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Deliverable D7.5

Dissemination, communication and standardization activities - Version c

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Responsible Author	Nikolaos Kanakaris(UoP) Ioannis Tomkos(UoP)		
Contributions from	Diego San Cristobal(ERC)		

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v0.1	28/06/2024	Initial version	Nikolaos Kanakaris(UoP)
v0.2	18/07/2024	Contributions to sections 2,3,4	Diego San Cristobal(ERC)
v0.3	02/08/2024	Corrections and revisions	Ioannis Tomkos(UoP)
v1.0	30/08/2024	Final editing and formatting	Franco Davoli (CNIT)

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Glossary of terms and abbreviations used

Abbreviation / Term	Description
AGV	Automated Guided Vehicles
ExFa	Experimentation Facility
IoT	Internet of Things
ISP	Internet Service Provider
UAV	unmanned aerial vehicle
UC	User Case
VR	Virtual Reality

Executive Summary

This Deliverable D7.5 discusses the key actions undertaken by the 5G-INDUCE consortium during the final year of the project, building upon the corresponding efforts contacted in the first and second year, relating with the major pathways to impacts, i.e., Dissemination / Communication, Standardization, and Innovation Management / Exploitation activities implemented collectively by the partners contributing to Tasks T7.1 / T7.3, T7.2 and T7.4 / T7.5, respectively. D7.5 focusses primarily on the Dissemination/Communication, and Standardization activities, while there are other dedicated deliverables focusing on the Innovation Management Activities (i.e., D7.6) and the Exploitable Market Potentials / Business Models (i.e., D7.7). All five WP7 tasks constitute the project work towards the realization of the project Outcomes at the end of the project, as well as the achievement of wider-scope and longer-term Impacts, while the associated Deliverables provide detailed account of the specific actions that the consortium partners contacted during the reporting period.

As illustrated in the Figure 1, WP7 partners, followed closely the work that was contacted within the other Technical WPs (WP2-WP3-WP4-WP5-WP6) with the goal to identify the key innovative Results of the project (e.g. the NAO, the OSS, …) and promote them within the community of researchers working at the individual consortium partners (i.e. internal dissemination), across other related projects working on Network-Apps (i.e. external dissemination) and event beyond to the wider community working on 5G networks and their applications in various vertical sectors of the economy with a particular focus on Industry 4.0 players. Besides the technical Objectives that the project realized as part of WP2 to WP6 activities, the work of WP7 is of equal importance as it ensures the realization of Objectives relating with the Standardization and Exploitation of the project innovations by the wider Network-Apps community and eventually by the whole 5G networks ecosystem, towards the establishment of EU as a key player in the broadband networks and services telecoms, as well as in the targeted end-users community of I4.0 industries.

1 Introduction

1.1 Scope

The key objective of this document is to present the communication and exploitation activities that took place in the final year of the project (M25-M42, 2024), aiming to the maximization of the impact that will lead to the exploitation of the produced results. It constitutes the written summary of the conducted work that was carried out in the framework of Work Package 7 (WP7), as it tracks the results that were committed by the tasks T7.1, T7.2, T7.3, T7.4 and T7.5 until the time of writing. Finally, it highlights the participation of 5G-INDUCE in 5G PPP activities and the liaisons with other sister projects.

The pathway to economical, societal, environmental, and other impacts is strongly connected to the exploitation of the innovations that will arise from the consortium's activity and it is dependent on achieving the strategic outcomes that concern:

- Testing and validation of Network-App solutions on top of a 5G virtualized experimental environment with different implemented functions and vertical-specific configurations.
- Secure interoperability beyond vendor-specific implementation across multiple domains and availability of related standards or reference implementations.
- Open-source repository of Network-Applications that can be further leveraged by other developers.
- Creation of 3rd party markets for start-ups and SMEs. 50% of SMEs are targeted for this action.
- Relevant 5G PPP KPIs; among others, Service Creation Time in minutes.
- Generation of results that may be appropriate for transfer towards an incubator or a start-up, either within the project or outside of the projects in follow-up actions

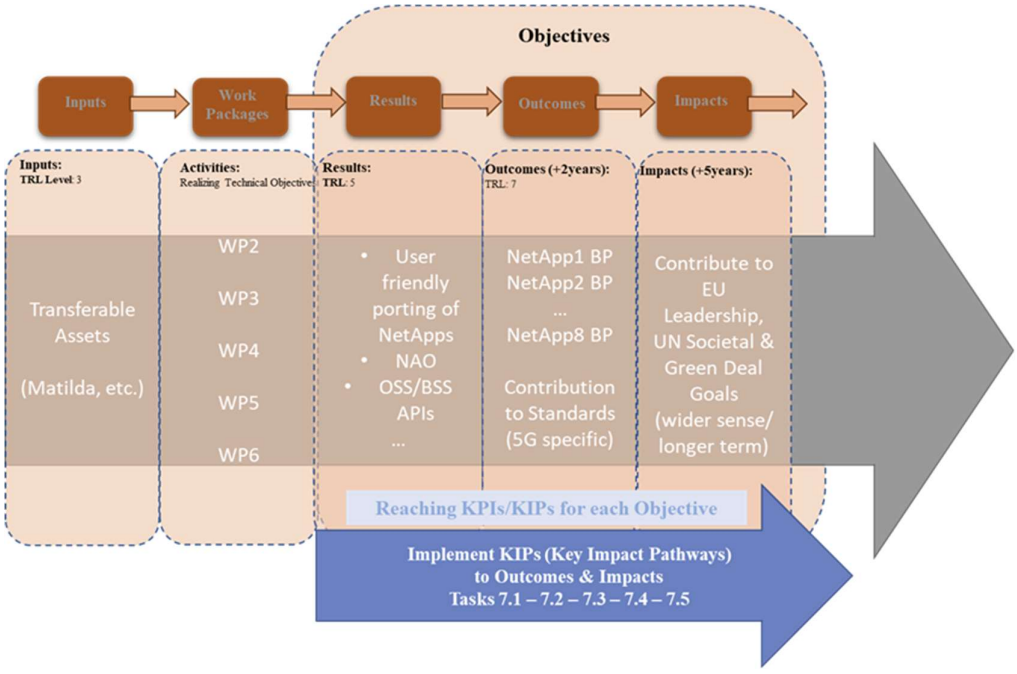

Figure 1 Pathway to Impact.

5G-INDUCE partners have the commitment to proceed for maximizing the popularity of the project, set up the proper communication links to attract and interact with a wide audience, including public and private stakeholders, and take care of spreading the project results in several different activities and actions. For attaining that goal, the consortium's members, either as Network-App developers or end users, have created messages in order to inform the interested third parties regarding the target groups, the use cases and expected impact of each Network-App individually.

It is understood by all partners that the diffusion of the aforementioned messages is instrumental to effectively promote the exploitation activities. In this framework, the measures to maximize 5G-INDUCE impact include publications in the individual communication channels through a number of collaborations, participation in industry and corporate events, organization of academic lectures and workshops. The dissemination and communication activities are expected to propagate the scientific and technological knowledge generated in the context of the project, aiming to ensure both mid- and long-term impact.

1.2 Structure

Following this introduction in Section 1, the remainder of this document has been structured as follows:

- Section 2 presents the actions made to communicate and disseminate the project's early results.
- Section 3 describes the effort dedicated to standardization activities.
- Section 4 presents the work done towards the maximization of impact of the project, by exploiting its tangible results.
- Section 5 presents the liaisons with other EU and international projects, as well as the clustering activities with industry associations (e.g., 5G ACIA), 5G PPP workgroups and collaborations (e.g., ICT-41 projects).
- Section 6 presents the KPIs for the evaluation of the progress of the implementation of the communication activities, as they were defined in the communication plan.
- Section 7 provides the document conclusions.

2 Communication and Dissemination Actions

In terms of Dissemination Activities, there have been 33 representations of 5G-INDUCE in form of workshops and webinars in major events hosted across Europe, while 12 paper presentations and publications in prestigious journals also took place. Some of the most important of those actions are the participation in Workshop at EuCNC/6G Summit 2021 and 2022, the joint participation at the MeditCom Conference with the other ICT41 projects, while for the publications some of the most important ones are "Flow Assignment and Processing on a Distributed Edge Computing Platform" on IEEE Transactions on Vehicular Technology and “Optimized Joint Allocation of Radio, Optical, and MEC Resources for the 5G and Beyond" on IEEE Transactions on Network and Service Management. All of the dissemination actions and the publications can be found at the private area of the project’s website under the corresponding tabs.

2.1 Communication and Dissemination Channels

2.1.1 Social Networks

The 5G-INDUCE project is active in three social networks LinkedIn, YouTube and Twitter. All the partners’ activities and participation in events are posted on LinkedIn and get twitted / re-twitted in Twitter, in order to maximize the outreach of the project. The videos uploaded will present what the project is about, which 5G use cases are explored, how the ExFas construct an Industry 4.0 testbed and how the 5G-INDUCE platform will be used to bring all these together. Finally, demos of Network-App development and deployment on top of the platform would be a great asset for the project, as they could be used as training for 3rd party experimenters even after the project ends, extending in that way its overall impact.

The YouTube channel "@5g-INDUCE" is a digital platform dedicated to showcasing the work and progress of the 5G-INDUCE project. This channel serves as a vital communication tool for disseminating information about the project's goals, achievements, and ongoing developments in the field of 5G technology and its applications in industrial settings.

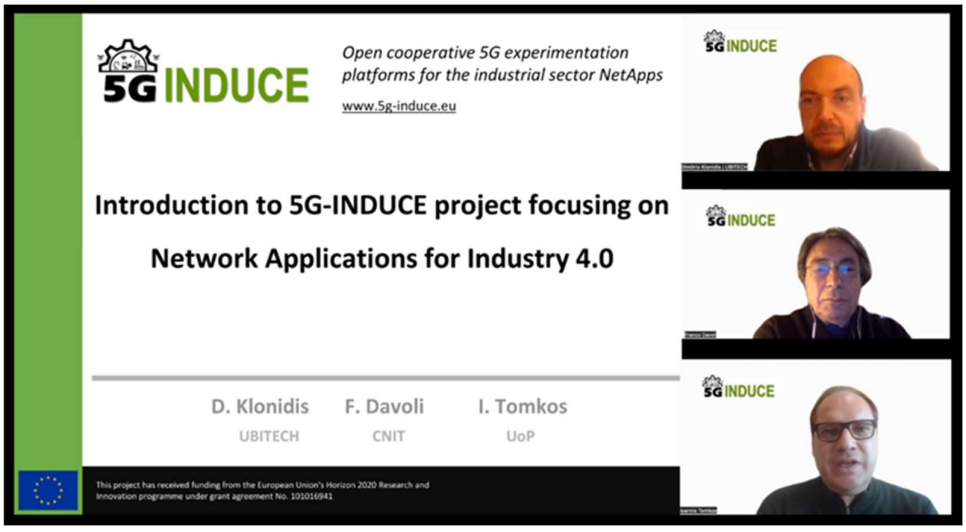

Figure 2 Video uploaded to YouTube channel.

The YouTube channel features videos that highlight various aspects of the 5G-INDUCE project, including:

- Technical Demonstrations: Showcasing the capabilities of the 5G orchestration platform and its applications in real-world industrial scenarios.
- Project Updates: Regular updates on the progress of the project, including milestones achieved and upcoming objectives.
- Use Case Presentations: Detailed explanations of specific use cases being developed or tested within the 5G-INDUCE framework, such as autonomous indoor fleet management or other Industry 4.0 applications.
- Expert Interviews: Discussions with project partners, researchers, and industry experts about the potential impact of 5G technology on various sectors.

2.1.2 Conferences and Workshops

The project partners actively participated at and organized conferences and workshops to

- encourage the dissemination of 5G-INDUCE projects results,
- empower bidirectional communication with 5G-INDUCE industry stakeholders to validate current results
- synchronize with other research projects in the field of Network-App development to build a common understanding and derive standards

The project partners were actively engaged in major upcoming events during 2023-2024, since they had received relevant invitations to act as co-organizers or participate as speakers. The following table shows an overview of all conferences and workshops in which 5G-INDUCE research partners participated.

Table 1 Conferences and Workshops.

	Partner	Conference (Session)	Title	Audience	Date and Venue
1.	**CNIT**	**IEEE ICC 2023**	5G-INDUCE Booth	Telecommunication research institutes and industry	28/5/2023 - 1/6/2023 Rome, Italy
2.	**UWS**	**2023 IEEE International Smart Cities Conference (ISC2)**	Transfer Learning-Enabled IoT System for Continuous Prediction of Vehicle CO2 Concentration	Industry (utilities, telecommunication vendors, ISPs, etc.), researchers in telecommunications	09/2023 Bucharest, Romania

	Partner	Conference (Session)	Title	Audience	Date and Venue
3.	**UWS**	**2023 International Conference on Software, Telecommunications and Computer Networks (SoftCOM)**	Empirical Comparison of Face Verification Algorithms from UAVs	Telecommunication research institutes and industry	09/2023 Split, Croatia
4.	**iLINK**	**Patras: Into the 5G-VERSE**	IoT and 5G technology in smart industrial safety applications developed under the 5G-INDUCE EU Project	IT and electrical engineering researchers/scientists, students, developers	22/04/2024 Patras, Greece
5.	**UWS**	**2024 International Wireless Communications and Mobile Computing (IWCMC)**	5G RAN service classification using Long Short-Term Memory Neural Network	Telecommunication research institutes and industry	05/2024 Ayia Napa, Cyprus
6.	**UWS**	**UWS-HAM Research Workshop 2024**	Cross-university communication on recent projects including 5G-INDUCE Ongoing Beyond 5G Hub Projects	IT and electrical engineering researchers/scientists, students, developers	23/05/2024 Paisley, UK
7.	**UWS**	**ITU AI for Good Global Summit 2024 - Machine Learning in Communication Networks Workshop**	AI for 6G Network Management and Control Optimisation	Industry (utilities, telecommunication vendors, ISPs, etc.), researchers in telecommunications	29/05/2024 - 31/05/2024 Geneva, Switzerland

	Partner	Conference (Session)	Title	Audience	Date and Venue
8.	**Joint**	**7th International Balkan Conference on Communications and Networking (BalkanCom 2024)**	Next-Gen Industry 4.0 with 5G: Enabling Secure and High-Performance Services for Critical Infrastructure	Telecommunication research institutes and industry	06/06/2024 Ljubljana, Slovenia
9.	**Joint**	**Contribution to the Special Session on "B5G Orchestration Platforms and Use Cases" at BalkanCom 2024**	Architecting Orchestrators in Dynamically Evolving Scenarios: From Network-Aware Micro-Services to Application-Aware Network Slices	Telecommunication research institutes and industry	06/06/2024 Ljubljana, Slovenia
10.	**ININ**	**Special Session on "B5G Orchestration Platforms and Use Cases" at the 7th International Balkan Conference on Communications and Networking (BalkanCom 2024)**	Harnessing Spatial Analysis for Next-Gen Industry 4.0 Connectivity Beyond 5G	Telecommunication research institutes and industry	06/06/2024 Ljubljana, Slovenia
11.	**CNIT, UBI, UoP**	**Special Session Organization at the 7th International Balkan Conference on Communications and Networking (BalkanCom 2024)**	5G and Beyond Orchestration Platforms and Use Cases — Enhancing Network Applications' Capabilities	Telecommunication research institutes and industry	06/06/2024 Ljubljana, Slovenia

2.2 Communication Material

2.2.1 Conferences Project's Logo

The project's logo has not been changed, in order for the external audience to have a coherent and unified view of the project for the whole timespan of the project.

2.2.2 Poster & Flyer

The 5G-INDUCE project showcased its innovations at the IEEE International Conference on Communications (ICC 2023) held in Rome from May 28 to June 1, 2023. As part of their participation, the project team created informative posters and flyers to display at the booth in La Nuvola Convention Center. These materials were designed to highlight the project's key achievements and ongoing work in 5G technology.

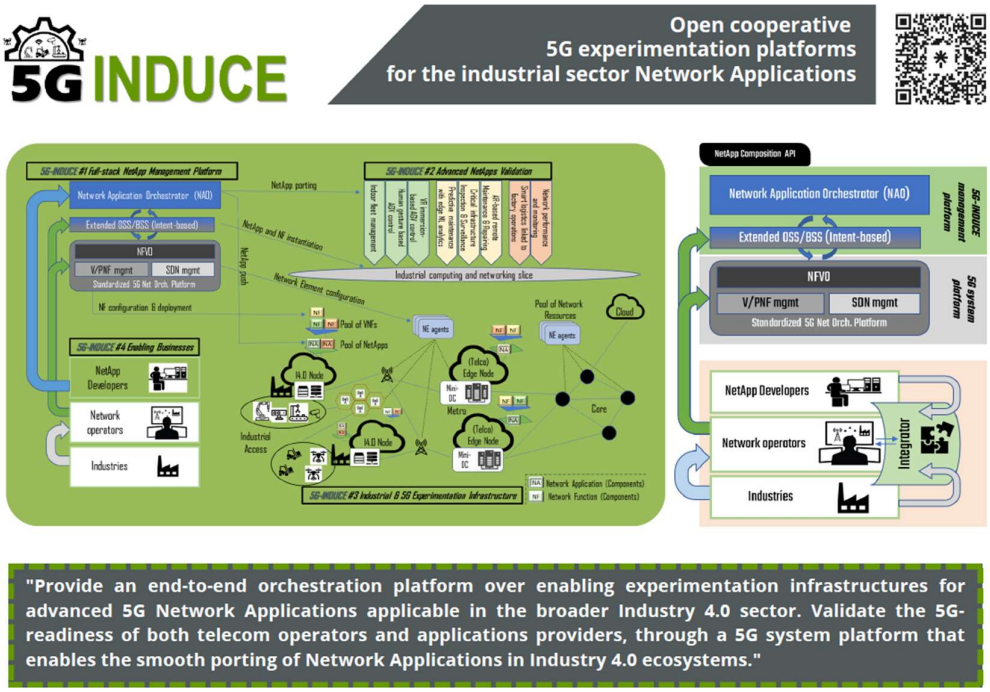

Figure 3 Flyer front page.

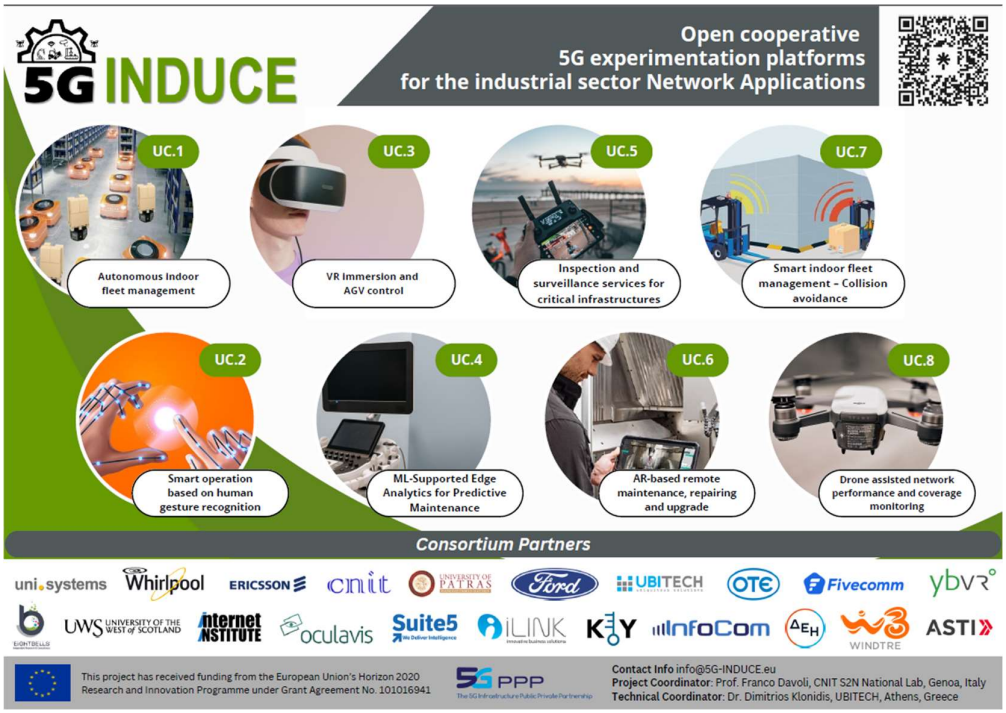

Figure 4 Flyer back page.

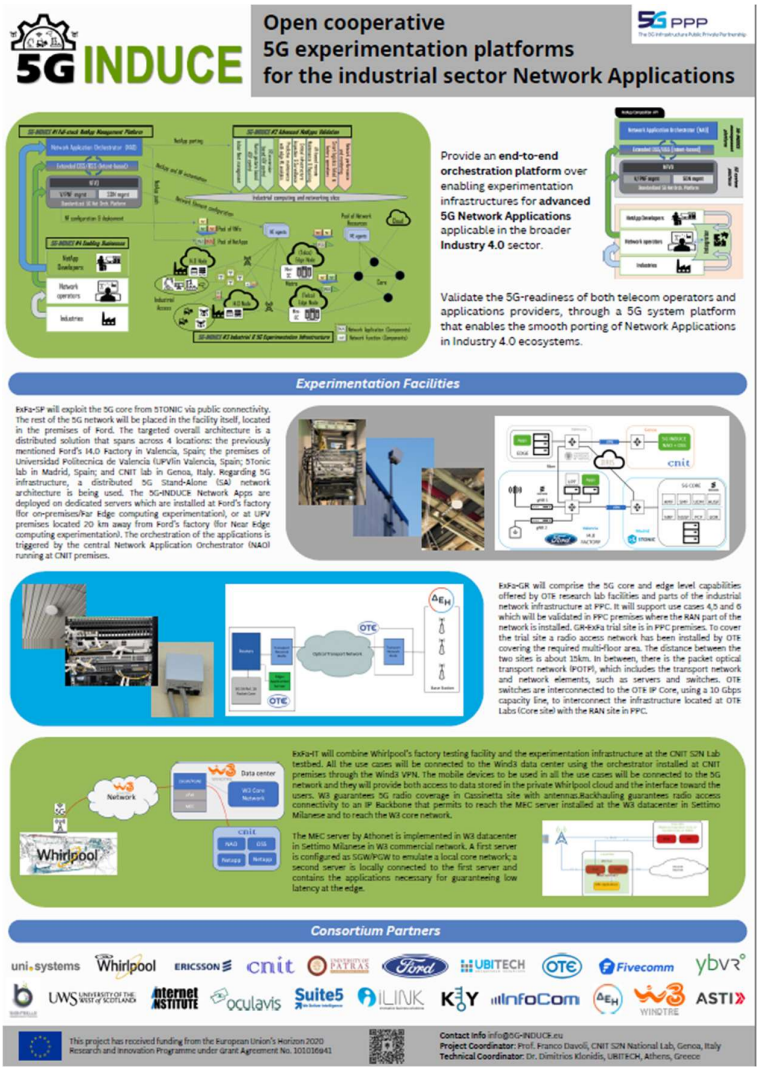

Figure 5 Poster with Platform and ExFas.

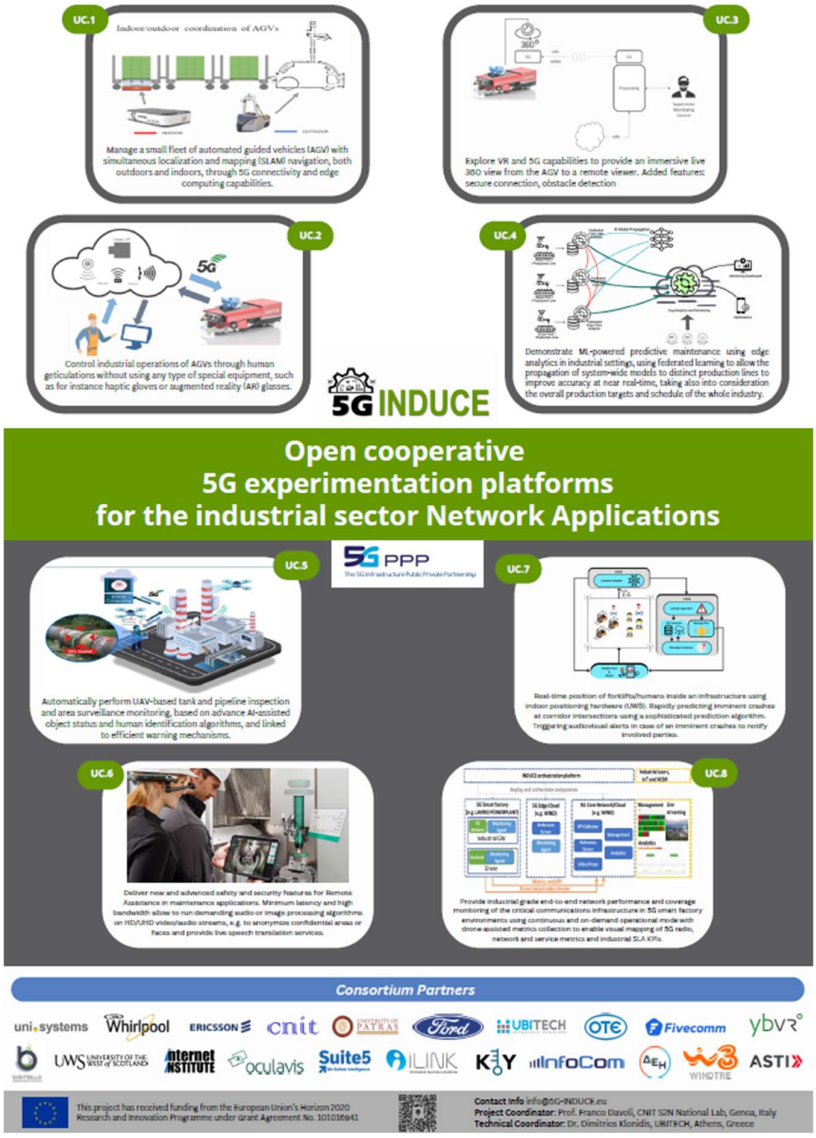

Figure 6 Poster with UCs.

2.2.3 Videos

Table 2 List of Videos.

Partner	Video Title	Short Description	Date
ILINK &WHP	Industrial Smart Safety Network App	A Smart safety scenario has been developed, aiming to improve personnel safety within the facilities, including dual-stage testing (LAB & ExFa). The indoor positioning system consisted of proper hardware (anchors, beacons) and software (entity location) equipped with iLink's collision detection algorithm, responsible for alerting the moving entities for imminent collision.	12/01/23
5COMM,ERC UPV,ABB, FORD	Spatial UC8 video Demo	Use case 2 is about controlling 5G-connected AGVs (automated guided vehicles) through human gestures in the Ford factory shopfloor, located in Valencia (Spain). This control is performed thanks to an AI based network application that analyses the video feed, processes the gestures and provides orders to the AGV to move. Both video and control features have been deployed at the edge of a 5G network located in the shopfloor. In this application, different gestures have been implemented to stop the vehicle or move it along a specific predefined route. A first successful demonstration of the use case took place in January 2023, as a result of a great collaboration between Fivecomm, Ericsson, UPV, ABB and Ford.	4/4/23
SUITE5&WHP	Predictive Maintenance Analytics v2	The video showcases a demo of UC4 in WHP Premises Using a Tablet Device with 5G connectivity	30/5/23
UWS&OTE&PPC	Corrosion detection Network-App UC5 video demo	The video showcases AI-based corrosion detection from a UAV	30/5/23
YBVR	UC3 Demo	The video showcases AGV and VR Headset connectivity and video along with metrics.	8/1/24
ILINK	UC7 Demo	Indoor positioning and crossroad control for safety showcasing in ExFa-IT.	3/6/24
ERC,UPV,FORD ABB,UBU,5COMM YBVR	Spanish-Facility	This video showcases the 3 UCs that take place in ExFa-SP.	5/6/24

Partner	Video Title	Short Description	Date
SUITE5&PPC	Demo at PPC premises	The video showcases a demo of UC4 in PPC Premises Using a Tablet Device with 5G connectivity	15/7/24
UOP&ERC	Industry 4.0, Private 5G & The Road to 6G	This video podcast, organized by the SNS ICE project under the Smart Networks and Services Joint Undertaking (SNS JU), explores the cutting edge of Industry 4.0 and the current state of private 5G networks.	28/5/24
ALL	5G-INDUCE Final Project Workshop "5G Innovations for Verticals-Demos Showcasing"	5G-INDUCE Final Project Workshop "5G Innovations for Verticals-Demos Showcasing" | Recorded Session	23/7/24

2.2.4 Handbook

This handbook is designed to guide third-party developers in preparing and onboarding their network applications onto the 5G-INDUCE platform. It aims to enable the rapid and cost-efficient creation of vertical services.

Section - 1. Introduction

5G-INDUCE Project Overview: The project aims to provide an open, standard-compatible 5G orchestration platform for deploying advanced 5G Network Applications. This platform supports application-oriented network management and optimization, allowing developers to define and modify application requirements without exposing infrastructure details.

Network Application Concept: A Network Application consists of networked virtualizable functions (VAFs and VNFs) deployable over 5G infrastructures. These functions are categorized into customer-facing service VAFs, network service VNFs, and value-added VNFs.

Experimental Facilities (ExFas): Spain, Italy, and Greece: Descriptions of the experimental facilities in these countries, including their specific architectures and connectivity setups for onboarding and orchestrating Network Applications. These facilities provide real-world environments for testing and deploying applications.

Section - 2. Network Application Preparation

Example Network Applications: The handbook provides use cases such as inspection and surveillance applications for critical infrastructures. Components include Video Proxy VNF, Intruder VNF, Corrosion VNF, and Message Bus VNF, each with specific operational and network requirements.

Operational and Network Requirements: Detailed resource and network requirements for each component and the overall application graph are provided, including CPU, memory, storage, and network bandwidth specifications.

Section - 3. Network Application Onboarding Methodology and Procedure

Registration and Composition: Steps for registering individual application components, composing the application graph, and deploying the application are outlined. This includes entering the web platform, registering components, and defining runtime policies.

Entering the Web Platform: Role-based access control and user interface details for onboarding components are described.

Runtime Policies: The policy manager enforces runtime policies for elasticity and security management, ensuring the application adapts to changing conditions.

Section - 4. Summary of Recommendations

Best Practices: Recommendations from various use cases to help developers prepare and onboard their Network Applications effectively. These include tips for managing resources, ensuring compatibility, and optimizing performance.

The 5G-INDUCE Network Application User Handbook is a comprehensive guide for developers looking to leverage the 5G-INDUCE platform for deploying network applications. It covers everything from initial preparation to deployment and runtime management, with practical examples and recommendations to ensure successful onboarding. The handbook emphasizes the platform's unique features and its role in supporting advanced 5G Network Applications across various industrial sectors.

Regarding its exploitation, the handbook could be used as the main dissemination material of the project. Due to its compact size and dense information, it will be much easier to disseminate than the deliverables of the project. In addition, its table of content could be easily included in flyers or posters of the project in booths or presentations of major events. Finally, its content could pave the way for workshops and videos dedicated to the Network-App onboarding process.

2.3 Dissemination Material

2.3.1 Scientific Publications

A core activity of the project is the provision of high-quality papers, showcasing the procedures followed through the specifications definition, the architecture creation, the actual development, the testing and validation of the solutions adopted and finally the description of the results. Those publications follow the open-access principles and peer-review processes of the scientific community, so as to maximize their validity and impact. Ten publications were created during the final year, and they were published in some well-established journals and conferences.

Table 3 Scientific Publications.

	Partner	Publication Title	Conference/Journal
1.	**UWS, OTE, PPC, UBI**	***Next-Gen Industry 4.0 with 5G: Enabling Secure and High-Performance Services for Critical Infrastructure***	**Proc. 7th International Balkan Conference on Communications and Networking (BalkanCom 2024)**, IEEE, New York, NY, USA, 2024
2.	**UWS**	***5G RAN service classification using Long Short-Term Memory Neural Network***	**Proc. 2024 International Wireless Communications and Mobile Computing (IWCMC)**, IEEE, New York, NY, USA, 2024

	Partner	Publication Title	Conference/Journal
3.	**UWS**	***Face Verification Algorithms for UAV Applications: An Empirical Comparative Analysis***	**Journal of Communications Software and Systems**, Vol. 20, No. 1, p. 1-12, Croatian Communications and Information Society in cooperation with the University of Split, FESB, Croatia, 2024
4.	**CNIT**	***A Stochastic Knapsack Model for Energy Efficient Management of Multi-Server Queues***	**7th International Balkan Conference on Communications ad Networking (BalkanCom 2024), Ljubljana, Slovenia, June 2024**, IEEE, Piscataway, NJ, 2024
5.	**UWS**	***Efficient CNN-based low-resolution facial detection from UAVs***	**Neural Computing and Applications**, Vol. 36, p. 5847-5860, Springer, New York, NY, USA, 2024
6.	**UWS**	***Transfer Learning-Enabled IoT System for Continuous Prediction of Vehicle CO2 Concentration***	**Proc. 2023 IEEE International Smart Cities Conference (ISC2)**, IEEE, New York, NY, USA, 2023
7.	**UWS**	***Empirical Comparison of Face Verification Algorithms from UAVs***	**Proc. 2023 International Conference on Software, Telecommunications and Computer Networks (SoftCOM)**, IEEE, New York, NY, USA, 2023
8.	**ILINK**	***The 5G-INDUCE European Project: Smart-safety proliferation as an Industry 4.0 Enabler***	**4th Symposium on Circular Economy and Sustainbility**, Technical University of Crete, Heraklion, Crete, Greece, 2023
9.	**CNIT**	***Machine-Learning-Based 5G Network Function Scaling via Black- and White-Box KPIs***	**Proc. 21st Mediterranean Communication and Computer Networking Conference (MedComNet), Ponza, Italy**, June 2023, p. 143-150, IEEE, Piscataway, NJ, USA, 2023
10.	**CNIT**	***Dynamics of Research into Modeling the Power Consumption of Virtual Entities Used in the Telco Cloud***	**MDPI Sensors**, vol. 23, no.1, art. 255, Jan. 2023, p. 1-69, MDPI, Basel, Switzerland, 2023

2.3.2 White Papers

The purpose of the white papers is to promote 5G-INDUCE concepts, platforms, and solutions, as well as to demonstrate how these solutions may handle various difficulties in key application cases, with an emphasis on commercial exploitation. Up to now, 5G-INDUCE has participated in four major White Papers both in cooperation with 5G-PPP, as well as other European projects. During the final year of the project 5G-INDUCE partners have contributed to two white papers.

The first one, “Innovation Trends in I4.0 enabled by 5G and Beyond Networks” [1] A white paper by the 5G-PPP Technology Board (October 2023). The Industry 4.0 (I4.0) concept revolutionizes how processes like quality, productivity, customization, and safety are managed in manufacturing. It has developed alongside 5G technology, and the two influence each other significantly. 5G supports the communication needs of I4.0, while I4.0 is a major sector for 5G growth. This whitepaper offers a comprehensive view of I4.0 design

principles, driven by collaboration between I4.0 leaders and contributors to 5G development. It also assesses the applicability of 5G for short and mid-term I4.0 challenges based on input from stakeholders. The report touches on evolving 5G technologies, like Deterministic Networking and Digital Twining, and explores the future of ecosystem dynamics, regulation, and sustainability. Ultimately, it provides valuable insights into the synergy between I4.0 and 5G, drawing from leading 5G-PPP Phase III projects.

The second one, "Network Applications: Opening up 5G and Beyond Networks" [2]. A white paper by 5G Public Private Partnership Software Network WG and ICT 41 Projects. (July 2023). Network Applications is seen as a full-potential enabler for future vertical industries beyond current deployment. Therefore, it must be considered along with other 6G enabling technologies in the next-generation network architecture. This paper focuses on the different technical aspects of Network Application, new business models for all stakeholders, experimental facilities to support Network Application, and new Network Intelligence (NI) solutions that can be enabled by using Network Application. This white paper is the second published by the Software Network WG and it goes into the implementation details of the two major Network Applications: "aaS" and hybrid models.

2.3.3 Project's Deliverables

Aside from being a duty and a method of project evaluation, the deliverables are a highly useful instrument for any interested party to have a full understanding of the project's operation and outcomes. The knowledge presented is broad and diverse, ranging from management and specification definition through architecture and development. Up to the time of writing this D7.5 the openly available deliverables on project's website are the ones included in the following table:

Table 4 Publicly available Deliverables.

Deliverable number	Deliverable Title
D2.1	5G platform design and requirements in support of Industrial sector Network-Apps
D2.2	Targeted use cases and Network-App related requirements
D2.3	5G technology and strategic investment sectors in Industry 4.0
D7.2	Data Management Plan
D7.3	Dissemination, communication and standardization activities - Version a
D3.6	The 5G-INDUCE orchestration framework platform
D5.2	Description of the Experimentation Facilities
D7.4	Dissemination, communication and standardization activities - Version b
D7.7	New business models and market potentials

3 Standardization

Along the second half of 5G-INDUCE project execution the technology concepts considered and implemented for achieving the actual establishment and formal validation of the trials have been selected, their dependencies have become clear and their status of maturity vs that of previous releases of the 3GPP standards have been assessed. In an Innovation Action project like 5G-INDUCE, the daily tasks of the project i) first of all leverage stable technology developments as a safe baseline to rely upon (this was mostly 3GPP Rel15 and Rel16), ii) integrate extensions beyond commercially available solutions for incorporating evolving concepts and architectures from the immediately previously released standards (this was Rel16 and then Rel17), and iii) identify beyond the state of the art concepts and solutions that address gaps identified at industry solutions and latest or even still developing standards (this has been the case for, firstly, Rel17 and then Rel18). Thus, in the first half of 5G-INDUCE project focus on 3GPP standardization was on Rel17 whilst for the second half of the project the addressed release of 3GPP has been Rel18.

On its side, the context addressed by 3GPP for its Release 18 was broad and compelling, but it did include or touch upon certain aspects that resonated well with some of the recurring aspects that our experimentation activities in 5G-INDUCE projects allow us to learn from. As a matter of fact the main perimeter of scope of our standardization-related activities (adoption, analysis, scan, contribution), was well aligned with key objectives of 5G-INDUCE project: experimentation with I4.0 trials over a variety of 5G Private Network technologies and architectures, and the actual onboarding and validation of the end-to-end use cases enabled by network applications created by the ecosystem of innovative firms focused on creating value for this vertical sector. In a very summarized way, and following the classical Telecom industry scheme of concurrency of various standardization time horizons explained above, 5G- INDUCE project experimentation activities were i) started off by relying on stable Rel15 compatible solutions for broad 5G support with either NSA and SA architecture options, ii) leveraged the evolution to Rel16 and enhancements across Rel17 for incorporating diverse patterns of solutions for SA support, Edge Computing support and NPN (Non-Public Network) model implementations, as well as contributing to Rel17 in specific aspects, as already reported in precious deliverables, and iii) addressed gaps of commercial solutions and available standards related to the E2E interwork and formal validation of 5G-Edge/Cloud and Network Apps.

It's worth to recap that while 5G industry solutions and commercial deployments along both 2022 and 2023 were mostly focused, worldwide, on NSA deployment of Public Networks, 5G-INDUCE was pursuing a much more specific and advanced target: Validating Advanced 5G Private Networks for the delivery of differentiated connectivity services to very diverse and demanding use cases of I4.0 implemented by novel Network Applications. The “single-standard” approach of 3GPP, that has granted global interoperability of all generations of mobile network solutions clearly focused first on addressing the needs of Public Networks, but also introduced and improved, release after release since especially Rel16 and Rel17, purpose-specific ingredients of very high added-value for applicability in contexts beyond that of Public Networks, such as Network Slicing capabilities, Edge Computing support, Non-Public Network models, Network Exposure and Analytics, etc. So, for completing so many technical tasks of 5G-INDUCE project all these new standards were understood, adopted, tested, and assessed. Creating and launching high-performance 5G Advanced private network systems that also flexibly and swiftly accommodate network applications at its Edge, and that incorporate trustworthy processes and tools for formally validating, for all involved actors of the ecosystem (verticals, CSPs, network vendors, and ISVs), the end-to-end behaviour and performance of the whole system, certainly remains, as of 2024, still a challenge for pioneers.

Our experience-based assessment of 3GPP standards in this context can be summarized as follows:

- From a *micro* perspective most technology ingredients for addressing the challenge introduced above have been thought of, at least first sketched -and sometimes even standardized- at 3GPP, with occasional reinforcement of connected initiatives at ETSI and in some of other fora like TMF or GSMA.
- From a *macro* perspective the situation is that even if a knowledgeable, skilled team of researchers may complete the complex puzzle of all complementary technologies and features required for creating a standards-compatible fully-functional overall solution, the industrialized solutions from the industry are still heavily focused towards the large 5G Public Network market and for the business model and paradigm it supports (enhanced broadband connectivity for sustaining the app economy). And although they can certainly be applied as the baseline for supporting private network scenarios and cases, many vital add-ons have to be incorporated on top, sometimes with good support of standards, sometimes only possible through sketching innovative ad-hoc solutions that may or may not be part of the next standards, eventually.

Moving from analysis to concrete actions the practical approach followed here towards adopting and impacting 3GPP standards from 5G-INDUCE standpoint implied:

- Scanning the range of topics defined in the charter of Rel18. In that regards the evolution of Edge Computing support, specification of NPN models, the consolidation of Network Exposure and Network Analytics, along with the number of key issues identified pivoting around two or even the three topics was deemed as providing good coverage for following up new specs and watch for potential gaps.
- Internally sharing and disseminating on the evolution of such key aspects, so that new features are known, potential technological risk can be anticipated and certain gaps and opportunities for improvements are known in advance. That way, ultimately, proper roadmaps were created at the 5G-INDUCE project and also contribution opportunities addressing current of foreseen issue were identified.
- Activities leading to actually contribute to the standard are obviously taken on, firm by firm, by 3GPP partners involved in 5G-INDUCE consortium under its own strategy and process.

Within 5G-INDUCE consortium, Ericsson is a key partner involved across all stages of 3GPP standardization, with both broad and detailed visibility of very many work items, and of all releases being worked on and/or defined. So as for many other ongoing research activities at Ericsson, the context and the challenges of projects like 5G-INDUCE are shared and considered when defining and updating the strategy (statement of direction) and securing the dedication of highly skilled resources to follow up and contribute to selected 3GPP areas. As a large multinational corporation Ericsson organizes for such a collective effort of achieving the best impact on technology evolution through involving resources from many countries and from many disciplines of knowledge and domains of the network. Ericsson Spain (5G-INDUCE partner entity of the Ericsson Group) hosts an R&D Center in Madrid with 600+ staff, focused on Core Network evolution, that significantly contributes to this collective standardization effort through dedicating senior researchers and architects working as chairs, delegates, coordinators, or contributors to standards. Such a team is involved in the development of tens of contributions to 3GPP standards every year, as part of the international team of Ericsson tasked for it.

Along 2023, 30+ Ericsson-only authored contributions to SA2 were registered and got agreed and accepted, as well as co-authored 70+ contributions to SA2 with other 3GPP members, as can be checked on 3GPP MoMs, publicly available. For the purpose of illustrating this effort and level of achievement, in this report, out from those many standardization initiatives, now we are going to reference two concrete Ericsson-only authored contributions to 3GPP SA2, for Rel18.. Carried out in 2023, more specifically at the 3GPP TSG-SA2

Meeting #156e, they affect Core Network specification. Both contributions stemmed from the analysis of the context of the demand of increased network observability and guaranteed QoS in 5G networks, aspects that are deemed essential for boosting Private Network capabilities and therefore the related ecosystem and market growth. These contributions address identified gaps, and propose generic technological solutions that could also be applied to other domains, now or in the future, so hopefully creating a higher impact in the technology development, over time. It is the case of:

- 23.502 CR 3953 - AIMLsys - QoS filtering criteria corrections – 2023-04-06 (Ericsson)
- 23.501 CR 4191- Translation of Internal-External Information for Assisting Application Layer AI/ML Operations – 2023-04-07 (Ericsson)

Both referenced contributions were approved and are now part of the Rel18 standard. They refer to key aspects of network information capabilities and exposure, that over time will have more and more influence in the ecosystem of innovative 5G-enabled industrial applications with closer relationships and trust between application providers, network operators and private network subscribers and users, allowing to overcome identified shared challenges related to end-to-end performance monitoring, observability, programmability and optimization. In the type of collaborative set-ups deployed for experimentation in projects like 5G-INDUCE there's open collaboration and plenty of shared information (architecture, configuration, KPIs, etc) enabled by the trust among partners and regulated by the Consortium Agreement. But in order to achieve a similar level of sharing of vital information at the further "real-world" service exploitation time, it is only through standardized interoperable solutions of network exposure and analytics that it will be possible to effectively doing it, for addressing collective end-to-end challenges and create competitive solutions in exploitation, in an industrialized way. That is the intention behind, among others, these selected contributions to 3GPP.

4 Exploitation and Impact Creation

4.1 IPR Management

The Intellectual Property Rights (IPR) management incorporates all actions involved in managing innovations and all background and foreground IPR in the framework of 5G-INDUCE.

The main exploitable results as identified and updated by the consortium, with the corresponding ER number and a short description, are presented in Table 5. The IPR table will be continuously updated through the whole duration of the project. As Network-Apps are in implementation and onboarding phase, more individual or combinations of exploitable assets will be included in the 5G-INDUCE platform and use cases

Table 5 IRP table.

KER Number	Exploitable Result (ER)	Main Partner(s)	Type of Protection	Ownership	TRL M0	TRL M42
kER1	NAO	UBITECH	Copyright	100%	3	6
kER2	OSS	CNIT INFO	Open source (except MetalCL)	70% CNIT 30% INFO	4	6
kER3	UC1 NetworkApps	ABB-UBU	Copyright	50%-50%	3	7
kER4	UC2 NetworkApps	FIVECOMM-UBU	Copyright	50%-50%	3	7
kER5	UC3 NetworkApps	YBVR	Copyright	100%	3	6
kER6	UC4 NetworkApps	Suite5	Copyright	100%	3	6
kER7	UC5 NetworkApps	UWS	Copyright	100%	3	6
kER8	UC6 NetworkApps	Oculavis	Copyright	100%	3	6
kER09	UC7 NetworkApps	iLink	Copyright	100%	0	7
kER10	UC8 NetworkApps	Internet Institute	Copyright	100%	5	7
kER11	PNI-NPN 5G System	Ericsson España	Copyright	100%	4	7

4.2 KER Exploitation

Table 6 shows the intention of every partners to exploit the KERs. They have to choose between **M**: Making a product and selling it, **U**: Using the project result internally for further development, **L**: Licensing the project result to third parties. **S**: Providing a Service, such as consultancy, etc.

Table 6 KER exploitation.

ER / Partner	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10	ER11
CNIT	-	U/S	-	-	-	-	-	-	-	-	-
OTE	-	-	-	-	-	-	-	-	-	-	-
WIND3	-	-	-	U	-	U	U	U	-	-	
ERC	-	-	U/S	U/S	U/S	-	-	-	-	-	M/U/S
UNIS	-	-	-	-	-	-	-	-	-		-
WHR/WHMAN	-	-	-	-	-	-	-	-	-	-	-
FORD	-	-	U	U	U	-	-	-	-	-	
PPC	-	-	-		-	-	-	-	-	-	-
UOP	-	-	-	-	-	-	-	-	-	-	-
UWS	-	-	-	-	-	-	M/U/L/S	-	-	-	-
UBITECH	M/U/S	U/S	-	-	-	-	-	-	-	-	
ININ	-	-	-	-	-	-	-	-	-	M/U/S	-
5COMM	-	-	-	M/U/L	-	-	-	-	-	-	-
YBVR	-	-	-	-	M/U	-	-	-	-	-	-
ABB /ASTI	-	-	U	-	-	-	-	-	-	-	-
ILINK	-	-	-	-	-	-	-	-	M/U/S	-	-
INFOCOM	-	U/S	-	-	-	-	-	-	-	-	-
8BELLS	U/S	-	-	-	-	U/S	-	U/S	-	-	-
SUITE5						M/S					
K3Y	U/S	-	-	-	-	U/S	-	U/S	-	-	-
OCULAVIS	-	-	-	-	-	-	-	U	-	-	-

4.3 Joint Exploitation Plans

A Joint Exploitation Plan in a research project details the collective intentions of all participants to effectively utilize the project's results and outcomes. This plan ensures a coordinated and synergistic approach to converting research findings into practical applications. The importance of having a Joint Exploitation Plan resides in its capacity to optimize the combined effect by promoting collaboration and utilizing the strengths of each member, resulting in stronger and more complete methods for exploitation. A Joint Exploitation Plan ensures that all participants in a project are aligned with its broader aims. This helps to establish a clear direction and facilitates coordinated exploitation operations, which in turn prevents disagreements and redundancies. It facilitates the effective distribution of shared resources, aiding in the prioritization of actions and investments that are crucial for the collective utilization of outcomes. Joint contingency plans are developed by Joint Exploitation Plans to identify and overcome potential barriers, hence improving risk management within the collaboration. They facilitate stakeholder participation by motivating participants to establish connections and jointly strategize dissemination actions, thus increasing the visibility and adoption of the research findings. Monitoring and assessment are made more efficient by establishing common, quantifiable objectives and benchmarks, enabling coordinated modifications and enhancements. In addition,

Joint Exploitation Plans guarantee the durability and expandability of research findings by strategically preparing for their prolonged utilization and wider implementation in a cohesive manner.

The consortium has received multiple strategic proposals outlining how they may effectively utilize and benefit from the 5G-INDUCE project once it is finished. The plans have been classified into three primary domains:

Product (Commercialization): The consortium partners have numerous prospects to develop and market goods generated from the entire project or its separate components.

- Complete Product Ownership: A consortium entity has the authority to possess the entire platform but has the option to delegate certain network applications (NetworkApps) or other components to guarantee complete functionality.
- Stakeholder Engagement: Partners have the ability to include stakeholders and potential clients in order to showcase the worth and usefulness of their offers, whether it is a whole product or certain components.
- Licensing: Partners have the ability to offer licenses for products that are built on the platform and NetworkApps, which allows for a continuous and ongoing source of revenue.
- New Ventures: They have the ability to create spin-offs, start-ups, or other related enterprises in order to market and monetize their valuable components or the platform itself.

Services: The second category pertains to the potential of providing services derived from the discoveries and advancements of the 5G-INDUCE project.

- Consulting Services: Offering advisory services that utilize the knowledge and skills acquired during the project.
- Policy and Procedure Development: Formulating or strengthening organizational policies and processes using the project's findings.
- Standardization Contributions: Making valuable contributions to standardization procedures, in order to influence industry standards and guarantee compatibility and interoperability.

Further Development: If the consortium deems their solutions insufficiently developed for market launch, they can pursue other avenues for further advancement.

- Consortium members have the option to independently finance their outcomes, in order to progress the Technology Readiness Level (TRL) of their discoveries.
- External funds: If self-financing is not possible, they can pursue outside funds to support further development. This might be accomplished by reapplying for Horizon Europe programs or by obtaining funding from external sources.

The partner's preferences can been seen in Table 3; their choice is between:

- **Product**: 1) Stakeholder Engagement, 2) Licensing, 3) Subcontracting, 4) Spin off or Startup.
- **Service**: 1) Consulting, 2) Policies, 3) Standardization.
- **Research**: 1) European or National Research Programs, 2) Self-Funded, 3) External Funded.

When partners collaborate to develop a product using their resources, they often select from two primary strategic approaches to enter the market and maximize the product's value. One such approach is to directly include stakeholders, such as customers, industry influencers, regulatory agencies, and other important individuals, in the promotion and distribution of their product. This method enables partners to cultivate robust relationships, collect useful input, and establish a community centred around their offering, so augmenting and mutually reinforcing their overall solution. An alternative approach is to grant a license for their solution to other companies, allowing them to generate income through licensing fees and royalties. This approach enables partners to generate revenue from their intellectual property without requiring major marketing and

distribution endeavours. It has the ability to create a consistent income flow, while allowing them to concentrate on more invention and development. None chose to subcontract or create an alternative company.

When it comes to offering a service, most partners opt to provide consulting services, a strategic choice that can pave the way for collaborative partnerships aimed at delivering comprehensive solutions. This approach leverages the combined expertise and resources of multiple stakeholders to address complex challenges, creating a holistic service offering. A key asset in this scenario is the 5G-INDUCE technology, which has the potential to foster partnerships through engagement with standardization bodies. By aligning with these bodies, partners can ensure their solutions meet industry standards, enhancing interoperability and credibility, ultimately driving widespread adoption and innovation within the 5G ecosystem.

In order to advance their research, most partners will seek external financing by collaborating with stakeholders and participating in research initiatives like Horizon Europe. This approach not only ensures the required financial means but also promotes cooperation among various entities. By obtaining finance through these channels, partners can commence new collaborative projects, harnessing the combined experience and potential for innovation of all parties involved. Collaborations of this nature expand the range and influence of research efforts, facilitating the creation of sophisticated solutions and technology. The collaborative endeavour in these projects not only expedites advancement but also establishes a robust groundwork for enduring alliances and continuous innovation throughout the sector.

Table 7 Exploitation Paths Towards Commercialization.

KER Number	Exploitable Result (ER)	Main Partner(s)	Product	Service	Research
ER1	NAO	UBITECH	1	1, 3	1, 3
ER2	OSS	CNIT/INFO	1	1, 3	1, 3
ER3	UC1 NetworkApps	ABB	1	1	1, 2
ER4	UC2 NetworkApps	5COMM	2	1	1, 3
ER5	UC3 NetworkApps	YBVR	2	1	1, 3
ER6	UC4 NetworkApps	SUITE5	2	1	1,2
ER7	UC5 NetworkApps	UWS	-	1	1
ER8	UC6 NetworkApps	OCULAVIS	2	1	1
ER09	UC7 NetworkApps	ILINK	1,2	1	1
ER10	UC8 NetworkApps	ININ	2	1	1,2
ER11	PNI-NPN 5G System	ERC	2	1	-

4.4 Business modelling & Market Potential

In order to outline a comprehensive strategy for the 5G-INDUCE platform's market entry, the evaluation of the platform's long-term viability must be involved by emphasizing its technological advancements and operational efficiencies. The aim is to present a clear value proposition that highlights the platform's ability to enhance operational efficiency, reduce costs, and create new business opportunities, thereby attracting investment and attention.

The methodology used employs two strategic frameworks: SWOT analysis and Lean Canvas.

SWOT Analysis: This framework assesses the strengths, weaknesses, opportunities, and threats associated with the 5G-INDUCE innovations. It helps in understanding both internal and external factors that can impact the project's success.

Lean Canvas: This is a concise business plan template that focuses on problem validation, customer segments, and other key business aspects. It is tailored for startups and emphasizes testing ideas through customer feedback before significant investments.

In Deliverable 7.7 - "New Business Models and Market Potentials" we provide detailed analyses for various use cases, such as NAO, OSS, and specific use cases (UC1 to UC8). Each use case is evaluated using Lean Canvas and SWOT analysis, focusing on:

- Problem and Solution: Identifying key problems addressed by the innovations and how the solutions provided by 5G-INDUCE effectively tackle these issues.
- Unique Value Proposition: Highlighting what sets the solution apart from competitors and why it is worth investing in.
- Customer Segments and Channels: Defining target customers and the channels through which the solutions will be delivered.
- Revenue Streams and Cost Structure: Outlining how the innovations will generate income and the associated costs.

All the above provide a detailed roadmap for leveraging the technological advancements of the 5G-INDUCE project in the market, focusing on effective business modeling and strategic analysis to ensure successful market entry and sustainability.

The business analysis in D7.7 uncovers the crucial functions of two cutting-edge resources within the 5G-INDUCE platform: the NAO and the OSS. These assets are crucial for the development and operation of NetworkApps, which are distinguished by their distinctive traits and innovations that promote the establishment of a stable and forward-looking ecosystem. The NAO and OSS enable this unique ecosystem, which serves as a strong foundation for the growth and long-term viability of 5G-INDUCE technologies.

Similarly, the market study reveals a substantial demand for these cutting-edge technologies, suggesting promising prospects for their utilization and monetization. The strong demand for these technologies highlights their capacity to efficiently fulfil market requirements and provide significant economic worth.

The partnership, headed by the technical leaders of the 5G-INDUCE project, has been provided with strategic routes and approaches. These strategies aim to utilize their technology developments to support the process of bringing products or services to market, improve the range of services they offer, and encourage additional growth and research. Each member of the consortium possesses customized plans that allow them to optimize the potential of their ideas, whether by entering new markets, expanding their service offerings, or continuously doing research and development to improve and enhance their goods.

A key factor that will determine the business model transformation associated with the exploitation of the developments undertaken by 5G-INDUCE is which market player will assume the role of NetworkApps Orchestrator/OSS. Given this dynamic market environment, will it be the Network Operator? An offering provided by a System Integrator or a specialized NetworkApps Orchestrator provider? Another possibility is that this role can be fulfilled by a collaboration among 5G-INDUCE partners or a spin-off stemming from the consortium.

5G presents CSPs with a unique opportunity, but to monetize 5G at scale, CSPs must ensure that their operational and business support systems can meet four main requirements. First, they need to orchestrate and deliver complex solutions that span different types of networks (e.g., 4G, 5G, Fiber) and various sources

of services (e.g., Edge, AR, VR), while effectively managing the challenge of dynamic 5G service activation. Second, CSPs must have flexible charging and monetization capabilities that enable them to charge for any event, unit of measurement, or characteristic, and to bundle and price offerings from network slicing and consumer IoT to industrial IoT solutions. Third, the development of partner ecosystems is crucial, enabling CSPs to co-invent and co-create joint 5G solutions with multiple third parties that better fit customer needs. The final requirement is the increased operational agility and speed which can be achieved with cloud-native solutions. Operators/CSPs can utilize the developments of 5G-INDUCE to become B2B2X enablers with quick onboarding of innovative value-added applications for any targeted vertical partner.

5 Evaluation and Reporting

In order to evaluate the impact of the project's dissemination and communication activities, the Consortium has set specific metrics per dissemination and communication activity, in order to effectively monitor its achievements. The effectiveness of the dissemination, as well as of the communication, activities will be assessed during the life of the project and the results of these assessments will be presented in each reporting period. For the final reporting period those results are showcased in **Error! Reference source not found.**.

Table 8 D&C Monitoring.

	Activities	1st Reporting Period	2nd Reporting Period	Final Reporting Period
1.	Number of workshops	2	6	10
2.	Number of demos	3	7	9
3.	Number of trainings	-	10	13
4.	Number of conference papers	2	4	10
5.	Number of journal papers	2	6	10
6.	Number of synergies with projects	7	15	18
7.	Number of joint activities	-	5	9
8.	Number of social media posts/month	3	~6	~2
9.	Number of accumulative followers	147	>250	>300
10.	Number of posts	36	~80	~100
11.	Number of videos	-	7	17

6 Conclusions

In this deliverable, we summarized the main activities undertaken towards the implementation of the five Key Pathways to Impact (KIPs)(figure 1); i.e., dissemination/communication, standardization, and innovation management/exploitation activities. It was shown how the technical project work that led to important innovative results, has been disseminated/communicated to i) the Network-Apps community specifically as well as the wider 5G networks, and to ii) I4.0 industrial partners, via the established dissemination/communications channels, the organization of events, the publication/presentation of articles at international fora, the preparation of informative videos, etc. The preparation of a Handbook and associated training videos on how to Network-App Developers, the Network Operators and System/Software Integrators can use the 5G-INDUCE platform for offering end-to-end services over 5G network infrastructures have been presented. Furthermore, the initiative of 5G-INDUCE project alongside other ICT-41 projects, as a collective Clustering effort, has been presented and the foundations that have been established towards the sustainability of all ICT-41 projects after the end of their lifetime have been defined in the form of three collaborative objectives and associated deliverables that would be realized under the umbrella of the Software Networks WG and the 5G-PPP Technical Board. With this ICT-41 project collaboration and the 5G-PPP community 5G-INDUCE contributed to two white papers published by the 5G-PPP organization. Finally, the key thoughts on the Network-Apps related topics that can be brought forward towards Standardization, as well as commercial Exploitation of the project innovations and the way that the various business actors across the value chain can interact together forming different business models that will assist in the enlargement of the monetary and societal value for their activities, have been outlined. On all aforementioned topics, the included summarized plans on how the consortium have been engaged with the related WP7 activities during the final project duration.

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