EXPERIMENTATION AND VALIDATION OPENNESS FOR LONGTERM EVOLUTION OF VERTICAL INDUSTRIES IN 5G ERA AND BEYOND

[H2020 - Grant Agreement No.101016608]

Deliverable D7.4

Standardization, Innovation, Exploitation and Technology Transfer Activities (Intermediate)

Editor D. Dimopoulos (LNV), A. Salkintzis (LNV)

Contributors (LNV), (COS), (IEA), (NCSRD), (TID), (FOGUS), (ATOS), (INTRA), (MAG), (UMA), (UPV), (GMI), (ININ), (CAF), (IQBT), (INF), (8BELLS), (PAL), (ZORTE), (IMM), (UMS)

Version 5.0

Date December 24th, 2022

Distribution PUBLIC (PU)

DISCLAIMER

REVISION HISTORY

Revision	*Date*	*Responsible*	*Comment*
1.0	*October, 3, 2022*	*F. Setaki (COS), D. Dimopoulos (LNV)*	*TOC*
1.1	*October, 19, 2022*	*F. Setaki (COS), C. Skoubridou (IEA), D. Dimopoulos (LNV)*	*First draft of all Sections*
1.2	*November, 11, 2022*	*All*	*Contributions in Sections 2 & 3*
2.0	*December, 1, 2022*	*F. Setaki (COS), C. Skoubridou (IEA), D. Dimopoulos (LNV)*	*Second draft of all Sections*
2.1	*December, 9, 2022*	*All*	*Additional contributions in Sections 2 & 3*
3.0	*December, 9, 2022*	*D. Dimopoulos (LNV)*	*Third draft of all Sections*
3.1	*December, 18, 2022*	*All*	*Additional contributions in Section 3*
3.2	*December, 20, 2022*	*D. Dimopoulos (LNV), F. Setaki (COS), C. Skoubridou (IEA)*	*Fourth draft of all Sections*
4.0	*December, 21, 2022*	*D. Dimopoulos (LNV)*	*Final draft for Internal Review*
4.1	*December, 23, 2022*	*F. Setaki (COS), V. Mavrikakis (INF), I. Manfredonia (UMS)*	*Internal Review*
5.0	*December, 24, 2022*	*D. Dimopoulos (LNV), F. Setaki (COS)*	*Camera-ready draft for publishing*

LIST OF AUTHORS

Partner ACRONYM	*Partner FULL NAME*	*Name & Surname*
TID	*TELEFONICA INVESTIGACIÓN Y DESARROLLO*	*J. Garcia, D. Artuñedo*
NCSRD	*National Centre for Scientific Research Demokritos*	*H. Koumaras, G. Makropoulos*
MAG	*Maggioli SPA*	*Y. Karadimas, T.Chihabi*
ATOS	*ATOS IT solutions and services Iberia*	*S. Castro, R. Marco Alvarez, P. Encinar*
Netcompany INTRASOFT	*INTRA*	*A.Dimitriou*
COS	*COSMOTE Mobile Telecommunications SA*	*F. Setaki, E. Theodoropoulou, I. Mesogiti, G. Lyberopoulos*
LNV	*Lenovo (Deutschland) GmbH*	*D. Dimopoulos, A. Salkintzis*
IEA	*Impact Entrepreneurship Award Ltd.*	*A. Nousias, M.Anagnostopoulos, Ch. Skoubridou*
UMA	*Universidad de Málaga*	*B. Garcia, F.Luque, P.Merino, L. Panizo,*
UPV	*Universitat Politecnica de Valencia*	*R. Gonzalez-Usach*
GMI	*GMI-AERO-SAS*	*G. Kanterakis*
ININ	*Internet Institute Ltd.*	*R. Susnik, L. Korsic, J. Sterle*
CAF	*CAFA Tech*	*T. Järvet, M.Rannu, S.Järvet*
IQBT	*InQbit Innovations*	*K. Koutroumouchos*
FOGUS	*FOGUS Innovations & Services P.C.*	*D. Tsolkas, K. Giannopoulou, E.Tsitos*
INF	*INFOLYSIS P.C.*	*V. Koumaras, T. Papadopoulos, M.Meleti*
8BELLS	*EIGHT BELLS LTD*	*G. Avdikos*
PAL	*PAL-robotics*	*A. Lebihan*
ZORTE	*ZORTENET P.C.*	*G. Xylouris, A. Kourtis*
IMM	*Immersion*	*Ch. Bailly, J.Castet, C. Chartier*
UMS	*Unmanned Systems*	*I.Manfredonia, D.Morris*

GLOSSARY

Abbreviations/Acronym	*Description*
3GPP	*3rd Generation Partnership Project (3GPP)*
5G-ACIA	*5G Alliance for Connected Industries and Automation*
5GC	*5G Core*
5G-PPP	*5G Infrastructure Public Private Partnership*
AEF	*API Exposure Function*
AMR	*Autonomous Mobile Robot*
API	*Application Programming Interface*
CA	*Consortium Agreement*
CAPIF	*Common API Framework*
CSP	*Connectivity Service Provider*
CT	*Core Network & Terminals*
DN	*Data Network*
EC	*European Commission*
ETSI	*European Telecommunications Standards Institute*
FoF	*Factory of the Future*
ICT	*Information & Communication Technology*
IETF	*Internet Engineering Task Force*
IM	*Information model*
INT	*Interoperability Testing*
IP	*Intellectual Property*
IPR	*Intellectual Property Right*
ISG	*Industry Specification Group*
JV	*Joint Venture*
K8	*Kubernetes containers*
M2M	*Machine to Machine*
MANO	*Management and Orchestration*
MEC	*Multi-access Edge Computing*
MRO	*Maintenance, Repair, Operations*
MTA	*Material Transfer Agreement*
NDA	*Non-Disclosure Agreement*
NEF	*Network Exposure Function*
NFV	*Network Function Virtualization*
NPN	*Non-Public Networks*
NS	*Network Services*
NWDAF	*Network Data Analytics Function*
OSM	*Open Source MANO*
OT	*Operational Technology*
PoC	*Proof of Concept*
RAN	*Radio Access Network*
SA	*Services & System Aspects*
SaaP	*Software as a Product*
SDN	*Software Defined Networking*

SDO	*Standards Development Organization*
SEAL	*Service Enabler Architecture Layer*
SFC	*Service Functions Chain*
SIEM	*Security Information and Event Management systems*
TC	*Technical Committee*
TSG	*Technical Specification Group*
TSN	*Time Sensitive Networking*
UGV	*Unmanned Ground Vehicle*
UWB	*Ultra-Wide Band*
WG	*Working Group*

List of Figures

List of Tables

EXECUTIVE SUMMARY

EVOLVED-5G focuses on maximizing the technological fingerprint and the business potential stemming from the integration of 5G in manufacturing by exploring novel technical capabilities that can lead to new business chains. The purpose of this document, Deliverable D7.4 "Standardization, Innovation, Exploitation and Technology Transfer Activities (Intermediate)", is to demonstrate the project's standardization and innovation achievements, as well as the exploitation and technology transfer activities carried out during this intermediate period (M11-M24) according to the specific plans identified in the beginning of the project and documented in previous deliverable D7.2 (M10). Besides, this intermediate deliverable reveals future plans for the final phase around the work carried out in Tasks *7.3 "Innovation Shaping and Standardization Alignment"* and *7.4 "Exploitation Activities, Technology Transfer and IPR Management"*, which will be included in the last deliverable of WP7 (D7.6 – due in M36).

The document provides a helicopter view of the project's achievements in three thematic areas:

- **The standardization and innovation actions**, which present the principal technological innovation accomplishments pursuit, as well as recent updates in standards groups and the respective project contributions. Furthermore, it identifies additional innovation areas to be chased during the project's final period in an attempt to increase impact.
- **The exploitation plan**, that builds upon the exploitation methodology documented in D7.2 and delves into the analysis of the initial project results performing a gap assessment focusing on project-wide outcomes, while additionally presenting the partners' specific individual plans.
- **The technology transfer plan** that explains the process of launching an idea to the market, presenting a specific methodology that any organization can use to bring a product to the market. It contains the Commercialization of Intellectual Property Guide, the Commercialization Blueprint tool and a training programme that includes four hands-on workshops for the partnership on how to use the tool and other elements of the Guide.

Concerning standardization activities, the primary focus is on 3GPP, and particularly in SA2 and SA6 groups, ETSI OSM, IEEE TSN, 5GPP pre-standardization WG and 5G-ACIA. To this direction, EVOLVED-5G has extensively contributed in 3GPP SA6 to standardize new enablers for verticals, such as enablers for "App-Layer Analytics" and for "Network Slice Capability Exposure". In addition, monitoring of all 3GPP working groups ensures alignment of the project implementations with the applicable standards in a broader perspective.

In respect of the commercialization of EVOLVED-5G results, it is noteworthy that the project has devised a holistic methodology to bind exploitation, intellectual property and technology transfer actions that need to take place during the project. During the intermediate period, the focus has been on the finalization of the technology transfer tools. In addition, the project has organized the first two training workshops on the technology transfer methodology for the consortium partners. The last two training workshops on technology transfer, dedicated to the consortium, will be delivered at the final project's year.

The project's exploitation plan considers a three-step approach, and the delivery of this document marks the completion of the second step, involving the revision of the initially identified project outcomes performing gap analysis. At the last step, to be completed by the end of the project, business case development methods, such as the Value Proposition Canvas [1], will be applied on selective exploitable outcomes based on the assessed maturity (TRL level) and dedicates workshops' results.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

EVOLVED-5G focuses on maximizing the technological fingerprint and the business potential stemming from the integration of 5G in manufacturing by exploring novel business chains. It focuses on prototyping artefacts (such as the NetApps) that implement and exhibit the benefits of this integration, addressing the business of interaction of employees and machines, Factory of the Future (FoF) operations, production line infrastructure automation and security guarantees for FoF management systems. Furthermore, the EVOLVED-5G facility through its open development and validation environments targets to facilitate the SMEs and third-party developers to create and verify NetApps, the key enablers for the envisaged Industry 4.0 vertical potentials.

The current deliverable D7.4, builds upon the concrete plans identified during the project's initial reporting period and illustrated through deliverable D7.2. It focuses on the various achievements in the areas of standardization and innovation, as well as on the exploitation results and accomplishments pertinent to the technology transfer activities. Furthermore, it serves as the basis for future activities in the areas of standardization, innovation, exploitation and technology transfer, which are foreseen for the last period of the project.

The engagement and involvement of the project members with the relevant standardization organizations is deemed important from the beginning of the project in order to safeguard that the project results are in accordance with the best practices and can have lasting and valid impact on the Industry 4.0 vertical business, successfully targeting the innovations set.

It is becoming evident that the exploitable opportunities that arise from the project's results are manifold, span in various categories –can be systems, applications, reports, as well as end-to-end service solutions and use cases- and are generated by many partners of versatile interests and strategic (profitable or non-profitable) goals. An all-encompassing exploitation strategy methodology has been devised during the project's initial reporting period and implemented during this intermediate period to manage the exploitation opportunities' diversity so as to capture and classify all possible prospects and partners' interests. On top of exploring the business gains that the technical integration of Industry 4.0 and 5G technologies brings, EVOLVED-5G has also performed concrete Technology Transfer Activities according to its initial plan, raising awareness and encouraging the engagement of the business people in the overwhelming developments, a critical factor for the adoption of the technology offerings in the society.

These very important work streams are realized through the dedicated specific tasks in WP7, and the purpose of this document is to summarize the achievements of these so far:

- Task 7.3: Innovation Shaping and Standardization Alignment
- Task 7.4: Exploitation Activities, Technology Transfer and IPR Management

The current deliverable aims to provide a detailed report on the achievements pursuit so far in the areas managed under its scope, as well as additional plans and ambitions for the final period (M25-M36). As the work of these tasks is continuous, conclusive results in the reported work shall be presented in the final deliverable D7.6 "Standardization, Innovation, Exploitation and Technology Transfer Activities (Final)" that will be submitted at the end of the project (due in M36).

1.2 Document Structure

The content for this deliverable is organized in the following main sections:

- **Section 2** presents the standardization and innovation actions of the project, dividing them between the accomplishments of the intermediate period (M11-M24) which are listed in subsection 2.1 and the plans towards the last period (M25-M36), articulated in subsection 2.2. In detail, clause 2.1.1 describes this intermediate period's (M11-M24) standardization achievements, whereas 2.1.2 lists the principal technological innovation accomplishments. Besides, clause 2.2.1 revolves around updates in the monitored standardization organizations (SDOs), the open-source communities assisting the project to reach its objectives, as well as the project's implementations to be considered publicly available as open-source. Finally, clause 2.2.2 envisions additional project innovation areas for the remaining period, in an attempt to increase the project's impact to the vertical community.
- **Section 3** delves into the analysis of the initial project results performing a gap assessment focusing on project-wide outcomes in 3.1, while additionally presenting the partners' specific individual plans in 3.2
- **Section 4** recaps on the Commercialization of Intellectual Property (IP), the focus of the EVOLVED-5G Technology Transfer Methodology, with an emphasis on the tools to support translation of the project research inventions to commercial products and startup companies. The Guide is envisioned as primary resource for the EVOLVED-5G consortium partners in moving from discovery to commercialization of ideas and technologies developed under the project. The IP Commercialization Blueprint tool is also presented in the scope of this section as a means to assist consortium members identify the important issues in IP commercialization.
- **Section 5** concludes by summarizing the key plans for the next and final period of the project.

1.3 Audience

This document is a public deliverable that focuses on the business potentials of the project's work. As such, the document seeks to reach and engage a wide audience:

- The Research Community, to acquaint with the project's already accomplished and future innovations, as well as the potential impact on Standard's Development Organizations (SDOs) activities.
- The Project Consortium, to reflect on the exploitable outcomes of the EVOLVED-5G framework, the developed NetApps and Industry 4.0 use cases, and also explore the business case opportunities, individually or jointly.
- The general public, to orient with the Industry 4.0 market potentials that are brought in by the 5G technology, so that to obtain a better understanding of the project's work and commercial impact.
- The European Commission, to justify the effort reported for the relevant activities.

2 STANDARDIZATION & INNOVATION ACTIONS

2.1 STANDARDIZATION & INNOVATION ACHIEVEMENTS INTERMEDIATE REPORT

This subsection exhibits the project's standardization and innovation achievements, which took place in this intermediate reporting period (M11-M24).

2.1.1 Standardization Achievements

Standardization activities, such as participation and contributions to SDOs as well as contributions to the open-source community, are fundamental for achieving long term sustainability and ensuring the widest possible exploitation of the EVOLVED-5G results. EVOLVED-5G implementation efforts build extensively on existing standards and specifications. Undoubtedly, successful contributions to standards not only highlight the project's impact and added value, but also validate the quality and relevance of its output. The complete list of standardization achievements is depicted hereinafter, structured around the associated SDOs, with explicit reference to the partners involved.

2.1.1.1 3GPP SA2, SA6 and other WGs

LNV is driving the standardization activities of the EVOLVED-5G project in 3GPP, in an attempt on the one hand to align the project activities with the applicable standards, and on the other to contribute novel project outcomes to the standards. During this intermediate period (M11-M24), LNV, in a joint effort of all T7.3 partners, has submitted several contributions to 3GPP which have been agreed. These contributions are tightly coupled with the project's aspiration on enabling and enhancing vertical application operations through NetApps which offer abstraction of the 5G network complexity, unleashing at the same time its tremendous capabilities. 3GPP contributions are highly impacting the vertical applications' enablement, opening up new opportunities in the development and operation of disruptive industrial applications.

The contributions submitted to **3GPP SA6** during this intermediate period, are divided in two areas, as depicted hereinafter.

i. *"Study on Application Data Analytics Enablement Service (**FS_ADAES**)"*
ii. *"Study on Network Slice Capability Exposure for Application Layer Enablement (**FS_NSCALE**)"*

Both Study Items (SID) are under the scope of Release-18 and the full list of the associated contributions is succinctly documented below.

i. The contributions to *"Study on Application Data Analytics Enablement Service (**FS_ADAES**)"* contain:

   a. **S6-220642**: *Key Issue (KI) on API related analytics*
   The goal of this KI is to enable API related analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.

   b. **S6-220644:** *Key Issue on support for analytics related to slicing*
   The goal of this KI is to enable slice-related analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.

   c. **S6-220645:** *Key Issue on CAPIF enhancements*
   The goal of this KI is to enable CAPIF enhancements to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.

   d. **S6-220646:** *Key Issue on DN related energy analytics*
   The goal of this KI is to enable DN-related energy analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.

e. **S6-220819:** *Solution to KI #1 - support for application performance analytics*

f. **S6-220972:** *Solution to KI #2 - support for edge analytics*

g. **S6-221349:** *ADAE layer architecture update*

ii. The contributions to "*Study on Network Slice Capability Exposure for Application Layer Enablement (**FS_NSCALE**)*" contain:

a. **S6-221863:** *Solution on predictive slice modification in edge based NSCE deployments*

TID complements LNV's leadership in standardization through an active presence in several 3GPP working groups.

In particular, TID keeps an active monitoring and close follow-up to 3GPP SA1, SA2 and SA5, and have attended the following 3GPP meetings since the submission of D7.2, where previous standardization activities were reported in the project.

Table 1: TID's attendance in 3GPP meetings

Meeting
RAN#95-e
RAN#96
RAN#97-e
SA5#141-e
SA5#142-e
SA5#143-e
SA5#144-e
SA5#146
SA3#84-LI-e-a
SA3#84-LI-e-b
SA3#85-LI-e
SA3#86-LI-e-a
SA3#86-LI-b
SA3#87-LI-b
CT#96
CT#97-e
SA#96
SA#97-e
SA1#97-e
SA1#98-e
SA1#100
SA2#149-e
SA2#151-e
SA2#153-e
SA2#154

In addition to regular attendance of calls, TID via its parent company Telefónica SA, has co-signed the following approved contributions:

Table 2: TID's co-signed contributions to 3GPP

Contribution	Title
S5-222574	DP on the relationship of CAMARA and SA work on capability exposure
S5-222756	pCR 28.824 Describe possible solution for EGMF

S5-222723	Discussion paper on 5G exposure
S5-223622	Rel-17 CR 28.541 network slice subnet provider capability IOC
S5-223743	Rel-17 CR 28.531 Network slice subnet capabilities

2.1.1.2 ETSI-OSM

OSM is an open-source Management and Orchestration (MANO) stack aligned with ETSI NFV Information Models that is being used in both Malaga and Athens EVOLVED-5G infrastructure. As users, some consortium partners follow this open-source community in order to be aligned with its latest updates. Currently, Malaga infrastructure uses OSM release 7, while release 8 is used in Athens.

On the other hand, ATOS has been an active member of OSM for several years now, contributing to the community through the work developed in different 5G-PPP projects. ATOS follows the activity of the community and attends some of its periodic meetings and hackfests. Concretely, during the period reported in this deliverable, ATOS attended the hackfests celebrated from release OSMv9 to the current OSMv12, providing some features as well as a PoC to the OSM community. In addition, ATOS participates in the periodic weekly meetings called OSM TECH, where the organization has presented some features and use cases of interest to the open-source community. Such features and use cases will be showcased as they evolve within the community.

The main goal of participating in these meetings is being aware of the topics that may be of interest for the EVOLVED-5G project. In addition, whenever possible, ATOS will try to give visibility of the work being done by the EVOLVED-5G project, fostering the collaboration among both communities, OSM and the project´s one.

Up to now, ATOS has evaluated different options to contribute to the OSM community through EVOLVED-5G project. One of them was related to the dispatcher, a component used by the EVOLVED-5G framework and that was developed by ATOS in 5GENESIS (ICT-17 project) and adopted by the OSM community. In WP3 meetings, we discussed about the possibility of updating this component to be integrated with an upgraded version of OSM that supports the deployment of containerized services. This would allow to introduce the EVOLVED-5G NetApp concept, which provides leading-edge technologies such as K8s and Helm for these deployments, to OSM. This option was discarded in the end as the consortium decided to follow a different approach within EVOLVED-5G project.

2.1.1.3 IEEE TSN

UMA is following 3GPP TSN standards. 3GPP standards are considering the key features and challenges proposed by the combination of TSN and 5G networks. The 3GPP System architecture (TS 23.501) [2] presents the 5G System as a TSN bridge, also supporting the TSN time synchronization by the TSN translators at the edges of the 5G network. Regarding the integration and configuration of the TSN over 5G, the TS 23.502 and TS 23.503 introduce procedures for supporting TSN, such as time synchronization methods or 5G flows management.

2.1.1.4 5G-PPP Pre-standardization WG

LNV is participating in all biweekly 5G-PPP Pre-Std WG meetings where constant monitoring and discussions around 5G-PPP projects' standardization results take place. This active engagement ensures alignment with all those relevant to the project SDOs, as well as cross-project coordination allowing the EVOLVED-5G consortium members to promptly identify standardization opportunities and the respective organizations to follow up and contribute, securing in parallel the project's roadmap. Indicatively, we may refer to the "2022 Q1 SDO Impact Report" where EVOLVED-5G officially included all the standardization achievements up

to 2022 Q1, in an attempt from the Pre-standardization WG to collect input from all 5G-PPP projects and analyze the standardization impact at programme level.

2.1.1.5 5G-ACIA

LNV has proposed in 5G-ACIA a new work item with objective to study use cases and requirements for using 5G NR sidelink device-to-device communication in industrial factory and process automation applications. This work item has been approved and a whitepaper will be drafted on "Industrial 5G NR sidelink device-to-device communications, ranging/relative positioning use cases and associated requirements". This solid collaboration with 5G-ACIA community does not only ensure the project's alignment with the standardization decisions produced by this SDO, but most importantly allows EVOLVED-5G to stay in the forefront and leave its mark on connected industry and process automation decisions, through its own contributions to standards.

2.1.1.6 Alliance for IoT Innovation (AIOTI), WG6, WG11

The Alliance for IoT Innovation (AIOTI) is an SDO created within the European Internet of Things Research Cluster (IERC). Among its activities, this alliance supports the European Commission in relation to the future of Internet of Things R&D and innovation and topics such as standardization and elaboration of IoT policy recommendations, including support for the constitution of cross-sectoral consortia and IoT landscape with 5G.

UPV has recently joined AIOTI and participates on several AIOTI Working Groups: IoT and Beyond 5G Relation and other WGs such as Edge Computing, Computing Continuum, Gap Analysis, and has monitored the standardization activity on those. Also, UPV is analyzing different possibilities to contribute assets from the EVOLVED-5G project to AIOTI WGs, and it has proposed the inclusion of EVOLVED-5G in the AIOTI annual report for 5G & IoT.

2.1.1.7 Data, AI and Robotics (BDVA/DAIRO)

As a member, of the BDVA/DAIRO, which drives the AI architecture standardization CEN/CENELEC JTC21, INTRA, has already communicated the EVOLVED-5G architecture and outcomes and will try, for the next year, to set-up a common workshop for further collaboration. JTC 21 committee produces standardization deliverables in the field of AI and related use of data to address European market and societal needs. This work aims to advance the EU legislation, policies, principles and values. The committee of JTC 21 also considers the adoption of relevant international standards and standards from other relevant organizations.

2.1.1.8 EFFRA (European Research Factories Association)

INTRA has a close relationship with EFFRA (European Research Factories Association). Since EVOLVED-5G results focus on innovative FoF solutions, the project shall explore the liaison to promote EVOLVED-5G results via this channel in the upcoming year.

2.1.2 Innovation Accomplishments

The term "innovation", as thoroughly analyzed in our previous deliverable D7.2, encompasses different types, such as products and services, processes and business models. The main target of our project for this intermediate period towards materializing innovation, was to focus on technology pertinent innovation aspects correlated with *Products – services*, as well as *processes.* More specifically, the innovation plans lied in the development of novel products/services and the introduction of new features in existing products/services, as well as on improving existing *processes* or creating new ones. To this direction the combined and well-coordinated efforts of EVOLVED-5G partners, led to innovation accomplishments which are described in detail hereinafter.

2.1.2.1 CAPIF

To avoid duplication and inconsistency of approach, between the various API specifications that 3GPP has released, the development of a common API framework (CAPIF) has been considered. CAPIF includes common aspects applicable to any northbound service APIs. As such, it is a complete 3GPP API framework that covers functionality related to: on-board and off-board API invokers, register and release APIs that need to be exposed, discovering APIs by third entities, as well as authorization and authentication.

CAPIF functionality is considered as a cornerstone in the realization of 5G openness, since it allows secure exposure of 5G core APIs to third party domains, and also, enables third parties to define and expose their own APIs. Indeed, CAPIF has become already a fundamental feature for the 3GPP SA6, targeting the interaction of various Vertical Industries with the 5G system, including Unmanned Aerial Systems, Edge Applications, Factories of the Future, V2X services, etc.

Within EVOLVED-5G, FOGUS and TID have developed the Core Function of the CAPIF (namely the CCF) together with ready to use examples for API provider and API invoker that someone can use in order to develop its own API provision/consumer entities. The CCF comes together with a set of automated tests which can be used to validate that your API provider/invoker is 3GPP CAPIF compliant (Rel. 17).

The solution is provided under Apache2.0 license and is already listed in the EU Innovation Radar [3].

2.1.2.2 NEF

Network programmability is one of the core technologies to be leveraged by the EVOLVED-5G project towards the NetApp implementation according to its principles. The exposure of APIs by the underlying network allows programmable access to network functionalities and resources in general. NetApp, which is the main component developed in the project, utilizes NEF services in order to expose business APIs to vertical applications. Therefore, it is considered mandatory that a NetApp is capable of communicating with the NEF services provided by the 5GC network. To expose the network capabilities, NEF needs to interface with a set of network functions within the 5GC (i.e., Southbound APIs). Taking into account that at this stage there are no commercial solutions implementing the entire service-based architecture and the southbound interfaces that NEF requires to offer the standardized APIs and the communication with network functions, this exposure has been achieved with the development of a NEF emulator.

In the light of the above, NEF emulator is a software component that emulates the 5G NEF APIs of 5GS Rel. 17 (3GPP). At its core, it implements a REST API approach in order to provide data. More specifically, it emulates the basic functionality of the control plane flow between the NEF and a NetApp, by providing tools for emulating events, acting according to realistic scenarios (i.e., mobility aware event where UEs are moving in predefined paths). The two APIs that have been implemented so far, are the AsSessionWithQoS and the MonitoringEvent API.

2.1.2.3 Marketplace

The Product Catalog page in the EVOLVED-5G Marketplace consists of a list of published NetApps which have been verified with the Open Repository and are available for purchase. For each NetApp listed, the user can click and view all the relevant details, understand what the NetApp does, and which problem solves, as well as review the pricing information.

When the users click on one of the NetApps, they are redirected to the NetApp public page, where they can read more about the NetApp, as well as purchase it.

Upon deciding to proceed with the purchase, a process in the background verifies the procedure and the user sees a confirmation message.

There is a need to create a digital signature of the purchase and store it in a public distributed database. The "proof of purchase" should exist publicly even if the marketplace is no longer in place.

At the same time, the process connects to the Ethereum Network, in order to log a digital signature of this purchase to the Blockchain Network. When the Blockchain transaction is completed, the user receives another automated email, notifying them about the transaction.

This hash string is then shown as a Digital Signature in the "My purchased NetApps" page, which is accessible via the "Dashboard" page. When the user clicks on the Digital Signature link, they are redirected to an Etherscan page, where they can view the corresponding Blockchain transaction.

The process of the "Proof of Purchase" is implemented through the following steps:

1. An Ethereum Wallet (which belongs to EVOLVED-5G), is responsible for creating a new Blockchain Transaction
2. The Transaction has the digital signature of the purchase, as its Input Data
3. The Transaction is then posted on the Ethereum Blockchain Network and is visible to all, containing also the digital signature.
4. The Blockchain transaction consists of a transfer of Ethereum (0.00000001 ETH => 0.00000001 EUR), using the same wallet as origin and destination. This wallet belongs to and is controlled by the EVOLVED-5G marketplace.
5. At the end, the wallet pays only the transaction costs, for creating and storing the transaction on the Blockchain Network. Currently, each Ethereum Transaction costs 2.5 EUR. The pilot now runs on the Rinkeby Test Ethereum Network [4], which is cost free.

Finally, for the Smart Contract implementation, EVOLVED-5G is using infura.io [5] which is a 3rd party service that allows free requests for up to 100K requests/day.

2.1.2.4 Cloud Native

In deliverable D7.2, submitted by the end of 2022, we mentioned that cloud native technologies had emerged as a new trend that promised to completely alter the software development landscape, changing the way of how applications and services would be built and managed. Nowadays, the move to cloud native is already a reality, being a mandatory step for those organizations that need a solid IT infrastructure to be competitive.

But… what cloud native is? The **Cloud Native Computing Foundation** (CNCF) [6], that defines itself as the open source, vendor-neutral hub of cloud native computing, hosting projects like Kubernetes and Prometheus to make cloud native universal and sustainable, defines cloud native as follows: "*Cloud native technologies empower organizations to build and run scalable applications in modern, dynamic environments such as public, private, and hybrid clouds. Containers, service meshes, microservices, immutable infrastructure, and declarative APIs exemplify this approach. These techniques enable loosely coupled systems that are resilient, manageable, and observable. Combined with robust automation, they allow engineers to make high-impact changes frequently and predictably with minimal toil*".

Generalizing, we can say that the term cloud native refers to the concept of creating and running applications to take advantage of the features that the cloud provides: scale, elasticity, resiliency, and flexibility.

Cloud native services are at the hotspot of digital innovations, and this is tightly linked with the EVOLVED-5G NetApp concept. The project conceives the NetApp as an independent service which will be containerized and, thus, isolated from the underlying infrastructure. The technology chosen by the project for containerizing these services is **Docker** [7], an open-source

technology that EVOLVED-5G uses just to build the services, even though this technology supports also their deployment and management.

In the case of EVOLVED-5G, two additional innovative cloud native technologies, Kubernetes and Helm, are used to support the orchestration of services. **Kubernetes**, also known as K8s, is a modern standards-based technology which can manage the whole lifecycle of the containers. On their website [8], Kubernetes is defined as "*an open-source system for automating deployment, scaling, and management of containerized applications*". On the other hand, **Helm** [9] is a graduated project in the CNCF which helps manage Kubernetes applications by using Helm graphs to define, deploy and update even the most complex Kubernetes applications.

Adopting these technologies, the most innovative on the market by the time this deliverable is submitted, allows EVOLVED-5G NetApps to provide services with greater portability and easy on demand scalability. This means that they can be deployed in any environment that supports container deployment, either it is a cluster of K8s, a container orchestrator such as **OpenShift** [10] or a NFV orchestrator which supports containerized service deployment such as OSM [11].

EVOLVED-5G have adopted two different approaches regarding NetApps: Non-StandAlone and StandAlone [12]. The first approach offers Business APIs to the vertical Application (vApp) as well as to the 5G System (5GS) for subscription-based events when applicable; in the second approach, the NetApp is integrated within the vApp offering direct communication to the 5GS. NetApps can be developed and deployed in a cloud native manner following any of the two approaches.

The project is developing a series of NetApps that will be hosted in EVOLVED-5G Open Repository and Marketplace [13]. Anyone will be able to download and use them in their cloud native environment.

On the other hand, EVOLVED-5G project offers developers a comprehensive, standards-based 5G platform for building, testing, and exposing their cloud native applications or NetApps. All libraries offered through the SDK to help with the development of NetApps can be bundled in a container, isolating the system components and allowing the inclusion of a secondary application, such as a database, for the creation of more complex and advanced vertical applications. Nowadays, most container engines can operate across several platforms, enabling the deployment in an easy and fast manner.

2.1.2.5 Auxiliary NetApp

LNV, as a result of their research activities conducted in the context of EVOLVED-5G, has created a prototype system which illustrates the potential of analytics to the vertical applications' tailored requirements. The developed prototype demonstrates how application layer analytics can be created and how these analytics can be consumed by vertical applications, addressing the problem of "vertical application (vApp) server selection". This proof-of-concept realizes a data collection and prediction analysis loop based on feeding (through standardized APIs) the Network Data Analytics Function (NWDAF) with vertical application measurements. For the problem of vApp server selection, a *vApp statistics collector*, collects performance statistics from the available vApp server instances, and feeds them into NWDAF utilizing the *CAPIF manager* and the SDK libraries that EVOLVED-5G has developed. Based on the vApp performance statistics (and potentially, additional input from other network functions), the *NWDAF* derives application analytics per indicated vApp server, by consulting an *AI analytics engine*. *NWDAF* can then provide the vApp client with analytics in order, for the latter one, to select the most appropriate vApp server instance to connect to; for instance, the selection can be done based on latency criteria at a specific time of day and location. This AI-assisted vApp server selection approach exploits analytics (statistics and predictions) assisting in network optimization through enhanced connectivity and efficiently managing resource allocation in the scalable and highly complex vertical industry scenarios. This prototype work is not explicitly listed among the EVOLVED-5G

project outcomes; however, it caters for as an important contribution towards improving operators' decisions on optimized network management or evolving vertical industry use cases.

2.2 Standardization & Innovation Activities Intermediate Plan

2.2.1 Target Groups' Update (SDO & Open-source community updates)

2.2.1.1 ETSI MEC

Even though the currently developed, in the scope of EVOLVED-5G project, NetApps do not entail any specific requirements for the consumption of MEC APIs, LNV keeps monitoring the ETSI MEC community as a relevant to the project SDO, the outcomes of which are expected to extend the capabilities of vertical applications in general, beyond the project's scope and lifetime.

The EVOLVED-5G partners will keep monitoring and actively contributing to the already identified, from the beginning of the project, standardization organizations ensuring the project's compliance with the applicable standards and contribution of the project's salient technological outcomes to the standards.

2.2.1.2 Open-Source

The EVOLVED-5G Consortium recognizes the importance of the Open-Source community, both as a source of valuable tools and expertise that are useful for achieving the goals envisioned by the project, and as a way to increase the impact of the project achievements, by providing them to the community.

The benefits of this approach are twofold: by making use of existing open-source solutions, the Consortium (I) avoids the development of new software components that may provide little benefit to society, and (II) increases the chance that, for components that are indeed developed by the Consortium, interest and support will continue beyond the project's lifetime.

A. <u>open-source tools/solutions used</u>

- **Docker** is an industry/academia renowned tool for creating containers.
- **Kubernetes** provides the infrastructure for managing containers. Along with **Docker**, these tools define the current state-of-art in microservices development and management, allowing for effortless creation of new cloud-native network applications and offering simplicity in deployment and scaling.
- **Jenkins** is a well-known in the DevOps community tool, used for automating processes related to building, testing, and deploying applications, as well as facilitating continuous integration and continuous delivery (CI/CD).
- **Trivy** is a Security scan analysis tool for detecting vulnerabilities in the static code and containers.
- **SonarQube** is a tool for guaranteeing quality in the source code repositories.
- **Robot Framework** is a tool assisting in automation of test execution.
- **Debricked** is a licensing scan tool assisting the operation of the certification process.
- **NMap** is a tool for analyzing port connectivity and as such, assists application developers to early identify any unnecessarily open ports and fix issues to further enhance application security and prevent intrusion.
- **Helm** tool manages Continuous Deployment of several Kubernetes applications and also includes version management.
- **TM Forum's** Open API program is a global initiative to enable seamless connectivity, interoperability and portability across complex ecosystem services. The server side code for TMF620-API that allows the Marketplace to utilize the TM Forum APIs and specifically the TMF620 (Product Catalog Management API) is publicly available in GitHub [14].

B. project's contributions to the open-source community

- **OpenTAP:** The OpenTAP test automation framework [15], originally developed by Keysight, is used as an additional automation tool in the platforms. UMA has contributed to this project by releasing the code of some internally developed plugins as open source in the official OpenTAP repositories [16].
- **Open5GENESIS:** The Open5GENESIS Suite [17], a result of the 5GENESIS H2020 ICT-17 project, is the basis of the Validation Framework. The ELCM component has received extensive upgrades, which are also available as Open-Source software [18]. Future updates to this or other components of the framework are also expected to be released under the Apache 2.0 license.
- **NetApps v2.0**: Within the framework of EVOLVED-5G project the NetApps can be considered as one of the main innovations that the project delivers. At the time of writing this document the second version (v2.0) of the NetApps has been already implemented [19] whereas version three (v3.0) is under development and will be described in detail in the deliverables within the frame of WP4. The second version of the NetApps comprises the SDK and the two APIs that are provided via NEF emulator, namely the AsSessionwithQoS and the MonitoringEvent API. On the other hand, v3.0 will include updates on the vApp side, the utilization of CAPIF for discovering the available APIs and enhancements on top of the already provided APIs (e.g., UE reachability and QoS notifications in a periodic manner), as well as an updated SDK including CAPIF and NEF libraries.
- **SDK libraries**: The SDK consists of set of tools to help developers with the creation of their NetApps:
  - Instructions, which provides the developers all the information they need for the creation of their NetApps
  - Pre-defined templates, where the developer can find the structure of folders and files where the NetApp code is stored.
  - A Command Line Interface (CLI) tool, which allows to create the repository of each NetApp from the template and run the CI/CD pipelines
  - Several libraries, which assist developers by simplifying the iteration of their NetApps with the 5G APIs emulators, as well as with the real 5GC APIs. Essentially, they offer an abstraction towards these APIs, relieving the developers from the tedious work of understanding and creating such interactions with a 5GS from scratch.

  The project has created an organization in GitHub [20] where all these tools are publicly available for the community.
- **The Marketplace** of the EVOLVED-5G project contains a public listing of the available NetApps. Demonstrates how NetApp creators can upload their NetApps to the marketplace and how potential buyers can explore, purchase and use these NetApps. The Marketplace implementation is publicly available in GitHub [21].

2.2.2 Future Innovation Areas

2.2.2.1 Marketplace business aspects as Business Model Innovation

Communication Service Providers (CSPs) are becoming more confident that they can monetize 5G core in both B2B and B2C fields. Several innovations and technological advances in network functions can act as the driving force, to achieve their target, such us Network slicing, function virtualization (NFV), software-defined networking (SDN), edge computing, cloud native infrastructures, in cooperation with network management and orchestration. The key enabler of the innovative use cases that all these technological advantages bring, would be a Marketplace that materializes the respective business models.

The first generation of CSPs e-shops sell pre-defined network plans (voice, SMS, data). With the advent of the digital added value services and specifically those targeting big audiences (tv/video, internet) the second generation of e-shops appeared. On these provider specific marketplaces, one could purchase bundles of telecommunication services. (fixed, mobile, internet, tv, etc.). A small step forward was achieved by the third generation of e-shops/marketplaces where all the services and bundles of services were available with the addition of API services, but still limited to SMS, MMS, and Rich Communication Services (RCS) APIs.

So far, the Marketplaces that the Communication Service Providers implemented and operated were limited to each CSP's services and technological limitations have prevented them from offering customers highly differentiated plans based on their divergent digital habits and needs. The fourth generation of marketplaces supports more complex business models summarized to the following:

- CSPs act as Retailers towards the Buyer bundling services from 3rd parties with Telecommunication services.
- CSPs act as Suppliers towards 3rd party Service Retailers which are bundling services with Telecommunication services.
- CSPs act as Suppliers towards a Virtual Network Operator who is bundling 3rd party Retailer services with Telecommunication services and acts as a Retailer.
- CSPs act as Suppliers towards a Platform Operator who is bundling 3rd party Retailer services with Telecommunication services and acts as a Retailer.

Additionally, Open APIs make it possible for CSPs to combine the software modules they need from multiple vendors or other CSPs. This adds to the aforementioned business models the following:

- CSPs act as Suppliers to a 3rd party Marketplace platform provider who acts as Wholesaler/Retailer of telecom services APIs.

Targeting to a Marketplace beyond the traditional e-shops and completing the more advanced business cases that emerged after the 5G evolution, EVOLVED-5G proposes an implementation of a Marketplace that supports the following business model:

- CSPs act as Suppliers towards the Buyer bundling services and APIs from 3rd parties (Cloud Native providers, vertical App developers, other CSPs) with the Telecommunication services they provide. CSPs have a chance to partner with the cloud native providers and the developers' community and provide the latter with a cloud flavor that extends and improves current public and private cloud capabilities.
- CSPs act as Technology providers/enablers towards 3rd parties, facilitating them to onboard their services, APIs and Vertical applications. CSPs are providing the means (CI/CD, SDKs, APIs) for the 3rd parties to implement, verify, certify and publish their products with the highest level of automation.
- CSPs act as Platform providers delivering an abstraction layer to federate and orchestrate the edge compute infrastructure and provide a web-based authentication, management, reservation, and payment model for consumers (B2C), enterprises (B2B) and developers (B2B2x) to monetize these new telecommunication services. Hybrid local cloud computing offers CSPs the opportunity to go up the value chain by providing new and enhanced connectivity and computing products directly to the mass market.

2.2.2.2 Certification as Process Innovation

Process Innovation is probably on the lesser-known sides of Innovation, as innovation is often related to products and services, and is referring to the introduction of developments and creations that are either new to the market, or significantly improve and disrupt already existing

ones. The so-called product innovation is unquestionably well-known and easily perceptible by the vast majority. However, users and customers are not aware of the countless ways organizations can find along the way to design, produce, and eventually deliver products and services to the market. Indeed, it is true that in many cases product innovation is first driven by a combination of resources, activities, and technologies that can change the series of actions or steps previously taken, in order to achieve a particular end. When these changes are determinant for the final production and delivery of a product or a service in the market, process innovation makes its appearance on the scene.

The approach of process innovation is especially relevant when it comes to designing new technology ecosystems. While inside organizations operational processes are often targeted by process innovation, relationships and dynamics that occur between stakeholders belonging to a particular ecosystem, form the basis for certain types of process innovation that are little known and to which not much attention is usually paid.

Indeed, EVOLVED-5G is above all proposing an entirely new ecosystem for NetApps to flourish. Under the realization and openness of 5G network programmability through the exposure of standard APIs, the EVOLVED-5G proposed ecosystem opens up a new world where third parties and verticals can access and exploit 5G network capabilities in a standardized and trusted way, unlocking the network intelligence to them and their vertical applications. Many stakeholders are considered to be part of the ecosystem, whose dynamics and relationships have been described extensively in deliverable D2.1 [22] and later upgraded in D2.3 [23], respectively.

Building such an ecosystem requires meticulous coordination work between design and practical implementation and mandates the design of new operations, relations and proceedings that did not exist before the EVOLVED-5G conceptualization. In that sense, EVOLVED-5G has actually conceived a new process for NetApps to be certified for practical adoption in the network operators' domain. This necessity is driven through two main pillars:

- Undeniably, the role of mobile network operators (MNOs) as key stakeholders goes one step further in this entirely new ecosystem. MNOs are playing a fundamental part either as the authority that exercises control over the network infrastructure and radio spectrum allocation, or as the entity allowed to operate a campus private network and deploy a real network infrastructure inside a laboratory that is not commercialized to end users.
- At the same time, a consequence of this 5G openness is the evolution of network functions to the software layer. Hence, MNOs have the mandate to develop new processes and include software conformance and quality assessment certifications and hence ensure appropriate security and transparency, in alignment to regulations set by the market and (various levels of) administrations.

The process itself not only pioneers how NetApps, as primarily third-party software interworking with the network, shall be certified in the proposed EVOLVED-5G ecosystem, but also expands traditional certification practices in mobile networks, primarily focused nowadays on devices interoperability and conformance. Although a detailed description of the two-step certification process can be found in previous deliverables of the project (D2.2 [24], D2.4), most innovative aspects of the proposed methodology are listed below as follows:

- **Certification creation process** [25]:
  - Aiming to deliver a concrete audit checklist to support interested partners to ensure that the objectives set for the NetApps certification are met. During this process, the certification objectives must become more specific and the technical evaluation criteria must be specified.
  - At this stage, an appropriate testing methodology is proposed, aimed at framing the certification execution environment for field testing where necessary.

- The design and implementation tools to execute the defined testing methodology in a transparent and repeatable manner is also conceived.

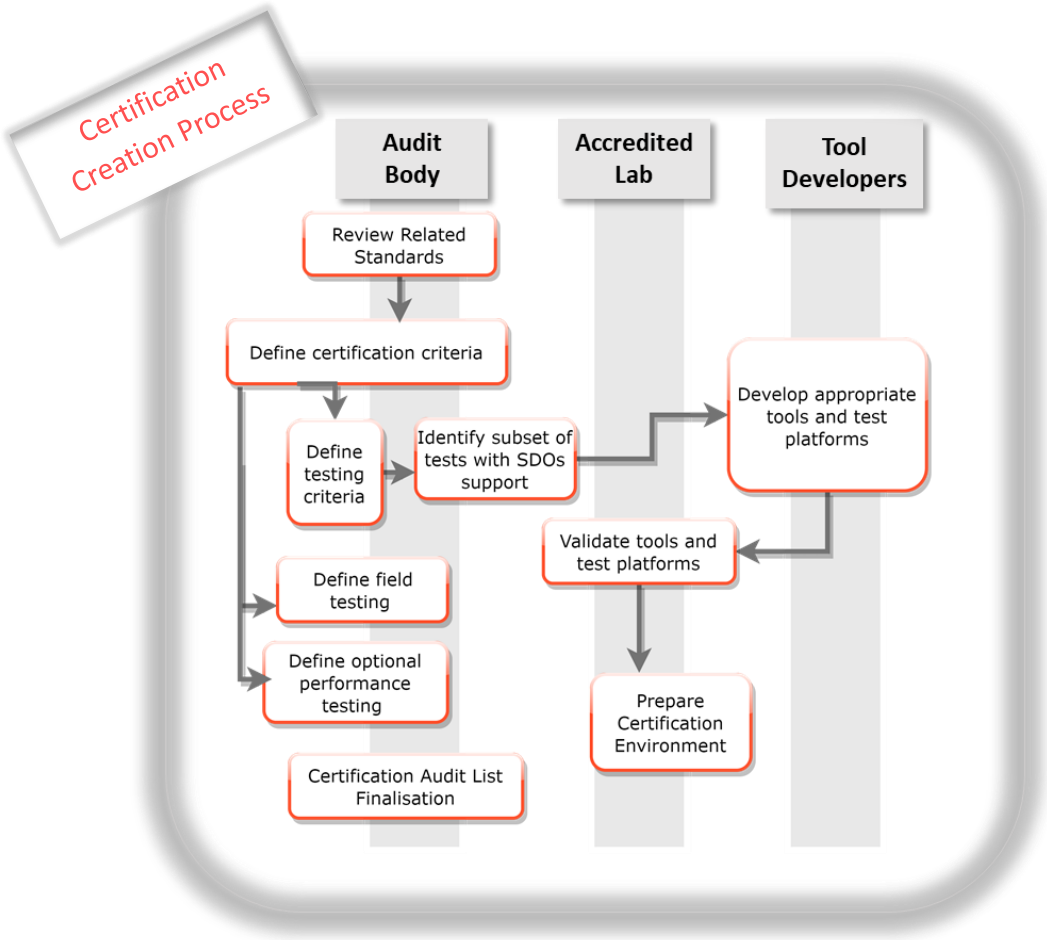

Figure 1: NetApps Certification Creation Process

- **Certification execution process** [25]:
  - Aimed at describing the execution of the certification audit for each requested NetApp, primarily refers to the audit list evaluation, performed as an automated testing process. In this process, it is possible that several testing iterations shall be necessary to achieve conformance, and findings of the certification process can trigger the software development process, providing concrete feedback on missing capabilities and issues to be treated.

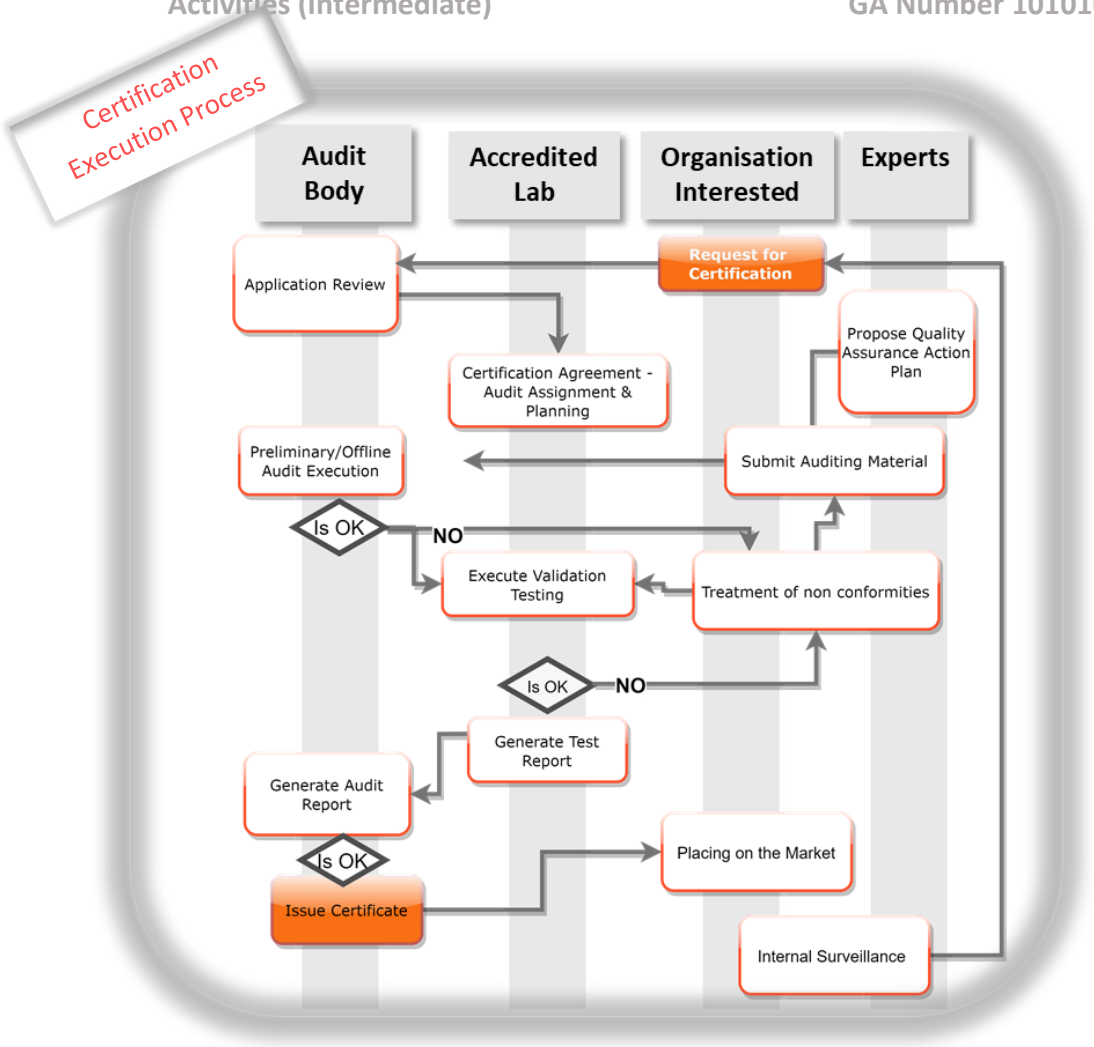

Figure 2: NetApps Certification Execution Process

3 EXPLOITATION PLANS

This section collects the exploitation activities at project level, studying the business case potentials of the exploitable outcomes developed as part of the project work (Section 3.1) and clarifies the individual exploitation strategy of each partner in relation to the project objectives (Section 3.2) as formulated in the intermediate period.

3.1 PROJECT-LEVEL EXPLOITATION INTERMEDIATE PLAN

The strategy to develop the exploitation methodology of the project has already been set in D7.2 [26] that has summarized the exploitation activities performed in the first year of the project and has set the execution plan that is graphically depicted in Figure 3. The first-year activities included the implementation of Step 1, identification of the project results, and their classification to reveal the exploitable outcomes. As the project developments evolve, revisions are foreseen, marked as Step 2 in the execution plan. The revision is considered a running process that spans all the cycles of the exploitation execution, and the final conclusive list shall be part of the final D7.6 deliverable.

During the second year, reported in this document, the focus has been the revision of the exploitable outcomes, the update on their TRL (Technology Readiness Level) as well as, the execution of a gap analysis, to reveal the opportunities, strengths, weaknesses and risks of each outcome, marked as Step 2 in the figure below. Step 3, the last step of the methodology, is to be analyzed during the last year of the project, focusing on selective high potential, mature project outcomes.

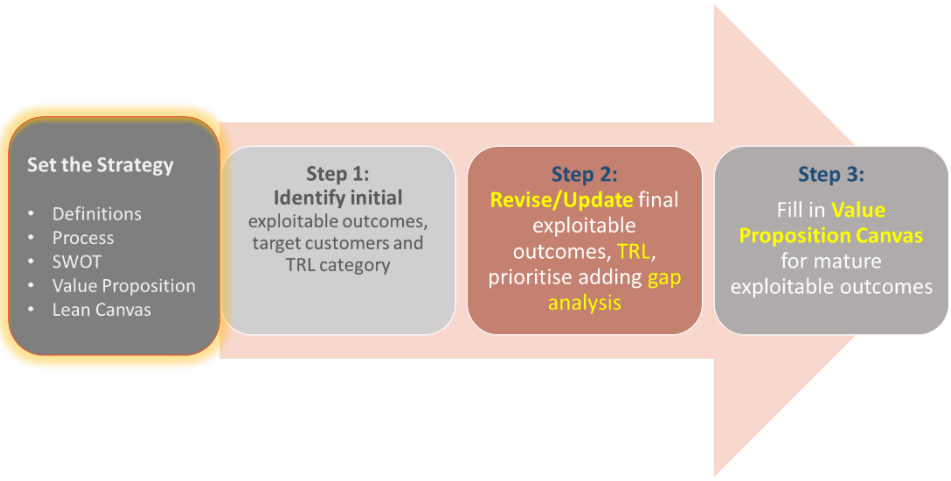

Figure 3: EVOLVED-5G Exploitation Strategy Execution Plan

3.1.1 Exploitable Outcomes Description & Gap Analysis

The project builds a fully-fledged framework, that once instantiated can support the automation of the development, integration and deployment of applications in an NPN 5G infrastructure, an essential task for the Industry 4.0 business. The components of the reference architecture, and the EVOLVED-5G facility itself are considered core outcomes and fundamental deliveries of the project and are referred to as platform-level outcomes.

Furthermore, the project involves a large variety of SMEs that, utilizing the capabilities of the EVOLVED-5G framework and facility, attempt as part of the project to develop innovative NetApps to support the business of their sector. These NetApps, are built in close collaboration with other project partners, and have a more vertical-oriented market value. During the preliminary analysis of the results, it was identified that there are two distinct exploitable means

for the NetApps developed and this separation is also reflected in the analysis of the below subsections:

- The (NetApp) prototype that can be marketed individually as a software artefact, and
- The demonstrator that can stand as a fully integrated, ready to be used turn-key solution.

3.1.1.1 *EVOLVED-5G Facility*

Description	EVOLVED-5G Facility is an integrated environment containing the set of all necessary components/tools towards the development, validation and certification of NetApps for FoF use cases, by utilising the NPN 5G.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator			
Target Markets	Regulators, technology providers and industry in general. Moreover, a main target market will be the ecosystem of the digital innovation hubs that can pave a straightforward way for the introduction of the EVOLVED-5G solution in the relevant SMEs' community.			
Innovations	NEF Emulator for NetApp verification CAPIF services for NetApp certification k8s NetApps for Cloud-native solutions CAPIF/NEF for Network Programmability Development of a NetApp validation environment (tools) Production of a Marketplace where to expose the NetApp			
Product Competition	There are no relevant products in the market			

3.1.1.1.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Support of the full lifecycle of a NetApp • Multi-tier architecture • Each environment introduces several innovative tools • It is a vertical industry agnostic facility	• Heterogeneity on hardware and software between the two 5G NPN infrastructures
(External) Opportunities	**(External) Threats**
• No relevant products in the market • Formation of the NetApp ecosystem	• Slow adoption of 5G technology in industry and enterprises

3.1.1.2 *SDK tools for NetApp Development*

Description	EVOLVED-5G SDK is a set of tools, delivered in the form of a downloadable package for local use, to support developers in the creation of NetApps. It includes: (1) Instructions, (2) a NetApp template, (3) a CLI tool, and (4) Libraries.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Software Developer			

Target Markets	All 5G Verticals that exploit NetApp capabilities
Innovations	• Containerized NetApps for Cloud-native solutions • NEF Emulator and CAPIF Core Function for NetApp verification • CI/CD integration for NetApp validation • CAPIF Core Tool integration to discover NEF APIs
Product Competition	There are no similar products on the market. As of today, even though other SDK tools from other research projects can be found, they are more focused on the creation of VNFs and NSs. None of them are related to the novel NetApp concept.

3.1.1.2.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Free software under Apache 2.0 license • Downloadable package for local use • No stringent download/execution requirements • Eases the creation of NetApps for developers as allows the generation of a python NetApp from a template • Provides access to a virtualized 5G environment for NetApp verification • Provides access to a virtualized 5G environment for NetApp validation • Provides free libraries for the NetApp to interact with different 5G APIs discovered through CAPIF (e.g., NEF APIs)	• Process to be started by developer: email needs to be sent to GitHub organization • Can be run only from a terminal, user- friendly front-end (GUI) not available • Requirements: OS Linux minimum 20.04, Windows 10, Python3, git and pip3 pre-installation required in local computer or virtual machine
(External) Opportunities	**(External) Threats**
• NetApp is a new concept with a lot of potential • Creation of NetApps ecosystems • No identified competition • Containerized NetApps to run in any cloud-native environment • Libraries may be reusable by other projects	• NetApp is a novel concept in the market • No standard definition of NetApps (among ICT-41 projects)

3.1.1.3 *NetApp Validation Tools*

Description	The NetApp Validation tools aim to provide the functionality required for the assessment of the correct functionality of the NetApp along with a Vertical App (non-functional testing), in near real network conditions.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Platform owner			
Target Markets	Certification bodies that are interested in validation of NetApps. Platform operators involved in the NetApps validation.			
Innovations	Extension of the existing Open5Genesis framework for the management of NetApps: - Support for the definition of complex experiment logic - Integration with CI/CD services			
Product Competition	Related automation solutions exist, however none of them are fine-tuned for NetApp Validation and 5G Experimentation			

3.1.1.3.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Free software under Apache 2.0 license • Modular architecture where many components are optional or replaceable • Extensible but able to control heterogeneous devices/software out-of-the-box	• Modularity increases deployment complexity • The different components have different requirements and configuration/usage procedures • Extensive use of (text) configuration files, no unified graphical user interface
(External) Opportunities	**(External) Threats**
• No other competing solution is fine-tuned and tested for NetApp Validation • Not only designed for NetApp Validation, able to orchestrate and manage general experimentation • No barrier of entry: Open-Source components that end-users may download and deploy without prior authorization	• Similar results may be achieved by using other tools, provided that enough work is devoted to their adaptation

3.1.1.4 *NetApp Certification Environment*

Description	The NetApp Certification Environment consists of a blueprint definition to set up a Certification Lab that enables the Certification of NetApps following EVOLVED-5G Certification process. This Blueprint contains all the needed components to build the facility and the interactions between them. It also provides reference implementations for these components, though it is up to the customer to use their own solutions.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Accredited Lab, Integrator			
Target Markets	Companies in the certification business of 3GPP devices and applications 5G Core vendors and API publishers in general Platform operators involved in the NetApps validation.			
Project Innovations	SDK environment (tools, libraries) to develop NetApps NEF Emulator for NetApp verification NetApp validation environment (tools) CAPIF implementation for NetApp certification			
Product Competition	As of today, there are no commercial products for NEF and CAPIF compliance certification. Competitors may arise from 5G Core vendors implementing NEF and CAPIF functionality as part of their 5G Core commercial releases.			

3.1.1.4.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Blueprint definition to build a Certification Lab for NetApps based on CAPIF and NEF standards • Automation tools providing fully automated certification process • Integration to Marketplaces defined • First worldwide CAPIF implementation and NEF Emulator are available • Tested and proved over NPN 5G infrastructure	• Currently limited to CAPIF and NEF APIs. • No coverage for data plane communications • No 3GPP specs on API testing equivalent to radio equipment, for instance

(External) Opportunities	(External) Threats
• Tools are Opensource and available for Certification Labs to replicate the environment • Can be extended with additional certification tests if needed • Tools are decoupled and can be replaced easily	• Global Certification Forum certify Devices, not Apps • Vendors are reluctant to build API testing specs to foster interoperability

3.1.1.5 *NetApp Marketplace*

Description	The EVOLVED-5G Marketplace is a SaaP (Software as a product) marketplace that allows its users to publish, search, discover, acquire and deploy NetApps and pre-configured network slices. It allows the users to engage in a number of ways and ensures that the published services conform to the marketplace rules through a certification mechanism. It also implements Dashboards for publishers and buyers to track (virtual) revenue/balances, view consumption of analytics and monitor API and services performance.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	NetApp Developer, Integrator, Vertical business			
Target Markets	Network operators, acting both as suppliers and buyers of NetApps Vertical Industries, acting both as suppliers and buyers of NetApps NetApp developers			
Innovations	NetApp validation environment (tools) CAPIF implementation for NetApp certification			
Product Competition	There are no relevant products in the market at the moment			

3.1.1.5.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Unique and efficient marketplace • Marketplace testing environment development by experienced maggioli group members • Excellent technological background • Friendly user interface	• Dependent on having access to 5G connectivity • Access to the certification environment is needed
(External) Opportunities	**(External) Threats**
• Opportunity to exploit new market segments • Potential demand of NetApp marketplace by public administration and telecommunication operators • No competition, no marketplace that sells 5G services (Blue Ocean market for 5G services). • High demand for cost-effective and novel NetApp solutions by SMEs	• Preference for proprietary solutions by telco operators

3.1.1.6 *NEF Emulator*

Description	The NEF emulator is a software component that emulates the 5G NEF APIs of 5GS Rel. 17 (3GPP). At its core, it implements a REST API approach in order to provide data. Specifically, the Emulator will emulate the basic functionality of the control plane flow between the NEF and a NetApp, by providing tools for emulating events,

	acting according to realistic scenarios (i.e., mobility aware event, using real life data).			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	NetApp Developer, Integrator			
Target Markets	Certification bodies, interested in testing the compliance of a NetApp with 3GPP specifications Platform operators, interested in testing the capabilities of the 5GC APIs. NetApp Developers			
Innovations	CAPIF/NEF for Network Programmability NetApp validation environment (tools)			
Product Competition	There are no relevant products in the market			

3.1.1.6.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Dockerized solution • Free software under Apache 2.0 license • Local installation for testing • Restful APIs implementation • Support of multiple actors within a scenario (complexity) • UI with functionalities • Support of various use cases and scenarios • Scalability	• Additional APIs based on the upcoming Releases of 3GPP need to be developed for a full-scale solution • Dependencies on open-source software • Need for continuous monitoring on potential bug fixes/updates of the open-source software
(External) Opportunities	**(External) Threats**
• No open commercial solutions implementing the entire service-based architecture and the southbound interfaces • Both developers and enterprises can create, launch, and manage new services or improve already existing processes • The adoption of SBA architecture by telecom vendors may last longer than expected	• The exposed APIs must be compliant with the standards set by 3GPP • Since the APIs of 3GPP are publicly available, similar solutions can be implemented

3.1.1.7 *CAPIF certification tool*

Description	The CAPIF Certification Tool is a prototype of the 3GPP CAPIF Core Function defined in TS29.222. It implements all APIs consumed by NetApps taking the role of API Invokers, and the APIs for API Publishers to publish APIs though CAPIF. It is delivered as working software component containerized and the goal is to publish it as Open Source.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	NetApp Developer, Integrator, Accredited Lab			
Target Markets	Certification bodies, interested in testing the compliance of a NetApp with 3GPP specifications Platform operators, interested in testing the capabilities of the 5GC APIs. NetApp Developers			

Innovations	CAPIF/NEF/SEAL for Network Programmability CAPIF Emulator for NetApp certification
Product Competition	As of today, there are no commercial products for NEF and CAPIF compliance certification. Competitors may arise from 5G Core vendors implementing NEF and CAPIF functionality as part of their 5G Core commercial releases.

3.1.1.7.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Dockerized solution • Free software under Apache 2.0 license • Local installation for testing • Restful APIs implementation • Automated testing included • Security based in Certificates included	• Multiple CAPIF Core Function instances not supported yet • CAPIF Specifications evolving in Release 18. Updates will be required. • Backoffice for operation needs to be developed
(External) Opportunities	**(External) Threats**
• First CAPIF implementation worldwide. Can foster CAPIF adoption by vendors. • Opensource software can be used in building commercial products (API Gateways, AFs, NEF, NWDAF, …) • Reference implementation usage will help detecting gaps in the 3GPP standards • CAPIF is Release 17 compliant, can be used in many more JU SNS projects shaping 6G	• Can be replicated as CAPIF APIs are publicly available in 3GPP specs • Lack of other CAPIF implementations blocks interoperability testing • No 3GPP tests defined for API compliance; leaves some interpretation open to implementation decisions

3.1.2 EVOLVED-5G SME Exploitable Results

3.1.2.1 *Digital/physical twin NetApp*

Description	The Digital / Physical Twin NetApp enables connectivity of aircraft repair patches (hot bonder(s) used for repair curing at the repair area), in order to transmit in real-time all related data to the Engineering Centre of aircraft manufacturer / airline / Maintenance, Repair, Operations (MROs) certification authorities (EASA, FAA etc.) This data will be used either to create in real-time a "Replica" repair using a second bonding console, identical to the "Source" repair (Physical-Twin) or to use such data for calculation of the Degree of Curing (DoC) applying corresponding material curing equations (Digital Twin).			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	Aeronautical market: Aircraft manufacturers, Airlines, Maintenance Repair Overhaul - MROs and civil aviation authorities (EASA, FAA etc.)			
Innovations	Presently, all maintenance data are transferred off-line and after the end of the repair. This causes both inability to intervene in order to remedy potential problems during the repair, as well as delays in processing and authorizing return of the aircraft to flight operations. Digital - Physical Twin NetApp will permit both on-line interventions and real time transfer of data, reducing time requirements through a new innovative capability.			
Product Competition	There are no relevant products in the market			

3.1.2.1.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Innovative development • Lack of competition • Sound technological background	• Need for continuous update • Difficult to explain to end-users • Updating costs
(External) Opportunities	**(External) Threats**
• Totally new market • Adoption by regulatory authorities • Important reduction of costs	• Reluctance of market to adopt • Need for extensive demonstrations • Specialized personnel requirements

3.1.2.2 *Composite repair physical / digital twin in the aircraft business*

Description	Composite Repair Digital / Physical Twin in the aircraft business will provide a new service, namely the ability to perform on-line interventions during the composite repair cycle as well as to transfer data in real time, reducing time requirements.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Aeronautical market: Aircraft manufacturers, Airlines, Maintenance Repair Overhaul - MROs and civil aviation authorities (EASA, FAA etc.)			
Innovations	Presently, all such data are transferred off-line and after the end of the repair. This causes both inability to intervene in order to remedy potential problems during the repair, as well as delays in processing and authorizing return of the aircraft to flight operations. The new service Digital - Physical Twin composite repair service will permit both on-line interventions and real time transfer of data, reducing time requirements through a very innovative capability.			
Product Competition	There are no relevant products in the market			

3.1.2.2.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Innovative development • Sound technological background	• Need for continuous update • Difficult to explain to end-users • Updating costs
(External) Opportunities	**(External) Threats**
• Totally new market • Adoption by regulatory authorities • Increased demand for cost reduction • Lack of competition	• Reluctance of market to adopt • Need for extensive demonstrations • Specialized personnel requirements

3.1.2.3 *Chatbot assistant NetApp*

Description	The Chat-bot NetApp will aid the workers of a factory at everyday maintenance tasks via a chat-bot application. For example, a predefined questionnaire will be provided for the facilitation of the reporting procedure of a faulty equipment. At the same time, the maintenance procedure will be enhanced by providing all the

	necessary documentation directly to the device where the chat-bot runs. The NetApp to be developed within the project will focus on maintenance procedures.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	Smart Factory - Manufacturing industries, production lines, factories with machine-human interaction			
Innovations	The outcome builds on the ability of the 5G system to provide precise indoor location information that will be used by the NetApp for authentication and identification of the workers.			
Product Competition	There are no relevant products in the market. Currently, chat-bots are used as online chat assistants, but these applications are not focused on factory workers interaction.			

3.1.2.3.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Strong technical background • Innovative use of chatbots • Friendlier User Experience • Simple Flow and easiness of use • Great compatibility	• Need for administration • Need for maintenance • Use of mobile device • Expensive initial 5G network deployment • Cost of updates
(External) Opportunities	**(External) Threats**
• New market audience • Further use in industry environments • High demand for faster and cheaper service provision • Regulations promoting better and safer work environment	• No immediate need to change existing ways • Misuse of equipment • Training of the workers is required • Mismanage/incompatibility/interoperability issues

3.1.2.4 *Location-aware chat-bot for precise maintenance in a 5G/NetApp-enabled Industry 4.0 manufacturing environment*

Description	The service targets precise maintenance in a 5G/NetApp-enabled Industry 4.0 manufacturing environment, by integrating a Location-aware NetApp chat-bot. The focus is to aid the technical workers of a factory at everyday maintenance tasks via accurate provision of necessary information based on the location of the involved technical team in comparison to the location of the faulty machine and the authorization levels/access of the team to the specific area.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Smart factory -Manufacturing industries, production lines, factories with machine-human interaction			
Innovations	The service exploits the popular and easy-to-use nature of a chatbot, and it enchases it with the indoor location of a factory, provided through the Chatbot Assistant Network Application. The final product is the location-aware chat-bot for precise maintenance in a 5G/NetApp-enabled Industry 4.0 manufacturing environment for authentication and identification of the workers (based on their location within the factory). This chatbot will authorize access in specific location in			

	the factory for an identified worker, provide guidance for that location, call authorized personnel for assistance in closest proximity.
Product Competition	There are no relevant products in the market. Currently, chat-bots are being used as online assistants' apps with no special focus on providing location aware services and information to factory workers in the manufacturing industry.

3.1.2.4.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Innovative development • Indoor location awareness • Versatile functionality • Ease of use and training • App interoperable in any smart device OS	• 5G connectivity dependency • Need for high density of small cells per factory for high accuracy or a similar solution • Need for mobile smart device • Signal quality dependent
(External) Opportunities	**(External) Threats**
• Adoption by other factories • High demand for cost-effective maintenance solution • Fast problem spotting and fixing • Security provision and Authorization areas • Expanding to services beyond maintenance • Lack of similar competitive offerings	• Other competitors researching similar ways for localization using 5G • Not many factories using 5G at the moment • Cost of 5G indoor implementation (many cells) • Infrastructure cost maintenance and upgrades

3.1.2.5 *Anomaly Detection NetApp*

Description	The product is an application that is able to receive monitoring information from 5G NPN exploiting NEF exposed monitoring, NWDAF analytics and additional sources of monitoring (i.e., LAN/WAN monitoring) in order to detect anomalies and provide alerts and in the greater extend mitigation policies.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	• ICT market and integrators that seek to include the monitoring/alerting provided by the product with their OT/IT management solutions. • Smart Factory, to be incorporated as a standalone deployable component that enables anomaly detection			
Innovations	The innovation is stemming from the use of 5G monitoring information and analytics in correlation to the plant-wiring infrastructure monitoring that is available in digitized factory plants. The innovations brought by EVOLVED-5G exposes this information and allows seamless access to the monitoring feeds with relation to the 5G operation and subscribers information.			
Product Competition	The anomaly detection employing AI and heuristic algorithms is widely used in wired and wireless network domains. However, its application for the networks inside Factories of the Future, in correlation with the specificities of the deployment environment, the divergent workflows each factory may have and the varied convergence levels of IT and OT, make anomaly detection operation a challenge. There exist equivalent products that mostly focus on the anomaly detection for predictive maintenance and mostly focus on the machine tools not on the networking itself. We anticipate that adoption of 5G NPN and the convergence of IT and OT will create the need for network-based anomaly detection in factory plants.			

3.1.2.5.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• The development/integration/validation environment that allows quick development of features and data acquirement • Expertise in anomaly detection and 5G • Prototype will offer OpenAPI for integration with other vendor solutions and integrations	• Fully automating classification of anomaly in order to mitigate may be very difficult for the project lifetime. • Difficulty to get real Industrial environment for accessing factory traffic patterns and threat signatures
(External) Opportunities	**(External) Threats**
• The application field is still open and is upcoming • New AI algorithms will make detection even better • The NetApp model simplifies the monitoring data acquiring • There is a clear gap in the network anomaly detection in FoF	• The industry uptake of 5G NPN may stall due to reluctance of upgrading the plant infrastructure • The 5G standards implementation varies between vendors making harder to access particular information and APIs.

3.1.2.6 *Network Monitoring and Anomaly Detection*

Description	In the envisaged service of 5G NPN in FoF environment, it is anticipated that the 5G will overtake all connectivity on the factory floor among sensors and actuators. Especially in a production/assembly line, where many different devices will be operating in sequence the deterministic and without latency communication between them and between the control processes is very critical. This use case emulates a manufacturing process line that uses moving rails that carry products. The products are being supervised by a video camera and the resulting video feed is analyzed for certain patterns/parameters (e.g., color, shape etc.). In case a defect product is identified, a command to a robotic arm is given in order to discard the product. In case of anomalies, that, may affect the timely operation of the closed loop for the detection. The anomaly can occur either by network defects or by attacks internal to the network. The integrated anomaly detection application will detect and mitigate if possible, the identified anomaly. Moreover, it will provide alerting through the plant monitoring system.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Smart Factory -Manufacturing industries, production lines, factories with assembly lines where linear processing is used and many sensors and actuators as well as control modules are employed			
Innovations	The introduction of 5G and TSN support in the factory plant connectivity are new concepts currently being integrated under the frame of Industry 4.0 theme. The anomaly detection over this new environment is rather new and poses many challenges.			
Product Competition	Solutions that deal with anomaly usually focus on the operational aspects not on network related issues and attack-imposed anomalies, since the openness of the plant network and the external connectivity for the time being are restricted. However, 5G adoption will bring more use cases for connectivity and open the plant network to more attack vectors.			

3.1.2.6.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Expertise in the anomaly detection for I4.0 environments • Integration with CAPIF and native 5G monitoring support via NWDAF • E2E integration on a small scale complete I4.0 testbed	• Pending testing to large scale testbed scenarios • Increased cost of equipment for initial deployments
(External) Opportunities	**(External) Threats**
• New industrial protocols to be investigated and identified as potential attack surfaces • EVOLVED-5G integration can enable holistic management of resources and services • Accelerated adoption of NetApps from the I4.0 industry	• 5G NPN cost of investment as a stalling factor • Training and uptake of skills related to NetApp integration can stall development • 5G standards vary for different industry bodies and implementations

3.1.2.7 *5G SIEM NetApp*

Description	The FOGUS 5GSIEM NetApp is an auxiliary middleware that allows the current Security Information and Event Management systems (SIEM), used in the industry domain, to incorporate information/data of a 5G system, and eventually support 5G-enabled industrial infrastructures. The NetApp will be provided together with the FOGUS SIEM system.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry SIEM system developers			
Target Markets	• ICT market and integrators that seek to include the security monitoring/alerting provided by the product with their OT/IT management solutions. • Digital security systems market for event management and analysis when multiple types of private networks (including 5G) are used.			
Innovations	The key innovation of the prototype is that it leverages standardized 5G exposure APIs to expand the monitoring and event management capabilities of a SIEM system towards the 5G NPNs. The prototype contributes to the broader innovation of integrating 5G-NPN in industrial spaces.			
Product Competition	There are no relevant products in the market			

3.1.2.7.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Customized according to end user's needs • Innovative development • Enlarged target group • Monitoring and event management on real time • Friendly user experience • Scalability	• The behavior of 5G SIEM NetApp is unknown in case a different SIEM system is used • A 5G NPN is required • Not a standalone product, it needs a SIEM
(External) Opportunities	**(External) Threats**
• Expanding the borders of the existing 5G NPN • Compatibility with different types of NPN • Security and instantaneous event management • Supporting 5G networks and devices • No relevant products in the market	• Slow progress on 5G NPN adoption • Many security threats • 5G connectivity is required

3.1.2.8 *Network event monitoring*

<table>
<tr><td rowspan="3">Description</td><td colspan="4">The service refers to the FOGUS SIEM with the FOGUS 5GSIEM NetApp integrated. The system encompasses all the key functionalities of a SIEM system, including the following:
• Vulnerability Assessment: Authenticated and (in some cases) un-authenticated scan can be applied towards a network or host of the industrial infrastructure.
• Intrusion detection: The process of intrusion detection can be applied at network level - NIDS (Network Intrusion detection), at host level - HIDS (Host Intrusion Detection) and at file level - FIM (File Integrity Monitoring) with major scope to identify network traffic-based anomalies and web traffic-based anomalies (SQL, XSS).
• Behavioral Monitoring: The identified anomalies (any statistical anomaly or malware detected) are analyzed through the behavioral monitoring process, to reveal the cause behind. Host-availability and service availability monitoring is provided as well.
• Security intelligence: Chained events are examined through correlation rules.</td></tr>
<tr><td>Outcome Type</td><td>Demonstrator</td><td>Outcome Category</td><td>Business Development</td></tr>
<tr><td>Target TRL category</td><td colspan="3">Technology Development and prototypes (5,6)</td></tr>
<tr><td>End Customer</td><td colspan="4">Smart Factory -Manufacturing industries with 5G NPN deployments</td></tr>
<tr><td>Target Markets</td><td colspan="4">Network management for manufacturing industries.</td></tr>
<tr><td>Innovations</td><td colspan="4">The service bridges the gap of incorporating in the network management the mobile network (5G-NPN) and the mobile devices of the employees. The solution leverages standardized 5G exposure APIs to expand the monitoring and event management capabilities of a SIEM system towards the 5G NPNs. In addition, a wide range of innovations could be built on top of the capabilities that the service provides, for instance extensions towards AI-based behavior analysis.</td></tr>
<tr><td>Product Competition</td><td colspan="4">There are no relevant products in the market. The current SIEM solutions ignore the potential of monitoring a 5G-NPN.</td></tr>
</table>

3.1.2.8.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• A standalone product • Scalability • Compatible with AI-based behavior analysis	• 5G NPN exposure capabilities are required • More tests have to be done under real conditions (increase TRL) • Need for updates according to AI behavior analysis • 5G connectivity is required
(External) Opportunities	**(External) Threats**
• Supporting 5G networks and devices • Keeping up with FoF • Compatible with the openness of 5G movement • Adoption of network event monitoring technologies by Smart Factory-Manufacturing industries • No relevant products in the market	• Slow progress on 5G NPN adoption • 5G NPN deployment is required • Lack of smart industries and smart devices

3.1.2.9 *Remote assistance in AR NetApp*

Description	Our prototype focuses on a Mixed Reality application for remote assistance in the Industry 4.0. More precisely, our vApp+NetApp consider a machine maintenance scenario conducted in Augmented Reality (AR). The NetApp will monitor the status

	of the 5G network and in case of issue (congestion, failure, etc.) it will find a compromise between the initially requested QoS and what is currently achievable. This way, the monitoring is offloaded to the NetApp. The vApp can focus on the core aspects of collaborative industrial maintenance in AR and simply follows the NetApp suggestions to enable or disable functionalities depending on the current QoS.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	The manufacturing industry and the maintenance Industry with end-user application, ICT market with a video streaming application, AR/VR market with a smart component to integrate.			
Innovations	Developers in the AR/VR market may be interested in the capabilities of the 5G network, but do not necessarily know how to access them. Users in the remote assistance are really in demand for this type of support. The NetApp will allow all of them to benefit from 5G network performance and facilitate the integration of 5G into their own applications. The NetApp offers an intermediate layer to negotiate with the 5G network about the QoS required by the vertical app including network monitoring and autonomously proposing adaptations in case of network issue.			
Product Competition	There are no relevant products in the market. Other NetApps may also propose some network monitoring but may not have a specific focus on QoS and TSN.			

3.1.2.9.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• IMM's expertise in AR • Existing technological bricks from IMM • Existing pool of industrial clients	• No 5G expert at IMM • No proprietary AR hardware
(External) Opportunities	**(External) Threats**
• Strong consortium about 5G technologies with EVOLVED-5G • 5G capabilities required for some AR usages • Significant growth of AR market and Industry 4.0 • Current need for remote cooperation tools, especially in the Covid-19 context.	• Slow adoption of 5G in factories • A lot of potential competitors for remote collaboration in AR, including GAFAMS • AR HMDs are made by GAFAMS. Most cannot handle 5G on their own or it is in an experimental state

3.1.2.10 *Autonomous adaptation to network performance and user needs*

Description	The service will illustrate end to end the key capacity of the IMM NetApp: the autonomous QoS adaptation to network performance and end-user needs. The NetApp is able to autonomously communicate with the 5G network, monitor its state and propose adaptations to the vApp. For instance, it can find an optimal compromise between the initial QoS requested by a vApp and the best QoS currently achievable after a network issue (congestion, failure, etc.). QoS is at the heart of the envisioned NetApp and targets to support vertical use-cases about remote assistance in Augmented Reality (AR) and Virtual Reality (VR).			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		

End Customer	Vertical Industry - Industry 4.0 companies with remote assistance needs (for instance: machine maintenance or inspection)
Target Markets	AR/VR and video streaming applications market. Machine maintenance & Inspection
Innovations	The service shall demonstrate: 1) Network monitoring + autonomously proposing adaptations in case of network issue. 2) Demonstration of 5G enabled AR application with AR headsets.
Product Competition	Remote AR cooperation/assistance products are already available (for instance, Microsoft Mesh), but do not include both 5G and AR.

3.1.2.10.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• IMM's expertise in remote collaboration • Improved understanding of 5G technologies thanks to the project	• No 5G expert at IMM, which complexifies future evolutions of the service after the end of EVOLVED-5G • No AI/Machine Learning expert at IMM to optimize the quality of NetApp recommendations for complex scenarios
(External) Opportunities	**(External) Threats**
• Growing interest for 5G • Many AR/VR competitors lack of technical knowledge about 5G	• A lot of potential competitors interested in 5G • Competitors taking advantage or getting inspired by the IMM NetApp

3.1.2.11 *Traffic Management NetApp*

Description	The NetApp builds upon 8Bells White Box Switch and targets an intelligent traffic steering mechanism that optimizes the number and sequence (chain) of service functions (SFC) based on higher layer inspection (Layer 7), i.e., traffic identification and classification at the application layer. This is achieved by integrating TSN-driven synchronization, enabling deterministic networking and intelligent data switching through classification of IoT and industrial networking protocols and applications based on L7 application signatures in data payloads.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	ICT market, manufacturing industry referring to the needs of detection and analysis, private 5G networks			
Innovations	Full value is shown in NFV or containerized (serverless) environments for flexible forwarding of data plane packets, like the one for cloud-native 5G Core deployment. Enabling an application-aware programmable data plane will allow high accurate service function chains, through avoidance of some unnecessary VNF stages. This is expected to be highly beneficial for service deployment time, end-to-end service latency and overall energy consumption			
Product Competition	There are no similar products in the market.			

3.1.2.11.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• No relevant products in the market • (Potential) innovative TSN-driven synchronization • Intelligent data switching • Reduced end-to-end service latency • Real time detection and monitoring	• A 5G NPN is required • 5G NPN exposure capabilities are required • Real Industrial environments are not easily accessible
(External) Opportunities	**(External) Threats**
• Strong EVOLVED-5G consortium expertise in 5G technologies • Fast adoption of NetApps from the I4.0 industry • Demand for security and authentication provision	• Slow progress on 5G NPN adoption • 5G connectivity is required

3.1.2.12 *Accurate measurement of "unregistered" traffic over the 5G network*

Description	The service will illustrate end to end the key capabilities of the NetApp integrated White Box Switch and demonstrate the following functionalities: • Monitoring Event Configuration • Reporting of Network Status • Communication Pattern Parameters Provisioning • Packet Flow Description Management • Network Parameter Configuration • Application Server (AS) session setup with required QoS			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical industry			
Target Markets	ICT market, manufacturing industry referring to the needs of detection and analysis, private 5G networks			
Innovations	The solution bridges the gap of incorporating in the network management and security the mobile network (5G-NPN) and the mobile devices of the employees. With Non-Public 5G Networks (NPN) already emerged, the existing experimentation platforms around Europe should increase the development pace to incorporate realistic business cases for the use of 5G in vertical industries. Furthermore, enabling an application-aware programmable data plane will allow high accurate service function chains, through avoidance of some unnecessary VNF stages (something resulting to a better-dimensioned 5GCore, being not possible with L2/3 info). This is expected to be highly beneficial for service deployment time, end-to-end service latency and overall energy consumption. The solutions will also be the basis for the TSN Translators needed for the 5G infrastructure upgrade			
Product Competition	There are no similar products in the market.			

3.1.2.12.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Innovative product • 5G Core with accurate dimensioning • Improved service deployment time • Low energy consumption • Scalability	• 5G NPN exposure capabilities are required • Real Industrial environments are not easily accessible • Need for continuous update

• Potentially compatible with TSN-driven synchronization	
(External) Opportunities	**(External) Threats**
• Strong EVOLVED-5G consortium expertise in 5G technologies • Demand for security and authentication provision • Support of 5G networks and devices	• Slow progress on 5G NPN adoption • Security threats vary • Lack of available mobile devices in industries

3.1.2.13 *Industrial-grade 5G connectivity with assured QoS and integrated SLA/SLS monitoring NetApp*

Description	The Industrial grade 5G connectivity NetApp will assure required industrial-grade service as specified by the corresponding SLA/SLS. This is achieved by leveraging certain capabilities available in the 5G network, based on exploitation of monitoring data collected and processed, i.e., network anomalies detection. It builds on the anticipation that IoT and M2M devices used for FoF require a stable communication environment with certain prerequisites (e.g., latency, bandwidth, local processing capabilities, internet access, security policy, etc.)			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	The NetApp targets stakeholders involved in integration and operation of reliable and resilient 5G communications services (e.g., private 5G networks vendors, system integrators, connectivity service providers, factories (FoF))			
Target Markets	Vertical industry, such as ports, Industry 4.0, critical communications, and others			
Innovations	Reduced IoT/M2M system/service deployment time. Supporting NEF capabilities. Extending the network performance monitoring capabilities to support collection of Industry 4.0 network and application specific metrics. Technological and operational validation, interoperability check and verification of the system's operational use in the Industry 4.0 environments.			
Product Competition	To our knowledge, there are no relevant products in the market addressing the same or similar issue/challenge.			

3.1.2.13.1.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Improved operability for the end customers • Beyond state-of-the-art technology • New and enhanced possibilities for customer applications developers • Scalability • Digital innovation	• Considerable infrastructure investments for 5G • Commercial availability of 5G UEs supporting specific functionalities • Certain target users may not be yet ready or willing to adopt new technologies • New approaches may require some adaptation/learning time for end users • Technology (5G NEF) not mature yet • 5G commercial equipment lacks NEF support.

(External) Opportunities	(External) Threats
• Expanding business as a flexible niche player able to build new services and adapt/digitalize existing ones • Specialized technology demand increases the potential to expand into multiple industrial verticals • Expanding business globally due to common 5G standards • Potential strategical alliances with established but less innovative players in Industry 4.0 • Strengthen the company brand as an innovator in 5G technology	• Market entrance barriers • Specific regulation requirements in different regions

3.1.2.14 *5G IIoT System Solution*

Description	The solution provides industrial grade 5G connectivity with assured QoS for the IoT and M2M devices connected to the 5G IIoT Gateway, i.e., IoT/M2M devices can be connected to the 5G IIoT GW via various physical interfaces (e.g., serial, USB, Ethernet). The 5G IIoT GW has integrated SLA/SLS monitoring capabilities and local compute capabilities. Novel features of the solution include, but are not limited to: • providing 5G SA connectivity from the IoT devices (connected to the 5G IIoT GW) to the application components deployed in the cloud or in the edge, • enabling fast and scalable local pre-processing and storage (Docker based packaging formats) of the data collected from the deployed IoT devices (e.g., video streams and local sensor data), • assuring the concept of IoT OAM (Operations, Administration, and Maintenance) supporting continuity check of the network path and applications, connectivity verification (based on emulation of the network and transport services and applications) and to provide performance measurement and monitoring of the network/transport paths and applications.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Targeted vertical markets are all emerging sectors, such as ports, Industry 4.0, critical communications and other vertical industries targeting reliable and resilient 5G communications.			
Innovations	Extending the capabilities of the 5G IIoT Gateway and backend components to support 5G NEF capabilities. Extending the network performance monitoring capabilities of the system to support collection of Industry 4.0 network and application specific metrics. Technological and operational validation, interoperability check and verification of the system's operational use in the Industry 4.0 environments.			
Product Competition	There are no relevant products in the market. Current baseline technologies used in similar products support only 2G/3G/4G capabilities and are controlled with monolithic back-end system.			

3.1.2.14.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Improved operability for the end customers • Interoperability (due to the common 5G global standards) • Beyond state-of-the-art technology • Scalability • Digital innovation	• Considerable infrastructure investments for 5G • Commercial availability of 5G UEs supporting specific functionalities • Certain target users may not be yet ready or willing to adopt new technologies • New approaches may require some adaptation/learning time for end users • Technology (5G NEF) not mature yet • 5G commercial equipment lacks NEF support
(External) Opportunities	**(External) Threats**
• Expanding business as a flexible niche player able to build new services and adapt/digitalize existing ones • Specialized technology demand increases the potential to expand into multiple industrial verticals • Expanding business globally due to common 5G standards • Potential strategical alliances with established but less innovative players in Industry 4.0. • Strengthen the company brand as an innovator in 5G technology	• Market entrance barriers • Specific regulation requirements in different regions

3.1.2.15 *Identity and access control NetApp*

Description	The NetApp provides the functionality of identity and access management for other applications, the controllers of which want to have fine control of what is accessed and how. It provides authentication and authorization mechanisms and manages the access rights of applications that seek access to the 5G core network APIs of the infrastructure. Additionally, it includes monitoring capabilities, used for suspicious behavior detection and the potential access rights revocation.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry.			
Target Markets	• ICT market and Integrators • Security systems market			
Innovations	The main innovation is adding an abstraction layer for security and access management between the 5G core network and the VApp+NetApp scheme.			
Product Competition	There are no relevant products in the market. While there are in general algorithms and products which provide access management and monitoring/ suspicious behavior detection and protection, these are general solutions for any case. On the contrary, this solution is specifically targeted to be incorporated with the EVOLVED-5G's VApp+NetApp scheme, by adding the security layer and resulting in a more robust solution.			

3.1.2.15.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Containerized solution • Scalability • Local deployment for testing	• Missing the rest of CAPIF's functionality aside from authentication & authorization • Dependent on open-source software (Keycloak)

• Support functioning as CAPIF or cross-provider SSO • Robust CAPIF-compliant solution	• Requires configuration of Keycloak clients
(External) Opportunities	**(External) Threats**
• No solutions implementing OIDC authentication and authorization • No solutions offering cross-provider SSO • Possible enhancement of CAPIF framework by using OIDC over OAuth2.0 without violating the standard	• Reluctance of adoption since CAPIF implementation suffices for certain purposes

3.1.2.16 *Authentication and authorization management for accessing the northbound 5G APIs*

Description	This service exposes the IQB Identity and Access Management solution, NetApp integrated, and used within a 5G environment. It provides an insight towards the usability, functionality, effectiveness, and efficiency of the IQB IAM NetApp.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Vertical Industry -ICT market and Security systems market seeking integration with 5G			
Innovations	The key innovation of this Demonstrator is highlighted through the underlying NetApp. It provides a new additional layer of security to vApps-NetApps by providing AAA and monitoring mechanisms.			
Product Competition	While there are traffic detection algorithms, the specific application of them being used for monitoring the behavior of NetApps, in addition to the IAM mechanisms, does not exist in competition.			

3.1.2.16.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Containerized solution • Scalability • Local deployment for testing • Robust CAPIF-compliant solution	• Missing the rest of CAPIF's functionality aside from authentication & authorization • Dependent on open-source software (Keycloak) • Requires configuration of Keycloak clients
(External) Opportunities	**(External) Threats**
• New market segments asking for innovative 5G technologies • AI algorithms can be enforced since they scale well with the volume of logs able to be generated when using OIDC	• Reluctance of adoption since the NetApps can operate without the additional security

3.1.2.17 *NetMapper NetApp*

Description	CAFA NetMapper registers the Netapp in the CAPIF-I service and transfers 5G Quality-of-Service QoS messages to vApp (SafeLyzer application), based on which the parameters of video feed or other high bandwidth data feed transmission can be decided.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrators; factories			

Target Markets	Smart Factory - manufacturing industry e.g., materials processing, energy, metal processing, wood processing etc.
Innovations	The 5G MEC based flexible hosting of the video analytics and near real time information about 5G QoS exploiting 5G strengths is an innovative solution
Product Competition	There are no relevant products in the market

3.1.2.17.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Previous experience in building 5G QoS applications. • Cooperation contacts with various 5G infrastructure owners from previous 5G field projects. • Cooperation ties in the EVOLVED 5G project with research organizations in the field of 5G.	• 5G infrastructures differ from country to country, and therefore developers need access to different networks to verify NetMapper compatibility and work. • Commercial availability of 5G UEs supporting NetMapper functionalities • The development of NetMapper depends on access to 5G network data, which may not be available in the development phase for commercial networks, in which the application mainly needs to be tested.
(External) Opportunities	**(External) Threats**
• Mapping the quality of the 5G network is necessary for many customers, which makes it possible to offer this product to other target groups in addition to factories. • NetMapper can be paired with 5G technologies offered by other companies, allowing easier entry into target markets.	• Difficulty to get real Industrial environment for development. • Different 5G networks have different configurations and therefore it is necessary to reconfigure the parameters of the NetMapper application.

3.1.2.18 *Occupational safety analysis application - SafeLyzer*

Description	The application is supporting factories safety officers to detect whether Personal Protective Equipment (PPE) such as helmets, safety glasses, protective gloves, is being worn by employees and provides near real time a warning signal directly to the control room safety officer when any element of PPE equipment is not being detected. The video from the factory is collected using a CAFA Worker robot, a wheeled platform that carries stereo cameras that cover a 360-degree field of view around the robot. The robot has a 5G communication modem that transmits the video feed over 5G network to the 5G MEC-based SafeLyzer.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industries: Construction companies; energy companies.			
Target Markets	Vertical Industry -ICT market and Security systems market seeking integration with 5G			
Innovations	The 5G MEC based flexible hosting of the video analytics and near real time information about 5G QoS exploiting 5G strengths is an innovative solution			
Product Competition	There are some video analytics solutions for detecting missing PPE but the disadvantage of current systems is that they use simple static cameras, while the situation in the factories is changing and flexible camera carrying platforms (mobile			

	robots) with adaptable computing power, as offered by CAFA is innovative methodology.

3.1.2.18.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Integrated to the mobile robot • Containerized solution • Scalability • Local deployment for testing • Robust CAPIF-compliant solution	• The technology is complicated, to integrate both mobile robot and Computer Vision system. • Difficulty to get real Industrial environment to collect training data for Computer Vision application developments.
(External) Opportunities	**(External) Threats**
• Occupational safety monitoring is important for all companies because it is required by law. • High demand for real time dynamic cameras (existing PPE analytics software in the market comes with static video cameras which experience increased latency, when relocated in order to execute dynamic tasks) • There are dynamic tasks in all sectors	• There are several Computer Vision solutions for monitoring PPE equipment on the market. • The operation of factories is mainly based on process technology, where there is no change. Therefore, there is no need to use dynamic safe analyses applications and systems. • In factories, there are fixed workplaces, where cable data connections are widely used, and 5G usage is low. • Slow adoption of 5G in factories • Industrial companies want certified technologies. Certification takes time.

3.1.2.19 *Localization NetApp*

Description	The NetApp shall build upon 5G technology and edge deployment with the goal to improve localization in FOF settings infrastructure for mobile robots. This development would allow mobile fleet robots to localize indoor better by using centralized command center.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry.			
Target Markets	Industry 4.0, IoT			
Innovations	Currently the problem of ¨Kidnap Robot (KR)¨ creates significant issues and uncertainties. To deal with it, the NetApp exploits information from the 5G network and GPS coordinates with 5 m accuracy or lower.			
Product Competition	There is no commercialized solution yet although research is undergoing in a number of both public and private entities.			

3.1.2.19.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Enables a new level of autonomy • Internal Innovation • Builds on several internal products	• 5G Infrastructure Dependent • Requires high density of small cells per factory for high accuracy

(External) Opportunities	(External) Threats
• Enables robotic scalability within a singular factory • Flexibility in robotic movement compared to existing solutions	• Other enterprises researching similar localization methods with 5G • Current slow 5G adoption within factories and enterprises

3.1.2.20 *Global Localization*

Description	This service will exploit the localization accuracy of less than one meter to address the problem of the ¨Kidnap Robot¨ and will exhibit the benefit of coupling the 5G technology and mobile fleet robots and the positive impact on mass-market automation.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Smart Factory, Industry 4.0, IoT			
Innovations	High accuracy and location precision exploiting 5G network information			
Product Competition	The “Kidnap robot” problem is an industry issue and barrier in the mass deployment of collaborative mobile robots and lots of different organization are currently developing similar solutions. For example, Robonik in Spain, HMS Industrial Networks Inc., and Verizon. Furthermore, there are a lot of research institutions experimenting with similar solutions			

3.1.2.20.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Unlocks additionalvalue in applications through efficiency • Scalability	• Slow customer adoption due to high capital expenditure.

(External) Opportunities	(External) Threats
• Vast number of potential customers • Applicable across several applications	• Other localization opportunities that may have lower accuracy, but at lower cost. • Cost of rolling out 5G infrastructure

3.1.2.21 *Teleoperation NetApp*

Description	The NetApp focuses on improving the teleoperation and tele maintenance with the use of 5G. This is achieved by tackling the bandwidth, security and service priorities through tight integration with the network.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry.			
Target Markets	Industry 4.0, Automation industry - numerous applications in healthcare, space exploration, IoT			

Innovations	• 5G based teleoperation achieved with NetApp with the use of UDP • Video and haptic feedback transfer with high bandwidth and QoS, Setting up VPN channels, • Adaptive Management and Security System, • Robot condition monitoring services with high frequency, • Channels configuration and management for data transfer
Product Competition	There is no commercialized solution yet although research is undergoing in several both public and private entities as for example 5G-PPP project for 5G blueprint and the Robotic System Lab developments or The Scotland 5G center that are making trials for teleoperations of a robotic arm over 5G.

3.1.2.21.1 Gap Analysis

(Internal) Strengths	**(Internal) Weaknesses**
• Improved operability for the end customers • New and enhanced possibilities for customer applications developers • Scalability • Digital innovation • Unlocks more value in applications through efficiency	• 5G Infrastructure Dependent • Slow customer adoption due to high capital expenditure
(External) Opportunities	**(External) Threats**
• Vast number of potential customers • Applicable across several applications • Flexibility in robotic movement compared to existing solutions • Potential strategic alliances with established but less innovative players in Industry 4.0.	• Cost of rolling out 5G infrastructure • Current slow 5G adoption within factories and enterprises • Certain target users may not be yet ready or willing to adopt new technologies

3.1.2.22 *Teleoperation services*

Description	The service focuses on industrial internet tele control architecture over 5G for robots combining high bandwidth, increased reliability, and ultra-low latency communications that is expected to enable highly interconnected systems and processes, leading to unprecedented workflow mechanization.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Smart Factory –Industry4.0 production lines			
Innovations	• 5G based teleoperation achieved with NetApp with the use of UDP • Video and haptic feedback transfer with high bandwidth and QoS, Setting up VPN channels, • Adaptive Management and Security System, • Robot condition monitoring services with high frequency, • Channels configuration and management for data transfer			
Product Competition	Alongside the extensive research that is undergoing in many research institutions big industry players are also investing in developing similar solutions such as KUKA, ABB and Huawei			

3.1.2.22.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Improved operability for the end customers • New and enhanced possibilities for customer applications developers • Scalability • Digital innovation • Unlocks more value in applications through efficiency	• 5G Infrastructure Dependent • Slow customer adoption due to high capital expenditure
(External) Opportunities	**(External) Threats**
• Vast number of potential customers • Applicable across several applications • Flexibility in robotic movement compared to existing solutions • Potential strategic alliances with established but less innovative players in Industry 4.0.	• Cost of rolling out 5G infrastructure • Current slow 5G adoption within factories and enterprises • Certain target users may not be yet ready or willing to adopt new technologies

3.1.2.23 *Smart Irrigation 5G Agriculture NetApp*

Description	The Smart Irrigation 5G Agriculture NetApp acts as the central point for the processing and storage of the data generated by the sensors distributed in the plantation. The NetApp makes use of the functionality provided by the 5G Core for the localization of the measurements so that they can be assigned to the correct kind of crops and terrain conditions in the vicinity of the generating sensor. The NetApp also acts as frontend for agricultural drones, that can request customized network slices to the 5G Core through the NetApp.			
	Outcome Type	Prototype	**Outcome Category**	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrator, Vertical Industry			
Target Markets	Agricultural sector, agribusiness, precision agriculture			
Innovations	Network-based positioning, network slicing			
Product Competition	Pre-5G sensors and existing precision agriculture solutions.			

3.1.2.23.1 Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
• Data is kept in a central location, available for any further processing • Separation between sensors, NetApp and dashboards allow for modularity and the usage of different consumers for the data	• Centralized data needs to be replicated in order to avoid single-point-of-failure data loss
(External) Opportunities	**(External) Threats**
• Huge reach with a vast number of possible adopters worldwide	• Difficulties in the deployment of 5G networks outside of urban environments • Competition from solutions based on pre-5G technologies

3.1.2.24 *Smart Irrigation services in Agriculture*

Description	The Smart Irrigation 5G Agriculture System, is composed of multiple heterogeneous sensors distributed along the surface of a plantation, one or more agricultural drones equipped with cameras that generate multi-spectral images of the crops, a central NetApp that processes and stores the data generated by the cameras and sensors, and a Vertical App that is able to display the measurements in a graphical interface and show an irrigation plan generated by using the data.			
	Outcome Type	Demonstrator	**Outcome Category**	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry			
Target Markets	Agricultural sector, agribusiness, precision agriculture			
Innovations	Network-based positioning, network slicing			
Product Competition	Pre-5G sensors and existing precision agriculture solutions.			

3.1.2.24.1 Gap Analysis

(Internal) Strengths • Scalable solution where sensors can be distributed without performing a previous configuration • Data is kept in a central location, available for any further processing • Sensors are individually replaceable and may be heterogeneous • Separation between sensors, NetApp and dashboards allow for modularity and the usage of different consumers for the data	**(Internal) Weaknesses** • Centralized data needs to be replicated in order to avoid single-point-of-failure data loss
(External) Opportunities • Huge reach with a vast number of possible adopters worldwide	**(External) Threats** • Difficulties in the deployment of 5G networks outside of urban environments • Competition from solutions based on pre-5G technologies

3.2 Intermediate Individual Exploitation Plans

3.2.1 Telefónica I+D (TID)

TID is using EVOLVED-5G as a direct step toward establishing a strong research position in the field of future network architectures and management systems. Based on the experience gained in EVOLVED-5G, TID has developed expertise in novel 5G network infrastructures and related technologies (CAPIF Framework, NEF APIs, 5G Programmability, NetApps lifecycle etc.) leading to the development of an automated experimentation framework for KPI assessment on top of 5G infrastructures.

TID is also validating internal practices around CICD in Evolved5G and plans to use this expertise and tools as services offered by TID to external companies and universities such as UMA in the context of national funded project TACTILE-5G in 2023-2024.

TID foresees further exploitation opportunities for CAPIF Open-Source implementation in new research activities such as SNS project 6G-Sandbox (Stream C) and FIDAL and IMAGINE-B5G (Stream D); all of them are about to start in early 2023.

Finally, TID plans to exploit further the NetApp/5G expertise by innovation activities related to internal new products development in the context of 5G Private Networks.

3.2.2 National Centre for Scientific Research Demokritos (NCSRD)

Participation in EVOLVED-5G is seen by DEMOKRITOS as a direct step toward establishing a strong research and scientific position in the field of future network architectures and management systems. Based on the experience gained by EVOLVED-5G trials, NCSR Demokritos has gained experience and expertise in novel 5G network infrastructures and related technologies (NEF APIs, 5G Programmability, NetApps lifecycle etc.) leading to the development of an automated experimentation framework for KPI assessment on top of 5G infrastructures. Such experimentation tools developed by NCSRD within EVOLVED-5G are planned to be further exploited as services offered by NCSR Demokritos to external SMEs in the framework of the digital innovation hub Ahedd [27] that operates within NCSR Demokritos premises. Furthermore, DEMOKRITOS is home to the "Lefkipos" Technical Park, which houses many private companies and startups in the fields of IT and telecommunications, where the results of the Athens platform trials will be promoted, looking for possible synergies and joint ventures.

Moreover, NCSRD foresees further exploitation opportunities of the expertise gained in 5G and NetApps by signing a partnership agreement with 5G Ventures Société Anonyme ("5G Ventures S.A.") has been established pursuant to Article 93 of Law n. 4727/2020 (Government Gazette A' 184) and is a direct subsidiary of the Hellenic Corporation of Assets and Participations (HCAP SA). The purpose of the 5G Ventures SA is the establishment and management of Phaistos Investment Fund, based on the provisions of Article 7 of Law n. 2992/2002 (Government Gazette A' 54), according to prevailing market conditions, with guarantees for full transparency and accountability and complying with International Financial Reporting Standards (IFRS). The objective of the Phaistos Investment Fund is the public investment in businesses that are actively involved in 5G-related research and/or development of products and/or services in Greece, in sectors such as transport and logistics, manufacturing, public goods and utilities, health, tourism, information and media. As a result, NCSRD by exploiting the EVOLVED-5G Athens Platform through this collaboration, will be able to support the development of services and products for the 5G NetApp ecosystem.

Finally, NCSRD plans to exploit further the NetApp/5G expertise by innovation activities related to entrepreneurship and for that purpose has proceeded to a collaboration agreement with the Municipality of Egaleo, and more specifically with the Entrepreneurship hub [28] for fostering further the development of innovative products and services related to 5G and NetApps by startups and young teams that are willing to get involved in the field.

3.2.3 Maggioli SPA (MAG)

Maggioli S.p.A has a leading role in Italy's Local Public Administration, offering a broad range of specific, highly professional solutions in several domains: firstly, Information Technology, secondly Services & Technologies, thirdly Publishing, Training and Education, as well as Document Management, and in addition to Museums, Art and Culture. More than 6,000 Municipalities out of 8,048 in Italy run about 100.000 modules provided by Maggioli Informatica, the most qualified system integrator in the provisioning of complete IT solutions and services for the Local Public sector. In addition, it provides services and solutions to more than 3,800 museums and 1,500 SMEs. The exclusive value proposition combines and integrates design capability, product knowledge and 35 years of experience in the sector. Maggioli aims to exploit the project's results as follows:

1. APKappa S.r.l is a member of Maggioli Group applying smart technologies to public services and is specialized in optimizing machine-to-machine data communication in utility networks. APKappa S.r.l is planning to use the industry 4.0 Net Apps to augment its vertical solutions in the manufacturing industry and IoT domains.
2. As a system integrator, Maggioli is currently exploring ways to embed the EVOLVED-5G security/privacy Net App into its broad portfolio of products (industry, smart cities, etc.).
3. Maggioli will encourage internally in its R&D department and on the group level the development of applications using the results obtained by EVOLVED-5G
4. Maggioli will investigate possible exploitation opportunities of the project results with its R&D partner network, also through EU funded projects.

3.2.4 ATOS IT solutions and services Iberia SL (ATOS)

In EVOLVED-5G, ATOS is leading the development of one of the key elements of the EVOLVED-5G framework, the workspace. The main goal, of this element is to support developers in the creation of NetApps by offering a set of functionalities through different open-source tools. It is composed of an SDK, an open repository (GitHub) and CI/CD services. As WP3 leader, ATOS is also following the tasks related to NetApps validation and certification and the development of the marketplace.

Results from the R&D EU projects play a vital role to boost the innovation process in ATOS and enhance the portfolio of products and technologies offered to its customers. Although further investigation is required, the following exploitation scenarios are foreseen as the most suitable to be explored during the project's lifetime.

- **Knowledge transfer**: Participation in projects like EVOLVED-5G helps ATOS to be strategically positioned in the new telecommunications paradigm and be at the forefront of the latest technology, methodologies, and industry trends. Knowledge, although an intangible result from the project, is critical for an organization like ATOS. ATOS Research and Innovation (ARI) Team, the one taking part in EVOLVED-5G, will make sure that this knowledge is transferred, both internally and externally. *Internally:* through the regular meetings that ARI holds with the ATOS TMT Industry, presentations in internal meetings / events, internal publications, etc. *Externally:* through participation in relevant fora (i.e.: standardization, collaboration with other 5G PPP / 6G IA projects, webinars, blog / paper publications, etc.)
- **Technology Transfer:** Whenever possible, the project assets will be presented in different fora for their potential reuse and extension. Internally in Atos, there is a process to accelerate that those results coming from R&I projects with the highest business potential are evolved in order to become part of the organization portfolio. Externally, technical results may be used in future R&I projects in order to keep maturing with the goal to reach the market.
- **Contribution to standardization:** ATOS is providing EVOLVED-5G all the knowledge and experience acquired thanks to its participation in SDOs and open-source communities like OSM. As stated in section *2.1.1.2 ETSI-OSM*, ATOS follows the activity of the community with the goal of being aware of those topics that may be of interest for the EVOLVED-5G project and, vice versa, giving visibility of the work being done by the project. The final purpose is fostering collaboration and increasing the possibility of influencing the community whenever possible.
- **Integration in existing and future research projects:** ARI participates regularly in national and European R&I projects with the goal of contributing to strengthen the TMT industry in Europe. Whenever possible, the assets resulting from EVOLVED-5G will be reused and /or evolved in order to grant the sustainability of such assets.
- **Enhancement of the ATOS TMT portfolio**: ATOS offers a suite of products oriented to achieve high-performance and flexibility of telco networks, as well as to deploy new

services to generate more business value. ATOS will use the knowledge and the expertise acquired during the project for evolving its telco portfolio and adapting it to the new cloud native paradigm.

3.2.5 INTRASOFT International SA (INTRA)

INTRASOFT's participation in EVOLVED-5G is immensely benefited by the cutting edge of technology knowledge sharing in the domain of 5G. Additionally, the ongoing scientific programme is benefited by the technological expertise of INTRASOFT and vice versa; meaning that the involvement in the EVOLVED-5G WP2 augments the rate of knowledge sharing in the field of telecommunications and broadens the field of NetApp development. Another aspect of the participation is the collaboration with the SMEs and the broadening of the horizon for future collaborations. INTRA monitors the development phase in WP4 and the evaluation and validation processes in WP5 from the manufacturing perspective. INTRA also participates in WP6, assisting in the development of the ecosystem for start-ups and SMEs and in the Industry 4.0 stakeholders engagement. Furthermore, within the frame of WP3 and WP4, INTRA assists in the establishment of a secure software development lifecycle. Security practices and processes have been identified for the implementation, testing and release phases of the developed NetApps. As far as the exploitation plan is concerned, INTRASOFT will reinforce its solutions portfolio through the offering of innovative and specialized applications and services not yet present in the market. More specifically, INTRASOFT will cooperate with the rest of the partners to create strategic alliances, especially in the evolving area of smart manufacturing and Industry 4.0 applications.

Through its participation in EVOLVED-5G, INTRASOFT is expecting to:

- Exploit the EVOLVED-5G platform and S/W components that can be sold to interested customers individually or in collaboration with the other consortium partners.
- The management of specialized and general purpose KPIs will allow the EVOLVED-5G offering to address broader markets and their requirements, leading to higher commercial value and outreach.
- Investigate the possibility of offering EVOLVED-5G as a service in collaboration with the rest of the Consortium partners (i.e., customization, maintenance, installation, service provision, training).
- Deliver consultancy services to customers interested in deploying similar infrastructures.
- Cooperating with the leading research institutes and software developers participating in EVOLVED-5G, may lead to strategic alliances in the field of commercialization and technology transfer of innovative aspects of technology. Hence, formation of synergies/collaboration with the partners in the context of another project is also being considered.

3.2.6 COSMOTE Mobile Telecommunications SA (COS)

COSMOTE has a clear objective to exploit the 5G business potentials for verticals and places particular focus on the Industry 4.0 domain, where private networks are gaining momentum, as they are becoming the backbone for innovative use cases. This strategy is aligned with the market reports [29] claiming that network operators see the enterprise use cases as the incremental opportunity to gain revenues outside the very-competitive-low-profit-margin telecommunications market, and at the same time rationalize the substantial financial investments necessary for 5G deployments.

The business opportunity for private networks is manifold and assumes revenue not only from building and operating networks but also from the services and applications running on them. An enterprise may engage with a network operator, systems integrator, network equipment vendor or even a hyper-scale cloud provider to build a network and then take over operations

and maintenance once it is built, or the company could buy a private network as a service from a communications service provider, opening the floor to new versatile business models. COSMOTE has already implemented a number of related projects and pilots such as the first 5G Campus Network in Greece for the Athens International Airport [30] in 2021, the Hellas Gold 300 meters underground [31] campus and Calpak's fully automated solar water production smart manufacturing campus [32]. Such initiatives stand as an evident proof of the interest and commitment by the operators to explore opportunities and lead the emerging market.

In addition to the deployment of private networks, the innovations promised through the network openness also create very attractive business opportunities, capitalizing on the data that the network already has in place (such as user authentication, location, behavioral characteristics and traffic patterns) that can be valuable for the vertical business development. COSMOTE takes advantage of the experience gained and the technologies delivered in the project around the NEF and CAPIF capabilities to evaluate the technical transformations, associated investments and foreseen risks so as to be properly and timely prepared for the integration of solutions. To this end, the NetApps certification process becomes very relevant as a systematic guide to ensure the appropriate collaboration between the emerging NetApps ecosystem stakeholders in order to meet the expectations of both the operators and the vertical business ends.

Obviously, through the innovative use cases addressed by EVOLVED-5G, COSMOTE will be able to investigate how to monetize the prospects offered by the collaboration with the involved SMEs. Finally, COSMOTE will share the results with the Deutsche Telecom (DT) Group to maximize the project's visibility and impact.

3.2.7 Lenovo (Deutschland) GmbH (LNV)

Lenovo is a leading technology company committed to pushing forward the development of information technology by delivering cutting-edge technologies incorporated into its own high-tech products. Lenovo specializes in the design and manufacturing of smart devices, including among others consumer electronics and high-tech enterprise products, as well as in the provision of business solutions and innovative services. In the scope of the project, Lenovo is driving the "Innovation Shaping and Standardization Alignment" work task and serves as the key interface between EVOLVED-5G and the 3GPP standardization community. In this context, Lenovo continues to bring the key results of the project to the appropriate standardization communities (3GPP SA2, SA6 / 5G-ACIA / 5G-PPP Pre-Std WG) and proposes standards enhancements to fulfill the objectives of EVOLVED-5G.

Through its participation in the EVOLVED-5G project, Lenovo plans to strengthen its current position in the global mobile communications research and standardization organizations. More specifically, Lenovo's involvement in the project will allow for the identification of possible gaps in the 5G specs, pertinent to the vertical applications' and NetApps' interaction with the 5G core network. In this way, Lenovo will continue to design and apply novel solutions to address such gaps and at the same time bring its solutions to standardization fora so as to enhance global standards and promote the company's interest in the research and standards area.

To this direction, the exploitation plans of Lenovo in the context of the EVOLVED-5G project can be articulated as follows:

- Lenovo intends to exploit the business development in 5G and TSN integration, as well as the native APIs exposure of the 5G Core (5GC) in order to contribute to the standardization activities of 3GPP in SA6 and other relevant groups.
- Lenovo product line end-devices incorporating the Industry 4.0 NetApp requirements defined through the project, can be adopted to smart manufacturing.
- It will be considered integrating the workspace of the project into Lenovo's solutions to enable Lenovo partners to develop NetApps.

- Lenovo's development of a prototype system (Auxiliary NetApp) through their own research activities in the context of EVOLVED-5G, is anticipated to enable scientific experiments around vertical industry scenarios and promote the company's standardization activities in 3GPP SA6.
- Lenovo will also consider exploitation of the technological advances offered by the project implementation actions, such as the CAPIF and NEF emulator, to expand their enterprise products' capabilities towards efficient interaction with 5G public or private networks, enabling disruptive use-case tailored applications.

3.2.8 Impact Entrepreneurship Award Ltd. (IEA)

Envolve/IEA is a business support organisation and an innovation agency based in Cyprus with a subsidiary in Greece. IEA undertakes the provision of practical tools and capacity building programmes (as part of WP6) on the benefits that transitioning to a 5G model will bring, in terms of high value job creation and the identification of new business growth opportunities. IEA will seek to build a relationship with complementary to the project networks to facilitate continuous knowledge exchange and advancement in 5G for the Industry 4.0 domain. Where it is possible and appropriate to do so, opportunities to directly collaborate on tool development, policy recommendations or dissemination activities will be seized (WP6 and WP7). Collaborating with other related projects and initiatives will also support the continuous expansion of the EVOLVED-5G multi-actor networks and the community. As the project outputs are developed, tested and validated, a series of policy recommendations will be produced to assist in their uptake (WP6). The policy recommendations will set out guidance on how to remove barriers to transitioning, advocate for long-term thinking on the value of 5G for Industry 4.0 and encourage the implementation of short-term actions that will support companies in transitioning.

3.2.9 Universidad de Málaga (UMA)

As a higher education center, the University of Málaga participates in multiple public and private-founded research projects. For instance, the Málaga platform has supported trials of the Broadport consortium [33] (part of the Broadway H2020 public procurement) and has been used during the evaluation of the Genasys National Emergency Warning System (NEWS) Cell Broadcast Center (CBC) [34]. In the context of EVOLVED-5G, UMA makes the Málaga platform available as infrastructure and acts as validation expert.

The UMA exploitation plan includes the following points:

1. To adapt and extend the Málaga platform for supporting new use cases and technologies. In this regard, the platform evolution efforts in EVOLVED-5G are focused on the integration and configuration of TSN communication. This effort which is shared with the Affordable5G project, in which the development of TSN translators was tackled as a separate activity) has already provided benefits to the Málaga platform: UMA is part of the 5G+TACTILE (UNICO I+D Spanish initiative) and 6G-SANDBOX (JU SNS) projects, in which the development and integration of TSN technologies will continue.
2. To position the Málaga platform as a reference in the support for testing, validation and certification of use cases brought by SMEs, researchers and verticals.
3. To define fine-tuned business models of the Málaga platform, considering the particular user profiles based on their requirements and funding approaches. The current approach of the Málaga platform defines a customized business model per partner or trial.
4. To participate in the definition of new national and international research projects that can benefit from the usage of the UMA experimentation facilities, which, in turn, provides opportunities for the improvement of the Málaga platform.
5. To act as examples or training material for potential users of the Málaga platform.
6. To produce scientific results in higher academic courses, MsC thesis and PhD thesis.

3.2.10 Universitat Politecnica de Valencia (UPV)

UPV is a major technical university in Spain, recognized in prestigious international rankings, and responsible for training material and the organization of coding and training events regarding the EVOLVED-5G project.

UPV plans to exploit technological and knowledge assets from EVOLVED-5G following different approaches:

- Academic exploitation: as a relevant entity in the academic world, UPV will take advantage of this position to incorporate paradigms, knowledge and technical assets from EVOLVED-5G in current teaching programs (i.e., MSc, PhD and online practical training courses), seminars and lectures. This action will allow future technicians to have a deeper awareness of the 5G potential and the advantages of the EVOLVED-5G NetApp approach and technical tools and solutions provided by the project. The registration fee to these MSc or PhD courses will be a manner of economic exploitation. Since future professionals will be familiar to the EVOLVED-5G technology assets, they will be prone to use the EVOLVED-5G solutions in the middle term once they start their career in IT areas and spread by word of mouth their significant potential for 5G exploitation.
- EVOLVED-5G online courses: as a part of the activity performed within the project, UPV is leading the creation of courses to provide training for the creation and use of 5G NetApps, specific FoF applications and 5G exploitation by verticals. These courses will be publicly accessible on prestigious educational platforms (EDx, UPVx). In this way, EVOLVED-5G courses are available online to any external public (e.g., external developers, academia, or other stakeholders) following a Freemium strategy, allowing some degree of commercial exploitation. Some of them would belong to UPV's individual exploitation plan (introductory courses related to 5G topics that could be associated to academic programs), and some of them would be part of the EVOLVED-5G joint exploitation plan. At this point of the project, some courses have already been published and some of them are currently under development. The overall plan in regard to the EVOLVED-5G training courses is fully described in D6.1.
- UPV will study the creation of a technological spin-off (consultancy) for providing information and guidance to stakeholders interested on 5G network potential exploitation leveraging both knowledge acquired, and assets developed in EVOLVED-5G. This consultancy service will allow synergies and mutual benefits with the other consortium partners.

3.2.11 GMI-AERO-SAS (GMI)

GMI Aero SAS [35] is a leading SME in the composite repair solutions sector in the last 30 years, having developed several equipment and methodologies for composite manufacturing, maintenance and repair, mainly for the aircraft industry. GMI offers to the manufacturers, airlines, and MROs a complete range of control equipment and instrumentation, engineering solutions, training and field assistance services. GMI developed and continuously upgrades a series of portable composite repair equipment for Innovative solutions for the NDT, surface preparation and curing of bonded composite repairs, as well as for the repair of emergency aircraft slides; all the steps which need to be followed for the performance of a "typical" repair to a composite structure (NDT, removal of damaged composite material by cutting, drilling and milling and composite patch application including vacuum bagging and heat application), fulfilling the repair specifications requirements and overcoming the numerous constraints of repair performance within hangars, repair workshops or even "on-wing". Most of this equipment is proposed in the Structural Repair Manuals (SRMs) of major aircraft manufactures (Airbus, Boeing, ATR, Embraer, Bombardier, Dassault etc.). GMI is currently participating into a significant number of European R&D projects, fostering the development of additional innovative solutions for bonded composite repairs.

When a bonded composite repair is performed, all repair data (temperature, humidity, vacuum level etc.) are recorded, in order to certify that the overall process has been performed according to specifications and confirm the physical and mechanical properties of the repaired part (especially the composite patch and the adhesive bond). However, several repairs take place "on-wing" and remotely (maybe even outside of hangars) at challenging environmental conditions, due to geographical location (extremely low temperature, increased humidity, very high altitude etc.). In addition, increased geometrical complexity of contemporary all-composite aircraft (e.g., A350, B787) may lead to extensive Temperature variations during curing, well beyond specified limits (usually +/-5°C), which may affect the curing degree and / or the mechanical properties of the produced repair. This may lead to ambiguities on the evaluation of the repair results and subsequently delay or even prohibit the authorization of aircraft to resume flight operations, especially when repairs on safety critical structures are performed.

Figure 4: ANITA 4.0 Hot Bonder
(Extract from GMI Aero commercial brochure)

Within the frame of EVOLVED-5G, the ANITA 4.0 hot bonder(s) used for repair curing, are able to connect to 5G, Wi-Fi or any other network existing (or specially created) at the repair area, in order to transmit in real-time all related data to the Engineering Centre of aircraft manufacturer / airline / MRO. This will help GMI to perform a technological leap in the face of emerging competitors by providing innovative solutions, adapted to the specific aircraft requirements, not available yet on global scale. It will help in optimizing the integration of systems in the airframe along with the validation of important structural advances and to make progress on the production efficiency and manufacturing of structures. Solutions will assist in avoiding part scraping during manufacturing, as well as in MROs, airlines and composite plants, by increasing the range of application of bonded composite repairs.

The **Digital-Physical Twin NetApp** enables connectivity of ANITA hot bonder(s) used for repair curing to the **WIFI or 5G network** at the repair area, in order to transmit in real-time all related data to the Engineering Centre of aircraft manufacturer / airline / MRO certification authorities (EASA, FAA etc.) This data will be used either to **create in real-time a "Replica"** repair through a second ANITA bonding console, identical to the **"Original"** repair **(Physical-Twin)** or to use such data for calculation of the **Degree of Curing (DoC)** applying corresponding material curing equations **(Digital Twin)**. The Digital-Physical Twin NetApp is expected to **significantly reduce down time of aircraft** subject to repair of primary structures in remote locations and enhance **Quality Assurance** procedures, while being a useful tool for **academic and R&D purposes.**

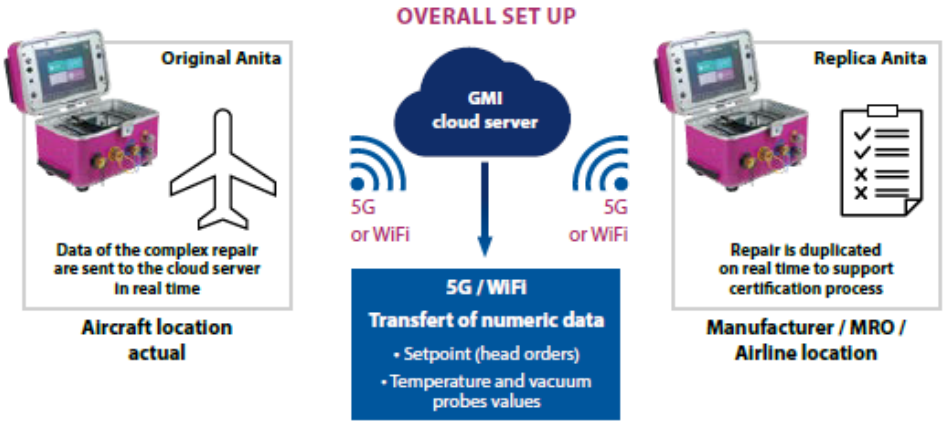

Figure 5: Digital – Physical Twin, as ANITA 4.0 proposed Application (Extract from GMI Aero commercial brochure)

Overall, EVOLVED-5G will be assisting in the reinforcement of the competitiveness and the performance of EU transport manufacturing industries and related services, facilitating the development of next generation of transport means, further exploiting the advantages of light composite structures, while enabling new manufacturing and maintenance techniques for both existing and new composite structures, in order to retain areas of EU leadership in the transport sector. GMI, being part of this ecosystem will be directly positively affected by these global advancements and innovations. To this end, GMI has already included EVOLVED-5G expected developments within its advertising material and exploitation strategy, so as to increase impact of the project results. Brochures and related material are available through [36]

3.2.12 Internet Institute Ltd. (ININ)

INTERNET INSTITUTE Ltd. (ININ) is positioning itself as a highly innovative SME focusing on business opportunities within the area of Industry 4.0, telecom operators, public safety organizations, infrastructure, and utility companies. In EVOLVED-5G, ININ is developing a critical communications solution, i.e., a NetApp and a service, enabling industrial grade 5G connectivity with assured QoS for IoT and M2M devices. The solution itself will be at first deployed and demonstrated facilitating ININ's 5G IIoT Gateway, which has been already in use for several PoCs, including a use case enhancing logistical processes in a seaport (i.e., H2020 project 5G-LOGINNOV).

In order to remain innovative, ININ's exploitation plan related to FoF/Industry 4.0 includes adding 5G NEF and NetApp supported IoT and M2M related products into its technological and business portfolio. These products' main benefits, according to ININ's expertise, stem from latest advances in network monitoring, and evidence-based decision support tools. Besides exploitation among potential industrial customers, the activities and associated results are expected to generate knowledge, experience and insights in 5G and cloud technologies exploitable in further research projects.

In particular, ININ's individual exploitation plan focuses to:

- conducting piloting activities and building knowledge and experience related with Industry 4.0 and Smart Factories.
- shaping its product roadmap in the area of 5G and cloud-native support for deployment and management orchestrations in industrial environments and apply novel business opportunities and models,
- establishing partnerships with relevant stakeholders in the EU research and industry domain and hence pursue new R&D partnerships and commercial opportunities with recognized stakeholders.

3.2.13 Cafatech (CAF)

CAFA Tech is an Estonian robotics company which develops:

a) Autonomous and tele-operated mobile robots, UGVs for logistics, construction, agriculture and ground maintenance tasks. UGV Worker Robot is a self-driving, autonomous and remotely controllable (over 4G/5G) robot.
b) Automated UAVs controlled over satcom or 5G communication.
c) UWB (Ultra-Wide Band) sensors for robots and drones. UWB uses a frequency up to 10 GHz to detect objects up to 200m distance.

The development and use of CAFA Worker robots is primarily focused on performing maintenance and situation monitoring tasks within the area of Industry 4.0. CAFA will create two applications within the EVOLVED 5G project: NetMapper and VideoAnalyzer. NetApp helps analyze the quality of the 5G network and thereby decide whether it is necessary to adjust the volumes of data or video streams sent from the robot. Said NetApp (called NetMapper) is also necessary for other robotics companies that use robots or remotely controlled sensors in the field of Industry 4.0 which are controlled over a 5G network. The VideoAnalyzer application analyzes the wearing of Personal-Protective-Equipment (PPE) by employees in near real-time. This application can be used as a starting point to develop further applications since the architecture and core components of Computer Vision analytics remain the same. The purpose of CAFA is to introduce both NetMapper and VideoAnalyzer applications to various Industry 4.0 stakeholders.

3.2.14 InQbit Innovations S.R.L (IQBT)

IQBT has formulated a detailed exploitation plan covering immediate and long-term goals. As a nascent technology company focusing on security and privacy solutions, IQB is actively developing an innovative single sign-on based authentication and authorization mechanism for third party NetApps that will enhance current CAPIF implementations and allow them to support cross-mobile operator NetApps. As such, IQB has developed a NetApp to act as intermediary (i.e., proxy) between different CAPIF instances on operators' premises. IQB's Identity Management and Access Control NetApp will be available over the EVOLVED-5G Marketplace to a wide audience of SMEs and mobile operators that would be interested in enabling SSO capabilities for their NetApps, thus fulfilling the short-term exploitation goals.

Furthermore, IQB is aiming to exploit its NetApp and expertise on Authentication and Authorization services in the long term to develop an innovative cloud-based solution for device onboarding, authentication and authorization in factories of the future. IQB is focusing on exploiting EVOLVED-5G outputs to extend its portfolio of solutions and services with NetApps addressing security and privacy aspects of 5G and beyond networks, as well as exploit 5G northbound APIs to address industrial IoT trust management more efficiently. Last, but not least, InQbit is in the process to develop a new business activity, providing consulting services to companies and professionals including cyber security training, data privacy, data management, etc.

3.2.15 FOGUS Innovations & Services P.C. (FOGUS)

FOGUS is currently designing new software products on risk analysis and security management over 5G networks. More specifically, FOGUS plans to re-design and optimize functional algorithmic components of those products to incorporate the potential of data monitoring and content analysis in Industry 4.0 environments. In parallel, FOGUS testbeds and simulation infrastructure will be extended in the context of EVOLVED-5G, towards being compatible with 5G and FoF standards. The fact that FOGUS monitors the activities in 5G-PPP and EFFRA associations will assist on that as well. In general, the involvement of the company in EVOLVED-5G project is expected to strengthen company's position against the competition in the fields of experimentation and benchmarking. Also, since FOGUS invests on training and consulting services, the know-how acquired by the EVOLVED-5G project will be exploited by the training and consulting sector of FOGUS to devise new courses and training material.

3.2.16 INFOLYSiS (INF)

INF is an innovative SME, established in Athens, Greece, specializing on the design and development of chatbots, either as custom-made standalone applications or as subscribed-based services (Chatbot as a Service) via the privately owned chatbot platform, operating also in 5G and IoT enabled environments. Chatbots are applications that simulate human conversation, based primarily on conversational flows and occasionally enriched with DL/NLP technologies for more sophisticated automation of use-cases.

INFOLYSiS, in parallel to its commercial activities, is committed to driving research results forward by experimenting with novel technologies and infrastructures, such as 5G, SDN/NFV at the network edge and container-based virtualization in IoT areas (mainly of IoT interoperability) in order to advance the chatbot capabilities and expand its applicability in novel ICT use-cases such as 5G and IoT enabled environments, smart home solutions and smart cities.

INFOLYSiS will exploit EVOLVED-5G results by increasing INFOLYSIS's presence and penetration in the respective areas of research and will facilitate the processes to make the project achieve maximum visibility and maximize its impact within the business and scientific communities, as well as within the chatbot apps commercial market, so as to guarantee a fast adoption of the project outputs and easier commercialization of its chatbot based services.

INFOLYSiS participation to the EVOLVED-5G project, in particular through the INFOLYSIS provision of Intent-driven Chatbots for precise maintenance and human-machine interaction to EVOLVED-5G use cases, and in conjunction with the participation and outcomes of relevant 5G related projects (5GENESIS and 5G!Drones) will further:

- Foster INFOLYSiS IoT and 5G R&D activities coupled with chatbot technologies
- Enrich the know-how and the research expertise of the company in 5G technologies under Industry 4.0 environments
- Encourage the development of Industry 4.0 chatbot based applications using the 5G network capabilities
- Create new chatbot based products and services targeting new markets and sectors
- Exploit EVOLVED-5G results within scientific communities and chatbot apps markets
- Enhance its participation in the evolving SMEs ecosystem and chatbot apps markets.
- Participate in new SME accelerator communities and incubator programs through which INF will further disseminate EVOLVED-5G developments, results and experimentation opportunities
- Use expertise gained in the research activities of ongoing 5G related projects in which INFOLYSiS participates for further enriching and promoting EVOLVED-5G project's activities and achievements.

3.2.17 EIGHT BELLS LTD (8BELLS)

8BELLS is a start-up company specializing in modelling and analysis for businesses as well as in selected parts of Information and Communication Technologies (ICT). 8BELLS delivers customizable solutions that enhance modern communications relevant to the area of 5G Mobile Technology, Network Function Virtualization (NFV) and management solutions for Cloud infrastructures. 8BELLS technical capabilities include Systems and Network engineering, Cloud Computing and Everything-as-a-Service, Privacy, Security and Data Protection, and Software development.

8BELLS participates in the project with its L7-aware whitebox switch with SFC capabilities with scope to be further upgraded towards the 5G with the respective NetApp development. This will enable the switching solution to integrate TSN-aware deterministic switching, allowing the switch to better support industrial environments with NPN-5G deployments. Therefore, 8BELLS expects to obtain significant insight from the results of EVOLVED-5G, which will reinforce the company's position in the communication and networking field through the upgrade of existing software solutions through cybersecurity VNFs at the network's edge. Specifically, by participating in this project, 8BELLS aims to understand, evolve, and exploit its existing software for virtualized usage. This will enable the capacity of transforming the company's current line of business applications in the field of networking to cybersecurity enabled solutions.

8BELLS will exploit EVOLVED-5G outcomes and incorporate the results regarding cybersecurity into its commercial and research activities, thus providing the results to its customers. In this context, awareness for cybersecurity issues as well as for possible solutions can thereby be disseminated and exploited through an efficient path which ensures impact and presence to security market.

3.2.18 PAL-Robotics (PAL)

PAL Robotics has extensive experience in designing and manufacturing highly integrated and reliable robotic solutions for service industries and research institutions worldwide. PAL is a trusted partner in the development of tailor-made advanced robotic platforms and modular robotic parts, their integration and software development. In this project, more specifically, PAL Robotics is going to adapt the mobile manipulator TIAGo to use the 5G technologies and NetApps to support ¨Factory automation and Indoor logistics¨ in an agile production line.

This will be done by tackling two main aspects: Tele-operation and Tele-maintenance. The aim is to develop an industrial internet tele-control architecture for robots in a production line. The main objective is to realize teleoperation and tele-maintenance tasks, which on the one hand meet user needs of the industry partners and can on the other hand be performed over the 5G communication infrastructure.

In general, PAL robotics will further facilitate the impact of the project within the targeted scientific and industrial communities and promote easier adoption of the project's outputs. Furthermore, the industrial partner would use the acquired know-how from the project to promote further developments and industry benchmarks. PAL Robotics' involvement in the project will enable the company to further advance its robotic solutions and the supporting infrastructure to the industry automation sector with more versatile applications whilst penetrating further into industrial sector and strengthening the company's position in the research sector.

3.2.19 ZORTENET (ZORTE)

ZORTENET expects to obtain significant insight which will reinforce the company's position in the communication, cloud computing and networking fields through the upgrade of existing software solutions, and particularly the line of applications and services for monitoring, traffic classification, network benchmarking and service performance. Specifically, by participating in

this project, ZORTENET aims to exploit its existing software for virtualized resource usage, evolve existing solutions to production-level availability and reliability, and complement its portfolio with newly designed products. This will enable the capacity of transforming the company's current line of business applications in the field of cloud computing.

The tight integration of this NetApp with the EVOLVED-5G solution will take advantage of:

i. the capabilities of the Network data analytics function (NWDAF) which allows analytics of the 5G core to be shared to external entities, and
ii. the integration with the NSSF function which can enable mitigation actions when a slice isolation breach or anomaly in its operation is detected.

Regarding a higher layer of interaction with the EVOLVED-5G platform, a preliminary set of functions will include amongst other:

- Monitoring Event Configuration
- Resource management of Background Data Transfer
- Non-IP Data Delivery
- Reporting of Network Status
- Communication Pattern Parameters Provisioning
- Network Parameter Configuration
- Application Server (AS) session setup with required QoS

This will enable ZORTENET to further solidify its position in the innovative I4.0 market as the set of intercommunication functions between the EVOLVED-5G platform and the Anomaly detection NetApp can serve as a stepping stone in building a concrete and cohesive solution for security operation in a FoF scenario.

3.2.20 Immersion (IMM)

Immersion is a French SME currently leading the development and distribution of multi-sensorial devices for AR/VR visualization, interaction, and collaboration. The company has both extensive experience on Research and Innovation as well as in industrial projects. On the one hand, IMM has participated to many national and European projects around XR and cooperation. On the other hand, IMM collaborated with a large panel of prestigious industrial partners including EADS, THALES, DASSAULT, EUROCOPTER, FIAT, ORANGE R&D, RENAULT and PSA PEUGEOT CITROEN.

The EVOLVED-5G project is a unique opportunity for IMM to explore the potential of 5G for XR applications. In particular, the company wants to investigate the benefits of 5G in terms of performance and new services in an industrial context. Remote assistance within factories through XR technologies reflects both the expertise of IMM about XR and collaboration and the needs of existing industrial partners. Exploring 5G for such remote assistance scenarios will unlock new research opportunities about XR, strengthen collaborations with existing partners and attract new customers interested in both XR and 5G. By participating to the EVOLVED-5G project and developing its own NetApp about QoS monitoring and autonomous adaptations, Immersions aims to:

- Investigate the benefits of 5G for remote assistance scenario in AR using a real 5G infrastructure to increase its internal knowledge about 5G technologies.
- Make new research contributions about XR collaboration and interaction and visualization, encouraging new scientific collaborations and projects on these topics.
- Develop new XR services and tools using 5G and complete existing IMM solutions with 5G compatibility to address existing customer needs and usages.
- Disseminate its involvement in 5G ecosystems to attract new customers interested in either XR or 5G applications. In particular, Immersion wants to showcase its NetApp to

demonstrate this involvement, promote developments and results achieved during and after the EVOLVED-5G project.

3.2.21 UM Autonomous Systems Ltd (UMS)

Unmanned Life is a global, multi-award winning, 5G Autonomy-as-a-Service SME at the forefront of the massive and transformative opportunities created by the rapidly increasing confluence of 5G, EDGE, AI and Autonomy. Unmanned life's core IP is the leading software platform for the seamless orchestration of autonomous robotics. Thanks to this platform UMS can deploy, control, and orchestrate at scale, integrated and hybrid swarms of different types of robotic devices (drones, AMRs, etc.) for industry 4.0 and smart cities' sectors, with existing projects in emergency response, hybrid manufacturing, autonomous surveillance & more. The unique connection and orchestration between robotic devices, makes them interoperable across networks, meaning UMS can work across 4G and private LTE, but leverage 5G to unlock the next step in automation, with high-speed, low-latency, and high-capacity networks creating value in robotic swarms.

In EVOLVED-5G, UMS is going to contribute to developing a NetApp which will allow an AMR fleet to localize in indoor environments and use a centralized command center to deploy these assets over 5G and EDGE infrastructures for a logistics-based use case in a FoF setting. Triangulating the position of robots using 5G cells at minimal latency is key to unlocking the scalability of robotic fleets.

A relevant phase of UMS participation to the project will be the robot integration, which will allow to explore and test the platform's potential for future applications and other business creation. By participating to the EVOLVED-5G project and developing its own NetApp about Agility in the production line, UMS aims to enable:

- Indoor localization and mapping for mobile robots
- Global localization using 5G technology to address the relocation issues when the robot gets lost due to localization mechanism failure
- Global localization to manage multiple IoT devices with same coordinates reference frames
- GPS coordinates with the accuracy up to 1 meter

UMS can commercially exploit these core capabilities in the future by combining them with their robotic orchestration platform to enable a series of efficient indoor use cases around logistics and warehousing. Specifically, this relates to the "decision management" section of the platform, where intelligent decision-making is created through a series of proprietary algorithms, and third-party applications, for which localization is a vital enabler.

Not only this, but key learnings could then apply to drone-based applications on the platform, in both indoor and outdoor settings, paving the way for new and innovative use cases in hybrid drone and robot logistics, inventory management, and inspections.

4 TECHNOLOGY TRANSFER PLAN

The Commercialization of Intellectual Property (IP) is the focus of the EVOLVED-5G Technology Transfer Methodology with emphasis on the translation of the project research inventions to commercial products and startup companies. The methodology is envisioned primarily as a support tool for the EVOLVED-5G consortium partners in moving from discovery to commercialization of ideas and technologies developed under the project.

The work of defining the technology transfer methodology of the project has started in the first project year and is being revised as the project's outcomes mature. The following sections are recapping the methodology while describing in detail the concepts and tools implemented.

4.1 TECHNOLOGY TRANSFER TERMINOLOGY, TOOLS & PLAN

The term "technology" has been defined by past academics and experts from a variety of perspectives and has been given various definitions. Its root is the Greek word "technologia", (techno, which means art, skill, and -logia, which is study, rationality). Technology is defined as "specialized knowledge applied to achieve a practical purpose". In other words, scientific knowledge is used to develop a product or service in order to satisfy an existing or a new need. Technology is therefore the culmination of intellectual and physical ingenuity in order to augment human skill [37].

The term "technology transfer" through its name suggests that the subject of the transfer is technology. This might seem obvious, but its content is also very general and needs explanation. Technology transfer is the introduction of technology, including equipment, knowledge, technological services and other facilities that are obtained from research, study, experimentation in the economic cycle, in order to create new, or improve the existing ways of meeting market's needs. In general, technology transfer is about the "know-how" and its commercialization. NASA has a very aimful definition of technology transfer: the process of providing technology developed for a specific purpose of an organization to other organizations for different purposes. There is also another definition of technology transfer, which is very remarkable and relative to this project: Technology transfer is the process of changing ownership and control over an invention from the creator to a party intending to generate a commercial product or service. It is typically an intermediate step between the development activity, that generates invention outputs, and the production activity, where commercial innovations are formed [38].

The aforementioned process of "changing ownership and control over an invention" is what this methodology is about: what are the legal ways of consigning copyrights and intellectual property from one entity to another. Intellectual property may be commercialized by sale or assignment, or by entering into various types of contractual business relationships such as licensing. The business vehicle by which this can be achieved, may be partnership, joint venture or a spin-out company. IPRs play a crucial role as the legal vehicle through which either the transfer of knowledge, or the contractual relationship, is affected. Alternatively, knowledge may be exploited in-house, in which case the role of IPRs is to block imitating competition. Commercialization can be defined as the process of turning an invention or creation into a commercially viable product, service, or process. Commercialization may require additional R&D, product developments, clinical trials or development of techniques to scale-up production prior to taking the results of research to market.

Based on the above concepts, the Commercialization of Intellectual Property (IP) is the focus of this Technology Transfer Methodology of the EVOLVED-5G with an emphasis on the translation of the project research inventions to commercial products and startup companies. The Guide is

envisioned as the primary resource for the EVOLVED-5G consortium partners in moving from discovery to commercialization of ideas and technologies developed under the project.

We define the commercialization of intellectual property as a continuum of activities and actions that provide for protection, management, evaluation, development and value-creation of ideas, inventions, and innovations to implement them in practice. Commercialization of technologies into products and companies that take these products to market based on intellectual property rights requires a continuum of activities to further refine, prove, and improve these inventions.

EVOLVED-5G technology transfer plan consists of three main elements:

- The Commercialization of Intellectual Property Guide (in 4.2)
- The IP Commercialization Blueprint tool (in 4.3)
- Four hands-on workshops for the partnership on how to use the tool and other elements of the Guide (in 4.4)

This compendium of information (the Guide) and the IP Commercialization Blueprint (tool) are designed to help guide the development of research findings and guide the appropriate pathway to a license, startup or spin-off company. The guide defines the terms, process, and methodologies for the commercialization of EVOLVED-5G inventions, research results and know-how by the members of the EVOLVED-5G to make them successful. The tool entitled 'IP Commercialization Blueprint' will support the members of the consortium to identify the important issues in IP commercialization, assisting them to understand what their needs are, what is important and how to deal with key issues before beginning the IP commercialization process.

The finalization of the content of the IP Guide and Commercialization Blueprint had been the main focus for delivery in the intermediate period, together with the execution of two workshops to orient the project members with the terminology and the process to be followed. During the last project period the hands-on workshops shall be delivered, and the overall approach shall be documented in a complete and conclusive manner as part of D7.6 due M36.

4.2 COMMERCIALIZATION OF INTELLECTUAL PROPERTY GUIDE

This guide presents the possible routes of IP commercialization of the outcomes of the EVOLVED-5G project. There are a number of different paths by which the outcomes can be commercialized as graphically depicted in Figure 6. Each of these paths, or models of commercialization takes place against a backdrop of legal rules, dealing with:

- What type of entities enjoy legal personality (and thus can enter into contracts etc. in their own right)
- How ownership of company or partnership property is determined and divided (including when a company or partnership is wound up)
- Who has the power to act on behalf of a company or partnership

Most models of commercialization are ultimately dependent on the transfer of property to another entity or granting to another entity the right to use the underlying intellectual property – that is, granting a license. The law places some controls on the form that an assignment or license can take, and these rules apply as much to the transfer of rights to a third party as they do to the transfer of rights between the creator and the 'first' owner of intellectual property rights. The purpose of this guide is to support the EVOLVED-5G partners to choose the right path for commercialization of the IP developed during the project lifespan. The guide is based on the "Your Guide to IP Commercialization" developed by the "European IP Helpdesk" [39].

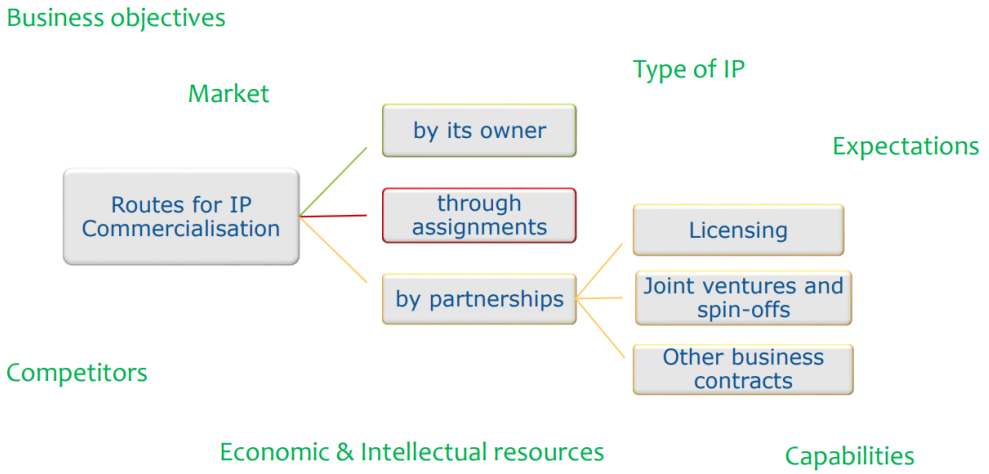

Figure 6: Routes for IP Commercialization

4.2.1 IP Commercialization by its owner

The most profound way for the owner of IP rights to turn them into a source of revenue is by using them to create and sell goods and services itself. Not all entities, be they academic institutions or innovative businesses, particularly those in economies in transition, have the necessary financial and technical capabilities to take an invention or creation all the way to market by themselves.

Converting an original or new idea, concept, or design to a desired product available in the marketplace requires:

- Time
- Funds (own or borrowed)
- Creative effort
- Innovative effort (own, of employees and of external collaborators, partners, advisors and consultants)
- Persistence
- Focused management of the entire process from idea to market.

The above description of the resources required, highlights the importance of skilled and effective management of the commercialization process. Considering the risks involved in commercialization, it is clear why intellectual property asset management and business planning are so important. The likelihood of commercial success increases when management ensures that, before R&D projects are initiated, there is clear customer demand for the new products or services and a profitable way to bring them to market. The ability to create economic value from intellectual assets is highly contingent on the management capabilities of the company and the implementation of appropriate business strategies. There is now significant empirical work to support the view that effective use of intellectual assets and technologies depends on the quality of management.

Often, it is only at the stage when IP protection has been secured that an organization confronts the task of commercialization. This belated, often superficial, market awareness is one of the main pitfalls to avoid as an IP owner. Technological and commercial merit of IP should be assessed at a very early stage so that successful commercialization can occur. Leading firms have increased the efficiency of their R&D processes by linking internal R&D activities more closely to their business strategy and relying on external sources to gain access to complementary knowledge and round out technology portfolios.

Intellectual asset management should aim to realize value from patented inventions through licensing and sale, and to link patents better with innovation through incorporation into

improved products and services. Such techniques are particularly important in competitive industries where innovative products become commodities rapidly through follow-on innovation and imitation.

Each situation should be analyzed taking into account the nature of the IP, the market conditions, the financial position of the IP owner and the available resources. The ability of the inventors or creators to assist further in the commercialization of the IP should also be assessed. Specific factors such as speed of market entry, the degree of control required and the potential for growth are considered important in selecting the appropriate commercialization vehicle.

In summary, market considerations should be introduced at an early stage in the IP commercialization strategy. In this way, the IP strategy will be, in part, shaped by that company's markets, customers, competitors, the nature of the technology and its relationships with research institutions, government departments and other organizations. A reasonable assessment of possible strategies for entering the market is also needed. Part of this assessment involves consideration of the levels of investment that will be required, and over what period, for successful commercialization of the IP. At this point, an entity can form a tentative view of whether it may be feasible to commercialize the IP itself, or whether possible licensees or potential purchasers of the IP should be identified and approached.

When one wants to take up commercialization activities on their own, without any partners, they should consider whether they:

- already have enough capabilities for marketing
- do not have sufficient capabilities/time for developing partnerships
- do not want to spend money and efforts on partnerships

Key rules for IP Commercialization by its owner:

1. Keep your ideas secret.
   Tips: Confidentiality measures with employees, researchers, collaborators. Check the public disclosures, do not let any leakages.
2. Save your records, record the evidence proving your ownership of the IP.
   Tips: Have an Investor's notebook. Use virtual sealing.
3. Protect your IP.
   Tips: Think of all possibilities for protection. Consult a professional. Register a patent.
4. IP databases and FTO.
   Tips: Ask for professional help. Perform an FTO. Check EPO, national, etc. databases.
5. Enforce your rights.
   Tips: Check possible infringing products. Take action against them.

4.2.2 Assignments

IP can also be assigned. Assignment is another form of commercializing IP. If you assign your IP to another party, you are selling it. Therefore, unlike licensing, when you assign IP, you will lose all ownership rights. If you continue to use the IP once you have assigned it, you will be infringing on the new owner's rights. If you wish to exercise your IP rights in the future, licensing would be a more suitable route for commercialization.

A Founder's IP Assignment or Assignment of Intellectual Property Rights sets out the transfer of ownership between the seller and the buyer of a company's intellectual property. An Assignment of Intellectual Property Rights grants the buyer ownership and consequently the right to use the intellectual property. For trademarks, patents, copyright, and designs, the assignment needs to be in writing to be effective. The Assignment of Intellectual Property Rights

allows the seller to get paid for the intellectual property rights and the buyer is free to commercialize (or "exploit") the intellectual property for any purpose.

As a result of an assignment, the assignee (that is, the person to whom the rights have been transferred) becomes the owner of the intellectual property and is free to deal with it accordingly. Assignment of intellectual property is similar to selling a house and by doing so the seller has no further right or obligations in relation to that house. One potential problem with an assignment is that it will result in the assignor losing the ability to control how the intellectual property is used and developed, and hence the assignor will be unable to prevent the intellectual property from being exploited in a manner prejudicial to the interests of its stakeholders. An assignment will therefore generally be the preferred option only where the assignor can be confident that the interests of its stakeholders will not be adversely affected, and where the financial risk is such that a commercial partner could not reasonably be expected to agree to anything less than an outright assignment. Further, the assignor will not have any rights to seek a new partner should the assignee fail to exploit the research. However, parties are free to impose conditions in assignments as to reassign in the event of certain circumstances (such as failure to exploit).

Figure 7: IP Assignment procedure

Key rules for Assignments:

1. Process confidentiality
   Tips: Sign an NDA before disclosing any information.
2. Risk management
   Tips: Perform due diligence. Clarify the value, ownership, restrictions. Check the legal status.
3. Key terms in the assignment agreement
   Tips: Clarify the to-be assigned IP. Warranties: contractual assurances for both parties. Payment: the form and method, calculation, etc. How to settle disputes. The law to be applied in case of disputes.

4.2.3 Licensing

The owner of the IP (licensor) grants a permission to use the licensed IP to the user (licensee). There is no change in the IP ownership.

IP Licensing is a process whereby the holder of an IP grants permission to third parties to utilize his/her IP asset/s for a specified duration, for a specific purpose, on a particular territory, and under agreed upon conditions. These terms are agreed upon between both the parties and are stated in a contract: your licensing agreement. Licensing is one of the most frequently used ways of commercializing an IP asset and earning money out of it.

These are some of the main features and steps of Licensing Agreements involving IPRs that are detailed in ANNEX A: NEGOTIATING A LICENSING AGREEMENT.

4.2.4 Joint Ventures

Business alliances of two or more independent organizations to undertake a specific project by sharing risks. Partnering with other companies is not only a necessity in many cases, but it is also an excellent way to save time and money. When two or more partners come together to take up a new project with specific shared goals, in legal terms this is called a "Joint Venture" (JV). Joint Ventures are often formed by creating a new and separate entity. Other times, they are simply established by way of a contract, whereby parties agree to work together and allocate roles and responsibilities. In some countries that limits the possibility for foreigners to independently carry out business, entering into a JV with a local business actor is the only possibility. In other cases, this is not a legal requirement. Other factors that can be a drawback are that JVs can be costlier than other forms of partnerships, like consortia, and also more bureaucratic issues, tax arrangements etc., may arise. However, Joint Ventures present significant advantages, including:

- Acquiring capitals or access to specific technologies and knowledge
- Enhancing the capacity to source raw materials or to use the best distribution systems in the new market
- Capitalizing on local knowledge and network to foster acceptability
- Access to new markets and networks
- Sharing risks and costs

In any event, a solid contractual agreement has to be established, providing for clear rules relating to management and decision-making responsibilities. When entering into a Joint Venture, partners start sharing risks, profits, assets, results etc. Their initial contributions may take the form of tangible and intangible assets, and many times, they also create new (tangible and intangible) assets in the process.

In this context, it is imperative to have a well-crafted contract with your partners, particularly with regard to:

- The contributions that each party is expected to make in terms of tangible properties, as well as in terms of IPRs (often referred to as IP BACKGROUND);
- The ownership, management and commercialization of new intangible assets created by the Joint Venture (this is called IP FOREGROUND).

<u>Key rules for Joint Ventures:</u>

1. Each venture brings their own IP to the table
2. Background, Foreground and access rights
3. Accepting new partners/exit of current partners
4. Termination

4.2.5 Spin outs

Bringing patent organizations' IP assets into the market. Spin out is a term commonly used to describe a new capital company designed to commercialize intellectual property/product or the specific knowledge generated by the academic or research staff in a given university or research organization.

The spin out may be an effective way of growing your business, improving your products or services and increasing your profits. A spin out is a buzzword that typically refers to transferring some tangible and intangible assets from an existing entity to a newly created business. Typically, a spin out company receives rights to IP from the university and researchers are the founders of the company and become shareholders in the corporation, sometimes along with the university. The company becomes an investment vehicle to develop further and commercialize intellectual property. In general, a spin-out has the following characteristics:

- Is incorporated by an academic institution or the university
- Acquires IP or IP rights from the university intending to develop and commercialize it
- Creates an investment vehicle for outside investors to provide funding in return for shares in the company
- Has several shareholders who may include the university, inventors, and investors

Setting up a spin out company is a complicated endeavor. The academic spin out faces the problems associated with traditional new start-ups, with the added complexity of developing and scaling completely new technologies. During the early stages of a start-up, the company faces typical issues centered around access to funding, forming a team, and other commercial related difficulties such as access to markets, regulation, and value chain associated activities.

Overall considerations when creating a spin out or undertaking the technology transfer of your IP assets as part of your business:

- To clarify the ownership of IP rights, outline the rights and obligations in an assignment or transfer agreement. Verify that all employees and contractors have signed a written agreement that assigns any IP to your business before your company transfers it in a technology transfer or spin out deal. The lack of signed written agreements may lead to disputes with employees or contractors who have created products or wish to lay claim to the IP.
- To retain the right to use IP assets when transferring or spinning out an asset, consider negotiating a grant-back provision in the assignment agreement for the transferred IP assets or rights to improvements created by your business after the spin-off or transfer. A grant-back provision gives you the right to use transferred IP for a fee or for no fee.
- Transferring IP rights for successful implementation by the start-up or the secondary business may require transferring a mix of IP rights: patents, copyright, trademarks (registered and unregistered), trade secrets or industrial designs. Ensure a spin-off or transfer agreement clearly defines the IP assets or IP rights that are being transferred.
- Consider payment structures for IP rights and assets. Similar to royalty payment agreements, spin-off or technology transfer payment structures may vary; they can be based on upfront lump-sum or annual fixed payments, payments based on performance goals or back-end financing arrangements negotiated by the spin-off or secondary business linked to their ability to commercialize.
- Consider that the spin out or secondary business may require warranty disclaimers, such as indemnification against damages of infringement. Considerations must be given on your business's ability to support such disclaimers.

Key rules for Spin outs:

1. Easy solution for marketing (e.g., for universities)
2. Intermediary between academia-industry
3. Can be formed by assignment or licensing

4.2.6 Other IP related business contracts

4.2.6.1 *Non-disclosure agreements*

In order to do business with potential partners, you will have to disclose to them sensitive information on your protected or to-be-protected IPRs, on the preliminary results of your R&D, on your production processes, Trade Secrets and know-how, etc. While all your contracts will imperatively have to contain well-crafted confidentiality clauses that will protect this type of information, there is one crucial step you should take even before commencing your discussions with a potential business partner, and certainly before you share with them your precious secrets and sensitive information: ensure that they sign a Non-Disclosure Agreement (NDA).

This is the only way you can ensure that your potential counterpart, who may or may not eventually sign the cooperation agreement with you, does not disclose to anyone your confidential information, or does it only and exclusively under the conditions agreed with you. Non-Disclosure Agreements, as the name suggests, are designed to prevent your potential business partners from disclosing any confidential information received by you in confidence and relating to your business. NDA may be mutual or non-mutual, depending on whether the obligations to maintain complete secrecy about certain information are undertaken by both parties, or by one party only.

A typical NDA contains the following clauses:

- Definition of Confidential Information.
- Specification of the type of information not covered by NDA.
- Indication of the choice of law and jurisdiction.
- Listing of specific purposes for which the information can be used by the other party.
- Possible indication of the entities with which the confidential information can be shared under certain specified conditions.
- Provision of damages in case of unlawful disclosure of confidential information.
- Specification of the duration of the NDA

Table 3: NDAs pros & cons

NDAs	
Advantages	**Disadvantages**
Information is safe	Can create an aura of mistrust
Clarity on what info can and cannot be shared	May discourage potential partnerships, due to this aura
Clarity on the consequences of leaks	If breached, huge law processes and lawsuits
Cost-effective, just a signed piece of paper	

<u>Key rules for non-disclosure agreements (NDAs):</u>
Prior to partnership:

1. Protect your assets
2. Clarify the consequences in case of breaching

4.2.6.2 *Material Transfer agreements*

A material transfer agreement (MTA) is a contract governing the transfer of materials between researchers. The researchers might be employed by universities, research institutions or commercial companies or be private individuals. The supplier/provider of the materials (the "Provider") is usually the organization owning the materials but may sometimes be an authorized licensee. In a large organization, the range of materials transferred under MTAs may be diverse, although they generally fall within the biological/chemical category. Familiar examples include cell lines, cultures, antibodies, vectors, nucleotides and chemicals. MTAs may also be used for equipment fabricated in house, blueprints, integrated circuit designs and even some types of software (although software is more commonly transferred under an evaluation agreement or license agreement).The Provider may be willing to provide the materials for altruistic reasons (e.g. to assist others to conduct research) or to obtain a benefit (sometimes a fee for supply, but more usually with a view to generating data on the materials or to obtain

longer-term rights, as discussed below). The recipient of the materials (the "Recipient") may want to use them for a variety of purposes, including:

- to carry out research with them (either on its own account or on behalf of the Provider); or
- to create intellectual property with them or from them; or
- to evaluate them to determine whether to enter into further agreements (such as further research or licensing arrangements); or
- to test them either alone or with other materials (e.g., for safety or efficacy purposes)

MTAs are important because they clarify the reasons, the restrictions and the obligations of both parties, the Provider's and the Recipient's. Material providers, for example universities, want to ensure that their time, money, research, reputation, and effort are protected and respected. MTAs are one of the ways these corporations can have signed agreements to feel safe that there is mutual understanding on the use of the data/material.

Key rules for Material Transfer agreements (MTAs):

1. Setting the process and the content of how the *Recipient* receives the materials from the *Provider*
2. Provide safety and clarification

4.2.6.3 *Consortium Agreements*

The Consortium Agreement is a private contract between the participants of a specific project, concerning internal arrangements on work coordination, IP management, liability and other matters of their interest. This agreement should embrace all the beneficiaries' rights and obligations related to these issues that are necessary for the execution of the project. For example, it contains provisions about internal organization and decision-making, financial queries and the handling of intellectual property rights. A CA is obligatory for most projects. Consortium Agreements usually specify the following topics:

- General provisions: definition, objectives, applicable law etc.
- Obligations of project partners: compliance with deadlines, deliverables, who does what, and consequences of non-compliance.
- Financial provisions: allocation of funding, payments, handling of receipts and financial losses etc.
- Provisions on the handling of intellectual property rights: access rights, project results, liability, non-disclosure, dispute resolution etc.

Consortium Agreements are, practically, just a tool. Its pros and cons cannot be listed, since whether someone carries on his business with a consortium or something else, maybe a JV, is up to his wants and needs.

Key rules for Consortium Agreements:

1. Clarify the internal regulation of the consortium
2. Provide for the management of important information

4.2.6.4 *Contract R&D*

The objective of research and development (R&D) contract between two or more small or mid-sized businesses is to obtain new knowledge, applicable to the businesses' needs, which can eventually result in new or improved products, processes, systems, or services that can increase the businesses' sales and profits by outsourcing the R&D activities to universities or research organizations. Elements of an R&D agreement often include a division of tasks, the distribution of cost and revenues, intellectual property (distribution of results), liability, termination,

exclusivity, and dispute resolution. In international cooperations, special attention must be paid to the choice of law and forum in the agreement.

There are three types of R&D activities: basic research, applied research, and development. Basic research has as its objectives a fuller knowledge or understanding of the subject under study, rather than a practical application thereof. Applied research is directed towards gaining knowledge or understanding, necessary for determining how a recognized and specific need may be met. Development is the systematic utilization of the knowledge or understanding gained from research toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

Since the content of these contracts are about research and development, most R&D contracts are directed toward objectives for which the work or methods cannot be precisely described in advance. It is difficult to judge the probabilities of success or required effort for technical approaches, some of which offer little or no early assurance of full success. Thus, R&D agreements are often a little complex to negotiate and they are considered, by a lot of people, high risk-high reward agreements. On the other hand, there are also a variety of pros:

- Networking. Collaboration between an SME with a university, a college or other enterprises open paths for future communication and cooperation.
- Reputation. The collaboration with trusted entities itself can lead to commercial success of the resulting products and services.
- Competitive edge. Through R&D, the development of new products may generate intellectual property which could lead to further financial benefits and to a comparative advantage over other competitors of the market.
- Financial benefits. R&D benefits enterprises in various financial ways, directly with revenues from the products and services, funding seeking, and indirectly, as well, through tax reliefs.

Key rules for Contract R&D:

1. Contract with simple content
2. Variety of direct and indirect benefits

4.2.7 IP Guide Summary

Intellectual Property serves as a potential commercial opportunity for companies, especially for those with extensive research, tech-based services and products. IP commercialization should be considered early during the first steps of a business's strategy. IP commercialization strategy is categorized with ownership status, dependent on the transfer of property to another entity or granting to another entity the right to use the underlying intellectual property: IP commercialization by its owner, assignment license.

Considering a company's risks, commercial capacity and market feasibility, the most obvious option is for the owner of IP rights to consider a revenue-based model of its intellectual property with the development of products and services. The ability to create economic value from intellectual assets is highly contingent on the management capabilities of the company and the implementation of appropriate business strategies.

In the second scenario, a founder could assign its Intellectual Property by transferring its ownership to a buyer. Intellectual Property serves as a commercial asset, as a product itself, bringing revenues to its seller. The buyer then either leverages on the IP ownership offering new services and products in the market or acquires it to possibly eliminate competition. In the latter case, the seller should consider the IP's importance in the market for technological change and market needs.

In the final scenario, the owner of the IP could license its use to a third party (licensee), who will commercially utilize the IP. The owner of the IP (licensor) grants a permission to the user (licensee) to use the licensed IP. There is no change in the IP ownership, although licensing out its assets offers an additional fixed revenue stream for a specified duration, purpose, territory and conditions. This scenario offers two main options of licenses: exclusive and non-exclusive (there is also sole licensing). Where in an exclusive license, the Licensor gives to the Licensee the exclusive rights to use its IPRs in a given territory (i.e.: the entire country, a particular region, etc.), in a non-exclusive license, the Licensor retains the right to appoint other Licensees to use its IPRs potentially in the same territory.

The Guide, summarizing the directives and definitions of the sections 4.2, above, is provided to EVOLVED-5G members in order to consider the strategic paths for the commercialization of their R&D assets and intellectual property.

4.3 IP Commercialization Blueprint

There's no solid recipe a business should take to commercialize its IP, however there are steps to consider during its commercialization journey. The tool can help the EVOLVED-5G partners to:

- develop and build effective IP commercialization strategy
- identify the important issues in IP commercialization strategy, assisting them to understand what is important and how to protect their interests
- deal with key issues before beginning the commercialization process of an IP

4.3.1 Instructions On how to use the tool

The tool has been devised considering the EVOLVED-5G partnership, and each outcome leader and/or project partner can practice with it following the instructions provided below.

Before you start:

There are a couple of things to remember before you start.

1. Get into a creative mindset. Observe people, pretend you don't know the answers and focus on what they do rather than what they say they do or think they do.
2. Be collaborative. The ideal team size is 5-8 people; make sure your core team has commitment, right skills, and authority to get things done. As a project lead, remember to be open and encourage different points of view.
3. Be visual. Remember to keep a visual record of your work. Find somewhere to stick everything up and use this to monitor the progress and inform future practice; take pictures or film the process.
4. Stock up the supplies. Marker pens, paper, tape, sticky notes, voting dots and blue tack.
5. Think big. Encourage visual thinking from your team and project participants. Find a printer that can print tools and worksheets on A1/A2 sheets.

Practicalities:

- Time: 2-3 hours
- Materials: Blueprint worksheet, marker pens and post-it notes and a camera.
- Facilitation: A senior member of your project team should facilitate this session, ensuring that the key
- points are captured and documented.

Steps:

Print the poster (Blueprint). Invite all your core stakeholders (senior management, service delivery, support staff, researchers, etc.) to a co-creation workshop and discuss all the Blueprint boxes. Think about what happens chronologically over time – before setting the strategy, during and after its use. Having captured all the Blueprint elements, it will be possible to produce a visual representation of how the proposed IP commercialization strategy should work and the assets required to enable this.

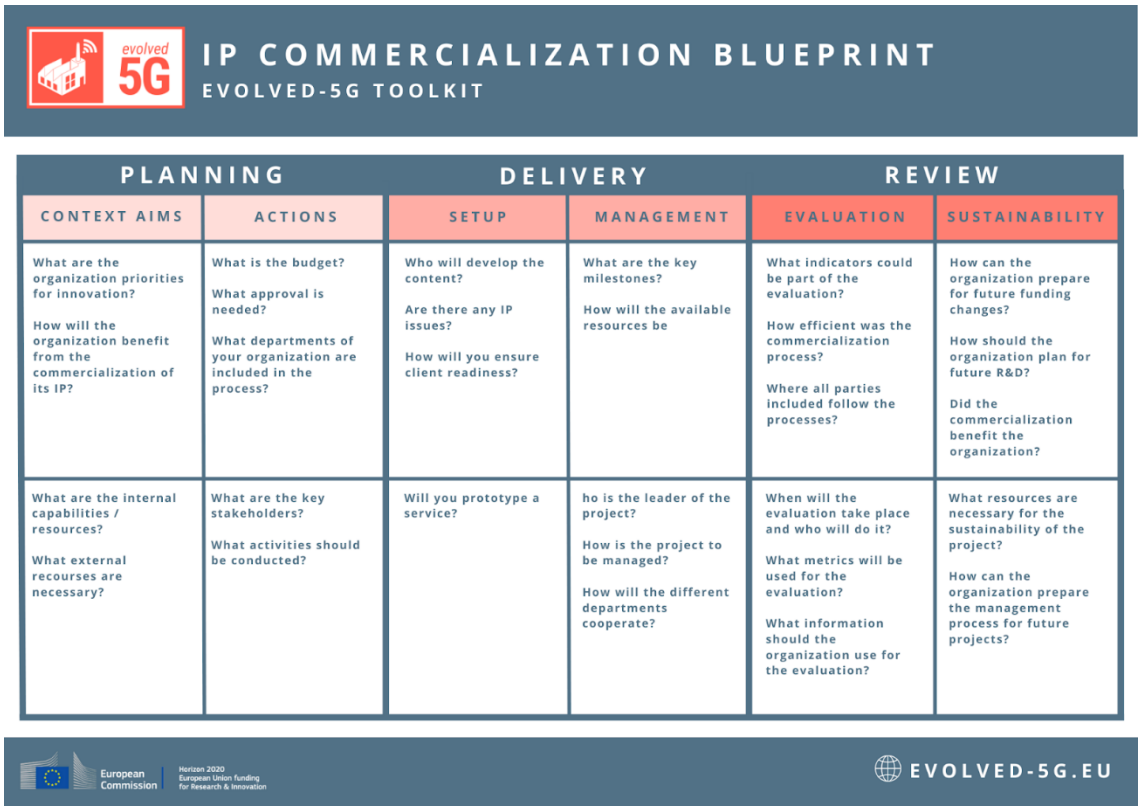

Figure 8: IP Commercialization Blueprint

4.4 Technology Transfer Workshops

Having set the key terminology, scope and tools to execute the technology transfer, the next step is the realization of the technology transfer workshops that are meant to stir the engagement of the EVOLVED-5G consortium towards the identification of new IPs and development potentials.

The plan includes four workshop sessions, two of which have already been implemented in 2022 as provided in Table 4 below:

Table 4: Technology Transfer Workshops Planned & Completed

Workshop #1 Understanding the fundamentals of technology transfer and the IP commercialization process		
Description	The basic training webinar is designed to provide to the EVOLVED-5G consortium members and especially the SMEs with well-structured information and knowledge on the legal basis, as well as, on practice in European and patent and IP law. The webinar has been organized by Envolve/IEA and had a key note speaker from the Hellenic Industrial Property Organization, Mr George Asimopoulos	
Status	Completed	**Date**: Thursday 26 of May at 15.00 CET **Place**: Digital MS Teams

		Participants: EVOLVED-5G Consortium
Workshop #2 How to use the Evolve 5G IP Commercialization Blueprint		
Description	This workshop is designed to provide an overview of the value of the Commercialization Blueprint Tool. It represents a methodology tailored by EVOLVED-5G on how an organization can bring a programme to the market by co-creating an in-depth plan and evaluation framework for the new products' commercial routes and value but also an assessment of the internal capabilities and feasibility for executing the new plan. The one-hour workshop is made up of one exercise. The exercise has been developed to explore the stages of planning, implementing, and reviewing the commercialization process by working through a series of questions on posters of the tools in small groups. As a result of this exercise, workshop participants have now an understanding of how to use this tool internally. The workshop was delivered and facilitated by Envolve/IEA.	
Status	Completed	**Date**: Thursday 15 of December at 12.00 CET **Place**: Malaga, Spain **Participants**: EVOLVED-5G Consortium
Workshop #3 Advancing IP commercialization processes: Negotiation, IP Transfer and License Agreements		
Description	Content to be finalized in 2023	
Status	Planned	**Participants**: EVOLVED-5G Consortium
Workshop #4 Feedback session for SMEs: Lessons learnt from using the Evolve 5G IP Commercialization Blueprint		
Description	Content to be finalized in 2023	
Status	Planned	**Participants**: EVOLVED-5G Consortium

5 CONCLUSIONS

Building upon the initial plans specified during the project's preliminary deliverable D7.2 [26], EVOLVED-5G has liaised with, and actively contributed to several standardization organizations during this intermediate reporting period. The focus has been on ensuring the alignment and conformance of the overall project's implementation with the applicable standards, as well as, delivering tangible contributions to the standardization community, in an attempt to standardize new enablers for verticals, such as enablers for "App-Layer Analytics" and "Network Slice Capability Exposure". The standardization work is an ongoing activity spanning throughout the project's lifetime and as such, EVOLVED-5G will continue at the same pace aiming to increase the project's influence on the vertical industry even further. In addition, the project's innovation area has been sufficiently addressed through the various novel technical innovations (products & services) which had been identified in previous work [26] and are reported in the current deliverable, as well as the envision of future innovation prospects around business and certification process innovation.

In respect to the exploitation activities and the commercialization of EVOLVED-5G results, it is noteworthy that the project has evolved following the holistic methodology identified during its initial phase, binding exploitation, intellectual property, and technology transfer actions. In line to the planned exploitation activities, the verification and TRL revision of the initially identified exploitable outcomes has been performed together with the respective product gap analysis. Updates on the intermediate individual exploitation plans per partner are also presented.

With regard to the technology transfer activities, EVOLVED-5G has developed solid understanding around the vertical industry divergent use cases and the way those can be realized and extended by the 5G network capabilities. The project mechanisms are currently set to assist vertical industry SMEs in their digitalization journey, distributing knowledge through the project's technology transfer outcomes; the Commercialization of IPR Guide, the IP Commercialization Blueprint tool and hands-on workshops on the usage of the tool and the guide, just to name a few. Furthermore, the different routes for IP commercialization have been presented (assignments, licensing, joint ventures, spinouts) as well as additional IP related business contracts (NDAs, MTAs, consortium agreements, etc.).

During the last year of the project, the attention will be shed on selective exploitable outcomes as resulting from the previous analysis and on executing the Value Proposition methodology for the preparation of a business case study in alignment and cooperation with WP6 and Task 6.3 "Techno-economic analysis and Stakeholders engaging" developments. This work will be discussed in D7.6 "Standardisation, Innovation, Exploitation and Technology Transfer Activities (Final)", due in M36 of the project.

6 REFERENCES

[1] "Value Proposition Canvas" [Online], https://www.b2binternational.com/research/methods/faq/what-is-the-value-proposition-canvas, Accessed Dec 2019.
[2] [Online], 3GPP TS23.501, https://www.3gpp.org/ftp/Specs/archive/23_series/23.501
[3] [Online], https://www.innoradar.eu/innovation/47486
[4] [Online], https://www.rinkeby.io/#stats
[5] [Online], https://www.infura.io/product/overview
[6] [Online], https://www.cncf.io/
[7] [Online], https://docs.docker.com/get-started/overview/
[8] [Online], https://kubernetes.io/
[9] [Online], https://helm.sh/
[10][Online], https://www.redhat.com/es/technologies/cloud-computing/openshift
[11][Online], https://osm.etsi.org/
[12] [Online], EVOLVED-5G-D2.2-v1.0_final.pdf
[13] [Online], https://marketplace.EVOLVED-5G.eu/product-catalogue
[14] [Online], https://github.com/EVOLVED-5G/marketplace-tmf620-api
[15] [Online], https://opentap.io/
[16] [Online], https://gitlab.com/OpenTAP/Plugins/university-of-malaga
[17] [Online], https://github.com/5genesis
[18] [Online], https://github.com/EVOLVED-5G/ELCM
[19] [Online], https://EVOLVED-5G.eu/wp-content/uploads/2022/09/EVOLVED-5G-D4.2_v_1.0.pdf
[20] [Online], https://github.com/EVOLVED-5G/
[21] [Online], https://github.com/EVOLVED-5G/marketplace
[22] [Online],https://EVOLVED-5G.eu/wp-content/uploads/2021/11/EVOLVED-5G-D2.1_v1.4.pdf
[23] [Online], https://EVOLVED-5G.eu/wp-content/uploads/2022/12/EVOLVED-5G_D2.3.pdf
[24] [Online],https://evolved-5g.eu/wp-content/uploads/2021/11/EVOLVED-5G-D2.2-v1.0_final.pdf
[25] [Online], EVOLVED-5G: The NetApps Certification Framework
[26] [Online],https://evolved-5g.eu/wp-content/uploads/2021/11/EVOLVED-5G-D7.2-v1.0_final.pdf
[27][Online], https://ahedd.demokritos.gr/
[28] [Online], https://hub.egaleo.gr/
[29][Online], GSMA Intelligence, 9/2022, "5G for the enterprise: headway, hurdles and the horizon for operators", https://data.gsmaintelligence.com/research/research/research-2022/5g-for-the-enterprise-headway-hurdles-and-the-horizon-for-operators
[30] [Online], https://www.cosmote.gr/cs/otegroup/en/5g_campus_network.html
[31] [Online], https://www.cosmote.gr/cs/otegroup/en/campus_network.html
[32] [Online], https://www.cosmote.gr/cs/otegroup/en/smart_manufacturing.html
[33] [Online], https://www.broadway-info.eu/ferry-fire-pilot-spain/
[34] [Online],https://www.globenewswire.com/news-release/2021/05/20/2232959/0/en/Genasys-NEWS-Cell-Broadcast-Center-Tested-in-Prestigious-University-of-M%C3%A1laga-s-LTE-Laboratory.html
[35] [Online], www.gmi-aero.com
[36] [Online], https://linkpage.gmi-aero.com/linkpage.html
[37]Van Wyk, R. J. (1988). Management of technology: New frameworks. Technovation, 7(4), 341-351.

[38]Lane, J. P. (2012). Tracking evidence of knowledge use through knowledge translation, technology transfer, and commercial transaction. FOCUS Technical Brief, 34.

[39]Executive Agency for Small and Medium-sized Enterprises (European Commission), (2019). Your guide to IP commercialization. *https://op.europa.eu/en/publication-detail/-/publication/a75b3213-ebf4-11e9-9c4e-01aa75ed71a1*

7 ANNEX A: NEGOTIATING A LICENSING AGREEMENT

Negotiating a licensing agreement is not an easy task. You need to have a strategy and clarity in your mind about your business objectives before you start the negotiation. You should make adequate preparation by acquiring relevant information about the counterpart, the target market, the legal and business environment, as well as all aspects relating to the IPRs to be granted or acquired, including their potential value. While defending your interests, you should also consider the needs of the counterpart (whether the licensor or the licensee). This is not only a question of fair play, but also because your monetary reward will depend on the commercial success of your counterpart: the more he/she earns from the license, the more you will receive in terms of royalties. Equally, the more valuable the IPRs in question, the more benefit you will likely derive from their Commercialization, on foot of the licensing arrangement. A successful IP license deal is one where both the parties are happy and both parties stand to derive benefit.

7.1 EXCLUSIVE, NON-EXCLUSIVE (OR SOLE) LICENSING

Generally, there are two main types of IP licenses: exclusive and non-exclusive.

In an exclusive license, the Licensor (i.e., owner of an IP asset) gives to the Licensee the exclusive rights to use its IPRs in a given territory (i.e.: the entire country, a particular region, etc.). The Licensor will not authorize any other person to use its IPRs on the same territory. As a matter of fact, under this model, not even the Licensor will be able to use them on that territory.

In a non-exclusive license, the Licensor retains the right to appoint other Licensees to use its IPRs potentially in the same territory. In other words, the Licensor is at liberty to further license its IPRs to other parties, and of course to use them itself.

There is also a third type of licensing agreement, called “sole license”. Under this model, the Licensor undertakes the commitment not to appoint further Licensees, but it retains the right to use the IPRs in question by itself.

7.2 COMPENSATION

As mentioned above, licensing carries numerous advantages. However, monetary compensation is certainly one of the main reasons for entering into an IP licensing agreement. This compensation usually takes the form of Royalties that the Licensee will pay to the Licensor for the privilege of using its IPRs. Both the Licensor and the Licensee should do a valuation of the IPRs in question to assess their potential market value, and this will influence the amount of the royalties. Calculating royalties represents a major part of the licensing agreement. Parties often have to agree on a method for calculating royalties. Similarly, at times parties may decide that in addition to royalties, the Licensee will have to pay a Lump Sum at the beginning of the contract.
From the outset, parties should also agree upon issues such as:

- When and how the payment/s will be made.
- Currency of payments.
- Criteria for the payment of royalties (e.g.: before or after taxes)

While in general the compensation for the Licensor consists of sums of money (i.e.: royalties and/or lump sums), in other situations the Licensor will receive in exchange the possibility of exploiting the Licensee’s IPRs, through a so-called cross licensing agreement.

The licensing benefits for licensors and licensees are illustrated in Table 3 below:

Table 5: Licensing benefits

For Licensors	For Licensees
Opportunity for new markets with existing products	Opportunity to new businesses
Reduced risks for market failure (existing clientele)	Reduced risks for market failure
No/less investment in marketing and distribution	No/less investment in R&D
Ownership and royalty	Ownership and test
Making a partner from a possible competitor	

The risks for licensors and licensees are illustrated in Table 4 below:

Table 6: Licensing risks

For Licensors	For Licensees
Licensee can become a competitor	Dependence on licensor
The licensor can lose their control over the licensed product/service	Danger for the technology to become obsolete
Not easy to find a reliable licensee	Not easy to find a reliable licensor
Plan B for market failure	

Types of licensing:

- Non-exclusive license
- Sole
- Exclusive

Key rules for Licensing:

1. Process confidentiality.
   Tips: Sign an NDA before disclosing any information. Signing a Memorandum of Understanding (MoU).
2. Know what you really grant.
   Tips: Possibility for sublicensing.
3. Key terms in the licensing agreement.
   Tips: Clarify the to be licensed IP. Duration and termination. Geographical scope. The type of the licensing. Payments. Warranties. How to settle disputes.