5GLOGINNOV

D4.2

Start-ups integration report

www.5g-loginnov.eu

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Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
EC	European Commission
HMI	Human-Machine Interface
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
TRL	Technology Readiness Level
WBS	Work Breakdown Structure
WP	Work Package

EXECUTIVE SUMMARY

This document reports about the 5G-LOGINNOV Open Call for the selection of 5 start-ups/SMEs aiming to develop innovative solutions to be implemented and validated within the 3 project Living Labs.

It contains an overview of the organisation and plans for the Open Call, together with details about steps and planned timing (evaluation process, selection criteria, results, etc.).

Furthermore, the last section (Annexes) includes the most relevant documents released along the Open Call preparation and evaluation process.

1 INTRODUCTION

1.1 Project intro

5G-LOGINNOV will focus on seven 5G-PPP Thematics and support to the emergence of a European offer for new 5G core technologies in 11 families of use cases. 5G-LOGINNOV's main aim is to design an innovative framework addressing integration and validation of Connected Automated Driving/Mobility (CAD/CAM) technologies related to the industry 4.0 and port domains by creating new opportunities for LOGistics value chain INNOVation. 5G-LOGINNOV is supported by 5G technological blocks, including new generation of 5G terminals notably for future Connected and Automated Mobility, new types of Industrial Internet of Things 5G devices, data analytics, next generation traffic management and emerging 5G network architectures, for city ports to handle upcoming and future capacity, traffic, efficiency and environmental challenges. 5G-LOGINNOV will deploy and trial 11 families of use cases targeting beyond TRL7, including a GREEN TRUCK INITIATIVE using CAD/CAM & automatic trucks platooning based on 5G technological blocks. Thanks to the new advanced capabilities of 5G relating to wireless connectivity and core network agility, 5G-LOGINNOV ports will not only significantly optimise their operations but also minimise their environmental footprint to the city and the disturbance to the local population. 5G-LOGINNOV will be a catalyst for market opportunities build on 5G core technologies in the logistics and port operations domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SMEs and start-ups. 5G-LOGINNOV will open SMEs' and start-ups' door to these new markets using its three Living Labs as facilitators and ambassadors for innovation in future European ports. 5G-LOGINNOV's promising innovations are key for the major deep-sea European ports in view of the mega-vessel era (Athens, Hamburg), and are also relevant for medium sized ports with limited investment funds (Koper) for 5G.

1.2 Purpose of the deliverable

The main purpose of this deliverable is to report about the organisation and management of 5G-LOGINNOV Open Call, including the description of the process, the main highlights about the applications, the overall scores, the contracting of selected applicants, the plans for implementation of the solutions, etc.

1.3 Intended audience

This deliverable is a public document intended for the following audience:

- 5G-LOGINNOV partners (especially Living Lab Leaders) can use the deliverable as a reference for the successful integration of selected applications within the Living Labs.
- The European Commission and related Agency (CINEA) and reviewers can use the deliverable to gain insights about the management of the Open Call, the success of the initiative, the transparency of the evaluation process and the expected outcomes of the inclusion of new actors.
- Any reader can use the deliverable to gain insights about the management and the results of the Open Call.

2 GENERAL INFORMATION

2.1 Scope and Terms of the Open Call

2.1.1 Aim and General Objectives

The project 5G-LOGINNOV[1] organised an Open Call for the selection of five innovative start-ups and SMEs aiming to develop 5G-based solutions in the framework of activities carried out at the three Living Labs of the project.

The Open Call was reserved to start-ups and SMEs complying with the conditions described in chapter 2.1.3. The scope of the Open Call was intentionally left as general as possible, given that all candidate solutions shall apply to the physical context and infrastructure of (one of) the three Living Labs; however, the tender conditions (annexed to the present document) provided some specific areas of interest that have been selected by the Living Labs during the scoping phase.

2.1.2 Type of Contract

The selected applicants will be incorporated into the 5G-LOGINNOV consortium through a service contract providing a global price of max. € 50.000 each (VAT included). The service contract will be granted by ICOOR and UNIMORE (University of Modena and Reggio Emilia) on behalf of the whole consortium, i.e. the services will be for the benefit of other beneficiaries of the project.

The services provided by selected applicants will include:

1. The design and development of the proposed ICT solution.
2. The provision of all paper/media documentation needed for its on-field operation.
3. The deployment of the proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project.
4. On-site support to the deployment, installation and validation of the solution.
5. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or CINEA Officers), as requested by the Project Coordinator through ICOOR.

Deployment and other on-site activities (points 3 and 4 of the list above) will be detailed and agreed between selected applicants and related Living Lab Leaders during the contracting phase, depending on the operation of proposed solutions and their level of integration with the physical context and infrastructure of the Living Labs.

2.1.3 Eligibility Criteria

The call was open to start-ups in the form of SMEs legally established in an eligible country according to chapter 2.1.4. An SME will be considered as such if it complies with the Commission Recommendation 2003/361/EC[2] and the SME user guide[3]. As a summary, the criteria which define a SME are:

- Headcount in Annual Work Unit (AWU) less than 250.
- Annual turnover less or equal to € 50 million or annual balance sheet total, less or equal to € 43 million.

[1] https://5g-loginnov.eu

[2] European Commission Recommendation 2003/361/EC, 2020, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:en:PDF

[3] The new SME definition, 2020, http://ec.europa.eu/growth/content/revised-user-guide-sme-definition-0

The (selected) applicants were called to:

- Declare their willingness to deploy and validate their ICT solutions (prototype) in the physical context and infrastructure of (at least) one of the three Living Labs of the project, as indicated at the time of application.
- Guarantee appropriate on-site support to the deployment/validation phase, as agreed with the relevant Living Lab(s) Leader(s) during the contracting phase.
- Ensure the free-of-charge usage of their ICT solutions by any project partner/appointed stakeholder involved in the execution of selected Living Lab(s) for the entire duration of the project; further commercial/production exploitation of the solution after the termination of the project may be agreed separately by the parties.
- Foresee the necessary reporting and contribution to the regular team and project meetings, in line with the project's related timelines and deliverables.
- Participate to project dissemination activities, including virtual/physical events, which will be organised by the project management along the duration of the project.
- Declare they are completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organisations or other kind of legal entities funded by or otherwise affiliated with 5G-LOGINNOV partners were not eligible.

Only one entity per application was admitted, so activities in co-operation were not considered eligible.

2.1.4 Eligible Countries

Only applicants legally established and operational in any of the following countries were considered eligible:

- The Member States of the European Union, including their outermost regions.
- The Overseas Countries and Territories linked to the Member States[4].
- H2020 Associated countries: according to the updated list published by the EC at http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf.
- The UK applicants are eligible under the conditions set by the EC for H2020 participation at the time of the deadline of the call.

2.1.5 Applicable law and tendering procedure

The service contract will be awarded and will be carried out in compliance with the Italian law, i.e. the Legislative Decree no. 50/2016 (Italian Code of Public Contracts), laying down the Implementation of Directives 2014/23/EU, 2014/24/EU and 2014/25/EU on the award of concession contracts, public contracts and the procurement procedures of entities operating in the water, energy, transport and postal services sectors, as well as for the reorganisation of the existing rules on public contracts for works, services and supplies.

2.1.6 Other applicable dispositions

The service contract will be qualified as "subcontract" in accordance with the Article 13 of the Grant Agreement of the Programme Horizon 2020 (hereinafter referred to as "GA").

In particular, the provider ("the subcontractor") shall as follows:

a) Allow checks, reviews, audits and investigations carried out by the Commission/Agency, European Court of Auditors, European Prosecutor Office and OLAF (see Article 22 GA).
b) Permit the evaluation of the impact of the action carried out by the Commission/Agency under the Article 23 GA.
c) Avoid any conflicts of interest in the performance of the service (see Article 35 GA).

[4] Entities from Overseas Countries and Territories (OCT) are eligible for funding under the same conditions as entities from the Member States to which the OCT in question is linked.

d) Maintain the confidentiality in accordance with the Article 36 GA.
e) Promote the action and give visibility to the EU funding (see Article 38 GA).
f) Indemnify the contractor of any damages deriving from the implementation of the service contract.
g) According to the Article 46 GA, the subcontractor shall not consider the Commission/Agency as responsible of the damages arising from the service contract and the relationship with the beneficiaries.

2.1.7 IPR clauses

Applicants were asked to indicate their background IPR in their proposal, which they consider relevant.

Selected applicants will retain this background IPR of their proposed solutions, but they are obliged to enable free-of-charge usage to the project (and appointed stakeholders) for the entire duration of the project. Specific post-project exploitation agreements may be signed between selected applicants and involved stakeholders.

The foreground IPR, generated in a common action between the selected applicant and the 5G-LOGINNOV partners during the execution of the action, will be handled by the specific contracts. The clauses will need to be compliant to the general IPR clause applied in the already established Grant Agreement of the project partners.

Non-selected partners will retain ownership of their background IPR of their proposed solutions, but the 5G-LOGINNOV project partnership is entitled to give reference to their background IPR, in any of its dissemination activities.

3 OPEN CALL MANAGEMENT

3.1 Open Call Preparation and Timing

3.1.1 Tender Conditions

The detailed tender conditions (annexed to the present document) have been prepared to inform potential applicants about the project concept and structure, the general objective of the call and the eligibility criteria, the legal information and documents to be included in their application form.

Tender conditions were published on the project website at the Open Call launch date.

3.1.2 Application Form

The applicants described their ICT solutions through an Application Form (annexed to the present document) published on the project website at the Open Call launch date.

The Application Form consisted of the following sections:

1. **General information** about the applicant: organisation type, legal address, contacts, etc.
2. **Identification of target Living Lab(s)**, describing general objectives (related to Living Lab layout) and specific areas of interest that are targeted by the proposed solution (if any).
3. **Ambition and development plans**, describing the exploitation paths foreseen for the proposed solution, preferably through a draft structured business plan.
4. **Technical description**, providing an exhaustive description of the ICT solution, including:
    - Aims and operating principles (preferably through sequence diagrams, flow charts or similar).
    - Distinctive features, advances over the state-of-the-art.
    - High-level functional architecture.
    - Interfaces/connectors with other ICT systems/platforms.
    - Deployment architecture (how the solution will be integrated with existing ICT/operational infrastructure of the Living Labs: hardware, software, libraries, field devices, etc.).
    - Preliminary layout of the Human-Machine Interface (HMI), if any (preferably including pictures, screenshots, sketches, etc.).
5. **Operating description**, providing a brief description of:
    - Expected benefits and measurable Key Performance Indicators.
    - Possible data sharing policies.
    - Planned support activities (remote and on-site).
    - Other on-site activities (e.g. installation, test, etc.) and needs (e.g. access to Living Lab area, involvement of Living Lab personnel, etc.).
6. **Project structure**, containing the Work Breakdown Structure (WBS) of the project, Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related deliverables and milestones (including types, contents, due dates).
7. **Resource/budget allocation**, indicating the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item (staff, purchase of equipment, travel and subsistence).

3.1.3 Collection and Evaluation of Applications

The Open Call was officially launched on 26-April-2021, to last until 15-Jul-2021. The event was advertised on the project website, on the ERTICO official site and through various communication channels (e.g. LinkedIn), as well as promoted by Living Lab leaders at local level. Applications have been collected through a dedicated functional mail active all along the opening period. The original deadline (30-Jun-2021) had been extended to cater for a significant number of applications received in the very last days.

After closing the application phase (15-Jul-2021), all applications underwent a technical/business evaluation process, aiming to determine their ranking and to select the 5 winners granted with a service contract for each provider (see chapter 3.2). The expected date for the announcement of selected applications (17-Sep-2021) was postponed due to the extension of application period and some further clarifications needed by some applicants.

The following table provides a summary of the general timing of the 5G-LOGINNOV Open Call.

Table 1. Open Call general timing

Planned Date	Phase/Event
26-Apr-2021	Launch of the Open Call (submission of applications opened)
15-Jul-2021	Closure of the Open Call
16-Jul 2021 - 08-Oct-2021	Evaluation of received applications
08-Oct-2021	Final ranking drawn up
12-Oct-2021	Final ranking ratified by project General Assembly in Hamburg
14-Oct-2021	Winners announced at ITS World Congress in Hamburg
15-Oct-2021 - 30-Nov-2021	Contracting of selected applications
01-Dec-2021	Contracts signed, kick off of activities

At the Open Call closing time (15-Jul-2021), 15 applications were received, addressing all the three Living Labs and covering a very broad range of application domains, including Intelligent Transport Systems (ITS), automated handling, safety and security, telecommunications, etc.

Please refer to chapter 4 for the complete list of applications.

3.2 Evaluation Process

The evaluation of eligible applications has been carried out by the 5G-LOGINNOV Project Management Team, including appointed representatives from:

- ERTICO (Project Coordinator and Technical Coordinator, Quality Manager, Leader of WP2, WP6 and WP7).
- VICOMTECH (Innovation Manager, Leader of WP1).
- AKKA (Data Manager).
- CIRCLE (Communication Manager, Leader of WP5).
- T-SYSTEMS (Leader of WP3 and Hamburg Living Lab).
- ICCS (Leader of Athens Living Lab).
- ININ (Leader of Koper Living Lab).
- ICOOR/UNIMORE (Leader of WP4).

The evaluation process has been carried out in respect of the principles of fairness and transparency, according to the criteria described in chapter 3.3. The process aimed to assess the applications under two distinct yet complementary perspectives:

- **Technical aspects**, mainly related to sections 2, 4, 5 and 6 of the Application Form: relevance to selected Living Lab(s), degree of innovation, overall architecture, expected impacts and benefits, data sharing, project structure, etc.
- **Business and market aspects**, mainly related to sections 3 and 7 of the Application Form: ambitions, time-to-market, costs structure, business plan, etc.

The following chapter thoroughly describes the assessment criteria followed in the evaluation process.

3.3 Assessment Criteria

All received applications have been first filtered according to their eligibility status, basing on criteria described in chapter 2.1.3. All applications were considered eligible and moved to technical/business evaluation, according to the criteria described in the following chapters.

3.3.1 Technical aspects

The following aspects have been considered and evaluated.

1. **Relevance to selected Living Lab(s)**. Compliance with selected Living Lab(s) objectives and use cases; technical feasibility (related to Living Lab layout); compliance with specific areas of interest.

2. **Innovation**. Distinctive features; degree of innovation of adopted technologies/operating principles; advances over the state-of-the-art for comparable solutions.

3. **Architecture**. Technical relevance of identified functionalities; flexibility and scalability; interoperability with legacy systems (if any); integration with existing ICT/operational infrastructure of the Living Lab(s); usability of proposed HMI (if any); security and privacy issues.

4. **Impacts**. Expected benefits; measurable Key Performance Indicators (KPIs); socio-economic impacts (sustainability, resilience); data sharing policies.

5. **Project structure**. Overall quality of the Work Breakdown Structure (WBS); methodology used; suitability of allocated resources; relevance of Deliverables and Milestones.

Each of the above criteria accorded scores as per the table below.

Table 2. Technical evaluation scoring

Evaluation	Description	Score
Fail	The proposal fails to address the criterion or cannot be assessed due to missing or incomplete information.	**0**
Poor	The criterion is inadequately addressed, or there are serious inherent weaknesses.	**1**
Fair	The proposal broadly addresses the criterion, but there are significant weaknesses.	**2**
Good	The proposal addresses the criterion well, but a number of shortcomings are present.	**3**
Very Good	The proposal addresses the criterion very well, but a small number of shortcomings are present.	**4**
Excellent	The proposal successfully addresses all relevant aspects of the criterion. Any shortcomings are minor.	**5**

Once all technical criteria were scored, applications have been filtered to ensure they were above a minimum acceptability threshold defined by the following rule:

- Each criterion reaches the minimum score of 3

and

- The application totalises an overall technical score of 18.

3.3.2 Business and market aspects

The following aspects have been considered and evaluated.

1. Business value. Impact of the innovation in terms of value created for the specific Living Lab.

2. Market aspects and exploitation outside the Living Lab. Possibility to apply the innovation in other Living Labs and contexts and to determine a sustainable business by itself.

Each of the above criteria accorded scores as per the Table 2.

The following minimum acceptability threshold was defined:

- Each criterion reaches the minimum score of 3.

Once all technical and business and marked aspects were scored, a final ranking of the proposals has been defined, as from chapter 6.

4 LIST OF APPLICATIONS

No	Acronym	Full Title	Applicant	Country	Athens LL	Hamburg LL	Koper LL
1	5G4A	5G-Loginnov-4-Amazon	eShuttle	Germany		X	
2	COMOS	5G Supported Cloud-based Operator Monitoring	SmartUniversal	Turkey	X		X
3	ANT5GCCAET	A 5G Enabled Cooperative, Connected and Automated Electric Tractor for Efficient Micro-maneouvers in Logistic Hubs	ANT Maschinen GmbH	Germany		X	
4	5GTrack	5G Vehicle Tracking	Sma-RTy Italia s.r.l	Italy			X
5	ITGS	Intelligent Traffic Guidance System	Roads.AI	Israel		X	
6	TRITON	auTonomous dRones for marITime OperatioNs	Hellenic Drones	Greece			X
7	TAADD	TAXi-AD Data	TAXi-AD GmbH	Germany		X	
8	B5.1.IO.a.p.p.	Bluetooth5.1 Indoor/Outdoor Asset Positioning Project	BK TELEMATICS LTD	Greece	X		
9	DataLuka	Real-time 5G transmission of container registration and/or HazMat/ADR codes from a AI-Camera on the TLEX platform, so that companies can use these registrations in real-time in their logistics planning	Monotch BV	The Netherlands	X	X	X
10	ATHAIS	Automated Transport Hail System	Nimera BV	Belgium	X		
11	deeptraffic 101	Innovative C-ITS and 5G based traffic management solutions for efficient and environmentally friendly freight transport management using deeptraffic 101	DEEPTRAFFIC P.C.	Greece		X	
12	ECO-HAMBURG	Environment Monitoring & Forecasting Solution for Hamburg	WINGS ICT Solutions	Greece		X	
13	RESONATE	Real timE drowSiness detectiON, AlerTing and rEporting	Libra AI	Greece	X		
14	SPINE	Supplying Ports with Innovative (5G) Networks to reduce Emissions	Ubiwhere	Portugal		X	
15	Mar5G	Maritime 5G Technology	Super Radio AS	Norway			X

5 EVALUATION SCORES

No	Acronym	Relevance	Innovation	Architecture	Impacts	Project	Business	Market	Total
1	5G4A	4.000	3.250	3.500	3.500	3.750	3.375	3.500	24.875
2	COMOS	3.000	3.125	2.875	3.125	3.000	2.875	3.125	21.125
3	ANT5GCCAET	2.500	3.500	3.125	3.375	3.500	3.125	3.125	22.250
4	5GTrack	2.625	3.250	3.375	3.125	3.250	2.625	2.875	21.125
5	ITGS	3.875	3.750	3.250	4.000	3.125	3.000	3.375	24.375
6	TRITON	4.500	4.375	4.500	4.000	4.250	4.000	4.125	29.750
7	TAADD	3.875	3.125	3.500	3.500	4.125	3.375	3.375	24.875
8	B5.1.IO.a.p.p.	1.500	2.625	2.875	2.500	3.375	2.875	3.125	18.875
9	DataLuka	3.375	2.750	3.250	2.875	3.250	3.125	2.875	21.500
10	ATHAIS	2.750	3.250	3.125	3.000	3.625	2.750	3.125	21.625
11	deeptraffic 101	3.750	3.000	2.875	3.125	3.250	2.500	2.750	21.250
12	ECO-HAMBURG	3.500	2.750	3.125	2.875	3.750	3.125	3.250	22.375
13	RESONATE	4.625	4.125	4.250	4.125	4.000	4.125	4.250	29.500
14	SPINE	2.875	3.125	3.250	3.250	3.000	3.125	3.000	21.625
15	Mar5G	2.125	4.000	3.750	2.875	3.500	2.875	3.250	22.375

Note: each of the scores above represents the average of the individual scores given by the 8 evaluators.

6 OVERALL RANKING

No	Acronym	Full Title	Applicant	Country	Total
6	TRITON	auTonomous dRones for marITime OperatioNs	Hellenic Drones	Greece	29.750
13	RESONATE	Real timE drowSiness detectiON, AlerTing and rEporting	Libra AI	Greece	29.500
1	5G4A	5G-Loginnov-4-Amazon	eShuttle	Germany	24.875
7	TAADD	TAXi-AD Data	TAXi-AD GmbH	Germany	24.875
5	ITGS	Intelligent Traffic Guidance System	Roads.AI	Israel	24.375
12	ECO-HAMBURG	Environment Monitoring & Forecasting Solution for Hamburg	WINGS ICT Solutions	Greece	22.375
15	Mar5G	Maritime 5G Technology	Super Radio AS	Norway	22.375
3	ANT5GCCAET	A 5G Enabled Cooperative, Connected and Automated Electric Tractor for Efficient Micro-maneouvers in Logistic Hubs	ANT Maschinen GmbH	Germany	22.250
10	ATHAIS	Automated Transport Hail System	Nimera BV	Belgium	21.625
14	SPINE	Supplying Ports with Innovative (5G) Networks to reduce Emissions	Ubiwhere	Portugal	21.625
9	DataLuka	Real-time 5G transmission of container registration and/or HazMat/ADR codes from a AI-Camera on the TLEX platform, so that companies can use these registrations in real-time in their logistics planning	Monotch BV	The Netherlands	21.500
11	deeptraffic 101	Innovative C-ITS and 5G based traffic management solutions for efficient and environmentally friendly freight transport management using deeptraffic 101	DEEPTRAFFIC P.C.	Greece	21.250
2	COMOS	5G Supported Cloud-based Operator Monitoring	SmartUniversal	Turkey	21.125
4	5GTrack	5G Vehicle Tracking	Sma-RTy Italia s.r.l	Italy	21.125
8	B5.1.IO.a.p.p.	Bluetooth5.1 Indoor/Outdoor Asset Positioning Project	BK TELEMATICS LTD	Greece	18.875

7 CONCLUSIONS

The 5 applications below satisfied all assesment criteria described at chapter 3.3 and have been selected to move to contracting phase. The relevant Application Forms are annexed to present document.

Acronym	Full Title	Applicant	Athens LL	Hamburg LL	Koper LL
TRITON	auTonomous dRones for marITime OperatioNs	Hellenic Drones			X
RESONATE	Real timE drowSiness detectiON, AlerTing and rEporting	Libra AI	X		
5G4A	5G-Loginnov-4-Amazon	eShuttle		X	
TAADD	TAXi-AD Data	TAXi-AD GmbH		X	
ITGS	Intelligent Traffic Guidance System	Roads.AI		X	

8 ANNEXES

The following documents are annexed to this document:

- Annex I: 5G-LOGINNOV Open Call for Innovative Start-ups Tender Conditions.
- Annex II: 5G-LOGINNOV Open Call for Innovative Start-ups Application Form.
- Annex III: Application Form: TRITON, auTonomous dRones for marITime OperatioNs (Hellenic Drones)
- Annex IV: Application Form: RESONATE Real timE drowSiness detectiON, AlerTing and rEporting (Libra AI)
- Annex V: Application Form: 5G4A 5G-Loginnov-4-Amazon (eShuttle)
- Annex VI: Application Form: TAADD TAXi-AD Data (TAXi-AD GmbH)
- Annex VII: Application Form: ITGS Intelligent Traffic Guidance System (Roads.AI)

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Annex I

5G-LOGINNOV Open Call for Innovative Start-ups Tender Conditions

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Open Call for Innovative Start-ups

Tender Conditions

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4G/5G	4th/5th Generation (of cellular networks)
AI	Artificial Intelligence
AR	Augmented Reality
ATP	Automated Tuck Platooning
CAD	Connected Automated Driving
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
CAM	Connected Automated Mobility
CAN	Controller Area Network (vehicular bus standard)
CNF	Cloud Native Functions
EC	European Commission
EU	European Union
FMS	Fleet Management System (vehicular communication standard)
FTED	Floating Truck and Emission Data
GLOSA	Green Light Optimal Speed Advisory
ICT	Information and Communication Technology
IoT	Internet of Things
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
MEC	Multi-access Edge Computing
ML	Machine Learning
OEM	Original Equipment Manufacturer (often referred to car-makers)
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
QoS	Quality of Service
SME	Small-Medium Enterprise
TLF	Traffic Light Forecast
TMS	Traffic Management System
TRL	Technology Readiness Level
UAV	Unmanned Aerial Vehicle
UC	Use Case
UHD	Ultra-High Definition (images)
USIM	Universal Subscriber Identity Module
VNF	Virtual Network Functions
WBS	Work Breakdown Structure
WLTP	Worldwide-harmonized Light vehicles Test Procedure
WP	Work Package

1 GENERAL INFORMATION

1.1 Issuing Body

This tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

1.2 Scope and Terms of the Open Call

1.2.1 Aim and General Objectives

The project **5G-LOGINNOV**[1], funded by the European Union's Horizon 2020 research and innovation programme, **organises an Open Call for the selection of five innovative start-ups and SMEs** aiming to develop 5G-based solutions in the framework of activities carried out at the **three Living Labs of the project** (see chapter 2.4).

The Open Call is reserved to start-ups and SMEs **complying with the conditions described in chapter 1.2.3**. The scope of such Open Call is intentionally left as general as possible, given that all candidate solutions shall apply to the physical context and infrastructure of (one of) the three Living Labs; however, chapter 4.2 provides some specific areas of interest that have been individuated by the Living Labs during the scoping phase.

1.2.2 Type of Contract

The selected applicants will be incorporated in 5G-LOGINNOV consortium through a **service contract providing a global price of max. € 50.000 each (VAT included).** The service contract will be granted by ICOOR and UNIMORE (University of Modena and Reggio Emilia) on behalf of the whole consortium, i.e. the services will be for the benefit of other beneficiaries of the Project.

The services provided by selected applicants will include:

1. The design and development of proposed ICT solution.
2. The provision of all paper/media documentation needed for its on-field operation.
3. The deployment of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project.
4. On-site support to the deployment, installation and validation of the solution.
5. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR.

Deployment and other on-site activities (points 3 and 4 of the list above) will be detailed and agreed between selected applicants and related Living Lab Leaders during the contracting phase (see chapter 4.4), depending on the operation of proposed solutions and their level of integration with the physical context and infrastructure of the Living Labs.

No financial reporting will be requested to selected applications, i.e. the contract will grant a lump sum corresponding to the total costs declared in the Application Form (see chapter 4.1, point 7) without need to declare/justify the different cost items.

No additional cost claim (travel/subsistence/equipment/service) **will be accepted outside the scope of the service contract**.

[1] https://5g-loginnov.eu

1.2.3 Eligibility Criteria

The call is open to start-ups in the form of SMEs legally established in an eligible country according to chapter 1.2.4. A SME will be considered as such if accomplishing with the Commission Recommendation 2003/361/EC[2] and the SME user guide[3]. As a summary, the criteria which define a SME are:

- Headcount in Annual Work Unit (AWU) less than 250.
- Annual turnover less or equal to € 50 million or annual balance sheet total, less or equal to € 43 million.

The applicant must declare the willingness **to deploy and validate its ICT solution (prototype) in the physical context and infrastructure of (at least) one of the three Living Labs** of the project, which will be indicated at the time of application on the application form. The technical terms of deployment and validation will be agreed with the relevant Living Lab(s) Leader(s) during the contracting phase.

The applicant must guarantee **appropriate on-site support to the deployment/validation phase**, as agreed with the relevant Living Lab(s) Leader(s) during the contracting phase. There are no travel and subsistence allowances/reimbursements planned for on-site activities, i.e. such costs must be considered as integral part of the global price as above mentioned.

The applicant shall ensure the **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project; further commercial/production exploitation of the solution after the termination of the project may be agreed separately by the parties.

The applicant shall foresee the **necessary reporting and contribution to the regular team and project meetings**, in line with the project's related timelines and deliverables.

Selected applicants are bound to **participate to project dissemination activities**, including virtual/physical events, which will be organized by the project management along the duration of the project. The possible participation to physical events will be covered by 5G-LOGINNOV through the reimbursement of travel and subsistence costs (outside the scope of the service contract).

Only **one entity per application will be admitted**, so activities in co-operation will not be considered eligible.

The applicant must be completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities funded by or **otherwise affiliated with a 5G-LOGINNOV partner are not eligible**.

The applicant recognises **the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[4]**. The related costs (target € 1.500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering.

5G-LOGINNOV retains the right to discard the selected application in case one (or more) of the conditions above are not satisfied.

1.2.4 Eligible Countries

Only applicants legally established and operational in any of the following countries will be eligible:

- The Member States of the European Union, including their outermost regions.

[2] European Commission Recommendation 2003/361/EC, 2020, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:en:PDF
[3] The new SME definition, 2020, http://ec.europa.eu/growth/content/revised-user-guide-sme-definition-0
[4] https://itsworldcongress.com

- The Overseas Countries and Territories linked to the Member States[5].
- H2020 Associated countries: according to the updated list published by the EC at http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf.
- The UK applicants are eligible under the conditions set by the EC for H2020 participation at the time of the deadline of the call.

1.2.5 Reference Documents

In addition to present document, applicants may refer to the following public deliverables[6] and attachments available on the 5G-LOGINNOV Open Call page *https://5g-loginnov.eu/open-call/*:

[1] **Project Deliverable D1.1 - 5G-enabled logistics use cases**: the document contains a thorough description of the three Living Labs (Athens, Hamburg and Koper) and related use cases.
[2] **Project Deliverable D4.1 - Plan for boosting marketplace and emergence of new actors**: the document contains the guidelines for the successful development and commercialization of 5G-related applications in the logistics domain.
[3] **Open Call Attachment 1 - Luka Koper (Port of Koper) - Rules on Internal Order**.
[4] **Open Call Attachment 2 - Luka Koper (Port of Koper) - Online Visitor Announcement Tool** (User Instructions).
[5] **Open Call Attachment 3 - Luka Koper (Port of Koper) - Access Permit Form**.
[6] **Open Call Attachment 4 - Luka Koper (Port of Koper) - Regulations on Trade Secrets Protection**.
[7] **Open Call Attachment 5 - Luka Koper (Port of Koper) - Statement of Protection and Confidentiality**.

1.2.6 Applicable law and tendering procedure

The service contract will be awarded and will be carried out in compliance with the Italian law, i.e. the Legislative Decree no. 50/2016 (Italian Code of Public Contracts), laying down the Implementation of Directives 2014/23/EU, 2014/24/EU and 2014/25/EU on the award of concession contracts, public contracts and the procurement procedures of entities operating in the water, energy, transport and postal services sectors, as well as for the reorganisation of the existing rules on public contracts for works, services and supplies.

In particular the present procedure consists in the acquisition of expressions of interest to participate in the negotiated procedure pursuant to Article 36, paragraph 2, letter b) of the Legislative Decree no. 50/2016.

The market survey notice is published in accordance with the Article 216, paragraph 9, of Legislative Decree no. 50/2016, for a period of min. 15 days on the institutional website of UNIMORE (https://www.unimore.it/).

1.2.7 Other applicable dispositions

The service contract will be qualified as “subcontract” in accordance with the Article 13 of the Grant Agreement of the Programme Horizon 2020 (hereinafter referred to as “GA”).

In particular, the provider (“the subcontractor”) shall as follows:
a) Allow checks, review, audits and investigations on carried out by the Commission/Agency, European Court of Auditors, European Prosecutor Office and OLAF (see Article 22 GA).

[5] Entities from Overseas Countries and Territories (OCT) are eligible for funding under the same conditions as entities from the Member States to which the OCT in question is linked.
[6] The two deliverables D1.1 and D4.1 have not yet been validated by INEA. Any position therein reported reflects the sole position of 5G-LOGINNOV consortium, without any implicit/explicit endorsement by INEA and/or the European Commission.

b) Permit the evaluation of the impact of the action carried out by the Commission/Agency under the Article 23 GA.
c) Avoid any conflicts of interest in the performance of the service (see Article 35 GA).
d) Maintain the confidentiality in accordance with the Article 36 GA.
e) Promote the action and shall give visibility to the EU funding (see Article 38 GA).
f) Indemnify the contractor of any damages deriving of the implementation of the service contract.
g) According to the Article 46 GA, the subcontractor shall not consider the Commission/Agency as responsible of the damages arising from the service contract and the relationship with the beneficiaries.

1.2.8 IPR clauses

Applicants will indicate their background IPR in their proposal which they consider relevant.

Selected applicants will retain this background IPR of their proposed solutions, but they are obliged to enable free-of-charge usage to the project (and appointed stakeholders) for the entire duration of the project. Specific post-project exploitation agreements may be signed between selected applicants and involved stakeholders.

The foreground IPR, generated by in a common action between the selected applicant and the 5G-LOGINNOV partners during the execution of the action, will be handled by the specific contracts. The clauses will need to be compliant to the general IPR clause applied in the already established Grant Agreement of the project partners.

Non-selected partners will retain ownership of their background IPR of their proposed solutions, but the 5G-LOGINNOV project partnership is entitled to give reference to the their background IPR, in any of its dissemination activities.

2 PROJECT OVERVIEW

5G-LOGINNOV proposes a strategic, innovative framework addressing integration of technologies as part of an overall architecture representing a subset of 5G network functions. 5G-LOGINNOV is supported by 5G technological blocks, including new generation of **5G terminals** for future **Connected and Automated Mobility** (CAM), new types of **IoT-5G devices** for field data acquisition and control, **data analytics**, next generation **traffic management** and emerging subsets of 5G networks functions, **for port areas and city-ports** to handle upcoming and future capacity, traffic, efficiency and environmental challenges. 5G-LOGINNOV project will also implement and deploy a **green truck initiative** using CAD/CAM and **automatic truck platooning** based on 5G technological blocks.

The project develops and validates **beyond-state-of-the-art solutions** that will increase efficiency and optimize land-use, while being financially viable, respecting circular economy principles and being of service to the urban environment. Through 5G-LOGINNOV, **ports will minimize their environmental footprint** to the city and will decrease disturbance to the local population through a significant reduction in the congestion around the port. The solutions developed by the project are being deployed and validated in three Living Labs in the ports (or neighbouring city areas) of Athens (Greece), Hamburg (Germany) and Koper (Slovenia), addressing challenges taken by the mega-vessel era as well as those relevant for medium-sized ports with limited investment funds for 5G infrastructure and automation.

5G-LOGINNOV will also boost economic development and business innovation, **promoting innovative high-tech start-ups and SMEs** to new markets through the present Open Call and other communication and networking initiatives.

2.1 Project Vision

The vision of 5G-LOGINNOV is to pave the way towards efficient freight and traffic operations at ports and logistics hubs by using new innovative concepts, applications and devices supported by the **disruptive 5G technologies**, including Internet of Things (IoT), data analytics, next generation traffic management and CCAM (Cooperative, Connected and Automated Mobility) in logistics corridors.

The project has a strong interest in the **emergence of new market players**, such as SMEs and start-ups, taking advantage of the growing adoption of distributed cloud computing technologies in 5G networks and making it possible opening innovation at service level in the logistics and Industry 4.0 sectors.

2.2 Project Objectives

In order to meet capacity and efficiency targets, lower its environmental impact and establish a truly bidirectional relation with the urban space surrounding it, a port-city area needs to invest in equally important **technological and societal innovations, novel business models and changes of mind-set**, which are reflected in 5G-LOGINNOV high-level objectives:

- **Objective 1 (O1)**: Develop and deploy next generation ports and logistics hubs operation system architecture integrated in 5G networks at three main ports in Europe (Athens, Hamburg and Koper), utilising new types of 5G IoT sensors and devices.
- **Objective 2 (O2)**: Optimise ports and logistics hubs operation and maintenance, for reducing their operational costs with innovative concepts and use cases.
- **Objective 3 (O3)**: Reduce significantly ports and logistics hubs operation emissions (CO_2/$NOX_)$ and regulate the resulting freight traffic on the future 5G logistics corridor in EU, including CAM truck platooning management.

- **Objective 4 (O4)**: Regulate the freight traffic generated by ports and logistics hubs on the future 5G logistics corridors in EU, and integrate future connected and automated truck platoons according to the EU Green Deal program.

- **Objective 5 (O5)**: Boost ports and logistics hubs operation/maintenance innovation with involvement of new market actors including SMEs and start-ups. 5G-LOGINNOV will support the creation of innovation incubators and will be connected to local research-intensive and innovative high-tech start-ups and the business community in order to promote innovation in the heart of economy.

- **Objective 6 (O6)**: Support standardisation of 5G-enabled next generation ports and logistics hubs operation system, in order to ensure interoperability, platform openness and operation harmonisation around future 5G Logistics cross-border corridors.

- **Objective 7 (O7)**: Support adoption and take up of 5G-enabled next generation ports and logistics hubs operation system in Europe and beyond.

2.3 Project Activities and Timing

5G-LOGINNOV is organised in **7 work packages (WPs)**, each corresponding to a main activity in the project; tasks within these WPs are assigned to leaders and participants with the required specific expertise:

- **WP1** - Living Labs requirements and specifications (led by VICOMTECH).
- **WP2** - Living Labs development and deployment (led by ERTICO).
- **WP3** - Living Labs trials and evaluation (led by T-SYSTEMS).
- **WP4** - Marketplace and emergence of new actors (led by ICOOR).
- **WP5** - Dissemination and exploitation (led by CIRCLE).
- **WP6** - Project management (led by ERTICO).
- **WP7** - Ethics (led by ERTICO).

The present Open Call, as well as most of the work of selected applications, **will be carried out in the context of WP4**, with strong interactions with Living Labs' execution **(WP3)** and dissemination/ exploitation activities **(WP5)**; both WP4 and WP5 will last until the end of the project (month 36, i.e. August 2023), while Living Lab activities (WP3) will terminate on month 32 (i.e. April 2023).

The objective of WP4 is to analyse the current and future market linked to the 5G core technologies innovations that are addressed in the 5G-LOGINNOV Living Labs, i.e. products, services and solutions at TRL7 or beyond, which exploit the potential of 5G to improve logistics operation. **WP4 will provide opportunities to start-ups and SMEs to create new businesses and emerge in the market**. The work package will:

- Define the gaps between the current and future market scenarios.
- Involve start-ups and SMEs in the proposition of new products and services based on 5G core technologies.
- Provide a market strategy for new stakeholders.
- Facilitate the introduction of 5G core innovation technologies in logistics operations.
- Support the participation of new actors in Living Labs' activities (WP4).
- Create and moderate a network of start-ups to be supported for addressing the development of economic opportunities of 5G-enabled next generation logistics hubs and port operation, liaising with WP5 (in particular Clustering and Networking task).

2.4 Project Living Labs

The solutions developed by the project (including those brought by selected applications) will be deployed and validated in **three Living Labs** in the ports (or neighbouring city areas) of **Athens** (Greece), **Hamburg** (Germany) and **Koper** (Slovenia), through a total of **11 use cases**:

- **UC1** - Management and Network Orchestration Platform (Koper).
- **UC2** - Device Management Platform Ecosystem (Athens).
- **UC3** - Optimal Selection of Yard Trucks (Athens).
- **UC4** - Optimal Surveillance Cameras and Video Analytics (Athens).
- **UC5** - Automation for Ports: Port Control, Logistics and Remote Automation (Athens, Koper).
- **UC6** - Mission Critical Communications in Ports (Koper).
- **UC7** - Predictive Maintenance (Athens).
- **UC8/9** - Floating Truck & Emission Data (Hamburg).
- **UC10** - 5G GLOSA & Automated Truck Platooning (ATP)-under 5G-LOGINNOV Green Initiative (Hamburg).
- **UC11** - Dynamic Control Loop for Environment Sensitive Traffic Management Actions (Hamburg).

Applicants may frame their solutions in the context of **existing use cases**, as well as **proposing new ones**.

The following chapters provide a brief overview of the main motivations and objectives of the three Living labs; applicants are invited to read project deliverable **D1.1 - 5G-enabled logistics use cases** [1] for further information about Living Labs and related use cases (download from 5G-LOGINNOV Open Call page *https://5g-loginnov.eu/open-call/*).

2.4.1 Living Lab 1 - Athens

5G-LOGINNOV will address several key aspects of day-to-day port operations at Piraeus Container Terminal (PCT) in Athens. The current local fleet size (about 170 operational trucks daily), in addition to incoming external trucks, imposes significant challenges in port operations that in turn affect various work chains in Piraeus. Efficiently managing and coordinating the movement of yard trucks within the port is of vital importance, as the majority of operations heavily rely on internal yard trucks for the horizontal movement of containers between stacking areas and loading/unloading areas for vessels and rail.

Unfortunately, current localization services lack several key elements for optimally allocating container jobs to yard trucks (given the availability pool), where often the selected trucks are not the ones closest to the container; this results in (unnecessary) longer travel duration for trucks, increased fuel consumption (and relative CO_2 and NO_x emissions) and traffic jam incidents, which have a direct impact in productivity levels and operational costs. The enhanced localisation services and low latency transmissions will constitute the key element blocks for the optimal assignment of container jobs to 5G-connected yard trucks.

Another issue relates to the safety of employees and other personnel within the premises of PCT. Frequent incidents involving boom collisions, gantry collisions or stack collisions, along with the presence of stevedoring personnel in the area, make the risk for serious bodily injuries considerable. A far-edge (low latency) computing approach, integrated into a pioneering 5G-IoT device, will detect human presence in areas not allowed, based for instance on innovative machine learning techniques.

A similar technological approach will be applied to remote automation of port operations and logistics support, focusing on detecting the presence/absence of container seals. Currently, the identification of presence or absence of container seals occurs manually, i.e. by an appointed employee, raising safety concerns, sub-optimal use of human resources in yard equipment and port operations, and increased manual effort (e.g. manual database update, etc.). Through far-edge computing (5G-IoT), devices

operating at port machinery (such as lifts, forklifts, terminal tractors, etc.) will automate and manage end-to-end the life cycle of the service for detecting container seals.

Finally, a key concern at PCT is storing and managing bulky assets (such as spare/repair parts) that occupy significant space of the port; 5G-LOGINNOV will implement a predictive maintenance tool for analysing telemetry data (e.g. CAN-Bus and other on-truck sensor data) collected from the fleet of 5G-connected trucks, to potentially predict possible breakdowns, reduce downtime for repairs and optimise stock of spare parts, increase the service life of yard vehicles and optimise operational efficiency through minimisation of breakdowns.

Overall, 5G-LOGINNOV will optimise port operations in PCT through a number of use cases, including the optimal assignment of container jobs based on localisation (and other) data of internal trucks, improvement of personnel safety through analytics of 4K video streams, predictive maintenance of yard equipment and reduction of the environmental footprint in port operations.

2.4.2 Living Lab 2 - Hamburg

With around 10 million containers, the Port of Hamburg is ranked No.3 in Europe. The disadvantage of the 70 km Elbe restricting access to the Northern Sea is compensated by the excellent rail network in the port and hinterland, of special importance for inter- and multimodal transport and logistics. Due to special situation as a city port, several terminals for container handling are spread across different parts of the city, which makes an efficient hand-over and automation within the intermodal transport chain (port internal transfers) of great importance for Hamburg's long-term competitiveness.

Hamburg Living Lab will demonstrate the potential of leveraging positive environmental impacts by using 5G for sustainable traffic management, and will develop and implement a methodology to capture the effect of the traffic infrastructure on regional emissions, thus making them comparable by quantifying relevant factors (driver profile, vehicle profile, loading, etc.) in the context of Traffic Management System (TMS) measures.

In intelligent traffic control, traffic flow and speed characteristics are usually considered at “macro” level (i.e. “average speed” or “average emission” by vehicle class), while it is proven that vehicle dynamics on “micro” scale (stop/accelerate/decelerate) are most relevant for emission peaks or energy consumption. The Hamburg Living Lab will automate the analysis and quantification of micro-scale dynamics according to the context (vehicle, load, driver, infrastructure, TMS situation, etc.) and will introduce a Traffic Light Forecast (TLF) service to be used in vehicle applications such as Green Light Optimal Speed Advisory (GLOSA); this chain will enable a cooperative micro-manoeuvre behaviour of vehicles, avoiding unnecessary energy spending and reducing pollutants to a considerable degree. The GLOSA app will use the TLF service (which provides signal switching time information) to determine the optimal speed towards the next intersection, thus avoiding energy consuming manoeuvres.

Furthermore, current vehicle trajectories (such as speed or position) can be handed back in the return low-latency channel; such data, when available in near-to-real-time mode to the traffic control system, will enable the cooperative intersection control action of intersection, thus bringing further energy savings. This feature, out of the scope of 5G-LOGINNOV, will be possibly developed in the framework of future activities in Cooperative Intelligent Transport Systems (C-ITS).

2.4.3 Living Lab 3 - Koper

Port of Koper is one of the most dynamic ports in Europe and one of the front runners of innovation. Located in the area of Koper municipality, it is the only Slovenian multi-purpose port connecting central Europe with access to the Adriatic and Mediterranean, and its activity influences the development of the region, Slovenian economy, and logistics in this part of Europe.

The Koper Living Lab targets implementation of 5G technologies and cutting-edge prototypes tailored to be operated in port environment. Novel virtualization and cloud-based principles such as VNF (Virtual

Network Functions) and CNF (Cloud Native Functions), as well as industry-proven infrastructures (e.g. Kubernetes and OpenStack), will be used as baseline technology to build private 5G system in the port of Koper.

Building upon this, the Living Lab will target Industry 4.0 related port operation with a focus on scenarios related to port control, logistics and remote automation. More specifically, the Living Lab will feature a video analytics system for identification of container markers and detection of structural damages and an advanced telemetry system for remote monitoring of operating machines (e.g. terminal tractors); furthermore, several activities related to the port security operation will be introduced through real-time video surveillance (using 5G-enabled body-worn cameras carried by security personnel) and automated drone-based surveillance.

2.5 Specific Areas of Interest

The following chapters describe a set of gaps and/or additional features that have been individuated within the analysis of Living Labs scope, in order to provide focused suggestions to the applicants. Such suggestions are merely indicative and do not set any binding constraint to the scope of proposed applications.

2.5.1 Living Lab 1 - Athens

Augmented Reality (AR) Platforms-as-a-Service can fully exploit their potential by using a fully developed 5G infrastructure. AR is placed on the real-world but offers a more comprehensive experience and perception of it by overlaying additional data. These services introduce new ways for content creation, consumption, and in how such data is communicated, that will undoubtedly help a wide variety of industries, in particular ports and their operations, to increase productivity levels, change the way they do business and view/plan/shape the evolution of their operations.

Through 5G-LOGINNOV, at Piraeus Container Terminal, applicants are invited to develop their platform solutions targeting innovative AR applications, including (but not limited to) the generic scope of the following use cases:

1. *AR-assisted guidance to speed up repairs in port assets (e.g. trucks, lifts, cranes, etc.)*. Production/operation lines are becoming increasingly complicated, hence, (unplanned) asset downtime is a potential (serious) revenue loss for port operators, and thus, cutting downtime for repairs is of paramount importance.
2. *Increase quality in manual production tasks and lower the chance of errors in warehouse operations*. AR-guided cargo load/unload operations (e.g. in open or closed space storehouses) can significantly speed up day-to-day port functions which are potentially part of other service chains in port operations, and thus, significantly improve the overall operational efficiency.
3. *Reduce training time at port operations and related assets, with on-the-job real-time tuition*. Training new personnel in highly complex port operations and relevant assets (e.g. quay cranes) can pose significant challenges for port operators. AR-guided tuition can speed up the training process, minimize the possibility of errors, and contribute to optimal human resource allocation.

Additional areas of interest include use cases that involve distracted driver & drowsiness detection. Distracted driving comprises any activity that takes away the (truck) driver's attention from the road. Drowsy driving signs, according to the American Academy of Sleep Medicine, are frequent yawning, difficulty keeping your eyes open, "nodding off", and having trouble keeping your head up. Technical 5G-enabled solutions, based on e.g. advanced computer vision and artificial intelligence, capable of recognizing -in video streams- indicators for both distracting and drowsy driving in real-time, are of paramount importance for within (and outside) port operations, to increase road (and asset) safety.

2.5.2 Living Lab 2 - Hamburg

From the overall design of the Hamburg LL, the 5G infrastructure enables the collection of extended Floating Car Data and expands this data to Floating Truck and Emission Data (FTED). A typical example is the detected fuel consumption available via CAN-Bus and FMS, which is transferred to the MEC platform (Multi-access Edge Computing) and used for further calculations and evaluations. By this way, the derived CO_2 emissions can be quantified much more reliable than the emissions derived from the WLTP reference cycle, measured in [%].

There are numerous other examples of available data from CAN-Bus and other sensor data which can be transferred from the vehicle to the MEC. This leads to the following possible topic of interest:

1. *Applications can make use of the given 5G-LOGINNOV infrastructure (e.g. MEC, Telematics Device, etc.)* and based on this:
   a. Design innovative value-added services for sustainable traffic management beyond the use cases described in 5G-LOGINNOV.
   b. Extend the 5G-LOGINNOV services beyond traffic management, making use of available data sets from the truck.
   c. Enrich 5G-LOGINNOV FTED by additional data from other sources inside the vehicle and the environment (e.g. additional in-vehicle sensors, weather data, environmental sensors).

GLOSA will be used first time for Automated Truck Platooning (ATP) and sustainable traffic management measures in a 5G environment. The platoon(s) will be operated manually during the demonstration; the technical transfer from this demonstration scenario to in-vehicle components (which will trigger fully automated operation) is not part of the Living Lab. This leads to the following possible topic:

2. *Contributions can elaborate an uptake of the described GLOSA-ATP for Hamburg LL to an OEM-centric integration vehicle data sources and their data fusion*. The objective is to use the Floating Truck Emission Data available in GLOSA-ATP as input for automated driving functions used directly for vehicle operation, e.g. gear shift.

The traffic management services proposed for implementation in 5G-LOGINNOV are based on the GLOSA principles. They do not consider other mobile services which will help to reduce emissions. Nevertheless, truck data is highly valid when used by modern navigation software, which leads to the following topic:

3. *How can navigation systems make use of FTED for "Green Navigation"*? Given the planned truck and emission data closely linked to Traffic Light Forecast, the calculation of routes can be expanded to emission reduction criteria, generating a strong environmental impact given the wide usage of mobile navigation.

Besides "Green Navigation", the truck and emission data can also be used for eco-drive training, nowadays very common by truck OEMs to promote their brands towards energy-efficiency. This leads to the following topic:

4. *How can 5G-LOGINNOV support Eco-Drive training out of the generated data and the data fusion out of 5G (MEC, etc.)*?

SMEs and start-ups who intend to apply for a demonstration in Hamburg LL may address all of these topics or make use of parts mentioned above.

2.5.3 Living Lab 3 - Koper

5G combined with the emerging technologies, such as UAVs (Unmanned Aerial Vehicles, e.g. drones) and AI-assisted video analytics deployed in cloud, presents immense potential for the development of innovative applications targeting services for the established vertical industries such as logistics, industry 4.0. and security.

As part of 5G-LOGINNOV Open Call, innovative SMEs are invited to develop beyond-state-of-the-art solutions and applications addressing security and environmental aspects of port operation, to be integrated, tested and showcased in live port theatre. Special attention should be given to the following supportive services and use cases:

1. *Providing autonomous operation of UAVs (e.g. drones without human pilots) in harsh industrial and port environment*, targeting technologies and applications for supporting automated charging of UAV, self-flying and self-piloting actions, scheduled and event triggered UAV take offs, mission control planning, head back to the landing/charging station and finally receiving mission data in real and non-real time as part of fully automated process.
2. *AI- and ML-based applications for cloud environments targeting support services for the port security operation*, based on the exploitation of real-time video streams from moving and stationary drones to recognize security-related events and to identify objects of interest in real time.
3. *AI- and ML-based applications for cloud environments targeting port safety and environment monitoring on the land and sea*, based on the exploitation of UHD video streams from moving and stationary drones and other supportive sensors to identify environmental, safety and other hazardous events that may present damage to the health of people and other organisms. These events can be oil and chemical spill and other maritime pollutants coming from the cargo ships and open cargo already stored in the port area.

Presented use-cases should not limit applicants to propose other novel beyond-state-of-the-art technologies and applications incorporating 5G and other supportive systems that are addressing security, safety and other environmental challenges of modern EU-based ports.

3 TECHNICAL BACKGROUND

This section illustrates the ICT infrastructure of the three Living Labs of the project, providing the basic information needed to understand how the candidate application will be integrated in there.

3.1 Living Lab 1 - Athens

At Piraeus Container Terminal (PCT), in Athens, the focus of the Open Call will be in two main areas of interest regarding the development of:

i. Pioneering AR applications and systems to support port operations, and
ii. Far-edge computing enabled services for detecting distracted drivers' symptoms (e.g. drowsiness, etc.) in yard trucks.

For AR applications, PCT will provide the following equipment for the development of the pilot case:

- EPSON MOVERIO BT-350 glasses.
- Access to the Brochesia B View software.
- Virtual servers based on the ESX platform and located at PCT private data centre (server specifications will be determined during the contracting phase).
- Access to the 4G/5G network (costs related to data transfer over the 4G/5G network will be assumed by PCT).

The glasses have a small camera on them to send image/video data to the support centre, while the lens can also display information (e.g. images, annotations, pdf manuals) transmitted back from the support centre. The glasses are connected via a cable to an Android device the size of a mobile phone (e.g. smartphone or tablet) through which communication is established with the support centre based on WiFi. In areas with no WiFi coverage (e.g. Quay Cranes, Rail Mounted Gantry Cranes, etc.) a mobile hotspot is deployed to establish communication over a 4G network at PCT facilities. Based on the current network type (4G or WiFi) and the channel dynamics, the transmitted image/video quality from (and back to) the AR glasses is adjusted dynamically, whereas features to annotate/mark objects in the user's field of view (by the support centre) as well as voice communications are also available for a full immersive AR experience. Suggested but not limited uses cases include:

- AR-assisted guidance to speed up repairs in port assets (e.g. trucks, lifts, cranes, etc.).
- AR-guided cargo load/unload operations (e.g. in open or closed space storehouses).
- AR-training service at port operations and related assets, with on-the-job real-time tuition.

For the driver condition use case, PCT will provide the following equipment for the development of the pilot:

- A Jetson Xavier NX Developer Kit to be used as a far-edge device.
- An HD camera installed in the yard truck cabin at a location that will not hinder operations and will not introduce security risks.
- A 10-inch tablet (Windows or Android based on use case requirements) or a Raspberry PI.
- A 4G/5G router located in the yard truck cabin.
- Virtual servers based on the ESX platform and located at PCT private data centre (server specifications will be determined during the contracting phase).
- Access to the 4G/5G network (costs related to data transfer over the 4G/5G network will be assumed by PCT).

Far-edge computing is a pioneering technology that enables the evolution to 5G and beyond architectures, designed to put applications and data closer to devices and their users in order to overcome the intrinsic problems of the traditional cloud, such as high latency and the lack of security. Applicants are invited to design and develop their innovative 5G-IoT devices (including hardware and software components) that will locally execute video analytics tasks, based e.g. on machine learning models (also developed by the applicant), to detect truck drivers' symptoms such as fatigue and

drowsiness. The proposed device will be placed inside (and powered by) the yard trucks, receiving a direct video feed of the respective driver's reactions, and executing analytics locally. The inference of the model (e.g. with 90% confidence, the yard truck driver suffers from drowsiness) will be transmitted from the 5G-IoT device to the back-end application at PCT terminal, triggering the necessary actions to prevent potentially dangerous situations.

3.2 Living Lab 2 - Hamburg

The overall service architecture as planned for Living Lab Hamburg is shown in Figure 1. On the right, one can see soft- and hardware systems linked to the city traffic management centre, from where traffic signal states (including forecast) are exchanged with the platoon. Additionally, external environmental data will be collected and made available for the virtual traffic management centre. On the left side, data is transferred from the floating vehicles equipped with telematic devices.

All telematic devices use the public 5G mobile network as available in inner urban area in the city of Hamburg. The foreseen telematic devices are:

1. Tec4U Entruck CarPC collecting raw CAN-Bus data and aggregating them as calculated data.
2. Continental IoT box selecting CAN-Bus data plus additional IoT devices.
3. T-Systems Smartphone LCMM App collecting GPS speed profiles for pre-configured vehicle parameters.

All of these data are transferred via the Telekom 5G public network to the service centre in charge of the use cases. For UC8 and UC9, the LL partners are focusing on floating vehicle emission data collection, evaluated by the three telematic devices running inside the platoon. The devices transmit detailed data sets of single vehicles and platoons including taxi fleet data. The data of UC8 and UC9 helps traffic managers to evaluate emissions along the road network and to help developing strategies for clean air policy measure (short-term and mid-term). Compared to this, UC10 evaluates traffic signal forecast data within the GLOSA APP sent previously from the virtual traffic centre. Additionally, 5G based precise positioning technology will be used to improve the accuracy of all calculations executed within the uses cases.

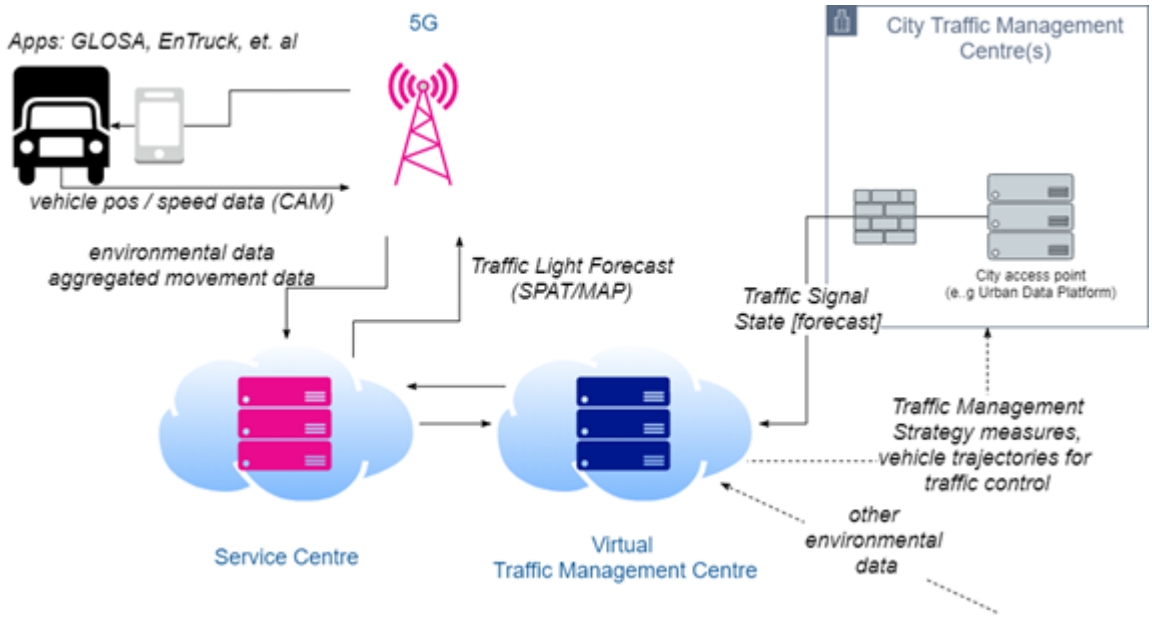

Figure 1. Service Architecture as planned for Living Lab Hamburg

Use case 10 has the objective to implement 5G-enabled truck platoons, including the lead platoon vehicle and the following vehicles. In order to keep the platoon safe and distance stable, the speed range of the lead vehicle has to be transferred to the platoon followers. For this purpose, vehicle-to-

vehicle communication (V2V) with low latency run times (<50 ms), a feature of the 5G mobile network, is foreseen and helps to guarantee the operation of the truck platoon, especially in urban traffic conditions where platooning is challenging. For this, the traffic signal forecast is sent the to the vehicle and drivers can adopt their speed to optimum according to road and traffic conditions.

SMEs and Start-Ups are welcome to design convincing business cases with the technical requirements for business implementation to attract fleet and traffic managers. Solutions should take features of telematics, IoT and 5G into their consideration and convince the Living Lab partners about their innovative go-to-market strategy.

3.3 Living Lab 3 - Koper

Mobile network – 5G NSA Release 15

- Supported User Equipment types:
  - eMBB.
  - NB-IoT.
- If required USIM with required data and QoS profile will be provided.
- Connectivity between User Equipment and Virtual Machines in the LL Cloud will be assured.

Cloud capabilities

- Standard Virtual Machines (e.g. VMware) can be deployed in Koper LL cloud environment. Required compute and storage capabilities needs to be agreed.
- Secure remote access will be available (e.g. VPN).

Services and applications

- Live video streams in standard formats (e.g. H264) from the deployed stationary UHD cameras and drones can be provided to the applicants, but they will be available only inside the Koper LL in the controlled cloud environment.
- Telemetry information data collected from the vehicles can be provided to the applicants, but they will be available only inside the Koper LL in controlled cloud environment.
- A general insight to know-how and the existing security-related drone capabilities in the port can be provided to applicants.

Physical access to the facility

- Physical access to the Koper LL will be also available for the deployment of applicant HW equipment (e.g. drone charging stations) and testing purposes, under the following conditions:
  - Physical access to the Koper LL facility is subject to security conditions set in the document named Rules on Internal Order at Luka Koper (Port of Koper), effective as of 15 April 2011, and is part of the tender documentation [3]. Applicants awarded on the Open Call should meet the provisions from the given document to be able to physically access LL Koper, for the duration of the 5G-LOGINNOV activities in LL Koper.
  - Before accessing the LL Koper facility (for the meeting purposes), the awarded applicant should announce its visit by using the Online Visitor Announcement Tool. User instructions for arranging access permits (e.g. data entry, confirmation process) is part of the tender documentation [4].
  - Before accessing the LL Koper facility (for the service work purposes, e.g. carry out on-site activities), the awarded applicant should fill-in the Application for Access Permit Form, which is part of the tender documentation. Instructions on how to fill and submit the access permit form are provided on the form itself.

Collaboration in Koper LL is subject to provisions set in the document named Regulations on Trade Secrets Protection, effective as of 15 October 2019, deriving from the Trade Secrets Act (Official Gazette of the Republic of Slovenia, No. 22/19), and implementing Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business

information (trade secrets) against their unlawful acquisition, use and disclosure (Text with EEA relevance), and is part of the tender documentation [6]. To gain access to information concerning LL Koper activities, applicants awarded on the Open Call should meet the provisions from the Regulation document and the corresponding legislation.

- Before accessing the LL Koper information, the awarded applicant should sign a statement on the protection of trade secrets of Luka Koper d.d., which is part of the tender documentation [7].
- The Trade Secrets regulation applies to LL Koper awarded applicant and is not limited to the duration of the 5G-LOGINNOV activities. Regulation on Trade Secrets Protection takes effect to applicants for and beyond the duration of the 5G-LOGINNOV action, according to the Trade Secrets Act provisions.

The above stated documents are part of the tender documentation and are available on the 5G-LOGINNOV Open Call page and at https://luka-kp.si/eng/port-security. Upon request, the documents can be transferred to applicants through email service.

4 HOW TO APPLY

This section outlines the procedures for the submission of applications to the 5G-LOGINNOV Open Call.

4.1 Application Form

The applicants shall describe their ICT solution through an **Application Form** published on the Open Call launch date, and then follow the procedure outlined in chapter 4.2; it is strongly recommended that applicants use the Microsoft Word template that will be made available for download at the link *https://5g-loginnov.eu/open-call/*, providing all requested information and respecting page limit constraints where indicated.

Compiled Application Forms must be converted to PDF format, electronically signed and sent to the application mailbox *openCall_applications@outlook.com* between 26-April-2021 and 30-Jun-2021 (see chapter 4.2 for more details).

The compiled Application Form shall not exceed 20 A4 pages, font Arial 11, line spacing 1.

The Application Form consists of the following sections:

1. **General information** about the applicant: organization type, legal address, contacts, etc.
2. **Identification of target Living Lab(s)**, including general objectives (related to Living Lab layout) and specific areas of interest that are targeted by proposed solution (if any).
3. **Ambitions and development plans**. The applicant shall describe the exploitation paths foreseen for the proposed solution, preferably through a draft structured business plan.
4. **Technical description**. The applicant shall provide an exhaustive description of its ICT solution, including:
   - Aims and operating principles (preferably through sequence diagrams, flow charts or similar).
   - Distinctive features, advances over the state-of-the-art.
   - High-level functional architecture.
   - Interfaces/connectors with other ICT systems/platforms.
   - Deployment architecture (how the solution will be integrated with existing ICT/operational infrastructure of the Living Labs: hardware, software, libraries, field devices, etc.)
   - Preliminary layout of the Human-Machine Interface (HMI), if any (preferably including pictures, screenshots, sketches, etc.).
5. **Operating description**. The applicant shall provide a brief description of:
   - Expected benefits and measurable Key Performance Indicators.
   - Possible data sharing policies.
   - Planned support activities (remote and on-site).
   - Other on-site activities (e.g. installation, test, etc.) and needs (e.g. access to Living Lab area, involvement of Living Lab personnel, etc.).
6. **Project structure**. The applicant shall provide the Work Breakdown Structure (WBS) of the project describing Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related Deliverables and Milestones (including types, contents, due dates). The overall timing of the project must comply with the execution of 5G-LOGINNOV Living Labs, i.e. the ICT solution must be deployed, tested and fully validated on selected Living Lab(s) by 30-Apr-2023.
7. **Resource/budget allocation**. The applicant shall indicate the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item (staff, purchase of equipment, travel and subsistence). The total costs allocated for the application must be below the ceiling of € 50.000, VAT included; the cost reduction towards the ceiling of € 50.000 will not be considered as a preferential criterion for the evaluation of the application.
8. **The tenderer shall fill in the section** that states:
   - The acceptance by the tenderer of all conditions laid down in this invitation to tender.

- His/her confirmation that there has been no collusion from his/her answer to tender with the other tenderers and the 5G-LOGINNOV beneficiaries.
- That all the documents submitted by the tenderer become the property of the consortium and are deemed confidential.

4.2 Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *openCall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

The application mailbox will be deactivated on 30-Jun-2021 at 05:00:00 PM CEST, and thus all applications received after this time will be automatically discarded; **applicants are strongly recommended to submit their applications with a reasonable advance over the deadline**, in order to ensure they are successfully delivered in time, even in case of technical or connectivity problems.

5G-LOGINNOV will send a confirmation receipt to the e-mail address submitting the application, notifying that it has been taken in charge by the system; such confirmation does not certify that the application is complete and suitable for evaluation, but simply that the e-mail was received in time.

4.3 Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

In case of specific queries on the call, **applicants may write an e-mail** to *openCall_helpdesk@outlook.com* with subject "support" **to get help from the 5G-LOGINNOV Applicant Helpdesk team**; the helpdesk will remain active from the beginning (26-April-2021) to 10 days before the closure (20-Jun-2021) of the submission period.

4.4 From Application to Contracting

After closing the application phase (30-Jun-2021), all applications will **undergo a technical/business evaluation process**, aiming to determine their ranking and to select the 5 that will be granted with a service contract for each provider.

The evaluation process will indicatively take 2.5 months from the closure of the submission phase; at the end of the evaluation process (planned date: 17-Sep-2021) the final ranking will be notified via e-mail to all applicants, and the 5 winning applications will start the contracting phase, which will end with the official kick-off of activities (planned date: 01-Oct-2021).

The awarded applicants will be informed by the contracting party (ICOOR) and they will be put in contact with the involved Living Lab leaders. **The stakeholders responsible for the ICT infrastructure or port operation (e.g. related to safety, liability, etc.) of selected Living Labs, where the Open Call solutions will be deployed, may add specific clauses to the contract**. Please understand that access to the port and its resources is a delicate process that needs careful planning and must comply with their internal processes and procedures. Granted applicants may be also asked to sign the appropriate NDAs with the involved and relevant project partners

The following table provides a summary of the general timing of the 5G-LOGINNOV Open Call.

Table 1. Open Call general timing

Planned Date	Phase/Event
26-Apr-2021	Launch of the Open Call (submission of applications opened)
30-Jun-2021	Closure of the Open Call
01-Jul 2021 - 16-Sep 2021	Evaluation of received applications
17-Sep-2021	Final ranking drawn up, information to applicants
20-Sep-2021 - 30-Sep-2021	Contracting of selected applications
01-Oct-2021	Contracts signed, kick off of activities

The dates above are merely indicative and may change depending on external factors, including the number of received applications; applicants are invited to visit the 5G-LOGINNOV Open Call page regularly (*https://5g-loginnov.eu/open-call/*), in order to get latest updates about the status and timing of the evaluation process.

4.5 Promotional Events

The 5 selected applications will also be presented in a **live panel session** organized by the project in the context of **ITS World Congress in Hamburg**, 11 to 15 October 2021, together with other Living Labs activities.

Furthermore, all the eligible applicants (not only the selected ones) will be included in the "**ERTICO Start-Ups Initiative**" and engaged about innovation and opportunities linked to 5G-LOGINNOV developments.

5 SELECTION

5.1 Evaluation Process

The evaluation of eligible applications will be carried out by the **5G-LOGINNOV Project Management Team**, including appointed representatives from:

- ERTICO (Project Coordinator and Technical Coordinator, Quality Manager, Leader of WP2, WP6 and WP7).
- VICOMTECH (Innovation Manager, Leader of WP1).
- AKKA (Data Manager).
- CIRCLE (Communication Manager, Leader of WP5).
- T-SYSTEMS (Leader of WP3 and Hamburg Living Lab).
- ICCS (Leader of Athens Living Lab).
- ININ (Leader of Koper Living Lab).
- ICOOR/UNIMORE (Leader of WP4).

Potentially, additional Living Lab partners and experts from the 5G-LOGINNOV project can be involved as additional contributors to the evaluation process, depending on the nature of the submissions.

The evaluation process will be carried out in respect of principles of fairness and transparency, according to the criteria described in chapter 5.2. The process will aim to assess the applications under two distinct yet complementary perspectives:

- **Technical aspects**, mainly related to sections 2, 4, 5 and 6 of the Application Form: relevance to selected Living Lab(s), degree of innovation, overall architecture, expected impacts and benefits, data sharing, project structure, etc.
- **Business and market aspects**, mainly related to sections 3 and 7 of the Application Form: ambitions, time-to-market, costs structure, business plan, etc.

Please note that the Project Management Team could ask for integrations and additional information at any time of the evaluation process, to reach a fully informed and fair judgement.

Also note that the cost structure will only be evaluated in terms of profitability and “value for money” of the proposed solution, in a market exploitation perspective; however, a possible cost reduction towards the ceiling of € 50.000 **will not be considered as a preferential criterion** for the evaluation of the application.

The decision by the project management is final and the tenderer will withhold any legal action against the decision taken.

The following chapter thoroughly describe the assessment criteria followed in the evaluation process.

5.2 Assessment Criteria

All received applications will be first filtered according to their **eligibility status**, basing on criteria described at chapter 1.2.3; for all non-eligible applications, no further evaluation will take place.

Remaining eligible applications will be evaluated according to the criteria described in following chapters.

5.2.1 Eligibility status

All received applications will be first filtered according to their eligibility status, basing on criteria described at chapters 1.2.3 to 1.2.8 included, and according to the indications provided by chapters 4.1, 4.2 and 4.3. For all non-eligible applications, no further evaluation will take place.

Remaining eligible applications will be evaluated according to the criteria described in following chapters.

5.2.2 Technical aspects

The following aspects will be considered and evaluated.

1. **Relevance to selected Living Lab(s)**. Compliance with selected Living Lab(s) objectives and use cases; technical feasibility (related to Living Lab layout); compliance with specific areas of interest (see chapter 2.5).

2. **Innovation**. Distinctive features; degree of innovation of adopted technologies/operating principles; advances over the state-of-the-art for comparable solutions.

3. **Architecture**. Technical relevance of identified functionalities; flexibility and scalability; interoperability with legacy systems (if any); integration with existing ICT/operational infrastructure of the Living Lab(s); usability of proposed HMI (if any); security and privacy issues.

4. **Impacts**. Expected benefits; measurable Key Performance Indicators (KPIs); socio-economic impacts (sustainability, resilience); data sharing policies.

5. **Project structure**. Overall quality of the Work Breakdown Structure (WBS); methodology used; suitability of allocated resources; relevance of Deliverables and Milestones.

Each of the above criteria will accord scores as per the table below.

Table 2. Technical evaluation scoring

Evaluation	Description	Score
Fail	The proposal fails to address the criterion or cannot be assessed due to missing or incomplete information.	**0**
Poor	The criterion is inadequately addressed, or there are serious inherent weaknesses.	**1**
Fair	The proposal broadly addresses the criterion, but there are significant weaknesses.	**2**
Good	The proposal addresses the criterion well, but a number of shortcomings are present.	**3**
Very Good	The proposal addresses the criterion very well, but a small number of shortcomings are present.	**4**
Excellent	The proposal successfully addresses all relevant aspects of the criterion. Any shortcomings are minor.	**5**

Once all technical criteria are scored, applications will be filtered to ensure they are **above a minimum acceptability threshold** defined by the following rule:

- Each criterion reaches the minimum score of 3
  and
- The application totalizes an overall technical score of 18.

5.2.3 Business and market aspects

The following aspects will be considered and evaluated.

1. **Business value**. Impact of the innovation in terms of value created for the specific Living Lab.

2. **Market aspects and exploitation outside the Living Lab**. Possibility to apply the innovation in other Living Labs and contexts and to determine a sustainable business by itself.

Each of the above criteria will accord scores as per the table below.

Table 3. Business and market evaluation scoring

Evaluation	Description	Score
Fail	The proposal fails to address the criterion or cannot be assessed due to missing or incomplete information.	**0**
Poor	The criterion is inadequately addressed, or there are serious inherent weaknesses.	**1**
Fair	The proposal broadly addresses the criterion, but there are significant weaknesses.	**2**
Good	The proposal addresses the criterion well, but a number of shortcomings are present.	**3**
Very Good	The proposal addresses the criterion very well, but a small number of shortcomings are present.	**4**
Excellent	The proposal successfully addresses all relevant aspects of the criterion. Any shortcomings are minor.	**5**

The following **minimum acceptability threshold** is defined:

- Each criterion reaches the minimum score of 3.

Once all technical and business and marked aspects are scored, a final ranking of the proposals will be defined and the 5 winners will be selected accordingly.

5GLOGINNOV

Annex II

5G-LOGINNOV Open Call for Innovative Start-ups Application Form

5GLOGINNOV

Open Call for Innovative Start-ups

Application Form

www.5g-loginnov.eu

This project has received funding from the
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Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
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TABLE OF CONTENTS

List of abbreviations and acronyms

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

GENERAL INFORMATION

This original tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

This document is a proposed template for innovators to answer the tender with their proposal. Applicants are advised to follow the template outline.

Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *opencall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

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Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

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APPLICATION

***Remark** : Double click on the checkboxes and if needed make them checked via the properties box*

Identification

Proposal:

- Acronym of the proposal (optional):
- Full title of the proposal (optional):

Organisation:

- Name of the organisation:
- VAT registration:
- Website:
- Legal address:

Contact:

- Prefix:
- Name:
- Position in the organisation:
- Email:
- Mobile:

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. ☐
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. ☐
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. ☐
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering. ☐
- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. ☐

[1] https://itsworldcongress.com

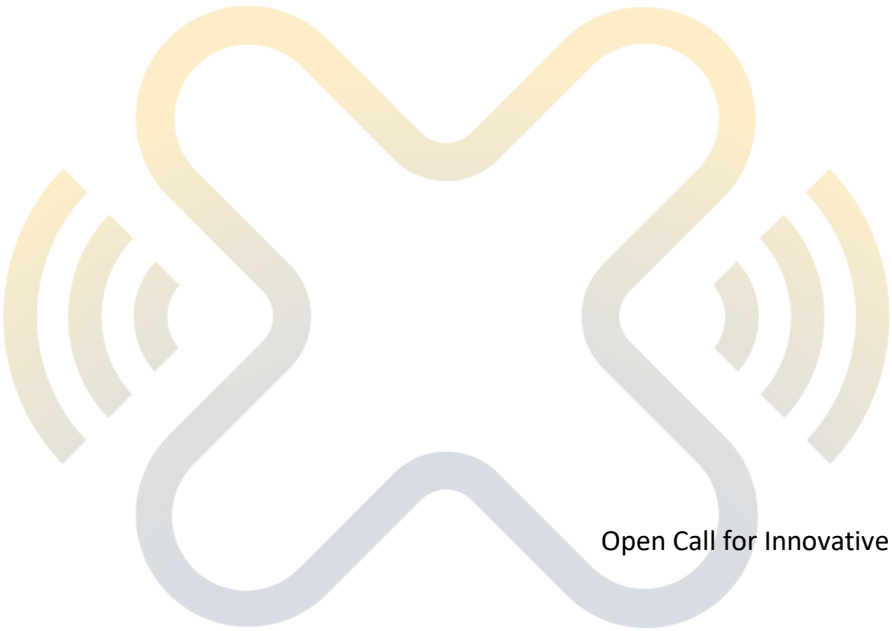
Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. ☐
2. The provision of all paper/media documentation needed for its on-field operation. ☐
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. ☐
4. On-site support to the deployment, installation and validation of the solution. ☐
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. ☐
6. To **participate to project dissemination activities**. ☐
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. ☐

Background IPR

Please list all applicable Background IPR, relevant to your proposal **(max 1 page A4)**



Targeted Living Labs

- Athens ☐
- Hamburg ☐
- Koper ☐

Related general objectives (max ½ page A4)

Specific areas of interest (max ½ page A4)

Ambitions and development plans

Describe your exploitation plans: (max 1 page A4)

Provide a draft structured business plan (max 1 page A4)

Technical description

(max 3 pages A4)

The applicant shall provide an exhaustive description of its ICT solution, including:

- Aims and operating principles (preferably through sequence diagrams, flow charts or similar).
- Distinctive features, advances over the state-of-the-art.
- High-level functional architecture.
- Interfaces/connectors with other ICT systems/platforms.
- Deployment architecture (how the solution will be integrated with existing ICT/operational infrastructure of the Living Labs: hardware, software, libraries, field devices, etc.)
- Preliminary layout of the Human-Machine Interface (HMI), if any (preferably including pictures, screenshots, sketches, etc.).

Operating description

(max 2 pages A4)

The applicant shall provide a brief description of:

- Expected benefits and measurable Key Performance Indicators.
- Possible data sharing policies.
- Planned support activities (remote and on-site).
- Other on-site activities (e.g. installation, test, etc.) and needs (e.g. access to Living Lab area, involvement of Living Lab personnel, etc.).

Project structure

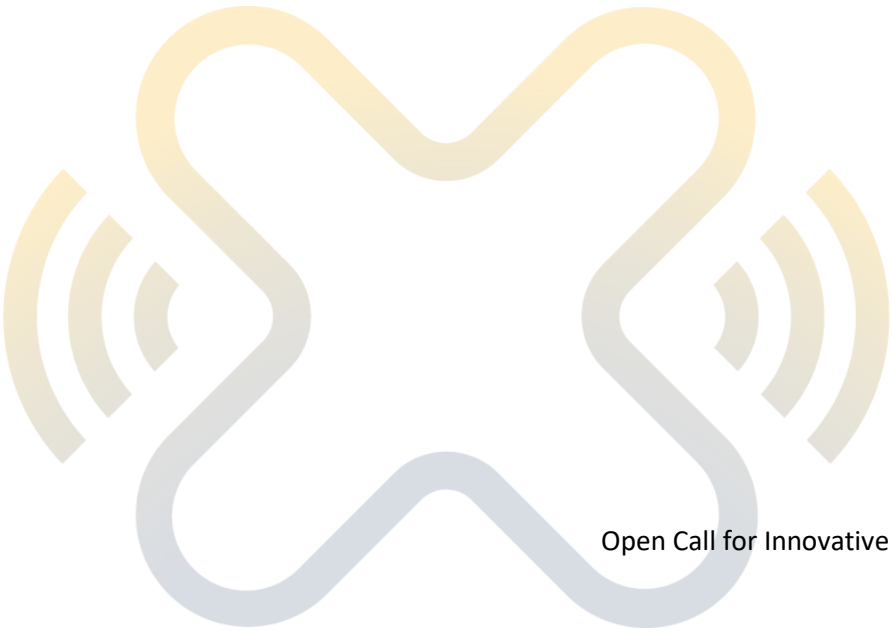
The applicant shall provide the Work Breakdown Structure (WBS) of the project describing Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related Deliverables and Milestones (including types, contents, due dates). The overall timing of the project must comply with the execution of 5G-LOGINNOV Living Labs, i.e. the ICT solution must be deployed, tested and fully validated on selected Living Lab(s) by 30-Apr-2023.

(max 4 pages A4)

Resource/budget allocation

The applicant shall indicate the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item (staff, purchase of equipment, travel and subsistence). The total costs allocated for the application must be below the ceiling of € 50.000, VAT included; the cost reduction towards the ceiling of € 50.000 will not be considered as a preferential criterion for the evaluation of the application.

(max 3 pages A4)



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Annex III

Application Form: TRITON, auTonomous dRones for marITime OperatioNs (Hellenic Drones)

Open Call for Innovative Start-ups

Application Form

Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
Dissemination Level	Public
Status	Final
Due date	23/4/2021
Document Date	22/4/2021
Version Number	1.1

Legal Disclaimer

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TABLE OF CONTENTS

List of abbreviations and acronyms

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

GENERAL INFORMATION

This original tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

This document is a proposed template for innovators to answer the tender with their proposal. Applicants are advised to follow the template outline.

Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *opencall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

The application mailbox will be deactivated on 30-Jun-2021 at 05:00:00 PM CEST, and thus all applications received after this time will be automatically discarded; **applicants are strongly recommended to submit their applications with a reasonable advance over the deadline**, in order to ensure they are successfully delivered in time, even in case of technical or connectivity problems.

5G-LOGINNOV will send a confirmation receipt to the e-mail address submitting the application, notifying that it has been taken in charge by the system; such confirmation does not certify that the application is complete and suitable for evaluation, but simply that the e-mail was received in time.

Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

In case of specific queries on the call, **applicants may write an e-mail** to *openCall_helpdesk@outlook.com* with subject “support” **to get help from the 5G-LOGINNOV Applicant Helpdesk team**; the helpdesk will remain active from the beginning (26-April-2021) to 10 days before the closure (20-Jun-2021) of the submission period.

APPLICATION

***Remark** :*

Right click on the text boxes to insert your input

Double click on the checkboxes and if needed make them checked via the properties box

Identification

Proposal:

- Acronym of the proposal (optional): **TRITON**
- Full title of the proposal (optional): au**T**onomous d**R**ones for mar**IT**ime **O**peratio**N**s

Organisation:

- Name of the organisation: ARTEMIS AGRAIA SYMVOULEYTIKI S.A. “HELLENIC DRONES”
- VAT registration: EL 800666973
- Website: https://hellenicdrones.gr/
- Legal address: Grigoriou Lampraki 17, Piraeus, 18533, Greece

Contact:

- Prefix: Mr.
- Name: Dimitrios Skliros
- Position in the organisation: CEO
- Email: info@hellenicdrones.com
- Mobile: +30 6948836112

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. ☒
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. ☒
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. ☒
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant’s staff) should be included in the applicant’s offering. ☒
- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. ☒

[1] https://itsworldcongress.com

Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. ☒
2. The provision of all paper/media documentation needed for its on-field operation. ☒
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. ☒
4. On-site support to the deployment, installation and validation of the solution. ☒
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. ☒
6. To **participate to project dissemination activities**. ☒
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. ☒

Background IPR

Please list all applicable Background IPR, relevant to your proposal **(max 1 page A4)**

N/A

Targeted Living Labs

- Athens ☐
- Hamburg ☐
- Koper ☒

Related general objectives (max ½ page A4)

The TRITON system aims to develop a system that will enable autonomous drone flights specifically designed for port environments. More precisely TRITON will define aerial paths for drones that will be used to conduct various port operations (port-to-ship deliveries, security monitoring, inspection of critical infrastructure). The most important aspiration for the successful implementation of the TRITON system is the system's ability to avoid mid-air collisions. In order to achieve this, a Multiple Object Tracking (MOT) modules will be embedded in the TRITON system. Inputs from multiple cameras (drone forward cameras, drone 360 cameras, ground cameras) will be used as inputs to the MOT modules. These sources of information will be combined by using fuzzy logic and probability theory tools and will enable precise estimation of the moving objects' trajectories. Key enabler for the system's ability to conduct complex computations and also allow real time path reconfiguration is the 5G connectivity. This allows data transmission from the drones to the port's central server without latency. The demanding compuatations for the path planning and MOT algorithms are executed at the powerful server and via 5G connectivity the system will be able to reconfigure the drones' paths in real-time in case a collision is expected.

Specific areas of interest (max ½ page A4)

The TRITON system builds its technical value proposition on the development of optimal path planning algorithms, the development of MOT algorithms that leverage multiple sources of information, and the implementation of these algorithms on drones and the port's central server via 5G connection. Through TRITON project significant innovation will be achieved in the areas of autonomous drone operations and particularly on the field of MOT. TRITON's feature of combining multiple sources of camera imput to enhance the exclusion and occlusion components of the MOT algorithms is a substantial contributions in the relevant field.

As regard the business value, TRITON aims to replace traditional methods for various port operations (port-to-ship deliveries, security monitoring, inspection of critical infrastructure) with autonomous drones. This will result in a number of different benefits for many stakeholders. Namely, the drone-based solutions will reduce greenhouse gas emissions, will allow safer transportation of humans from the port to the ship, inspections will be carried out safer and more frequently, accidents will be prevented.

Ambitions and development plans

Describe your exploitation plans: (max 1 page A4)

TRITON Value Proposition

TRITON aspires to develop a system that will enable autonomous drone operations targeting activities taking place in a port. This project opens up brand new value propositions wholly unrelated to the way the drone technology is currently being utilized in the maritime domain. TRITON develops the technology for the reduction of greenhouse gas emissions in the port's environment, increases the port's operational flexibility, enhances health and safety standards, and reduces costs. The most important step forward in the TRITON project relies on the fact that the drones will autonomously navigate, and more importantly, automatically recognise moving obstacles in the port's airspace in order to reconfigure their aerial paths to avoid mid-air collisions.

Target Market

TRITON will develop the technical solution at TRL 7. The developed system will be tested in an operational environment (Koper Living Lab). TRITON in Y1 targets clients through the participants (Koper, Athens, and Hamburg ports) in the customer research phases, and there is no advertising needed. Y2 onward sales team headcount has been accounted for. Post-pilot, there will be an opportunity to increase average contract value and retain customers through the upsell of more advanced features. Also, the outbreak of the COVID-19 pandemic has highlighted the need for autonomous and remote operations, which boosts even more the necessity of the TRITON system.

TRITON offers a cost-effective alternative to the traditional methods for port-to-ship deliveries, security monitoring, and inspections of critical port infrastructure, and consequently TRITON B2B addressable market consists of port authorities, and port service providers. Globally there exist 1817 registered well-known ports and in each one of them many different service providers carry out services that can be conducted more efficiently by drones that will be integrated with TRITON.

Market Barriers

TRITON proposes a game-changing solutions for port operations which can be upscaled and applied to urban and rural environments. However, a number of barriers should be overcome before TRITON can become a commercially available product. The most important challenges are related to: i) acceptance of the proposed solution of end-users, ii) establishment of regulation regarding autonomous drone operations, and iii) acceptance of the general public.

In order to address the challenges mentioned above the project team has created a proactive plan of action. More specifically, the TRITON project will leverage the strong consortium of the 5G-LOGINNOV project in order to present the system's functionalities and present its advantages to end-users (5G-LOGINNOV Living Labs). Moreover, the methods used to validate the system functionalities will be presented to EASA and local Civil Aviation Authorities in order to contribute to the development of the necessary regulatory framework for autonomous drone operations, which have not been set by any regulatory body. Funding of the TRITON project will contribute significantly to a rigorous discussion regarding autonomous drone operations and will ultimately accelerate the development of the relevant regulations that will pioneer air transport services. Finally, TRITON accounts for the dissemination of the system's outcomes to the general public in order familiarise individuals outside the aerospace industry with autonomous drones' operations. Also, the applications that autonomous drones can have in urban and rural environments and their advantages (reduced environmental footprint, increased safety, and reduced costs) compared to the traditional methods of transportation will be highlighted.

Provide a draft structured business plan (max 1 page A4)

The aim of TRITON's business plan is to maximise the market penetration and exploitation potential of project results and define a realistic plan on the long-term viability of the project's technical offerings. The three major part of the business plan, that are presented in this section, are the competitor analysis, the financial analysis, and the growth model.

Competitor Analysis

TRITON's competitors are: i) traditional techniques for port operations, ii) manually operated drones for port operations.

As regards the traditional techniques, these have the advantage that are well-known methods that are available in all ports and end-users are familiar with. However, their disadvantages are related to the fact that some of the traditional techniques contribute significantly to CO2 emissions (diesel operated launch boats), create dangerous conditions for humans and in some cases lead to accidents (inspections using scaffold and roping), and on many occasions they are not very efficient in task related to security and safety monitoring (many accidents have been reported due to poor maintenance or lack of supervision during port operations). The autonomous drone operations offered by the TRITON system will be able to replace most of the traditional techniques and benefit end-users to the challenges mentioned above.

Also, TRITON's competitors are drone-based services that are controlled by human operators. The most important advantage of manually operated drones compared to the TRITON system is the fact that the regulatory framework for most operations conducted by remotely piloted aircraft is in place for a few years (only human transportation is not permitted at the moment), and for this reason they are already used for port operations. However, the large-scale application of drone-based services will result in the simultaneous flights of many drones in the port's airspace. Manually operated drones result in increased risk of mid-air collisions which is unacceptable for aerospace operations. Therefore, the only viable and scalable concept of operations for drone-based port operations can be achieved by TRITON's proposed solution.

PROFIT AND LOSS PROJECTION (EUROS - €)					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue	144,000	172,800	207,360	248,832	298,598.4
Cost of sales	(80,000)	(100,000)	(100,000)	(140,000)	(140,000)
Gross Margin	64,000	72,800	87,360	108,832	138,598
Other costs	(20,000)	(23,000)	(26,450)	(30,417.5)	(34,980.13)
Operating profit (EBITDA)	44,000	49,800	60,910	78,415	103,618

Table 1 Profit and Loss Projections

Financial Analysis

The TRITON service will be offered to port authorities subject to a monthly fee based on the number of drones registered on the TRITON platform (regardless of the number of flights each drone executes). The cost for each drone registration will be €150 and based on published and empirical data related to the daily number of port-to-ship deliveries, the typical area of a port, the number of critical inspections of critical infrastructure, each drone's endurance, it is estimated that approximately 40 drones will be able to cover the needs of a port that has a similar size to Koper. The annual revenue generated from each port is expected to be €72,000. Assuming that by the end of the 1st after 5G-LOGINNOV project terminates, 5 ports will adopt TRITON, the annual revenue is expected reach €144,000. By taking into account that the CAGR of the drone industry is 25%, an achievable growth of 20% is anticipated for the

TRITON service. As regards the costs, TRITON is a software-based solution, therefore, there is not require personnel at the locations this service is deployed, thus a small team consisting of engineers, sales and administration personnel will be able to support the product development and commercialisation. The financial projections for 5 years after the termination of the 5G-LOGINNOV project are presented in Table 1.

Technical description

(max 4 pages A4)

The applicant shall provide an exhaustive description of its ICT solution, including:

- Aims and operating principles (preferably through sequence diagrams, flow charts or similar).
- Distinctive features, advances over the state-of-the-art.
- High-level functional architecture.
- Interfaces/connectors with other ICT systems/platforms.
- Deployment architecture (how the solution will be integrated with existing ICT/operational infrastructure of the Living Labs: hardware, software, libraries, field devices, etc.)
- Preliminary layout of the Human-Machine Interface (HMI), if any (preferably including pictures, screenshots, sketches, etc.)

At the moment, the methods used to conduct critical port operations (e.g. port-to-ship deliveries, inspections of critical port infrastructure, environmental surveys, and port security monitoring), on many occasions, are unsafe for humans, time consuming, expensive, environmentally harmful, and not particularly effective. For these reasons, port authorities, shipping companies and regulatory authorities are investigating alternative solutions. The recent developments in drone technology are able to provide promising solutions to the aforementioned challenges. Namely, there have been developed drones that can carry a payload up to 200kg and their range can reach 250km. These unmanned vehicles can be used to transport people or material between ports and ships faster, cheaper, and since they are electrically powered, they do not produce greenhouse gases. Furthermore, a wide variety of sensors (e.g. optical, radiometric, multispectral, lidar, and gas detectors) can be mounted on smaller drones in order to conduct environmental surveys, inspections, and security monitoring. However, by taking into account the number of drone operations that can be conducted simultaneously in a port environment, in order to create a sustainable and scalable concept of operations, drones should be able to navigate autonomously whilst considering; i) other aerial vehicles operating in the port's airspace, ii) moving obstacles (birds, moving cranes), iii) the drones' energy reserves.

The aim of this project is the design of a system that will enable autonomous drone flights, specifically tailored for port operations. The TRITON system (Figure 1) will utilise optimisation algorithms to define the drones' flight paths, while Multi Object Tracking (MOT) algorithms will automatically estimate the trajectory of moving obstacles, in real-time, in order to protect drones from mid-air collisions. Thus, the system's boundary conditions will be constantly updated (via the MOT algorithms), and the drones' flights paths will be reconfigured in case moving obstacle interfere with their flight paths. Inputs to the MOT algorithms will be provided by high resolution optical sensors installed on the drones, as well as ground sensors, that will monitor the port's airspace. The path planning and MOT algorithms will be running at the Koper's Living Lab central server, in order to leverage the server's high computational capabilities, while 5G connectivity will enable data transmission without latency, hence real-time decisions.

As regards the algorithms that will be used to define the drones' flight paths, these will be based on methods from the Smart Delivery (SD) problem in Smart Logistics (SL) applications. A key feature in SL is to consider groups of drones (swarms) where a self-organised community-like behaviour can solve tasks more efficiently. The developed algorithms will be based on new distributed biologically inspired decision-making approaches to determine the most 'economic' and safe-flyable route for the swarm to complete its objectives in an off-shore environment. Due to the scale of environment, the number of variables to be optimised, and the requirement for the proposed algorithm to perform online and real-time, a deterministic approach (i.e. based on Dynamic Programming to solve the standard multiple Travelling

Salesman problem) may not be appropriate. Instead, Evolutionary Algorithms (EA), that are based on stochastic optimisation techniques, will be preferred. These methods have shown successful results in the generation of accurate minimum energy paths that meet the physical and functional limitations for the aerial vehicles. EA algorithms offer the following advantages compared to deterministic optimisation approaches: high robustness; ease of implementation relatively to a high number of constraints; high adaptability to special characteristics of the problem; and local optima can be avoided. More specifically, in order to define each drone's flight path, a series of waypoints from the take-off to the landing position will be defined. This will be achieved by an Evolutionary Algorithm (EA) setup that will produce different seeds for the resulting safe flyable path generator, where each candidate competes. Additionally, mutation and crossover operators will be included to overcome possible local optima and the most efficient setup to solve the aforementioned path planning problem will be investigated. Additionally, terms that penalises trajectories that are outside of a vehicle's flight envelope can be included. Following the calculation of the drone flight paths a stability assessment is carried out by Lyapunov theory tools, in order to ensure that the drones' routes are robust to small perturbations.

Moreover, in order to ensure safe autonomous drone operations, an obstacle detection and avoidance module is embedded in the TRITON system. The flight paths of the TRITON drones will be known thus, the obstacle avoidance module will be activated for cases a drone from the swarm has a fault and deviates from the predefined flight path, or in cases external obstacles interfere with the drones' trajectories. This module is able to identify obstacles in the port's air space (birds, moving cranes, drones or other aerial vehicles that do not belong in the TRITON system), estimate their trajectories, and based on them, reconfigure the drones' flight paths in order to avoid mid-air collisions. In order to achieve this, Multiple Object Tracking (MOT) algorithms will be developed to identify moving obstacles that can be present in the port's airspace.

The obstacle detection module is structured around four main pillars; i) Swarm Worker Drones, that execute the various port operations (deliveries, environmental surveys, security monitoring), ii) Swarm Support Drones, that have installed onboard sensors in order to provide additional information to the MOT algorithms, and iii) Ground Camera Sensors, that observe the port's airspace, and iv) the port's central server in which the necessary computations will take place.

The Worker Drones are equipped with forward viewing onboard cameras and therefore are able to detect only forward obstacles. The Support Drones are not contributing to any port operation, instead they are equipped with 360° cameras provide coverage for blind areas, in order to enhance the inputs to the MOT algorithms and boost the robustness of the obstacle detection and avoidance module. Finally, the Ground Cameras provide a third layer of information to the MOT algorithms covering a different point of view. The central Server is responsible for processing the drone camera inputs and reconfigure the drones flight paths in order to avoid mid-air collisions whilst fulfilling the mission objective. More specifically, the algorithms executed in the server calculate the Generative Adversarial Network (GAN) optimised trajectories for the UAV missions, process the video data from the ground cameras and the 360° support drones, use ML techniques to track potential hazards, and calculate new trajectories to avoid mid-air collision.

The MOT modules will generate bounding boxes for the detected obstacles and will use non-linear models to estimate their trajectory. Due to the fact that many aerial vehicles will operate simultaneously in a small airspace the development of the exclusion and occlusion components of the MOT algorithms are significantly challenging. In order to overcome this:

- The TRITON drones' paths will be known therefore, the MOT algorithms will not account for these, since the path planning algorithms make sure that their trajectories are not interfering.

- Multiple camera sources will be used as inputs to the MOT algorithms; thus the developed algorithms will be able to differentiate the existence of multiple obstacles and estimate their trajectories much precisely (compared to single camera inputs).

The TRITON system is specially designed to allow autonomous drone operations in port environments. For this reason, the system will leverage public domain data that model birds' motion in order to customise the MOT algorithms to recognise one of the most typical moving obstacles in port environments. Also, other domain specific characteristics will be leveraged in order to tailor appropriately for port operations. Some examples are the areas that the ports cranes operate (in order to avoid flight there), as well as port areas that should be regularly inspected.

The most important step forward in the TRITON project relies on the capability of developed MOT algorithms to combine inputs from multiple cameras in order to calculate more accurately the trajectory of moving obstacles in the port's airspace. Typically, MOT algorithms are based on single camera input, and consequently the cannot account for obstacles moving at areas that the drone camera does cover (blind spots). TRITON will leverage camera inputs that cover many different angles, in order to achieve a full coverage of the port's airspace. The fusion of the multiple camera inputs will be based on fuzzy logic and probability theory techniques that will assign weights to the various cameras' inputs considering its proximity to the detected obstacle and the number of other objects that exist in the obstacle's vicinity. Finally, the beyond SoA contributions of TRITON's obstacle detection and avoidance modules can be summarised as follows: i) GAN trajectory optimisation, ii) fine-tuned Computer Vision ML models and trajectory calculations for the most common hazards in ports, iii) Edge to Cloud real-time integration courtesy of 5G, iv) design and development of MOT algorithms that combine inputs from multiple cameras.

Finally, it should be highlighted that key enabler for the TRITON service is 5G connectivity, that allow data transmission between the drones and the central server without latency. This allows the execution of complex computations to a powerful server while the drone cameras can update the inputs to the MOT and the path planning algorithms can redefine their routes in real-time.

Figure 1 presents a schematic representation of the system's operation. Given of set boundary conditions, the path planning algorithms will define the drone routes. Simultaneously, the onboard cameras of the worker drones, the support drones and the ground cameras will transmit video feed to the central server and the MOT algorithms will detect moving obstacles and estimate their trajectories. In case that the trajectory of a moving obstacle is expected to interfere with the drones' flight paths, the boundary conditions are updated, and the flight paths are recalculated. TRITON's ultimate aim is to define drone safe flyable paths for the drones in order to fulfil the port's operations.

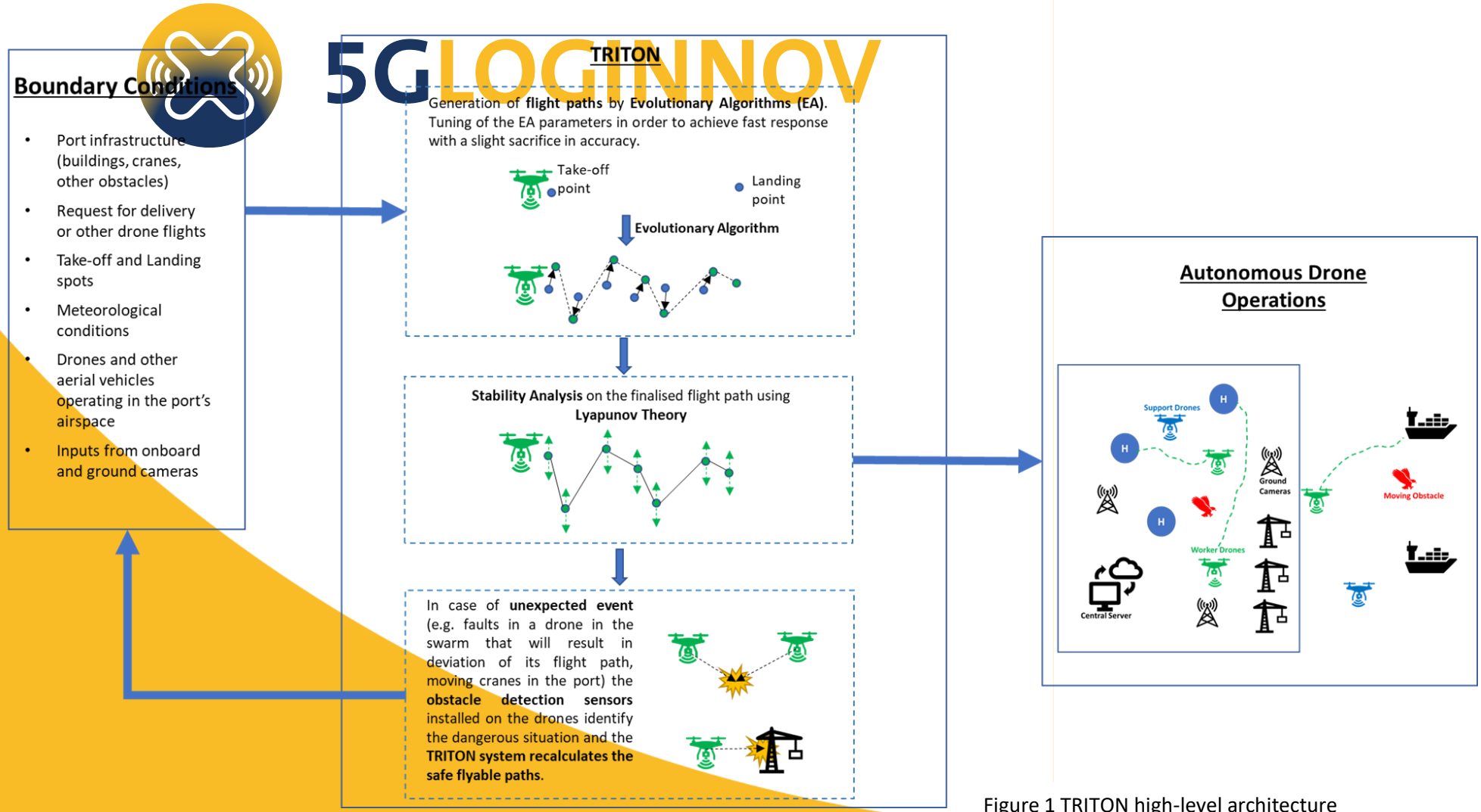

Figure 1 TRITON high-level architecture

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 957400

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www.5g-loginnov.eu

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Operating description

(max 3 pages A4)

The applicant shall provide a brief description of:

- Expected benefits and measurable Key Performance Indicators.
- Possible data sharing policies.
- Planned support activities (remote and on-site).
- Other on-site activities (e.g. installation, test, etc.) and needs (e.g. access to Living Lab area, involvement of Living Lab personnel, etc.).

The TRITON project significantly pushes the boundary in the field of autonomous drone operations, by creating a system that is able to: i) define optimal flights paths for the drones operating in a port, ii) detect moving obstacles and estimate their trajectory, in order to avoid mid-air collisions by reconfiguring the flight paths. This system will be specifically designed for port-related operations in the Koper Living Lab. Therefore, the development of the path planning and MOT algorithms will consider domain specific characteristics of this port. More precisely, the development of the path planning algorithms will take into account aspects such as: the typical number of simultaneous drone flights in the Koper port, the average distances that the drones should cover, and the available take-off and landing spots. Also, as regards the MOT algorithms, these will leverage multiple sources of information (worker drones, support drones, and ground sensors) and will be trained to recognise the most typical obstacles in the port's airspace (birds, moving cranes, drones that do not belong in the swarm, or aerial vehicles). Finally, it should be highlighted that key enabler of the TRITON system is 5G communication between the swarm and the Koper's Living Lab central server. This will allow the execution of computations that require high computational power at the port's server, and data transmission between the drones and the server without latency. Therefore the system will be able to make real-time decisions.
In order to establish quantitative metrics for the system's outcomes, Key Performance Indicators (KPIs) relevant to port environments are defined. These have been categorised in four categories and are tabulated in Table 2.

KPIs	**Baseline Value**	**Target Value (large-scale development of TRITON)**
Environmental		
Reduction of greenhouse gas emission by replacing launch boat services with electrically powered drones.	At the moment it is estimated that each launch boat service lasts approx. 4 hours and generates 1.2 tons of CO2 emissions. Koper port has in average 40 ship calls per day and half of these are expected to request a launch boat service. Therefore, launch boats (in the Koper port) contribute 24 tons of CO2 emissions per day.	Based on the current state-of-the-art, drones are able to carry a payload up to 200kg and their range can reach 250km. The large-scale application of the TRITON system (considering the existing drone technology) will be able to replace 40% of the existing launch boat services. Thus, TRITON is expected to reduce the CO2 emissions generated by launch boats by 40%, which corresponds to 3,504 tons of CO2 per year (considering a port similar to Koper).

Reduction of marine pollution (e.g. oil/fuel spills, load spills) generated by accidents.	The majority of oil/fuel and load spills in ports are generated by: i) negligence in maintaining cleanliness, and ii) another accident. These incidents which are both dangerous for humans and harmful for the environment, represent 4% of the total port incidents.	Aerial surveillance by autonomous drones will enable constant monitoring of the entire port by optical, thermal, and multispectral sensors and it is expected to reduce by 90% incidents related to poor cleaning conditions, and promptly identify all other accidents (100%) that can result in oil/fuel and load spills.
Safety		
Reduction of accidents related to human errors (e.g. embarkment/disembarkment to cargo vessels from launch boats, poor supervision of port activities).	Accidents related to human errors correspond to 36.4% of the total port accidents.	The large-scale application of the TRITON human will be transported from ports to the ship by autonomous drones, thus, accidents related to humans boarding on ships via rope ladders will be completely removed (100% reduction).
Reduction of accidents in the port environment related to poor maintenance (e.g. damaged equipment, damaged roads, flood)	Accidents related to poor maintenance of the port's infrastructure account for 40% of the total accidents that occur in a port.	TRITON system will enable constant monitoring of the entire port facilities on a 24/7 basis. Also, by taking into account the fact the symptoms of at least half of these maintenance related faults can be observed externally, 50% reduction is expected in accidents that are caused by poor maintenance.
Operational		
More flexible port-to-ship deliveries.	The current method to conduct port-to-ship deliveries results is huge delays for end-users. The typical lead time for launch boat services is 1 day since launch boats cannot be instantly dispatched, and when they are dispatched, they serve multiple vessels.	The TRITON system will enable port-to-ship deliveries via autonomous drones, which can be instantly dispatched and transfer humans, medical supplies, spare parts, or other material to the ships. Therefore, TRITON reduce the delivery lead time to 2-3 hours and offers personalised transportation services to the cargo vessels.
Increased port security monitoring.	Port security at the moment relies on fixed cameras and patrols by security guards. Based on this method, only few port locations are monitored and moreover, human guards are exposed to various threats (e.g. invaders, fire).	The TRITON system will enhance the ports security system by drones that can carry many sensors
Cost		

Cost reduction of port operations.	The traditional port operations are executed by human operators and rely on expensive techniques (launch boats, scaffolding).	TRITON will replace the traditional techniques for various port operations with drone-based solutions. Drones are expected to efficiently replace 40% of the port-to-ship deliveries, and all inspection and security related services. Therefore, TRITON is expected to reduce 50%-70% the costs of port operations.

Table 2 TRITON KPIs

The system's testing will be conducted in 3 stages: i) testing via computer simulations, ii) testing in a relevant environment (in-lab testing), iii) testing in an operational environment (deployment at Koper Living Lab). In order to conduct the pilots in Koper Living Lab, the TRITON project team will require inputs from the port's personnel in order to identify the port locations that are more critical for security monitoring, the infrastructure that that requires frequent inspections, and areas where many activities are taking place and consequently accidents are likely to happen. This information will generate a list of predefined missions for the TRITON drones that can be assigned to any drone from the system's user. Also, inputs from the Koper's personnel will be required in order to identify the most appropriate take-off and landing spots. Major considerations for the selection of these spots will be location of the port's infrastructure and the aim to spread these throughout the entire port's area in order to allow operational flexibility and create adequate landing spots in case of emergencies. According to the project plan, initial tests will be conducted at Koper during M10-M11 in order to test the communication protocols between the Living Lab's digital infrastructure and also identify the port's locations that will be used for the system's piloting during M18-M19.
During the full-scale pilot testing, multiple missions will be uploaded to the drones simultaneously. This will test the system's ability to define optimal flight paths and navigate the drones autonomously in order to execute their mission without interfering with the other drones in the swarm. Drones will autonomously select a landing spots based on their energy reserves. Moreover, in order to test the MOT module, manually controlled drones will be flown in such a way that they will interfere with TRITON drones. This will emulate cases in which moving obstacles are interfering with the TRITON drones' routes and will test the system's ability to successfully detect them, estimate their trajectory and reconfigure the drones flight paths. Multiple scenarios regarding the speed and direction of the manually controlled drones will be executed in order to rigorously investigate the system's robustness and limitations. Prior to the pilots' execution, a detailed risk assessment will be conducted, and appropriate mitigation measures will be in place to avoid injuries or equipment damage. Hellenic Drones is a company with significant experience in drone operations in challenging environments and the company prioritises safety in all its activities.
Finally, in order to evaluate TRITON's ability to successfully address the predefined KPIs, feedback from the port's personnel will be given. Based on the pilot demonstrations, the port's personnel will be able to assess TRITON's potential to replace the traditional methods for port operations with autonomous drones. The interaction with end-users will provide valuable feedback regarding the technical features of the system, as well as business opportunities that might not be obvious at this stage.

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Project structure

The applicant shall provide the Work Breakdown Structure (WBS) of the project describing Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related Deliverables and Milestones (including types, contents, due dates). The overall timing of the project must comply with the execution of 5G-LOGINNOV Living Labs, i.e. the ICT solution must be deployed, tested and fully validated on selected Living Lab(s) by 30-Apr-2023.

WP, Key Tasks, and Activities
WP1: Project & Technical Management **T1.1. Project administrative, financial coordination and planning:** Organisation of the management and technical meetings, progress, and quality to be monitored, tracked, and reported, problems to be solved, communications between the partners to be ensured at all levels, risk management, documents, periodic reports production, and legal issues. In order to ensure that the project is progressing as planned, a risk has been created (Table 6) and proactive actions will be taken in order to execute the project on time and on budget. For this reason, two progress reports will be released (M9 and M19), that will document the progress of each task. **T1.2. Technology strategic steering:** Within this task, initiatives will be undertaken for proposing technical solutions and fine-tuning technical and scientific orientations whenever necessary. Moreover, control of the technical work will be carried out in the related tasks and propose technical modifications and reallocation of resources as necessary for achieving the project objectives.
WP2: User & System Requirements and Reference Architecture **T2.1 User Needs Analysis and Requirements Specification, Use Case Scenarios and KPIs Definition**: This task aims to understand the real needs and problems of users and stakeholders and in order to design services that will satisfy these needs. The user requirements and will be used to validate the systems functionality by a traceability matrix that will further link defined user requirements with technical specifications and will allow tracking and assessment of compliance to these requirements throughout the course of the project. **T2.2 Definition of System Requirements, Technical Specification & Reference Architecture of the TRITON System:** System requirements, overall architecture, and design. The design process will follow a rigorous assessment of the user requirements defined in T2.1 in order to develop TRITON's technical specifications and the system's reference architecture. TRITON will follow an iterative approach, realised in 2 short cycles, allowing the feedback gathered from the initial in-lab testing against the pre-identified user and functional requirements to be incorporated into the product development process, revising it if and whenever necessary. The end of the first system development cycle is marked by the release of the initial technical specifications and reference architecture in M3, whilst the second cycle's completion is set at M12.
WP3: Path-planning module **T3.1. Mathematical modelling & development of navigational algorithms:** In this task, the "off-shore delivery via autonomous drones" problem will be mathematically modelled and there will be developed the optimisation and stability algorithms to autonomously navigate the drones. These algorithms will be based Evolutionary Algorithms in order to calculate precise and fast the drone routes. **T3.2. Simulations under static boundary conditions:** The developed algorithms will be tested under static boundary conditions in a simulation environment. These boundary conditions will be extracted from the system's technical specs as defined in T2.2. **T3.3. Simulations under dynamic boundary conditions:** Following the simulations of the navigation algorithms under static boundary conditions, these algorithms will be tested under dynamic boundary conditions. In this task, there will be executed simulations in which unexpected events are forcing the system the reconfigure the flight paths. There will be emulated cases that a drone develops a fault and deviates from its predefined route and cases that of moving obstacles (e.g. birds, other aerial vehicles, cranes).
WP4: Multiple Object Tracking module **T4.1. Appearance model, Motion modelling:** In this task there will be developed algorithms to visually represent the airspace obstacles and estimate their trajectories. Technique from probability theory will be used to identify the bounding boxes of the aerial obstacles. As regards the estimation of their trajectories, non-linear models will be used, and model that describe bird trajectories will be leveraged.

T4.2. Exclusion model, Occlusion handling: In this task, the algorithms that are able to differentiate different obstacles will be developed (exclusion model). Also, based on the exclusion model, the motion tracking algorithms developed in T4.1 will be further enhanced in order to avoid fragmented trajectories (occlusion handling). **T4.3. Fusion of multiple camera inputs (worker drones, support drones, ground cameras):** In this task there will be developed the system's most innovative feature. TRITON will leverage the simultaneous flights of multiple drones in order to collect optical data from all members of the swarm and integrate them with ground-based sensors in order to create more robust MOT algorithms. Fuzzy logic and probability theory techniques will be adopted in order to integrate the multiple sources of information in order to create more robust MOT algorithms (compared to the exiting state-of-the-art) that will be applied in the TRITON system.
WP5: System integration **T5.1. Hardware adaptations and configuration:** In this task the drone prototypes that will be used to test the TRITON system functionalities will be developed. Apart from the typical drone components (frame, propulsion system, flight controller, GPS antenna), the drones will be also equipped with the necessary companion computer and obstacle avoidance sensors in order to be integrated with the TRITON system. **T5.2: Communication Protocols & Integration with Koper Living Lab infrastructure:** In this task the 5G telecommunication protocols between the drones and Koper's central server via 5G connection will be developed.
WP6: System demonstration & validation **T6.1. In-lab Testing:** This task accounts for the rigorous tests that will be conducted on individual system elements as well as on the integrated system in a lab environment. These will be both based on computer simulations as well as in the design and execution of experiments that will validate the functionalities of the developed modules and integrated system. **T6.2. Pilot Studies and System Validation:** The integrated system will be tested in a relevant environment (Koper Living Lab) in order to prove the system's functionalities as defined in T2.1. These tests will test the ability of the drones to navigate autonomously, detect aerial obstacles, estimate their trajectory, and reconfigure their routes in cases of unexpected events in order to fulfil their mission.
WP7: Exploitation Activities **T5.1: Market Analysis and Business Modelling:** This task will analyse the market by collecting existing approaches, products, and research projects. In this task, a thorough market analysis will be conducted, leading to a viable business plan and suitable delivery model for the final product. **T5.2: Standardisation and IPR Management:** The key goal of this task is to coordinate the process of exploitation of project results maximizing the impact of the project. Within this task, the exploitable outcomes of the project will be continuously monitored and collected delivering the list of exploitable knowledge, updated by each partner individually. These will be communicated to the potential clients and end users as well as to regulatory authorities and the general public. In line to the plan, proper IPR management actions will be defined and deployed, taking into account all the standardization issues.

Table 3 TRITON Work Packages

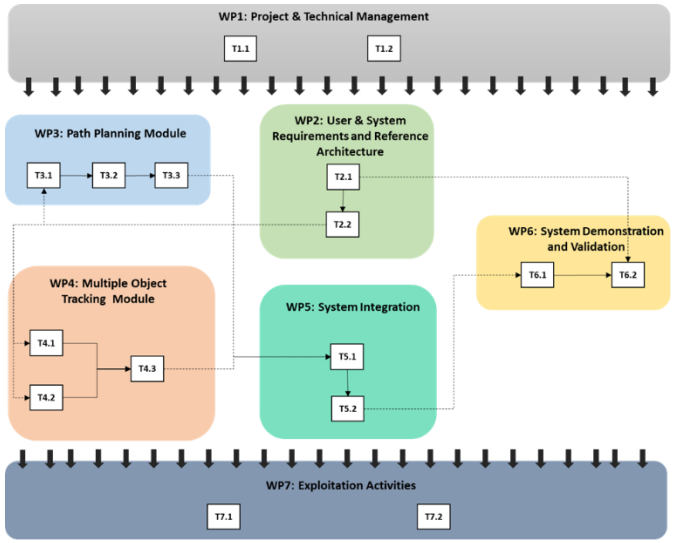

Figure 2 Pert Chart

	Deliverable	Type	Due date
D1.x	User Requirements, Technical Specification & System Reference Architecture	Report	M3 (Initial) & M12 (Final)
D2.x	Project progress	Report	M9 (Interim) & M19 Final
D3	Finalisation of path planning module	Demonstration in operational environment & Report detailing the algorithms' development and validation	M16
D4	Finalisation of MOT module	Demonstration in operational environment & Report detailing the algorithms' development and validation	M16
D5	Functional prototype integrated with Koper's Living Lab Infrastructure	Demonstration in operational environment & Report detailing the algorithms' development and validation	M17
D6	System Validation	Report documenting the tested carried out and connecting them with the predefined KPIs	M19
D7	Market Analysis	Report including a detailed market analysis and the Minimum Viable Product	M19

Table 4 TRITON Deliverables

	Milestone	Means of verification	Due date
M1.x	User Requirements, Technical Specification & System Reference Architecture	Report including the user needs and requirements, as well as the system's technical specs and reference architecture.	M3 (Initial) & M12 (Final)
M2	Finalisation of path planning algorithms under static boundary conditions	Testing in a relevant environment (in-lab testing).	M11
M3	Finalisation of path planning algorithms under dynamic boundary conditions	Testing at the Koper Living Lab, by designing experiments that will validate the algorithm's functionality.	M16
M4	Finalisation of the MOT algorithms based on fusion of inputs form multiple cameras	Testing at the Koper Living Lab by designing experiments that will validate the algorithm's functionality.	M16
M5	System prototype integrated with Koper Living Lab infrastructure	Testing the drones, the telecommunication system and the path planning and MOT modules at Koper's Living Lab.	M17
M6	Finalisation of tests in operational environment and system validation	Report detailing the tested of the integrated system at Koper's Living Lab and the system's ability to meet the KPIs.	M19
M7	Definition of the Minimum Viable Product and Market Analysis Report	Report documenting the Minimum Viable Product and the way forward in order to develop a sustainable service.	M19

Table 5 TRITON Milestones

Work Breakdown Structure			2021			2022												2023			
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19
WP1	Project and Technical Management	PMs																			
T1.1	Administrative & Financial Planning and Coordination	5																			
T1.2	Technology & Scientific Strategic Steering	5									D2.1										D2.2
	Estimated Effort (WP1)	10																			
WP2	User & System Requirements and Reference Architecture	PMs																			
T2.1	User Needs Analysis and Requirements Specification Use case Scenarios and KPIs Definition	2																			
T2.2	Definition of System Requirements, Technical Specification & Reference Architecture of the TRITON System	2			M1.1 D1.1									M1.2 D1.2							
	Estimated Effort (WP2)	4																			
WP3	Path Planning Module	PMs																			
T3.1	Mathematical modelling, data representation	1											M2								
T3.2	Simulations in static environment	3																M3			
T3.3	Simulations in dynamic environment	4																D3			
	Estimated Effort (WP3)	8																			
WP4	Multiple Object Tracking Module	PMs																			
T4.1	Visual representation, motion modelling	5																			
T4.2	Exclusion model, Occlusion handling	5																M4			
T4.3	Fusion of multiple camera inputs (worker drones, support drones, ground cameras)	5																D4			
	Estimated Effort (WP4)	15																			
WP5	System Integration	PMs																			
T5.1	Hardware adaptations and configuration	4																	M5		
T5.2	Communication Protocols & Integration with Koper Living Lab infrastructure	4																	D5		
	Estimated Effort (WP5)	8																			
WP6	System Demonstration and Validation	PMs																			
T6.1	In-lab testing	4																			M6
T6.2	Pilot Studies and System Validation	2																			D6
	Estimated Effort (WP6)	6																			
WP7	Exploitation Activities	PMs																			
T7.1	Market Analysis & Business Modelling	2																			M7
T7.2	Standardisation & IPR Management	2																			D7
	Estimated Effort (WP7)	4																			
	Total Estimated Effort	55																			

Table 5 TRITON Gantt Chart

ID	Description	Causes	Consequences	Before Mitigation			Mitigation Actions	After Mitigation		
				(P) *	(I)*	(A) *		(P)*	(I)*	(A) *
R1	Conflicting requirements from different sources.	Poor understanding of user requirements. Failure of the project scoping exercise to fully capture all needs.	Work done in WP1 and WP2 may need to be redone. Scope creep. Project delays.	**3**	**2**	**6**	Standards and compliance requirements, end-user requirements, use cases and infrastructure requirements might be conflicting. A traceability matrix including priorities and impact indicators will be produced.	**3**	**1**	**3**
R2	Deployment delayed.	The pilot demonstration is technically feasible, but the deployment time is slowed down due to changes in requirements.	The deployment time is slowed down, and the final product will not be ready on time	**2**	**5**	**10**	Mitigation measures during the platform's definition and planning will be assessed, whilst user requirements will be constantly monitored and considered in order to choose the part of the processes that are less affected by uncontrolled dynamics.	**2**	**2**	**4**
R3	Technology does not deliver the required performance.	Insufficient interaction with the users.	The results will be limited, insufficient and underperform.	**2**	**4**	**8**	Careful analysis of user requirements and possible replacement with alternative solutions as well as the engagement of users in the early stages of the project, and the extended validation activities that involve the deep analysis of regulations, policies, and communication with ports operators, to ensure that the system will achieve the expected performance.	**1**	**2**	**2**
R4	Systems to be integrated are not mature enough for integration; interface with differing systems proves to be an issue.	Not testing the efficiency and limits of each component or feature of the system. Poor analytical interface system methodology.	The product will not excel.	**2**	**5**	**10**	The integration process will be progressive and step by step. As soon as an intermediary version of a component is ready, it will be tested in the integration platform. The issues will therefore be solved gradually and not discovered at the end. In addition, early and clear definition of technologies, interfaces and conventions will help to reduce this risk.	**1**	**2**	**2**
R5	Ensuring continuity of TRITON beyond the project	Failure in promoting the product after the project completion.	Not being able to create revenue.	**2**	**4**	**8**	TRITON is a sustainable solution by creating early-stage commercial revenue. Dedicated tasks to create a strong platform Roadmap for beyond project revenue. Several Business-related activities will take place, in order to ensure sustainability and project exploitation.	**2**	**1**	**2**
R6	Slow or no engagement from targeted audience of early adopters, especially during the PoC campaigns.	Venues owners may claim: 1. Lack of resources to implement PoC on their side (Covid-19 pandemic) 2. Sluggish process within the Digital Transformation and IT Governance departments for PoC to receive approvals.	Inability of TRITON to be properly road-tested at scale, delaying potential commercial activities.	**3**	**3**	**9**	Present the upcoming opportunities to selected TRITON target clients well before the PoC is scheduled for launch. The team will liaise with the decision makers at least 3 months before the PoC, ensure that TRITON becomes part of the IT and Digital Transformation agenda of the targeted ports. Engagement with ports operators that promote safety and security progress, will put TRITON at the forefront for discussions with port and ships owners. Engagement with international organisations will further strengthen the adoption of TRITON and highlight the imminent need for adoption.	**1**	**2**	**2**
R7	Insufficient end user's engagement in evaluation	Failure to engage with possible customers.	The product will not be promoted, and the project will not create revenue.	**3**	**5**	**15**	TRITON will be developed in the 5G-LOGONNOV project in which 3 major European ports are participating and there have been developed Living Labs in them to validate the developed technologies. We will continue to engage with the interested stakeholders but also identify new users/customers to broaden our target market.	**1**	**2**	**2**

Table 6 TRITON Risk Assessment

Risk Matrix

Probability \ Impact	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Low
Medium
High

* (P)robability and (I)mpact are assessed from 1-5 (1=low 5=high). The (A)ssessment is found by multiplying these together, so has a lowest possible score of 1 and a highest possible score of 25.

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Resource/budget allocation

The applicant shall indicate the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item (staff, purchase of equipment, travel and subsistence). The total costs allocated for the application must be below the ceiling of € 50.000, VAT included; the cost reduction towards the ceiling of € 50.000 will not be considered as a preferential criterion for the evaluation of the application.

Budget allocation per Work Package (Total project cost: 50,000 €)

WP1: Project & Technical Management

PMs: 10, Costs:10,000 €, Duration: M1-M19

WP2: User & System Requirements and Reference Architecture

PMs: 4, Costs:2,000 €, Duration: M1-M3 & M10-M12

WP3: Path-planning module

PMs: 8, Costs: 10,000 €, Duration: M4-M16

WP4: Multiple Object Tracking module

PMs: 15, Costs: 15,000 €, Duration: M4-M16

WP5: System integration

PMs: 8, Costs: 5,000 €, Duration: M9-M17

WP6: System demonstration & validation

PMs: 6, Costs: 5,000 €, Duration: M7-M12 & M16-M19

WP7: Exploitation Activities

PMs: 4, Costs: 3,000 €, Duration: M12-M19

The total budget is distributed as follows:

Labour Costs: 40,000 € (80%)

- Project Manager: 10,000 €
- Senior Control Engineer: 8,000 €
- Senior Machine Vision Engineer: 12,000 €
- Electronics Engineer: 7,000 €
- Product Manager: 3,000 €

Capital Usage: 2,500 € (5%)

- Personal computers (x3): 2,500 €

Material: 5,000 € (10%)

- Drone consumables (frame, flight controller, propulsion system, batteries): 1,000 €
- Onboard forward cameras: 1,000 €
- Onboard 360 cameras: 2,000 €
- Ground cameras: 1,000 €

Travel: 2,000 € (4%)

- Travelling to Koper Living Lab: 1,500 €
- Travelling to support 5G-LOGINNOV activities: 500 €

Other expenses (marketing): 500 € (1%)

- Social media campaigns: 500 €

The TRITON project members will be carefully selected and recruited to cover all the required research areas of the project in a well-balanced way, utilising their expertise and prior collaborations to match the project's objectives successfully. The project team's structure will be based on excellence, complementarity, trans-nationality and multi-disciplinarily. The rationale for selecting the team members is to achieve (a) a balanced team with an adequate inclusion of experts in all research domains, (b) scientific excellence, (c) high profile researchers to attract user involvement, (d) high exploitation and dissemination potential, (e) top quality level of management. Overall, TRITON asserts that (i) a critical mass of skilled resources will be committed to the project, (ii) it has close collaboration and complementary strengths, and (iii) the scientific team has a long track record and scientific credentials, as demonstrated in the appendix attached.
The project team will include all the essential actors of the value network covering thus the end user and market needs in the field, across the globe. TRITON's team members are all committed to working towards the goal of the project which represents a breakthrough concept worldwide. The scientific and technical expertise needed can be found within the current members of Hellenic Drones' linked experts, ensuring that the project can start quickly and guarantees that junior staff hired for the project will receive high-quality training. The manner in which the main roles will be assigned guarantees a balanced work contribution, as each person will have a clearly defined role in each task and work package. The core team members are the following:
Dr. Christos Skliros holds a Ph.D. in Systems Diagnostics from Cranfield University, a M.Sc. in Applied Mathematics from the National Technical University of Athens, and B.Eng. in Aeronautical Engineering from the Hellenic Air Force Academy. Dr. Skliros has held supervisory positions in aircraft maintenance departments in the Hellenic Air Force and has worked as a Researcher Associate in the Integrated Vehicle Health Management (IVHM) Centre in Cranfield University. His research work in Cranfield University focused on the

development of Artificial Intelligent algorithms for aircraft systems diagnosis, with emphasis on the Auxiliary Power Unit (APU) and the Environmental Control System (ECS). Dr. Skliros will be the technical manager of the TRITON project, he will participate in the development of the system's technical specifications, collaborate with Cranfield during the development of the navigation algorithms and lead WP3.

Dr. George Kladis holds a B.Sc. in Industrial Automation from the Piraeus University of Applied Sciences, a M.Res. in Statistical Pattern Analysis and Artificial Neural Networks, form ASTON University and a Ph.D. in Autonomous Systems from Cranfield University. Dr. Kladis current research emphasises in the development of optimisation algorithms for UAV and robotics control. Dr. Kladis has published many research articles in high impact factor journals and has participated as Principal Investigator in numerous research projects. Dr. Kladis will lead the activities related to the integration, testing, and validation of the navigation algorithms on the drone prototypes in the TRITON project.

Mr. Evangelos Petrongonas holds a M.Eng. in Electrical Engineering from the National Technical University of Athens and has extensive experience in the development of Machine Learning algorithms targeting intelligent navigation and control systems. He particularly emphasises technology related with High Performance Embedded Systems design, Frameworks, Heterogeneous Computing Systems & applications on Drones and Space. In the TRITON project, Evangelos will emphasise on the development the MOT module.

Mr. Athanasios Papamarinos holds a B.Sc. in Mechatronics Engineering from the Technical University of Thessaloniki and a M.Sc. in Robot Systems from the Southern University of Denmark. Mr. Papamarinos has extensive experience in developing advanced navigation algorithms for autonomous UAV operations. Also he has worked on many projects that use Machine Learning algorithms for image recognition and has integrated such algorithms onboard UAVs. Mr. Papamarinos will emphasise on the development and testing of the drone prototypes that will be used to test the functionality of the navigational algorithms and will participate in the integration and testing activities.

Ms. Angela Fallida holds a B.Sc. in Industrial and Systems Engineering from Ohio State University. She has more than 30 years' experience in the industry by holding managerial positions in production management, procurement, and marketing. Namely, Ms. Fallida has worked for 15 years in The Coca-Cola Company as a production manager responsible for the EMEA regions and for another 15 years in Merck & Co. in which she worked in the company's marketing and in the procurement departments for the EMEA area. Ms Fallida will lead the exploitation activities in TRITON project.

DIMITRIOS SKLIROS

Digitally signed by DIMITRIOS SKLIROS
Date: 2021.06.30 14:38:02 +03'00'

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Annex IV

Application Form: RESONATE Real timE drowSiness detectiON, AlerTing and rEporting (Libra AI)

5GLOGINNOV

Open Call for Innovative Start-ups

Application Form

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Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
Dissemination Level	Public
Status	Final
Due date	23/4/2021
Document Date	22/4/2021
Version Number	1.1

Legal Disclaimer

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TABLE OF CONTENTS

List of abbreviations and acronyms

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
AI	Artificial Intelligence
ML	Machine Learning
LL	Living Lab
LSTM	Long Short Term Memory Neural Network
CNN	Convolutional Neural Network
DSS	Decision Support System
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

APPLICATION

Identification

Proposal:

- Acronym of the proposal (optional): RESONATE-Real timE drowSiness detectiON, AlerTing and rEporting
- Full title of the proposal (optional): Real time drowsiness detection, alerting and reporting

Organisation:

- Name of the organisation:LIBRA AI TECHNOLOGIES PRIVATE IDIOTIKI KEFALAIOUCHIKI ETAIREIA
- VAT registration:EL801280970
- Website:https://www.libramli.ai/
- Legal address:Evristheos 2, 11854, Athens, Greece

Contact:

- Prefix:Dr.
- Name:Ioannis Kopsinis
- Position in the organisation:CEO
- Email:yannis.kopsinis@libramli.ai
- Mobile:6970886654

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. ☒
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. ☒
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. ☒
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering. ☒
- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. ☒

[1] https://itsworldcongress.com

Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. ☒
2. The provision of all paper/media documentation needed for its on-field operation. ☒
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. ☒
4. On-site support to the deployment, installation and validation of the solution. ☒
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. ☒
6. To **participate to project dissemination activities**. ☒
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. ☒

Background IPR

LIBRA AI Technologies tentatively works on systems dedicated to the characterization and recognition of human behaviour states, such as emotion recognition and unobtrusive eye gaze detection and characterization. In these applications, we have developed proprietary approaches for fusing the results of edge, low complexity on-device Machine Learning models with highly accurate models running on the cloud. The aforementioned approaches include effective data handling and management between far-edge devices and the cloud. Our major focus and application so far is indoor marketing. However, it turns out that the driver drowsing detection, as proposed here, fits exactly our expertise and background IPR.

Targeted Living Labs

- Athens ☒
- Hamburg ☐
- Koper ☐

Related general objectives

The primary objective of this proposal is the development of an effective yet relatively low-cost Driver Drowsiness detection system targeting professional drivers and fleets. According to a Eurostat report, in 2019, 11.6 million people aged over 15 were employed in transport occupations in the E.U., including 35% heavy truck and bus drivers, which ultimately accounts for over four (4) million professional drivers. The system will have the following features:

1) It will comprise an edge, GPU-enabled computing device equipped with a camera and 5G communication capabilities that will be installed in the vehicle. The onboard system operates in standalone mode offering continuous robust drowsiness detection (including early drowsiness symptom detection) and it promptly warns the driver even in the absence of an internet connection.

2) The system will benefit from a high-performing cloud-based ML-API service that will offer enhanced drowsiness detection whenever 5G connection is present, reducing false positives considerably. Moreover, the cloud-based service will retrospectively improve the drowsiness state predictions (in offline mode) made during the absence of 5G connection. This later feature allows highly accurate reporting and fleet alertness performance analytics.

3) The system is accompanied by an interactive data visualization and reporting business intelligence system that offers a 360º view of the whole fleet alertness performance.

4) The system is aimed to be driver agnostic.

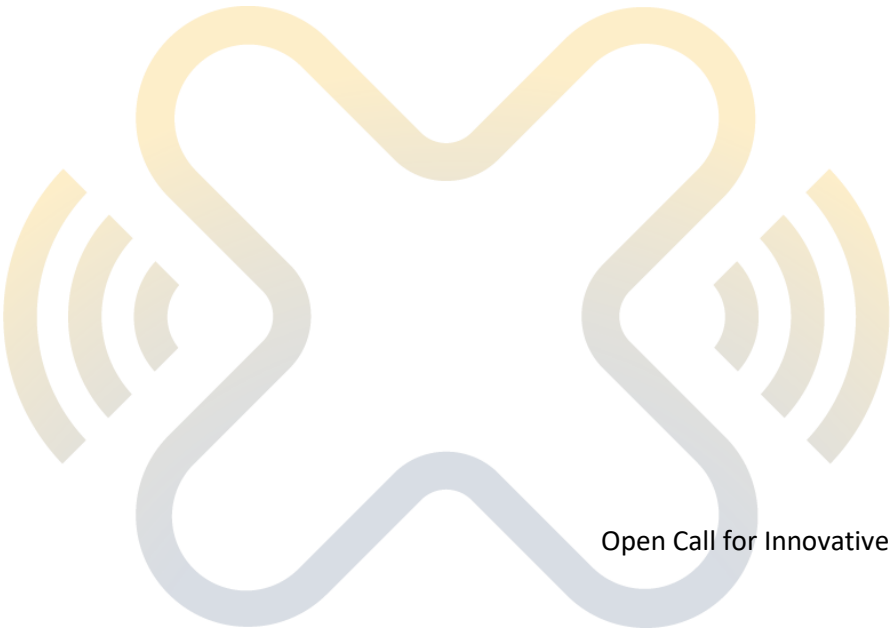
5) The whole architecture and approach can support future extensions of the system for the detection of driver states beyond drowsiness, such as distracted driver detection.

Specific areas of interest

The introduction of 5G technology in the Athens living lab will allow deploying new types of Internet-of-Things (IoT) devices and Artificial Intelligence (AI) with Machine Learning (ML) analytics to optimize port operations and guarantee public safety.

Targeting the technological advancement of the Athens Living Lab, we focus on the safety of employees and other personnel within the premises of PCT. A far-edge (low latency) computing approach, integrated into a pioneering 5G-IoT device, will detect human fatigue and drowsiness based on innovative machine learning techniques. According to the American Academy of Sleep Medicine, drowsy driving signs are frequent yawning, difficulty keeping your eyes open, "nodding off", and having trouble keeping your head up. Thus, technical 5G-enabled solutions, based on advanced computer vision and artificial intelligence, capable of recognizing -in video streams- indicators for drowsy driving in real-time, are of paramount importance for within (and outside) port operations to increase road (and assets) safety. The proposed device will be placed inside (and powered by) the yard trucks, receiving a direct video feed of the respective driver's reactions and executing video analytics locally. The inference of the model (e.g., with 90% confidence, the yard truck driver suffers from drowsiness) will be transmitted

from the 5G-IoT device to the back-end application at the PCT terminal, triggering the necessary actions to prevent potentially dangerous situations.



Ambitions and development plans

Exploitation plans

Despite the overall economic slowdown during the COVID-19 pandemic, the latter has led to a surge in e-commerce and digital transformation and consequently placed additional strains on the global supply chain. Both businesses and consumers "went digital", raising e-commerce share of global retail trade from 14% in 2019 to about 17% in 2020[2], while this trend is here to stay, as stated by the U.N. General Assembly President Volkan Bozkir[2]. At the same time, despite an E.C. directive regulating the maximum number of working hours for professional drivers to not exceeding 9 hours a day or 56 hours a week, studies have shown that numerous truck drivers work more than 12 hours per day, of which at least 60% is usually spent driving, while a working week of over 70 hours is common practice for many owner-drivers.

On top of this, increasing pressure generated for the professional drivers, higher levels of sleeping disorders in last years, and also awareness on improved driver safety are key enablers for the growth of the global driver drowsiness detection system market. Additional incentives for this market segment increase are stricter governmental regulations in the European Union, due to increased demand for automotive safety. On the other hand, the high costs of most existing detection systems are hampering a wider adoption in the relevant market, while usually complex installation procedures are also limiting the growth of the adoption. Noteworthy competitors include prominent OEMs and Tier-1 suppliers who have developed advanced detection systems for vehicle users (including for instance Panasonic Corporation[3], Mercedes-Benz[4], Continental, Bosch, Valeo, Denso among others[5]), yet with solutions tailored to specific vehicles and of high investment costs. On the contrary, one should note a handful of start-ups focused on this particular product, as is the case of Affectiva Automotive A.I., recently acquired by SmartEye, with an in-cabin sensing system mostly tailored for passenger vehicles, that included fatigue and drowsiness sensing, as well as the Israel-based Eyesight Technologies, whose 'Drive Sense' solution tracks down the head position of the driver, eye blink rate, gaze vector, and other visual attributes in order to detect distraction or signs of drowsiness of the driver.

The successful piloting and potential further operational adoption of Libra's driver drowsiness detection system by one of the E.C.'s top-8 port hubs, and third in container traffic in the Mediterranean sea will provide a significant blueprint and case study for the Libra SME. As such, it has the potential of opening opportunities for the proposed system being adopted by local/Greek fleet managers that include transport hubs (ports – Piraeus Port Authority, Port of Thessaloniki, airports - AIA), public transport operators (OASA), utilities and oil&gas fleet operators (EYDAP, PPC, MOTOROIL, ELPE, etc.). In addition, a successfully demonstrated system could potentially be taken up by large retailers, that either operate directly or through 3PLs (third party logistics providers) their supply chains, using heavy or lighter commercial vehicles for long-haul or urban area/last-mile trips. Such retailers predominantly include the FMCG (fast-moving consumer goods) retail segment that frequently use night shifts for ensuring prompt deliveries, hence would be even more interested in such a system. Finally, the exploitation opportunities are not limited only to the local market, but the company aspires an EC-wide visibility that could be taken up by a multi-national 5G-LOGGINOV partnership and its coordinator, that has members in numerous E.U. countries; a successful pilot adoption can be disseminated through the project channels and streams and can thus enlarge the related stakeholder base.

[2] https://unctad.org/news/how-covid-19-triggered-digital-and-e-commerce-turning-point
[3] https://news.panasonic.com/global/press/data/2017/07/en170727-3/en170727-3.html
[4] https://media.daimler.com/marsMediaSite/en/instance/ko/ATTENTION-ASSIST-Drowsiness-detection-system-warns-drivers-to-prevent-them-falling-asleep-momentarily.xhtml?oid=9361586
[5] https://www.prnewswire.com/news-releases/driver-monitoring-systems-market-size-worth-usd-2-39-billion-by-2027--cagr-of-10-6-emergen-research-301155946.html

A draft structured business plan

According to a Eurostat report, in 2019, 11.6 million people aged over 15 were employed in transport occupations in the E.U., including 35% heavy truck and bus drivers, which ultimately accounts for over four (4) million professional drivers. Nevertheless, a large number of drivers are self-employed or belong to logistics providers SMEs, and, as such, show low adoption and investment rates in ICT and telematics solutions. On the contrary, fleet operators that have already or are in the process of onboarding telematics-based solutions, and suffer from significant economic damage or work-related accidents due to driver fatigue issues, are better placed for adopting such technology. Naturally, this potential onboarding is dependent on a seamless and non-intrusive installation process, as is the proposed one, and an overall value for money investment, ensuring long-term ROI (return on investment), whereas a key factor of adoption is the solution being mindful of each fleet operators' specificities, a flexibility that is not the case for most competitive products discussed in the previous section.

According to this Technavio report of the European fleet management market, the latter has the potential to grow by USD 8.78 billion during 2021-2025 from a current baseline of USD 2.24 billion in 2020, and the market's growth momentum will accelerate at a CAGR of 16.72%. In the same report, it is evident that the market segmentation includes predominantly other aspects, such as performance management, vehicle maintenance and fleet analytics and reporting, thus, currently adopted solutions are not including driver fatigue or drowsiness monitoring. Indeed, the driver monitoring market segment seems to be more early-stage, as identified by Emergen research, estimated to be at USD 1.06 Billion in 2019, and projected to reach 2.39 Billion in 2027 for both passenger and commercial vehicles, at a market growth CAGR of 10.6%. National-level statistics regarding the specific local (Greek) market are not available in existing reports, yet they exist for several other European states, including France, Germany, Italy and BENELUX; the common noteworthy fact that the majority of professional vehicles fleets' management tools are lacking this significant feature for the drivers' and infrastructure's safety applies to both national and E.U. level. Thus, using B2B collaborations with local players of fleet management that are lacking the specialised expertise needed for the proposed technology (Cosmote, PowerFleetTelematics, Telenavis, Fleetcomplete, Emphasis, Pavla, and others), is a necessary step in the potential uptake of the piloted technology for the anticipation in the low- and high-adoption scenario for the local Greek market are provided in the table that follows.

Local market of professional vehicles (medium and heavy-duty[6])	Fleet management market size estimate[7]	Market penetration rate vs potential revenue – local level
229,776	83 Million USD	1% - 0.83 Million USD 15% - 12.45 Million USD
E.U. market of professional vehicles (medium and heavy-duty)	Fleet management market size	Market penetration rate vs potential revenue – E.U. level
6,200,000	2.24 Billion USD	1% - 2.24 Million USD 10% - 22.4 Million USD

Regarding the exploitation to an E.U. level, the channels through which this will be potentially enabled is the project (extended) partnership as well as the fact that a successful pilot and onboarding in the COSCO-owned PCT could pave the way for its adoption by other COSCO-owned transport hubs in Europe, including Valencia, Tangiers, Genoa, Marseilles, Bilbao, Le Havre, Bruges, Antwerp etc.

[6] https://www.acea.auto/files/ACEA_Report_Vehicles_in_use-Europe_2019-1.pdf#page=16
[7] Due to the lack of data regarding local market, a simplifying assumption of market size proportional to the number of trucks has been made, which is obviously dependent on other factors in each country.

Technical description

Introduction

Driver drowsiness is one of the leading causes of motor vehicle crashes. This finding was confirmed by a study[8] conducted by the AAA Foundation for Traffic Safety, which showed that 23.5% of all automobile crashes recorded in the United States in 2015 were sleep-related: 16.5% for fatal crashes and 7% for non-fatal crashes. Essentially, this report implied that over 5,000 Americans lost their lives due to sleep-related vehicular crashes. Furthermore, the National Highway Traffic Safety Administration report estimates that drowsy driving leads to 100,000 police-reported crashes each year, 71,000 injuries and 800 fatalities, and a $12.5 billion cost. In addition, the National Sleep Foundation reported that 37% of people admitted to falling asleep behind the wheel.

The development of drowsiness detection technologies is both an industrial and academic challenge. Volvo developed the Driver Alert Control in the automotive industry, which warns drivers suspected of drowsy driving by using a vehicle-mounted camera connected to its lane departure warning system (LDWS). Following a similar vein, an Attention Assist System was developed and introduced by Mercedes-Benz that collects data drawn from a driver's driving patterns incessantly ascertains if the obtained information correlates with the steering movement and the driving circumstance at hand. The driver drowsiness detection system, supplied by Bosch, takes decisions based on data derived from the sensor stationed at the steering, the vehicles' driving velocity, turn signal use, and the lane-assist camera mounted at the car's front.

Notably, these safety systems that detect drowsiness are not widespread and are uncommon among drivers because they are generally available in luxury vehicles. An increased embedding and connecting of smart devices equipped with sensors and mobile operating systems, such as Android, which is installed as an operating system in several cars, is shown by surveys in 2015[9]. In addition, machine learning has made ground-breaking advances in recent years, especially in deep learning. Thus, using these new technologies and methodologies can be an effective way to increase the efficiencies of the existing real-time driver drowsiness detection system and provide a tool that drivers can widely use.

Existing Solutions

In a bid to increase accurateness and accelerate drowsiness detection, several approaches have been proposed. This section attempts to summarize previous methods and approaches to drowsiness detection. Drowsiness detection technologies can be classified into three main categories.

The first category involves measuring cerebral and muscular signals and cardiovascular activity[10]. These techniques are invasive and not commercially viable. The second category includes techniques of measuring overall driver behavior from the vehicle patterns[11]. Unfortunately, these techniques do not work with micro-sleeps (driver falls asleep for a few seconds) since measuring many of these parameters requires a significant amount of time and user data. The third category consists of using Computer Vision techniques as a non-invasive way to monitor the driver's sleepiness. Drowsiness is detected by feature level and decision level fusions using different CNNs[12] such as AlexNet[13] and VGG-

[8] Drowsy Driving NHTSA reports. (2018, January 08). Retrieved from https://www.nhtsa.gov/risky-driving/drowsy-driving.
[9] Cornez T, Cornez R. Android Programming Concepts. Jones & Bartlett Publishers; 2015.
[10] L. Oliveira, J. S. Cardoso, A. Lourenço and C. Ahlström, "Driver drowsiness detection: a comparison between intrusive and non-intrusive signal acquisition methods," 2018 7th European Workshop on Visual Information Processing (EUVIP), 2018, pp. 1-6, doi: 10.1109/EUVIP.2018.8611704.
[11] Saini, Vandna and R. Saini. "Driver Drowsiness Detection System and Techniques : A Review." (2014).
[12] Park, S., Pan, F., Kang, S., Yoo, C.D.: Driver drowsiness detection system based on feature representation learning using various deep networks. In: Chen, C.-S.,Lu, J., Ma, K.-K. (eds.) ACCV 2016. LNCS, vol. 10118, pp. 154–164. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-54526-4 12
[13] Krizhevsky, A., Sutskever, I., Hinton, G.E.: Imagenet classification with deep convolutional neural networks. In: NIPS, pp. 1097–1105 (2012)

FaceNet[14]. This approach achieved an accuracy of 73.06% on the NTHU dataset[15]. A slightly modified version of ResNet-50[16] detects a closed eye versus an open eye[17]. VGG-19[18] was used for feature extraction, without fine-tuning, to detect multiple driver distractions and achieve 80% accuracy on a custom dataset[19]. In more recent work[20], a combination of CNN and Long Short-Term Memory (LSTM) blocks exploited spatio-temporal features to detect drowsy states. This approach has been shown to achieve 90% accuracy on the NTHU dataset[15]. The approaches reviewed so far use well-known CNNs such as AlexNet[13], VGG-Net[18] and ResNet[16], or custom-defined CNNs, which are computationally intensive and unsuitable for embedded implementation. Thus, there is a need to develop computationally light CNNs and efficient implementation techniques for embedded systems.

Proposed solution

Here, we propose an image-based solution for detecting and recognizing drowsiness based on a video HD feed of the driver's face. The model aims to monitor a driver's condition in real-time. From the video, an image-based non-invasive technique is used to detect the driver's facial features with time and identifying the level of drowsiness. Then according to the drowsiness level, it will trigger an alert (by sounding an alarm that will be installed in the truck's cabin or by firing another similar alerting functionality).

The system's functionality is divided into two steps (i) face detection and (ii) drowsiness detection. Once the driver's face is detected, the modules use deep neural networks architectures to detect the state of several facial features that give clear cues to whether someone is drowsy or not. The eyes give cues such as increased or prolonged blinking. The mouth shows signs of yawning or drooping. Even the position of the head can indicate drowsiness if it is drifting downward or bobbing frequently. These are all signs and indications that humans perceive as drowsiness.

Here we propose a hybrid approach to detect drowsiness, see Figure 1. Using a far-edge device and the PCT's server infrastructure with the full exploitation of 5G capabilities, we aim to leverage the potential of accurate drowsiness detection in real-time conditions. Specifically, we intend to couple the available far-edge device (NVidia Jetson Xavier NX Developer Kit) with the existing PCT server infrastructure (ESX platform). The proposed solutions highlights:

- It comprises an HD camera that allows good operating performance in low lighting conditions.
- The condition detection can be realized in a far-edge device without needing an internet connection.
- The system can optionally alert the driver when it detects drowsiness (aural or visual warning).
- The system will be accompanied by a central data repository and reporting engine with a dedicated visual analytics dashboard that allows monitoring and performance analysis of the drivers regarding certain Distraction / Drowsiness key performance indicators.
- The system will fires an alert in less than 2 seconds from the event.
- The expected success rate of the prototype is greater than 70%
- The whole process will collect enough data to proceed in a later stage with the detection of other driving-impairing conditions.
- The system will rely on a diverse set of deep machine learning modules that will need the appropriate training.

[14] Parkhi, O.M., Vedaldi, A., Zisserman, A.: Deep face recognition. In: BMVC, vol.1, p. 6 (2015)
[15] Weng, C.-H., Lai, Y.-H., Lai, S.-H.: Driver drowsiness detection via a hierarchical temporal deep belief network. In: Chen, C.-S., Lu, J., Ma, K.-K. (eds.) ACCV 2016. LNCS, vol. 10118, pp. 117–133. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-54526-4 9
[16] He, K., Zhang, X., Ren, S., Sun, J.: Deep residual learning for image recognition. In: CVPR, pp. 770–778 (2016)
[17] Kim, K.W., Hong, H.G., Nam, G.P., Park, K.R.: A study of deep CNN-based classification of open and closed eyes using a visible light camera sensor. Sensors 17(7), 1534 (2017)
[18] Simonyan, K., Zisserman, A.: Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556 (2014)
[19] Koesdwiady, A., Bedawi, S.M., Ou, C., Karray, F.: End-to-end deep learning for driver distraction recognition. In: Karray, F., Campilho, A., Cheriet, F. (eds.) ICIAR 2017. LNCS, vol. 10317, pp. 11–18. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-59876-5 2
[20] Lyu, J., Yuan, Z., Chen, D.: Long-term multi-granularity deep framework for driver drowsiness detection. arXiv preprint arXiv:1801.02325 (2018)

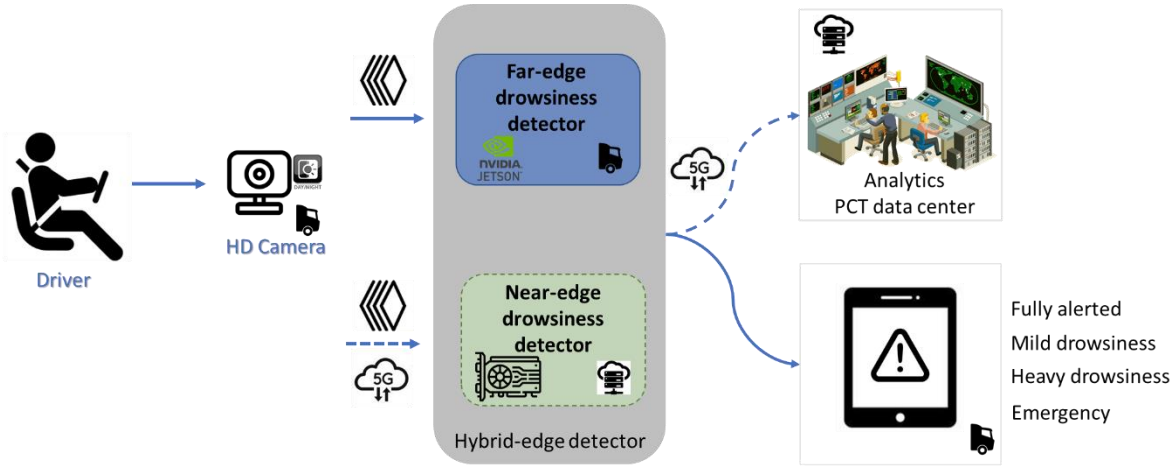
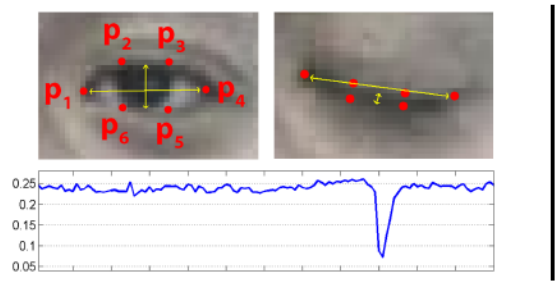


Figure 1. Hybrid edge drowsiness detector. A real-time solution combing far-edge and near-edge resources fully exploiting the 5G technology.

Below we describe in detail the different modules of the proposed solution.

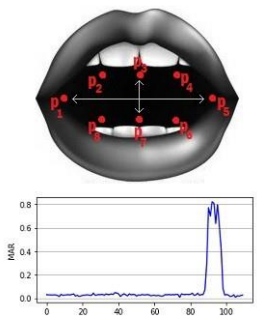
Hybrid edge module. It is a methodology that will combine the decision of far-edge and near-edge sub-modules to decide the condition of the truck's driver. The module will depend on the state-of-the-art machine learning techniques in both sub-modules. It will achieve real-time decision-making due to the far-edge solution implemented in the truck and the real-time communication between the truck cabin and the far-edge (through a dedicated API) based on 5G network availability. The different drowsiness levels will be classified into 4 discrete classes (Fully alerted, Mild drowsiness, Heavy drowsiness signs, and Emergency).

Far-edge sub-module. In this sub-module, we will use the position of key facial features, including the eyes, nose, mouth, chin, eye-aspect ratio (EAR), and mouth-aspect ratio (MAR), to detect drowsiness. The importance of these features is learned as a time series within a sequential model.



$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|},$$

Figure 2. Eye-Aspect Ratio (EAR) [21]. Graphical representation (left). Mathematical formula (left).



$$\mathrm{MAR} = \frac{\|p_2 - p_8\| + \|p_3 - p_7\| + \|p_4 - p_6\|}{2\,\|p_1 - p_5\|}$$

Figure 3. Mouth Aspect Ratio (MAR)[21]. Graphical representation (left). Mathematical formula (left).

[21] Soukupová, T. and Jan Cech. "Real-Time Eye Blink Detection using Facial Landmarks." (2016).

To extract the features, we will need at least 16 videos of driving a yard truck under different conditions (day/night, weather). This subset will represent the drowsy and alert case for five participants. Each video frame will then be used as an image to extract the x, y coordinates of 68 facial features. These feature coordinates will be reduced to 24 features: The edges of the eyes, the outer lips, the tip of the nose, and the tip of the chin. These features will provide information on blinking, yawning, and the movement of the head while minimizing the size of the input. From the coordinates of these positions, the EAR and MAR will be calculated. The EAR gives context for blinking, shown as a rapid decrease approaching zero, as well as reduced eye aspect ratio characteristic of "drowsy" eyes.

The extracted feature positions and ratios will then be inputted into the LSTM network architecture. The model will be implemented using state-of-the-art technologies Keras and Tensorflow. The output will be given as the probability of being drowsy or alert.

This approach will be very efficient in terms of computational needs. It will always be up and running because the far-edge submodule will run on NVidia Jetson Xavier NX Developer Kit, which will be installed in the yard truck's cabin, and requires no internet connection to provide the result.

Near-edge sub-module. The second sub-module extends this idea further and allows a model to learn only a sequence of extracted features and a temporal sequence of images. The first step in this model is to extract the faces from each frame. Face detection will be done by using Viola-Jones Haar Feature-based Cascade Classifier. To avoid false positives, we will first detect the Region of Interest (ROI) around the face and apply face detection to obtain a rectangular localized patch containing the whole face. A frame is extracted from the video stream for processing and CAMshift to track the ROI in the following frames. Histogram Oriented Gradient (HOG) algorithm is then applied to the first frame to extract dense features from the image. This algorithm can extract all features from a region of interest (ROI). The candidate face among the detected faces is then decided as the one with the largest area, assuming that the driver is nearest to the camera. Only this face region is then processed in subsequent video frames, reducing the processing cost. Each video is converted into a set of cropped facial images in the sequence of time.

To extract significant visual features from the images, we will use a Deep Convolutional Neural Network (CNN). We will use either sota pre-trained models, such as Inception v3 and VGG, and transfer learning or completely retrain these networks. Each video frame will then be run through the model, and the output will be a multi-dimensional vector of features passed to the sequential neural models. Finally, these extracted features will be converted into sequences of extracted features which will be used to train an LSTM architecture predicting the probability of being drowsy or alert.

This approach will be very demanding in terms of computational needs. It will always be up and running in the PCT's server. When the yard truck can connect to the internet, the near-edge submodule will assist the far-edge submodule in making an ensemble prediction on the driver's drowsiness levels. Furthermore, the near-edge submodule will run offline to make predictions for samples that did not reach it in real-time due to no internet availability.

Central data repository and reporting infrastructure. Next, we present the architecture of a modern AI-enabled reporting infrastructure. Such a system comprises the following 4 elements:

a. **A pool of heterogeneous data sources** that embodies all possible exploitable information towards understanding the habits of truck drivers and drawing exploitable insights.

b. **The data warehouse** which collects, conditions, and homogenizes available data streams. It also guarantees their safety and compliance with regulations. It transforms and fuses the data in forms ready for analysis, visualization, and Data science modelling.

c. **Interactive data exploration capability** that serves as a decision-support system. This allows to investigate multiple aspects of the data, derive and track Key Performance Indicators (KPIs), get day-

by-day real-time monitoring of safety objectives, drill-down and focus on certain cases, detect correlations, and draw actionable insights that help the management team to their decision-making and marketing strategies. This platform will be deployed using open-source software, such as Apache Superset.

d. **Machine Learning modeling framework** that offers the infrastructure and capability to deploy production-ready predictive models and perform data-driven data analysis. Indicative functions that can be performed are data-driven data analysis and interrogation, detection of trends and correlations, testing hypothesis, and truck driver profiling.

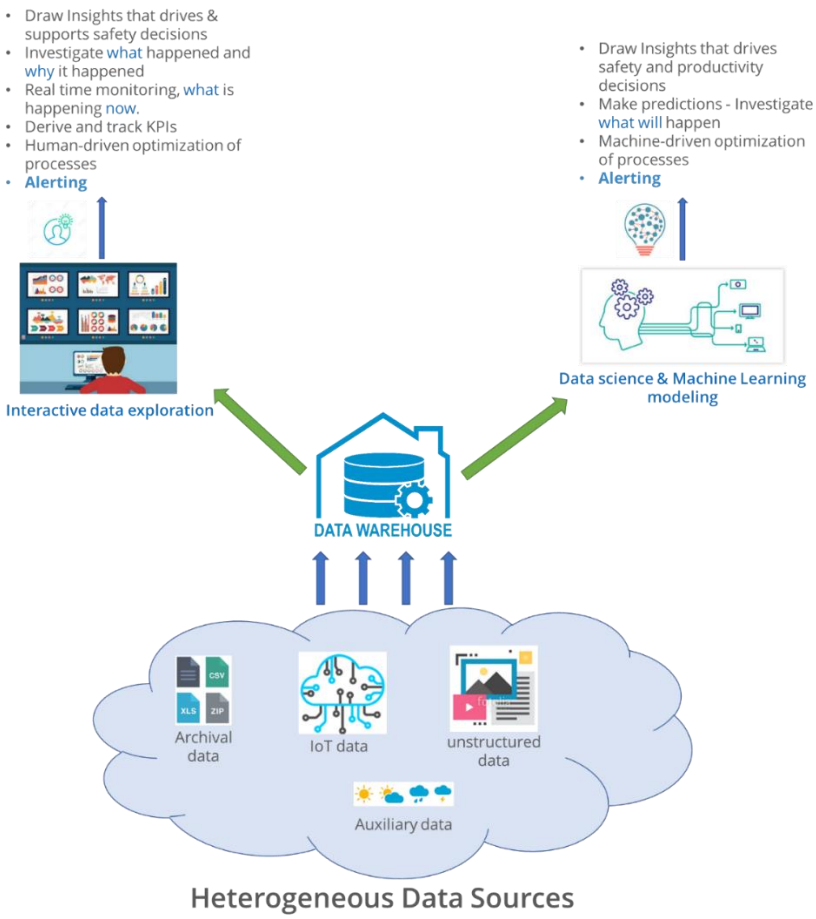


Figure 4. Central data repository and reporting infrastructure

Alerting capabilities. The proposed solution will enable the creation of different types of alerting systems based on the requirement of the Athens Living Lab. The most significant feature of the alerting mechanism will be to alert the driver in real-time in the yard truck cabin when the hybrid module detects the drowsiness symptoms (either by alarm mechanism or by specialized tablet application). Furthermore, an alerting system will be incorporated in the developed platform to support a versatile, real-time, rule-based and event-triggered alerting system.

Operating description

The Federal Motor Carrier Safety Administration (FMCSA) cites truck driver fatigue as one of the leading factors contributing to commercial trucking crashes. While driving when tired does not always cause a crash, it can dramatically increase the likelihood of occurring. According to U.S. Department of Transportation statistics, driver fatigue is a factor in roughly 13 percent of large truck accidents in the U.S. each year. According to the Center for Disease Control and Prevention (CDC), truck drivers are also more likely than the general population to drive fatigued. In this respect, a reliable real-time onboard drowsiness detection and alerting system is critical for increasing drivers' safety and reducing considerably the costs related to accidents. On the other hand, the advanced reporting/BI system that will offer a 360º view of the alertness of the fleet staff and capabilities to drill down to certain cases and situations will play a critical role in decision making for fleet management optimization to further reduce the possibility of drowsiness-induced accidents.

There are three major KPIs that the system will be assessed upon. The event to alert time (EAT), which indicates the time lag between an emergency drowsiness event (such as nodding off) and the delivery of the alarm, the false positive rate (FPR), which is the rate of video segments that were normal yet estimated by the system as positive, i.e., indicating a drowsiness sign, and the false-negative rate (FNR), which is the rate of video segments that were falsely characterized as normal, however, they were exhibiting drowsiness signs. Regarding EAT, we target maximum times equal to 2 seconds. FPRs are considered way less critical than FNRs, in the sense that a relatively high FPR rate means that there will be quite many false alarms, i.e., the driver will be alarmed for drowsiness while being alerted. On the other hand, a high FNR rate means that critical drowsiness situations might be missed altogether without delivering any alarm. When operating without a 5G connection, the onboard device will be set up for high FPRs and low FNR. FNR is targeted to be lower than 90%, whereas FPR could be as high as 20%. In the presence of 5G, where the cloud-based module will contribute to the overall performance, the FPRs will be reduced to 5%, and the FNR will get increased to 95%. For emergency drowsiness signs (head drop, extended eyes close, etc.) FNR is expected to reach 99% of performance.

Data sharing policy

Considering that 5G-Loginnov is a collaborative project based on the Horizon 2020 framework and developed by a Consortium of partners playing specific and significant roles, data sharing, exchange, and dissemination are crucial topics. For this reason, we must face comprehensively all the aspects related to sharing and dissemination of information: what data will be shared, how data will be shared, access policies, restrictions, technical needs for sharing, openness, etc. The first main distinction can be considered the data accessibility: publicly available or for internal use of the 5G-Loginnov Consortium. For any other shareable data that do not require to be undisclosed, specific ways, procedures and requirements for dissemination must be outlined and respected for the best impact of the project on society and to safeguard partners' interests. It must be pointed out that partners wishing to publish or disseminate any content or material should notify this intention to Libra in order to enable assessing whether the requested action is suitable in terms of IPR protection. In any case, since this solution aims to propose an improvement for drowsiness detection by implementing new technical solutions, the achievements are required to be communicated publicly and the results to be distributed openly. However, some specific data, such as the individual's data, will be considered private, therefore, accessible after granting permission. In parallel, specific datasets collected or generated during this project, such as research data about modeling procedures, KPI validation, event modeling, real-time drowsiness detection, will be distributed freely.

On-site activities

In order to accomplish the proposed solution, we need to proceed with several on-site activities, such as equipment installation in yard trucks and on-site testing. Furthermore, we will need access to the Living Lab area and the involvement of Living Lab personnel.

Equipment installation in trucks

We will install the necessary equipment in a truck that will be used to demonstrate the drowsiness detector system in real-time conditions. In this yard truck, we will install the necessary monitoring hardware and software. Specifically, we will install an H.D. camera in the cabin at a location that will not hinder operations and will not introduce security risks. Furthermore, we will install an Nvidia Jetson Xavier NX Developer Kit in the yard truck to be used as a far-edge device that will receive images in real-time. Finally, we will install a 4G/5G router in the cabin to transmit data in real-time to fully exploit 5G and thus the PCT server computational power to predict the driver's drowsiness condition more accurately.

We will set up all of the infrastructure needed to collect data and train the drowsiness detection modules. In five trucks, we will install the essential monitoring hardware and software at a modest cost. The data for training is not required to be transferred real-time in the PCT's data center. As a result, data will be collected in yard trucks and subsequently sent in an asynchronous mode to the PCT's data warehouse at the end of each shift. Specifically, using a real-time camera system, i.e., a battery-powered Raspberry Pi 3B+, which can transmit images captured by its camera wirelessly, we will collect the required training data.

Involvement of PCT personnel for training data collection and testing the pilot

We will oversee the data collection procedure from the trucks. We will work closely with truck drivers to collect enough data in real-world situations, capturing various sleepiness levels and driving scenarios (e.g., day/night driving, i.e., variable cabin illumination, bad weather conditions, i.e., different eye states owing to low visibility), for at least two weeks. Furthermore, we will collaborate with PCT's control room personnel to define the reporting platform's functional requirements. Last but not least, we will need to collaborate with a truck driver that will be involved in the Living Lab's pilot demonstration.

Data annotation

In order to annotate collected data efficiently, we will build an approach capable of identifying frames of interest concerning drowsiness. When drivers enter fatigue, they often have series of biological reactions such as prolonged eyes closed, yawning, etc. Based on this biometric response, driver fatigue can be calibrated by calculating the PERCLOS parameter and the FOM parameter.

The PERCLOS parameter indicates the ratio between the number of closed eyes' frames and the total number of frames in unit time[22]. The formula is as follows:

$$f_{PERCLOS} = 100 \times \frac{n}{N} \quad (1)$$

where n is the number of closed eyes' frames and N is the total number of frames. The PERCLOS parameter can be used to quantify the degree of driver's eyes closing. When PERCLOS reaches a certain value (0.15 in the literature[23]), it can be judged that the driver has closed eyes for a long time and can be initially considered fatigue.

[22] Wierwille, W.W., Ellsworth, L.A.: 'Evaluation of driver drowsiness by trained raters', Accid. Anal. Prev., 1994, 26, (5), pp. 571-581

[23] F. Zhang, J. Su, L. Geng, and Z. Xiao, ''Driver fatigue detection based oneye state recognition,'' in Proc. Int. Conf. Mach. Vis.Inf. Technol. (CMVIT),Feb. 2017, pp. 105-110

FOM (Frequency of open mouth) is similar to PERCLOS, and it means the ratio between the number of open mouth frames and the total number of frames in unit time. The formula is as follows:

$$\mathbf{f}_{\boldsymbol{FOM}} = 100 \times \frac{n}{N} \quad (2)$$

like PERCLOS, n is the number of open mouth frames, and N is the total number of frames. The larger the value of these two parameters, the greater the degree of fatigue is.

So to identify frames where drowsiness symptoms exist in the video, we will build an approach combining both metrics and indicating to the annotator the corresponding frames. In the sense that when these metrics are higher than a certain value, in certain video intervals, then the annotator will characterize those frames accordingly to the drowsiness detections classes (Fully alerted, Mild drowsiness, Heavy drowsiness signs, and Emergency).

Project structure

This section provides the Work Breakdown Structure (WBS) of the project, describing Work Packages and Tasks and related Deliverables.

WP1: Infrastructure installation and integration (M1-M12)

T1.1 Functional and technical requirements (M1-M2)
This task will exploit the expertise of the PCT employees. Through interactive methods (such as virtual tabletop exercises and one workshop (W.S.)), we will discuss towards extracting functional (e.g., automation and autonomy, sensing properties, ruggedization, data formats and visualization, information filtering, network coverage and throughput, etc.) and non-functional requirements (e.g., security, reliability, availability, modularity, etc.) of the entire project. The requirements will drive technical developments and will be translated to technical requirements, specifications, and module design principles. Three additional iterations will exist following the integration, testing and pilot validation plan, adding needs, and fine-tuning the integration activities. Moreover, this living document of user needs will input the benchmarking and KPIs to validate the module. **Output: D1.1**

T1.2 Equipment installation in trucks for training data collection (M2-M3)
In this task, we will install all the infrastructure needed to gather data to train the models used in the drowsiness detection module. We will install necessary monitoring low-budget hardware and software in 5 trucks. For the training data collection, there is no need for real-time streaming data. Thus, the data will be gathered in yard trucks and then transferred to the PCT's data warehouse in offline mode at the end of each shift. Having installed all the necessary equipment, we will ensure that the communication protocol between the five trucks and the PCT data center (truck to PCT interconnection) is functional and support the proposed application successfully. **Output: D1.2**

T1.3 Equipment installation in trucks for the pilot (M11-M12)
In this task, we will install the necessary equipment in a truck that will be used to demonstrate the drowsiness detector system in real-time conditions. In this yard truck, we will install the necessary monitoring hardware and software. Specifically, in the yard truck, we will install a Jetson Xavier NX Developer Kit to be used as a far-edge device, an HD camera in the cabin at a location that will not hinder operations and will not introduce security risks, and a 4G/5G router located in the cabin. The acquired data will be exploited in real-time by the far-edge device to predict the drowsiness condition and simultaneously by the well-trained module in the PCT server based on the internet availability. The final decision will be made by the hybrid module considering the available predictions. Then the truck's driver and the safety's key personnel will be alerted. Furthermore, data will be gathered on the PCT's data warehouse to exploit further the modules reporting system (KPI's estimation, visualization etc.). Having installed all the necessary equipment, we will ensure that the communication protocol between the truck and PCT data center (truck to PCT interconnection) is functional and support the proposed application successfully. **Output: D1.3**

Deliverables

D1.1 A living document containing functional and technical requirements (M2)
D1.2 5 fully equipped yard trucks for training data collection (M3)
D1.3 1 fully equipped yard truck for the pilot (M12)

WP2: Data collection and annotation (M5-M7)

T2.1 Training data collection (M5-M6)
In this task, after installing the low-budget mechanism in T1.2, we will supervise the data acquisition process from the trucks. We will closely cooperate with truck drivers to obtain sufficient data in real conditions, capturing different drowsiness levels and driving scenarios (e.g., day/night driving, i.e., different cabin illumination, bad weather conditions, i.e., different eye states due to low visibility). The

data will be sent from the yard trucks to the PCT's data repository based on the network availability. **Output:** D2.1.

T2.2 Data semi-automatic annotation (M6-M7)
In this task, we will implement a pipeline to facilitate data annotation. Specifically, we will implement an anomaly detection approach to focus on specific time intervals of the datasets collected in T2.1. Thus, we will enable the annotator to focus on time intervals with a higher probability of drowsiness characteristics. Thus making an error-prone and time-consuming procedure more efficient and productive. **Output:** D2.2.

Deliverables
D2.1 Collected data (M6)
D2.1 Annotated dataset (M7)

WP3: Drowsiness detector implementation (M6-M12)

T3.1 Preprocessing module implementation (M6-M7)
In this task, we will implement the necessary functionalities to support T3.2, T3.3 and T3.4. Specifically, we will use and orchestrate state-of-the-art face detection, face alignment, and landmarks identification algorithms according to the needs of each submodule. **Output:** D3.1.

T3.2 Far-edge module implementation (M7-M8)
In this task, we will use the acquired data from T2.1 to train a neural network for drowsiness detection in the far-edge, i.e., in the yard truck's cabin. Specifically, the module will extract hand-crafted features (position of key facial features, including the eyes, nose, mouth, chin, eye-aspect ratio (EAR), and mouth-aspect ratio (MAR)). Using the computed features, we will use Long-Short Term Memory (LSTM) neural networks to learn the importance of these features on the drowsy driver's features. It is noteworthy that the far-edge module will be able to function as an independent module. **Output:** D3.2.

T3.3 Near-edge module implementation (M9-M10)
In this task, we will use the acquired data from T2.1 to train the deep neural networks for drowsiness detection in the near-edge, i.e., in the PCT's virtual server. Specifically, the module will be a Deep Learning model based on Convolutional Neural Networks (CNNS) and Long-Short Term Memory (LSTM) neural networks extracting the knowledge and the patterns existing in the drowsy driver's features. It is noteworthy that the near-edge module will also be able to function as an independent module. **Output:** D3.3.

T3.4 Hybrid detector module implementation (M7-M12)
A versatile end-to-end drowsiness detection system will be developed based on cutting-edge deep learning technologies. The system will be robust against detrimental effects that are likely to appear in the operational conditions. These include low image quality (including blurring, illumination instabilities etc.), unconstrained face pose and face expression variabilities. Furthermore, the system functionality will not depend on 5G, but willfully exploit 5G availability to increase the drowsiness detection accuracy. **Output:** D3.4.

Deliverables
D3.1 Preprocessing module (M7)
D3.2 Far-edge module (M8)
D3.3 Near-edge module (M10)
D3.4 Hybrid detector module (M12)

WP4: Central data repository and reporting platform (M3-M12)

T4.1 Central data repository implementation (M3-M4)

We will implement a central data repository, namely a data warehouse (DW), in this task. It will provide the means for collecting in a centralized point all the available data. It will prepare the data for analytics, visualizations, and AI modeling and it will provide enough processing power to perform data exploration. The DW will be central in the architecture of the whole system, and we will design it to serve multiple usages and functionalities. The DW will be responsible for storing the data collected from T2.1 and the data collected from T5.1. **Output:** D4.1

T4.2 Platform development for reporting (M5-M12)

In this task, the system and user specifications collected in T1.1 will be analyzed to compile an interactive platform comprising the DSS/business intelligence component. The dashboard suite will be cloud/web-based. A set of 1-2 distinct dashboards are envisioned to capture important PCT aspects, safety and productivity monitoring and analysis. The task involves the following developments. For each dashboard, we will conduct a short design study that includes analyzing the questions that the dashboard will answer, the list of the data sources and AI component outputs that need to be blended and the draft UX design considering the user(s) profile. We will design the alerting system and the alert rules will be specified. In the same framework, the rules that can potentially lead to semi-automatic decisions will be specified. We will perform the required (extract, transform, load) ETL processes to develop as many as column-oriented databases needed to serve each of the developed dashboards. The aim is to achieve sub-second query capabilities with the big streaming data collected for real-time analytics. We will develop the designed dashboards (ideally, using open-source platforms). The alerting system will be embedded within the dashboard suite letting key personnel in the PCT's control room have a 360-degree view of the yard truck activities. **Output:** D4.2

Deliverables

D4.1 Data repository (M4)
D4.2 Reporting platform (M12)

WP5: Demonstration in an operational environment (M13-M14)

T5.1 Drowsiness detection in real conditions (M13-M14)

In this task, we will test the module of T3.4 in the Athens Living Lab. Specifically, we will demonstrate the functionality of the drowsiness detection system in real conditions. We will show alerting functionality both in the yard truck's cabin (direct alert to the driver) and in the PCT's control room (indirect alert to the key personnel). The pilot will run on a single truck, which will have been modified accordingly, see T1.3. **Output:** D5.1

Deliverables

D5.1 Drowsiness detection pilot (M14)

WP	Month													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WP1 Infrastructure installation and integration														
T1.1 Functional and technical requirements		D1.1												
T1.2 Equipment installation in trucks for training data collection			D1.2											
T1.3 Equipment installation in trucks for the pilot												D1.3		
WP2 Data collection and annotation														
T2.1 Training data collection						D2.1								
T2.2 Data semi-automatic annotation							D2.2							
WP3 Drowsiness detector implementation														
T3.1 Preprocessing module implementation							D3.1							
T3.2 Far-edge module implementation								D3.2						
T3.3 Near-edge module implementation										D3.3				
T3.4 Hybrid detector module implementation												D3.4		
WP4 Central data repository and reporting platform														
T4.1 Central data repository implementation				D4.1										
T4.2 Platform development for reporting												D4.2		
WP5 Demonstration in an operational environment														
T5.1 Drowsiness detection in real conditions														D5.1

Figure 5. Gantt chart of the RESONATE proposal.

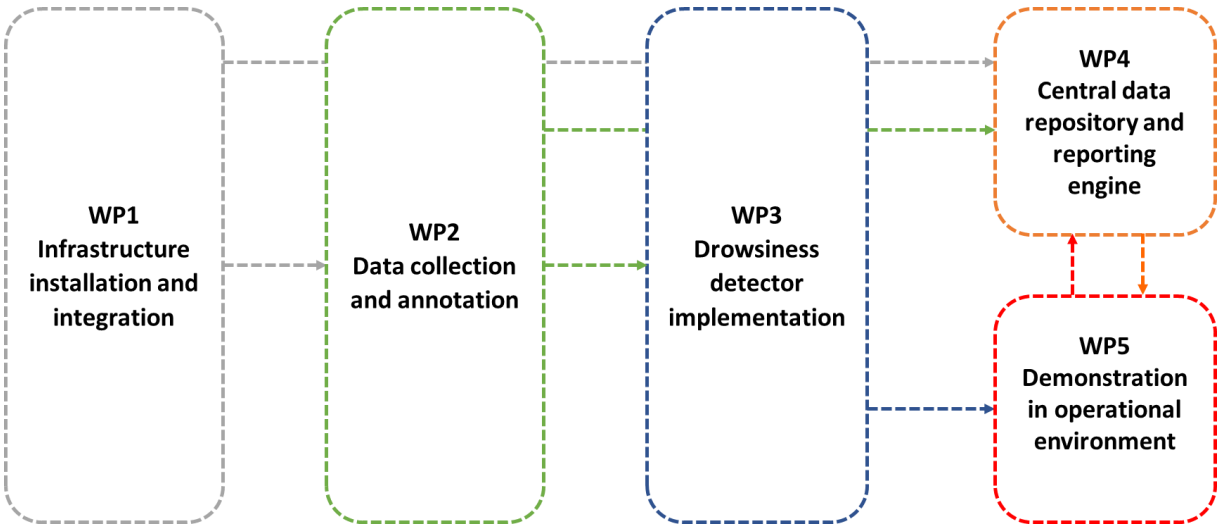


Figure 6. Pert chart of the RESONATE proposal

Resource/budget allocation

This section indicates the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item.

Due to the nature of this proposal, we focused on allocating the available budget to direct personnel costs. With an overall resource volume of 6.4 person-months over 14 months, RESONATE undoubtedly has the critical mass required to accomplish its goals. The table shows the distribution of the resources over the different WPs. The technical WPs (WP1-WP2) require 2 PMs (31% of the total effort). Special attention is put to the R&D activities and prototyping, devoting 4 PMs (62.5% of the total effort), which is fully justified with the project's ambitious research and innovation goals. Focus has also been put on real-world (appropriate environment) case validation, devoting 0.4 PM (6.5% of the total effort).

WP1 Infrastructure installation and integration	1 PMs
WP2 Data collection and annotation	1 PMs
WP3 Drowsiness detector implementation	2 PMs
WP4 Central data repository and reporting platform	2 PMs
WP5 Demonstration in an operational environment	0.4 PMs

Equipment costs

Here we list the equipment that we will need based on the equipment provided by the Living Lab – Athens for the pilot.

- A Jetson Xavier NX Developer Kit
- An H.D. camera.
- A Raspberry PI.
- A 4G/5G router
- Virtual servers based on the ESX platform.
- Access to the 4G/5G network

Since we will train deep neural networks for the near and far-edge submodules (WP4), we will need the virtual server (ESX platform) to support at least one GPU processor.

Furthermore, we use extra equipment for the training data collection (see T2.1) as described in T1.2. The list is provided below:

- 5x Raspberry PI
- 5x Camera
- 5x Extras for installation & power
- 5x SSD hard disks

LIBRA AI will provide this equipment for the duration of the project. Consequently, there will be no extra equipment cost.

Travel costs

Libra AI is located in Athens. Thus, the involved Libra's personnel will attend the Athens Living Lab on the company's costs, when needed, according to the proposed work plan. Furthermore, as far as ITS World Congress Hamburg costs are concerned, they will be the entrée fees for two persons (2x € 1580).

We present an overview of the proposal costs in the table below:

Personnel costs (WPs)	€ 37.120
Travel costs	€ 3.160
Equipment costs	€ 0
Total without VAT	€ 40.280
Total with VAT	**€ 49.947**

Ioannis Kopsinis
CEO

DocuSigned by:
Ioannis Kopsinis
41F850A468A44B7...

LIBRA AI Technologies

6/30/2021

5GLOGINNOV

Annex V

Application Form: 5G4A 5G-Loginnov-4-Amazon (eShuttle)

5GLOGINNOV

Open Call for Innovative Start-ups

Application Form

www.5g-loginnov.eu

This project has received funding from the
European Union's Horizon 2020 research and innovation programme
under grant agreement No. 957400

Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
Dissemination Level	Public
Status	Final
Due date	23/4/2021
Document Date	22/4/2021
Version Number	1.1

Legal Disclaimer

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TABLE OF CONTENTS

List of abbreviations and acronyms

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
FTED	Floating Truck Emission Data
TAVF	Test field Autonomous and Connected Driving
ATP	Automated Truck Platoon
GLOSA	Green Light Optimum Speed Advise
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

GENERAL INFORMATION

This original tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

This document is a proposed template for innovators to answer the tender with their proposal. Applicants are advised to follow the template outline.

Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *opencall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

The application mailbox will be deactivated on 30-Jun-2021 at 05:00:00 PM CEST, and thus all applications received after this time will be automatically discarded; **applicants are strongly recommended to submit their applications with a reasonable advance over the deadline**, in order to ensure they are successfully delivered in time, even in case of technical or connectivity problems.

5G-LOGINNOV will send a confirmation receipt to the e-mail address submitting the application, notifying that it has been taken in charge by the system; such confirmation does not certify that the application is complete and suitable for evaluation, but simply that the e-mail was received in time.

Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

In case of specific queries on the call, **applicants may write an e-mail** to *openCall_helpdesk@outlook.com* with subject "support" **to get help from the 5G-LOGINNOV Applicant Helpdesk team**; the helpdesk will remain active from the beginning (26-April-2021) to 10 days before the closure (20-Jun-2021) of the submission period.

APPLICATION

Remark :

Right click on the text boxes to insert your input

Double click on the checkboxes and if needed make them checked via the properties box

Identification

Proposal:

- Acronym of the proposal (optional):5G4A
- Full title of the proposal (optional):5G-Loginnov-4-Amazon

Organisation:

- Name of the organisation: eShuttle
- VAT registration: DE 27/200/39912
- Website: www.e-shuttle.de
- Legal address: Flughafenstraße 2, 30855 Langenhagen

Contact:

- Prefix: Mr.
- Name: Gazi Yildrim
- Position in the organisation: CEO & Founder
- Email: Gazi@thaj.de
- Mobile: 01517 4509175

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. ☒
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. ☒
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. ☒
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering. ☒

e-Shuttle AG
Flughafenstraße 2, 30855 Langenhagen
Postfach 42 02 24, 30662 Hannover
Telefon: 0511/877 2240
Fax: 0511/877 2242

[1] https://itsworldcongress.com/

- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. ☒

Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. x
2. The provision of all paper/media documentation needed for its on-field operation. x
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. x
4. On-site support to the deployment, installation and validation of the solution. x
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. x
6. To **participate to project dissemination activities**. **x**
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. x

Background IPR

Please list all applicable Background IPR, relevant to your proposal **(max 1 page A4)**

None, but planned

Targeted Living Labs

- Athens ☐
- Hamburg x
- Koper ☐

Related general objectives (max ½ page A4)

Specific areas of interest (max ½ page A4)

Ambitions and development plans

During the Corvid 19 pandemic, it became evident all over the world that digital logistics and e-commerce must be considered as one of the core services and backbones to ensure the provision of goods and food, so urgently needed, when shopping malls and restaurants are closed. Nevertheless, the pandemic also showed that the already difficult carbon footprint caused by logistics activities rather increases then decreases through e-commerce. In Germany, road transportation is regularly accused for contributing high to the overall emissions of the society bringing negative climate impact to the political goals of carbon reductions.

For our company eShuttle, it is clear that our economic future is closely linked to our work ability to reduce emissions and this has been always highly appreciated by our B2B customers such as Amazon, Volkswagen shuttle services, Continental and others. For stock market listed companies, the so-called SCOPE-3 emissions have high priority on the political agenda meaning that our company doing business in the SCOPE-3 area is directly affected. It is known that SCOPE-3 carbon emissions count to almost 90% of the overall carbon emissions of large-scale enterprises and are therefore bringing the strategic inclusion of smaller logistics service providers (SMEs) into the overall carbon reduction strategies of the larger business entities listed on the stock market.

For our company, the business cooperation with Amazon it's very successful and we know that Amazon is a giant in the logistics area. Being a certified supplier of the Amazon logistics group, means that we strengthen our position in our business to business corporation with Amazon by showing to the Amazon sustainability department that our carbon emissions are successfully reduced for all Amazon tours operated by us in the north of Germany. Exactly in this sense, we see our fruitful cooperation with the project partners in Hamburg. After talking to 5G-Loginnov Hamburg partners T-Systems and tec4u about their technical equipment and approach for using Floating Truck Emission Data (FTED) for tour analysis and eco-drive, we decided to join this Open Call for further cooperation. The proposed idea is targeting to share anonymized data of telematics devices including vehicle and driving behavior as well negative road characteristics (congestion, rush-hour, etc.) occurring regularly for our fleet delivery 24/7 hours per week for Amazon logistics services.

Assuming that the overall approach presented here and the FTED emission data evaluated with the Hamburg partners is successful, a joint presentation of eShuttle with 5G-Loginnov Hamburg partners to the Amazon Sustainability Department can be arranged with the objective to show that 5G-Loginnov and eShuttle developed a joint solution for carbon minimum tour planning and eco-drive training. As Amazon certified logistic supplier, eShuttle can operate logistics services all over Europe and worldwide, enabling my company through international partnerships to expand our logistics B2B Amazon service to other regions of Europe and worldwide. This means our market share can grow through innovation in the business area of carbon reduction in road transport.

Provide a draft structured business plan (max 1 page A4)

Our solution	**Target market**
For all certified Amazon logistics suppliers, the continuous dialogue and order management via the Amazon platform as well of the Amazon APP is a key element to guarantee just-in-time delivery. All drivers and dispatchers from third-party suppliers of Amazon are connected via APP and the dispatching software the Amazon service centre. With the smartphone APP based GPS profiles, Amazon can track delays and take measure with the Logistics service operator. As all GPS profiles are available in a operational database, they can also be used for the planned 5G Loginnov test trials in Hamburg. Our company eShuttle will equip Amazon CEP delivery vans with the 3 telematics devices foreseen by the 5G-Loginnov project partners. The usage of these devices is targeted to improve dispatching and order management of Amazon fleets in the North of Germany showing the potential of carbon reduction by optimizing route and tour planning. As the reduction of Amazon third-party logistics partners (Scope 3 emissions) is high on the agenda of Amazon sustainability department in Luxembourg, the implementation of 5G-Loginnov Use cases are designed to support the overall carbon reduction targets of the Amazon group.	In principle, all logistic service providers certified for logistics operation for Amazon can use the solution with the simple APP update. Based on the cloud solution design of 5G-Loginnov, Amazon 3rd party suppliers can also use the speed profiles to develop reduction strategies based on energy demand managing. Additionally, proven fuel savings will help to give priority to certain routes and tours saving fuel costs.
The competition	**Revenue streams**
Given the importance of Amazon delivery services in Europe and worldwide, Amazon is considered as a very innovative and fast-moving company scaling up solutions with the necessary investment funds to succeed. For eShuttle as a certified 3rd party logistics supplier, any successful business partnership with Amazon helps to stabilize our market share in the highly competitive landscape of logistics. As 5G-Loginnov for Amazon delivery is unique and no competitive solutions yet exist, we plan to patent our business approach and will bring it to other logistics markets where we are active.	1. Saving fuel costs 2. Carbon credits as Amazon reduces Scope 3 carbon emissions 3. Licenses for other Amazon 3rd party CEP logistics service providers...

Technical description **(max 4 pages A4)**

In the following chapters a brief technical description of the solution will be presented.

Aims and operating principles

The overall operational service design is presented in **Figure *1***. The Amazon Logistics Order Management Center (Box [1]) send an order and tour request to the certified logistics service provider, in this case e-Shuttle AG with headquarter in Hanover (Box [2]).

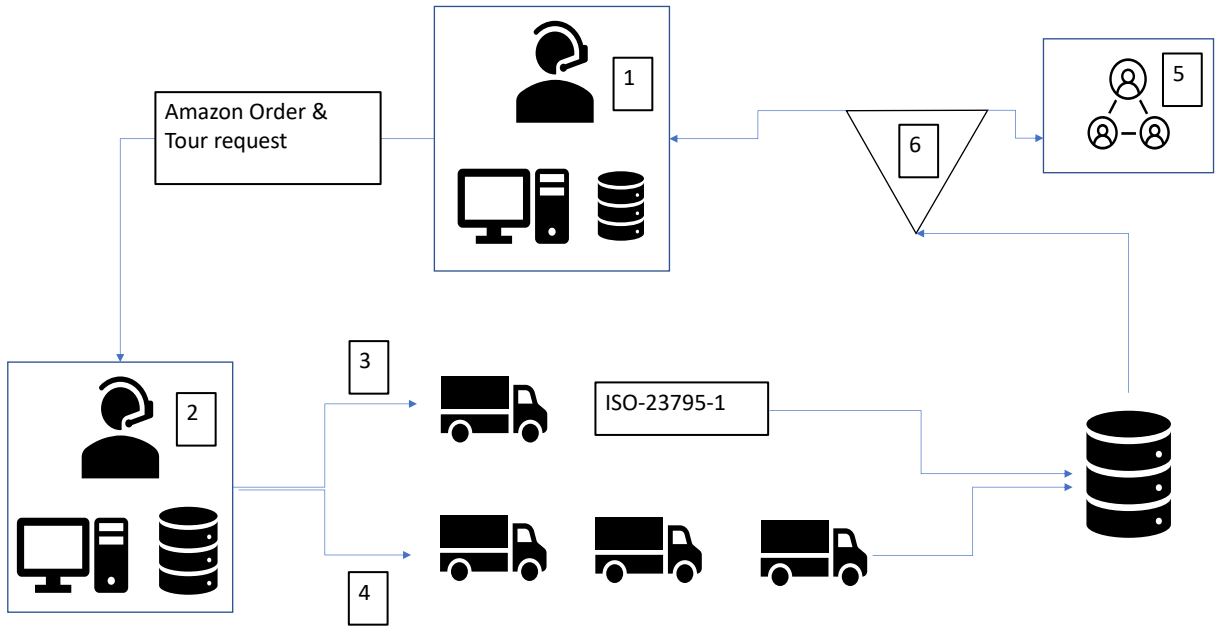


Figure 1 - 5G-LOGINNOV-4-AMAZON SERVICE FLOW

The dispatcher of eShuttle then selects the vehicle for the Amazon tour request. eShuttle operates various tours in the North of Germany, for Amazon the current certificate gives tour permission for the region of Hannover but can be easily expanded to Hamburg as the certificate lists our company as trusted Amazon supplier world-wide. It is planned to equip 3-5 Amazon fleet vehicles with smartphones and tec4u-entruck equipment for tour analysis in Hannover first and then decide how to expand the FTED service of 5G-Loginnov to our vehicles in the North of Germany. The aim of this service implementation is to learn how to use GPS speed profile analysis from nomadic devices (ISO/DIS-23795-1) and CAN-Bus data from tec4u product enTruck on a daily for fuel and carbon reduction. Additionally, eShuttle will decide with the 5G-Loginnov partners in Hamburg when (time of the day) and how (number of platooning vehicles) to collect data from the Hamburg test field TAVF to support the Living Lab Hamburg with the ATP tests and data analysis by using GLOSA function and 5G network capabilities along the TAVF test field of the city of Hamburg. In **Figure *1***, this is shown in Box [4] indicating that the eShuttle operation centers sends a request to the vehicles for platooning along the test field. All of the data will be anonymized according the GDPR rules and handed over after anonymization to Amazon ([6]) and to interested 3rd parties, for example Continental, T-Systems, tec4u and SWARCO.

High-level functional architecture

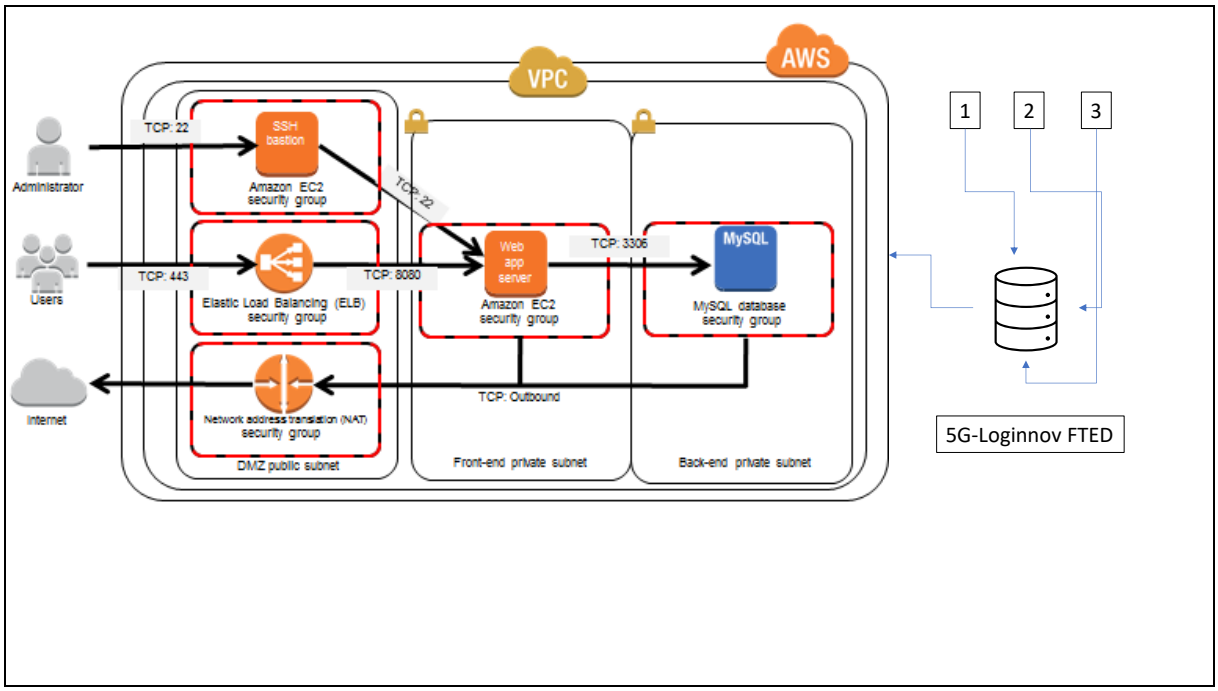


Figure 2 Data flow Amazon to 5G-Loginnov database in Hamburg

In **Figure *2***, the overall Amazon components as known from public internet sources are presented in a schematic manner. A back-end with mySQL database operated in the AWS (Amazon cloud) might be a possible interface for exchanging data between the 5G-Loginnov service center as used by the Living Lab Hamburg partners and the Amazon logistics service centers. Given the limited budget of the project, the data exchange of the 5G-Loginnov partners will be used as blueprint information to Amazon IT people, interested in SCOPE-3 carbon emissions. Given such an architecture, the 5G-Loginnov data base can be open for external subscribers, e.g. Amazon, to pull-mechanisms for receiving data about SCOPE-3 carbon emissions. On the other hand, truck data collected by 5G-Loginnov has the three input sources [1] GPS smartphones, [2] enTruck CarPC and [3] Continental IoT device connected to CAN-Bus data of the vehicle, especially fuel consumption, therefore energy demand and carbon emissions. The Amazon ICT architecture might differ from country to country, nevertheless, the database exchange mechanisms of pull to Amazon in the first operational phase will hold valid and can be taken as reference for further exploitation.

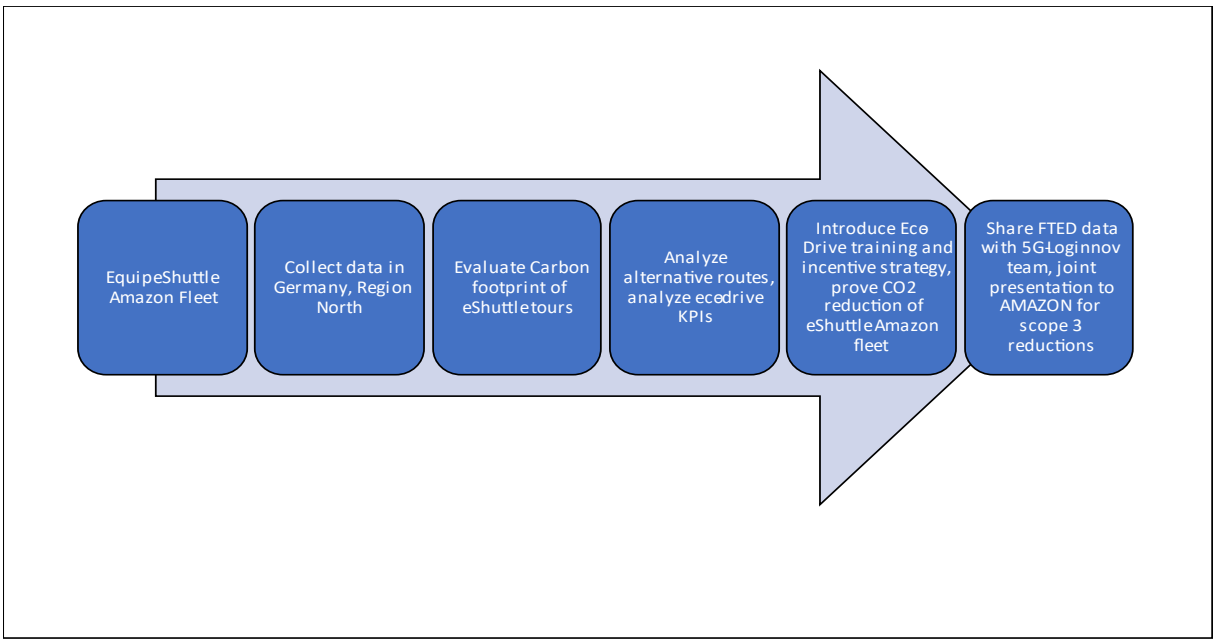


Figure 3 Deployment and activities

In **Figure 3**, the operational steps towards implementation are presented. Starting with equipping the selected eShuttle fleet vehicles in Hanover (Amazon) and Hamburg (B2B shuttle services), the next step will be the selection of Use Case roll-out for FTED and truck platooning. The next key activity will be the carbon footprint analysis along the selected logistics corridor of interest with the objective to find alternatives with lower carbon emissions. This also includes based on the detected eco-drive KPIs to select eco-drive training strategies and to make drivers and dispatchers aware of such strategies. Especially, incentive concepts linked to best-practise will be studied using in-depth analysis of speed profiles detected. After the implementation of fuel and carbon saving strategies, the experiences will be shared with Amazon and the potential of SCOPE-3 reductions discussed.

Preliminary layout of the Human-Machine Interface (HMI)

Figure 4 Smartphone with GLOSA App, see https://5g-loginnov.eu/wp-content/uploads/2021/06/Willenbrock_TSYS1.pdf

In Figure *4*, the APP design as presented in the 5G-Loginnov Hamburg web-reference (see attachment) is shown indicating how to use is by our drivers. For simplicity and budget constraints, the APP will not be re-developed but permission requested for our fleets to use it according to the technical description in this chapter.

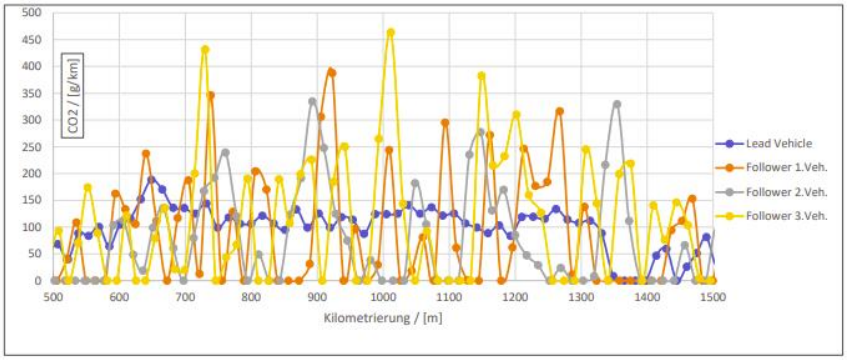


Figure 5 Back-end trip analysis of FTED, see https://5g-loginnov.eu/wp-content/uploads/2021/06/Willenbrock_TSYS1.pdf

For eco-drive training purposes, the trip analysis as shown in Figure *5* is planned to be used. Here we will use the data to re-arrange trips based on time and road characteristics and evaluate how time pressure causes additional emissions and increased fuel consumptions. Furthermore, it might be possible to substitute certain vehicle configuration, for example to replace combustion engines by hybrid or electric vehicles taken into consideration the charging infrastructure in the area of logistics operation.

Operating description

(max 3 pages A4)

Expected benefits and measurable Key Performance Indicators

By using the Hamburg Living Lab set-up and given the well-known experience of eco-drive benefits, eShuttle expects fuel and carbon savings of 10% by applying FTED use case as suggested by 5G-Loginnov in Hamburg. This leads to
KPI-1 Fuel and carbon savings by FTED >> 10%
For the Automated Truck Platooning tests in Hamburg additional fuel and carbon savings are foreseen, but rather in a limited test trip leading to
KPI-2 Fuel and carbon savings by GLOSA Truck Platooning >> 10%

Possible data sharing policies.

Anonymized data can be shared following the European wide GDPR rules and the Amazon data privacy standards. Data sharing with the Hamburg Living Lab partners will be discussed before collection starts and all legal issues agreed-upon with Amazon and the e-Shuttle labour contract with professional drivers delivering data to 3rd parties and external servers. This includes a limited data storage strategy to be ensured by the Hamburg pilot site partners.

Planned support activities (remote and on-site).

1. Installation of T-Systems and tec4u equipment in case of Open Call award (September)

2. I.T.S. Congress October 2021: Presentation of eShuttle solution to Hamburg's traffic authorities, world-wide traffic ministries, OEMs, suppliers, and logistics service providers in Hamburg

3. Joint Marketing activities with T-Systems, tec4u and Continental in 2022, alignment with ERTICO how to present

4. Selection of time-frame for truck platooning based on GLOSA in Hamburg, alignment with the Hamburg Living Lab partners

5. Selection of data collection in the wider area of Hamburg according to the FTED requirements

All support activities will be part of the project structure presented in the following chapter.

Marketing activities 6. I.T.S. Congress October 2021: Presentation of eShuttle solution to Hamburg's traffic authorities, world-wide traffic ministries, OEMs, suppliers, and 3rd parties (UBER, Deutsche Bahn, etc.) 7. Joint Marketing activities with T-Systems 8. Presentation to 5G-Loginnov partner Continental for marketing upscale (2022) 9. Joint marketing with ERTICO/T-Systems as part of the 5G-Loginnov marketing activities 10. Joint marketing with ERTICO/T-Systems as part of the Logistics sector activities within ERTICO	Expenses • Requirement analysis to implement GPS data collected by the 3 On-Board units (LCMM, tec4u, Continental) in eShuttle Amazon fleet vehicles (Oct.-Dec 2021) • Project implementation according to requirement phase (Jan.-Mar. 2022) • Tests and Roll-out in Hannover and Hamburg, evaluating fuel and carbon savings • Marketing costs • Total: 50.000€ + additional expenses for Taxi-Ad marketing campaigns
Team and key role Currently, eShuttle has a team of …	Milestones 1. Winning award as project partner (Oct. 2021) 2. Presentation of eShuttle project during the Hamburg world congress (Oct. 2021) 3. Selection and installation of 5G-Loginnov Telematics On-Board units in selected Amazon fleet vehicles (Jan.-Mar. 2022) 4. Execution of 5G-Loginnov Platooning tests with Amazon vehicles on Test Field TAVF and data analysis (Apr.-Dec. 2022) 5. In case of positive results presentation of Amazon sustainability department

Project structure

The applicant shall provide the Work Breakdown Structure (WBS) of the project describing Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related Deliverables and Milestones (including types, contents, due dates). The overall timing of the project must comply with the execution of 5G-LOGINNOV Living Labs, i.e. the ICT solution must be deployed, tested and fully validated on selected Living Lab(s) by 30-Apr-2023.

(max 4 pages A4)

Project structure

This chapter will include a basic GANTT chart to describe the time-dependent framework of the work activities planned in the described work packages, tasks and milestones. The tasks are listed in the work package description, followed by deliverables and milestones.

Work package WP1 - Specification phase

Task T1.1 will focus on the specification of the anonymization connector as presented in **Figure *1***. A key element of the service is to cut off specific driver information and to evaluate only those parts of the trip which are needed for re-routing and eco-drive. The GDPR connector will be specified in close cooperation with the Hamburg Living Lab partners and their three different telematics devices used in the field trials. Whereas T1.1 focuses on data specification according to **Figure *1*** and **Figure *2***, Task T1.2 elaborates the details for a full specification document. Such a document will include specific system requirements of the Amazon order and tour management, as used in the eShuttle service center. This will include a formal request to Amazon what of information is public and can be used for the sake of data sharing and what type of architecture information is disclosed.

Milestone MS1.1 – Draft specification ready
Milestone MS1.2 – Full specification ready
Deliverable D1.1 – Draft specification deliverable
Deliverable D1.2 – Full specification deliverable

Work package WP2: Technical implementation phase

In work package WP2, a showcase demonstrator will be developed and presented first to the visitors of the I.T.S. congress and second to the interested customer groups in Hamburg and Hanover. The demonstrator should show the data elements of GLOSA, FTED and ATP and especially how to use them in Hamburg for the 5G-Loginnov pilot site. The demonstrator will make reference to real-time trip experiences as taking place for eShuttle drivers in Hanover for FTED and in Hamburg for truck platooning. The implementation phase needs detailed elaboration of work items and hardware usage with the Living Lab partner which take place in task T1.1 leading to the Milestone of a demonstrator.

Deliverable D2.1 – eShuttle Demonstrator for FTED and truck platooning
Milestone MS2.1 – eShuttle Demonstrator ready

Work package WP4: Pilot site demo case

In Hamburg and Hanover, eShuttle will implement a fleet with telematics devices delivered by T-Systems, tec4u, SWARCO and Continental. It is planned to use smartphones and tec4u devices within

the fleet vehicles of eShuttle and to give access to the data via standard graphical interfaces. The work items of rolling out vehicle fleets in Hamburg will be set-up in very close cooperation with Living Lab partners and the tour requirements of Amazon B2B services, well-known from an operational perspective by eShuttle. Consequently, the task T3.1 will include the deliverable D4.1 Field trial documentation and the milestone M3.1 Field trial implementation.

Milestone M3.1 - Field trial implementation
Deliverable D3.1 – Field trial documentation

Work package WP4 : Dissemination activities

In work package WP4 the related task 4.1, will be executed with the 5G Loginnov Hamburg team towards Amazon sustainability department. As amazon announced to reduce SCOPE-3 carbon emissions and has a highly skilled expert team to deal with this objective, dissemination will focus on convincing Amazon that the 5G-Loginnov solution planned in Hamburg has the potential to support this overall Amazon company policy. The task T4.1 therefore has the focus on preparing presentations to Amazon Sustainability Headquarter and to show how FTED can help Amazon to reduce carbon emissions caused by road transport and logistics.

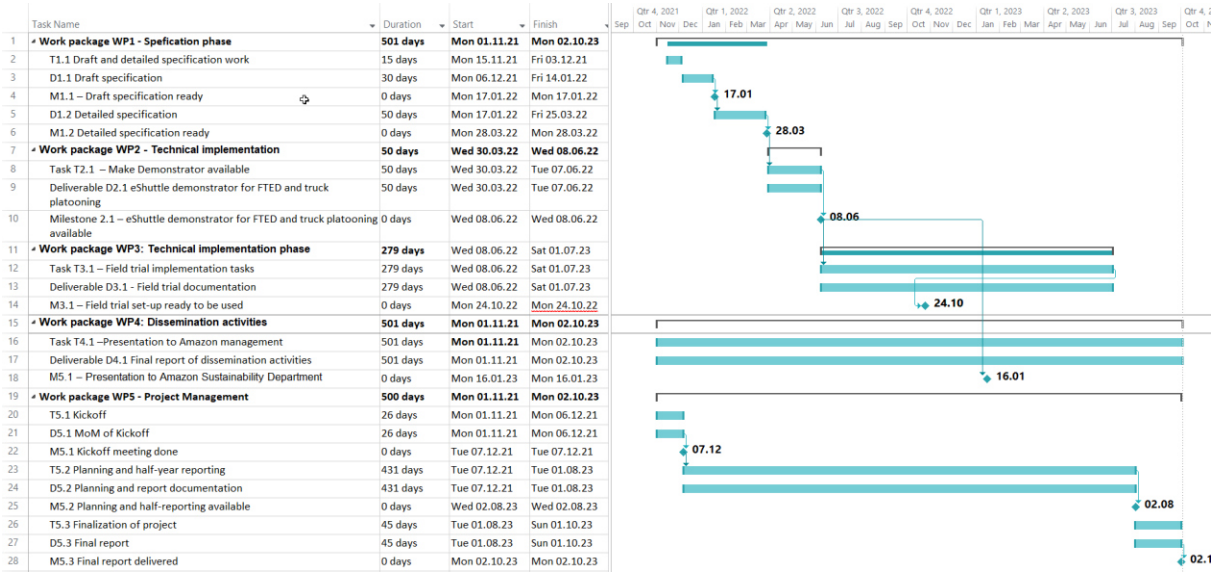
Deliverable D4.1 – Final report of dissemination activities
Milestone M4.1 – Presentation to Amazon Sustainability Headquarter

Work package WP5 - Project Management

The overall project management tasks will be executed by the eShuttle CEO Mr. Gazi Yildrim, who will appoint a project manager. Within Task T5.1 a kickoff meeting with all Livings Lab leaders and ERTICO will take place. In this meeting, eShuttle will align with the 5G-Loginnov Hamburg team how to proceed for reporting and documentation of all work package items and how to fulfill the milestone lists. Task 5.2 includes the documentation of progress of work and how committed targets progress. It is planned to report on a 6-Month turn to the consortium and to the consortium coordinator ERTICO. Task 5.3 is elaborating the final report including results and achievements at the end of the project.

Deliverable D5.1 – Meeting minutes of kickoff
Deliverable D5.2 – Planning document for half-year reporting
Deliverable D5.3 – Final report
Milestone 5.1 - Kick off meeting done and minutes of kickoff ready
Milestone 5.2 – Planning and progress report document available
Milestone 5.3 – Final report ready and delivered

The GANTT chart for the timelines planned per work packages is shown in MS Project next page. WP5 and WP5 are planned from Nov.21 to project end Oct.23. All other work packages have timelines typical for €50.000 IT projects, meaning that this budget must be considered small and can only show the principles of FTED and truck platooning on a demonstrator level, rather than on a full implementation scale.



	Task Name	Duration	Start	Finish
1	**Work package WP1 - Spefication phase**	**501 days**	**Mon 01.11.21**	**Mon 02.10.23**
2	T1.1 Draft and detailed specification work	15 days	Mon 15.11.21	Fri 03.12.21
3	D1.1 Draft specification	30 days	Mon 06.12.21	Fri 14.01.22
4	M1.1 – Draft specification ready	0 days	Mon 17.01.22	Mon 17.01.22
5	D1.2 Detailed specification	50 days	Mon 17.01.22	Fri 25.03.22
6	M1.2 Detailed specification ready	0 days	Mon 28.03.22	Mon 28.03.22
7	**Work package WP2 - Technical implementation**	**50 days**	**Wed 30.03.22**	**Wed 08.06.22**
8	Task T2.1 – Make Demonstrator available	50 days	Wed 30.03.22	Tue 07.06.22
9	Deliverable D2.1 eShuttle demonstrator for FTED and truck platooning	50 days	Wed 30.03.22	Tue 07.06.22
10	Milestone 2.1 – eShuttle demonstrator for FTED and truck platooning available	0 days	Wed 08.06.22	Wed 08.06.22
11	**Work package WP3: Technical implementation phase**	**279 days**	Wed 08.06.22	Sat 01.07.23
12	Task T3.1 – Field trial implementation tasks	279 days	Wed 08.06.22	Sat 01.07.23
13	Deliverable D3.1 - Field trial documentation	279 days	Wed 08.06.22	Sat 01.07.23
14	M3.1 – Field trial set-up ready to be used	0 days	Mon 24.10.22	Mon 24.10.22
15	**Work package WP4: Dissemination activities**	**501 days**	**Mon 01.11.21**	**Mon 02.10.23**
16	Task T4.1 –Presentation to Amazon management	501 days	**Mon 01.11.21**	Mon 02.10.23
17	Deliverable D4.1 Final report of dissemination activities	501 days	Mon 01.11.21	Mon 02.10.23
18	M5.1 – Presentation to Amazon Sustainability Department	0 days	Mon 16.01.23	Mon 16.01.23
19	**Work package WP5 - Project Management**	**500 days**	**Mon 01.11.21**	**Mon 02.10.23**
20	T5.1 Kickoff	26 days	Mon 01.11.21	Mon 06.12.21
21	D5.1 MoM of Kickoff	26 days	Mon 01.11.21	Mon 06.12.21
22	M5.1 Kickoff meeting done	0 days	Tue 07.12.21	Tue 07.12.21
23	T5.2 Planning and half-year reporting	431 days	Tue 07.12.21	Tue 01.08.23
24	D5.2 Planning and report documentation	431 days	Tue 07.12.21	Tue 01.08.23
25	M5.2 Planning and half-reporting available	0 days	Wed 02.08.23	Wed 02.08.23
26	T5.3 Finalization of project	45 days	Tue 01.08.23	Sun 01.10.23
27	D5.3 Final report	45 days	Tue 01.08.23	Sun 01.10.23
28	M5.3 Final report delivered	0 days	Mon 02.10.23	Mon 02.10.23

Figure 6 GANNT chart eShuttle project for 5G-Loginnov Living Lab Hamburg

Source/budget allocation

A total cost breakdown per work package is shown in

	Person-Hours	Staffing Costs	Other costs
WP1	42	4.200 €	500 €
WP2	105	10.500 €	500 €
WP3	105	10.500 €	4.000 €
WP4	126	12.600 €	2.000 €
WP5	42	4.200 €	1.000 €
Sum	420	42.000 €	8.000 €

Table *1*.

	Person-Hours	Staffing Costs	Other costs
WP1	42	4.200 €	500 €
WP2	105	10.500 €	500 €
WP3	105	10.500 €	4.000 €
WP4	126	12.600 €	2.000 €
WP5	42	4.200 €	1.000 €
Sum	420	42.000 €	8.000 €

Table 1 Cost break down per work package

All costs stated in *Table 2* are estimated on the cost base of €100 per person-hour. As shown in the GANTT chart, WP5 reflects the underlying Project Management task and is assumed to be executed with 42 person-hours (PH) of the total budget of 420 PH. The run-time of WP1 covers the entire project duration same is true for WP4 (Marketing and Dissemination). As indicated in *Table 3* WP4 is estimated to be the most expensive as it will cost effort to arrange meetings with Amazon management to convince their sustainability department that FTED and truck platooning based on 5G-GLOSA have the potential to help Amazon to reduce their SCOPE-3 carbon emissions. Nevertheless, it should be targeted to achieve this, therefore the effort of 126 PH is allocated. WP1 to WP3 have resources as usual in the balance of specification, implementation, and demonstration. Other costs are including in

WP1 – travel only (various trips from Hanover to Hamburg)
WP2 – travel only (various trips from Hanover to Hamburg)
WP3 – Material and costs for garage, travel to test equipment, vehicle and trip allocation
WP4 – Marketing and professional results' material for Amazon management
WP5 – Travel to consortium meeting and presentation on-site

5GLOGINNOV

Annex VI

Application Form: TAADD TAXi-AD Data (TAXi-AD GmbH)

5GLOGINNOV

Open Call for
Innovative Start-ups

Application Form

www.5g-loginnov.eu

This project has received funding from the
European Union's Horizon 2020 research and innovation programme
under grant agreement No. 957400

Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
Dissemination Level	Public
Status	Final
Due date	23/4/2021
Document Date	22/4/2021
Version Number	1.1

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

GENERAL INFORMATION

This original tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

This document is a proposed template for innovators to answer the tender with their proposal. Applicants are advised to follow the template outline.

Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *opencall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

The application mailbox will be deactivated on 30-Jun-2021 at 05:00:00 PM CEST, and thus all applications received after this time will be automatically discarded; **applicants are strongly recommended to submit their applications with a reasonable advance over the deadline**, in order to ensure they are successfully delivered in time, even in case of technical or connectivity problems.

5G-LOGINNOV will send a confirmation receipt to the e-mail address submitting the application, notifying that it has been taken in charge by the system; such confirmation does not certify that the application is complete and suitable for evaluation, but simply that the e-mail was received in time.

Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

In case of specific queries on the call, **applicants may write an e-mail** to *openCall_helpdesk@outlook.com* with subject "support" **to get help from the 5G-LOGINNOV Applicant Helpdesk team**; the helpdesk will remain active from the beginning (26-April-2021) to 10 days before the closure (20-Jun-2021) of the submission period.

APPLICATION

***Remark**:*

Right click on the text boxes to insert your input

Double click on the checkboxes and if needed make them checked via the properties box

Identification

Proposal:

- Acronym of the proposal (optional):TAADD
- Full title of the proposal (optional):TAXi-AD Data

Organisation:

- Name of the organisation: TAXi-AD GmbH

- VAT registration: DE813107231
- Website: https://www.taxi-ad.de/
- Legal address: Kieler Str. 464 – 470
  22525 Hamburg

Contact:

- Prefix: Miss
- Name: Anela Smriko
- Position in the organisation: Patent- and Subsidies Coordinator
- Email: anela.smriko@uze-mobility.com
- Mobile:+4916095668554

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. x
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. x
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. **x**
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering. **x**
- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. **x**

Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. x
2. The provision of all paper/media documentation needed for its on-field operation. x
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. x
4. On-site support to the deployment, installation and validation of the solution. x
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. x
6. To **participate to project dissemination activities**. **x**
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. x

[1] https://itsworldcongress.com

Background IPR

Patent number	Claims	Strategy
PCT/EP2019/053176	Telematics Unit Describes partly blockchain based transaction process without revealing exact method.	Shields from competition with extensive number of claims.
PCT/EP2020/058661	Device for arrangement on a vehicle Describes a method to mount a display on a vehicle	Shields from competition with broad choice of words covering multiple possible attachments. Creates market barrier by protecting most efficient methods of attachment.
US 17107794	Modular patent Protects modular arrangement of the display-casing	Shields from competition with detailed description of most efficient and functional design.
DE 10130569B4	Mobile advertisement medium Protects any information display based on location & time in Germany.	Actively prevents competition from market entry, as it covers any OOH activity in Germany. Secures superiority in partnerships.
EP 1262 371 B1	Publicity carrier for vehicle roof Protects carrier with basic frame for fixing on a roof of a vehicle (taxi in particular)	Grants freedom to operate for rooftop applications
DE 10 2017 213 283 A1	Digital publicity carrier for vehicle roof Protects same carrier in digital format.	Shields from international competition.
To be patented during the Living Lab	Modular digital publicity carrier for roof Protects the data collection via rooftop device	Will protect the developed innovation from international competition

Targeted Living Labs

- Athens ☐
- Hamburg x
- Koper ☐

Related general objectives (max ½ page A4)

TAXi-AD's mission is to form an independent network of mobile digital screen space equipped with sensors to realize the full potential of yet unmonitored mobility data.

Particularly, the city of Hamburg is calling for reliable data of energy demand and pollution patterns caused by road traffic as it's realizing its I.T.S. strategy.

Our company generates innovative business cases using yet unmonitored mobility data. Data is collected by gearing up taxi vehicles (including self- driving vehicles, bicycles, motorcycles, and trucks) with digital displays that comprise sensors. The sensors in the mobile advertising displays continuously record situational geo-targeting criteria (e.g. weather, traffic situation, location, time).

Additionally, repurposed data is acquired from a broad range of existing and accessible data bases such as governmentally provided services and data bases of IT companies and the automotive industry.

This allows us to build the basis for a traffic management system that will assist in creating speed- and acceleration profiles, analyzing traffic flow and building artificially intelligent (AI) traffic applications.

We regard the entire urban eco-system and its outdoor advertising possibilities as a living point of interest. This enables us act green, smart and fair.

Specific areas of interest (max ½ page A4)

TAXi-AD business cases align perfectly with the objectives of the 5G-LOGINNOV project in Hamburg. With TAXi-AD, it will have the opportunity to gather data for hire.

In the early stages of the project, call-a-cabs can assist to simulate a truck platoon (use case 8/9), gather demonstrative emission and traffic light data (use case 10) and place the nuts and bolts for management applications within the dynamic control loop for environment sensitive traffic (use case 11).[2]

A detailed manoeuvre analysis of drivers and vehicle's regarding energy behaviour will first provide insight in Hamburg's traffic behaviour but can easily be extended to other cities.

In its daily business, TAXi-AD is already providing the foundation for research relevant to the environment (ex. air/street quality), social structures (ex. age/biological gender/number of people) and other societal issues (ex. traffic/parking monitoring, real time/hyper targeted public information display) and to commercial causes.

The Living Lab in Hamburg offers the unique opportunity to test an industrial case exploiting all of the company's prior experience.

TAXi-AD is the ideal partner for the 5G-LOGINNOV Living Lab Hamburg. The project will reduce its testing costs massively, due to the high daily driving distance and on-demand availability of taxi cabs. TAXi-AD will profit from the increase in data-/taxi demand and exposure of the advertisement.

[2] 5G - LOGistics value chain INNOVation Authors: Ralf Willenbrock (T-System), Pavlos Basaras (ICCS), Janez Sterle (INTERNET INSTITUTE), Selini Hadjidimitriou (ICOOR), Eusebiu Catana (ERTICO-ITS Europe)

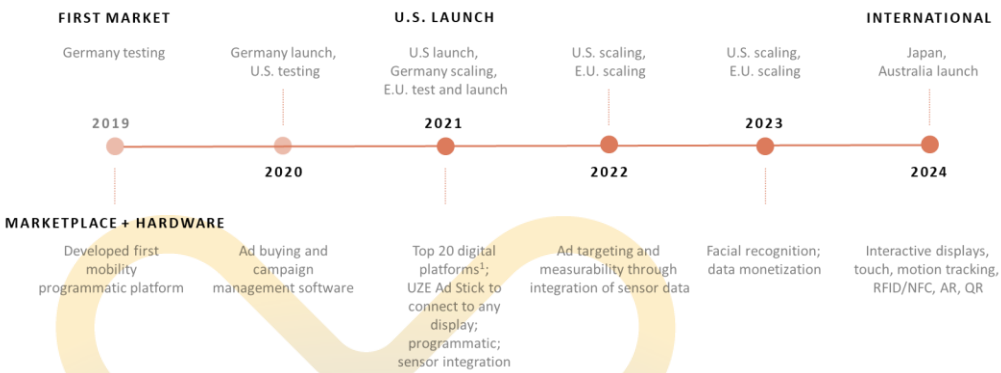
Ambitions and development plans

Traffic data is widely uncollected. The existing methods include static traffic cams and analogue counting. Conclusions are merely derived from facts such as use of fuel or driven km. Inner city traffic is optimized in a reactive manner. The problem needs to unfold before it can be fixed. The degrees of pollution, road quality, density of traffic, impact of construction sites, efficiency of parking spots, functionality of traffic flow and many other mobility factors are guesswork. Existing solutions concerning data collection lack the flexibility that TAXi-AD offers. Current methods are cost- and time intensive. Sensors are either permanently embedded in traffic lights, for instance, or require a service provider, which implies a scheduled appointment, additional personnel costs and planning.

TAXi-AD offers the solution:
By booking a dedicated driver for test trips along an agreed road segment, an agreed time and an **agreed driving style (eco, sporty, aggressive), the principle of scheduled floating car data collection** is applied and will help to save costs compared to equipping expensive vehicle fleets collecting data by cost-intensive engineering teams. For autonomous driving tests, engineers can instead be connected online and analyze vehicle data in real-time.

This will be the ideal method to tackle the challenges the Hamburg Living Lab is facing.[3]
The data will be gathered within precise time slots in a representative manner.

Every community has an interest in the traffic behaviour of its individuals. However, the means to measure said behaviour remain rudimental. Berlin, for example, conducted its most recent surveys in 2018 to estimate the percentages of different traffic participants (cyclist, pedestrians, motorized vehicles) in the inner-city environment. The TAXi-AD fleet can collect the masses of required data to map out traffic participants, parking structures, environmental circumstances such as air pollution, street quality, space efficiency and many more in real time and over unlimited time periods. Once the algorithms are trained, the TAXi-AD fleet will allow to collect highly precise data to meet the needs of researchers who, for example, take gender or other social structures into account. Possible use cases include parking-, weather-, emission-, noise- and visibility monitoring. Furthermore, warning systems in case of objects on the road, aquaplaning/snow, traffic jams, blocked emergency lane and many more are feasible. With further support of our strong partners such as T-systems and Continental, TAXi-AD will contribute significantly to the achievement of this goal. TAXi-AD's plans to expand in Europe in 2022 and the following years fall into place with the ambitions of the 5G-LOGINNOV Living Lab to create an European environmentally sensitive road management by 2024.



[3] https://5g-5G-LOGINNOV.eu/wp-content/uploads/2021/06/Willenbrock_TSYS1.pdf

Provide a draft structured business plan

Problem

Clean air policy is a crucial pillar of Hamburg's I.T.S. strategy. Reliable data on energy demand and pollution patterns caused by road traffic is vital. Nevertheless, traditional traffic data does not cover the Hamburg road network and the influence of traffic management systems sufficiently. The current data coverage fails to provide the groundwork for traffic flow analysis in form of speed and acceleration profiles for Autonomous and Connected Driving in Hamburg's test field (TAVF).

Our solution

As a partner, TAXi-AD could provide a solution to this issue. Taxi fleets equipped with sensors could be hired for platooning and autonomous driving tests. The vehicles would be able to provide data on the energy behaviour by providing a detailed manouvre analysis in bookable time-windows. This would serve the 5G-LOGINNOV testing scenarios or traffic managment control tests executed by traffic authorities in particular.
The 5G-LOGINNOV Project site in Hamburg will demonstrate an easily transferrable use case for other cities.

Target market

Air pollution problems caused by road traffic pose a major issue in European cities. As digital taxi advertisement based on GPS positioning and point of interests (POIs), Taxis can play a crucial role in collecting data from relevant road networks without any expensive upgrade of stationary traffic detectors such as loops, video cameras or others. Taxis can be booked easily 24/7 to collect relevant data for control tests (traffic management) or product design tests (OEMs, suppliers, 3rd parties). In Hamburg, this is linked to the test field for autonomous and connected driving. For North-Rhine-Westphalia, cities will be contacted to use taxi-data for supporting Clean-Air-policies and sustainable traffic management.

The competition

Since the early 1990ies, the principle of using Taxi-GPS data for traffic management or I.T.S. service deployment is well-known and was applied world-wide during large-scale events or for dynamic navigation based on RDS-TMC. Traffic authorities regularly see the non-representativeness of taxi routes and driving styles as objectionable. The booking of Taxis for data collection exclusively solves this issue. Additionally, the TAXi-AD fleet is already equipped with GPS sensors and therefor location data can be used without additional costs.

Revenue streams

Revenue is generated by charging traffic and environment authorities or OEMs, suppliers, or 3rd party users of the test field for autonomous and connected driving (TAVF) booking TAXi-AD fleets per hour and access to the GPS data portal. The 5G-LOGINNOV cloud-based solution and described use cases will host the planned TAXi-AD service and enable product designers to use the Hamburg TAVF easily for their product development and deployment. Recently, OEMs such as Volkswagen, Daimler and others announced their plans for Autonomous Driving product launch followed by T-Systems, Continental, Apple, Google and Huawei. All of them need extensive test periods in complex urban driving conditions to guarantee safety and reliability.

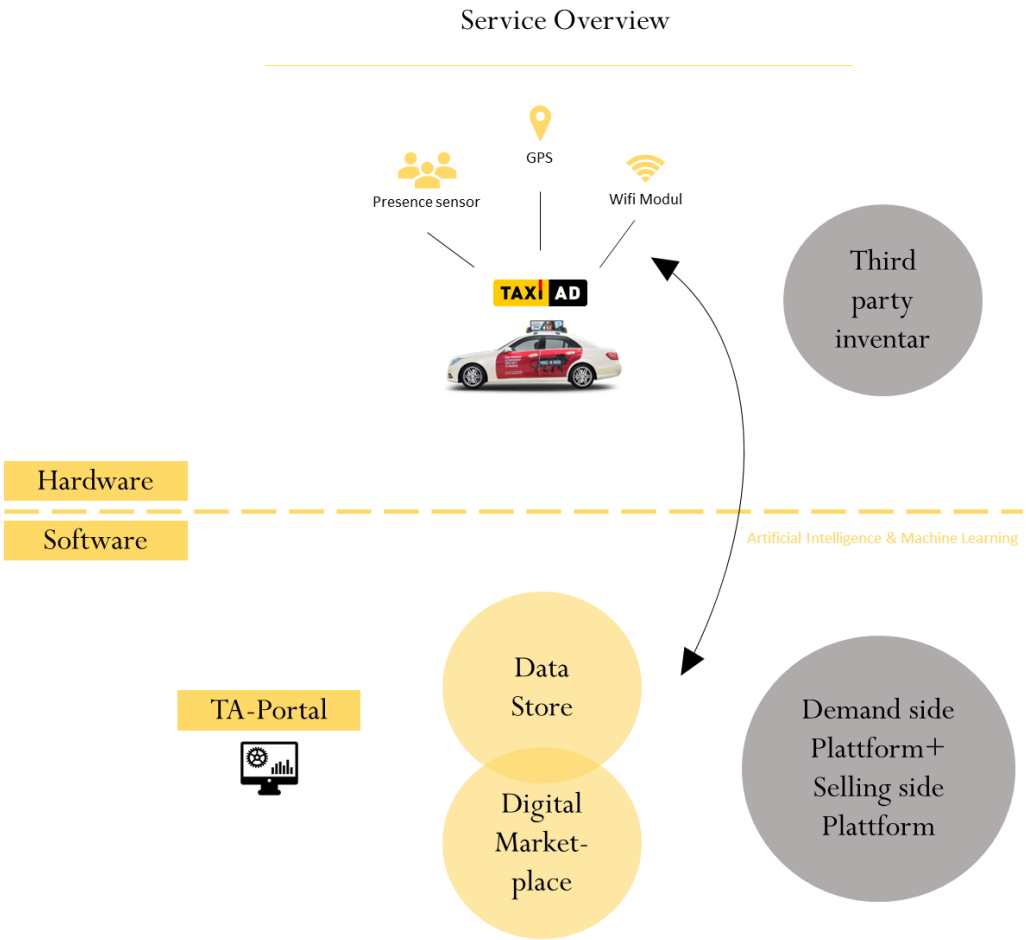
Team and key role

TAXi-AD, a team consisting of roughly thirty employees is steered by Falk Röbbelen and Ralf Johansson. The board has proven leadership skills and impeccable work ethic throughout 10 years of successful work in the advertisement and data industry. Most recently, TAXi-AD partnered up with the high tech start up uze! Mobility GmbH to exploit the full potential of their respective digital traffic data solutions.

Technical description

TAXi-AD is offering a lucrative combination of a data collection services and advertisment opportunities.

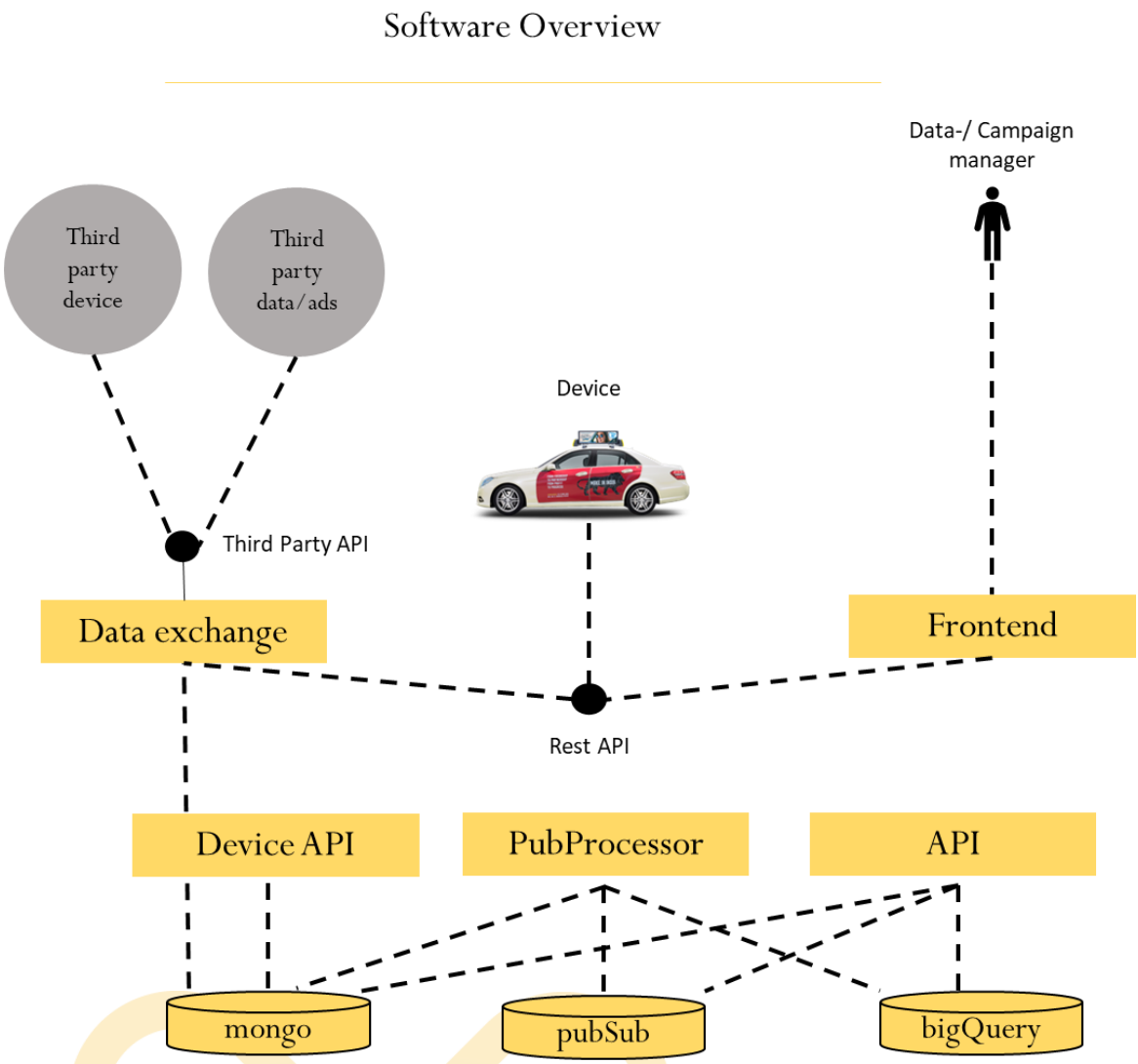
The taxi-top advertisment devices roam inner city sreets displaying hyper targeted customer's content based on the collected surrounding data.The sensors collect location data via gps, detect the presence via presence sensors and identify devices in their proximity via wifi modules.
Additionally, TAXi-AD purchases third party data to add to the gathered information.
The supplementary information includes meteorological, demographic and sociographic data.



The entire acquired data will be integrated in the data store and digital marketplace.
The data store will provide chronological, filterable information gathered by all devices.

The marketplace already offers a real-time bidding process for advertisers. Together they will allow **small business competitors to come together without compromising or negotiating**. Any owner of any screen in and close to traffic will be able to join the marketplace and data base.

The marketplace and data base will not only allow SMEs to compete with market giants such as JCDecaux and Ströer. It will **offer a cardinal advantage** by opening up **accurate targeting and analyzing** methods to the **DOOH market**.



The 5G-LOGINNOV Living Lab could profit from the accuracy and flexibility of TAXi-AD solutions.
The data collected by designated devices could be tailored to the Living Labs needs.
Drivers could be instructed to follow a predetermined driving pattern, to assure the collection of representative data.
Data-on-demand in form of one or more call-a-cabs could also facilitate the simulation of autonomous driving use cases.
The taxis will provide high quality data which will allow to form countless use cases for the Living Lab Hamburg once it is refined.
The data will cover traffic management in the city of Hamburg in general as well as smaller, less frequented roads and even access roads to for example construction sites. Data on the latter is typically. derived from basic parameters and thus less conclusive.

Finally, the 5G-LOGINNOV Living Lab could profit from the access to all of TAXi-AD's data in the city of Hamburg. Due to the milage and representative routes of taxi cabs, TAXi-AD data complements the 5G-LOGINNOV use cases optimally.
Particularly data intensive use cases, such as truck platoons will profit from the additional data sets for on-site and online simulations.

The Living Lab in Hamburg will lay the contentual groundwork for more complex data related follow-up projects and the methodology and results will be applicable to other inner city traffic analysis projects. Furthermore, it will build the basis for the deployment of future 5G technologies.

Operating description

Key Performance indicators

Time	Technological		Practical		Economical	
	Current	KPI	Current	KPI	Current	KPI
01.03.21-01.10.21	50 Taxi in Hamburg		Data collection along ordinary taxi route		Price/ playout	Reduce the cost of advertisements by scaling the fleet and adding industrial use cases
01.10.21-01.12.21		55 Taxi in Hamburg		Industrial service available		Reduced Price/Playout
01.11.21-01.09.23	Provide on-demand data to Living Lab					

Marketing activities

1. I.T.S. Congress October 2021: Presentation of TAXi-AD's 5G-LOGINNOV solution design to Hamburg's traffic authorities, world-wide traffic ministries, OEMs, suppliers, and 3rd parties (UBER, SHOW, HEAT, etc.)
2. Joint Marketing activities with Deutsche Telekom Group partner of the European wide Taxi-association and their web- and APP-portal www.taxi.eu
3. Implementation of 5G-LOGINNOV Hamburg Use Case UC8/9 into the TAXi-AD dispatching software, presentation to Taxi-EU for marketing upscale (2022)
4. Joint marketing with ERTICO/T-Systems as part of the SHOW marketing activities towards innovative service deployment and Automated Driving in Public Transport

Joint marketing with ERTICO/T-Systems as part of the 5G-LOGINNOV and TAVF-Hamburg marketing activities for Sustainable Traffic Management and Green Deal projects

Planned support activities;

TAXi-AD will ensure the secure and complete transmission of the desired data.

Other on-stie activities:

TAXi-AD will conduct two on-site tests to define the conditions of the 5G-LOGINNOV Living Lab and test the telecommunication requirements.

Data sharing policy

This project aims to provide on demand data taxis for the use of the 5G-LOGINNOV Living Lab in Hamburg. It does not require a data sharing policy.

However, the work packages include the creation of a business model tailored to the needs of the Living Lab for further data exchange.

Project structure

The TAXi-AD project is structured according to the general work plan of the 5G-LOGINNOV project. [4]

It is set out to provide data for simulation from the earliest stages of the Living Lab until its end. This way, the Hamburg-Use cases (Nr. 8/9 - FTED ; Nr.10 - GLOSA ; Nr.11 – DCET) can be prepared and simulated in december 21 as per general plan. Even the most elaborate and futurist use cases (FTED & DCET) can be tested prior to their deployment.

The TAXi-Ad Data will cover all of the objectives listed in the general plan. In particular, objective 5 : Boost ports & logistics hubs operation & maintenance innovation with involvement of new market actors including SMEs and Start-ups.

TAXI AD DATA							
by Taxi Ad							
Task Name	Start Date	End Date	October21	November21	December21	January 22	Jan 22 - Sept.23
1. Concept, architecture	01.10.21- 01.11.21						
2. Choice of Components, Integration, Konfiguration	01.10.21- 01.11.21						
3. Installation of five Systems	01.11.21- 01.12.21						
4. On field test five Systems	01.11.21- 01.12.21						
5. Evaluation and next steps	01.11.21- 01.12.22						
6. Business model for collected data	01.01.22						
7. Provide Call-a-data-cab service	- 01.09.23						

[4] The 5G-5G-LOGINNOV Project General Presentation (Slide 17)

Work package number 1	
Work package title	Concept, architecture of the entire system

WP description:

1) Creation of at least three different compositions
2) Plan transmission of large body of data
3) Choice of the software technology to be used

Description of tasks:

1) Think through different relevant surroundings, plan differnt possibilities of hardware combinations
2) Identify required gigabyts/terrabyts, assess fluput, evaluate means to scale
3) Try different softwares, filter quality, go through initial tests,
   combination of hard and software to be tested,
   maintenance of software to be tested, comparison of popularity/ universal use

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Detailed concept	1
1.2.	Plan design	1

Work package number 2	
Work package title	Choice of Components, Integration, Konfiguration

WP description:

1) Comparison and testing hardware and sofrware
2) Adapt algorithm and cloud architecture
3) Standartize data

Description of tasks:

1) Describe Mathematical model
2) Simulation of different approaches

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Mathematical model	1
1.1.	Protocol of Simulations	1

Work package number 3	
Work package title	Installation of five Systems

WP description:

1) Equip systems with sensors
2) Roll out software on IoT clients
3) Data management service goes live
4) Roll out of Algorithm

Description of tasks:

1) Mount Hardware on vehicle
2) Choose virtual, centralized, highly scalable data processing infrastructure

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Five Operational systems	2
1.2.	Data processing infrastructure set up	2

Work package number 4	
Work package title	On field test five Systems

WP description:

1) Sample data, anomality detection

Description of tasks:

1) Protocoll realization

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Excel protocol on sample data and anomality detection	2

Work package number 5	
Work package title	Evaluation and next steps

WP description:

1) Monitor stability of IoT client
2) Test accuracy of collected data
3) Monitor performance of cloud infrastructure

Description of tasks:

1) Data rates to be monitored, expectation (simulation) vs. realization, temperature monitoring

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Evaluation Paper	2

Work package number 6	
Work package title	Business model for collected data

WP description:

1) Evaluate provisory pricing and margin

Description of tasks:

2) Create an adapted model contract

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	Sales model for collected data	3

Work package number 7	
Work package title	Provide Call-a-data-cab service

Description of tasks:

3) Provide the created service until the end of the Living Lab Project

Number	Deliverable name	Delivery date (in months from the project start)
1.1.	On- demand service	3 - 36

Resource/budget allocation

Expenses

- Project activities to analyze implementation requirements for booking and dispatching software (2021-Q4)
- Training and selection process for taxi-drivers: they have to be capable to use required driving styles (eco, sporty, aggressive) and collect data according to the principle of scheduled floating cars (2021-Q4)
- Project implementation according to requirement phase (2022-Q1)
- Marketing costs

Total: 50.000€ + additional expenses for TAXi-AD marketing campaigns

Milestones

1. Winning award as project partner (2021-Q4)
2. Presentation of 5G-Taxi-GPS project during the Hamburg world congress(2021-Q4)
3. Selection and installation of 5G-LOGGINOV Telematics On-Board units in selected TAXi-AD fleet (2022-Q1)
4. Execution of 5G-LOGGINOV Platooning tests on Test Field TAVF and GPS-data analysis (2022-Q2)
5. Regular taxi-fleet data collection during 5G-LOGGINOV trial period

	Person-Days (incl. Travel) /Equipment	**Sum**
WP 1	3 PD	3.750€
WP 2	8 PD + 5 Systems à 5.000€	10.000€ + 25.000€ Hardware
WP 3	5 PD	6.250€
WP 4	2 PD	2.500€
WP 5	1 PD	1.250€
WP 6	1 PD	1.250€
WP 7	On demand	According to agreed business model
Total :	**50.000€**	

5GLOGINNOV

Annex VII

Application Form: ITGS Intelligent Traffic Guidance System (Roads.AI)

5GLOGINNOV

Open Call for Innovative Start-ups

Application Form

www.5g-loginnov.eu

This project has received funding from the
European Union's Horizon 2020 research and innovation programme
under grant agreement No. 957400

Work Package	WP4 - Marketplace and new actors
Task	T4.2 - Emergence of new actors
Authors	Frank Daems (ERTICO), Marco Gorini (CIRCLE)
Dissemination Level	Public
Status	Final
Due date	23/4/2021
Document Date	22/4/2021
Version Number	1.1

Legal Disclaimer

5G-LOGINNOV is funded by the European Commission, Horizon 2020 research and innovation programme under grant agreement No. 957400 (Innovation Action). The information and views set out in this deliverable are those of the author(s) and do not necessarily reflect the official opinion of the European Union. The information in this document is provided “as is”, and no guarantee or warranty is given that the information is fit for any specific purpose. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein. The 5G-LOGINNOV Consortium members shall have no liability for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law.

TABLE OF CONTENTS

List of abbreviations and acronyms

Abbreviation	Meaning
4G/5G	4th/5th Generation (of cellular networks)
CAdES	CMS (Cryptographic Message Syntax) Advanced Electronic Signatures
ICT	Information and Communication Technology
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LL	Living Lab
PAdES	PDF Advanced Electronic Signatures
PERT	Project Evaluation and Review Technique
SME	Small-Medium Enterprise
WBS	Work Breakdown Structure
WP	Work Package

GENERAL INFORMATION

This original tender is issued by ICOOR, with its third-party University of Modena and Reggio Emilia (UNIMORE), with registered office in Modena (Italy), via Accademia 4, as a representative for the 5G-LOGINNOV project partnership, and as the legal contracting company for the services.

This document is a proposed template for innovators to answer the tender with their proposal. Applicants are advised to follow the template outline.

Submission of Applications

The compiled Application Form shall be **converted to PDF format** and **electronically signed by the legal representative of the SME**, using any format having legal value (e.g. **CAdES, PAdES**). The signed document (P7M or PDF format, respectively) must be **attached to an e-mail** sent to the application mailbox *opencall_applications@outlook.com* **between 26-April-2021 and 30-Jun-2021 (05:00:00 PM CEST)**.

The application mailbox will be deactivated on 30-Jun-2021 at 05:00:00 PM CEST, and thus all applications received after this time will be automatically discarded; **applicants are strongly recommended to submit their applications with a reasonable advance over the deadline**, in order to ensure they are successfully delivered in time, even in case of technical or connectivity problems.

5G-LOGINNOV will send a confirmation receipt to the e-mail address submitting the application, notifying that it has been taken in charge by the system; such confirmation does not certify that the application is complete and suitable for evaluation, but simply that the e-mail was received in time.

Further Information for the Applicants

Applicants are invited to **visit the 5G-LOGINNOV Open Call page regularly** (*https://5g-loginnov.eu/open-call/*), in order to get latest news and to consult Frequently Asked Questions (FAQs) about the call.

In case of specific queries on the call, **applicants may write an e-mail** to *openCall_helpdesk@outlook.com* with subject "support" **to get help from the 5G-LOGINNOV Applicant Helpdesk team**; the helpdesk will remain active from the beginning (26-April-2021) to 10 days before the closure (20-Jun-2021) of the submission period.

APPLICATION

***Remark** :*

Right click on the text boxes to insert your input

Double click on the checkboxes and if needed make them checked via the properties box

Identification

Proposal:

- Acronym of the proposal (optional):Intelligent Traffic Guidance System (ITGS)
- Full title of the proposal (optional):

Organisation:

- Name of the organisation: Roads.AI
- VAT registration: 515593200
- Website: www.roadsai.co
- Legal address: 1 Hasharon st., Even-Yehuda, Israel

Contact:

- Prefix: Mr.
- Name: Roni Dulberg
- Position in the organisation :CEO
- Email: ronidulberg@gmail.com
- Mobile: 972-54-5611202

Eligibility as an organisation

I declare, I represent this SME, according to the eligibility criteria mentioned in the tender conditions: (please tick the box)

- Headcount in Annual Work Unit (AWU) less than 250. ☒
- Annual turnover less or equal to €50 million or annual balance sheet total, less or equal to €43 million. ☒
- This SME is completely independent from project partners, their affiliated entities and/or their controlled companies. Institutions, organizations or other kind of legal entities **funded by or otherwise affiliated with a 5G-LOGINNOV partner are not eligible**. ☒
- This SME recognises the mandatory presence at the 5G-LOGINNOV start-up event at the ITS World Congress Hamburg[1]. The related costs (target € 1500 and additional entrée fees for the applicant's staff) should be included in the applicant's offering. ☒
- This SME give consent to all 5G-LOGINNOV project partners to use freely all information provided for the purpose of realising the deliverables of the 5G-LOGINNOV project. ☒

[1] https://itsworldcongress.com

Contractual terms

Please tick your compliance to the services that you will provide:

1. The design and development of proposed ICT solution. ☒
2. The provision of all paper/media documentation needed for its on-field operation. ☒
3. The deployment and validation of proposed ICT solution in the physical context and infrastructure of (at least) one of the three Living Labs of the project. ☒
4. On-site support to the deployment, installation and validation of the solution. ☒
5. The **free-of-charge usage of its ICT solution by any project partner/appointed stakeholder** involved in the execution of selected Living Lab(s) for the entire duration of the project. ☒
6. To **participate to project dissemination activities**. ☒
7. Any other support to project management activities (including demonstration and/or provision of additional information to the European Commission and/or INEA Officers), as requested by the Project Coordinator through ICOOR. ☒

Background IPR

Please list all applicable Background IPR, relevant to your proposal **(max 1 page A4)**

Vehicles (both human and automated drivers) have a need to build traffic perception but no matter how many (various) sensors you install on the vehicle – It's traffic perception will always be limited because it's point of view is limited by definition. Roads.AI develops a local intelligent Traffic Guidance System (ITGS) to be deployed at congestion hot-spots, bottlenecks and merging lanes. The ITGS generates common traffic perception as an external observer (i.e. without the need for collaboration from the vehicles in obtaining information about their trajectory, speed or geo-location), which provides opportunities for novel traffic management schemes as well as to be soil the deployment of automated driving systems.

The ITGS is a beyond state of the art active traffic management solution designed, among other use cases, to generate and allow for cooperative driving manoeuvring. It is composed of a hardware and software roadside unit (RSU) that contains traffic camera (and other sensor data, if existing), controller and a communication module. The ITGS monitors a pre-defined segment of the road network. The ITGS is the equivalent to a traffic officer that monitors a section of the road and guides passing vehicles in order to generate the needed cooperation between vehicles in order to improve the road network efficiency or execute any other policies (such as to prioritize specific road users).

The ITGS uses AI tools to build situational awareness, predict the unfolding situation on the road, and generate optimal driving decision for specific vehicles. The last step in the local process is the transmission of the relevant driving guidance to the relevant vehicles. Optimization of the driving decisions is done off-line, on a regional/central server, while the recognition of pre-congestion situations and transmission of the selective advisories is done locally at the edge - in the ITGS, on-line.

Several ITGS can be deployed in neighbouring interchanges to formulate an Intelligent Corridor Traffic Management network.

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Targeted Living Labs

- Athens ☐
- Hamburg ☒
- Koper ☐

Related general objectives (max ½ page A4)

Demonstrate and validate the ITGS in its operational environment – the ITGS has been tested in the lab until now (using computational simulations) and it reached the stage of testing outside the lab.

Test the efficacy of ITGS in reducing CO_2 emission and improving traffic flow by transmitting optimal driving advisories to selected vehicles on the network over 5G cellular network and regulate the resulting freight traffic on the future 5G logistics corridor in EU, including CAM truck platooning management.

Introduce a novel business model Traffic Management as a Service (TMaaS)

Evaluate the potential of the ITGS as an infrastructure support scalable solution for the deployment of cooperative, connected and automated driving systems – the ITGS capabilities to generate context awareness (in addition to situational awareness) can assist autonomous driving systems in mixed traffic environment.

Specific areas of interest (max ½ page A4)

As we are introducing a new intelligent element into the driving ecosystem specific areas of interest are to explore and to get feedback from the 5GLoginnov consortium members about our vision of the business model - a marketplace for cooperative driving decisions. While the ITGS is a software based product to be sold as a service (SaaS) to road owners, for human drivers – it is a free service and the advisories can be integrated into any personal navigation device. Roads.AI vision is of a platform where driving decisions are the base for economic and commercial trade between various stakeholders. A toll road operator can for example incentivize drivers to comply to flow optimization messages by giving a discount on the driver monthly bills. Truck fleet operators can incentivized their drivers for compliance in order to reduce their CO_2.

For automated driving systems – The ITGS provides intelligent guidance as a service. By actively guiding the AV, the ITGS takes part in the driving process (for example to create a better user experience for the passenger in the automated vehicle) and by doing so, It allows for deep disruption and redistribution of the different driving responsibilities, in the right direction. We believe the infrastructure should be generating optimal driving decisions and guiding vehicles through inherently complex situations. In case of conflict between the guidance and self-awareness of the automated vehicle – the automated driving system will of course, have the right to bypass the ITGS instructions

Ambitions and development plans

Describe your exploitation plans: (max 1 page A4)

The market of active traffic management is rapidly growing and is expected to be $60Bn by 2024. In order to enter this market, it is necessary for Roads.AI to demonstrate the benefits of the ITGS out side the lab. Therefore we consider the 5GLOGINNOV LL as an important test case to demonstrate the advantages of the ITGS, this will enable roads.AI to approach future clients and to build a solid client base.

The first and natural step will be expending the ITGS deployment further from the port of Hamburg to the strategic road network around the city of Hamburg, the EU 5G cross-border corridors for connected and automated mobility and the European Green-Deal.

In a broader perspective, the outcomes of this project will help us to:

- Distribute and establish the TMaaS as the future business model – "The market for Active Traffic Management (ATM) software is a relatively new business area… For a real ATM breakthrough, defined as: ATM-applications used by the majority of road authorities, ATM in SaaS-form will be a big step forward (and probably necessary)". Ottenhof et. al, “Active Traffic Management (ATM) as an online service”, 19th World Congress on Intelligent Transportation Systems At: Vienna, Austria

- Establish the ITGS as an enabler for automated mobility – despite the rapid advancements in the development of automated systems, some of the core challenges have not been addressed, namely the distribution of liability. Recent works demonstrated the importance of the infrastructure in building context awareness and its important role in the deployment of future automated systems. Gopalswamy and Rathinam, “Infrastructure Enabled Autonomy: A Distributed Intelligence Architecture for Autonomous Vehicles”, 2018 IEEE Intelligent Vehicles Symposium

It is Roads.AI ambition to develop the ITGS as a camera agnostic product so every infrastructure owner can deploy the ITGS with any traffic camera they care to use

Provide a draft structured business plan (max 1 page A4)

The ITGS is a category-defining product as it creates the foundation of a two-sided platform.

On one side of the platform, Roads.AI customers are Infrastructure owners, Cities and road authorities (B2B2G) – looking to improve the road network performance by providing I2V selective and cooperative driving advisories.

On the other side of the platform, our customers are human drivers, truck fleet operators and in the future – automated driving systems fleet operators.

It is important to emphasis that the idea is for voluntary compliance and that human drivers will be users of the platform but they will not pay in order to receive the flow optimization messages. However, a city can incentivize their residents for complying to flow optimization messages and contributing to the greater good.

Just as airline companies need and pay for guidance their planes receive from control towers, so will automated driving system fleet operators pay for the services provided by ITGS, and especially for carrying part of the burden and taking part of the responsibility for the driving decision process. For example, a commercial commitment from Rods.AI to a minimal number of Transition of Control requests while the vehicle is being guided in an automated lane by ITGS).

We are of the opinion that the proposed engineering approach and the introduction of a new intelligent element in the ecosystem, will in fact enable AV to integrate into traffic on highways and strategic traffic corridors in a safe manner and one that will create real value for the entire economy.

Technical description

(max 4 pages A4)

Aims and operating principles (preferably through sequence diagrams, flow charts or similar).

Aims:

The aim of ITGS is to improve traffic flow by transmitting optimal driving advisory to selected vehicles on the network.

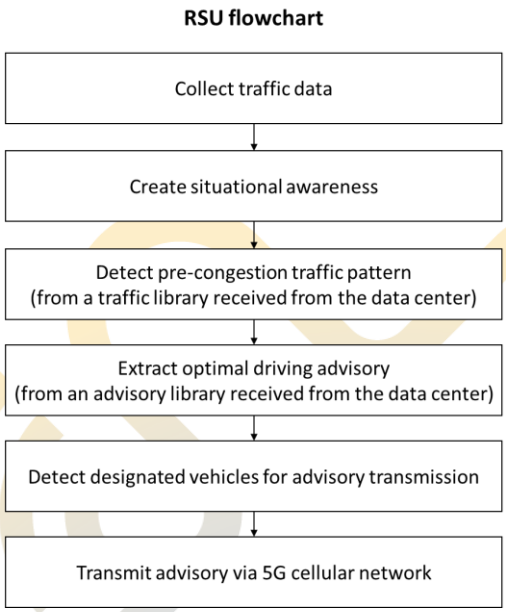
Operating principles:

Optimal driving decisions – are driving decisions that consider the road network needs and not only the ego-vehicle's self interests.

The ITGS acquires traffic data from various sources, builds situational and context awareness, generates optimal driving decisions and transmit it to selective vehicles. The system learns the unique traffic properties of a road segment and detects traffic patters that are typical for the development of road congestion / event.

Since calculating the optimal driving decision from the ego-vehicle point of view in real-time requires immense resources, and therefore practically impossible, Roads.AI is taking a unique approach to solve this challenge by distributing the computational tasks between the RSUs and an external data center:

RSU – Real-time data processing is carried out in in RSU, which constantly monitors the traffic situation in the road segment, detects traffic patterns that will most likely lead to a congestion event (from a pre-existing library), selects the optimal driving advisory that fits the specific traffic situation (from an advisory library), designation of specific vehicles on the network that will receive the advisory and transmission of the advisory to the specific drivers via 5G cellular network.



Data center – carrying out off-line heavy calculation, where the main outputs are the two libraries that are used by the RSU. Traffic data from the road segment is analysed to detect typical traffic patterns that commonly lead to congestion events.

The detecting typical traffic patterns that usually lead to a congestion events and optimal driving advisory that will reduce the impact of such events by changing the driving behavior of trucks on the network to prevent the event or reducing its impact.

Data centre – traffic calculations are carried out off-line. Traffic data from the road segment is analysed in this data.

The core of the ITGS is a new traffic mathematical model that fits to the unique needs of the system. This model combines element from the leading traffic models published in the literature as well as elements that are part of Roads.AI IP.

Distinctive features, advances over the state-of-the-art.

Current ICT solutions, such as variable speed limits and ramp meters, are at the macro level, i.e. rely on aggregated statistical data and as such are limited with their management schemes to provide managements on the macro level and not able to generate cooperative driving manoeuvres.

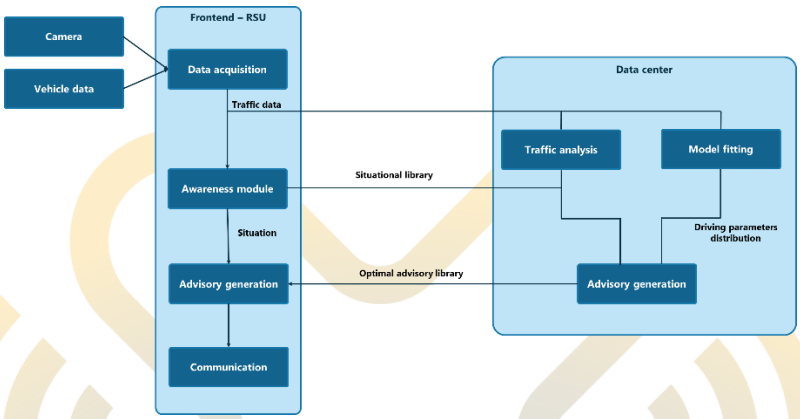
Specifically:

- VSL systems show significant impact on traffic flow under severe weather and environmental conditions. However, their efficacy under normal conditions is debatable and given their cost there is an ongoing debate on their effectiveness

- RM are both costly systems and require extended topographical needs. Due to the latter there are many sites where it is impossible to install such systems. These system control only the merging vehicles with a basic stop-go commands with no influence on the vehicles on the main road.

ITGS is designed on micro level, providing a more accurate solution. 5G network provide direct advisories to selected vehicles and therefore enabling more accurate solutions. As such these systems are not for specific merging vehicles and therefore can control vehicles on the main road.

High-level functional architecture.



The ITGS consists of two main components:

RSU –

- Data acquisition – Traffic data will be acquired from cameras (image processing and visual analytics will take place within the traffic camera. No images (or raw data) will be transferred to the ITGS). The various data will by combined and delivered to the awareness module. Additionally, traffic data will be sent to the data center for learning and improving the traffic control libraries (situational library and optimal advisory library).

- Situational module – pattern recognition of traffic configurations and detection potential road event from the pre-congestion pattern library.

- Advisory generation – Selection of optimal advisory from the Optimal Driving Advisory Library and identification of the designation of vehicles for the advisory

- Distribution- transmission of the advisory to the selected vehicles via 5G network

Data center – Off-line traffic analysis is carried out in the data center, using advanced machine learning and artificial intelligent methods. The outcome consist of the data center is two libraries: pre-congestion pattern library and optimal driving advisory library.

The core of the data center is an agent based traffic model that was developed to fit the needs of the ITGS. This model consists of components from leading traffic models published in the literature and code components developed by roads.ai. The code is specifically designed to minimize the amount of driving parameters while maintaining a reliable simulation of the road segment for the duration up to 2 minutes for a predictive analysis.

Interfaces/connectors with other ICT systems/platforms.

The ITGS is a stand-alone system and therefore does not require to be connected to existing traffic management systems. The necessary interface for the ITGS to work is with the 5G cellular network that is installed in the port, to transmit the driving advisories to the vehicles on the network.

In future the ITGS will be able to interface with other ICT systems to receive traffic data and to update these systems with traffic conditions.

Deployment architecture (how the solution will be integrated with existing ICT/operational infrastructure of the Living Labs: hardware, software, libraries, field devices, etc.)

Since the ITGS is an novel concept of a stand-alone system it does not require a complex deployment architecture.

Stage 1 – system installation – camera calibration, traffic data acquisition for learning

Stage 2 – connection of the system to the 5G network that is deployed in the port

Stage 3 – installation of designated apps on trucks / specific devices that, for example and for the testing, can be handed to the drivers at the entrance to the port

Preliminary layout of the Human-Machine Interface (HMI), if any (preferably including pictures, screenshots, sketches, etc.).

Interface with drivers will be via a designated app with clear and simple graphic and audio guidance to the vehicles. Preliminary sketches below

Operating description

(max 3 pages A4)

Expected benefits and measurable Key Performance Indicators.

Expected benefits:

ITGS improves traffic flow by transmitting optimal advisories to selected vehicles. The main impact of the system will be shown in merging points and bottlenecks sites, which are known to be congestion hotspots. Since there are multiple merging sites and non-signalized intersections in ports improving traffic in these locations will have high impact on CO2 emission. Additional impact is improving the flow due to local and temporal traffic congestion events, also known as ghost congestions.

KPI:

Measurement of speed variance - an indicator for CO2 emission reduction, preventable deceleration-acceleration events are major contributors to CO2 emission.

Traffic flux – an indicator for streamlining driving on the selected sites.

Possible data sharing policies.

Except for the core propriety (mainly the traffic model, software and optimization algorithms) Roads.AI will share acquired data and results from simulations and from tests obtained in the LL.

Personal data – The ITGS does not require, use or keep any personal data.

Planned support activities (remote and on-site).

Selecting the sites for deployment.

Integrating with the 5G network.

Designing the drivers UI

Other on-site activities (e.g. installation, test, etc.) and needs (e.g. access to Living Lab area, involvement of Living Lab personnel, etc.).

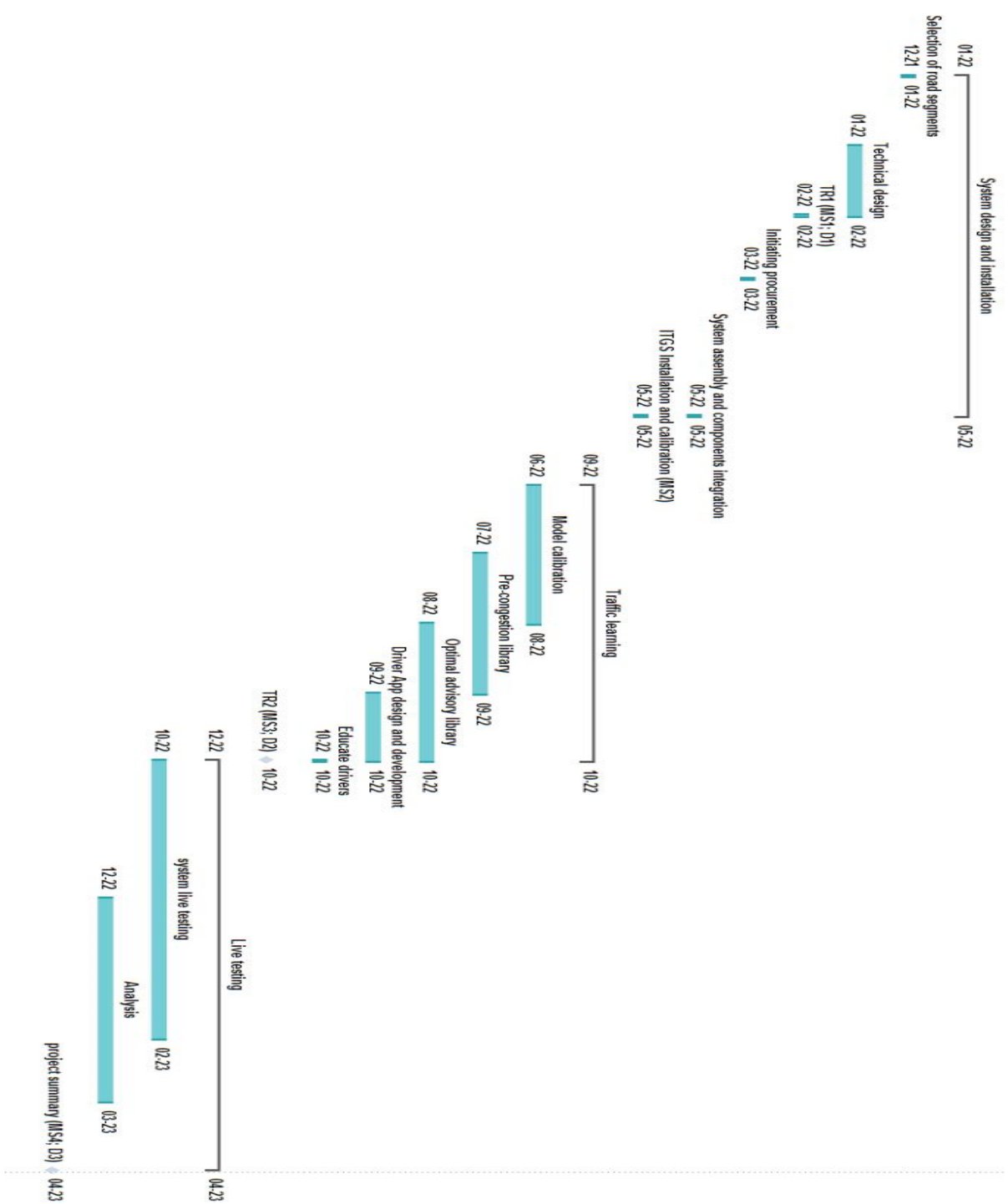
We will need access for the deployment and installation of the ITGS in the LL

Project structure

The applicant shall provide the Work Breakdown Structure (WBS) of the project describing Work Packages and Tasks (preferably including graphical representations such as Gantt charts, PERT charts, etc.) and related Deliverables and Milestones (including types, contents, due dates). The overall timing of the project must comply with the execution of 5G-LOGINNOV Living Labs, i.e. the ICT solution must be deployed, tested and fully validated on selected Living Lab(s) by 30-Apr-2023.

(max 4 pages A4)

- System design and installation
    - Selection of road segments to be tested – together with the port of Hamburg we will search for potential locations that will provide the maximal benefit
    - System technical design – the number of camera and their location will be determined based on existing infrastructure at the selected locations, communication requirements, regulatory demands etc.
    - Installation of traffic cameras and RSU's, connection to existing traffic management system, design the needed connection to 5G network system
    - UI design the development of the advisory application
    - Modification of the traffic model to the topography of the selected sites
- Traffic learning – data collection for
    - Model calibration to the traffic in the selected sites
    - Buildup of pre-congestion library
    - Test and optimization of driving advisory
    - Educate drivers
- Test
    - Distribution of advisory devices/apps
    - System run
- Analysis



Resource/budget allocation

The applicant shall indicate the estimated allocation of resources (person-months) and costs per Work Package, specifying a budgetary breakdown per cost item (staff, purchase of equipment, travel and subsistence). The total costs allocated for the application must be below the ceiling of € 50.000, VAT included; the cost reduction towards the ceiling of € 50.000 will not be considered as a preferential criterion for the evaluation of the application.

(max 3 pages A4)

We calculate our costs based on:

Cost of engineering hour - 50€

Cost of one day on site - 800€ (traveling and subsistence included)

Participating in Hamburg ITS WC (2 personal)	3,000€
System design and installation	
Selection of road segments (2 staff members, 2 days on site)	3,200€
Technical design (110 engineering hours)	5,500€
TR1 (MS1; D1)	-
Initiating procurement (cameras, dedicated computers and additional hardware)	20,000€
System assembly and components integration (subcontractor)	3,000€
ITGS Installation and calibration - on site (MS2) (1 technician on site - 4 days)	3,200€
Traffic learning	
Model calibration (60 engineering hours)	3,000€
Pre-congestion library (40 engineering hours)	2,000€
Optimal advisory library (40 engineering hours)	2,000€
Driver App design and development (subcontractor)	1,700€
Educate drivers (1 technician 3 days on site)	2,400€
TR2 (MS3; D2)	-
System live testing	-
Analysis	-
project summary (MS4; D3)	-