AI for real-world network operation

WP5 – Dissemination, communication, and exploitation of results

D5.2 – Exploitation plan and strategy phase 1

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DISCLAIMER

SUMMARY

The present document presents the exploitation plan and strategy (phase 1) of the AI4REALNET project, developed in the framework of Task 5.4 – "Exploitation strategy and plan", led by INESC TEC, as part of Work Package 5 – "Dissemination, Communication, and Exploitation".

This document presents a preliminary exploitation plan encompassing several important components. First, it provides a detailed characterization of the Key Exploitable Results (KERs), elucidates their significance, and explores potential avenues for exploitation. The KERs summary is:

KER	Partners Involved	Type	Licensing	TRL (Initial → Final)
Conceptual AI framework for decision-making in critical infrastructures	All partners	Concept	Copyright Creative commons	n.a.
AI building blocks: knowledge-assisted, hierarchical, and distributed	UvA, POLIMI, ZHAW, ENLITEAI	Software	EUPL	2 → 4
Software XAI/HMI functions for transparent, safe, and trustworthy AI	TUD, POLIMI, ZHAW, Fraunhofer, UKASSEL, ENLITEAI, INESC TEC	Software	EUPL	2 → 4
Domain-agnostic dynamic AI-assistant	ENLITEAI, INESC TEC, UvA, UKASSEL, Fraunhofer	Software	EUPL	3 → 5
Human-AI co-learning and adjustable autonomy functions	ZHAW, TUD, POLIMI, UvA, FHNW	Software	EUPL	2 → 4
Integrated autonomous AI-driven decision system	ZHAW, DB, SBB	Software	EUPL	2 → 4
Evaluation protocol for AI	All	Software /concept	EUPL	n.a.
Digital environments	IRTSX, UKASSEL, TUD, RTE, TenneT, DB, SBB, FLATLAND	Software	MIT, GPL-3.0, MPL-2.0	3/4 → 5

Additionally, it outlines Intellectual Property Rights (IPR) concepts and strategies, shedding light on the approach to open-source software. This ensures the effective safeguarding and utilization of intellectual assets. The pre-existing open-source code and projects (background of the AI4REALNET project) will follow their own development cycle and autonomous management in separate repositories. Thus, AI4REALNET adopts a distributed control governance model for OSS.

Furthermore, the document focuses on partner motivations for exploitation, examining the context and drivers that fuel collaborative efforts to achieve the exploitation objectives.

The document also presents the methodology for identifying the key stakeholders whose engagement and support are pivotal in shaping the trajectory of our project. Finally, the document commits to unveiling a preliminary business model, offering insights into anticipated revenue streams, cost structures, and value propositions integral to the project's commercialization strategy.

This deliverable will be updated in 12 months (M18): Deliverable D5.4 – "Exploitation plan and strategy phase 2". This report will include an updated exploitation plan (compared to version V1) to provide an up-to-date and detailed description of the consortium's exploitation strategy.

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ABBREVIATIONS AND ACRONYMS

Acronym	Expansion
AGPL	Affero General Public License
AHMS	Aerospace Human-Machine Systems
AI	Artificial Intelligence
ANSP	Air Navigation Service Providers
ATCO	Air Traffic Controller
ATM	Air Traffic Management
BMC	Business Model Canvas
BSD	Berkeley Software Distribution
CAGR	Compound Annual Growth Rate
DSO	Distribution System Operator
EASA	European Union Aviation Safety Agency
EDIH	European Digital Innovation Hubs
EEN	Enterprise Europe Network
EID	Ecological Interface Design
ELISE	European Learning and Intelligent Systems Excellence
ELLIS	European Lab for Learning and Intelligent Systems
EPL	Eclipse Public License
EUPL	European Union Public License
FATE	Fairness Accountability Transparency and Ethics in AI
FIR	Flight Information Regions
GPL	GNU Public Licence
HMI	Human Machine Interface
ICAO	Civil Aviation Organization
ICT	Integrated Control Systems
IEEE	Institute of Electrical and Electronics Engineers
IPR	Intellectual property rights

IoT	Internet of things
JCF	Joint Control Framework
KER	Key Exploitable Results
LACC	Levels of Autonomy Cognitive Control
LFE	Linux Foundation Energy
LGPL	Lesser General Public License
LOA	Levels of Automation
LVNL	Luchtverkeersleiding Nederland
ML	Machine Learning
MPL	Mozilla Public License
NLP	Natural Language Processing
NLR	Netherlands Aerospace Centre
NRA	French National Regulation Authority
OSS	Open-Source Software
PPP	Public-Private Partnerships
R&D	Research and Development
RL	Reinforcement Learning
RTO	Research and Technology Organizations
SME	Small Median Enterprise
SSH	Social Sciences and Humanities
TRL	Technology Readiness Level
TSO	Transmission System Operator
USP	Unique Selling Point
UVP	Unique Value Proposition
WG	Working Group
WP	Work Package
XAI	Explainable Artificial Intelligence

1. INTRODUCTION

The AI4REALNET project stands at the forefront of integrating Artificial Intelligence (AI) into the operation of critical infrastructures, namely: power network, railway network, and air traffic space. The project lies on a novel and multidisciplinary framework designed to augment decision-making in critical infrastructures through human-AI collaboration and autonomous AI systems, with the developments supported by AI-friendly open-source digital environments for testing new AI approaches.

The primary purpose of this document is to outline the first version of the exploitation plan and strategy for the AI4REALNET consortium. This plan serves as a roadmap, guiding the project towards achieving its objectives and maximizing the impact of its results. It is designed to ensure that the project's outcomes are not just theoretical advancements but also practical solutions that can be implemented in real-world scenarios and with tangible impacts on the AI ecosystem. The exploitation plan is also a tool for managing the project's intellectual property rights (IPRs). It outlines the project's IPR strategy, ensuring that the rights to the project's results are clearly defined and protected. This is crucial for enabling the project results to be effectively used and commercialized.

Thus, the Exploitation Plan and Strategy (phase 1) aims to establish a foundation for the development of individual and common exploitation plans in the project, including IPR considerations and open-source strategies. The planned activities encompass the following pillars:

1. Characterization of the Key Exploitable Results (KERs).
2. Introduction to the open source principles and strategy and the project's approach to intellectual property rights and exploitation routes.
3. First assessment of the consortium partners individual exploitation goals.
4. Identification of the key stakeholders and initiatives crucial for the project's success.
5. Provide a market overview through a preliminary business model, including anticipated revenue streams and value propositions.

Moreover, as the exploitation plan is an iterative document that will evolve throughout the project, reflecting refinement in the project's results and context, the last chapter identifies the next steps.

2. EXPLOITATION AND SUSTANABILITY PLANS

The activities in Task 5.4, spanning from months M1 to M6, have primarily focused on three topics:

- Identification of the key exploitable results (KERs) identified by all the consortium partners. This defines a joint exploitation plan, which should describe how to exploit the work resulting from the consortium synergy. This is a complex plan that involves the definition of the exploitable results, the value proposition, the target market, the IPR, and the licensing approach.
- Once exploitable outcomes were identified, the partners had the opportunity to begin the definition of their individual exploitation plans. The partners' contributions were collected using the template in Annex 1 to obtain specific information and ensure contributions' compliance.
- Open-source strategy that coordinates the development team from an open-source perspective, validating contributions for release and participating in open-source engagement events/platforms (e.g., AI-on-demand platform).

2.1 KER CHARACTERISATION

As defined by Horizon Europe, a KER is an identified main interesting result that has been selected and prioritised due to its high potential for exploitation[1]. In other words, this means a result that is made use of and derived benefits from, downstream of the value chain of a product, process, or solution, and/or acts as an important input to policy, further research, or education. Table 1 summarises the KERs of the AI4REALNET project identified by the project's partners, which will be all released in open source (see Section 2.3). New KERs may emerge during project development.

ID	KER	Partners Involved	Type	Licensing	TRL (Initial → Final)
KER 1	Conceptual AI framework for decision-making in critical infrastructures	All partners	Concept	Copyright Creative commons[2]	n.a.
KER 2	AI building blocks: knowledge-assisted, hierarchical, and distributed	UvA, POLIMI, ZHAW, ENLITEAI	Software	EUPL	2 → 4
KER 3	Software XAI/HMI functions for transparent, safe, and trustworthy AI	TUD, POLIMI, ZHAW, Fraunhofer, UKASSEL, ENLITEAI, INESC TEC	Software	EUPL	2 → 4
KER 4	Domain-agnostic dynamic AI-assistant	ENLITEAI, INESC TEC, UvA, UKASSEL, Fraunhofer	Software	EUPL	3 → 5
KER 5	Human-AI co-learning and adjustable autonomy functions	ZHAW, TUD, POLIMI, UvA, FHNW	Software	EUPL	2 → 4

[1] https://intellectual-property-helpdesk.ec.europa.eu/system/files/2022-02/HEU%20Results%20platform.pdf
[2] https://creativecommons.org/

ID	KER	Partners Involved	Type	Licensing	TRL (Initial → Final)
KER 6	Integrated autonomous AI-driven decision system	ZHAW, DB, SBB	Software	EUPL	2 → 4
KER 7	Evaluation protocol for AI	All	Software /concept	EUPL	n.a.
KER 8	Digital environments	IRTSX, UKASSEL, TUD, RTE, TenneT, DB, SBB, FLATLAND	Software	MIT, GPL-3.0, MPL-2.0	3/4 → 5

TABLE 1 - LIST OF KERS FROM THE AI4REALNET PROJECT

The AI4REALNET partners worked together to achieve a first characterization of each KER. The KER characterisation template (Annex 1) follows the framework as proposed by the Horizon Results Booster[3] . At this stage, each KER is defined according to:

- **General characterization**, including identification of the problem, alternative solutions in place, the unique selling points, and the description of the KER.
- **Market characterization**, containing the identification of the target market, early adopters and recognition of the competitors already in the market.
- **Go to market strategy**, with the description of the use model, timing and IPR background and foreground.

Other dimensions will be added to the characterization of each KER, conducting to a Strategic Exploitation Plan, such as costs of implementation and operation, readiness levels (technology, market, societal, regulatory), among others, which will be presented in D5.4 – Exploitation plan and strategy phase 2 (M18). The tables below (from **TABLE 2** to Table 9) present the first characterisation of the eight KERs based on the information provided by the partners.

KER1: Conceptual AI Framework for Decision-Making in Critical Infrastructures	
Problem	To apply AI to the operation of critical infrastructures, it is fundamental to optimize the social-technical system (cooperation between humans and AI) under design and capture a set of constraints and functional and non-functional requirements that ensure trustworthiness and transparency and mitigate algorithmic aversion. Companies and organizations lack conceptual frameworks that support these systems' design, development, and testing, particularly for critical infrastructures characterized by high-stakes decisions traditionally performed by humans.
Current Solution	Presently, new AI-based recommenders or automation systems are being integrated without considering the full environment (and required changes at the technical and organisational level) since there is a lack of a framework to integrate this automation with humans in the same environment and without creating algorithmic aversion. Existing conceptual frameworks such as Joint Control Framework (JCF), Ecological Interface Design (EID), or Humane AI Ethical Framework only cover a part of the design needs, and other frameworks are mainly software-based and focused on AutoAI or low-code AI.
Unique Selling Point (USP) & Unique Value Proposition (UVP)	The multi-disciplinary conceptual framework enables the co-design of the social-technical system considering the organisation, AI developer, and user (e.g., a human operator) and focuses on critical infrastructures.

[3] https://www.horizonresultsbooster.eu/

KER1: Conceptual AI Framework for Decision-Making in Critical Infrastructures	
Description	Domain-general conceptual framework for applying, developing, and validating AI-based approaches in the operations of critical network infrastructures. It will a) augment decision-making in critical networks via human-AI interaction/co-learning and autonomous AI and b) address use cases from 3 different industries within a unified framework for sequential decision-making. Moreover, an adapted template from the ISO/IEC TR 24030 was created to describe in a technology-agnostic and standardised way six use cases for AI that can be replicated by other network operators in power grids, railways, and air traffic management.
Market: Target market	AI and automated systems; human-machine interfaces. *Customer Segments:* Network operators (of critical infrastructures); ICT/Control system providers; AI service providers.
Market: Early Adopters	Network operators (of critical infrastructures). They will be the ones to set the fundamental requirements for AI systems and how they should be integrated with the existing ecosystem.
Market: Competitors	As far as we know, there are no multidisciplinary AI conceptual frameworks like the one AI4REALNET is designing. These concepts can be found in the literature, standards, and industry initiatives but are fragmented, sometimes missing the human side, not unified in a single framework, and do not cover the decision needs of critical infrastructures.
Go to Market: Use model	Public software repositories: The KER will be made openly available in GitHub and iterated along the project to create new versions. Contributions are also open to the AI community, following a similar approach to software components. AI4REALNET will also generate examples (project's use cases) of applying this framework, and combined with the algorithms from WPs 2-3; it will offer proof-of-concept of this framework for industry and academia.
Go to Market: Timing	1 year after the end of the project.
Go to Market: IPR Background	Joint control framework (type: concept; LiU). Methodologies and approaches from Ecological Interface Design (type: concept; TUD)
Go to Market: IPR Foreground	Conceptual framework (All AI4REALNET partners), openly available in GitHub under Creative Commons license.

TABLE 2 - KER 1: CONCEPTUAL AI FRAMEWORK FOR DECISION-MAKING IN CRITICAL INFRASTRUCTURES

KER 2: AI Building Blocks: Knowledge-Assisted, Hierarchical and Distributed	
Problem	Complex algorithms and heuristics have been applied to decision-making problems with little success due to their inflexible nature, poor scalability, and long computational times. These effects are compounded by a loss of human domain expertise, which provides important insights into environmental dynamics and significantly improves solution quality and overall system flexibility. Solvers to complex planning and optimisation problems tend to scale poorly to problem size. Realistically sized optimisation problems can thus typically not be optimised exactly. Instead, solutions revolve around heuristics such as a) following a manually designed strategy or b) solving an abstracted version of the problem where specific details are left out or will be filled in at a later step. In either case, there might be a significant gap in quality with the optimal solution.
Current Solution	Companies currently rely on human expertise to monitor and interact with critical infrastructure, using forecasts and simple models for environmental interaction. However, manually designed strategies often fall short, particularly with unfamiliar problem types. Traditional machine learning (ML) methods require extensive training time and struggle with the complexity seen in real-world network domains. Existing algorithms and heuristics designed for specific domains lack the flexibility to integrate with human operators effectively. In scenarios where these methods fail to produce viable

KER 2: AI Building Blocks: Knowledge-Assisted, Hierarchical and Distributed	
	solutions, humans are forced to take over despite often lacking the capability to understand or solve these complex problems independently.
USP and UVP	AI methods are set to revolutionise how we approach realistic, varied problem formulations in planning and decision-making. These methods stand out for their scalability, adaptability to different problem types, efficiency with limited data, and ability to tackle stochastic or dynamic issues. This starkly contrasts manual strategies, which may falter at unforeseen "blind spots" not accounted for by human designers. The potential solution lies in reinforcement learning (RL), which enhances scalability through innovative techniques. Specifically, problem decomposition (Task 2.2) breaks complex issues into manageable parts while leveraging existing knowledge (Task 2.1) accelerates learning processes. With its emphasis on scalability and adaptability, RL presents a promising avenue for overcoming these challenges, facilitating more effective collaboration between automated systems and human supervisors. A key selling point of these AI techniques is their scalability and the capacity to harness existing knowledge — be it human domain expertise, heuristic approaches, or established solvers. This synergy between human insight and AI capabilities leads to superior outcomes compared to what either could achieve on their own, effectively merging the best of both worlds to tackle complex problems efficiently and innovatively.
Description	This KER is based on two fundamental concepts. 1. exploit knowledge-based heuristics to enhance ML performance by using coarse solutions to guide early learning, identifying key solution space aspects for a general strategy with fewer data needs; this will improve ML performance in low-data situations. 2. improve RL scalability by factorisation of the environment (considering spatial and/or temporal dimensions), achieve better convergence guarantees and enable distributed computation.
Market: Target market	*Target Market:* AI-based decision systems for large networks where scalability is a key challenge for AI adoption, along with knowledge databases with heuristics rules and mathematical models for decision making. *Customer Segments:* Network operators (of critical infrastructures); ICT/Control system providers; AI service providers.
Market: Early Adopters	Network operators of critical infrastructures. AI community (researchers, developers, and practitioners, corporate R&D). Integrators and AI and service providers; ICT and control systems providers.
Market: Competitors	Current approaches consist of complex algorithms and heuristics which are not yet capable of handling disturbances or stochasticity and, therefore, often deliver suboptimal results or fail altogether. Current approaches are consequently reliant on human operators to work alongside a system not designed to be understandable and manage cases that their current systems cannot. This unreliability is the key weakness of current systems. While there is significant research in the fields of hierarchical/distributed learning and integration of human feedback, there are few readily available open-source modules which facilitate the design of such systems. Particularly, the core issues of scalability, data availability and stochasticity limit most all available solutions. In this light, our products would be among the first of their kind.
Go to Market: Use model	Public software repositories: Release the AI building blocks as open-source software on platforms like GitHub and the AI-on-demand platform. Base knowledge for future R&D projects: leverages the AI building blocks as a foundation for developing new and innovative AI solutions for network infrastructures and other domains. This can create new opportunities for collaboration, funding, and commercialisation. Capacity building and consultancy: The project partners can offer training and advice on how to use and integrate the AI building blocks in specific domains and scenarios. Integration into commercial products: EnliteAI is a technology provider that is already in the process of integrating RL-based optimisation into the energy sector.

KER 2: AI Building Blocks: Knowledge-Assisted, Hierarchical and Distributed	
Go to Market: Timing	2 years after the end of the project.
Go to Market: IPR Background	Maze-RL: Applied Reinforcement Learning Framework (type: software with dual license – MazeRL Software License, ENLITAI). Knowledge-assisted AI tools (type: algorithms/methodologies, UvA). Hierarchical and distributed RL (type: software/algorithms, POLIMI).
Go to Market: IPR Foreground	Open-source software with mixed IP strategy: open-source research, protective publications, and maintaining some innovations as trade secrets.

TABLE 3 – KER 2: AI BUILDING BLOCKS: KNOWLEDGE-ASSISTED, HIERARCHICAL AND DISTRIBUTED

KER 3: Software XAI/HMI Functions for Transparent, Safe, and Trustworthy AI	
Problem	In the AI4REALNET concept, humans are expected to collaborate with an AI agent in the same work environment. Thus, it becomes critical that the human operator is fully aware of the capabilities and limitations of the automated agent. The problem that is addressed is a) the lack of explainability, safety, and trustworthiness of AI solutions for critical network infrastructures; b) the need for effective human-machine interfaces (HMI) that can provide valuable and understandable explanations of the AI behaviour, as well as support human-AI collaboration and co-learning; c) the challenge in designing and evaluating XAI/HMI functions that are tailored to the specific context, domain, and user needs in each use case.
Current Solution	Critical infrastructure management primarily relies on human expertise due to a mistrust of AI solutions, largely stemming from their lack of explainability. The complexity of these domains and the growing solution space challenge human capabilities, highlighting the need for AI integration. Efforts are being made to develop explainable and trustworthy AI tools, but their validation in safety-critical infrastructures remains incomplete, keeping AI's implementation limited in these areas.
USP and UVP	Integrating AI with human operators presents a competitive advantage by aligning AI constraints and interfaces with human needs and cognitive conditions. AI agents offer a significant benefit by exploring a larger solution space than human experts, leading to potentially optimal solutions. These agents also provide crucial information alongside their actions, such as highlighting critical geographical regions and helping operators understand the rationale behind decisions. This approach aims to build trust in AI solutions, ensuring they are valid and comply with grid constraints without necessarily achieving the global minimum. The AI4REALNET project emphasises the development of explainable, safe, and trustworthy AI, adopting a trustworthiness-by-design approach. This method integrates trust as a fundamental requirement, making these AI solutions more robust than general explainable AI (XAI) approaches. This strategy aims to streamline the adoption of AI across critical sectors, ensuring safety and efficiency through enhanced human-AI collaboration. For instance, in the ATM field, the creation of HMI software and XAI algorithms enhances flight trajectory efficiency and reduces workload for air traffic controllers through AI-generated solutions. This improved understanding allows humans to ensure the safety of AI solutions or adjust them for better outcomes, fostering a co-learning environment between AI and humans. The improvements in grid operation can lead to overall reduced system costs, including significant costs due to sub-optimal re-dispatching as well as unplanned outages.
Description	The approach includes a) applying Social Sciences and Humanities (SSH) methodologies to design AI decision support, incorporating psychological insights into human cognition; b) developing explainable AI (XAI) to make AI actions understandable to operators, including policy clarity, decision explanation, action explanation, and early fault detection in extreme scenarios; c) investigating cognitive engineering for AI transparency and

KER 3: Software XAI/HMI Functions for Transparent, Safe, and Trustworthy AI	
	aligning AI and interfaces with human needs; d) design an ecological HMI tailored to the end user to support the understanding of the XAI algorithms.
Market: Target market	*Target Market:* Operators and decision-makers across various industries, including but not limited to defence, healthcare, finance, and logistics, starting in critical infrastructures. These professionals seek advanced AI systems that enhance decision-making processes while ensuring transparency and reliability. They value solutions that integrate SSH methodologies to align with human cognition, providing clear explanations and early fault detection in critical scenarios. *Customer segments:* • Integrators: AI service providers, ICT and control system providers. • AI community: researchers, developers, and practitioners, corporate R&D): XAI/HMI. • Network operators of critical infrastructures: ○ ATM: Air Navigation Service Providers (ANSP), Aviation safety agencies (ICAO, EASA, among others). ○ Power network: transmission system operators (TSOs) and distribution system operators (DSOs). ○ Railway network operators.
Market: Early Adopters	In the energy sector, smart grid operators, renewable energy companies, and energy management software providers are leading the adoption of XAI/HMI functionalities to enhance decision-making transparency in demand-response management, energy forecasting, and efficiency recommendations. TSOs that incur high costs due to dispatching and system outages can also be considered. Similarly, in the railway industry, urban transit authorities, freight rail operators, and rail infrastructure maintenance firms could embrace these technologies to improve overall operational efficiency. In ATM, ANSPs and their operators (strategic and tactical ATCOs) can benefit from the solution.
Market: Competitors	Critical infrastructure environments are, in most cases, fully controlled by a human operator, with limited support of automation. Consequently, there are no systems supporting the understanding of automation (AI/optimisations/heuristic approaches). In the energy sector, GE Digital, Siemens Energy, and Schneider Electric are leading the charge with AI solutions focused on operational efficiency and reliability. For railways, Alstom Digital Mobility, Siemens Mobility, and Hitachi Rail stand out by offering AI-driven traffic management systems to enhance safety and efficiency. In ATM, the Thales Group announced the OneSKY program with AI as one technology to manage 11% of the world's airspace. These companies are key competitors in adopting and developing XAI and HMI functionalities for transparent and trustworthy AI applications.
Go to Market: Use model	Public software repositories: Release the AI building blocks and the ecological HMI as open-source software on platforms such as GitHub and the AI-on-demand platform. Base knowledge for future R&D projects: leverages the AI building blocks as a foundation for developing new and innovative AI solutions for network infrastructures and other domains. This can create new opportunities for collaboration, funding, and commercialisation. Capacity building and consultancy: The project partners can offer training and advice on how to use and integrate the AI building blocks in specific domains and scenarios.
Go to Market: Timing	2-3 years after the end of the project.
Go to Market: IPR Background	Methodologies and approaches from Ecological Interface Design (type: concept; TUD)
Go to Market: IPR Foreground	Open-source software with mixed IP strategy: open-source research, protective publications, and maintaining some innovations as trade secrets.

TABLE 4 - KER 3: SOFTWARE XAI/HMI FUNCTIONS FOR TRANSPARENT, SAFE, AND TRUSTWORTHY AI

KER 4: Domain-Agnostic Dynamic AI Assistant	
Problem	In critical infrastructures that are aligned with the EU AI Act risk-based approach, AI assistants can play an important role in supporting human operators in analysing and deciding complex and dynamic operating scenarios. However, the AI assistant should be able to handle uncertainty and variability in the system (network) operation, including the impact of natural hazards, but also communicate with humans. The potential risks and confidence of recommendations made by the AI system to human operators. This gap hinders operators' ability to select the most trustworthy AI solutions based on past performance and to appropriately adjust their risk thresholds in alignment with the criticality of the decisions at hand, ultimately affecting the decision-making process and trust in AI-assisted operations. An important question is whether the uncertainty aspect of an AI assistant can be made in a domain-agnostic way or whether the types of uncertainty are too domain-specific for a unified approach.
Current Solution	Currently, real-time decisions regarding the operation of critical infrastructures heavily rely on the cognitive abilities of human operators, who draw upon their mental models and experience. However, this decision-making process lacks adequate support from recommendation tools capable of swiftly providing actionable advice. Consequently, operators often face challenges in promptly assessing complex situations, identifying optimal courses of action, and mitigating potential risks or disruptions. This highlights the pressing need for advanced recommendation systems empowered by AI and data analytics, which can analyse vast streams of real-time data, anticipate emerging issues, and offer timely insights to assist operators in making informed decisions with greater speed and accuracy.
USP and UVP	Due to the near-instantaneous speed of evaluation, the AI assistant offers a unique opportunity to report the issue and offer a solution nearly simultaneously. The AI assistant automatically proposes action recommendations and feedback to human operators. It will also be capable of adapting to the operator's preferences, needs, and cognitive load, as well as to the system's uncertainties and risks. This can significantly reduce the burden on operators, who are potentially freed from developing a solution from scratch and can instead spend their efforts verifying the proposed solution and considering minor adjustments.
Description	The system alerts the operator for needed interventions, offering recommendations that impact key performance indicators (KPIs) for operator selection. It aims to build trust through a methodology that defines the level of human involvement required, varying from full autonomy in standard modes to complete human control in critical situations, considering cognitive capacity. The system would also follow a methodology to estimate and convey decision uncertainty and risk to operators, such as choosing the AI algorithm with the highest trust based on past performance or adjusting human risk thresholds based on decision stakes.
Market: Target market	*Target Market:* Industry where operators and decision-makers seek advanced technologies that optimise KPIs while ensuring trust and reliability in decision-making processes. This means industries where operational efficiency and risk management are critical, such as manufacturing, transportation, energy, and emergency services. *Customer Segments:* Network operators. AI service providers; ICT and control system providers.
Market: Early Adopters	The early adopters are the critical infrastructure operators in the project: RTE and TENNET for the power grid, SBB and DB for the railway, and NAV for air traffic management. These companies already have AI in their roadmap and are conducting proof of concepts with academia and AI providers. Therefore, they offer an adequate environment for proof of concept and early construction of business cases for AI assistants.
Market: Competitors	AI assistants in critical infrastructures are in an early stage of development, and currently, there are no mature solutions in the market. However, start-ups are customising their products to create AI assistants, and other sectors are already offering solutions such as Smart Virtual Personal Assistants or Google Assistant. With the emergence of natural

KER 4: Domain-Agnostic Dynamic AI Assistant	
	language processing (NLP) and generative AI, a promising prospect arises for seamlessly integrating the AI assistant developed by AI4REALNET with other counterparts built on NLP frameworks.
Go to Market: Use model	Public software repositories: The project partners can release the AI building blocks as open-source software on platforms such as GitHub and the AI-on-demand platform. Base knowledge for future R&D projects: leverages the AI building blocks as a foundation for developing new and innovative AI solutions for network infrastructures and other domains. This can create new opportunities for collaboration, funding, and commercialisation. Capacity building and consultancy: The project partners can offer training and advice to network operators, AI service providers, ICT and control system providers, and other potential customers on how to use and integrate the AI building blocks in their specific domains and scenarios.
Go to Market: Timing	2-3 years after the end of the project.
Go to Market: IPR Background	Human in the loop utilities (type: software with dual license – MazeRL Software License, ENLITAI). Curriculum agent (type: software – MPL-2.0 license, UKASSEL, Fraunhofer)
Go to Market: IPR Foreground	Open-source software with mixed IP strategy: open-source research, protective publications, and maintaining some innovations as trade secrets.

TABLE 5 - KER 4: DOMAIN-AGNOSTIC DYNAMIC AI ASSISTANT

KER 5: Human-AI co-learning and adjustable autonomy functions	
Problem	The problem is the inability of current AI systems, particularly in RL environments, to effectively incorporate human decisions, understand optimal human behaviour, transparently communicate AI decision-making processes, and dynamically adjust autonomy based on the human operator's condition and preference. Furthermore, there's a need for AI to accommodate multi-objective optimisation that aligns with human preferences, ensuring informed and contextually appropriate decision-making in critical operations.
Current Solution	Low TRL research has been conducted both on co-learning (AI-based) and on adjustable autonomy (structured optimisations/heuristic approaches/AI-based); these remain mostly unused in the industry. Most co-learning research is limited to the development of concepts and frameworks rather than implementations. Alternative approaches involve or observe human experts during training and aim to replicate human behaviour or find optimal behaviour with respect to human goals.
USP and UVP	Our co-learning technology unlocks human-AI collaboration potential. It fosters a partnership where humans and AI learn from each other in real time, enhancing decision-making. The platform, built on trust and adaptation, ensures AI responds to queries and anticipates needs. Human operators maintain control, enriching the AI with their expertise and gaining new knowledge for improved outcomes. Experience decision-making where human intuition and AI intelligence converge.
Description	The core AI technologies include a) order-agnostic network architectures for RL that incorporate human data in their training or mimic human perturbations for decision-making with human input; b) inverse RL to deduce an optimal reward function incorporating to some degree human behaviour while still exploring new solutions; c) deep RL with XAI to clarify AI decisions to humans; d) adjustable autonomy in RL, using preference, stress or fatigue levels to decide when to transfer control between AI and human operators. Additionally, RL is adapted for multi-objective settings, allowing for human-specified preferences and a preference learning module to enhance decision-making in critical operations.

KER 5: Human-AI co-learning and adjustable autonomy functions	
Market: Target market	*Target Market:* Spans across industries where human-machine collaboration is paramount, such as autonomous vehicles, healthcare, robotics, and critical infrastructures. Operators and decision-makers in these sectors are seeking advanced AI solutions that seamlessly integrate human input while optimising decision-making processes. *Customer Segments:* XAI/HMI researchers. Network Operators: the methods and systems developed are ideal for the complex multi-objective environments that e.g. railway network operators are confronted with, offering a quality-of-life improvement for their employees, as well as improved performance.
Market: Early Adopters	Network operators in the consortium will be "lighthouses" through their effort and commitment to learn with AI, tailoring human and machine roles dynamically, and sharing with policymakers and "followers" new organisational architectures, processes, behaviours, and attitudes. The novel co-learning and dynamic autonomy systems are of interest to researchers in AI and psychology, who can utilise the methods developed as building blocks in their own research.
Market: Competitors	Critical infrastructure environments are mostly controlled by human operators without automation support. There's a lack of co-learning and adjustable autonomy systems. While alternative solutions perform acceptably within their limited scope, they lack functionality, scalability, and flexibility. Co-learning methods, which are human-centric and future-oriented, improve motivation, facilitate learning, enhance performance, and provide system stability. Unlike alternative methods that lead to deskilling, co-learning aims to mitigate this.
Go to Market: Use model	Public software repositories: The project partners can release the XAI algorithms with co-learning and adjustable autonomy functions as open-source software on platforms such as GitHub and the AI-on-demand platform. Base knowledge for future R&D projects: leverages the XAI algorithms with co-learning and adjustable autonomy functions as a foundation for developing new and innovative AI solutions for network infrastructures and other domains. This can create new opportunities for collaboration, funding, and commercialisation. Capacity building and consultancy: The project partners can offer training and advice to network operators, AI service providers, ICT and control system providers, and other potential customers on how to use and integrate the co-learning and adjustable automation functions in their specific domains and scenarios.
Go to Market: Timing	3-5 years after the end of the project.
Go to Market: IPR Background	Joint continual human-ML from preferences (type: algorithms, ZHAW). Inverse RL (type: algorithms, POLIMI).
Go to Market: IPR Foreground	Open-source software with mixed IP strategy: open-source research, protective publications, and maintaining some innovations as trade secrets.

TABLE 6 - KER 5: HUMAN-AI CO-LEARNING AND ADJUSTABLE AUTONOMY FUNCTIONS

KER 6: Integrated Autonomous AI-Driven Decision System	
Problem	Many critical infrastructures are not suitable for full human control, nor is it always feasible to have a human agent collaborating with an AI agent. Current automation systems (complex algorithms and heuristics) are static and unable to adapt to dynamic environments. While expert knowledge is often considered in their development, this is limited to the design process and does not extend into the training process.
Current Solution	Trust in autonomous AI solutions remains low due to several factors: lack of transparency and interpretability, human aversion to algorithmic decision-making, and inadequate supervision and maintenance. Consequently, adoption in critical infrastructures is minimal. Most systems rely on rule-based expert systems due to their perceived

KER 6: Integrated Autonomous AI-Driven Decision System	
	transparency. Addressing these challenges requires improving transparency, user interfaces, and governance frameworks to foster trust and wider adoption of autonomous AI solutions.
USP and UVP	AI capable of independently navigating complex, high-risk networks such as railways or ATM. Autonomous AI learning to imitate and expand on human behaviour, enabling it to act in and safely navigate human-dominated systems. Explainability and transparency make autonomous agents certifiable and auditable and enable human operators to maintain accurate mental models while performing supervisory duties.
Description	The technology involves multi-agent RL, with each agent tasked with a) achieving an individual goal, b) seeking the optimal global solution, and c) communicating with relevant agents to embody swarm behaviour. Training incorporates human expertise by having agents initially mimic human interactions, then progressively tackling more complex network setups. Despite AI's autonomy, accountability to a human overseer is crucial, facilitated by XAI methods for performance assessment and enhanced transparency through detailed protocolling and logging for failure analysis.
Market: Target market	*Target Market:* Industries requiring complex coordination and decision-making, such as logistics, cybersecurity, smart infrastructure, and autonomous systems. In these industries, accountability to a human overseer is paramount, ensuring transparency and performance assessment in AI-driven decision-making processes. *Customer segments:* ▪ Regulators: particular interest in automated technologies being explainable/transparent, as this is essential for regulation/certification / auditability considerations. ▪ Operators of critical infrastructure: particularly in critical infrastructure, where intricate systems and time pressure can make decision-making difficult for human operators, explainable autonomous AI can allow for performance and capacity improvements while still safeguarding safety. ▪ Other sectors: any sector which requires transparent decision-making can derive value from the explainable AI systems developed.
Market: Early Adopters	Operators of critical infrastructure: critical infrastructure is highly regulated and subject to safety and security considerations which hinder automation. For these reasons, explainable and transparent autonomation provides significant value potential. AI researchers / R&D: the autonomous decision systems developed can be adapted for implementation in other areas or serve as a basis for continued development.
Market: Competitors	Currently, critical infrastructure environments are, in most cases, fully controlled by a human operator, without the support of any automation. Consequently, there are no readily available co-learning and adjustable autonomy systems.
Go to Market: Use model	Public software repositories: Release AI building blocks on platforms like GitHub and the AI-on-demand platform, adopting an open-source model. Base knowledge for future R&D projects: These AI building blocks also serve as a versatile foundation for future research and development endeavours. They enable the pursuit of innovative AI applications across various domains, fostering opportunities for new collaborations, funding, and pathways to commercialisation. Capacity building and consultancy: The project partners can offer training and advice to support the effective utilisation and integration of AI building blocks within their unique operational contexts. Support services: offering maintenance services and customisation options. These services aim to support organisations in leveraging open-source AI solutions, aligning with current industry practices where the value lies in personalised adaptation and ongoing support.
Go to Market: Timing	3-5 years after the end of the project

KER 6: Integrated Autonomous AI-Driven Decision System	
Go to Market: IPR Background	None
Go to Market: IPR Foreground	Open-source software with mixed IP strategy: open-source research, protective publications, and maintaining some innovations as trade secrets.

TABLE 7 - KER 6: INTEGRATED AUTONOMOUS AI-DRIVEN DECISION SYSTEM

KER 7: Evaluation Protocol for AI	
Problem	The problem addressed is the need to comprehensively evaluate AI's performance, safety, and overall impact on stakeholders and communities to maximise benefits and minimise harm. There is a need to comprehensively evaluate AI's technical performance, safety, and overall impact on the social-technical systems, stakeholders (including citizens), and communities to maximise benefits and minimise the risks. This involves assessing the current ecosystem of AI usage and understanding to ensure technology advances are equitable and beneficial across all affected groups. In addition to quantitative and qualitative KPI, an evaluation protocol for critical infrastructures is needed so that AI developers and end-users can test different dimensions, in particular robustness, resilience, safety, user experience and acceptability, and trustworthiness, along different dimensions, and identify required organisational changes.
Current Solution	AI-based solutions adopted by the industry are being mainly tested following best practices in software development and testing. However, classical software and AI testing are different in many aspects, namely: i) software testing detects bugs in the code, while AI testing seeks to correct bugs in input data, learning process and structure, and model's hyper-parameters; ii) the behaviour of AI can change with input data and historical data update, while the behaviour of a software code is, in general, fixed; iii) test inputs may have different forms in AI, e.g., input data (for training and operation), model's functions; iv) AI tends to give more false positives in detected bugs; v) in AI bugs may be present in data, code, mathematical algorithm, which requires the active involvement of the AI engineer in the testing phase. Presently, new AI-based recommenders or automation systems are being researched without a structured framework and evaluated without a structured protocol, therefore incurring in the risk of not being comprehensive, impacting their performance and safety.
USP and UVP	This protocol distinguishes itself by not only evaluating AI in isolation but also considering the ecosystem in which AI operates, aiming for equitable and positive outcomes for all affected parties. It provides a comprehensive and rigorous framework to evaluate AI in critical network infrastructures, considering both quantitative and qualitative aspects, as well as human user experience and acceptability. This protocol will be associated with three digital environments (Grid2Op, Flatland, BlueSky), which offer AI developers a complete package for evaluating their AI algorithms between TRL 4 and 5, and that can be further upgraded to higher TRL.
Description	The evaluation protocol will capture the wide spectrum of AI performance, safety, and impact to ensure that all affected stakeholders and communities reap the benefits of the technology, rather than any harm, by looking at the current ecosystem in which AI is used and understood.
Market: Target market	*Target market:* Organisations that are investing in the responsible deployment of AI technologies recognise the critical importance of assessing AI performance, safety, and impact to ensure beneficial outcomes for all involved parties and communities. *Customer segments:* AI developers; AI service providers. In ATM segments, aviation safety agencies (ICAO, EASA, among others), Network operators of critical infrastructures (ANSP). ICT/Control system providers; AI service providers; universities and research institutes aiming to develop AI.

KER 7: Evaluation Protocol for AI	
Market: Early Adopters	The early adopters are the critical infrastructure operators in the project: RTE and TENNET for the power grid, SBB and DB for the railway, and NAV for air traffic management. Therefore, they offer an adequate environment for proof of concept. The early adopters will be industries which fall under the high-risk category of the AI Act.
Market: Competitors	Microsoft created the Fairness, Accountability, Transparency, and Ethics in AI (FATE) initiative, but it mainly studied the societal implications of AI and was driven to develop techniques that comply with the FATE principles by design. IBM is following a similar approach. Partnership on AI involves major companies like Amazon, Facebook, Google, and others and has a Safety Critical AI Program. This program launched an AI incident database and the SafeLife AI learning environment for training non-destructive agents. Finally, there are different standardisation WG working in verification methods. One example is ISO/IEC 24029-2 ("Artificial intelligence (AI) — Assessment of the robustness of neural networks — Part 2: Methodology for the use of formal methods"). Another is the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, which published the 7000-2021 – IEEE Standard Model Process for Addressing Ethical Concerns during System Design. As far as we know, there are no multidisciplinary AI evaluation protocols like the one AI4REALNET is designing. Evaluation criteria can be found in the literature, standards, and industry initiatives but are fragmented, sometimes missing the human side, not unified in a single protocol, and do not cover the needs of critical infrastructures. For the final evaluation, competitors might be certification agencies and technical standards; both are expected to be developed in the next years.
Go to Market: Use model	Public software repositories: The KER will be made openly available in GitHub and iterated along the project to create new versions. Contributions are also open to the AI community, following a similar approach to software components. AI4REALNET will offer proof-of-concept of this evaluation protocol for industry and academia by applying it to the algorithms and use cases from WPs 1-2-3. Base knowledge for future R&D projects: leverages the XAI algorithms with co-learning and adjustable autonomy functions as a foundation for developing new and innovative AI solutions for network infrastructures and other domains. This can create new opportunities for collaboration, funding, and commercialisation. Capacity building and consultancy: The project partners can offer training and advice to network operators, AI service providers, ICT and control system providers, and other potential customers on how to use and integrate the co-learning and adjustable automation functions in their specific domains and scenarios. Regulators might use the protocol to assess the trustworthiness dimensions of an AI.
Go to Market: Timing	2-3 years after the project end
Go to Market: IPR Background	Levels of Autonomy Cognitive Control (LACC) and Levels of Automation (LOA) (Type: concepts; LIU, TUD)
Go to Market: IPR Foreground	Evaluation protocol and software scripts.

TABLE 8 - KER 7: EVALUATION PROTOCOL FOR AI

KER 8: Digital Environments	
Problem	The problem addressed is the lack of accessible, specialised digital environments for AI development and benchmarking in critical infrastructure sectors such as electricity, railway, and ATM networks. This gap hinders innovation, collaboration, and the iterative improvement of AI applications, leading to underutilisation of AI's potential in enhancing the efficiency and reliability of these essential services.

KER 8: Digital Environments	
Current Solution	There are currently no open-source digital environments that enable the testing of AI algorithms. Some research has been done on the development of AI test-benches, but source codes are not publicly available. The alternative to accessible digital AI environments is to have isolated, disunified efforts spread across research institutes and industry partners. This would make benchmarking nearly impossible, given the effort required to adapt AI software to different frameworks for apples-to-apples comparisons. It also hinders progress when each individual effort must spend time developing their own digital environment, rather than starting from a well-supported, open-source environment and focusing instead on the AI tools and agents.
USP and UVP	Enable the development, testing, and validation of novel AI algorithms for sequential decision-making problems in complex and dynamic systems, as well as the engagement and co-creation with the AI community and other sectors. A stable set of scenarios that can be used as a benchmark over long periods of time is essential to marking progress in developing AI solutions and comparing the performance of different approaches. A well-supported, well-documented and open-source digital environment can be more easily extended to new use cases or challenges, as well as a more realistic solution space. An example of this is the electrical network, where the Grid2Op digital environment has progressively extended its solution space to include topology switching actions, redispatching, and battery control.
Description	Open-source and AI-friendly digital environments for electricity, railway, and ATM networks, enabling AI development and benchmarking. Open code will be made available to boost further refinements and applications and increase reusability in future projects on platforms such as GitHub.
Market: Target market	*Target Market:* Developers, researchers, and organisations within the electricity, railway, and air traffic management (ATM) sectors, as well as the broader AI development community. By providing open-source digital environments tailored for specific sectors, we empower developers and researchers to experiment, innovate, and benchmark AI solutions effectively. The availability of open code on platforms like GitHub facilitates collaboration and knowledge-sharing, accelerating the pace of AI development and refinement. Moreover, the reusability of open-source code promotes cost-effectiveness and scalability, allowing organisations to leverage existing frameworks for future projects and adaptations. *Customer Segments:* AI service providers, / ICT and control system providers. AI community, corporate R&D (network service providers), researchers, developers, and practitioners.
Market: Early Adopters	SMEs that are relying on their AI know-how but lack direct access to a real-world network (and corresponding network simulations) may have the most benefit from an open-source digital environment with which to develop their AI solutions.
Market: Competitors	In regard to the ATM sector, the AAM-Gym platform was developed at MIT Lincoln Laboratory as a testbed for an AI algorithm for ATM research, using BlueSky as a backhand. This is, however, not open source. In the electrical grid domain, there are few, if any, competing digital environments that simulate the operational scenarios addressed in Grid2Op. Continual focus on user-friendliness and good documentation can help to avoid competing environments that split the efforts of the field.
Go to Market: Use model	Operators training and internal testing/benchmarking of AI. Capacity building and consultancy: The project partners can offer training and advice to network operators, AI service providers, ICT and control system providers, and other potential customers on how to use and integrate the Digital environment for AI development and testing in their specific domains and scenarios. Public software repositories: The project partners will release the Digital environment for AI development and testing as open-source software on platforms such as GitHub and the AI-on-demand platform. Base knowledge for future R&D projects: leverages the Digital environment for AI development and testing as a foundation for developing new and

KER 8: Digital Environments	
	innovative AI solutions for network infrastructures and other domains, internally to AI4REALNET and externally. This can create new opportunities for collaboration, funding, and commercialisation. The digital environment can be used as a testbed for proving out AI solutions before deploying them in real-world cases. These environments should have interfaces and APIs that are close enough to real-world systems that AI agents can easily transfer to a similar environment in an operational control room.
Go to Market: Timing	3 years after the end of the project
Go to Market: IPR Background	BlueSky: open Air Traffic Management simulator (type: open-source software – GPL-3.0 license; TUD). Flatland: Code in open source to facilitate enhancement and reusability in future projects (type: open-source software – MIT license, Partner: FLATLAND) Pandapower: an open-source python tool for convenient modelling, analysis, and optimisation of electric power systems: Partners: Fraunhofer, UKASSEL). Grid2Op (Type: open-source software – MPL-2.0 license; RTE)
Go to Market: IPR Foreground	An open-source digital environment for AI development and testing was released considering the IPR background licenses.

TABLE 9 - KER 8: DIGITAL ENVIRONMENTS

As the project advances, this list and characterisation of KERs will be reviewed, and the granularity (i.e., division of the KER into different subcomponents) will increase.

The next steps will apply the Design Thinking methodology for validation and gathering more inputs to characterise each KER's potential exploitation. Workshops will be implemented with all partners participating in each KER to discuss and redesign the Value Proposition, IP and Go to Market strategy. This iterative approach ensures that the consortium refines and enhances the understanding of each result's relevance, routes for exploitation and business models, scalability, market viability, and adoption conditions. In Section 2.4, the initial exploiting routes for the KERs are presented.

2.2 INDIVIDUAL EXPLOITATION PLANS

This section details how each of the consortium partners envisages their role in the future exploitation of the results of AI4REALNET. At this stage, each partner defined their individual motivation and exploitation plan. Particularly, they provided an outline of their organisation, described their context, and elaborated on their focus area. Secondly, under the exploitation strategy, the partners have specified their exploitation goals and identified their planned exploitation activities. The information below was collected from each partner through the same template (see Annex 2).

In the upcoming phases, we will engage in discussions with all partners to meticulously analyse this information. This collaborative effort will inform the development of a comprehensive Strategic Roadmap for Exploitation. Our overarching objective is to foster dialogue and ensure that all exploitable results effectively progress to the market adoption stage.

INESC TEC – INSTITUTO DE ENGENHARIADE SISTEMAS E COMPUTADORES, TECNOLOGIA E CIENCIA

PARTNER DESCRIPTION: INESC TEC is a private, non-profit Research and Technology Organization (RTO) dedicated to scientific research and technological development, technology transfer, advanced consulting and training, and pre-incubation of new technology-based companies. As an institution operating at the interface between the academic and business worlds, bringing academia, companies, public administration, and society closer together through its "managed science" model, INESC TEC leverages the knowledge and results generated as part of its research through technology transfer projects seeking impact in value creation and social relevance. The dual mission of INESC TEC is to excel in research, seeking social relevance and international influence, and to foster pervasive intelligence, contributing to the competitiveness and internationalisation of Portuguese companies and institutions.

ECOSYSTEM: INESC TEC has a relevant role in the European Knowledge and Innovation Communities (KICs) – EIT Raw Materials, EIT Manufacturing and EIT Digital. It is strengthening a base of operations outside Portugal to increase the capacity to promote projects, secure funding, and attract human resources at an international level. The operation in Brazil, with the creation of INESC P&D Brazil and its recognition by the Brazilian Science and Technology agencies as a Brazilian ICT (Institution of Science and Technology), and the creation of INESC Brussels Hub and a service for international relations contribute to increasing INESC TEC ecosystem outside Portugal. Moreover, in the area of AI, INESC TEC is a member of the euRobotics, ETSI, and AIOTI associations, as well as the ADRA PPP.

INESC TEC is leading the DIH ATTRACT (Digital Innovation Hub for ArTificial InTelligence and High-PeRformAnce CompuTing[4]), which mission is to promote and support experimentation, testing, development and adoption of solutions using AI and high-performance computing, as well as to address training needs, while boosting the innovation ecosystem in these fields. This is enabling the creation of a national ecosystem for AI.

FOCUS AREA: INESC TEC's vision is to be a relevant international player in Science and Technology in the domains of Computer Science, Industrial and Systems Engineering, Networked Intelligent Systems, and Power and Energy. Research and development; technology transfer via software licensing or creation of start-ups, mainly in AI, electrical and computer engineering, and informatics. One example of a start-up launched by INESC TEC in AI is iLoF, which commercializes a cloud-based library of optical fingerprints powered by photonics and AI and provides non-invasive tracking, screening and stratification for drug discovery, adapted to each clinical trial needs.

EXPLOITATION GOALS: Centered on the research exploitation model, INESC TEC's primary goal is to leverage the acquired research expertise for continual application in forthcoming research endeavours and demonstration activities. This involves not only creating a robust repository of knowledge but also actively contributing to the development and maintenance of open-source code. This code is strategically developed and disseminated to captivate the attention of diverse entities from academia, start-ups, and SMEs from the AI community. On top of the developed software and experience in testing AI technologies, the commercial exploitation of the results as a service is also expected,

[4] https://attract.inesctec.pt/

leveraging our long-term partnerships with operators of critical infrastructures such as EDP, REN in power grids, NAV in air traffic control, or EPAL in water distribution.

PLANNED EXPLOITATION ACTIVITIES:

- Enhance and create new partnerships with key stakeholders in academia, industry, and RTO to facilitate the exchange of ideas, resources, and expertise. The participation in the associations (e.g., AIOTI and ADRA) and leadership of a DIH will be instrumental, as will the involvement of INESC Brussels HUB and contributions to the AI-on-demand platform.
- Increase the involvement in open-source initiatives by developing and maintaining high-quality code repositories. This should include regular updates, community engagement, and responsiveness to user feedback.
- Leverage from INESC TEC experience in preparing advanced courses for industry and provision of consultancy services using the R&D knowledge to organize capacity-building programs for industry and organisation and also offer specialised consultancy in the area of AI for the operation of critical infrastructures.
- Design technology transfer programs aimed at transitioning research findings from AI4REALNET into practical applications in a timeline of 2-3 years after the project. The idea is to depart from the 6 project's use cases but collaborate with industrial partners from and outside the consortium to identify new use cases where AI brings added value and co-develop solutions that address real-world challenges.
- Actively contribute to academic publications, conferences, and industry events to showcase our research findings.
- Explore partnerships with start-ups and SMEs to support the growth of their products by integrating the knowledge generated during the project in the areas of simulation for AI testing and evaluation frameworks for AI (e.g., robustness, resilience, interpretability).

Beyond the project duration, INESC TEC expects to promote demonstration projects showcasing the practical applications of our research. This will generate tangible examples of the value proposition of our work to attract industry partnerships and additional funding.

IRTSX - INSTITUT DE RECHERCHE TECHNOLOGIQUE SYSTEM X

PARTNER DESCRIPTION: The Institute for Technological Research (IRT) is an interdisciplinary thematic institute that develops economic sectors related to its field through a balanced strategic public-private partnership. For this, it manages research programs coupled with technology platforms, conducts research and development projects at the international level, contributes to the engineering of initial and continuous training (qualifying professional training and/or degree delivering), and ensures the exploitation of the obtained results. The functioning of the Institute is based on two fundamental aspects: Bringing talents together. The institute brings together all the partners involved in its projects under one roof, thus creating a melting pot of interaction between stakeholders in the public and industrial research sectors. Pooling of skills and platforms. SystemX is consolidating its technological platforms by pooling the components and infrastructures of its research projects and is developing expertise in the service of its public and private partners.

ECOSYSTEM: Comprising the University of Claude Bernard Lyon 1, three graduate engineering schools (INSA Lyon, Polytech Lyon and CPE Lyon), several University Institutes of Technology, the Lyon Campus is one of the main sites of research of the Auvergne-Rhône-Alpes region with nearly 2,000 researchers. At the heart of this land of innovation, IRT SystemX aims to expand its R&D activities in the areas of new mobility, energy and digital security in collaboration with the Lyon Metropole, renowned scientific centres, industrial players in the region and competitiveness clusters of the region involved in digital technologies in line with the activities of SystemX, such as the CARA and ECC4IU clusters.

FOCUS AREA: The integration of data science and AI into technology and industry is transforming how we observe, interact with, and understand complex systems. This transformation is highlighted across several key focus areas:

- Data Science and AI are crucial for efficiently modelling complex systems, using statistical learning techniques adaptable to various data types for classification, detection, prediction, and causality research.
- Human-digital interaction is evolving with digitalisation, emphasizing the need for interfaces (haptic, gestural, vocal, among others) that enhance human cognitive capabilities and simplify tasks.
- Scientific Computing underlines the importance of precise physical modelling for realistic simulations, balancing model accuracy and computational resources through methods like model reduction and distributed computing.
- Optimization bridges descriptive analytics to prescriptive insights, exploring modelling spaces to identify valuable subsets despite data volume, uncertainties, and time constraints.
- Systems Engineering approaches the design and operation of complex systems holistically, considering both technological and organisational complexities to meet stakeholder needs throughout a system's lifecycle.
- Safety in systems engineering faces challenges from integrating heterogeneous components, impacting system dependability, and highlighting the need for improved safety and security measures.
- Digital Security and Blockchain call for a shift towards designing systems that are robust, resilient, and trusted from the start in response to evolving cyber threats.
- IoT and Networks reflect the shift towards adaptive, intelligent, and autonomous network architectures to meet increasing digital service demands, emphasising less centralized data collection and connectivity.

EXPLOITATION GOALS: Code in open-source to facilitate enhancement and reusability in future projects and active involvement from the AI community. Operators training and internal testing/benchmarking of AI. Consultancy and training for AI developers /industry (AI users). Code and metrics were released as open-source (in KER 8) and in a technical report.

PLANNED EXPLOITATION ACTIVITIES: Mainly interested in the research exploitation model, aspiring re-utilisation of the research know-how acquired in future research activities. From a commercial exploitation model, IRTSX is interested in founding spin-offs and start-ups to commercially exploit the developed research results.

FRAUNHOFER - FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

PARTNER DESCRIPTION: The Fraunhofer Institute for Energy Economics and Energy System Technology (Institut für Energiewirtschaft und Energiesystemtechnik, IEE) is one of 76 institutes comprising the Fraunhofer Society, a German research organisation dedicated to applied research and partially funded by the German government. Growing out of an existing Fraunhofer institute, Fraunhofer IEE was established in Kassel as an independent branch in 2018 with a focus on research and industrial applications for the sustainable transformation of renewable-based energy systems.

ECOSYSTEM: Fraunhofer IEE enjoys a close collaborative relationship with partners in the European industry and beyond, earning a significant portion of its revenue from industry contracts, with the rest coming from publicly funded sources. Concerning the electrical grid domain, Fraunhofer has a close working relationship with electrical grid operators, spanning from low- and medium-voltage distribution operators to high- and extra-high-voltage transmission grid operators. The institute also maintains close collaboration with its spin-off company, Retoflow, and expects to foster additional spin-offs in the future. Finally, Fraunhofer IEE is a member of the FVEE Renewable Energy Research Association, the DERlab (European Distributed Energy Resources) network, and the European Energy Research Alliance EERA.

Fraunhofer IEE also enjoys close collaborative partnership, as well as shared personnel, with the University of Kassel and its Energy Management and Operation of Electrical Networks (e2n) department. The relationship allows mutual benefit in the form of shared expertise and rapid technology transfer from the domain of academic research into real-world industry projects. Fraunhofer IEE also collaborates closely with the universities of Hannover and Darmstadt.

FOCUS AREA: Fraunhofer IEE has a wide range of research areas, including energy informatics, energy economics and system design, grid stability and integration, energy storage and thermal energy technologies, and energy meteorology. Most relevant to the main goals of AI4REALNET, Fraunhofer IEE specialises in electrical grid planning and operation, developing tools to efficiently operate electrical grids in transmission and distribution networks with a growing proportion of distributed energy resources. Fraunhofer IEE pursues a strategy of grid operation with a heavy focus on decentralised automation and the exploitation of modern AI solutions.

Key to the strategy of Fraunhofer IEE is the development of open-source tools for energy system management. One such project is pandapower, an open-source tool for modelling and simulating electrical grids developed at Fraunhofer IEE and the University of Kassel. Pandapower has become a leading grid modelling software package, reaching in 2024 the milestone of 500,000 downloads since its release in 2016.

EXPLOITATION GOALS: Plans to use its involvement in the project to further develop our expertise in AI and RL, with the goal of applying our knowledge to a wide array of applications in energy systems and grid operation. AI is a powerful tool whose benefit has been demonstrated in nearly every area of research at Fraunhofer IEE, and we expect the experience gained in AI4REALNET will contribute to Fraunhofer's overall focus on AI. In addition, we have current and planned future projects at Fraunhofer IEE that overlap with the grid use cases covered in AI4REALNET and therefore expect to

build on the solutions developed in this project. Fraunhofer IEE strategically pursues the model of open-sourcing its software and offering its expertise as a service to clients in the industry, with Pandapower as the prime example. In the AI4REALNET project, we aim to adopt a similar strategy in which the open-source AI software developed within the project will serve as a basis from which we can offer our expertise and know-how to clients to develop real-world deployments of the AI models.

PLANNED EXPLOITATION ACTIVITIES:

- Contribute to the development and refinement of the open-source frameworks (both the general AI framework as well as those specific to the grid use cases) to support the development of high-quality, community-based tools that can be used as the basis for real-world projects.
- Strengthen the partnership between our institute and the project partners and stakeholders in the AI4RealNet project to mutually benefit from our various areas of expertise and seek potential opportunities for future collaborations on AI-related research projects.
- Develop open-source reinforcement-learning-based grid operation tools that align with the goals of the AI4RealNet project but which also may serve as the basis for application in real-world industry projects.
- Apply the principles learned in the AI4RealNet use cases for other automation processes in the focus areas at Fraunhofer IEE.
- Contribute to the dissemination and publication of academic research papers and other material to demonstrate the results of the AI4RealNet project and generate increased interest in AI projects for critical infrastructure.

With this strategy, Fraunhofer IEE is eager to serve as one of the bridges between scientific research and the deployment of AI in real-world applications.

UKASSEL - UNIVERSITAET KASSEL

PARTNER DESCRIPTION: The University of Kassel is a modern university in northern Hesse with a wide range of bachelor's, master's, and pedagogy programs. This young institution, founded in 1971, stands out for forming unusual multidisciplinary and multi-layered networks within Germany under the 'independent comprehensive university' model, maintaining a focus on nature, technology, culture, and society. That is why UKASSEL offers the best conditions for innovative and multidisciplinary research through the multi-layered approach, which focuses on both short and long-term solutions. Within this framework, numerous students and researchers are currently working on various projects to achieve the sustainability goals of the Paris Climate Agreement.

ECOSYSTEM: Among the different departments of the University are the e2n department (Energy Management and Operation of Electrical Networks) and the Intelligent Embedded Systems (IES) department. The former is part of the Competence Center for Decentralized Electric Power Supply Engineering (KDEE) and is closely linked to the Fraunhofer Institute for Energy Economics and Energy System Technology (IEE) at the Kassel site through personnel links. Within the ecosystem, there is also the ITeG department (Research Center for Information System Design), which focuses on social

responsibility regarding the design of IT systems so that IT system designs are socially acceptable in the long term.

FOCUS AREA: The projects developed in e2n are focused on the technically and economically optimised design, control and operation of the future decentralised energy supply system (Smart Grid) with a high share of renewable energies, an important challenge of the energy transition for ensuring a secure, cost-efficient and sustainable energy supply. The IES department focuses on developing deep learning techniques for various application areas such as automotive driving, experimental physics, renewable energy, and energy systems. In the context of the AI4REALNET project, among the innovation resources developed by UKASSEL are the operation, control, and planning of electrical networks through various AI techniques, with a particular focus on RL.

EXPLOITATION GOALS: Primarily focused on research rather than commercial exploitation. UKASSEL aims to continuously apply its acquired research expertise in forthcoming research opportunities. This encompasses showcasing the acquired knowledge and developed code by contributing to open-source code repositories. UKASSEL also aims to disseminate its findings through publications in reputable journals and presentations at conferences, further enhancing the visibility and impact of its research outcomes. Through these measures, we intend to attract the interest of various stakeholders, including academia and industry, within the AI community. Furthermore, an essential objective is to utilise the developed research methods within the project to secure new funding and create proposals for future research projects.

PLANNED EXPLOITATION ACTIVITIES:

- Strengthen and forge novel partnerships with key stakeholders in academia, industry, and Research and Technology Organizations (RTOs) to foster the exchange of ideas, resources, and expertise.
- Increase and enhance contributions to open-source repositories, including both general AI frameworks and projects in the grid control domain.
- Identify and develop extensions for the power grid use cases and seek collaborations with industry and research partners to prepare the acquisition of successor projects that utilise AI to solve complex novel problems in power systems.
- Maximize the visibility and impact of the conducted research work by fostering collaboration and knowledge exchange within the broader community through targeted submissions to journals, participation in conferences, and networking within industry circles.
- Leverage the knowledge generated throughout the project, aiming to attract funding and craft compelling proposals for innovative projects in the field of RL for power system control, focusing on aspects such as robustness, trustworthiness, and explainability.

POLIMI - POLITECNICO DI MILANO

PARTNER DESCRIPTION: The Polytechnic University of Milan is a public institution and the largest technical university in Italy, with about 47,000 students. The university offers undergraduate, graduate and higher education courses in engineering, architecture and design. Founded in 1863, it is the oldest university in Milan. POLIMI is committed to achieving excellence in research. The path to excellence is

developed along the following actions: supporting basic and industrial research activities; developing strategic partnerships with academia and industry worldwide to make a significant contribution to society; developing new interdisciplinary lines of research to address societal challenges; and incorporating scientific developments and research results into university education. Polimi departments are responsible for implementing the mission in their scientific fields.

ECOSYSTEM: Public scientific-technological university that trains engineers, architects and designers. It has always focused on quality and innovation in teaching and research, developing a fruitful relationship with the economic and productive reality through experimental research and technology transfer. Research is increasingly linked to teaching and constitutes a priority commitment that enables the POLIMI to achieve results of a high international level and to realise the meeting between the university and the business world. Moreover, research activity constitutes a parallel path to that of cooperation and alliances with the industrial system.

POLIMI participates in numerous research and training projects, collaborating with the most qualified European and international universities from North America to Southeast Asia to Eastern Europe. Today, the push for internationalisation sees POLIMI participating in the European and global network of leading technical universities and offering numerous exchange and double degree programs and several courses of study entirely in English.

FOCUS AREA: Holistic approach, addressing not only technical challenges but also economic and regulatory aspects of AI deployment, involving the following areas: a) the Artificial Intelligence and Robotics Laboratory, as one of the longest-standing research groups in Italy working on AI, Robotics and Machine Perception, and b) the department of management, economics and Industrial engineering cover other academic areas, addressing the economics and regulation aspects of the AI4REALNET project.

EXPLOITATION GOALS: Partnership with industry to facilitate technology transfer, applied research, internships, and job placements for students. Integrate sustainable practices related to AI into operations, curriculum, and research initiatives to address environmental challenges and promote sustainable development. Provide opportunities for faculty and staff professional development, including training, workshops, and conferences to enhance teaching effectiveness, research productivity, and leadership skills.

PLANNED EXPLOITATION ACTIVITIES:

- Develop online and blended learning programs, collaborate with industry organisations, and provide customised training solutions to offer advanced training and upskilling opportunities to professionals in the workforce in the area of AI for the operation of critical infrastructures.
- Create industry partnerships and file patents for promising innovations in order to bridge the gap between research and industry. For example, bringing research findings from AI4REALNET into practical applications in a timeline of 2-3 years after the project.
- Build strong relationships with potential clients to provide consulting services to government agencies, businesses, and other organisations (e.g., stakeholders of the AI4REALNET projects).
- Develop community-based research projects, offer STEM programs, and organise public lectures and workshops to engage a wider community. Address technical challenges, promote

STEM education, and provide educational resources. For example, POLIMI will organise webinars that collect AI knowledge in the domain of AI4REALNET and make them available to the public.

UvA - UNIVERSITEIT VAN AMSTERDAM

PARTNER DESCRIPTION: The University of Amsterdam (UvA) is the Netherlands' largest university, offering the widest range of academic programmes. At the UvA, 42,000 students, 6,000 staff members and 3,000 PhD candidates study and work in a diverse range of fields connected by a culture of curiosity. The University of Amsterdam promotes an open and curious attitude. UvA considers digitalisation in research transformative to research in all disciplines and the teaching of the future. For this reason, the UvA invests in new areas of expertise, teamwork and a state-of-the-art infrastructure for research and new, innovative teaching methods. This leads to closer cooperation between disciplines – helped by our strength in AI, data science and complexity – and to a smart combination of on-campus and online teaching, allowing for more interaction and a more intensive learning experience.

ECOSYSTEM: The informatics institute (IvI) of the University of Amsterdam is part of a thriving ecosystem around computer science and AI in the Amsterdam region. This includes knowledge institutes, which includes the Vrije Universiteit Amsterdam, the Amsterdam Unversity of Applied Science, and the Centrum Wiskunde & Informatica research institute. Furthermore, the ecosystem includes big technology firms, such as Booking.com, TomTom, Microsoft, Google, and Qualcomm, as well as a productive scene of start-ups and companies of various sizes such as ZetaAlpha, Rhite, UbiOps, ALLAI, BrainCreators, databricks, codam, UIpath, Sensity, etc.

The University of Amsterdam is involved in various networks. For example, the university is strongly involved in the local unit of the ELLIS Society. The informatics institute partners with companies and the public sector in over 15 collaborative 'labs' with multiple PhD students and experienced researchers working on collaboratively defined problems. The institute was and is also part of collaborative projects such as the national "Efficient deep learning" and "Hybrid intelligence" projects and the ERC-funded ELISE network.

FOCUS AREA: The informatics institute focuses on four research teams: AI, Computational Science, Data Science, and Systems & Networking. The AI and Data Science themes are directly relevant to AI4REALNET. The Amsterdam Machine Learning Lab specifically focuses on research in ML, AI, and its applications to large-scale data domains in science and industry. In line with the aims of AI4REALNET.

EXPLOITATION GOALS: The informatics institute of UvA aims to create societal impact through its research and education and aims to develop further collaborations with highly innovative industries. The institute further embraces open science.

PLANNED EXPLOITATION ACTIVITIES: As part of furthering the institute's exploitation goals as it relates to the AI4REALNET project, the following steps will be taken. Advancing open science will be pursued by releasing high-quality open-source code repositories and publishing and participating in high-quality open-access venues such as journals and conferences. This allows wide and inclusive access to research results and, most effectively, allows the research community and industry to build on

obtained research. Research results with innovation potential can be pursued with new industrial partners or existing partners within the consortium or external to it, such as Bosch, Tomtom, Ortec, Qualcomm, NS, etcetera. Such further steps could be pursued within a public-private partnership with the support of the Dutch Research Council or more small-scale in the joint supervision of interns.

TUD - TECHNISCHE UNIVERSITEIT DELFT

PARTNER DESCRIPTION: The Delft University of Technology (Technische Universiteit Delft, TU Delft) is the largest university of technology in the Netherlands, with over 26,000 students. Born from a tradition of 180 years in civil engineering, we have developed a broad research portfolio that, divided across 40 departments and eight faculties, spans practically the entire range of engineering sciences: Architecture and the Built Environment, Civil Engineering and Geosciences, Electrical Engineering, Mathematics & Computer Science, Industrial Design Engineering, Aerospace Engineering, Technology, Policy & Management, Applied Sciences, Mechanical, Maritime and Materials Engineering. The mission is to contribute to solving global challenges by educating new generations of socially responsible engineers and expanding the frontiers of the engineering sciences. The Faculty of Aerospace Engineering conducts research in 5 departments: Space Engineering, Control & Operations, Flow Physics and Technology, Aerospace Structures and Materials. The individuals involved in AI4REALNET bring expertise from the Air Traffic Management (ATM) and Communication, Navigation & Surveillance (CNS) chair and from the Aerospace Human-Machine Systems (AHMS) chair.

ECOSYSTEM: The Faculty of Aerospace Engineering enjoys a long and varied tradition of collaboration with the aerospace sector, both in teaching and research. This includes Dutch and European research projects, in many cases in collaboration with businesses, strategic partnerships with industrial parties, and fostering local entrepreneurship. We host TU Delft's Aerospace Innovation Hub, a community of aerospace-related startups, academics, students, corporates, and industry professionals aiming to support innovations in space technology, solutions enabling the long-term sustainability of aviation, and novel drone technology. At the Control & Operations department, we are involved in various projects via European funding programmes such as Horizon2020, Clean Sky and SESAR. ATM and AHMS research are being conducted within the abovementioned projects and in cooperation with Eurocontrol, LVNL, KLM, DLR, NLR and many universities across the world. Additionally, AI spin-off companies of the TU Delft are located on the TU Delft Campus.

FOCUS AREA: The ATM/CNS chair focuses on studying innovative solutions to aid air traffic controllers but also on studying the dynamics of air transportation as a complex system of inter-acting aircraft, spanning across several domains: conventional air transport, unmanned aerial vehicles and personal air mobility. Methodologies used are big data analysis and traffic simulations, often in combination with the BlueSky open ATM Simulator and data from our ADS-B receiver on top of the roof of our building. The AHMS chair focuses on supporting the human operator in manual and supervisory control tasks by developing innovative human-machine interfaces and clever automation tools. Relevant expertise includes the design of air traffic control ecological interfaces, creating visual representations of the data that aid the understanding of the nature of a control problem and support creative decision-making.

Our objectives within AI4REALNET are the development of an (open-source) extension to the BlueSky open ATM Simulator for the development and testing of AI algorithms on historical or custom ATM scenarios and, subsequently, the development of explainable AI algorithms coupled with ecological user interfaces that will aid air traffic controllers in planning of optimised air traffic flows, to safely and efficiently increase the capacity of the airspace. Our goals, therefore, align with AI4REALNET activities on the development of a common framework for AI tools aiding the optimisation of critical infrastructure, on the development of the AI testing platforms and on the development of transparent, safe and trustworthy AI through explainable AI techniques.

EXPLOITATION GOALS: The assets and knowledge that will be developed through this project might be integrated into our educational program as part of course materials and tools. In addition, our goal is to contribute to the body of research in the fields of ATM/CNS and AHMS. As such, assets and knowledge developed within AI4REALNET will be used by us for scientific publications and presented at relevant conferences. Beyond the project duration, the activities of AI4REALNET are likely to foster additional research, for which the gained knowledge and assets will be exploited. The results of the project will not be exploited financially by TUD.

EXPLOITATION STRATEGY: PLANNED EXPLOITATION ACTIVITIES

- Scientific publications related to the conceptual framework for AI for ATM.
- Scientific publications related to the BlueSky platform for the development and testing of AI algorithms.
- Research and scientific publications related to XAI algorithms for long-term, strategic flight planning to find optimal solutions in terms of safety, efficiency, consistency, predictability and understandability.
- Research and scientific publications related to ecological interface design supporting human understanding of the solutions generated by the XAI algorithms for the above-described cases, as well as supporting their ability to steer the outputs in desired directions.
- Development of educational material related to the above to be presented to the students of TU Delft.
- Research and academic publications on other scenarios exploiting the newly developed open-source BlueSky AI testbed.

LiU - LINKÖPING UNIVERSITET

PARTNER DESCRIPTION: Linköping University is different from many other universities in that it has multidisciplinary departments reporting directly to the vice-chancellor. This is conducive to thinking along new lines and conducting research and education across disciplinary borders. Innovation is LiU's only tradition. Since becoming Sweden's sixth university in 1975, we have conducted world-leading research and boundary-crossing education in close and productive collaboration with society and industry. For almost five decades, we have guided curious, innovative students towards influential roles and successful careers while our researchers have tirelessly investigated the world around us and published groundbreaking findings about its complex nature and functions. With our new strategic plan for 2030, LiU continues its conviction that innovation is our only tradition.

ECOSYSTEM: At LiU, world-leading research is conducted in several important fields of AI. Computer Vision – deep learning in which computers, with the aid of advanced image processing and AI, can draw their own conclusions – is one strong field, while another is knowledge systems and advanced decision support, which requires logical reasoning. A third field is research into the role of humans in the systems, together with how we can maintain the knowledge required to take over if the systems fail. At LiU, AI research extends beyond academia, with strong collaborations with industry partners and governmental agencies. For instance, the Linköpings Universitet Holding AB, LiU Holding, assists in making new research available by bringing it to market. Furthermore, the university's interdisciplinary approach encourages cross-pollination of ideas, bringing together experts from diverse fields to tackle complex challenges. Collaborations between the Department of Computer and Information Science and other departments, such as engineering, medicine, and social sciences, lead to holistic solutions that address real-world problems. LiU's AI ecosystem also extends beyond research, encompassing comprehensive educational programs in AI and related disciplines. Through courses, workshops, and seminars, the university equips students with the knowledge and skills needed to excel in the rapidly evolving field of AI.

FOCUS AREA:

- Advancing the frontiers of knowledge and research with a firm commitment to global perspectives, diversity, gender equality, and equal opportunities.
- Educational programs are continually refined to remain relevant and engaging for both current and future students. Through our own research successes and the integration of external knowledge, we ensure that innovation and topicality are at the core of our academic offerings.
- Contribute with new knowledge and innovations for a sustainable future. By integrating the global goals of Agenda 2030 into all aspects of our operations, we aim to position ourselves as a coveted partner for collaboration in the quest for sustainable societal transformation.
- Advance our role as a long-term competency resource and knowledge hub across all sectors—business, public, and civil society.

EXPLOITATION GOALS: Capacity building and consultancy. Public software repositories (GitHub via AI-on-demand platform) to facilitate enhancement and reusability in future projects and scientific publications. Base knowledge for future R&D projects. Consultancy and training for AI developers /industry (AI users).

PLANNED EXPLOITATION ACTIVITIES: Mainly interested in the research exploitation model, aspiring re-utilisation of the research know-how acquired in future research activities. From a commercial exploitation model, we are interested in founding spin-offs and start-ups to commercially exploit the developed research results.

ENLITEAI - ENLITEAI GMBH

PARTNER DESCRIPTION: Technology provider for AI specialised in RL and Computer Vision/geoAI. Our customers are medium-sized and large enterprises from the DACH region from a wide range of industries. enliteAI is always looking for motivated employees who actively support us on our way.

ECOSYSTEM:. Strategic partnerships with leading academic institutions, research organisations, and industry players. These collaborations facilitate knowledge exchange, access to cutting-edge research, and the integration of emerging AI technologies into practical applications. Moreover, ENLITEAI is committed to nurturing talent and fostering the next generation of AI professionals. Through internships, training programs, and collaborations with universities, the company provides opportunities for students and young professionals to gain hands-on experience and contribute to meaningful AI projects. In addition to research and talent development, ENLITEAI places a strong emphasis on ethical AI practices and responsible innovation. Active member of ELISE - European Learning and Intelligent Systems Excellence.

FOCUS AREA:

- Detekt is a modern geospatial data platform supporting the entire mobile mapping and asset management life cycle.
- Developers of MazeRL, one of the first open-source frameworks for applied RL.
- Power Grid Optimization by achieving adaptability and reliability with RL.

EXPLOITATION GOALS: Expand its presence in key target markets by entering in new sectors and industries, offering consultancy and development services on the top of the open-source MazeRL library. By developing new AI-based products and services tailored to specific industries or use cases, the company aims to enhance its competitive edge and unlock new revenue streams. Forge strategic alliances with key industry players, technology partners, and research institutions.

PLANNED EXPLOITATION ACTIVITIES: Interested in the commercial exploitation model, providing the project results to the end users. We are interested in the technological exploitation model, delivering products and/or services built on top of the project results. Use the project's results to improve business performances and open new opportunities with a sustainable business model.

RTE - RTE RESEAU DE TRANSPORT D'ELECTRICITE

PARTNER DESCRIPTION: France's Transmission System Operator (TSO) in charge of 105 000 km of high and ultra-high-voltage lines and 50 interconnections with neighbouring European countries: the transmission system links electricity producers to consumers and links France to its European neighbours while guaranteeing the constant balance between production and consumption and between imports and exports. RTE oversees 3 main missions – develop, maintain, and operate the electrical system to enlighten the public authorities by publishing schedules and forecasts, support and accelerate the energy transition, and provide everyone with 24/7 access to safe and clean electricity. RTE is a public utility company composed of 9,500 employees, among whom 500 are involved in real-time operations (flow management & balancing). It was established in 2000 in the application of the law requiring the establishment of a TSO separated from generation utility.

ECOSYSTEM: To successfully complete the energy transition in accordance with the EU's objectives, transmission systems must continuously come up with novel solutions. RTE's R&D department includes around 140 people and allows RTE to be actively involved in European research programs seeking to develop technological innovations, standardisation activities, and worldwide cooperation through more than a hundred partnerships. RTE is also strongly involved in the international experts'

community, such as CIGRE, where it is convening a Working Group on the impact of the growing use of ML/AI in the operation and control of Power Networks from an Operational perspective.

RTE strongly supports open science and open source. It is an active member of Linux Foundation Energy (LFE), which is an open-source foundation supporting projects that provide a unified approach to developing non-differentiating code to enable the world's power systems to transform rapidly to electrification. For example, LFE is hosting OperatorFabric, a project initiated by RTE in 2019. It is a modular, extensible, industrial-strength platform that facilitates operational activities for utilities in electricity, water, and other domains. The Grid2Op framework is another open-sourced digital environment developed by RTE that will be used in the AI4REALNET project.

FOCUS AREA: RTE is preparing grid operations for the 2030 horizon with higher shares of renewable energy in the electric system, which increases situations atypicality, complexityand modelling risk. Starting from the strong conviction that the human operators (dispatchers) must remain at the centre of the decision-making for managing the flows, RTE is working on several R&D projects to enhance human decision-making with the help of virtual assistants. To promote open science and improve the attractivity of the AI community, RTE has run multiple challenges to create a near real-time assistance module for the dispatchers that offers recommendations for strategies aimed at safely managing overloads on the electrical lines: see Paris Region AI Challenge for Energy Transition, April 2023.

EXPLOITATION GOALS: The AI4REALNET project is directly linked with other projects already carried out by RTE in the domain of assisted decision-making for grid operators, with a human-centred approach. Thus, RTE expects to reuse the results and acquired knowledge from the project (see KERs of the project) in future research work and in internal projects with high Technical Readiness Levels (TRL). RTE should benefit from the theoretical work done with the other academic and research partners to facilitate the integration of AI systems in control rooms. Besides, by addressing several use cases for critical infrastructure operations, the project's results should attract the community of AI researchers more broadly than if only the electricity use cases were addressed. AI4REALNET project will also bring new features to the open-source Grid2Op framework that will, in turn, serve the whole open-source community.

PLANNED EXPLOITATION ACTIVITIES:

- Disseminate results via conferences, technical reports, position papers, and public consultations.
- Internal dissemination action towards the operation department and control room staff.
- Reuse the results and acquired knowledge from the project in future research work, as well as in internal projects that shall improve the management of the power system in the Energy Transition context (leveraging on the electricity use cases studied in the project).
- Update the open-source repo for Grid2Op with new features (and update the open-source repo for other complementary tools of Grid2Op with new features, as the case may be).
- Continue organising AI competition, leveraging AI4REALNET's notoriety and dissemination of its results.

TENNET - TENNET TSO BV

PARTNER DESCRIPTION: As the Transmission System Operator (TSO) for the Netherlands and a significant part of Germany, TENNET owns and operates over 25,000 kilometres of high-voltage lines and cables. We deliver electricity to 43 million domestic and business users safely and reliably, 24 hours a day and 365 days a year. With over 7,400 employees in two countries, we are driven by our mission to ensure the lights stay on and that power is available at the flick of a switch whenever and wherever you need it. To do this, we design, build, maintain and operate a high-voltage grid stretching across land and sea. This carries electricity from where it is made – including a rapidly increasing proportion of wind and solar energy – to where it is used. We carry it over the ground, underground, under the sea and across borders, over our rapidly expanding high-voltage grid. With a service level as high as 99.99963 %, we are one of the best in the world at our job.

ECOSYSTEM: As international TSO, we are literally connected to many of our stakeholders and other organisations in the electricity system. We collaborate with other European TSOs we are either directly or indirectly connected to, such as distribution system operators (DSOs), connected parties such as generation and load units, and market parties to collaboratively maintain a reliable grid. This collaboration consists of several topics, from alignment on network development planning to grid operations. Many of these collaborations and alignments are part of our involvement in the European Network of Transmission System Operators for Electricity (ENTSO-E), Regional Control Centres (RCC) or Cigré. Additionally, the ministries and regulators are important stakeholders for TenneT.

FOCUS AREA: As the energy transition speeds up, TENNET's grid faces unprecedented strain, which is only expected to intensify. Rising electricity demand and production, coupled with unpredictable peaks from renewables, strain the grid's capacity. To address this, TENNET prioritises expanding the grid and deploying assets for efficient power flow management. In 2023, the company invested approximately 8 billion euros in grid expansion. However, as grid expansion is very costly, TENNET also increases its focus on using the existing assets more efficiently. This will not only limit the required grid expansion but also ease the pressure on the grid for the coming years that are needed to build the electricity grid of the future. The Control Room of the Future program at TENNET has, therefore, initiated the GridOptions project that aims to optimise the grid by providing decision support on remedial actions to manage congestion to provide the required transport capacity in a reliable and efficient way.

EXPLOITATION GOALS: The goal of TENNET's involvement in the AI4REALNET project is twofold. Firstly, the goal is to bring in our experience with the development of AI algorithms that can propose remedial actions for congestion management. Secondly, the goal is to leverage the outcomes of AI4REALNET on the level of AI models as well as improvements in the Human Machine Interface and integrate relevant outcomes in our decision support tool. As TENNET is innovating with an open mindset, it is collaborating with other European TSOs to share developed functionalities, which increases the output of TENNET and the other TSOs. AI4REALNET is an open-source project, so this fits well within the TSO collaborations.

PLANNED EXPLOITATION ACTIVITIES: To ensure the results of AI4REALNET will be leveraged to benefit society, TENNET will implement relevant outcomes of the project into its internal decision support tooling. During the project, the TENNET colleagues working on the internal decision support tool will, therefore, also work on AI4REALNET. This means that the AI4REALNET results will be used as soon as they are available during the project.

DB - DB INFRAGO AG

PARTNER DESCRIPTION: The Deutsche Bahn AG is Germany's national railway company and a state-owned enterprise under the control of the German government. Headquartered in the Bahntower in Berlin, it is a joint-stock company (AG) and the largest railway company in the world. Deutsche Bahn is the second-largest transport company in Germany after the German postal and logistics company Deutsche Post / DHL. DB provides both long-distance and regional transport, serving around 132 million long-distance passengers and 1.6 billion regional passengers in 2022. In 2022, DB transported 222 million tons of cargo.

ECOSYSTEM: DB InfraGO AG has established a robust AI ecosystem aimed at revolutionising infrastructure management within the DB Group. At the core of this ecosystem lies a dedicated team of AI specialists, engineers, and data scientists united by a shared vision of leveraging cutting-edge technologies to optimise railway operations and enhance passenger experience. Strategic partnerships with leading technology providers, research institutions, and startups further enrich DB InfraGO AG's AI ecosystem. Collaborations facilitate knowledge exchange, access to innovative AI solutions, and exploring new opportunities for enhancing railway operations and service delivery. Through training programs, workshops, and hackathons, employees are empowered to explore emerging AI technologies, experiment with new ideas, and contribute to the evolution of the company's AI ecosystem.

FOCUS AREA: Leveraging cutting-edge technologies, particularly AI, to revolutionise railway infrastructure management. It aims to optimise operational efficiency, enhance passenger experience, and ensure the reliability and safety of railway systems. Additionally, it harnesses AI-powered predictive analytics to optimise resource allocation and scheduling across the railway network, e.g., optimising train schedules, allocating resources efficiently, and improving infrastructure asset utilisation.

EXPLOITATION GOALS: Staying at the forefront of technological advancements in railway infrastructure management. Leverage open-source, in particular from the Flatland digital environment, to create strategic partnerships and a culture of innovation to explore emerging AI technologies and develop transformative solutions for the vehicle (train) re-scheduling problem. These new AI-based developments might influence and shape the way modern traffic management systems are implemented not only in railways but also in other areas of transportation and logistics.

PLANNED EXPLOITATION ACTIVITIES:

- Forming partnerships with technology providers, research institutions, and startups to access innovative AI solutions, stay abreast of technological advancements, and explore new opportunities for improvement. The new human-AI interaction use cases to be implemented in the Flatland environment will be fundamental for this exploitation activity.
- Fostering a culture of innovation within the organisation through training programs, workshops, and hackathons, empowering employees to experiment with new AI technologies and contribute to the evolution of railway network management.
- Use project results in standardisation activities and policy-making actions.

NAV - NAVEGACAO AEREA DE PORTUGAL

PARTNER DESCRIPTION: The Air Navigation of Portugal — NAV Portugal, E.P.E., is a public business entity responsible for providing air traffic services - Air Traffic Control Service, Flight Information Service, and Alerting Service - within the two major areas under Portugal's responsibility: The Flight Information Regions (FIRs) of Lisbon and Santa Maria. NAV Portugal, E.P.E.'s mission is to provide air traffic services within the FIRs under the responsibility of the Portuguese State – Lisbon and Santa Maria – ensuring compliance with applicable national and international regulations and the highest standards of safety, optimising the utilisation capacities of airspace and airport infrastructures, improving the efficiency of the services provided, and promoting environmental sustainability. In this context, NAV Portugal must guarantee its customers high-quality and efficient service, creating value for the State as the holder of all its statutory capital, and ensure high levels of professional qualification and motivation among its staff.

ECOSYSTEM: A key contributor to the Single European Sky ATM Research (SESAR) initiative, NAV Portugal operates within a dynamic ecosystem aimed at advancing air traffic management and airspace modernisation across Europe. Positioned as a leader in aviation technology and innovation, NAV Portugal plays a critical role in enhancing safety, efficiency, and sustainability within the European airspace. At the core of NAV's ecosystem are state-of-the-art air traffic management systems equipped with advanced functionalities such as trajectory prediction, conflict detection and resolution, and collaborative decision-making tools. These systems enable NAV Portugal to optimise airspace utilisation, minimise delays, and enhance the overall capacity and performance of the European ATM network. NAVs' ecosystem is further enriched by strategic partnerships with industry stakeholders, research institutions, and regulatory bodies. NAV actively engages in research and development activities, contributing to the continuous evolution of SESAR solutions and technologies. By participating in SESAR research projects and trials, NAV Portugal remains at the forefront of ATM innovation, testing new concepts and methodologies to improve operational efficiency and air traffic flow management.

FOCUS AREA: Air traffic management support system, aeronautical infrastructure, safety, free route airspace, Critical Incident Stress Management.

EXPLOITATION GOALS: NAV Portugal anticipates leveraging the outcomes and expertise gained from the project to enhance internal initiatives with advanced TRL. Specifically, this involves integrating new requirements into technical specifications to augment the capabilities of human air traffic controllers. Integrating NAV's use cases and innovative features into the BlueSky digital environment will enable NAV to benefit from theoretical advancements from academic and research partners, facilitating the seamless integration of AI systems into control rooms. Moreover, this initiative will foster a community of AI researchers dedicated to advancing air traffic management.

PLANNED EXPLOITATION ACTIVITIES:

- Disseminate results via conferences, technical reports, and position papers.
- Internal dissemination action towards the operation department and control room staff.

- Reuse the results and acquired knowledge from the project in future endeavours, including internal projects aimed at enhancing operational efficiency, streamlining processes, and advancing technological capabilities within the organisation.
- Use the findings and insights derived from the project to actively contribute to standardisation efforts within the industry, ensuring that best practices and innovative AI-based solutions are adopted and implemented uniformly. Additionally, leverage the project results to inform policy-making decisions, advocating for evidence-based approaches and driving regulatory frameworks that promote safety, efficiency, and sustainability in air traffic management.

ZHAW - ZURCHER HOCHSCHULE FUR ANGEWANDTE WISSENSCHAFTEN

PARTNER DESCRIPTION: The ZHAW Centre for Artificial Intelligence (CAI) is a hub for excellence in applied AI research and application. Our mission is to advance human-centric and trustworthy AI research in Switzerland, thereby providing students with career opportunities in the AI sector, attracting young talent and addressing the significant challenges of our time through innovative use of AI. Expertise in the following areas: Autonomous Learning Systems (RL, multi-agent systems, and embodied AI), Computer Vision, Perception and Cognition (Pattern recognition, machine perception, and neuromorphic engineering), Trustworthy AI (Trustworthy ML, Robust deep learning, AI & society), AI Engineering (MLOps, Data-Centric AI, Continuous Learning), and Natural Language Processing (Dialogue systems, text analytics, and spoken language technologies). Together with the ZHAW Institute of Data Analysis and Process Design (IDP), we drive an ambitious agenda in applied responsible AI research.

ECOSYSTEM: Created the first interdisciplinary academic research centre for data science in continental Europe, the ZHAW Datalab, in 2013. Out of this initiative, a thriving national and European ecosystem around data-intensive products and services emerged, including the national association Data Innovation Alliance (with the goal to bring businesses and research institutions together to co-create innovation), the IEEE Swiss Conference on Data Science (a unique business and academic conference on all aspects along the data science value chain), and the European Association for Algorithmic Fairness. Furthermore, we have been instrumental in the formation of the Confederation of Laboratories for Artificial Intelligence Research in Europe (CLAIRE), host the Swiss office of CLAIRE in Zurich and are members of large European research excellence networks like TAILOR and AI4Media.

FOCUS AREA: Research and development; technology transfer via applied R&D projects in collaboration with industry or creation of start-ups, mainly in AI, data science, and informatics. One example of a start-up launched by ZHAW in AI is AlpineAI, which makes generative AI and large language models safe and valuable in a corporate or governmental context. An example of an applied R&D collaboration is the DISTRAL project on industrial process monitoring for injection molding with distributed transfer learning in conjunction with Kistler Instrumente AG.

EXPLOITATION GOALS: Mainly focused on the research exploitation model, aspiring re-utilization of the research know-how acquired in future research and development activities that attract interest from academia, start-ups, and SMEs from the AI community. On top of the developed software and experience in deploying AI technologies, the results of commercial exploitation with partners are also expected. Centred on the research exploitation model, ZHAWs' primary goal is to leverage the

acquired research expertise for continual application in forthcoming applied research and development endeavours as well as in teaching. This involves not only creating a robust repository of knowledge but also contributing to the development of open-source code and open-access publications. Such results are explicitly disseminated to captivate the attention of diverse entities from academia, start-ups, and SMEs beyond the core AI community. On top of the developed software and experience in AI technologies, the commercial exploitation of the results by industrial partners is also expected, leveraging our long-term partnerships with operators of critical infrastructures such as SBB or via the FLATLAND Association.

EXPLOITATION STRATEGY: PLANNED EXPLOITATION ACTIVITIES

- Enhance and create new partnerships with key stakeholders in academia and industry to facilitate the exchange of ideas, resources, and expertise. The participation in associations (e.g., CLAIRE, FLATLAND) will be instrumental, as well as the involvement in the national Swiss data-based business ecosystem.
- Leverage ZHAW experience in preparing advanced courses for industry and provisioning of consultancy services using the gained R&D knowledge to organize capacity-building programs for industry and organisations and also offer specialised consultancy in the area of AI for the operation of critical infrastructures (and generally human-AI collaboration).
- Leverage our established strength in technology transfer to transition the research findings from AI4REALNET into practical applications on a timeline of 2-3 years after the project. The idea is to depart from the 6 project's use cases but collaborate with industrial partners from and outside the consortium to identify new use cases where AI brings added value and co-develop solutions that address real-world challenges.
- Actively contribute to academic publications, conferences, and industry events to showcase our research findings.
- Explore partnerships with start-up and SMEs to support the growth of their products by integrating the knowledge generated during the project, in the areas of human-AI collaboration and socially compatible deployment of AI, as well as in evaluation frameworks for AI (e.g., robustness, resilience, interpretability).

Beyond the project duration, ZHAW expects to promote demonstration objects showcasing the practical applications of our research. This will generate tangible examples of the value proposition of our work to attract industry partnerships and additional funding.

FHNW - FACHHOCHSCHULE NORDWESTSCHWEIZ

PARTNER DESCRIPTION: One of the leading universities of applied sciences and comprises 9 universities in the fields of life sciences, applied psychology, architecture/construction and geomatics, design and art, music, education, social work, technology, and economics. The FHNW School of Applied Psychology (APS) was established over fifteen years ago. It is now one of the leading centres of excellence for occupational, organisational, and business psychology in German-speaking Europe. The school's key objective is to make use of professional and scientific psychology in society, the economy and the world of work and business. With innovative research-based psychology, the APS makes an interdisciplinary contribution to the humane design of the working and professional world and to the

development and dissemination of humane offers in its fields of design and innovation. The APS is at the forefront of testing and practising the technically sound design approaches and innovations that it develops together with its project partners.

ECOSYSTEM: The research groups are involved in a large number of national and international applied research projects. In these networks, we work on interdisciplinary projects to develop solutions with the aim of making work more human and thus contributing to increasing the effectiveness and efficiency of work organisations. We share the latest findings from research and development in applied psychology with society by periodically organising a number of regional and national events and exchange platforms where we present and discuss our latest findings with representatives from academia, industry and authorities (especially regulators). We are also involved in expert groups and academies (e.g., the Swiss Academy of Engineering Science, where Prof. Dr. Toni Wäfler is a member of the Industry 4.0 expert group) and cooperate with local promotion agencies. Our Digital Innovation Lab is a place where we work on user experience, usability, virtual technologies and innovation.

FOCUS AREA:

- APS focuses on the domains of work and business and their interfaces with other areas of life. We work closely with the other specialist disciplines that are active in these domains.
- The primary goal of APS activities is to research and design the fit between people, technology and organisation. On the one hand, we pursue a human-oriented approach to the design of work, with the aim of designing working conditions humanely (adapting work to people). On the other hand, we are equally concerned with the selection and qualification of the human workforce (adapting people to work).
- APS prefers to support proactive, innovative design projects aimed at the (further) development and promotion of organisational, social, and personal resources. In this way, we take a proactive approach to work design in order to avoid reactive and corrective measures as far as possible.

EXPLOITATION GOALS: The APS focuses on integrating research findings into programs at the BA and MA levels and into postgraduate continuing education, with a particular emphasis on incorporating practical insights into teaching. A further key priority is to ensure that the knowledge generated directly informs projects at regional, national, and international levels. This approach ensures that APS research outcomes make a direct and sustainable contribution to the development of educational and project solutions across different contexts.

PLANNED EXPLOITATION ACTIVITIES: Dissemination of the results in conferences, journals, and position papers. Integration of the results into educational and further educational programs. Integration of results and acquired knowledge from the project into future research.

SBB - SCHWEIZERISCHE BUNDESBAHNEN SBB

PARTNER DESCRIPTION: Connecting Switzerland, SBB is the backbone of the Swiss public transport system. We have been transporting goods and people for over 100 years. SBB connects people, goods, and places, bringing millions of people together and linking cities, cantons, and rural regions. Day in and day out, our connections are there for Switzerland. SBB is a reliable partner of the Swiss

government, cantons, municipalities, and suppliers. Integrated rail is the heart of what we do. It comprises the business areas of passenger services production, passenger services markets, real estate, infrastructure, and freight services. This is SBB's core business, which is run in the interest of our customers. Its foundation is the railway infrastructure with its rail, energy, and telecoms networks. By 2030, SBB intends to be economically stable and to anticipate customer needs better, providing a public service for Switzerland. SBB also aims to deliver targeted and smart growth in areas where rail has its strengths, to be a leader in sustainability and to provide a railway run by people, for people.

ECOSYSTEM: Strategic partnerships with regional transportation authorities, local municipalities, and international railway operators further enrich SBB's ecosystem. Collaborations enable seamless interconnectivity between different modes of transportation, such as trains, buses, trams, and ferries, facilitating convenient and sustainable mobility options for passengers throughout Switzerland. Moreover, SBB actively engages in research and development activities to drive innovation and stay at the forefront of technological advancements in the railway industry (where the Flatland initiative is one example). Collaborative projects with academic institutions, industry partners, and startups foster the co-creation of new solutions and the exploration of emerging trends, such as autonomous trains, electrification, and digitalisation. A subsidiary, SBB GmbH, manages passenger transportation in Germany, specifically operating the Wiesentalbahn and Seehas services. Other subsidiaries include THURBO, RegionAlps, AlpTransit Gotthard AG, Cisalpino, and TiLo, with the latter being a joint venture with Italian authorities. Swiss Federal Railways also has significant stakes in Zentralbahn and Lyria SAS.

FOCUS AREA: Sustainability is a key pillar of SBB's ecosystem, with a commitment to reducing carbon emissions, minimising environmental impact, and promoting eco-friendly transportation alternatives. It also places a strong emphasis on the use of AI to optimise various aspects of railway operations and enhance passenger experience. Use AI-powered analytics to optimise train scheduling and resource allocation, allowing SBB to improve punctuality, reduce congestion, and enhance the overall travel experience for passengers.

EXPLOITATION GOALS: By participating in the Flatland community, SBB can share best practices and benchmark algorithms and contribute to the advancement of AI technologies in railway operations. Moreover, by harnessing the power of simulation technology, SBB expects to accelerate the development and deployment of AI solutions, ultimately enhancing the efficiency, reliability, and sustainability of railway operations. These collaborative projects will enable the co-creation of new solutions and the exploration of emerging AI trends, such as intelligent transportation systems.

PLANNED EXPLOITATION ACTIVITIES:

- Forming partnerships with technology providers, research institutions, and startups to access innovative AI solutions. The new human-AI interaction use cases and features to be implemented in the Flatland environment will be fundamental for this exploitation activity.
- Fostering a culture of innovation within the organisation through training programs, workshops, and hackathons, empowering employees to experiment with new AI technologies.
- Use project results in standardisation activities and policy-making actions.

FLATLAND - FLATLAND ASSOCIATION

PARTNER DESCRIPTION: The Flatland Association and the Flatland framework aims to empower industry partners, academic researchers and the broader Flatland community to achieve an unprecedented level of interdisciplinary research and translation into industry applications. Our mission is to open new avenues for innovation dedicated to solving a class of resource allocation problems applied to various industry use cases by actively inviting and enabling all kinds of methodological approaches. Our vision is that Flatland is a central hub for open research, providing a space for highly specialised interest groups and cross-disciplinary exchange. To that end, Flatland provides a rigorous, technical problem formulation and the standard benchmark recognised by both industry and the academic research community. Our expertise lies in a) the development of a digital environment to simulate use cases related to research allocation problems with a focus on railway and vehicle rescheduling problem, b) the enabling of ML approaches to tackle the challenges of these use cases, and c) in facilitating translation of ML research into industry practice.

ECOSYSTEM: Intersection between research and industry. FLATLAND has a strong network with the members of the Flatland Association and is part of a larger ecosystem with industry partners, technology companies, and research institutions all over the world. Further, FLATLAND has a strong community of ML and operations research researchers and software developers who have an integral part in developing the open-source Flatland framework.

FOCUS AREA: Digital environment for ML research; resource allocation problem focusing on railway use cases; problem formulation for industry use cases and translation of research results to industry application.

EXPLOITATION GOALS: Leverage the extension of the Flatland framework and the wealth of knowledge garnered from the railway use cases. The aim is to develop open-source tools and establish industry problem benchmarks that will serve as invaluable resources for fostering long-term applied AI/ML research. By providing an open-source AI-friendly simulation environment and standardised benchmarks, FLATLAND seeks to catalyse innovation, collaboration, and advancement in the field of AI for railway operations, ultimately driving progress and addressing real-world challenges within the mobility sector. It is worth noting that the vehicle dispatching problem has broader applications beyond rail transportation and can be adapted to address similar challenges in other domains, including bus and logistics transportation.

PLANNED EXPLOITATION ACTIVITIES:

- Extension of the Flatland framework for applications across industry use cases to enable ML/AI research beyond the scope of the AI4REALNET project and into future use cases by providing a high-quality and well-documented open-source code repository.
- Extend the FLATLAND network into new industries, grow the community to connect relevant stakeholders, and foster industry-research collaborations.
- Run an ML/AI competition with the AI4REALNET use cases during the project to attract interest and get novel solutions to the use cases.

- Create a platform with ongoing long-term benchmarks for the use cases that allow the community and academic partners to experiment with the use cases and develop novel solutions beyond the end of the AI4REALNET project. Further, the benchmarks serve as a model for other industry partners on utilising open research to tackle real-world challenges. Active contribution to scientific publications.

2.3 OPEN-SOURCE STRATEGY

Oopen-source software (OSS) plays a crucial role in the AI market by facilitating adoption, reducing bias, and influencing competitive dynamics. Through its collaborative and community-driven development model, OSS serves as a catalyst for innovation and ensures fairness and transparency in AI technologies. This approach fosters usability, functionality, and collective intelligence, allowing for simultaneous design and testing phases that bypass traditional intellectual property constraints (Nichols and Twidale, 2002; Kogut and Metiu, 2001). Both the public and private sectors benefit from OSS, as it provides the flexibility and creativity necessary for innovation. Additionally, OSS projects often set *de facto* standards, promoting interoperability and reducing compatibility issues across software and platforms. Standardisation will be crucial for the seamless integration of technologies in diverse software landscapes (Henley and Kemp, 2008).

Finally, the open model ensures the longevity and independence of OSS projects, making them not reliant on the financial or strategic decisions of any single entity. However, AI initiatives face several challenges that must be addressed to realise their full potential. These challenges range from technical hurdles, such as data access and algorithm complexity, to broader issues, such as community engagement, legal and ethical considerations, societal challenges to gain social acceptance and trust in the technology from both citizens and civil servants, and risk management (Rossi, 2018; Kaur et al., 2022).

2.3.1. INTELLECTUAL PROPERTY RIGHTS AND LICENSES IN OSS

Before navigating through OSS and its valorisation strategy, it is important to be aware of the IPRs that can cover the different intellectual property assets produced in AI4REALNET. Particularly how the different rights are influenced or not by the freedoms given by open-source licenses (freedom to use, modify, and distribute the original and derivative work).

IPR are multifaceted and plays a crucial role in OSS strategy, particularly in the governance, distribution, and development routes chosen. IPRs are crucial, particularly in the realm of OSS, as they provide a legal foundation that balances the protection of original works with the principles of openness and collaboration and expands the valorisation routes (namely via an IP-based model, combining trademark registering and dual licensing). These rights are manifested in various forms, including:

- **Copyrights** protect creative expression and not ideas. Among the works protected by copyrights are computer programs and electronic databases, if the last has an original structure. Hence copyrights are the primary rights covering software and electronic databases, and OSS licenses are legal documents where the owner of the rights permits

others to use, modify, and distribute their work under certain conditions as long as the 4 freedoms are kept.

- **Patents** can also play a significant role in OSS, particularly in areas such as software algorithms, in which patent claims can affect the use and distribution of OSS. Some OSS projects require contributors to grant patent licenses to all software users, preventing any single entity from facing innovation through patent litigation.
- **Trademarks** protect the names and logos associated with OSS projects, ensuring that the software's identity and reputation are not misused. While not directly affecting the software's code, trademarks help maintain quality and trust in OSS projects by ensuring that only genuine versions or distributions carry the project's name.

A recognised OSS license by either an Open-Source Initiative or a Free Software Foundation will never restrict the use of software (freedom zero). However, they do place some obligations on how modified software is redistributed (freedom three), such differences create the two major categories of OSS licenses:

- **"Permissive" OSS licenses:** typically give the freedom to make, use, modify, and share software, but with the right to develop proprietary derivative works. They usually have very light-touch requirements, such as keeping copyright notices and disclaimers in the code. Examples include BSD, MIT, and Apache.
- **"Restrictive OSS licenses:** typically give the freedom to use, modify and share the software, but with a requirement to provide a licence to the modified software on the same terms. Examples include Gnu public licence (GPL) and Mozilla Public Licence (MPL).

However, the obligations of an open-source license are mostly triggered when you distribute software. There are other differences, namely how they relate to patent rights, that must be considered when choosing the best-fitting OSS license; a summary of the most common OSS licenses is presented in Table 10. A short description of the licenses can be found in Annex 3.

License	Commercial use	Distribution	Modification-on	Patent use	Private use	Disclose source	License and copyright notice	Network use is the distribution	Same license	State changes	Liability	Trademark use	Warranty
EUPL	X	X	X	X	X	X	X	X	X	X	X	X	X
MIT	X	X	X		X		X				X		X
MPL	X	X	X	X	X	X	X		X		X	X	X
GPL	X	X	X	X	X	X	X		X	X	X		X
APACHE 2.0	X	X	X	X	X		X			X	X	X	X
BSD 2nd	X	X	X		X		X				X		X
BSD 3rd	X	X	X		X		X				X		X
LGPL	X	X	X	X	X	X	X		X	X	X		X
AGPL	X	X	X	X	X	X	X	X	X	X	X		X
EPL	X	X	X	X	X	X	X		X		X		X

TABLE 10 - VISUAL SUMMARY OF THE LICENSE'S CHARACTERISTICS

AI4REALNET builds upon existing knowledge and expertise readily available in the open-source domain, complemented by associated licenses. Table 11 presents the list of pre-existing OSS (background) that will be used in the project.

Pre-existing software assets (background)	Short description	Related KERs	Partner(s)	Licenses
Maze-RL: Applied Reinforcement Learning Framework	Application-oriented RL framework to a) enable AI-based optimisation for a wide range of decision processes and b) make RL as a technology accessible to industry/developers.	2-5, 7	ENLITEAI	MazeRL Software License
Grid2Op digital environment	AI-friendly virtual environment for running sequential decision-making scenarios for electricity network operations by an AI agent and/or a human.	8	RTE, Fraunhofer, TENNET	MPL-2.0
Flatland digital environment	AI-friendly digital environment was developed for easy development and experimentation with the vehicle rescheduling problem for railway networks.	8	SBB, DB, FLATLAND	MIT
BlueSky digital environment	A multi-platform software tool for fast-time and real-time realistic air traffic simulation was developed as a tool to perform R&D on ATM and air traffic flows, which achieves high fidelity without using proprietary data.	8	TUD	GPL-3.0

TABLE 11 – LIST OF PRE-EXISTING OSS USED IN AI4REALNET

In the upcoming chapter, we will explore how we preview strategically use the Open Source IPR Strategy to safeguard intellectual property rights while uncovering the essential pathways for exploiting our key results within AI4REALNET.

2.3.2. AI4REALNET ROADMAP FOR IPR AND OSS MANAGEMENT

The OSS strategy must be defined holistically, assuring that conditions are given for a community to drive but also that risks are mitigated. To successfully implement an OSS strategy with a holistic IPR strategy, a systematic approach needs to be in practice, and AI4EALNET is adopting the methodology described in this section.

APPROACH

- **Continuous assessment of the project goals and needs:** Assessing the goals and needs along the development of the project allows us to understand the intended use, distribution model, potential commercialisation avenues, and any unique requirements related to IP.

- **Identification of IPR risks and opportunities:** Conduct a comprehensive analysis to identify potential risks and opportunities related to IP. This includes assessing a patent landscape, a trademark landscape, potential conflicts with partners and third-party IP, and an obligatory software compliance analysis. But also identify the project's licensing needs.
- **Holistic IPR approach –** Identifying the IPRs available for each type of KER and identifying the best fit according to its valorisation strategy (e.g., economic, social impact) and commercialization strategy (e.g., IP-based, service base).
- **Critical evaluation of "freedom 0" in OSS –** As any recognised OSS license will never restrict the use of software (freedom zero), it is morally important to evaluate the potential of misuse of the original software for other applications that can cause harm to others. If this risk is identified, AI4REALNET can create a custom license, restring the use of software and mitigating risks and misuse.
- **Evaluate the type of support to be given to the community –** identify if support is going to be given to the user community, and if so, who will support the users of the software during the project, but above all after the project.
    - Will each owner of the software give support individually via their own OSS platforms in GitHub?
    - Will the AI4REALNET create its own OSS management team? Or will the SW be managed by a company (e.g., ENLITEAI) or a foundation (e.g., LF Energy) or via an AI-on-demand platform? This is particularly relevant for community engagement with the tools being delivered by AI4REALNET and the sustainability of the project.
- **Define a governance model –** with clear policies for releasing code, policies for accepting contributions from external entities, compliance, and promotion of adoption for each type of KER developed.
- I**ntegration of IPR considerations into the development processes:** Integrate IPR considerations into the project's development processes and workflows. This includes incorporating IP reviews into code contributions, maintaining clear documentation of licensing obligations, and conducting periodic audits of project assets.
- **Monitoring and quality control:** Implement monitoring and quality control procedures for OSS compliance, including contributions from third parties. These procedures are detailed in Deliverable D6.3 – Quality Management and Risk Mitigation Plan.
- **Code of conduct:** A code of conduct, which is a social contract that encourages good behaviour and discourages bad behaviour in a community, will be adapted from the Contributor Covenant, version 2.1.

GOVERNANCE

Clearly defining roles and responsibilities is essential to effective OSS community management. Governance is the rules or customs by which projects decide who gets to do what or is supposed to do what, how they're supposed to do it, and when. In phase 1 of the AI4REALNET project, the following governance principles were defined:

- The pre-existing open-source code and projects (background of the AI4REALNET project – see Table 11) will follow their own development cycle and autonomous management in separated

repositories (forked to AI4REALNET GitHub). Thus, AI4REALNET adopts a distributed control governance model for OSS.

- The following roles were defined:
  - **Maintainer:** INESC TEC. Responsible for leading and maintaining the project, setting goals and objectives, making decisions about development direction, solving technical issues, enforcing code of conduct, and collaborating with others to ensure all stakeholders' needs are met.
  - **Contributor:** INESC TEC, Fraunhofer, ZHAW, IRTSX, UKASSEL, POLIMI, UvA, TUD, RTE, TENNET, ENLITAI, FLATLAND. Partners who contribute directly to the project, from coding to documentation to testing. Help promote awareness of the open-source project through public speaking and other activities.
  - **User:** SBB, DB, NAV, LiU, DB, FHNW. Integrate or use the OSS assets in their company or be involved in software testing and requirements specification.
  - These roles can be changed upon request from each partner.
- The consortium encourages external contributions to open-source projects upon specific request from the project coordinator (approval of contributions is made with consensus in the consortium).
  - The contributions should follow the quality control guidelines from Deliverable D6.3 (available in the GitHub repository).
  - For external contributions, a contributor agreement will be required that clarifies IPRs and licensing terms for contributions to the project. This will ensure that contributors understand their obligations and rights regarding IPR, such as copyright and trademarks, among others. Nevertheless, alternative schemes like "inbound=outbound" (contributions are accepted under the same license as the project distributes its code) or Developer Certificate of Origin (it is a statement developers give with each commit by including a "Signed-off-by" statement in the commit message) can be considered to be a low barrier for third party contributions. Automating that process as much as possible is beneficial, e.g., using a Contributor License Agreement assistant.

Along the project, and if necessary, a more formal governance structure will be created if the number of external contributors increases. The basis for the governance model will be the Minimum Viable Governance.

DEVELOPMENT AND RELEASE APPROACH

AI4REALNET will adopt a well-defined release management process to plan and execute software releases effectively. It will follow semantic versioning principles to convey the significance of changes accurately and provide release notes highlighting new features, enhancements, and bug fixes to keep users informed. These releases will be aligned with the project deliverables, namely:

- D1.2 Digital environment – Version 1 (M18)
- D1.3 Digital environment – Version 2 (M24)
- D1.4 Digital environment – Final Version (M36)

- D2.2 AI fundamental blocks – beta release (M18)
- D2.4 AI fundamental blocks – final release (M30)
- D3.2 AI-powered decision-making beta software release (M30)
- D3.3 AI-powered decision-making final software (M42)

The project will also adopt a culture of continuous improvement by iteratively enhancing the software based on user feedback and research advancements.

PLATFORMS

Platform	Description	Role in AI4REALNET
GitHub	Internet hosting service for software development and version control using Git. It provides the distributed version control of Git, plus access control, bug tracking, software feature requests, task management, continuous integrations, and wikis for every project. It is commonly used to host open-source software development projects.	Version control. Main repository of the project results; A repository was created for AI4REALNET: https://github.com/AI4REALNET
AI-on-demand (AIoD)	Facilitator of knowledge transfer from research to multiple business domains. It is a one-stop shop for anyone looking for AI knowledge, technology, tools, services, and experts. A new version was recently released under the scope of the AI4EUROPE project in 2024.	The OSS assets from AI4REALNET will be made available on the AI-on-demand catalogue. The possibility of integrating the digital environments with the AIoD is also a possibility to explore in the future.
Linux Foundation	Neutral, trusted hub for developers and organisations to code, manage and scale open technology projects and ecosystems. It provides turnkey technology and support programs for developer enablement, business operations, training and certification, marketing and events, and membership development to help projects scale fast.	It will be considered as a potential hub for exploitation beyond the project duration, leveraging the active involvement of RTE in this domain.

TABLE 12 – PLATFORMS RELEVANT TO AI4REALNET

LICENSES

The European Union Public License (EUPL) is AI4REALNET default, and it should be unless there is a specific reason not to, such as a) compatibility with pre-existing OSS implementations/licenses (as indicated in Table 11), b) the main audience for this release is a community which has standardised around another license, or c) the revenue streams compatible with OSS licenses (see Table 13).

Licences	Revenue Streams
MIT, Apache, BSD (2-clause and 3-clause)	Dual Licensing, Support and Services, SaaS (Software as a Service), Contributions and Donations
GNU GPL, LGPL, AGPL	Commercial Licensing, Support and Consultancy, Contributions, Compliance and Integration Services
Mozilla Public License 2.0 (MPL), Eclipse Public License (EPL)	Support and Development Services, Dual Licensing, Certification Programs, SaaS
European Union Public License (EUPL)	Cross-Border Services, Subscription Models, Partnerships and Funding

TABLE 13 - LICENCES AND REVENUE STREAMS

COMMUNITY ENGAGEMENT

Stakeholders' engagement and consultation ensure that the goals of an open-source initiative are agreed upon and understood. A stakeholder is considered any individual or group that is affected by, can influence or may have an interest in the outcomes of an open-source project. During the project, partners could thus consult the following stakeholders:

- Other open-source communities, in particular, the AI-on-demand platform.
- Domain-specific stakeholders (network operators, AI developers),
- Other critical infrastructures (e.g., water, ICT, offshore/ocean infrastructures),
- Research groups in AI and MSc/PhD students. The competitions that will be organised with the digital environments are an excellent opportunity to increase the academic community and make them long-term contributors to OSS development.
- Standardization bodies.

To increase this engagement, the following actions will be taken:

- Make it easy for someone to use the project by making available clear code examples and documentation.
- Clearly explain how to contribute, using your CONTRIBUTING file and keeping your issues up to date.
- Explicitly labelling issues that are simple enough for beginners to tackle.
- Promote the open-source digital environments through various channels, including conferences, workshops, blogs, and academic publications. The showcase of these real-world use cases will attract users and contributors. Moreover, it promotes collaboration with industry partners, research institutions, and government agencies outside the consortium.

2.4 KEY EXPLOITATION ROUTES

Routes for exploiting KERs refer to pathways for leveraging the potential benefits or outcomes identified within a project or initiative. These routes typically involve actions or plans aimed at maximising the value or impact of the KERs. Table 14 outlines possible routes that will be explored in the next phases of the project.

Route	How	Who
IPR Licensing Agreements	Analyse OSS IPR strategy licensing for AI building blocks and AI-based decision systems.	ALL
Spin-off Companies	Creating spin-off companies dedicated to developing and commercialising specific KERs or technologies.	INESC TEC, IRTSX, Fraunhofer, UKASSEL, POLIMI, UvA, TUD, ZHAW, FHNW, LiU
Collaborative Research and Development	Exploring partnerships with industry players to jointly develop and implement AI building blocks and KERs into new products, services, or processes.	INESC TEC, IRTSX, Fraunhofer, UKASSEL, POLIMI, UvA, TUD, ZHAW, FHNW, LiU, FLATLAND

Route	How	Who
Industry Partnerships	Forming partnerships with industry players to jointly develop and implement KERs into new products, services, or processes.	RTE, TENNET, DB, SBB, NAV, and ENLITAI ensure internal and external exploitation channels for the results of the project.
Public-Private Partnerships (PPPs)	Collaborating with public and private entities to further develop and deploy KERs in real-world applications. *Examples of PPP already in execution or planned: Adra-e, AI4EUROPE, projects funded under CL4-2022 HUMAN02-01, European network of AI excellence (e.g., ICT-48-2020), and ICT-49-2020*	ALL
Knowledge Transfer and Exchange	Organising workshops, seminars, and conferences to share project findings, KERs, and best practices with a broader audience. Participation in conferences and events. Liaison and cross-fertilisation with stakeholders, projects.	ALL
Training Programs	Developing training programs to disseminate knowledge and skills acquired during the project to relevant stakeholders.	INESC TEC, IRTSX, Fraunhofer, UKASSEL, POLIMI, UvA, TUD, ZHAW, FHNW, LiU
Open Innovation and Collaboration Platforms	Use open-access platforms or repositories to share project data, software, and other KERs with the broader research community and industry stakeholders. *Strategies considered: Use of public software repositories (GitHub and AI-on-demand platform) to facilitate enhancement and reusability in future projects, scientific publications.*	ALL
Collaborative Networks	Joining collaborative networks and consortia to exchange knowledge, resources, and expertise with other European projects and initiatives. *Networks established within the project partners: CLAIRE and ELLIS General Assemblies/thematic workshops; EPRI AI and Electric Power Summit; JRC AI Watch (energy & mobility); OECD-AI; SESAR events (AI); CIGRE WG on AI; CANSO Strategic Technology Workgroup; and Europe's Rail.*	ALL
Policy Influence and Advocacy	Generating policy briefs and recommendations based on project findings and KERs to influence decision-making at the national and European levels.	RTE, TENNET, DB, SBB, NAV,
Advocacy Campaigns	Engaging in advocacy campaigns to raise awareness of the project's outcomes and promote the adoption of KERs by relevant stakeholders and policymakers. *Examples: Open digital environments and competitions (Flatland, L2RPN, etc.); Participation in conferences and events. Liaison and cross-fertilisation with stakeholders, projects*	RTE, TENNET, SBB, DB, NAV, FLATLAND
Venture Capital, Funding Opportunities, and European Funding Programs	Pitching project outcomes and KERs to venture capitalists, angel investors, and other funding sources to secure additional financing for further development and commercialization. Explore the European Funding Programs.	RTE, TENNET, DB, SBB, NAV, ENLITAI

TABLE 14 - POTENTIAL ROUTES FOR EXPLOITATION

In the next phase of the exploitation activities, workshops with partners will be implemented to design a detailed strategy aligned with the characteristics and motivations of each partner. The last version of the exploitation plan will include a clear strategic approach for exploitation, per each KER, and a roadmap for implementation.

3. STAKEHOLDERS AND RELATED INITIATIVES

A Stakeholder is defined as an entity that can influence or is impacted by the decisions of another organisation. This includes individuals, groups, or organisations with a legitimate relationship to the organisation[5]. As stakeholders hold in-depth knowledge of their own needs and are essential to creating trustworthy systems tailored to specific applications, we plan to engage them since the beginning of the project to support the project's efforts and results. Stakeholder collection and identification will occur throughout the project, with periodic reinforcements facilitated by all seventeen partners through an online survey. We have selected the LimeSurvey Platform, a dependable open-source survey tool, for this purpose (full detail of all questions in the survey, see Annex 4). The survey was launched in January and has captured 48 stakeholders so far, as reflected in the preliminary list of stakeholders, according to the different application fields of the project (Figure 1 to Figure 5).

[5] Stakeholder | European Foundation for the Improvement of Living and Working Conditions (europa.eu)

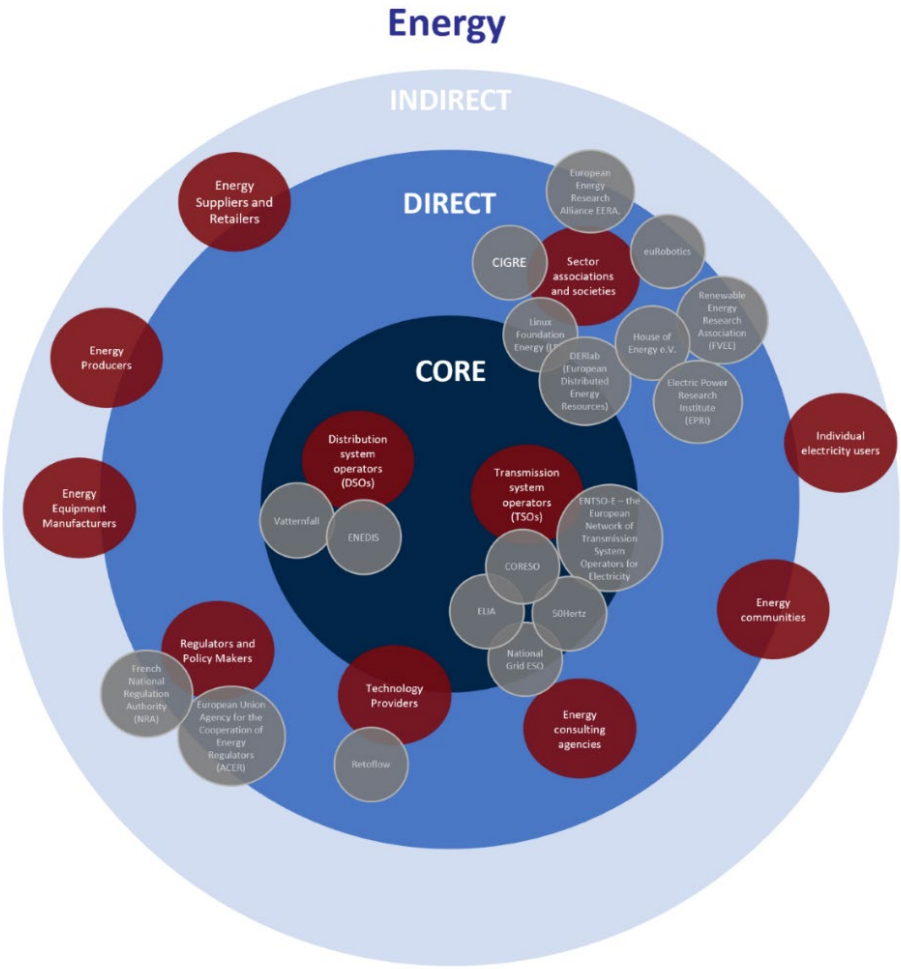

FIGURE 1 - ENERGY SECTOR STAKEHOLDERS IDENTIFIED

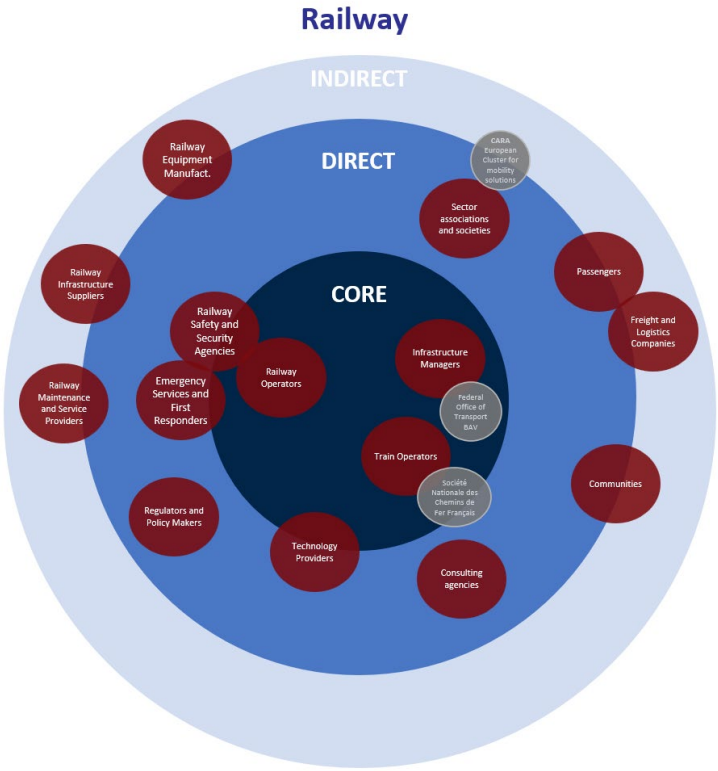

FIGURE 2 - RAILWAY SECTOR STAKEHOLDERS IDENTIFIED

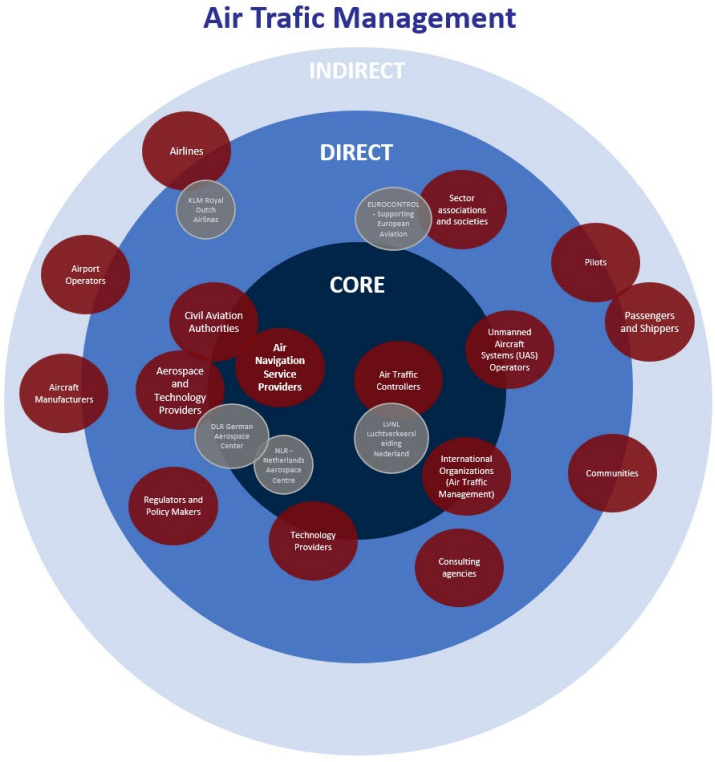

FIGURE 3 - AIR TRAFFIC MANAGEMENT SECTOR STAKEHOLDERS IDENTIFIED

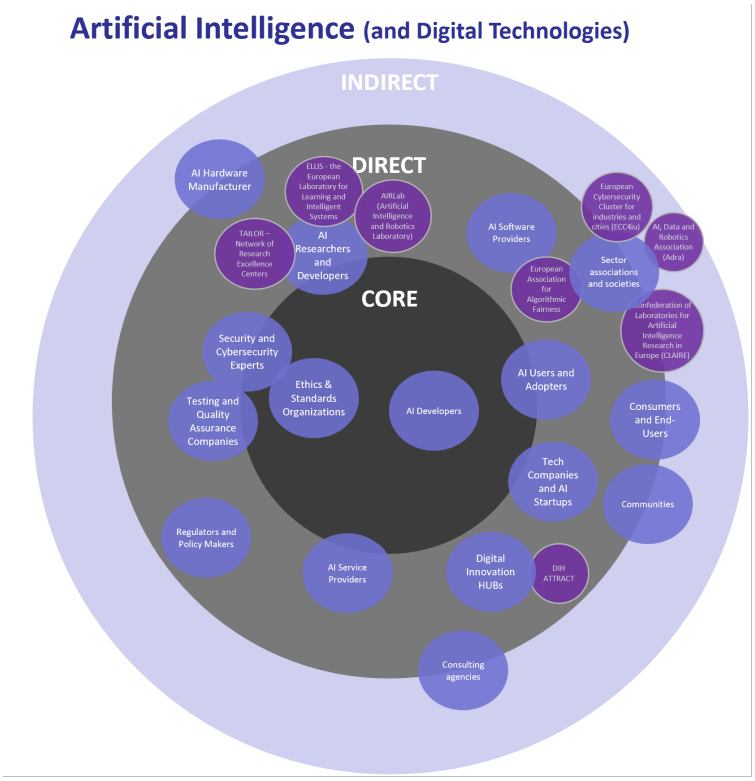

FIGURE 4 - AI SECTOR STAKEHOLDERS IDENTIFIED

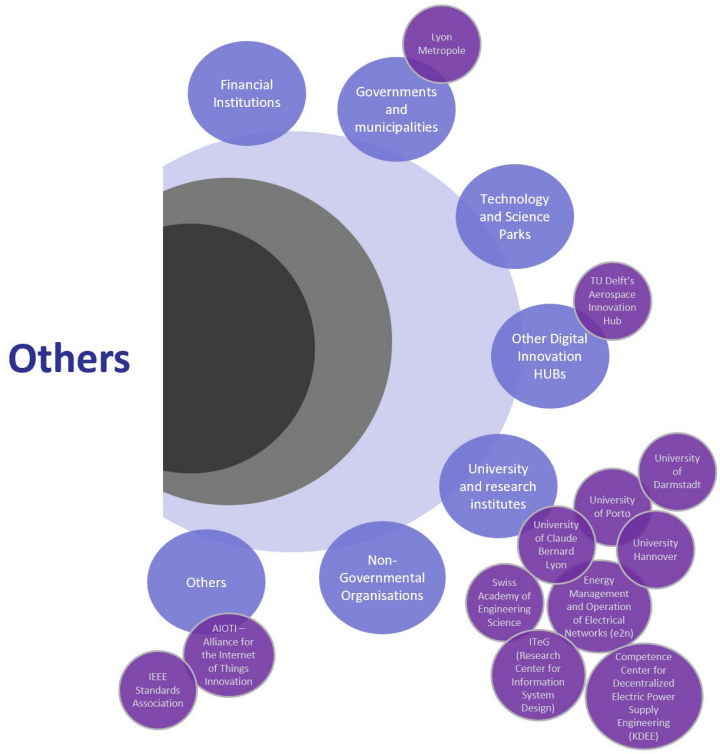

FIGURE 5 - OTHER STAKEHOLDERS IDENTIFIED

This process will continue throughout the project. By nurturing collaborations with the stakeholders, our objective is to cultivate a dynamic innovation ecosystem that fosters the advancement of technological innovation within the domain of AI applied to Critical Systems.

Additionally, we will pinpoint strategic opportunities to collaborate with related initiatives that align with our objectives, thereby accelerating the future utilisation and adoption of AI4REALNET outcomes. During the development of the proposal and the project, AI4REALNET partners identified and committed to collaborating with initiatives that are strategically important for achieving the full impact of the results. These initiatives include Ai4Europe|AI-on-Demand, Adra-e, Horizon Results Booster, and EDIH, among others.

4. MARKET OVERVIEW AND BUSINESS MODEL

4.1 TARGET MARKET ANALYSIS

OPEN SOURCE AND AI TRENDS

The global market for open-source services is expected to grow rapidly. It reached $25.6 billion in 2022 and is projected to reach $54.1 billion by 2027, according to research by MarketsandMarkets (2022)[6]. In 2021, interviews with IT leaders worldwide found that 65% of enterprises plan to start using open-source software. The main reasons cited for this shift are the agility, flexibility, and reliability of open-source services, along with lower overall costs (Cormier, 2022). The same source valued the global Human Machine Interface market at $3369.8 million in 2024 and estimated that it would reach $5674.8 million by 2031[7].

Additionally, the community effect and the increasing number of open-source software vendors, coupled with advancements in technologies, are contributing to this trend. Open-source software is particularly crucial in the development and implementation of AI. A complete landscape of players building open-source tools for AI development is presented in Figure 6, with more than seventy players of more than 15 categories, including AI development platforms.

[6] https://www.marketsandmarkets.com/Market-Reports/open-source-services-market-27852275.htmlgad_source=1&gclid=CjwKCAiA6KWvBhAREiwAFPZM7lkjdm_eNkWycG4aJFkM3tU7rhNYCLfYZVVC9USRfJMx9qqE2t0f9RoCRBwQAvD_BwE

[7] https://www.linkedin.com/pulse/2031-human-machine-interface-hmi-market-size-share-jcjtf/

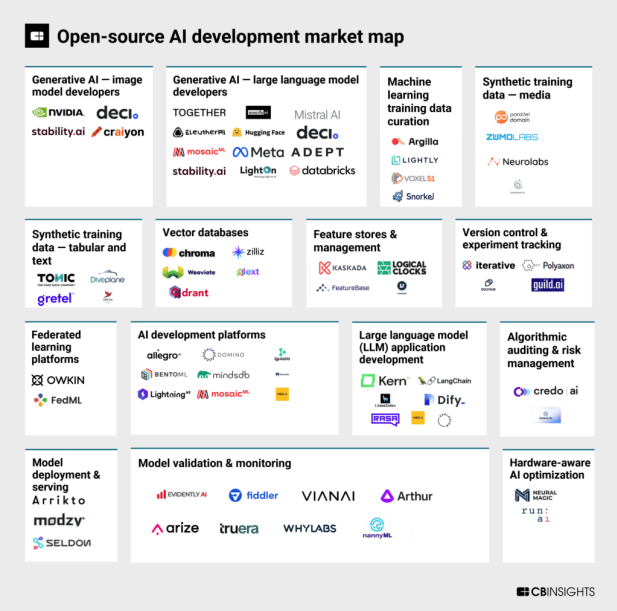

FIGURE 6 – OPEN-SOURCE AI DEVELOPMENT ECOSYSTEM

Source: https://www.cbinsights.com/research/open-source-ai-development-market-map/

A study conducted by the Economist Intelligence Unit in 2021 shows that European companies see AI/ML as their top IT investment priorities over the following years. Accenture highlights that businesses that successfully apply AI could increase profitability by an average of 38% by 2035.[8]

ENERGY SECTOR

According to Prescient Strategic Intelligence (2019), the global AI in the energy management market was valued at $4,439.1 million in 2018 and was expected to generate $12,200.9 million in revenue in 2024, exhibiting a compound annual growth rate (CAGR) of 19.8% during the forecast period. In another report on AI in Energy Market Size for the period of 2021-2031[9], the energy market is projected to reach $19.8 billion by 2031. The drivers pointed for market growth are an increase in demand to make grids smarter and satisfy the requirements of changing energy systems.

AI is being employed more and more in the trading of power, smart grids, and the fusion of the transportation, heat, and electricity industries. AI services also support the integration of AI solutions into core business functions and processes. The application fields pointed out by the report are safety and security, demand forecasting, renewables management, robotics, and infrastructure, among others. By application, the safety and security segment is the highest revenue contributor to the market, with a CAGR of 18.0%, Major key players in this sector have been identified: ABB Ltd., Accenture plc, Amazon Web Services Inc., Autogrid Systems, Inc., C3.ai, Centrica plc, Cisco Systems Inc.,

[8] https://www.cbinsights.com/research/open-source-ai-development-market-map/

[9] Source: "AI in Energy Market Size, share, Competitive Landscape and trend analysis by component type, by application, by end user, by deployment type: Global opportunity analysis and industry forecast for 2021-2031" report, retrieved from: https://www.alliedmarketresearch.com/ai-in-energy-market-A12587

General Electric, HCL Technologies, Huawei Technologies Co., IBM Corporation, Intel Corporation, Mitsubishi Electric, Schneider Electric, and Senseye.

AIRSPACE SECTOR

Driven by rising air passenger traffic, the global ATM market is projected to grow from $11.50 billion in 2021 to $16.11 billion in 2028 at a CAGR of 4.93% (Markets and Markets, 2022)[10]. In 2018, the Thales Group announced the OneSKY program with AI as one technology to manage 11% of the world's airspace, according to Fortune Business Insights report (2022). According to the International Air Transport Association, investment capital of around USD 1,2 to 1.5 trillion is estimated to be spent in infrastructure development up to 2030 (Fortune Business Insights, 2022).[11] New airports will need efficient air traffic management services, equipment, and software solutions in the forthcoming years. This is expected to boost air traffic management and consulting market growth during the forecast period.

Several airports around the world are incorporating AI technology into their air traffic control systems to improve efficiency, safety, and capacity. While the specific implementations and extent of AI usage may vary, here are a few examples of airports that are known to be utilising AI technology in air traffic control[12]:

- London Heathrow Airport, United Kingdom: Heathrow Airport has been exploring the use of ML/AI algorithms to optimise runway operations, predict flight delays, and manage air traffic flow. The airport has collaborated with tech companies and research institutions to develop AI-powered solutions for air traffic management.
- Singapore Changi Airport, Singapore: Changi Airport has implemented AI-based systems to enhance runway scheduling, aircraft movement planning, and air traffic flow management. The airport leverages predictive analytics and ML algorithms to optimise runway utilization and minimise delays.
- In Norway, the "Remote Towers" solution was implemented in the first phase in 15 airports in 2019 and in 2021 in six more. For pilots operating aircraft, there are no differences in procedures.
- Helsinki Airport, Finland: Helsinki Airport has deployed AI-driven software solutions to improve air traffic management, aircraft routing, and runway operations. The airport utilises AI algorithms to analyse real-time data, predict traffic patterns, and optimise flight trajectories for maximum efficiency.
- Seattle-Tacoma International Airport, United States: Sea-Tac Airport has adopted AI technology to optimise air traffic flow, reduce congestion, and improve safety.

[10] https://www.marketsandmarkets.com/Market-Reports/air-traffic-management-market-160955838.htmlgad_source=1&gclid=CjwKCAjw17qvBhBrEiwA1rU9w1lTSI9jgBIXBqsAw6wzkXoCEgHqx1hUTPKJOx6nOSrx3nF5avWQhRoCkMUQAvD_BwE

[11] https://www.fortunebusinessinsights.com/industry-reports/air-traffic-management-market-101813

[12] https://www.linkedin.com/pulse/ai-powered-digital-towers-future-airport-operations-agus-setiawan-zqumc/

- Dubai International Airport, United Arab Emirates: Dubai Airport has invested in AI-based air traffic control systems to enhance operational efficiency and capacity. The airport employs AI algorithms for airspace optimisation, traffic prediction, and route planning, enabling smoother and more efficient aircraft movements.

However, there are, according to the same report, some restraining factors such as high costs associated with the deployment of ATM and consulting solutions that involve huge hardware costs, such as monitors, communication systems, displays, radars, surveillance systems, navigation, and others. These systems are comprised of modern technology and complex engineering for development. Another key restraining factor to this market growth is the rising sophisticated cyber-security attacks at airports in a scenario with heavy reliance on ICT and navigation systems to run operations.

In conclusion, the integration of AI-powered systems in airport operations has revolutionised various aspects of airspace management, conflict detection, and decision support. By leveraging AI technologies, such as ML and predictive analytics, airports are equipped to enhance controller decision-making processes. These systems provide real-time insights and predictions, facilitating proactive measures to mitigate potential conflicts and optimise traffic flow. Furthermore, the use of AI enables more informed and timely decisions, improving overall efficiency and safety within airport operations. As a result, airports can achieve smoother traffic management and precise route planning and ultimately enhance the overall passenger experience.

The key sector payers are Thales Group, Raytheon Technologies Corporation, Indra Sistemas, S.A., L3Harris Technologies, Inc., Northrop Grumman Corporation, Honeywell International, Inc., BAE Systems PLC, Saab AB, Lockheed Martin Corporation, and Capgemini S.E.

RAILWAY SECTOR

According to Markets and Markets Research (2022), the global digital railway market is expected to expand at a CAGR of 8.4% through 2024, and Straits Research expects global IT spending in railways to increase at a 9.8% CAGR through 2026[13]. The driving factors are the penetration of digital infrastructure and the requirement for automated and autonomous rail operations.[14] However, high installation costs and infrastructure changes to the existing system are expected to restrain the market's growth during the forecast period. According to KBV report (2022), the market growth factors are the following[15]:

- Railway operators require a variety of digital railway solutions, such as traffic management tools, passenger information systems, and passenger analytics, to effectively manage passenger traffic and deliver high-quality transportation services to an increasing number of passengers. These solutions improve client travel experiences while boosting the effectiveness of railroad operations.
- As an effect of globalisation, travel needs ask for an increase in speed, security, and dependability. Therefore, regardless of the distance travelled or the anticipated number of

[13] https://www.marketsandmarkets.com/Market-Reports/digital-railway-market-206122052.html

[14] https://airwaysmag.com/artificial-intelligence-air-traffic-control/

[15] https://www.kbvresearch.com/digital-railway-market/

steps needed to reach the destination, the next railway transportation ecosystem must provide solutions to satisfy the demand from source to destination with a high quality of service.

- TThere is an absence of robust rail infrastructure in developing countries that still do not have the resources to upgrade their train systems. Investment in rail infrastructure becomes more important than the digitisation of the infrastructure for nations lacking robust train networks. The deployment of cutting-edge digital technology requires a robust train infrastructure and a robust communication system. Only when used at a particular degree of scale are some digital technologies, like traffic management or passenger analytics, effective.
- The Digital Railway Market is bifurcated into solutions and services (see Figure 7). The solution segment acquired the highest revenue share in the Digital Railway Market in 2021. To maintain a good service level across their network, transportation companies are under pressure to strengthen and invest in their current infrastructure and resources as the number of rail trips increases year over year.

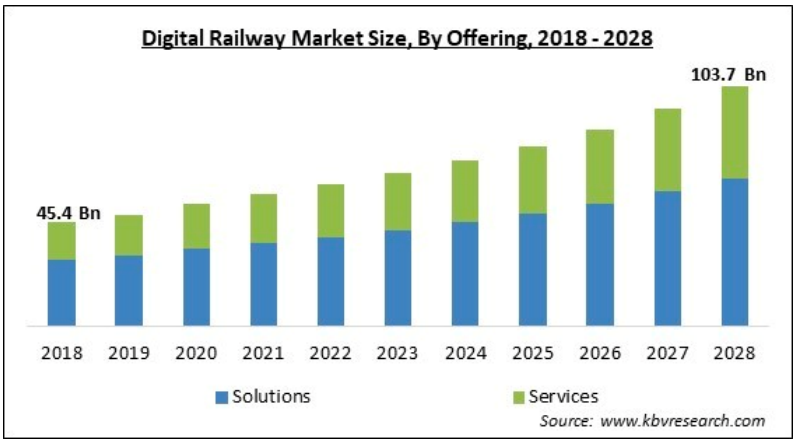

FIGURE 7 – DIGITAL RAILWAY MARKET SIZE – SOLUTIONS AND SERVICES

Source: https://www.kbvresearch.com/digital-railway-market/

MAIN TAKEAWAY

In conclusion, the integration of AI technology within AIREALNET key application markets holds immense potential for revolutionising operational efficiency, safety, and sustainability. By harnessing AI's capabilities, these industries can benefit from real-time decision-making, leading to enhanced reliability and cost-effectiveness. Moreover, AI-powered solutions offer the opportunity to mitigate risks and improve resilience in complex and dynamic environments, ensuring smoother operations and minimising disruptions.

4.2 INITIAL BUSINESS MODEL

This section introduces the initial Business Model AI4REALNET grounded on the framework of Business Model Canvas (BMC) (Osterwalder and Pigneur, 2010). AI4REALNET will adopt the concept of the open business model as a subclass of business models that explore ecosystem collaboration and will be a decisive and novel element of value creation. The design of the business model and exploitation roadmap will take special attention to technology adoption requirements (legal, technological, ethical,

and organizational), respect the community practices and settings, and consult with representatives of the open-source supply chain.

The following revenue streams are considered: a) dual licensing & 'open core' (IP-based), b) service-based, and c) voluntary donations. The 'open core' model will build on the KERs, presented in Section 2.1 into its freely available open core (freemium) and other features that help enterprises extract additional value from the solutions, such as enhanced interface, adapters with third-party software, security, and high availability, go into the commercial license. The service-based model will be mainly focused on using the open-source software to upsell consultancy services (expertise in XAI, robustness and safety assessment of AI, RL), maintenance, integration with third-party software, and providing advanced training courses.

Moreover, since AI4REALNET creates social and environmental value, a donation model to maintain the open-source code can also be set up. The business model will be revised during the project, mainly to adapt to up-to-date, real-life conditions and feedback from different stakeholders. Having this first BMC as a departing point (see Figure 9), scenarios will be constructed with the key partners taking into account the different segments of market trend analysis and value propositions.

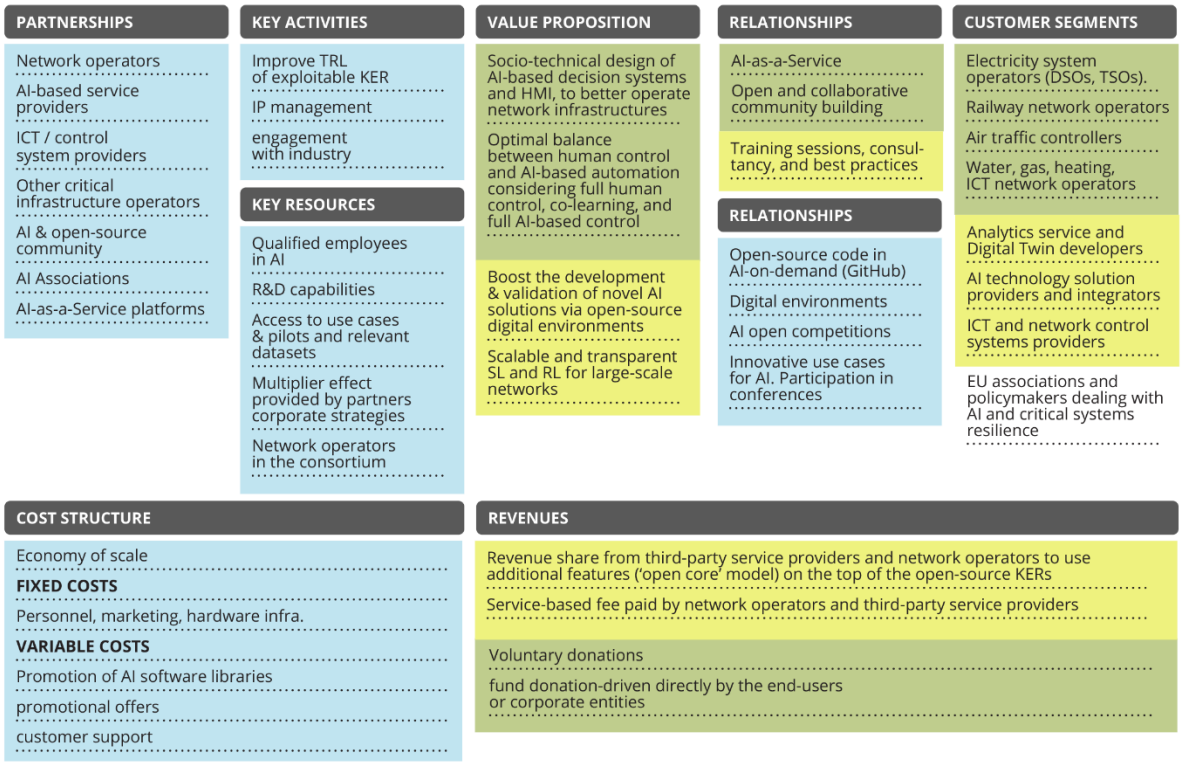

FIGURE 8 – INITIAL BUSINESS MODEL

This initial iteration of the BMC serves as a foundational step in our project journey, laying the groundwork for further exploration of its potential outcomes. Moving forward, we will implement a lean start-up methodology to gather validation inputs from users and stakeholders. This approach will enable us to unlock the full value and impact of the project by iteratively refining our strategies based

on real-world feedback. By embracing this methodology, we aim to maximise the effectiveness of our efforts and ensure that we realise the project's objectives to their fullest extent.

5. CONCLUSIONS AND NEXT STEPS

In crafting the initial version of our exploitation plan for the KER derived from our AI4REALNET project, we have laid the foundation for unlocking the full potential of our research and innovation endeavours. Through a collaborative and participative approach of all partners, we have identified many routes for exploiting the KERs, each presenting unique opportunities for maximising the impact of the AI4REALNET project.

As we move forward, we will focus on implementing the following steps outlined in the Description of Action. This involves delving deeper into the various routes identified, conducting thorough assessments of their feasibility and potential outcomes, and charting a course that aligns closely with our overarching objectives. We will proceed with the Lean Startup methodology, ensuring a user-centred process of reviewing and validating. We will prioritise intellectual property management, safeguarding our valuable KERs through open-source strategies to ensure their long-term sustainability and impact. It is in our plan to identify the value proposition, establish the open-source components, the customer segments, revenue mechanisms, and revenue model and develop an extensive BMC for each KER. At the same time, we will continue to identify and engage with stakeholders, including project partners, potential end-users, and the wider scientific community. Their feedback will be invaluable in refining the exploitation strategies.

With ongoing exploitation activities, AI4REALNET aims to realise the full potential of project outcomes. We are committed to advancing a vision that encompasses making meaningful contributions to society and fostering innovation-driven growth through collaborative discussions with all partners and stakeholders.

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ANNEX 1 – KER CHARACTERIZATION TEMPLATE

KER Name	
Problem	*Describe the problem you are addressing (the problem your potential users have).* *Potential users are the people, companies, organisations, etc. that you expect will use the result (and generate an impact). They are your "Customers".*
Current Solution	*Describe how your "customer" has solved the problem so far.*
Unique Selling Point (USP) & Unique Value Proposition (UVP)	*Describe the competitive advantages, the innovative aspects. What does your solution do better, what are the benefits considering what your user/customer wants, how does your solution solve his/her problem better than alternative solutions, what distinguishes the KER from the competition/current solutions?*
Description	*Describe in a few lines your result and/or solution (i.e. product, service, process, standard, course, policy recommendation, publication, etc.). Use simple wording, avoid acronyms, make sure you explain how your UVP is delivered.*
Market: Target market	*Describe the market in which your product/service will be used/can "compete", answering the following questions:* *- What is the target market?* *- Which are the customer segments?*
Market: Early Adopters	*Early adopters are the "customers" you are willing to address first. They are usually the ones that feel the problem harder than all the others. (they are not the project partners).*
Market: Competitors	*Who are your "competitors" (note: they are the ones offering "alternative solutions")?* *What are their strengths and weaknesses compared to you?*
Go to Market: Use model	*Explain what is your "use model", how the KER will be put in use (made available to "customers" to generate an impact). Examples of use models: manufacturing of a new product, provision of a service, direct industrial use, technology transfer, license agreement, contract research, publications, standards, etc. Note training is a service.*
Go to Market: Timing	*What is the time to market?*
Go to Market: IPR Background	*What is the Background (type/ partner)?*
Go to Market: IPR Foreground	*What is the Foreground (type/ partner)?*

ANNEX 2 – TEMPLATE TO COLLECT PARTNERS INDIVIDUAL EXPLOITATION PLAN

PARTNERS' EXPLOITATION PLAN
CONTEXT
PARTNER DESCRIPTION Provide a brief description of your institution, its vision and mission. Add some background information and your core competencies. ECOSYSTEM What is your ecosystem and how do you connect to other relevant stakeholders in your region and beyond? Additionally, list some existing networks. FOCUS AREA What are your focus areas? Further, if possible, how do they align with the project's mission and activities?
EXPLOITATION STRATEGY
EXPLOITATION GOALS Describe your institution's exploitation goals. PLANNED EXPLOITATION ACTIVITIES Describe the concrete actions and steps to achieve their exploitation goals.

ANNEX 3 – OSS LICENSES UNDER CONSIDERATION

Description of the licenses under consideration
The European Union Public License (EUPL) is an open-source license tailored to the legal framework of the European Union. It is specifically designed to be compatible with various national laws of EU member states, making it unique among open-source licenses. The EUPL allows the use, modification, and redistribution of licensed software, both within the EU and internationally, under the same terms as the license itself. A key feature of the EUPL is its compatibility with other popular open-source licenses, such as the GPL, allowing for the integration of EUPL-licensed software with projects under different licenses. This compatibility is facilitated through a list of compatible licenses explicitly mentioned in the license text, aiming to foster greater interoperability, and sharing within the open-source community.
The MIT License is one of the most popular and permissive open-source licenses. It allows users nearly unrestricted freedom to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the software, provided that the original license and copyright notice are included with any substantial distribution of the software. Its permissiveness encourages widespread use and incorporation into both open and proprietary projects.
The GPL is a copyleft license that requires any modified versions of GPL-licensed software, or any software that incorporates GPL-licensed components, to be also licensed as GPL. This ensures that the software and any derivatives remain free for all users. The GPL aims to guarantee the freedom to share and change all versions of a program—to ensure it remains free software for all its users.
The Mozilla Public Licence (2.0) MPL is a free and open-source license that seeks a balance between permissive and copyleft licenses. It requires that modifications to licensed files be made available under the MPL but allows the combination of the MPL-licensed code with proprietary code. This makes it more flexible for integration into larger projects.
Other Open-Source Licenses
EUPL, MIT, GPL and MLP are the privileged licenses considered under the AI4REALNET project. Nevertheless, other licenses can be further contemplated: ▪ **Apache License 2.0:** The Apache License 2.0 is a permissive license like the MIT License but includes an explicit grant of patent rights from contributors to users. It allows for the use, reproduction, modification, distribution, and sublicensing of the software. When modifications are made and distributed, it requires a changelog to be included, making it clear how the software has been altered. ▪ **BSD Licenses (2-clause and 3-clause):** The BSD licenses are a family of permissive free software licenses. The 2-clause license, also known as "Simplified" or "FreeBSD" license, and the 3-clause license, known as "New" or "Revised" BSD license, both allow for almost unrestricted freedom similar to the MIT License. The main difference between them is the 3-clause license includes a non-endorsement clause that prohibits the use of the name of the project or its contributors for promotional purposes without permission. ▪ **GNU Lesser General Public License (LGP**L): The LGPL is a more permissive variant of the GPL designed mainly for software libraries. It allows non-(L)GPL licensed software to use LGPL licensed libraries without the whole software becoming subject to the GPL's terms. This encourages the use of free libraries in proprietary software, enhancing their adoption. ▪ **GNU Affero General Public License (AGPL):** The AGPL is similar to the GPL but includes provisions for software used over a network. It requires operators of networked services to provide source code to the users of those services, closing a loophole in the GPL that did not require such sharing for software used over a network. ▪ **Eclipse Public License (EPL):** The EPL is an open-source license used by the Eclipse Foundation for its projects. It allows the software to be used, modified, and distributed freely, provided that the original code and any modifications are made available under the EPL. The EPL is designed to be

commercially friendly, allowing the code to be incorporated into proprietary products under certain conditions.
Licensing Conditions
Commercial use: Usage of the licensed material and its derivatives for commercial purposes is permitted;
Distribution: The licensed material is allowed to be shared;
Modification: Alterations to the licensed material are permitted;
Patent use: Patent rights from the contributors are expressly granted through this license, which also clarifies that it does NOT extend any patent rights owned by contributors
Private use: The licensed material can be utilized and altered for personal use.
Disclose source: When distributing the licensed material, its source code must be provided.
License and copyright notice: The distribution of the licensed material must include a copy of the license and the copyright notice.
Network use is distribution: The right to obtain the source code is granted to users interacting with the licensed material over a network.
Same license: When distributing the licensed material or its modifications, the same license must be applied. In certain instances, a license that is similar or related may be acceptable.
State changes: Documentation of modifications made to the licensed material is required
Liability: A limitation of liability clause is included in this license
Trademark use: The license explicitly specifies that it does NOT convey any trademark rights, addressing the common misconception that licenses without such a declaration might implicitly grant trademark rights
Warranty: This license makes it clear that it does not offer any form of warranty.

ANNEX 4 – STRUCTURE OF THE SURVEY FOR STAKEHOLDERS' IDENTIFICATION AND CARACTERIZATION

Stakeholders Survey
The survey has a total of 7 questions. The first 4 questions identify the Stakeholder organisation and the person of contact:
1. Stakeholders' organisation name. **2.** Stakeholders' organisation country. **3.** Name of the person of contact from that organisation. **4.** Person of contact email address.
Then, the survey asked about the Field of Activity of that Stakeholder. This question is a multiple-choice question, and the guideline set was to choose only one option. In exceptional circumstances, a maximum of two choices could be selected
5. Field of Activity ☐ Energy ☐ Railway ☐ Air Traffic Management ☐ Artificial Intelligence ☐ Other
The stakeholders' identification acquires an added value once we classify them properly. In this process, we reviewed the literature to identify the various types of stakeholders, either core, direct or indirect, for the five areas identified above.
6. Stakeholder Classification: Table below lists the different categories for each field of activity.

Field of Activity	**Stakeholder Classification**
Energy Sector	☐ Communities ☐ Consulting companies ☐ Consumers ☐ Distribution system operators (DSOs) ☐ Energy Producers ☐ Energy Suppliers and Retailers ☐ Equipment Manufacturers ☐ Regulators and Policy Makers ☐ Sector associations and societies ☐ Technology Providers ☐ Transmission system operators (TSOs) ☐ Other (open question)

Railway sector	☐ Communities ☐ Consulting companies ☐ Emergency Services and First Responders ☐ Equipment Manufactures ☐ Freight and Logistics Companies ☐ Infrastructure Management ☐ Passengers ☐ Railway Infrastructure Suppliers ☐ Railway Maintenance and Service Providers ☐ Railway Operators ☐ Railway Safety and Security Agencies ☐ Regulators and Policy Makers ☐ Sector associations and societies ☐ Technology Providers ☐ Train Operators ☐ Other (open question)
ATM sector	☐ Aerospace and Technology Providers ☐ Air Navigation Service Providers ☐ Air Traffic Controllers ☐ Aircraft Manufacturers ☐ Airlines ☐ Airport Operators ☐ Civil Aviation Authorities ☐ Communities ☐ Consulting companies ☐ International Organizations (Air Traffic Management) ☐ Passengers and Shippers ☐ Pilots ☐ Regulators and Policy Makers ☐ Sector associations and societies ☐ Technology Providers ☐ Unmanned Aircraft Systems (UAS) Operator ☐ Other (open question)
Artificial intelligence	☐ Communities ☐ Consulting companies ☐ Consumers and End-Users ☐ Developers ☐ Ethics & Standards Organizations ☐ Hardware Manufacturer ☐ Regulators and Policy Makers ☐ Researchers ☐ Sector associations and societies ☐ Security and Cybersecurity Experts ☐ Service Providers ☐ Software Providers ☐ Tech Companies and AI Startups ☐ Testing and Quality Assurance Companies ☐ Users and Adopters ☐ Other (open question)

Other group of stakeholders	☐ Digital Innovation HUBs ☐ Financial Institutions ☐ Governments and municipalities ☐ Non-Governmental Organisations ☐ Technology and Science Parks ☐ University and research centres ☐ Other (open question)

The last question is a matrix to supports the project management categorise and manage stakeholders and their interaction. The Power Interest Grid, also known as the Power Interest Matrix, is a method of stakeholder management that analyses the power and influence of the stakeholders in a project (Bryson, 2004; Mitchell et al., 2021). Once the stakeholders are identified, they are plotted on the grid based on two key parameters: their power and their interest. Power refers to the ability of the stakeholder to influence the project, while interest refers to the level of concern the stakeholder has in the project.

It is a dynamic tool that that proves to be useful in segregating and prioritising the identified stakeholders and developing targeted strategies for managing each stakeholder.

7. Power-Interest grid	**Low**	**Medium**	**High**
Power: how strong is the stakeholders' capacity to block or boost the project?			
Interest: how interested is the stakeholder in what we are doing?			