment maps, elevator pitches, characterisation tables. Particularly, the HBR will help to answer the previous questions in two phases, considering the following strategy:

Q1 - How are we going to ensure we are fulfilling a worth-problem solving?

HORIZON RESULTS BOOSTER — European Commission

PDES action

1. Review of the key exploitable results of the project
2. Revise, complement and clarify existing exploitation plans of project results
3. Identify all relevant stakeholders in the exploitation value chain.
4. Support to perform a risk analysis related to the exploitation of results.

Q2 - How are we to ensure continuity of our project results beyond the end of the project?

HORIZON RESULTS BOOSTER — European Commission

BPD action

1. Market analysis.
2. Business Strategy.
3. Operations Plan.
4. Competitor identification and analysis.
5. Clear action plan and estimation time to market.

3. Current risk assessment tables

The following tables contain the current information of the risk assessment tracking file (live document) managed in ASSIST-IoT. Those risks marked in light purple correspond to the risks identified since the proposal stage, those in green come from the enhancement reported in D2.5, the ones that we identified in the period M9-M18 for D2.6 are highlighted in blue, those that arose within M19-M27 for D2.7 are in orange, and finally, three new detected risks are in cyan.

3.1. Management risks

Table 3. Management related risks in ASSIST-IoT

Risk description, comments and potential consequences	Mitigation measures, corrective actions and status/comments per iteration
Name Partners related risks (identified since Proposal stage) ***Description:*** Underperforming, leaving the project, key-personnel temporally not available, reorganisation distracting day-to-day activities. ***Potential consequences:*** • As per D2.5 (M9): Delays, extra efforts to be justified. • As per D2.6 (M18): Not reaching on time documentation and software (enablers) delivery, jeopardising further activities. • As per D2.7 (M27): Jeopardising integration of enablers or deployment of ASSIST-IoT in the pilots. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Medium* • At D2.6 (M18): *Low + Medium* • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.5 (M9):*** COVID-19 increases possibility of materialisation of these risks. Moreover, partners may be overburdened by the success/failure	***Mitigation measures:*** Flexible project management structure and project CA allow quick shift of resources to alternate partners, and quick inclusion of new partners in the Consortium, if necessary. All Consortium partners are involved in related areas with more than one staff member, ensuring an immediate substitution. ***Additions in D2.5 (M9):*** COVID-related aspects of these risks, and possible mitigation approaches (including importance of the need of efficient communication) have been discussed during the Kick-off meeting, and have been acknowledged by the partners. So far, no need to elaborate this risk further occurred. ***Additions in D2.6 (M18):*** Managerial measures proposed were discussed again in the February 2022 meeting with partners, with no red flag or issue raised. ***Additions in D2.7 (M27):*** This period has been characterised by several holidays timeframes which might have caused underperforming warnings, however a solid plan for deliverable contributions and early advances in technical tasks, alongside a holiday control spreadsheet, diminished the likelihood of this underperformance. ***Status:***

related to the COVID pandemics (too many/too few activities). Related also to the next risk. ***Notes in D2.6 (M18):*** By the middle of the project, execution is overall smooth and the partners are in a good position to face the pilot deployment and to welcome Open Call winners. ***Notes in D2.7 (M27):*** By January 2023, partners are performing well in general, some delays have been noticed but mitigation measures are being put in place. No underperformance that might jeopardise the success of the action. ***Notes after the latest execution period: M28-M36:*** With only 5 months to go, key people is still involved and the project is being executed properly.	• At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*
Name: Planning problems (identified since Proposal stage) ***Description:*** Resources underestimated, project timing not appropriate, deliverables/milestones delayed ***Potential consequences:*** • As per D2.5 (M9): Delays, extra efforts to be justified. • As per D2.6 (M18): Not reaching on time documentation and software (enablers) delivery, jeopardising further activities • As per D2.7 (M27): Not submitting deliverables, diminishing the scope of pilots, not reaching KPIs, WP2 timing disrupted. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Medium* • At D2.6 (M18): *Low + Medium* • At D2.7 (M27): *Medium + High* • At D.13 (M36): *Low + Medium* ***Notes in D2.6 (M18):***	***Mitigation measures:*** Potential solutions: involvement of other partners with available resources, rearrangement of resources among partners, change of project plan, as a result of self-assessment activities (in direct communication with the EC / Project Officer), and ensuring timely implementation of corrective actions ***Additions in D2.5 (M9):*** COVID-related aspects of these risks, and possible mitigation approaches (including importance of the need of efficient communication) have been discussed during the Kick-off meeting, and have been acknowledged by the partners. So far, no need to elaborate this risk further occurred. ***Additions in D2.7 (M27):*** In order to mitigate this risk, an amendment has been launched including an extension request of 5 months. Receiving a positive confirmation of the application of such expansion, the project as a whole would end in March 2024 instead of October 2023. This fact would allow planning problems to be relaxed, enabling technical, pilot, and mostly, Open Call and impact activities to finalise smoothly and on time. A

COVID-19 outbreaks have prevented the project to host physical meetings, which has had certain influence in the planning of tasks, etc. This is about to change as the 4th Plenary Meeting of the project is expected to take place in Valencia during M19. ***Notes in D2.7 (M27):*** The materialisation of several risks, alongside the addition of external factors such as global chip shortage, inclusion of third linked parties, among others, have shifted this risk to the focus of the task, being tackled straightforwardly during this period. ***Notes after the latest execution period: M28-M36:*** The extension allowed mitigating this risk, allowing an optimal production and in-time delivery of the project outcomes. With the four deliverables to be finalised this month, the project will have five months to end all the activities related to pilots, assessment and impact, to be reported in the last six deliverables of the project. No additional mitigation measures needed in this period.	contingency plan that included this amendment's extension request was prepared alongside a careful and thorough re-distributions of deadlines. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *Some symptoms detected and under control* • At D2.7 (M27): *Materialised. Mitigation measures are being put.* • At D2.13 (M36): *No additional symptoms detected.*
Name: Collaboration issues (identified since Proposal stage) ***Description:*** Consortium cannot agree, WP interaction not satisfactory, coordination not efficient. ***Potential consequences:*** • As per D2.5 (M9): Delays, extra efforts to be justified. • As per D2.6 (M18): Not reaching on time documentation and software (enablers) delivery, jeopardising further activities • As per D2.7 (M27): Preventing tasks and WPs to finalise on time and to accomplish their objectives. ***Likelihood + Severity:*** • At D2.5 (M9): *Medium + High* • At D2.6 (M18): *Low + Medium* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low*	***Mitigation measures:*** The project management (as described in Project Handbook; D2.1) provides appropriate decision-making and conflict resolution procedures, which will be applied. As the last instance, management of the affected organisations, including the coordinating organisation, will be involved in problem resolution. ***Additions in D2.5 (M9):*** COVID-related aspects of these risks, and possible mitigation approaches (including importance of the need of efficient communication) have been discussed during the Kick-off meeting, and have been acknowledged by the partners. So far, no need to elaborate this risk further occurred. ***Additions in D2.6 (M18):*** Additional communication/collaboration channels have been put in place like GitLab comments, GitHub account and Slack. ***Additions in D2.7 (M27):***

Notes in D2.5 (M9): Issues considered in this risk are on "higher level" than the ones discussed in the previous risk. While symptoms of the communication risk have been observed and mitigated, no symptoms covered by this risk have been spotted. ***Notes in D2.6 (M18):*** COVID-19 outbreaks have prevented the project to host physical meetings, which has had certain influence in the planning of tasks, etc. This is about to change as the 4th Plenary Meeting of the project is expected to take place in Valencia during M19. Severity is also considered a bit lower as partners are more gotten to each other at this stage of the project and communication is more fluid. ***Notes in D2.7 (M27):*** This risk has been diminished, as face-to-face meetings are now being held. Interaction by partners has been benefitted from the previous. A Plenary Meeting was hosted in Valencia on May 2022, and another one took place in Warsaw in October 2022. In addition, specific 1-to-1 meetings between partners, PRO-UPV, TWOT-CERTH-UPV and many others were scheduled and conducted. Finally, a code-camp to boost final development and integration was organised in Bilbao in January 2023. ***Notes after the latest execution period: M28-M36:*** F2F meetings continued being held (Thessaloniki, Malta), as well as a second code camp. Collaboration among teams is satisfactory, and any additional mitigation measure is needed.	Meetings were resumed and measures devised in previous periods are being executed as usual. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *Risk has diminished.* • At D2.13 (M36): *No symptoms detected.*
Name: External risks (identified since Proposal stage) ***Description:*** Change of project requirements due to evolution of relevant technology and market landscape ***Potential consequences:*** • As per D2.5 (M9): Enablers developed become obsolete before even getting out to the "market".	***Mitigation measures:*** The PC/TC/PIC/PCC will immediately analyse concrete impact on the project and propose corrective actions in the work plan. Role of Advisory Board is foreseen. Proposed actions, if necessary, will be consulted with the Project Officer. ***Additions in D2.5 (M9):*** COVID-related aspects of these risks, and possible mitigation approaches (including importance of the need of efficient communication) have been discussed during the

• As per D2.6 (M18): Architecture designed in ASSIST-IoT struggles to become a real reference for NGIoT deployments and the orchestrating/deploying approach is no longer sound. • As per D2.7 (M27): Technology has evolved so quickly that tools and mechanisms used in ASSIST-IoT become outdated and real deployments would require other approaches. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + High* • At D2.6 (M18): *Low + Medium* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):*** Particularly relevant due to research related to cutting-edge areas. Meeting of ASSIST-IoT with its AB took place in M9 and no indication of risk from this category was raised by its members. ***Notes in D2.6 (M18):*** Severity has been shifted to "Medium" as it has been observed that the underlying technologies upon which ASSIST-IoT approach is based (K8s, Helm charts) are becoming de-facto standards in the edge-cloud deployment commercial and research projects. ***Notes in D2.7 (M27):*** Consideration of container workloads managed by Kubernetes-oriented deployment technologies and philosophy seem completely aligned with the reality and the trends of the sector. Therefore, severity has been shifted to Low. This risk can be considered overcome. ***Notes after the latest execution period: M28-M36:*** Evolution of Cloud Native and Edge Native trends, like the emergence of Wasm, do not force a change on the ASSIST-IoT reference architecture, being compatible as it is. No additional mitigation measures are needed.	Kick-off meeting, and have been acknowledged by the partners. So far, no need to elaborate this risk further occurred. ***Additions in D2.6 (M18):*** No further specific measures have been elaborated during this period. ***Additions in D2.7 (M27):*** No further specific measures have been elaborated during this period. ***Additions after the latest execution period: M28-M36*** No further specific measures have been elaborated during this period. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*

Name: AB support issues (identified since Proposal stage)

Description: Advisory Board members are not able to conduct satisfactorily the required assessment and/or advisory roles

Potential consequences:

- As per D2.6 (M18): Decisions taken based on AB's feedback may guide the project to non-advantage positions.
- As per D2.7 (M27): The project might suffer tunnel-vision by not considering external experts' perspective (coming from other research or Industrial areas)

Likelihood + Severity:

- At D2.5 (M9): *Low + Low*
- At D2.6 (M18): *Low + Low*
- At D2.7 (M27): *Low + Low*
- At D2.13 (M36): *Low + Low*

Notes in D2.5 (M9):

In M9, during the initial meeting of the AB, all its members were present and were very excited about the project and actively (one could even say, enthusiastically) provided advice and offered further help. The AB took place in M9 and no indication of risk from this category was raised by its members.

Notes in D2.6 (M18):

Further meetings and interactions have taken place with the AB members and the feedback has been immensely satisfactory.

Notes in D2.7 (M27):

Another meeting has taken place with AB members alongside a request for getting formal feedback now that developments in enablers and advances in pilot deployment are occurring.

Additions after the latest execution period: M28-M36

Any critical risk has been spotted by the AB members so far. A total of 9 new recommendations were drawn from the last meetings

Mitigation measures:

The Consortium will monitor AB activities assuring that they are aligned with the project, implementing the adequate procedures. AB membership can be adjusted in case some AB member underperforms.

Additions in D2.5 (M9):

COVID-related aspects of these risks, and possible mitigation approaches (including importance of the need of efficient communication) have been discussed during the Kick-off meeting, and have been acknowledged by the partners. So far, no need to elaborate this risk further occurred.

Additions in D2.6 (M18):

The second meeting with the AB was co-located with the February 2022 meeting of ASSIST-IoT, and inputs retrieved from the first contact were endorsed as well as new information was provided. Willingness from all AB members to keep proactiveness going, eager to know more about project advances, was experienced.

Additions in D2.7 (M27):

Apart from holding the usual yearly meeting (virtual) with the AB members and several exchanges spread across the period, the project has planned the first face-to-face meeting with AB members that will take place in Thessaloniki on April 2023. This should completely prevent this risk from materialising in the project.

Additions after the latest execution period: M28-M36

Apart from a last virtual meeting presenting to the AB members the final outcomes of the project, they will be formally invited to attend to the final event of the project, to be held on March 2024.

Status:

- At D2.5 (M9): *No symptoms detected.*
- At D2.6 (M18): *No symptoms detected.*
- At D2.7 (M27): *No symptoms detected.*
- At D2.13 (M36): *No symptoms detected.*

(separated into 3 global management consideration, 3 global research direction, 2 technical additions and 2 exploitation points). This risk is considered overcome.	
Name: Communication issues (identified during the 1st iteration) ***Description:*** Lack of direct (personal) contact (due to COVID pandemics travel restrictions) leads to problems in in-depth understanding between partners. Particularly "dangerous" when partners are involved in "joint activities". ***Potential consequences:*** • As per D2.5 (M9): Delays, extra efforts to be justified. • As per D2.6 (M18): Not reaching on time documentation and software (enablers) delivery, jeopardising further activities. • As per D2.7 (M27): Same as previous periods. ***Likelihood + Severity:*** • At D2.5 (M9): *High + Medium* • At D2.6 (M18): *Medium + Medium* • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.5 (M9):*** COVID-19 increases possibility of materialisation of these risks. Moreover, partners may be overburdened by the success/failure related to the COVID pandemics (too many/too few activities). Related also to the next risk. Potential problems related to/originating from lack of personal communication have been discussed during the Kick-off meeting, and acknowledged by all partners. ***Notes in D2.6 (M18):*** The situation has substantially improved, mobility restrictions are increasingly being removed and physical meetings are again an option (next one to be taking place in Valencia – May 2022). Likelihood shifted to "Medium". ***Notes in D2.7 (M27):***	***Mitigation measures introduced in D2.5 (M9):*** Flexible project management structure and project CA allow quick shift of resources to alternate partners, and quick inclusion of new partners in the Consortium, if necessary. All Consortium partners are involved in related areas with more than one staff member, ensuring an immediate substitution. The PC and the TC pay particular attention to the way partners are communicating, and the common understanding is achieved. As a counter-measure, extra teleconferences (involving "handpicked" groups of partners) have been introduced to mitigate effects of materialisation of this risk. Positive effects of these teleconferences have been observed. For instance, there are no delays in project schedule, while the quality of deliverables is adequate. However, the very fact that the risk has started to materialise requires extra attention. This risk will be monitored with high level of involvement by the PC/TC and the PCC/PIC, in upcoming months. ***Additions in D2.6 (M18):*** 4th Plenary Meeting (that will be physical) will be hosted in Valencia on 17th, 18th and 19th May 2022 and will count with hybrid option. ***Additions in D2.7 (M27):*** This risk is now overcome as face-to-face meetings are being now held again with (almost complete) normality. ***Additions after the latest execution period: M28-M36*** Additional partner-to-partner sessions and physical code-camps being held to ensure that everyone is aligned and objectives and KPIs are being met. ***Status:*** • At D2.5 (M9): *Some symptoms detected. Initial problems in reaching appropriate level of common understanding between WP/Task leaders, and partners involved in these WPs/Tasks, have been observed*

Meetings have been resumed (see R.Mgmt.3). Three official meetings have been conducted besides 1-to-1 partner sessions. ***Additions after the latest execution period: M28-M36*** Apart from general meetings (Thessaloniki and Malta in this period) and 1-to-1 partner sessions, two code-camps have been executed (M27 in Bilbao but not stated in the notes from D2.7, and M33 in Eindhoven) to work physically together in technical joint work. In this phase partner-to-partner telcos have been intensified.	• At D2.6 (M18): *Situation has improved with regards to this risk.* • At D2.7 (M27): *This risk can be considered overcome.* • At D2.13 (M36): *No symptoms detected.*
Name: Technical management correlation (identified during the 1st iteration) ***Description:*** Complexity of interrelations between WP4, WP5 and WP6 leads to managerial problems and negatively influences realisation of action outcomes. ***Potential consequences:*** • As per D2.5 (M9): Delays, extra efforts to be justified. • As per D2.6 (M18): Not reaching on time documentation and software (enablers) delivery, jeopardising further activities. • As per D2.7 (M27): Not conducting all planned tests, existing misalignments between enablers, not enough end to end integration evidences. ***Likelihood + Severity:*** • At D2.5 (M9): *High + Medium* • At D2.6 (M18): *Medium + Medium* • At D2.7 (M27): *Low + High* • At D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):*** COVID-19 increases possibility of materialisation of these risks. Moreover, partners may be overburdened by the success/failure related to the COVID pandemics (too many/too few activities). Related also to the next risk. ***Notes in D2.6 (M18):***	***Mitigation measures introduced in D2.5 (M9):*** TC and PC are aware of the potential problems and will pay extra attention to the progress in interrelated tasks. Potential problems related to the need of on time delivery of results to avoid bottlenecks have been discussed during the Kick-off meeting and acknowledged by all partners. Extra teleconferences (with presence of TC and, possibly, PC) are planned to mitigate effects of materialisation of this risk. ***Additions in D2.6 (M18):*** Periodic teleconferences between WP4, WP5, WP6 and WP7 leaders are now taking place. In addition, WP8 has just started and the technical leaders are also keeping constant communication with responsible partners so that WP3 requirements, WP4-5-6 technical deliveries, WP7 testing (in pilot) actions and WP8 measurements via KPIs will be aligned. ***Additions in D2.7 (M27):*** Several measures have been put: • WP4 and WP5 are following mirroring management techniques, so structures are replicated across technical management to ensure partners alignment. • Webinars about how to package and build enablers are being held among packers. • A code-camp was organised and took place on January 2023 for aligning developments, packaging and integration.

This risk has not impacted the project and considering that partners are more used to each other now, likelihood is shifted to Medium. ***Notes in D2.7 (M27):*** The risk is considered less likely as measurements are being put to ensure alignment. However, the criticality has increased considering that the project has advanced (now, M27) and, in case of materialisation, this risk would imply larger consequences than in the past. ***Notes after the latest execution period: M28-M36:*** DevSecOps methodology along with all the measures taken in the previous phase have been proved very effective to reduce the likeness of this risk. Now that the three work packages finish, the risk is considered avoided, and any mitigation measure is needed.	• All partners have been provided access to a single integration environment (provided by CERTH) so that joint tests are feasible in a proper cloud set up. • There is the firm belief that the extension of the project (if it is accepted) will have a positive effect in terms of testing, integration and overall technical management. ***Status:*** • At D2.5 (M9): *Some symptoms detected.* • At D2.6 (M18): *Less symptoms detected.* • At D2.7 (M27): *Less symptoms detected.* • At D.13 (M36): *No symptoms detected. Risk not applicable anymore.*
Name: Open Call winners reliability (identified during the 2nd iteration) ***Description:*** The Open Call winners end up not being reliable as: (i) to complete their committed works, (ii) to carry out the expenditures of the budget, (iii) to justify their work, (iv) to achieve proper successful communication with ASSIST-IoT Coordination or with partners. ***Potential consequences:*** • As per D2.6 (M18): Other (better) participants have been excluded, time from partners would have been lost and further efforts to find other candidates should be put in place. • As per D2.7 (M27): Budget assigned not able to be executed, missed opportunity to increase impact of ASSIST-IoT. ***Likelihood + Severity:*** • At D2.6 (M18): *Low + High* • At D2.7 (M27): *Low + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):***	***Mitigation measures introduced in D2.6 (M18):*** During the evaluation phase, a pre-screening has been performed analysing (among other) the trajectory of the potential winners of the OC as participants of H2020 or similar projects. In addition, a Collaboration Agreement will be drawn (based on DESCA model) and signed (by both parts) between each winner and the Project Coordinator, in which enough articles to ensure responsiveness and reliability will be included. As a corrective action, budget of the OC winners in the 1st call that fall under the prior conditions (if this risk materialises) will be devoted to other participants of the Open Call in the 2nd round. ***Additions in D2.7 (M27):*** Two reviews (initial, for the pre-financing and intermediate, to check real advances) have been performed to all 7 currently running Open Call projects. All of them were passed satisfactorily, having submitted the committed deliverables and showing good progress towards their goals. ***Status:*** • At D2.6 (M18): *This risk is not applicable yet.* • At D2.7 (M27): *No symptoms detected.*

The criticality of this risk has been reduced because Open Call projects are now at the last stages of their execution (M8 out of 9) and two (successfully passed) reviews have already taken place. Thus, their satisfactory completion is closer to be guaranteed. ***Notes after the latest execution period: M28-M36:*** All winners from the Open call #1 delivered their work and, after internal evaluations, have been paid. Now, the project is in the middle of the second round of Open calls. Given that the experience from the first round was overall positive, and the mitigation measures good enough, any additional mitigation measure was needed to be added.	• At D2.13 (M36): *No symptoms detected.*
Name: Open Call dependency to ASSIST-IoT assets (identified during the 3rd iteration) ***Description:*** For the Open Call projects to complete their objectives, there might be the compelling need of ASSIST-IoT assets (e.g., enablers, data, pilot premises…) available, that might not be available during their execution timeframe. ***Potential consequences:*** • As per D2.7 (M27): OC projects not being able to be finalised or having to diminished their scope. Incurring in accomplishment of Grant Agreement. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + High* • At D2.13 (M36): *Medium + High* ***Notes in D2.7 (M27):*** It has been materialised in a couple of situations: (1) the dire need of enablers put in a globally accessible repository for OC projects to use them and (2) projects needed data -labelled images- for training and inference. It was solved thanks to measures put: (1) establishing a GitLab repo for those purposes and (2) pursuing proper persons in the proper entities to gather the data to ensure completion. ***Notes after the latest execution period: M28-M36:***	***Mitigation measures introduced in D2.7 (M27):*** Task T7.2 and task T2.6 are working together to: (i) early identify potential situations in which this can happen and to (ii) put in place solutions to these cases. ***Additions after the latest execution period: M28-M36*** For the second round of Open callers, the Consortium has defined integration via Open API as the recommended way of proceeding. ***Status:*** At D2.7 (M27): *Some symptoms have been detected.* At D2.13 (M36): *Some symptoms have been detected.*

The first round of Open Calls ended up and the mitigation measures taken were enough. The same apply for the second round, ongoing.	
Name: Open Call bureaucracy timing in announcement (identified during the 3rd iteration) ***Description:*** Potential mistakes in announcement of the Open Call 2nd round due to miscommunication in the process. ***Potential consequences:*** • As per D2.7 (M27): Re-opening of the application window of the Open Calls. Winners of OC round 2 not finalising within the active timeframe of ASSIST-IoT. ***Likelihood + Severity:*** • At D2.7 (M27): *High + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):*** This risk materialised. The likelihood was, then, high, as it was noticed just after the closing of submission window of Open Calls round 2 due to misalignment on the communication procedure. ***Notes after the latest execution period: M28-M36:*** The Open calls are being executed in time, expected to finished by January and to receive the final payment before the project finishes.	***Mitigation measures introduced in D2.7 (M27):*** As this risk was detected, an immediate reaction took place by the Consortium which consisted of augmenting in 2 months the application window opening (till mid-January 2023) to comply with bureaucratic procedures. To cope with this consequence of risk materialisation, the mitigation measure put in place was to request an extension of the project (this has been included in the amendment where 5 months of expansion are asked for). This way, OC projects (round 2) would have enough time to complete their actions and contribute to the added value of ASSIST-IoT pilots and to architecture's validation. ***Status:*** At D2.7 (M27): *Risk materialised and mitigation measures are being put.* At D2.13 (M36): *No additional symptoms detected. The risk is overcome.*
Name: Addition of third linked parties (identified during the 3rd iteration) ***Description:*** One of the requests included in the amendment launched in the period is the addition of two linked parties of partner P05 TL. ***Potential consequences:*** • As per D2.7 (M27): This addition implies a series of risks such as: (i) managerial burden of new -even though associated- entities, (ii) proper balance of the workload	***Mitigation measures introduced in D2.7 (M27):*** P01 UPV is experienced managing the introduction of third parties from a coordination perspective. A specific task force was created to conduct the whole process of addition of the parties (legal documents to be submitted to validate PIC, LEAR, signatories…) and a special effort is being put under T2.1 to deal with this aspect. Besides, the amendment request included a thoroughly detailed letter with the specific information of the new third linked parties, describing their role, budget, tasks to be devoted to, etc. ***Additions after the latest execution period: M28-M36***

according to expertise and skills, (iii) financial management of the new period and consolidation of figures. ***Likelihood + Severity:*** • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *High + Medium* ***Notes after the latest execution period: M28-M36:*** The third parties of TL were effectively included in the project, after the first amendment. A second inclusion of a third-party linked to Konecranes has been deemed necessary, and coordination has recently prepared the second amendment to deal with this risk. The likelihood was increased as being the second time this risk takes place, and its severity has been increased to *medium* as the amendment has not been signed yet.	A second amendment request was made, following the same procedure than in the first one. ***Status:*** At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *A second amendment was launched to include another third-party. The risk materialised and is under control.*
Name: Potential risks of a project extension (identified during the 3rd iteration) ***Description:*** The extension of the project may entail risks, considering that it may likely end in March 2024 instead of October 2023. ***Potential consequences:*** • As per D2.7 (M27): The potential consequences of materialisation of this risk are threefold: (i) unbalanced management of budget, settling partners in a position where no further personnel time can be devoted to ASSIST-IoT, (ii) limited resources for attending events after M36 and (iii) potential key members leaving their entities after M36. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):*** Risk is considered medium in likelihood and severity as it is reasonable that partners may run out of budget if they must devote huge efforts during the reminders of 2023 and beginning of 2024,	***Mitigation measures introduced in D2.7 (M27):*** First mitigation measure that was put to avoid this risk was to discuss the amendment request (i.e., the extension duration and implementation means) in a face-to-face plenary meeting. In addition, this decision was later ratified by all the Consortium following the formal voting procedures and rules as set out in the Consortium Agreement. In addition, once the decision was taken all partners were properly informed so that all partners had been able to devise effort re-distribution plan provided the request would be accepted. Finally, Coordination is continuously updating the Consortium on the status of the amendment approval (every two weeks) so that all partners can prepare with enough time their effort re-distribution. ***Status:*** At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *No symptoms detected.*

which may imply leaving relevant finalisation actions unfinished, jeopardising full accomplishment of project goals. ***Notes after the latest execution period: M28-M36:*** The Coordination is monitoring the status of the partners and does not expect that the risk is materialised. No additional mitigation measurements are needed.	
Name: Advisory Board plan adjustment (identified during the 3rd iteration) ***Description:*** Initial commitments in the GA included two face-to-face meetings with the AB. As per the COVID-19 applied restrictions, plan was re-structured to only envisage virtual meetings. Now, the plan must be re-scheduled. ***Potential consequences:*** • As per D2.7 (M27): Not keeping GA commitments. ***Likelihood + Severity:*** • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.7 (M27):*** Risk is considered of low criticality as meetings with the AB are being performed anyway. The only applicable risk is to falling short on face-to-face meetings, now that those can be resumed. ***Notes after the latest execution period: M28-M36:*** First face-to-face involvement with AB members occurred. The final meeting will be virtual, in December 2023, and members will be invited to the final events. No additional measures are required.	***Mitigation measures introduced in D2.7 (M27):*** The plan was re-scheduled and was presented to AB members on the virtual meeting that took place on January 20th, 2023. The new plan will include, at least, one F2F meeting to be conducted in Thessaloniki on April 2023. AB members accepted the plan and committed to keep bringing valuable feedback in the form of recommendations to the Consortium. ***Status:*** At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *No symptoms detected.*
Name: Uncertainties due to current geopolitical and warlike situation (identified during the 4th iteration) ***Description:*** Current worldwide status (war between Ukraine and Russia, and recently between Israel and Hamas) can increase	***Mitigation measures introduced in D2.13 (M36):*** Analysing the possibility of having the final event planned online and not in person. No more physical meetings planned for the next of the action. Internal communication to be aware of the status of all partners due to this situation. ***Status:***

problems to partners to travel, and if situation escalates, it may involve some unexpected consequences in daily work. ***Potential consequences:*** • As per D2.13 (M36): Potential reduction of impact in last communication and dissemination stages. In-person modality of the final review not possible. (Less potential) day-to-day job affected. ***Likelihood + Severity:*** • At D2.13 (M36): *Medium + Low* ***Notes after the latest execution period: M28-M36:*** The possibility of partners not able to travel (due to internal organisation or country-wise policies) can increase if their security is endangered. As the project is quite advanced, the Consortium does not expect a severity in case that scenario occurs, but still it has to be considered.	At D2.13 (M36): *No symptoms detected so far*.

3.2. Technical risks

Table 4. Technical related risks in ASSIST-IoT

Risk description, comments and potential consequences	Mitigation measures, corrective actions and status/comments per iteration
Name: Dynamic market environment (identified since Proposal stage) ***Description:*** The market environment or the user views change making the results obsolete ***Potential consequences:*** • As per D2.5 (M9): Enablers developed become obsolete before even getting out to the "market". • As per D2.6 (M18): Architecture designed in ASSIST-IoT struggles to become a real reference for NGIoT deployments and the orchestrating/deploying approach is no longer sound.	***Mitigation measures:*** Robust effort on market analysis in WP2 and development of an appropriate exploitation plan in WP8, including a business analysis, will assure that users' needs and wishes, as well as market trends, are constantly taken into account. ***Additions in D2.5 (M9):*** Assessment based on monitoring performed continuously by the IM. ***Additions in D2.6 (M18):*** A spin-in customer taskforce has been put in place during this period of the project with the goal of defining personae and potential customers. This

• As per D2.7 (M27): Adoption of ASSIST-IoT by external entities (even by own stakeholders) is diminished as new technologies would cover their needs. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + High* • At D2.6 (M18): *Low + Med* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** As mentioned before, this severity has been reduced as it has been witnessed that K8s and Helm charts are widely used nowadays and are also expected so in the foreseeable future. ***Notes in D2.7 (M27):*** The criticality level has been reduced in this period after realising that the technological choices made for the architecture and instantiation of ASSIST-IoT are accepted by the stakeholders and are aligned with the current trends in the SotA. ***Notes after the latest execution period: M28-M36*** Cloud Native and Edge Native technologies are expected to be SotA for many years. Additionally, the ASSIST-IoT architecture is prepared for the foreseeable coexistence between containers and Wasm as (lightweight) virtualisation technologies. Hence, any additional mitigation measure is needed.	exercise has helped to realise whether or not the initial requirements are still sound. ***Additions in D2.7 (M27):*** The survey of T8.4 to understand the barriers of ASSIST-IoT adoption has been oriented to minimise this risk, maximising the understanding of ASSIST-IoT's tool appropriateness. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*
Name: Insufficient testing (identified since Proposal stage) ***Description:*** Not enough testing of technical components, either from a single, isolated perspective and also as parts of a wider system. ***Potential consequences:*** • As per D2.5 (M9): leading to failures, lack of functionality or dissatisfaction by users. • As per D2.7 (M27): Issues with Open Call modules integration and delay of pilots advances.	***Mitigation measures:*** Design of adequate testing plan (WP6) taking into account information gathered during design (WP3) and monitoring of technical tasks (WP4 and WP5) should result in avoiding this risk. ***Additions in D2.7 (M27):*** An integration methodology including packaging, public and internal repositories, utilisation of tools like GitLab and, mostly, a practically specified

Likelihood + Severity: • At D2.5 (M9): *Low + High* • At D2.6 (M18): *Low + High* • At D2.7 (M27): *Low + High* • At D2.13 (M36): *Low + High* ***Notes in D2.6 (M18):*** Some deliverables have been elaborated establishing clearly: • Unit and integration tests per enabler (D6.2) • Joint integration tests with different enablers (D6.2) • Enough documentation per-enabler basis (D6.5) ***Notes in D2.7 (M27):*** Now, integration has started following the guidelines in D6.2. Progresses are being made and a clear structure of packaging, joint testing and end-to-end testing is being applied over the own-managed GitLab instance of the project. ***Notes after the latest execution period: M28-M36*** The existence of unit, functional and integration testing provided the security of testing enablers multiple times. End-to-end, acceptance and performance testing provided the security of meeting the requirements and the KPIs. Constant monitoring of these actions mitigates the risk of insufficient testing.	step-by-step DevSecOps methodology is facilitating the integration of the enablers of ASSIST-IoT. ***Additions after the latest execution period: M28-M36*** Collaboration between technical (WP4-5-6) and pilot teams (WP7) to ensure a smooth transition from development and integration stages to pilot deployments and required tailoring. Specifically, during the validation of end-to-end and acceptance testing. ***Status:*** • At D2.5 (M9)*: This risk is not yet applicable as component development, and their testing (according to project schedule) are still to be initiated.* • At D2.6 (M18): *Tests have been just initiated for PoCs of enablers, it is still early to assess the status of this risk in a proper scale.* • At D2.7 (M27): *Tests advancing as expected.* • At D2.13 (M36): *Apart from functional tests, all integration, end-to-end and acceptance tests executed (reported in D6.8). Some performance tests executed as well (not all, to be reported in D8.3).*
Name: Self-* and AI mechanisms match (identified since Proposal stage) ***Description:*** Problems with including/using results of machine learning / artificial intelligence in self-* mechanisms ***Potential consequences:*** • As per D2.7 (M27): self-configuration of the nodes or the network not really adjusting to the most beneficial scenario for the architecture as a whole. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Medium* • At D2.6 (M18): *Low + Medium*	***Mitigation measures:*** For one side, there will be thorough analysis of mechanisms to be implemented in the architecture and, for the other, within the ASSIST-IoT, three complex pilots with several scenarios will be implemented and thoroughly analysed to prepare a reproducible catalogue of self-* capabilities. ***Additions in D2.6 (M18):*** Bi-weekly meetings are being held between the responsible partners involved in the FL task and the self-* mechanisms in order to align both deliveries (SRIPAS, PRO, CERTH). Stakeholders also partake under request so that their needs are considered in the technical design of the enablers. ***Additions in D2.7 (M27):***

• At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Tasks T5.1 and T5.2 are now much more advance, having developed PoCs of diverse enablers. ***Notes in D2.7 (M27):*** Criticality has been reduced as the application cases of the self-* enablers have been more clearly specified. ***Notes after the latest execution period: M28-M36*** The AI/ML models of the Smart orchestrator and the auto-configurable network enabler have been integrated without further issues, providing the features expected at the respective design phases. Hence, any additional mitigation measure is needed.	Technical advances (software development and integration) have been performed considering the whole functioning of the architecture. In addition, tests (specially for self-healing and self-resource allocation) have been performed, delivering promising results. ***Status:*** • At D2.5 (M9): *This risk is not yet applicable as use of ML/AI/self-* mechanisms (according to project schedule) is still to be initiated.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*
Name: Selected approaches for enablers (identified since Proposal stage) ***Description:*** The different technologies selected for the development of enablers might not be the better ones. ***Potential consequences:*** • As per D2.5 (M9): Incompatibilities could exist if this exercise is n not well supervised. • As per D2.6 (M18): Too many encapsulation exceptions could appear. • As per D2.7 (M27): Need of re-visiting enabler designs or existence of overlaps, duplicities between technologies. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + High* • At D2.6 (M18): *Low + Med* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):***	***Mitigation measures:*** Special care must be placed on evaluation of requirements and existing solutions for each plane/enabler. A proof of concept, based on a technology, can be created if its capacity is not fully understood. ***Additions in D2.6 (M18):*** In order to mitigate this potential risk, the technical partners adopted two additional measures: • Design of a "template" per enabler in which the technologies, libraries and API methods selected for that enabler (and its inner components) were to be described. • Explain in several meetings (bi-weekly WP4 and WP5 teleconferences) to the rest of technical partners and also to the whole Consortium (in Plenary meetings) the chosen technologies. That way, if anyone detected any incompatibility (or would like to suggest a better choice), this could be identified in advance. ***Additions in D2.7 (M27):***

All tasks in WP4 and WP5 are now much more advanced, having developed PoCs of diverse enablers and this risk has not materialised. ***Notes in D2.7 (M27):*** Criticality and likelihood are now reduced to the minimum as the design of the enablers was closed, the development is almost finished and are being currently integrated following DevSecOps and architecture guidelines. ***Notes after the latest execution period: M28-M36*** In some few cases, enablers did not fully meet some pilots' requirements (e.g., smart orchestrator could not natively work for edge environments with private and dynamic IP addresses). Instead of redesigning them, an alternative *flavour* was added in their charts (a tailored version that can be deployed instead of the *normal* one). In any case, main technologies have not been changed, so any additional mitigation measure is needed.	The following actions have been added in this period to prevent this risk from happening: • Mirroring management, design, execution, encapsulation and testing procedures for all enablers, establishing a parallel WP4 and WP5 execution. • Leveraging as maximum as possible existent artifacts (e.g., Helm charts already defined, well consolidated tools and images…) ***Status:*** • At D2.5 (M9): *This risk is not yet applicable as realisation of enablers within pilots (according to project schedule) are still to be initiated* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*
Name: Data standardisation and interoperability (identified since Proposal stage) ***Description:*** The project has committed to be active in regards to standardisation. In addition, the achievement of data interoperability in the to-be reference architecture for NGIoT is one of the most ambitious challenges. ***Potential consequences:*** • As per D2.6 (M18): Misalignment with current standardisation trends and technology, redounding in future (potentially uncomfortable) needed changes to the technical provisions. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Low* • At D2.6 (M18): *Low + Low* • As per D2.7 (M27): *Low + Low* • As per D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):***	***Mitigation measures:*** A specific task devoted to data interoperability has been envisioned to avoid this risk, and to create the most adequate data standardisation, in order to homogenise the information provided by each pilot ***Additions in D2.5 (M9):*** A number of activities, involving data interoperability, have been envisioned within the project. Moreover, a number of activities related to various aspects of standardisation have been already undertaken. Hence, due to the direct involvement in these and, hence, awareness of existing standards, potential problems related to interoperability and data standardisation can be avoided. ***Additions in D2.7 (M27):*** A specific effort has been put to contribute to standards by the side of pilot execution. From Pilot 1 perspective, TIC4.0 is being tackled as the main reference initiative to standardise tools and data models related to maritime port terminals. On pilot 2, a specific contribution has been made to a CEN/TC standard. ***Status:***

Project actively participates in CSA activities related to standardisation. Moreover, one of members of the AB leads IEEE SAB and promised active help in standardisation efforts. ***Notes in D2.6 (M18):*** Deliverable D9.3 reports about the standardisation-related activity by the partners. ***Notes in D2.7 (M27):*** WP9 is keeping its advance at a healthy pace, including the involvement of partners in task T9.3. ***Notes in D2.13 (M36):*** Risk is monitored and no additional mitigation measures are needed.	• At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27)*: No symptoms detected.* • At D2.13 (M36)*: No symptoms detected.*
Name: Security, privacy inline with the market (identified since Proposal stage) ***Description:*** Security, privacy, and trust design decisions are not aligned with the IoT market and standard trends, potentially causing the need of future improvement of the enablers. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Medium* • At D2.6 (M18): *Low + Medium* • As per D2.7 (M27): *Low + Low* • As per D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):*** Based on analysis performed by pertinent partners (CERTH and 21SEC) and Innovation Manager ***Notes in D2.6 (M18):*** DevSecOps methodology, as well as definition of security and privacy enablers have advanced in the period M9-M18. ***Notes in D2.7 (M27):***	***Mitigation measures:*** DevSecOps has been selected as the development methodology, in order to guarantee that security, privacy and trust are considered and in line with the market. Additionally, link with security agents will be kept as part of the impact. ***Additions in D2.6 (M18):*** DevSecOps methodology has been defined. ***Additions in D2.7 (M27):*** A series of de-facto standards mechanisms and tools have been decided to be used in diverse parts of the projects to align ASSIST-IoT security and privacy with the market: • SAST/DAST tools • Usage of own instance of GitLab • Keycloak and orbiting tools for identification management and authorisation • Usage of OAuth2 • Usage of judiciously selected features and modules of HyperLedger Fabric.

Criticality and likelihood have been diminished after considering the appropriate tool selection that has taken place during this period. ***Notes after the latest execution period: M28-M36*** Apart from the DevSecOps methodology, the identity management and authorisation enablers have been integrated to manage the user access to some enablers (smart orchestrator, tactile dashboard, open API). S21Sec is working alongside pilots to ensure that the security enablers of the project are implemented correctly.	***Additions after the latest execution period: M28-M36*** Dedicated meetings of cybersecurity task, as well as pilot telcos with S21Sec, to ensure a suitable integration of security enablers (cybersecurity, access control, role-base authorisation) in the pilots' use cases. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected.* • At D2.7 (M27): *No symptoms detected.* • At D2.13 (M36): *No symptoms detected.*
Name: Transversal enablers concept (identified during the 2nd iteration) ***Description:*** Lack of understanding of the concept of transversal enablers by stakeholders. The role of transversality (crossing planes) and functionalities that should be provided may be confusing to the potential end user. ***Potential consequences:*** • As per D2.6 (M18): Lack of application and/or problems in applying transversal enablers by users of ASSIST-IoT solution, as well as identifying which transversal enablers are needed for each pilot. • As per D2.7 (M27): Lack of accuracy on the integration of Open Call external modules or delays in the pilots execution. ***Likelihood + Severity:*** • At D2.6 (M18): *Low + Moderate* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Whereas the concept of horizontal enablers is quite intuitive, the idea and justification of transversal (or, better, vertical, as used in ASSIST-IoT) enablers is harder to understand. ***Notes in D2.7 (M27):***	***Mitigation measures introduced in D2.6 (M18):*** Providing a comprehensive documentation and usage examples e.g., in the context of pilot applications. A complete Wiki page per each enabler (Readthedocs of the project) has been created that is continuously updated. Conducting integration between enablers and application of transversal enablers in pilots to verify and justified functionalities provided by them. ***Additions in D2.7 (M27):*** Internal webinars for explaining the evolution of transversal enablers (i) development status and (ii) application. In addition, specific sessions in the meetings have been created to discuss the status of the enablers. A code-camp was organised in Bilbao in January 2023 where the technical members (mostly, software developers) by ASSIST-IoT partners clarified the potential misalignments and boosted the joint testing of both horizontal and transversal enablers. ***Additions after the latest execution period: M28-M36*** Dedicated meetings held between pilot owners and technical teams to agree in the benefits of using the developed self-*, FL, cybersecurity and DLT-related enablers, and the way to integrate them. ***Status:*** At D2.6 (M18): *Some symptoms detected but mitigation measures as well as communication with all stakeholders seem to be working.*

The likelihood and overall criticality has been relaxed as the concept has been more naturally accepted when the vertical enablers have started being applied to specific use cases (e.g., manageability). ***Notes after the latest execution period: M28-M36*** Vertical enablers have been continued to be applied in use cases (cybersecurity, DLT, FL, etc.).	At D2.7 (M27): *Symptoms have ceased.* At D2.13 (M36): *No symptoms detected.*
Name: Delays in enabler (software) development (identified during the 2nd iteration) ***Description:*** Delay in releasing PoCs and next versions of enablers may negatively impact integration activities and pilots' implementation. ***Potential consequences:*** • As per D2.6 (M18): Delays in project execution, jeopardising the integration activities and unit and joint tests. • As per D2.7 (M27): Lack of accuracy on the integration of Open Call external modules or delays in the pilots' execution. ***Likelihood + Severity:*** • At D2.6 (M18): *Moderate + High* • At D2.7 (M27): *Low + Moderate* • At D2.13 (M36): *Low + Moderate* ***Notes in D2.6 (M18):*** This risk has appeared in the 2nd iteration as the enablers are advancing at different speeds and this period has been intensive in the development tasks. MVPs are being defined. ***Notes in D2.7 (M27):*** Criticality and likelihood are still a factor but mitigation measures must be carefully observed. The project is now facing a critical stage where the proper delivery of functioning enablers is paramount for the evolution of pilot execution and Open Call projects integration. ***Notes after the latest execution period: M28-M36***	***Mitigation measures introduced in D2.6 (M18):*** Monitoring on task and WP level. Reporting on any problems and risks as soon as they are identified. Keeping Enablers status spreadsheet up-to-date. Organising periodic telco on tasks and WP level. Having tasks registry with current statuses. Defining a series of "essential" enablers, first ballot artifacts that are considered top priority and that will be present in any ASSIST-IoT deployment. These enablers are prioritised whenever delays or blockages are a threat. Also, a global prioritisation structure has been created. This way, the most prioritised enablers will be given preference and their integration-deployment will be more protected. ***Additions in D2.7 (M27):*** Organisation of a code-camp in Bilbao in January 2023 to foster the advance speed of the enablers. Topics discussed (and clearly moved forward) were: • GWEN training with K8s + features discussion. • Improvement of Helm charts + tests with Smart Orchestrator. • LTSE security. • Integration of authentication and authorisation code in clients • PUD representation in Tactile dashboard • DLT + FL integration. • Data pipelines realisation + features of the *Composite services manager (manageability).* • Enablers' Tests and integration with GitLab pipelines. Before that, a series of special sessions were organised in the meetings of Valencia and Warsaw to let specialist partners to focus on technical advances

All the enablers have final versions ready, and most of them had their final versions ready by M30, leaving more than 10 months for being used in pilots' environments for addressing the use cases and being assessed.	on deliverables. This was done through the conduction of parallel work streams in separate rooms during those meetings. ***Additions after the latest execution period: M28-M36*** A second code-camp was held in Eindhoven in July 2023 (M33), to foster the packaging and integration activities of enablers, aiming at ensuring a smooth finalisation of pilots' execution and evaluation towards the end of the project. ***Status:*** At D2.6 (M18): *Some symptoms detected but mitigation measures proposed above promise to work. A relevant milestone will need to be carefully observed: Pilot deployment with integrated ASSIST-IoT enablers.* At D2.7 (M27): *Some symptoms detected but mitigation measures proposed above have demonstrated their utility to help catch up with schedule.* At D2.13 (M36): *No further symptoms detected.*
Name: Integration issues (identified during the 2nd iteration) ***Description:*** Inconsistencies or incompatibilities while integrating enablers (incompatible technologies, versions, dependencies…). ***Potential consequences:*** • As per D2.6 (M18): Delays in project execution and/or reduced performance. ***Likelihood + Severity:*** • At D2.6 (M18): *Moderate + High* • At D2.7 (M27): *Low + High* • At D2.13 (M36)*: Low + Moderate* ***Notes in D2.6 (M18):*** Although not explicitly mentioned above, it is also possible that "developing and/or testing environments" affect also to this risk. ***Notes in D2.7 (M27):***	***Mitigation measures introduced in D2.6 (M18):*** Monitoring on WP level. Regular technical meetings to report progress and discuss issues Dedicated testing and integration infrastructure to allow testing in real environment. This has already been put in place, although not completely exploited. ***Additions in D2.7 (M27):*** GitLab system set up and being used with proper folder structure, repository policies, merging mechanisms, packaging guidelines and instructions for all partners. Integration played a major role in the conducted code-camp at M27. ***Additions after the latest execution period: M28-M36*** Dedicated personnel consulting and instructing on how to use the environment and proposing modifications for better integration. Major role also in code-camp at M33. ***Status:*** At D2.6 (M18): *No symptoms detected. The actual "integration" has not started yet. At this moment, only PoCs of communicating enablers are in*

Criticality is still high as, in case of materialisation, the consequences could directly impact the work plan. However, alleviation and mitigation measures are being put in place. ***Notes after the latest execution period: M28-M36*** All integrations among project's enablers have been carried out, and hence the severity has been reduced to moderate, as they have not been extensively tested in pilot conditions. Also, it has not been reduced to "low" as some integrations with legacy applications are still pending (e.g., TwoTronic's web application with tactile dashboard).	*places, whereas most enablers have delivered at least a working version. It is expected that this risk might materialise to a larger scale during the next period (M18-M27).* At D2.7 (M27)*: Still some misalignments exist but the risk seems to be under control.* At D2.13 (M36): *All the integrations among project enablers have been carried out. Some legacy integrations pending. Risk under control.*
Name: UC-enablers compatibility (identified during the 2nd iteration) ***Description:*** Use cases may not be developed as already described due to the enablers are not totally developed yet. ***Potential consequences:*** • As per D2.6 (M18): Leads to issues in the limited evaluation of the ASSIST-IoT architecture or delays on the pilot deployment. • As per D2.7 (M27): Delays in execution, workplan jeopardised, impossible integration of Open Call projects, lower impact achieved. ***Likelihood + Severity:*** • At D2.6 (M18): *Moderate + Moderate* • At D2.7 (M27): *Low + Moderate* • At D2.13 (M36): *Low + Moderate* ***Notes in D2.7 (M27):*** The likelihood of occurring of the risk has been reduced, as several measures have been put in place to prevent it from happening. In addition, both pilots and enablers are more mature in their development at this point of the project, and no major issues or incompatibilities have been found. ***Notes after the latest execution period: M28-M36*** Pilots require a few dedicated enablers to work, as they cannot be fully solved with "generic" WP4-5 ones. For instance, pilot 3a require dedicated functions for locally processing edge data. Most of the project enablers are used in at least one of the pilots' use cases.	***Mitigation measures introduced in D2.6 (M18):*** Formalisation and fine-tuning of the use case in accordance with requirements traceability matrix. Multi-round testing and integrations based on RTM. ***Additions in D2.7 (M27):*** All pilots assigned a technical partner associated that has taken over the exercise of mapping ASSIST-IoT enablers to the specific scenarios of the pilots. This has been done in order to ensure a proper translation of the technical knowledge into actual use case needs through the features provided by the enablers. In addition, the fact of launching the amendment that includes a request for 5 months' extension of the project has been partially motivated by the possibility of this risk materialising. Provided that this extension will be accepted, the materialisation likelihood is diminished. ***Additions after the latest execution period: M28-M36*** In some cases, adapting developed WP4-5 enablers to pilot requirements is a great effort, especially for very particular needs. In this kind of cases, designing and developing pilot-dedicated enablers, with limited scope, is preferred. ***Status:*** *At D2.6 (M18): No symptoms detected.* *At D2.7 (M27): No symptoms detected.* *At D2.13 (M36): No symptoms detected.*

Name: Isolated enablers (identified during the 2nd iteration) ***Description:*** All the enablers may not be interlinked and worked together under the ASSIST-IoT architecture. ***Potential consequences:*** • As per D2.6 (M18): This may introduce computing delays and dependencies that may negatively affect in ASSIST-IoT architecture. • As per D2.7 (M27): Some enablers may imply duplicities in technologies (e.g., monitoring utilities, databases, UIs) that might interfere with other enablers scope. ***Likelihood + Severity:*** • At D2.6 (M18): *Moderate + Moderate* • At D2.7 (M27): *Low + Moderate* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Compatibility issues may occur during the integration phase of the enablers. ***Notes in D2.7 (M27):*** Likelihood has been reduced as the Consortium has been able to organise three specific 2/3 day-long face-to-face technical meetings where the various overlaps have been tackled and corrected. ***Notes after the latest execution period: M28-M36*** After the intense work executed in pilots, almost any incompatibility was found. Only case happened with smart orchestrator and SD-WAN enabler, as they make use of different K8s' network (CNI) plugins, i.e., Cilium and Calico, respectively. In any case, issue was easily solved considering *Multus* for allowing multi-CNI capabilities to the deployments, when needed. No additional mitigation measures are needed.	***Mitigation measures introduced in D2.6 (M18):*** Developing enablers based on the needs of the ASSIST-IoT architecture and interaction with the collaborative enablers Multi-round testing in the phase of enablers integration and mapping of the required enabler per use case ***Additions in D2.7 (M27):*** Apart from the three dedicated face-to-face sessions in which the technical staff of ASSIST-IoT technological partners have shared the technologies used, the code (and/or artifacts) obtained and the tools leveraged, specific integration exercises (pre-and-during pilots) have been conducted in order to identify and correct major overlaps. ***Status:*** At D2.6 (M18): *No symptoms detected.* At D2.7 (M27): *Some symptoms detected but measures have been applied and the risk is under control.* At D2.13 (M36): *Some symptoms detected but easily solved, so the risk is under control*
Name: Encapsulation exceptions (identified during the 2nd iteration) ***Description:*** Some enablers (due to the underlying technologies/libraries that they use) cannot follow the encapsulation rules set out for ASSIST-IoT enablers (k8s, Helm charts...).	***Mitigation measures introduced in D2.6 (M18):*** As long as they will be reachable from the network and interactable via APIs (this is the real important matter for those enablers), they will be able to be integrated.

Potential consequences: • As per D2.6 (M18): They are not able to be deployed via the smart orchestrator nor can be controlled the same way as the others from the manageability interface. • As per D2.7 (M27): Encapsulation exception make the architecture unfeasible and irrelevant. ***Likelihood + Severity:*** • At D2.6 (M18): *High + Low* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Moderate + Low* ***Notes in D2.6 (M18):*** Examples: MR enabler (HoloLens), ~~and the actual manageability interface (the PUI9-based software is installed as-is in the host that will act as k8s master in the deployment).~~ ***Notes in D2.7 (M27):*** The measures put in place have demonstrated to be effective, and the likelihood and the criticality of this risk have been reduced drastically. Encapsulation is now clearly guided and the exceptions are well covered by the installation script and instructions attached to the architecture. ***Notes after the latest execution period: M28-M36*** Two exceptions were found, still, they are not critical. Cybersecurity monitoring agent and self-healing enablers work at host level, not virtualised and hence not possible to encapsulate. This is considered good as they are able to perform better if are deployed over host's operating system; if virtualised, privileged modes should be enabled, opening security loopholes and attack surfaces. PUI9 and manageability enablers have been encapsulated. No additional mitigation measures are needed.	The first mitigation strategy is to select as much as possible open technologies that had already been tested / used in similar deployment environments as those of ASSIST-IoT (K8s, Helm charts, DevSecOps, etc.). If this is not possible, as a second mitigation strategy, an external service (automated) interacting with such enabler (e.g., MR device) and exposing an API to be reached, is planned. ***Additions in D2.7 (M27):*** During this period, some actions to mitigate the occurrence of this risk have been put in place: • A Helm chart generator has been developed by UPV and made available to all the partners. Thus, encapsulation is easier for al ASSIST-IoT enablers. In addition, the usage of this generator has helped make evidence some misalignments that have been corrected, smoothing the encapsulation process. • Code-camp and meetings have allowed partners to realise the necessities and to generate better alignments between enablers. • An installation script (that includes, whenever necessary, the exceptions) has been developed and tested in multiple environments. ***Status:*** At D2.6 (M18): *Some enablers have already been detected as "encapsulation exceptions". See D3.6. No actual issue has derived from this risk yet.* At D2.7 (M27): *Although two more enablers have been declared as exceptions, the measures put are keeping this risk under control in a very advanced stage of the project.* At D2.13 (M36): *No further symptoms.*
Name: Open Call integration (identified during the 2nd iteration) ***Description:*** Open Call winners integration require too much adaptation effort, having to re-design some enablers or to deliver ad-hoc technology, APIs... ***Potential consequences:***	***Mitigation measures introduced in D2.6 (M18):*** In the Open Call evaluation process, two steps within the whole flow consider the "intervention" of ASSIST-IoT technical partners to ensure that the proposed projects fit the plan and technological approach of ASSIST-IoT. In addition, a specific task in WP7 (T7.4) has been established to work together with Open Call participants. Specially at the beginning of their

• As per D2.6 (M18): Inner tasks of the project, including development of enablers might be delayed and/or even jeopardised. • As per D2.7 (M27): Jeopardised timing, not achieving final outcomes of OC projects and of ASSIST-IoT. ***Likelihood + Severity:*** • At D2.6 (M18): *Medium + Medium* • At D2.7 (M27): *High + Medium* • At D2.13 (M36): *Medium + Medium* ***Notes in D2.7 (M27):*** Now, this risk is being materialised as the integration phase of OC projects with ASSIST-IoT is at its peak (for 1st round projects). This risk is now critic. ***Notes after the latest execution period: M28-M36*** The second round of open callers coexist with the last 10 months of project execution, with little time for tailored efforts in the development work packages. For this reason, the likelihood is still significant, with some risk related to the little remaining time for addressing them.	actions, it will be paramount to align their technical scope (communication protocols, technologies to be using, databases, integration approach, etc.) to minimise the materialisation likelihood of this risk. ***Additions in D2.7 (M27):*** For the 2nd round of Open Call submissions, the descriptions of the architecture, the technologies, inner components of enablers, etc. have been enhanced (this is a preventive measure for this risk not to happen in the 2nd round of OC projects). For the current execution, a special task force (including the technical leader partners of every involved pilot) has been created and put in contact with the OC project entities to smoothen the collaboration. In addition, several actions have been performed to allow software contributions and better cooperation: (i) creating accounts in the GitLab instance of ASSIST-IoT to OC members (including access control per repository), and (ii) creating a public GitLab repository with ASSIST-IoT's enabler artifacts so that OC projects can directly access the necessary outcomes of ASSIST-IoT. ***Additions after the latest execution period: M28-M36*** Integrations via Open API has been fostered as the preferred way to integrate third-party developments within pilots, being a less-disruptive way of work together. ***Status:*** At D2.6 (M18): *This risk is not applicable yet.* At D2.7 (M27): *Several symptoms have been detected.* At D2.13 (M36): *Some symptoms have been detected*.
Name: Natively inclusion of ASSIST-IoT in the GWEN (identified during the 3rd iteration) ***Description:*** There is the risk that the GWEN (prominent hardware outcome of ASSIST-IoT) has problems to natively equip the basic components (essential enablers or required pre-installed deployment frameworks). ***Potential consequences:***	***Mitigation measures introduced in D2.7 (M27):*** Three measures have been put in place during this period in order to alleviate the occurrence of the risk: • Specific incorporation of k3s built-in in the booting SD card of the GWEN was designed and is being put in place. • The first and foremost session of the Code-camp in Bilbao in January 2023 was devoted to analyse this aspect and have all technical partners agree in an approach.

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- As per D2.7 (M27): Requires additional effort by partners to adjust the installation of ASSIST-IoT in the GWEN. Eventual technical misalignments and execution delays across the workplan.

Likelihood + Severity:

- At D2.7 (M27): *Low + Medium*
- At D2.13 (M36): *Medium + Medium*

Notes in D2.7 (M27):

The first version of the GWEN was able to run Kubernetes framework, but considering the constrained computing resources and its high modularity it was required to ember a lightweight version of the deployment framework and still be accepted as ASSIST-IoT native. There are currently works being done to cope with this risk.

Notes after the latest execution period: M28-M36

Some issues encountered when using it in the pilots, hence the risk has been increased to medium. Although most have been solved, the GWEN was manufactured with little RAM available (2 GB), insufficient for hosting a set of enablers when growing in number.

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- The extension request included in the amendment should favour relax the pressure on the time constraints for achieving such integration.

Additions after the latest execution period: M28-M36

In further implementations of the GWEN, it will be manufactured with additional RAM memory. For its usage in pilot premises, it has been used as a Kubernetes worker/slave of another gateway active as a master, allowing in this way its normal integration in the project.

Status:

At D2.7 (M27): *Early symptoms detected at the beginning of the period that are being solved with the proposed mitigation strategy.*

At D2.13 (M36): *Some symptoms detected, but workarounds have been found for the project's execution, easy to address in further releases. Risk under control.*

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Name: Disparate speeds of advance in enablers (identified during the 3rd iteration)

Description: The enablers are advancing at different speeds, either due to their varying complexity or to the temporal efforts devoted to ones in detriment of the others.

Potential consequences:

- As per D2.7 (M27): This might create misalignments in the intercommunication of enablers are might impose a delay in the integrations, thus in the pilots' execution.
- As per D2.13 (M36): Enablers developed at lower speed may not be possible to be used by Open callers.

Likelihood + Severity:

- At D2.7 (M27): *Medium + Low*
- At D2.13 (M27): *Medium + Low*

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Mitigation measures introduced in D2.7 (M27):

Several measures were put in place:

- All enablers must comply with the same API for metrics, health, interaction with underlying components, etc. This way, even though those are completed in different moments, intercommunication is guaranteed by design.
- Establishment of a detailed roadmap, aligned with pilot necessities, to ensure that the disparate speeds do not affect the pilots execution.
- Creation of specific per-enabler GitLab repositories where it is easy to check and control which enablers are being left behind at a quick glance.
- Code-camp meeting in M27 to boost the development of enablers, that has helped harmonise the advance status and to identify potential problems or interdependencies.

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Notes in D2.7 (M27): In early stages of the period (~M19), in several control teleconferences, it was noted that the different speeds may occasion troublesome interdependencies. However, at the end of the period, thanks to the mitigation measures designed, the risk seems under control. ***Notes after the latest execution period: M28-M36*** Although some enablers were slightly delayed (finalised beyond M30), open callers' and pilots' respective schedules are being fulfilled.	***Additions after the latest execution period: M28-M36*** A second code-camp was performed in M33 to speed up the packaging and integration of the more delayed enablers, to reduce the risk. ***Status:*** At D2.7 (M27): *Some symptoms detected. Risk under control.* At D2.13 (M36)*: No symptoms detected.*
Name: Questioning of integration success (identified during the 3rd iteration) ***Description:*** Integration efforts (including end-to-end data pipelines) require enablers to be finalised. ***Potential consequences:*** • As per D2.7 (M27): Sterile efforts in integration as there was not enough material to ensure a proper outcome out of the integration. Cascading delays in pilots and impact achievement. • As per D2.13 (M36): Difficulties in addressing pilots' use cases if teams have to devote additional time in performing many integrations. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):*** The fact of tackling the previous risk (in the table) by default minimises the likelihood of this risk to take place. This is a very important risk that might be critical for the pilots and the project as a whole, therefore it will be carefully observed during the next execution period. ***Notes after the latest execution period: M28-M36*** All project's enablers integrations planned have been addressed, still, under testing in pilots (that is why severity has not been reduced, only likelihood).	***Mitigation measures introduced in D2.7 (M27):*** Apart from the previously mentioned measures (code-camp, GitLab, enablers spreadsheet control…), the extension request has been accompanied by a carefully elaborated plan for WP6 deliverables, keeping the need of reporting by M30 and extending the integration time and possibilities till M36. ***Additions after the latest execution period: M28-M36*** Thanks to Pilot 2 being executed earlier than the others (not on purpose, but due to the time plan of the pilot site), very valuable feedback was gained, which enabled the preparation of reports to improve current integration efforts at M33. Thanks to it, the execution in the rest of the pilots will be eased. ***Status:*** At D2.7 (M27): *Early symptoms detected. Risk under control.* At D2.13 (M36): *Some symptoms detected during Pilot 2 execution, addressed. Risk under control.*

Name: Poor performance in end-to-end and/or stress testing (identified during the 3rd iteration) ***Description:*** During the integrated system's testing (i.e., testing the pilots' pipelines) the performance of the system is poor/inadequate for the pilot tests to succeed. ***Potential consequences:*** • As per D2.7 (M27): Poor pilot results. • As per D2.13 (M36): Low utility outside the scope of the project pilots. ***Likelihood + Severity:*** • At D2.7 (M27): *Low + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):*** End-to-end and stress testing are starting to be performed by the time of preparing this deliverable. ***Notes after the latest execution period: M28-M36*** Some performance tests have been carried out in this phase, but not all the planned ones. In any case, all the performance-related KPIs measured so far have returned positive results.	***Mitigation measures introduced in D2.7 (M27):*** During the development phase special attention has been given to the performance of the individual modules. In addition, the development teams are actively monitoring the integration activities and will provide solutions and optimisations in any problems that arise. Development teams will provide fixes and/or updates to the individual components to ensure acceptable performance. ***Additions after the latest execution period: M28-M36*** Performance tests require dedicated methodologies and environments. Pilot implementation and monitoring will provide better feedback on the performance of individual enablers and of the solution as a whole. This is the reason why some performance tests have been delayed to M37-M38, to characterise them well. These will be reported in D8.3 instead of D6.8. ***Status:*** At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *No symptoms detected.*
Name: Not sufficient data for technical validation (identified during the 3rd iteration) ***Description:*** Several enablers (such as Federated learning enablers) require data from pilots to be validated (i.e., training, proper models, models aggregation…). A slow advance in pilots or the lack of data might damage their validation. ***Potential consequences:*** • As per D2.7 (M27): Incomplete enablers, cascading delays in the workplan execution across the board, less reliable outcomes, thus less potential adoption by internal and external stakeholders.	***Mitigation measures introduced in D2.7 (M27):*** The measures put in place are two-fold: • Enablers that require real data from pilots for a true validation have been clearly identified and priority has been given in pilots' workplan to procure equipment/data sources to ensure proper validation. • A set of emulated (synthetic) data is being generated (aligned with the expected format by the enablers) so that training/validation can start taking place even though real data was not available yet. ***Additions after the latest execution period: M28-M36***

• As per D2.13 (M36): Enablers not properly tested, leading to potential misleading conclusions. ***Likelihood + Severity:*** • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.7 (M27):*** Risk is considered of low likelihood and low criticality as the measures being put in place should cope with the event of not having enough data. ***Notes after the latest execution period: M28-M36*** Especial effort has been put in data for testing the semantic and the FL suite, without neglecting other enablers that require real datasets.	For those enablers that required real data, dedicated meetings between pilot owners and enabler responsible teams were held to ensure that these data are available, real or synthetic. ***Status:*** At D2.7 (M27): *Some symptoms detected.* At D2.13 (M36): *No symptoms detected.*

3.3. Pilot risks

Table 5. Pilot related risks in ASSIST-IoT

Risk description, comments and potential consequences	Mitigation measures, corrective actions and status/comments per iteration
Name: KPI computation (identified since Proposal stage) ***Description:*** Unable to measure or compute the KPIs as planned ***Potential consequences:*** • As per D2.5 (M9): Ability to extract information and measures for pilots can be altered. • As per D2.6 (M18): In case the defined KPIs for the pilots cannot be measured, the validation will be incomplete, and the project will not be able to verify the benefits of their developments. • As per D2.7 (M27): KPIs not able to be measured, therefore no way to validate the impact of ASSIST-IoT technology. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + High* • At D2.6 (M18): *Low + Medium*	***Mitigation measures:*** Due to unexpected factors, ability to extract information and measures for pilots and the project in general, in order to compute the KPIs, can be altered, thus leading to change and adapting the planning of KPIs calculation. ***Additions in D2.6 (M18):*** D8.1 has included a specific exercise of defining the specific measurement procedure that will be carried out for each KPI (surveys, benchmarking, analysis of results, acceptance methodologies, etc.). Drawing from this, D8.2 should be ready to start reporting about those KPIs, while the partners still expect some minor changes in other to accommodate for this risk to not materialising. ***Additions in D2.7 (M27):*** Deliverable D8.2 has been planned and executed in a way that: (1) it already reports the early state of some KPIs (those that are able to be measured, mostly technical), (2) enhance the descriptions of the KPIs and ensure that they are still valid and applicable – and judiciously modify if needed), (3) provide details on the specific

• At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.6 (M18):*** It is considered Medium (the severity) as D8.1 has served the good purpose of fine-tuning the KPIs and address the measurement strategies. ***Notes in D2.7 (M27):*** Likelihood and criticality have increased due to the proximity of the project finalisation and after the realisation of what can actually be done and the final scope of the developed technologies. ***Notes after the latest execution period: M28-M36*** Likelihood has been reduced as KPIs status have been continuously monitored during the past phase, and all definitions, methodologies and (in some cases) results are in place. Severity remains as medium as many KPIs are yet to be quantified.	plan to be followed to measure the KPIs. The previous should contribute to reduce the likelihood of risk materialisation. In addition, the project extension request can be considered part of the strategy to reduce this likelihood. ***Additions after the latest execution period: M28-M36*** D8.3 follows D8.2 in a more structured way, aiming at reporting KPIs in a more homogeneous way. All methodologies have been requested to be put in place in the document, to avoid any kind of unexpected issue related to late design, planning and/or measurement execution of the KPIs, especially if pilots are involved. ***Status:*** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *Some symptoms detected. Actions put in place through D8.1 are expected to overcome the potential materialisation of this risk.* • At D2.7 (M27): *Some symptoms detected and tackled through D8.2.* • At D2.13 (M36): *Some symptoms detected while completing D8.3. Working with involved teams to ensure that all assessments can be carried out.*
Name: Pilot description detail level (identified during the 1st iteration) ***Description:*** Detailed specification of pilots (performed in WP3) leads to realisation that some goals / KPI's may be very difficult to reach. ***Potential consequences:*** • As per D2.5 (M9): Potential issues to complete the pilot goals (either too ambitious or too vague to work upon). • As per D2.6 (M18): Insufficient quality for finalising key tasks in the project – T3.2 and T3.3. • As per D2.7 (M27): Erratic execution of pilots in WP7, with major changes compared to the original description. ***Likelihood + Severity:*** • At D2.5 (M9): *High + Medium* • At D2.6 (M18): *Medium + High* • At D2.7 (M27): *Low + Low*	***Mitigation measures introduced in D2.5 (M9):*** Analysis reaching beyond State-of-the-Art (T3.1), seeking alternative solutions to be able to reach goals / KPI's. Establishing hierarchy of goals to be able to focus on realising the most important ones (engineering 80:20 rule). Engaging Advisory Board and/or Project Officer and/or Project Reviewers to adjust the goals and KPIs in a way that will be satisfactory to all parties. ***Additions in D2.6 (M18):*** D3.3 has enriched the information that was contained in D3.2, making it more actionable and directly engaging current actions of the pilot owners to finalise the use-cases definition. ***Additions in D2.7 (M27):*** In this period several activities have been performed in order to minimise this risk and for the sake of proper pilot execution:

• At D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):*** Based on self-assessment performed in M8, jointly by the PC and the TC. ***Notes in D2.7 (M27):*** This period has been characterised by the advance in the pilots. For doing so, specific detailed plans divided in clearly described and reported activities is taking place. This risk is now very well tackled and should not occur nor have consequences in the foreseeable future. ***Notes after the latest execution period: M28-M36*** More detailed system architectures for addressing the use cases in place. Pilot teams consolidated and not reporting issues related to pilots' description and objectives. No need of further mitigation measures.	• Thorough description of the activities to be performed in the pilots, based on the business cases and scenarios described in WP3. • Drill down of activities to be performed in the pilots in: procurement, development, integration and verification, listing all the activities to be done with enough detail in D7.2. • Detailed reporting on the advances performed in the period M19-M27 in those sub-activities through deliverable D7.3. ***Status:*** • At D2.5 (M9): *Some symptoms detected.* • At D2.6 (M18): *Less symptoms detected.* • At D2.7 (M27): *Risk should now be overcom*e. • At D2.13 (M36): *No risk*.
Name: Global chip shortage (identified during the 2nd iteration) ***Description:*** The Global Chip Shortage will probably affect the delivery of procured equipment needed to: (i) produce the GWEN, (ii) carry out on-premise pilots. ***Potential consequences:*** • As per D2.6 (M18): Delays and in the worst-case failures on pilots deployment validation. • As per D2.7 (M27): Same consequences as above. ***Likelihood + Severity:*** • At D2.6 (M18): *Medium + Serious* • At D2.7 (M27): *Low + High* • At D2.13 (M36): *Low + High* ***Notes in D2.6 (M18):*** Project partners are finalising the list of procured equipment that will be used in the pilots' trials.	***Mitigation measures introduced in D2.6 (M18):*** Flexible pilot procurement strategy, aiming at considering more than a single solution for carrying out pilots' trials Two alternatives were considered in order to have the HW on place on time. ***Additions in D2.7 (M27):*** Datasheet was properly modified (CPU, components, capacitors, global layout, etc.) and adjusted to provide more flexibility if the risk occurred. Status: • At D2.6 (M18): *Some symptoms detected.* • At D2.7 (M27): *Partners (especially NEWAYS) experienced this risk during several months in the period but were able to gather the material. Thus, the critical phase of this risk has long passed. However, pilots might still be affected if there is the need of modification of any components.* • At D2.13 (M36): *Risk is overcome, as all hardware needed to carry out the pilots and the project assessment is already in place. However, Pilot 1 is*

Notes in D2.7 (M27): Criticality has been reduced as the Consortium has been able to find ways to obtain the necessary semiconductors and equipment in general to produce the necessary GWENs and to carry out procurement activities in the pilots. ***Notes after the latest execution period: M28-M36*** All pilots have a GWEN in their premises (except pilot 3B that will not need it), as well as all the hardware procured or manufactured. This risk is overcome, and no additional mitigation measure is required.	*behind original schedule due to the unavailability of Remote crane HW specific.*
Name: Pilot's KPIs realisation (identified during the 2nd iteration) ***Description:*** Detailed specification of pilots KPIs and requirements in WP3 may be very difficult to reach in real deployments in pilots ***Potential consequences:*** • As per D2.6 (M18): Problems in pilot assessment and validation, risking the fulfilment of the expectations of the pilots. • As per D2.7 (M27): The execution of tasks T8.2, T8.3 and T8.4 is compromised during the last stage of the project. ***Likelihood + Severity:*** • At D2.6 (M18): *Low + Moderate* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Project partners are finalising the list of procured equipment that will be used in the pilots' trials. ***Notes in D2.7 (M27):*** The risk likelihood and criticality has been reduced after the delivery of D8.2. ***Notes after the latest execution period: M28-M36***	***Mitigation measures introduced in D2.6 (M18):*** Engaging Advisory Board and/or Project Officer and/or Project Reviewers to adjust the goals and KPIs in a way that will be satisfactory to all parties. Reviewing all KPIs in D8.1, proposing the shift of some of them that seem unfeasible towards other (equally relevant) valid alternatives. The scope of the pilots is not being changed, but rather enhanced with the selection of more fine-tuned validation metrics to check/report. Establishing hierarchy of goals to be able to focus on realising the most important ones (engineering 80:20 rule) ***Additions in D2.7 (M27):*** Revision of all KPIs in D8.2 including the following information: (i) whether or not the KPI is still valid, (ii) indicating if the target value is still acceptable and (iii) specifying how each KPI is going to be measured (clearing the potential uncertainty depicted in D8.1). ***Additions after the latest execution period: M28-M36*** All methodologies have been requested to be updated in D8.3, to avoid any kind of unexpected issue related to late design, planning and/or measurement execution of the KPIs, especially if pilots are involved. Also, dedicated pilots' KPIs monitoring sessions being held in one of each two WP7 meetings, in parallel to general WP8 in which all types of KPIs are overseen. ***Status:*** • At D2.6 (M18): *Some symptoms detected.*

Continuous monitoring of the list of pilots' KPIs, any significant warning has been raised.	• At D2.7 (M27): *Less symptoms detected.* • At D2.13 (M36): *Minimum symptoms detected.*
Name: Port cartography (identified during the 2nd iteration) ***Description:*** BS-P1-1 requires the use of port terminal detailed cartography, which was initially assumed it was available but it has been realised that it is not. ***Potential consequences:*** • As per D2.6 (M18): The demonstration of BS-P1-1 would not be as accurate as possible due to not having an accurate provisioning of terminal layout. ***Likelihood + Severity:*** • At D2.6 (M18): *Low + Moderate* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Project partners are finalising the list of procured equipment that will be used in the pilots' trials. ***Notes in D2.7 (M27):*** The mitigation measures were put in place, and now that the pilot has advanced, the risk is considered no longer applicable. ***Notes after the latest execution period: M28-M36*** No need of more actions.	***Mitigation measures introduced in D2.6 (M18):*** Make use of open-source libraries available online. In case Pilot 1 partners are not able to obtain a very detailed terminal layout GIS map, they will make use of open source ortophotos provider such as OpenStreetMap or Mapbox ***Status:*** • At D2.6 (M18): *The risk that was not identified was realised due to its actual materialisation. With the proposed measures, the impact should be mitigated.* • At D2.7 (M27): *This risk is now overcome.* • At D2.13 (M36): *No risk.*
Name: Port database access (identified during the 2nd iteration) ***Description:*** The port HW infrastructure is currently facing severe overloaded resource conditions ***Potential consequences:*** • As per D2.6 (M18): Until these very demanding conditions are relaxed, ASSIST-IoT development will not be able to be deployed in Pilot 1, or at least at the expected pace.	***Mitigation measures introduced in D2.6 (M18):*** Instead of accessing to the Production environment of the port terminal, Pilot 1 partners will set up a pre-production, controlled environment specific for the trials of the project. ***Status:*** • At D2.6 (M18): *Some symptoms detected.* • At D2.7 (M27): *This risk is now overcome.*

Likelihood + Severity: • At D2.6 (M18): *Low + High* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.6 (M18):*** Project partners are finalising the list of procured equipment that will be used in the pilots' trials. ***Notes in D2.7 (M27):*** The mitigation measures were put in place, and now that the pilot has advanced the risk is considered no longer applicable. ***Notes after the latest execution period: M28-M36*** No need of more actions.	• At D2.13 (M36): *No risk.*
Name: Open Call deployment and pilots (identified during the 2nd iteration) ***Description:*** The proposals from Open Call winners differ too much from the goal of pilots' use-cases, preventing actual added value to be provided. ***Potential consequences:*** • As per D2.6 (M18): (i) Too many roundabouts must be taken, or (ii) ad-hoc infrastructure equipment must be provided for them, or (iii) too much effort is needed to be devoted from ASSIST-IoT stakeholders, deviating their focus from succeeding in the pilot. • As per D2.7 (M27): Same consequences as above, added to potential administrative inconvenient related to payments to external parties (OC projects). ***Likelihood + Severity:*** • At D2.6 (M18): *Low + Medium* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low*	***Mitigation measures introduced in D2.6 (M18):*** In the Open Call evaluation process, one step within the whole flow considers the "intervention" of ASSIST-IoT stakeholders' partners to ensure that the proposed projects fit the pilots' approach. In addition, the expert evaluators of the Open Call proposals have been specifically instructed to consider the "stickiness to pilot spirit and goals" as a paramount evaluation criterion. ***Additions in D2.7 (M27):*** A specific mitigation strategy has been put in place to ensure that the execution of OC projects is aligned with ASSIST-IoT technology and pilot goals. The strategy consists of: • Periodic check in the advances of the OC projects ("reviews") in which the execution is evaluated, including stickiness to plan and to ASSIST-IoT views. • Establishment of communication channels and software exchange through GitLab public repositories and GitLab participation by OC projects. ***Status:*** At D2.6 (M18): *This risk is not applicable yet.*

Notes in D2.7 (M27): This period has been characterised of covering the major part of the OC projects (round 1) execution. During this period, two controls (in the form of reviews of checks) to the OC projects have been applied. This, together with other mentioned measures has helped minimise the likelihood and criticality of this risk. ***Notes after the latest execution period: M28-M36*** The experience with the first Open call projects showed that the actions carried out and mitigation measures were fine, so there is no need of major changes in the procedure for the second round of Open calls.	At D2.7 (M27): *No symptoms detected.* At D2.7 (M36): *No symptoms detected.*
Name: Pilot 2 construction site timing (identified during the 3rd iteration) ***Description:*** Due to the contract signed by the construction company (MOW – partner of ASSIST-IoT) with the promoter of the building, the construction works must be finalised by September 2023, which limits the practical time to perform on-field ASSIST-IoT demo site validation activities until July-August 2023. ***Potential consequences:*** • As per D2.7 (M27): Validation activities not ending on time, diminished impact of the pilot, enablers not fully validated on field. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Low* ***Notes in D2.7 (M27):*** This risk, although controlled, it may affect the final validation activities if some enablers are not developed on time. ***Notes after the latest execution period: M28-M36*** The activities of pilot 2 that needed to be carried on site were executed, and hence the risk is overcome. No sense to add mitigation measures as the trials have been successfully completed. Some minor tests to be	***Mitigation measures introduced in D2.7 (M27):*** The mitigation strategy is consisting on speeding up those activities in pilot 2 that require the performance of on-site tests in the Warsaw construction works. This is being dealt with properly, as documented in D7.3. In addition, those Open Calls projects to be funded in round #2 will be properly informed that the integration works will not be able to take place in the real pilot site environment due to this constraint. ***Status:*** At D2.7 (M27): *The risk has materialised. Partners in pilot 2 are shifting their focus on the practical, validation activities so that to ensure that the pilot is not jeopardised by this fact. For now, the risk seems under control but will need to be followed carefully throughout the M28-M36 period.* At D2.13 (M36): *The risk is overcome.*

finalised in laboratory conditions, not affecting the assessment of pilot 2 KPIs.	
Name: Open Call technological dependency and assets provisioning (identified during the 3rd iteration) ***Description:*** Some Open Call projects might require specific assets from ASSIST-IoT partners (e.g., images, data, spaces, connection to software or hardware…). ***Potential consequences:*** • As per D2.7 (M27): This might damage the execution goals and/or rhythm of Open Call projects and potentially disrupt the actions of pilot partners as the retrieval of required assets might consume unexpected resources and efforts. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Low* • At D2.13 (M36): *Medium + Low* ***Notes in D2.7 (M27):*** This risk might be repeated along the next periods, as several incidences about required assets could happen at the end of OC projects (round 1 and all the period of round 2). ***Notes after the latest execution period: M28-M36*** Solutions for the technical challenges during the second round of Open Call projects are being addressed quickly, so that their objectives are met in time.	***Mitigation measures introduced in D2.7 (M27):*** Specific attention is being put to this risk by partners involved in T7.4. A specific taskforce including project coordination (UPV) and Innovation Managers (PRO) has been set up to deal with these special cases, always supported by the technical lead partner associated to each pilot. ***Status:*** At D2.7 (M27): *Some symptoms detected: labelled images of people and machinery in the yard of the port of Malta and construction site personnel and works in SMART SONIA. Both aspects have been dealt successfully during the period. Therefore, the risk is under control.* At D2.13 (M36): *Some symptoms still detected.*
Name: Measurement means for KPIs (identified during the 3rd iteration) ***Description:*** The description on how KPIs will be measured is, for some KPIs, not very clear and it might become a problem in later stages. ***Potential consequences:***	***Mitigation measures introduced in D2.7 (M27):*** The Deliverable D8.2 aims to provide an update of deliverable D8.1 (Evaluation plan) focused on initial results over technical KPIs as well as updating the evaluation plan and status of all the defined KPIs of the project. ***Additions after the latest execution period: M28-M36***

• As per D2.7 (M27): Not possible to measure validates nor to compare against targets set. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Medium* • At D2.13 (M36): *Low + Medium* ***Notes in D2.7 (M27):*** KPIs is a relevant part of the evaluation of project success (including solution, technologies, pilot approach, adoption, etc.), and not being able to measure them would be critical for the project. However, it is considered medium at this stage as some mitigation measures have been put in place and the WP8 will have enough time to carry out proper technical, pilot and process evaluation strategies. ***Notes after the latest execution period: M28-M36*** WP8 and WP7 teams have been continuously monitoring the KPIs to ensure that methodologies are clear and measurement plans are in place, overall reducing the likelihood of the risk.	More clear structure in D8.3 to report the description, methodologies and results of the KPIs, fostering that all methodologies are clear and results reported as soon as possible. ***Status:*** At D2.7 (M27): *Some symptoms detected at the beginning of the period. Applied measures to correct them via D8.2.* At D2.13 (M36): *Less symptoms detected thanks to the mitigation measures applied.*
Name: Target goal of KPIs is too ambitious (identified during the 3rd iteration) ***Description:*** It might happen that the initial KPI target values, as per defied in the proposal, were no longer valid, having been too reaching or falling short to true potential of the project. ***Potential consequences:*** • As per D2.7 (M27): Unfeasible to be achieved (those target numbers) during the lifetime of the project, resulting in poor metrics. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + High* • At D2.13 (M36): *Medium + High* ***Notes in D2.7 (M27):*** The risk is considered medium (and not high) as a first run of checking the target numbers (and adjusting them, if needed) took place in D8.1	***Mitigation measures introduced in D2.7 (M27):*** Deliverable D8.2 has included a review of the validity and soundness of KPI target goals. D8.2 presented a thorough update of all the (five-dimensions structured) KPIs of the project. In this deliverable, technical KPIs have been mainly enhanced in terms of detail, procedures and early evaluation results. Although some measurements have been able to be tackled, the work in WP4, WP5 and WP6 is still on-going and only partial results have been obtained. The results are looking good so far, and now that integration in a common "lab" infrastructure is close to be finalised, data about performance, technical connection between elements and other aspects are closer to be settled. ***Additions after the latest execution period: M28-M36*** As with pilot KPIs, all types of KPIs are being closely monitored in regular meetings (in WP8, and WP7) to detect any issue related to poor planning, methodology or feasibility of results. ***Status:***

before this period. The likelihood of this risk is still medium as, even though D8.2 is completed with another review round, this stage of the project is very relevant for KPIs and some valid KPIs target numbers could turn into difficult figures to reach. ***Notes after the latest execution period: M28-M36*** Although mitigation measures are in place, many KPIs have not been yet characterised, thus the risk is still there and then its likelihood should not be reduced, at least until most of the KPIs are measured.	At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *No symptoms detected.*
Name: Difficulties integrating security enablers in legacy solutions (identified during the 4th iteration) ***Description:*** The project provides its own identity management and authorisation enablers. Pilots may involve some legacy software that might not possible to be integrated, or that requires a huge effort with little revenue in the long-term. ***Potential consequences:*** • As per D2.13 (M36): Lower user experience during the execution of pilot trials because of having different ways of managing users. ***Likelihood + Severity:*** • At D2.13 (M36): *Medium + Medium* ***Notes after the latest execution period: M28-M36:*** This possibility has been seen primarily in Pilot 3b, as a legacy web server with its own security technologies was already in place and was deemed necessary to be integrated with the tactile dashboard. Also, in PUI9 framework from Prodevelop. Integrations are being carried out, with promising results so far.	***Mitigation measures introduced in D2.13 (M36):*** Technical meetings for integrating legacy platforms with the tactile dashboard and the security enablers, so that from the users' perspective double-logins are not required without compromising the cybersecurity of the overall system. ***Status:*** At D2.13 (M36): *Some symptoms detected and on track*

3.4. Impact risks

Table 6.Pilot related risks in ASSIST-IoT

Risk description, comments and potential consequences	Mitigation measures, corrective actions and status/comments per iteration
Name: Lack of interest (identified since Proposal stage) ***Description:*** Lack of interest in the project results by external stakeholders. ***Potential consequences:*** • As per D2.5 (M9): Lead to problems in applying successfully the impact plans and meeting the set KPIs • As per D2.7 (M27): Not meeting the KPIs expected related to impact and process evaluation. ***Likelihood + Severity:*** • At D2.5 (M9): *Low + Low* • At D2.6 (M18): *Low + Low* • At D2.7 (M27): *Medium + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.5 (M9):*** Based on responses to the result dissemination as performed within the scope of WP9. ***Notes in D2.6 (M18):*** All events organised by the project (Webinars, surveys with stakeholders, Open Call landing acceptance, etc.) have been reasonably followed by the community and all KPIs are under control. ***Notes after the latest execution period: M19-M27*** Likelihood has been augmented due to the proximity of the end of the project. A series of KPIs are expected that require formal/informal involvement by potential adopters, that might need time and additional explanations. ***Notes after the latest execution period: M28-M36***	***Mitigation measures:*** Targeted dissemination and communication plans focused mainly on industry and academia will be provided, elaborating further the core ASSIST-IoT impact plans (D9.2), for raising external stakeholders' awareness and increasing interest in results ***Additions in D2.5 (M9):*** They will be systematically evaluated and adapted (through upcoming WP9 deliverables), to assure successful results sharing and impact. ***Additions in D2.6 (M18):*** Closely following, executing and adapting the impact plans described in D9.2. New, updated content is being continuously generated and communicated through all ASSIST-IoT channels on a daily basis. Quarterly issued ASSIST-IoT Newsletter is communicated through website and ASSIST-IoT social media channels addressing 1000+ website visitors and social media followers. Interaction with other projects is continuous through events, associations and impact task forces. ***Additions in D2.7 (M27):*** Taking advantage of the amendment request to adapt the plan to ensure proper coverage of external adopters actions. In addition, an enhanced description was requested to all partners and has been included in D8.2, clearly detailing the plans for accomplishing the KPIs and increasing the impact and potential interest of adopters. ***Additions after the latest execution period: M28-M36*** Methodologies for suitably capturing the interest in the project have been carefully prepared in D8.3, extending the information provided in D8.3. **Status:** • At D2.5 (M9): *No symptoms detected.* • At D2.6 (M18): *No symptoms detected. KPIs are meeting expectations in global lines.* • At D2.7 (M27): *No symptoms detected.*

In the preliminary stage of D8.3 (five months to be submitted), almost all target KPIs related to the project's interests have been met. Hence, the likelihood has been reduced to low.	• At D2.13 (M36): *No symptoms detected.*
Name: Underperformance in scientific dissemination (identified during the 1st iteration) ***Description:*** There is the risk that the project will fall short in achieving KPIs of scientific dissemination (e.g., 38 total publications by M36). ***Potential consequences:*** • As per D2.6 (M18): Less dissemination capacity, reduced impact outreach, weaker scientific baseline for further research. ***Likelihood + Severity:*** • At D2.5 (M9): *High* + *Low* • At D2.6 (M18): *High* + *Low* • At D2.7 (M27): *Low* + *Low* • At D2.13 (M36): *Low* + *Low* ***Notes in D2.5 (M9):*** Based on self-assessment performed in M8, jointly by the PC and the TC. ***Notes in D2.6 (M18):*** This risk is the second one that has started to materialise. It has been spotted and is being monitored by the PC/TC and T9.2 leader. ***Notes in D2.7 (M27):*** Likelihood has been drastically reduced as several conference and journal papers have been published or have been produced and are under publication review. ***Notes after the latest execution period: M28-M36*** The number of publications is very close to the target, with 6 months to go. Some publications are planned, submitted or under review, and there is very little risk that the target is not met.	***Mitigation measures introduced in D2.5 (M9):*** Due to the COVID-19 a number of potential target conferences did not materialise (e.g. they were postponed or did not happen). Moreover, participation in online conferences has considerably lover impact in comparison with on-site conferences. Moreover, due to the, above mentioned, communication issues, resources have been devoted to delivery of core results, rather than dissemination-related activities. This problem has been spotted during M6 project review. In M9, the situation in this area is much better and it is still possible to "catch-up" with scientific dissemination; e.g. because travel resources have been preserved due to COVID-imposed travel restrictions. ***Additions in D2.6 (M18):*** The creation of "Technical Reports" has been enhanced, uploading to project's website any scientific article created even though it has not yet been accepted or published (pre-print). Attending conferences/workshops and making ASSIST-IoT presentations remain a top activity even in virtual format. In M18, the situation in this area is much better and from now on it is expected that scientific dissemination events will be resumed, where ASSIST-IoT presence is foreseen (e.g., IoTWeek2022, EU-IoT Hackathon, TRA2022). ***Additions in D2.7 (M27):*** T9.2 created a specific workforce group to organise the preparation of scientific articles. This was agreed on 5th Plenary Meeting and a control has been conducted every month on periodic telcos and also in F2F plenaries (e.g., Warsaw in M24). ***Additions after the latest execution period: M28-M36*** Continuous sharing of opportunities in journals and conferences communicated internally, having internal agreements to ensure that all teams are collaborating to meet this KPI and effort is not unbalanced. ***Status:***

	• At D2.5 (M9): *Some symptoms have been spotted in M5-M8 and counter-measures applied.* • At D2.6 (M18): *Situation is much better and more events and special issues are being tackled.* • At D2.7 (M27): *Situation has improved enormously. This risk is almost overcome.* • At D2.13 (M36): *The risk is under control.*
Name: COVID-19 impact for dissemination (identified during the 2nd iteration) ***Description:*** COVID-19 restrictions related to travelling and organisation of physical events. ***Potential consequences:*** • As per D2.6 (M10-M11): COVID-19 may continue to restrict travelling and organisation of physical events, affecting in this way the impact activities of the projects (mainly the ones related to scientific dissemination and F2F communication through physical attendance of scientific events, workshops, exhibitions etc.). ***Likelihood + Severity:*** • At D2.6 (M10-M11): *Moderate + Moderate* • At D2.6 (M18): *Low + Moderate* • At D2.7 (M27): *Low + Low* • At D2.13 (M36): *Low + Low* ***Notes in D2.7 (M27):*** Face-to-face meetings have been resumed in ASSIST-IoT. Two plenary meetings (Valencia, Warsaw) plus a code-camp meeting (Bilbao) have been organised alongside partner-to-partner specific meetings. ***Notes after the latest execution period: M28-M36*** COVID has not affected in this phase. No further mitigation measures required.	***Mitigation measures introduced in D2.6 (around M10-M11):*** Alternative types of communication and dissemination activities will continue to apply (as already done during the first period of the project) i.e participation in virtual events, use of digital content for enhancing communication. Impact activities will continue through participation in activities and events organised virtually. Most type of events offered a virtual type of organisation during the last two years. If physical events are not resumed, all partners will continue creating impact through digital channels and means ***Additions in D2.7 (M27):*** Meetings have been organised and conducted ***Status:*** • At D2.6 (M10-M11): *Not possible to perform on-site dissemination. The risk is materialising.* • At D2.6 (M18): *By the time of closing this deliverable (D2.6 – M18), the situation with travelling and physical events is little by little resuming the pre-pandemic scenario, therefore the likelihood of this risk has been reduced to Low.* • At D2.7 (M27): *This risk is considered overcome.* • At D2.13 (M36): *This risk is considered overcome.*

Name: Low responses in the adoption measures survey (identified during the 3rd iteration) ***Description:*** T8.4 is carrying out a series of surveys to identify potential barriers of adoption of ASSIST-IoT technologies. ***Potential consequences:*** • As per D2.7 (M27): Reduced impact outreach. ***Likelihood + Severity:*** • At D2.7 (M27): *Medium + Low* • At D2.13 (M36): *Medium + Low* ***Notes in D2.7 (M27):*** This risk might materialise as ASSIST-IoT partners do not have total control of the potential answers received to the forms, however, lessons learned make this risk considered of low criticality. ***Notes after the latest execution period: M28-M36*** Number of answers of the first survey is not very high. For the next surveys the Consortium will put more effort in the mitigation measures in place, to minimise the risk.	***Mitigation measures introduced in D2.7 (M27):*** The following mitigation measures have been put in place: • Thoroughly analysed plan of surveys in order to minimise overburdening requests to potential responders. • Enhanced communication campaigns to ensure proper outreach. • Extension of the timeline of the project so that the answering windows are larger. ***Additions after the latest execution period: M28-M36*** If the number of answers is not significant for some specific type of target user, although not ideal, answers from reputed people will be collected via personal contacts. ***Status:*** At D2.7 (M27): *No symptoms detected.* At D2.13 (M36): *Some symptoms detected.*
Name: Reduced success in the adoption of the project outcomes after its ending (identified during the 4th iteration) ***Description:*** The project delivers a set of novel technological enablers, hardware devices and a reference architecture that are not adopted by actors from the research nor the business sector. ***Potential consequences:*** • As per D2.13 (M36): Low real success of the project. ***Likelihood + Severity:*** • At D2.13 (M36): *Low + High* ***Notes after the latest execution period: M28-M36:***	***Mitigation measures introduced in D2.13 (M36):*** Continuous monitoring of the impact KPIs to gain awareness of the real situation of the project. Participation in the Horizon Results Booster programme of the European Commission to better stream the key innovations of the project to the market, with the support of experts. Launching of dedicated surveys and adoption of technological transfer strategies to ensure that the project is aligned with the real needs of the market. ***Status:*** At D2.13 (M36): *Little symptoms detected.*

This risk has been set with a severity of *high* as the aim of all projects is to be useful, otherwise all the effort and the funds provided could be considered not well spent.	