



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

[H2020 - Grant Agreement No.101016608]

Deliverable D7.2

# Standardisation, Innovation, Exploitation and Technology Transfer plan

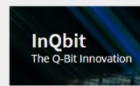
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## GLOSSARY

<b>Abbreviations/Acronym</b>	<b>Description</b>
<b>3GPP</b>	<i>3rd Generation Partnership Project (3GPP)</i>
<b>5G-ACIA</b>	<i>5G Alliance for Connected Industries and Automation</i>
<b>5GC</b>	<i>5G Core</i>
<b>5G-PPP</b>	<i>5G Infrastructure Public Private Partnership</i>
<b>AEF</b>	<i>API Exposure Function</i>
<b>API</b>	<i>Application Programming Interface</i>
<b>CA</b>	<i>Consortium Agreement</i>
<b>CAPIF</b>	<i>Common API Framework</i>
<b>CSP</b>	<i>Connectivity Service Provider</i>
<b>CT</b>	<i>Core Network &amp; Terminals</i>
<b>DN</b>	<i>Data Network</i>
<b>EC</b>	<i>European Commission</i>
<b>ETSI</b>	<i>European Telecommunications Standards Institute</i>
<b>FoF</b>	<i>Factory of the Future</i>
<b>ICT</b>	<i>Information &amp; Communication Technology</i>
<b>IETF</b>	<i>Internet Engineering Task Force</i>
<b>IM</b>	<i>Information model</i>
<b>INT</b>	<i>Interoperability Testing</i>
<b>IP</b>	<i>Intellectual Property</i>
<b>IPR</b>	<i>Intellectual Property Right</i>
<b>ISG</b>	<i>Industry Specification Group</i>
<b>K8</b>	<i>Kubernetes containers</i>
<b>M2M</b>	<i>Machine to Machine</i>
<b>MANO</b>	<i>Management and Orchestration</i>
<b>MEC</b>	<i>Multi-access Edge Computing</i>
<b>MRO</b>	<i>Maintenance, Repair, Operations</i>
<b>NDA</b>	<i>Non-Disclosure Agreement</i>
<b>NEF</b>	<i>Network Exposure Function</i>
<b>NFV</b>	<i>Network Function Virtualization</i>
<b>NPN</b>	<i>Non-Public Networks</i>
<b>NS</b>	<i>Network Services</i>
<b>NWDAF</b>	<i>Network Data Analytics Function</i>
<b>OSM</b>	<i>Open Source MANO</i>
<b>OT</b>	<i>Operational Technology</i>
<b>PoC</b>	<i>Proof of Concept</i>
<b>RAN</b>	<i>Radio Access Network</i>
<b>SA</b>	<i>Services &amp; System Aspects</i>
<b>SaaS</b>	<i>Software as a Product</i>
<b>SDN</b>	<i>Software Defined Networking</i>
<b>SDO</b>	<i>Standards Development Organization</i>
<b>SEAL</b>	<i>Service Enabler Architecture Layer</i>
<b>SIEM</b>	<i>Security Information and Event Management systems</i>
<b>TC</b>	<i>Technical Committee</i>
<b>TSG</b>	<i>Technical Specification Group</i>
<b>TSN</b>	<i>Time Sensitive Networking</i>
<b>WG</b>	<i>Working Group</i>

## EXECUTIVE SUMMARY

EVOLVED-5G focuses on maximising 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 D7.2 “Standardisation, Innovation, Exploitation and Technology Transfer plan” is to explore the project activities and respective plans and the work carried out in Task 7.3 “Innovation Shaping and Standardization Alignment” and Task 7.4 “Exploitation Activities, Technology Transfer and IPR Management” for the first ten months of the project’s course.

The document provides a helicopter view of the project’s achievements in four thematic areas:

- **The standardisation and innovation plan**, that clarifies the principal technological innovations the project sets out to pursuit, and through a well-established approach, presents the plan to liaise with the relevant standardisation groups, with the target of active collaboration.
- **The exploitation plan**, that starts by describing the exploitation methodology to be applied, and subsequently presents the initial results focusing on project-wide, as well as, partners’ specific individual plans.
- **The Intellectual Property Rights (IPRs) management plan**, considering agreements set prior to the project’s start, as well as, necessary auditing in the project’s course.
- **The technology transfer plan** that explains the process of launching an idea to the market, presenting a specific methodology devised as part of the project and proposing the respective tools, such as the guide for IPR commercialisation and the commercialisation blueprint.

In respect to the results reported in this work, for the standardisation activities the primary focus is on 3GPP, and specifically SA2 and SA6 groups, ETSI OSM and MEC, IEEE TSN, 5GPP pre-standardisation WG and 5G-ACIA. To this direction, EVOLVED-5G is already bringing contributions to 3GPP SA6 to standardize new enablers for verticals, such as enablers for “App-Layer Analytics” and for “Network Slice Capability Exposure”.

In respect to the commercialisation 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. The plan considers a three-phased approach, and the delivery of this document marks the completion of the first phase, involving the establishment of the relevant methodologies, and the identification of the initial results for further analysis. During the second phase, the focus shall be put in the finalisation of the technology transfer tools (the guide and the blueprint) while in parallel the IPR status per project’s outcome and involved partners will be clarified. At the last phase, to be completed by the end of the project, business case development methods, such as the Value Proposition and Lean Canvas tools, will be applied on selective exploitable outcomes as resulting from the previous analysis.

As the project results mature, potential amendments in the methodology and provided plans will be reported in the next deliverable D7.4 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Intermediate)” due M24 of the project.

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# 1 INTRODUCTION

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## 1.1 PURPOSE OF THE DOCUMENT

EVOLVED-5G focuses on maximising 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.

At the same time, the engagement and involvement of the project members with the relevant standardization organizations is important 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. Therefore, it becomes important to devise an all-encompassing exploitation strategy methodology that captures and classifies 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 is also considering a tangible Technology Transfer Plan, necessary to raise awareness and encourage the engagement of the business people in the overwhelming developments, a critical factor for the adoption of the technology offerings in the society.

To address these very important work streams, the project has dedicated specific tasks in WP7, and the purpose of this document is to summarise the achievements of these so far:

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

As the work of these tasks is continuous, updates and enhancements in the reported work shall be presented in the subsequent deliverable D7.4 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Intermediate)” on M24, and results will be included in D7.6 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Final)” that will be submitted at the end of the project.

## 1.2 DOCUMENT STRUCTURE

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

- **Section 2** presents the standardisation and innovation plan, by describing the principal technological innovations in 2.1, explaining the project's standardisation approach in section 2.2 EVOLVED-5G Standardization Approach, detailing the relevant target groups in 2.3 and providing the detailed activities plan in 2.4.

- **Section 3** focuses on the exploitation plans, by explaining the exploitation strategy in 3.1 and presenting the initial results of the exploitation activities in 3.2, focusing on the project-wide results in 3.2.1 (platform-oriented) and 3.2.2 (SME's oriented) as well as the partners' individual exploitation plans in 3.2.3.
- **Section 0** recaps on the Intellectual Property Rights (IPR) approach set for the project, considering agreements prior to the project's start in 4.1 and the necessary auditing in the project's course in 4.2.
- **Section 5** introduces a methodology to drive the technology transfer plan from the idea to practise, by proposing the publishing of a guide for IPR commercialisation as discussed in 5.1 and utilising a commercialisation blueprint, presented in 5.2 to drive the process for each company.
- **Section 6** concludes by summarising the key plans for the next period.

### 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 target innovations and potential impact on Standard's Development Organisations (SDOs) activities.
- The Project Consortium, to reflect on the exploitable capabilities of the EVOLVED-5G framework, the developed NetApps, and Industry 4.0 use cases, and 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 STANDARDISATION & INNOVATION PLAN

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### 2.1 PROJECT INNOVATIONS

Starting with the definition of the term “innovation” [1], which is broadly used in a plethora of cases, we could concur that it mainly refers to the process of creating value by applying novel solutions to meaningful problems. Innovation could be further materialised in different types, such as products and services, processes and business models. *Products – services* innovation is referred to the development of novel products/services and the introduction of new features in existing products/services; *processes* innovation is related to the continuous evolvement and improvement of existing processes or creation of new ones and finally *business* model innovation is connected to the definition of disruptive business models and new revenue streams[1][2].

EVOLVED-5G has focused in identifying potential innovations at an early stage of the project lifetime. Several salient outcomes of the project, derived from partners’ engagement in the various tasks, can be considered product innovations, and are analysed extensively as part of the project exploitation strategy in 3.1.1.

Additionally, in the scope of the standardisation activities of the project, the focus for innovations is shifted towards technology-related, novel research activities that are pursued by the project, and refer to niche project developments that are deriving from or affecting the future work of well-established standard-development organisations (SDOs). In the following subsections the topics for EVOLVED-5G innovations are discussed, consequently pointing to the relevant SDOs for which engagement, either through monitoring or contributing, is sought.

#### 2.1.1 NetApps

The NetApp ecosystem that the project introduces, proposes an all-encompassing framework that follows the lifecycle of the NetApp from the development to the deployment and operation stages. Within this framework the NetApps per se, along with the EVOLVED-5G facility, can be considered as the main innovations of the project, due to the fact that this is a novel solution in the way vertical applications can communicate with the 5GC Network and utilise its capabilities leading to the enablement of network aware applications and services.

The full list of the NetApps to be developed within EVOLVED-5G is the following:

- Digital/physical twin NetApp
- 5G enabled intent-driven chat-bot NetApp for human-machines interaction NetApp
- Network Monitoring and Anomaly Detection of I4.0 5G NPN NetApp
- Trusted event management NetApp
- 3Autonomous 5G network monitoring for AR/VR usage NetApp
- Authentication and authorization management towards 5G APIs NetApp
- FoF IoT System Netapp
- Identity and access management NetApp
- Occupational safety analysis NetApp
- Teleoperation NetApp
- Global Localization NetApp

As a next step, the project will identify specific innovative aspects based on the development process and the technologies that will be utilised for each of the NetApps, and this material will be further reported in detail in deliverable D7.4 due M20 of the project.

#### 2.1.2 CAPIF/NEF emulators for Network Programmability

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 [3]. To this end, the 5G network infrastructure that will be used as the base for EVOLVED-5G activities, exploits the NEF northbound APIs to 3<sup>rd</sup> party applications that do not just seek to exploit network connectivity services, but also interact with the network in a standardised and trusted way in order to compose valuable services for the vertical industries. Another key innovation of the project while envisioning the certification of the produced NetApps is the implementation of the CAPIF emulator as a core architecture enabler. The idea introduced by 3GPP for enabling a unified approach concerning the interaction between 5GC northbound APIs and vertical applications, will be materialised through the project activities, providing NEF Emulator as API Exposure Function (AEF) exposed using CAPIF framework for NetApps to Discover and Consume NEF APIs.

#### 2.1.3 Containerised NetApps for Cloud-native solutions

Although a few years ago the general belief was that there was no space for cloud computing within telecom networks, the truth is that, nowadays, many telecommunications providers have already moved much of their IT infrastructure delivery and maintenance to the cloud. Some of the benefits are clear: less IT operating costs and improved flexibility and agility, both highly required to face the increasingly market demand and diverse set of users' applications and requirements.

The introduction of technologies such as Network Function Virtualization (NFV), that coupled with Software-Defined Networking (SDN) are cornerstone technologies for 5G networks, opened the door to the "cloudification" of the future telecom networks. It suggests to replacing traditional network appliances with virtualised functions running on common industry-standard IT equipment.

More recently, a new trend has emerged in relation to the cloudification of telecom networks: cloud-native software like micro-services and containers (such as Kubernetes k8s) have become commonplace in the design of virtualised network functions. For EVOLVED-5G, this links tightly to the innovative NetApp concept and the requirements for flexibility and automation. EVOLVED-5G project perceives the NetApps as containers that can be deployed as Network Services (NSs). SDOs, like ETSI, are currently developing this concept so, be aligned with such activities and joining forces may be beneficial for both parties.

#### 2.1.4 A novel NetApp: the "Auxiliary" NetApp

A new type of NetApp has been identified through the EVOLVED-5G brainstorming activities towards envisioning NetApps, considering the novel capabilities they are expected to provide in the vertical industries and their position in the 5G system architecture. A novel NetApp, identified as "Auxiliary" NetApp is envisaged, which does not expose services to vertical applications but performs "auxiliary" functions (e.g., collecting data to enable analytics). Auxiliary NetApps can be stored in the marketplace and deployed by the network operators, offering them additional innovative capabilities on network data collection and analytics exploitation, increasing efficiency in network management and operation.

The auxiliary NetApp is primarily a concept for EVOLVED-5G, and as such, it is not explicitly listed among the project outcomes. Nevertheless, as it is an important contribution towards improving operators' decisions on optimised network management there will be some work towards materializing this Auxiliary NetApp as a proof-of-concept.

## 2.2 EVOLVED-5G STANDARDIZATION APPROACH

Standardization could be defined as a framework of agreements for all relevant parties in an industry to ensure the creation of well-performing systems, products, and services in accordance with set guidelines. The main objective is to maximise compatibility, interoperability, safety, repeatability, and quality. The development of a new technical standard within a standardization organization is based on the consensus of different parties, including vendors, operators, end-users, interest groups and governments. The main advantages of standardization as identified in industry are the global device interoperability, the rapid consumer access to the latest and best technologies, the promotion of competition and innovation in connected hardware and services as well as the collaboration of global R&D organisations to certain directions (universities, companies, research institutions).

The EVOLVED-5G project specific standardization purposes, identified through the partners' collaborative activities, taking place for the realization of the EVOLVED-5G technical innovations, are succinctly summarised hereinafter. An advantage of standardization activities, stemming from the EVOLVED-5G project is the common approach on 5G northbound API(s). In this way, the definition, implementation, exposure and consumption of API(s) is common across vendors, CSPs, NetApp developers, integrators, experimenters & end-users. Another aspect of standards' contribution to the EVOLVED-5G facility could be the NetApps' guaranteed quality, interoperability across vertical industries and applications either in standalone or non-standalone setup, maintainability and security, just to mention a few.

Furthermore, standardization is anticipated to unleash the full potential of 5G network capabilities, allowing for the extensive NetApps exploitation across vertical industries. Finally, standardization is heavily connected to monetization. More specifically, the certified NetApps will eventually reach the Marketplace which is the final point in NetApps lifecycle process. NetApps' release to market in conjunction with new 5G standardised APIs, will provide innovative applications and services, preparing the ground for new synergies and business models which will in turn drive sustained economic growth.

### 2.2.1 Objectives

EVOLVED-5G Consortium aims at contributing to key standardization bodies and fora. Standards (technical reports, specifications and/or recommendations) will reflect key results from the project activities. In order to achieve a complete alignment between the standards and project innovation actions, the opposite direction is also examined. In this approach we investigate how the EVOLVED-5G project aligns and benefits from the SDOs. To this end, leveraging some partners' experience in SDO participation, we identify the most appropriate organisations to learn from, in an attempt to apply the latest technology standards in the project's novel solutions.

This activity will also foster other developed plans of the standardisation task, tightening links with standards community and ensuring proper dissemination of project results. Exploitation will also benefit from this action, as standardization process is a key in trust building.

### 2.2.2 General Approach

Standardization efforts are an essential part of the project's strategy. Without standards to back up the developed technology, any interoperability efforts run an increased risk of marginalization due to lack of market wide adoption. The standardization efforts will begin early in the project with identification of expected outcomes on requirements and architecture.

In detail, the stepwise standardization approach to be followed in EVOLVED-5G project, is depicted below:

- Identify and collect from partners all possible target innovations that shall be considered as candidates for pre-standardization activities, i.e. create and distribute to the consortium a partners-innovations-template each partner should fill in with joint or individual standardization and innovation actions.
- Once feedback is received by all partners, assess the standardization possibilities.
- Classify the collected candidate standardization actions according to possible SDOs/WGs where those innovation concepts could be presented and promoted.
- Identify which partner could attend each SDO, i.e. according to their present active engagement in SDOs.
- Identify the agenda to be presented in each relevant SDO.
- Stimulate intra-project collaboration on standardization topics by creating a task-force team which is going to address possible standardization impediments and drive internal discussions efficiently.
- Dissemination of standardization activities' successful progress.

## 2.3 TARGET GROUPS

The standardization of EVOLVED-5G results will be focused on relevant standards development organizations (SDOs) pertinent to the areas of Mobile System Standards and 5G Software Networks orchestration. The EVOLVED-5G team has performed an initial analysis of the most promising of these SDOs and the relevant committees, the results of which are presented in this section. The goals and processes of each SDO are introduced, together with an analysis of the committees and working groups where EVOLVED-5G results can be contributed and become part of the produced standards. Since the EVOLVED-5G partners acknowledge that the complete standardization process may well take longer than the project lifetime we want to express our commitment to continue the effort required to achieve full standardization of the fruitful contributions beyond the end of the project, as part of a further exploitation of EVOLVED-5G results.

There are two main target categories where innovation and standardisation engagement is anticipated by the project. The SDOs, with a well-established standards-publishing procedure, as well as open-source communities, with the de-facto adoption of their public developments in the industry. Furthermore, the EVOLVED-5G team is committed to a continuous observation and evaluation of further standardization opportunities that may appear during the project lifecycle.

### 2.3.1 SDOs

The consortium partners with strong expertise and experience in the field are committed to perform standardization efforts constantly. Initially, the project will focus on participating and contributing from the next generation networks perspective in 3GPP SA2 & SA6 WGs, 5G-PPP Architecture and Pre-standardization WGs, ETSI OSM, MEC & NFV ISGs, including other SDOs such as IETF/IRTF, ETSI INT. Furthermore, links to Industry 4.0 and FoF bodies, such as Alliance

for IOT Innovation, BDVA/DAIRO, EFFRA (European Research Factories Association) are actively pursuit. The structure and objectives of each of the listed target groups are presented in ANNEX A: Standardization Groups Structure & Objectives. The specific activities and EVOLVED-5G plan of actions for these groups are detailed in 2.4.

### 2.3.2 Open-Source Communities

The consortium understands that open-source communities represent industry-driven, de-facto standardization mechanisms. Some open-source communities support a different mechanism for standardization, equally or even more effective than documented specifications. This mechanism consists of the definition of open APIs and the availability of a reference implementation distributed as open source. Obviously, to achieve this standardization effect, open-source communities need to have a wide industrial support and governance mechanisms in place that make them in practice similar to SDOs and their processes. EVOLVED-5G considers this additional way for achieving a high impact in industrial practice, and the team has therefore identified those open-source communities widely accepted by the industry where there is common ground for collaboration. Specifically, EVOLVED-5G monitors and builds upon the work of the following open-source communities and repos:

- OpenTAP: The OpenTAP<sup>1</sup> test automation framework is used as an additional automation tool in the platforms. Partner UMA has already contributed to this project by releasing the code of some internally developed plugins as open source in the official OpenTAP repositories.
- Open5GENESIS: The Open5GENESIS<sup>2</sup> Suite provides the orchestration capabilities of the Validation environment. It is expected that any modification to the framework will also be released as open source.
- Open-Source MANO (OSM): OSM<sup>3</sup> is an open-source Management and Orchestration (MANO) stack aligned with ETSI NFV Information Models. A production-quality MANO stack that meets operators' requirements for commercial NFV deployments. OSM Release EIGHT is used in both Málaga and Athens EVOLVED 5G infrastructures.
- Open API Generator: The Open API Generator<sup>4</sup> is used for developing the CAPIF tool. This tool can take API definition files (YAML) to generate server and client code that can be used as baseline for development.
- FAST APIs: The FAST API<sup>5</sup> framework is used for the development of the NEF Emulator. The specific framework and set of tools aim to the development of a high performance, robust and stable approach of the RESTful APIs.
- CICD Services: CICD services encompass several open-source tools such as Jenkins<sup>6</sup>, JFrog Artifactory<sup>7</sup>, Packer<sup>8</sup>, Terraform<sup>9</sup> and are used as the means for achieving dynamic, automated execution within the EVOLVED-5G environments.

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<sup>1</sup> <https://gitlab.com/OpenTAP/opentap>

<sup>2</sup> <https://github.com/5genesis>

<sup>3</sup> <https://osm.etsi.org>

<sup>4</sup> <https://github.com/OpenAPITools/openapi-generator>

<sup>5</sup> <https://github.com/tiangolo/fastapi>

<sup>6</sup> <https://www.jenkins.io/>

<sup>7</sup> <https://jfrog.com>

<sup>8</sup> <https://www.packer.io>

<sup>9</sup> <https://www.terraform.io>



The project, beyond the use of open-source software as the base for project development, considers the further distribution of project developments in a public repository, under an open-source license so that to maximise impact.

## 2.4 ACTIVITIES PLAN

Standardization activities, in all their facets, including the participation in standards development organizations (SDOs) and the contribution to open-source communities, constitute a key way of achieving long term sustainability and the widest possible use of the EVOLVED-5G results. The work in EVOLVED-5G builds extensively on existing standards and specifications. Successful contributions to standards not only help to ensure the project's impact and usefulness, but also serve to validate the quality and relevance of its output. The complete list of ongoing and planned standardization activities is depicted hereinafter, structured around the identified SDOs, with explicit reference to the partners involved.

### 2.4.1 3GPP SA2, SA6 and other WGs

LNv is driving the standardization activities of the EVOLVED-5G project, primarily in 3GPP (see 8.1) and ETSI. There is a plan to deliver standards contributions that enable 5G APIs, which can support a wide range of NetApps. In this context, LNv, together with the support of T7.3 partners, has submitted to 3GPP the following contributions, which were agreed:

- i. "Support of DN performance analytics by NWDAF"
- ii. "Study on Application Data Analytics Enablement Service"
- iii. "Network Slice Capability Exposure for Application Layer Enablement"

Details on each of the aforementioned standardisation contributions as depicted in Figure 1: 3GPP TS 23.288, Support of DN performance analytics by NWDAF, are provided hereinafter. According to the contribution in 3GPP SA2 on "Support of DN performance analytics by NWDAF", a new sub-clause is added in TS 23.288 describing the procedure for the NWDAF to collect the data required to derive analytics for DN performance.

3GPP TSG-SA2 Meeting #143e  
24 February - 9 March 2021, eMeeting

S2-2101388

CR-Form-v11.2

### CHANGE REQUEST

**23.288**    **CR 0233**    **rev 1**    **Current version: 16.6.0**

For **HELP** on using this form: comprehensive instructions can be found at  
<http://www.3gpp.org/Change-Requests>.

**Proposed change affects:**    UICC apps ☐    ME ☐    Radio Access Network ☐    Core Network ☒

<b>Title:</b>	Support of DN performance analytics by NWDAF		
<b>Source to WG:</b>	Lenovo, Motorola Mobility, Huawei, Samsung		
<b>Source to TSG:</b>	3GPP SA2		
<b>Work item code:</b>	eNA_Ph2	<b>Date:</b>	2021-03-01
<b>Category:</b>	<b>B</b> Use one of the following categories: F (correction) A (mirror corresponding to a change in an earlier release) B (addition of feature) C (functional modification of feature) D (editorial modification) Detailed explanations of the above categories can be found in 3GPP <a href="#">TR 21.900</a> .		<b>Release:</b> Rel-17 Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12) Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)

Figure 1: 3GPP TS 23.288, Support of DN performance analytics by NWDAF

The contribution is based on the following principles:



- Many instances of a vertical server application (e.g. a VR server) can be deployed, each instance in a different location, e.g. in a shopping mall, stadium, city center, factory, etc.
- NetApp can request “DN Performance” analytics to determine which server instance is expected to provide the “best” performance for a UE in a certain location and time period.
- The NetApp can then instruct the UE to connect with the server instance expected to provide the “best” performance.
- The performance is expressed as a [Rate, Delay, Loss] tuple
- The NWDAF needs to collect performance data (e.g. TCP statistics) so that it can build the big-data needed for the “DN performance” analytics

In 3GPP SA6, a new Study Item (SID) has recently been approved (see Figure 2) on “**Study on Application Data Analytics Enablement Service**”. The context behind this study item is that in vertical scenarios, further data analysis on top of the 5GS may be needed, to provide a useful output to the application specific layer for the end-to-end application service. Such data analytics may relate to predictions on application layer parameters for the end-to-end service. Such parameters can be vertical specific or common parameters for all verticals. For example, this may include analytics on:

- Application QoS parameters sustainability (e.g. delay, reliability, jitter, ...)
- Expected/predicted group formation / parameters for group-based services for a given area/time horizon
- Expected/predicted EDN/EAS performance degradation for a given area/time horizon.,
- Expected/predicted enabler layer load / conditions (ECS/EES, SEAL) at a target area and time of the day

Additionally, data analytics can be provided by the edge/cloud platform and lies outside the 5GS scope. Such edge/cloud data analytics can relate to stats/predictions on computational resources and expected/predicted load of the platform that hosts the applications and possibly the abstracted network services, and may be necessary to be provided to the vertical applications as well as to the 5GS.

3GPP TSG-SA WG6 Meeting #45 bis-e  
e-meeting, 11<sup>th</sup> – 19<sup>th</sup> October 2021

S6-212396

Source:	Lenovo, Motorola Mobility
Title:	New SID on Study on Application Data Analytics Enablement Service
Document for:	Approval
Agenda Item:	11

### 3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>  
See also the [3GPP Working Procedures](#), article 39 and the TSG Working Methods in [3GPP TR 21.900](#)

Title: Study on Application Data Analytics Enablement Service

Acronym: FS\_ADAES

Unique identifier: xx

Potential target Release: Rel-18

Figure 2: 3GPP SA6 SID, Study on Application Data Analytics Enablement Service

An additional new study in 3GPP SA6 entitled “**Network Slice Capability Exposure for Application Layer Enablement**” has recently been agreed and shall enable new types of NetApps i.e., NetApps that support new services, such as requesting communication via specific network slices. The list of use cases is not yet defined; EVOLVED-5G has the opportunity to contribute with its own requirements.

TID is also constantly monitoring 3GPP activities and in particular 3GPP SA1, SA2, SA5 & CT so as to ensure that the work performed in project is aligned with the most recent standards. Active collaboration between LNV & TID will ensure the compliance of the EVOLVED-5G components with the latest standards and also bring the key results of the project to the 3GPP and other SDO working groups proposing standards enhancements to fulfil the objectives of EVOLVED-5G.

#### 2.4.2 ETSI-OSM

Open-source solutions have generated a lot of interest in the context of network virtualisation. In this regard, ATOS has been member of one of the most prominent open-source orchestration solutions, OSM (see 8.3), for several years now and has contributed to it through the work developed in projects like SONATA (phase 1), 5GTANGO (phase 2) or 5GENESIS and 5GTOURS (phase 3). ATOS was even member of the OSM Technical Steering Committee for the Releases SEVEN and EIGHT Cycles.

OSM holds periodic meetings for all members of the community. During these first months of life of the EVOLVED-5G project, ATOS actively participated in the OSM community and attended most of these meetings. ATOS also participated in the two OSM Hackfest that took place on 8-12 March and 31May-4 June 2021.

One of the main reasons for EVOLVED-5G to monitor this community is to be aware of the topics covered in these meetings, taking advantage of those that could be of interest for the project. An example is the alignment of the OSM Information Model (IM) with ETSI NFV SOL006. Furthermore, ETSI allows the deployment of containers, as OSM does, although in a different way. At the last OSM Hackfest, ETSI presented the possibility to create a VNF with container images. In this case, OSM is not aligned with the standard (although the intention is to be), but they do allow the deployment of K8s, which may be very useful for the EVOLVED-5G project, as the idea is that NetApps are k8s and can be deployed as Network Services (NS).

During EVOLVED-5G timeline, ATOS will provide the project with the knowledge and experience acquired as a result of its contribution to OSM, as well as the opportunity to give visibility of the project in this open-source community. The plan is to encourage collaboration, increasing the possibility of the project to influence its direction and even, when possible, contribute to it, widening the impact of EVOLVED-5G.

#### 2.4.3 IEEE TSN

TID and UMA plan also to monitor IEEE TSN (see 8.5) since the evolution of this technology is considered as candidate for NetApps in the area of industrial automation, where stringent requirements for latency and deterministic data transmission request for time sensitive networking. They will focus on IEEE TSN enhancements that will impact TSN over 5G.

#### 2.4.4 5G-PPP Pre-standardization WG

LNv is monitoring and reporting the project's standards contributions to the 5G-PPP pre-standardization working group (see 8.2). Following and contributing the project results to this group, helps identify early enough the standardization and regulatory bodies to align with e.g.

the 5G-ACIA, as well as prepare the ground for influencing the topics to be standardised and the roadmap to be followed.

#### 2.4.5 ETSI MEC

LNV explores possible standardization actions in the area of ETSI MEC (see 8.4.1). NetApps for Edge Computing are envisaged, that consume ETSI MEC APIs (i.e., the Location API, the WLAN Information API, etc.), instead of 5G northbound APIs. A NetApp for Edge Computing could e.g.

1. Collect radio information (such as signal strength, packet delay, loss rate, throughput) and provide this information to the vertical app
2. Inform the vertical app when a user/device enters a specific location or when a radio event occurs (e.g. loss rate exceeds a threshold)

The MEC Sandbox, which is an experimentation platform supporting several ETSI MEC APIs leveraged by developers to test their edge apps, will be used to experiment with NetApps for edge computing.

#### 2.4.6 5G-ACIA

An additional activity in terms of standardization alignment, is LNV's membership and participation in 5G-ACIA (see 8.6). This activity will firstly ensure that the NetApps developed by EVOLVED-5G to serve the diverse and heterogeneous manufacturing use cases promoting industrial automation, will be disseminated to the global industry ecosystem and, as a second step, ensure that industrial use cases and applications will reach 5G-related SDOs in order to adequately address the requirements of industrial use cases & applications.

#### 2.4.7 Alliance for IoT Innovation (AIOTI), WG6, WG11

INTRA is member of Alliance for IOT Innovation (see 8.7) and more specifically at the 3rd Working Group (WG3) regarding standards and 11<sup>th</sup> working group (WG11) about Manufacturing. WG3 has been recognised as a major contributor to the worldwide interoperability, security, privacy and safety of IoT systems and applications, and particularly for the development of the market in Europe. WG11, deals on how IoT should evolve to support the challenges for Sustainable Manufacturing. Through this membership INTRA will actually try to communicate the outcomes and results of EVOLVED-5G in the aforementioned WGs.

#### 2.4.8 Data, AI and Robotics (BDVA/DAIRO)

INTRA, being a member of BDVA/DAIRO (see 8.8) which drives the AI architecture standardization CEN/CENELEC JTC21<sup>10</sup> will be able also to communicate EVOLVED-5G outcomes and collaborate. More specifically JTC 21 produces standardisation deliverables in the field of AI and related use of data to address European market and societal needs. This work aims to advance EU legislation, policies, principles and values. The committee of JTC 21 also considers the adoption of relevant international standards and standards from other relevant organisations.

#### 2.4.9 EFFRA (European Research Factories Association)

INTRA has a close relationship with EFFRA (European Research Factories Association, see 8.9). Since EVOLVED-5G results focus on innovative FoF solutions, the project shall explore the liaison to promote EVOLVED-5G results via this channel.

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<sup>10</sup> <https://www.cenelec.eu/areas-of-work/cen-cenelec-topics/artificial-intelligence/>

### 3 EXPLOITATION PLANS

#### 3.1 PROJECT-LEVEL EXPLOITATION STRATEGY

This Section explains the methodology applied for the project's exploitation strategy. It focuses on the collaborative project outcomes, making a clear separation with the partner's individual exploitation plans that are presented separately in 3.2.3. As part of the project-level exploitation work, a common methodology and strategy to explore potential business cases have been agreed as described in this section. The methodology starts by clarifying the definition of an exploitable outcome and the proposition of a generic classification of the project's results in 3.1.1. Building on these constructs, it then introduces in 3.1.2 the methodology to identify exploitation opportunities and further analyse the business case potentials. As an outcome of the preliminary analysis performed in this study, the initial list of the perceived project's results has been determined, presented in 3.3.

##### 3.1.1 Exploitation Outcome Terminology

Various types of partners may participate in a R&D EU funded project -Universities, Research Centres, commercial companies and SMEs-, and depending on their expertise and areas of interest, the exploitation strategy and activities vary accordingly. Universities and Research Centres focus on exploitation activities promoting research however without direct commercialisation potential, while commercial companies and SMEs are mainly involved with the exploitation of commercially oriented products. In the light of this diversity, we can summarise the major categories of exploitable outcomes and associated types, as graphically depicted in Figure 3:

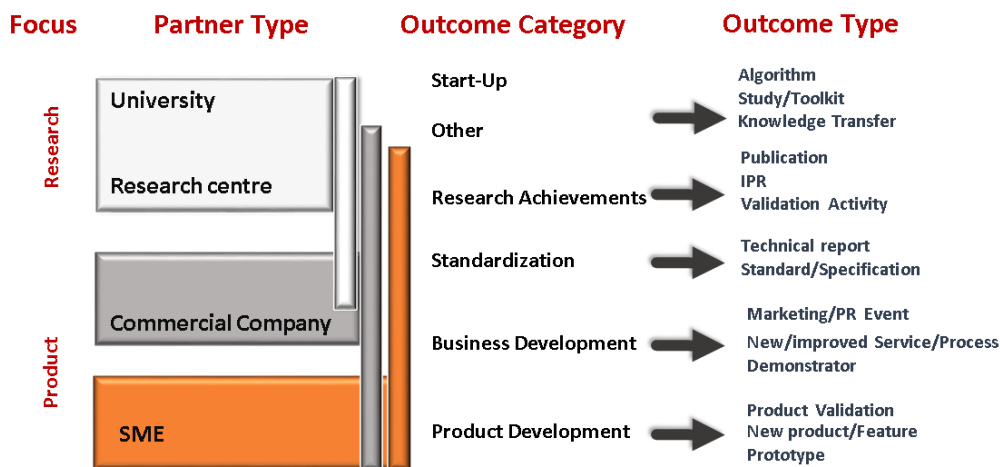


Figure 3: Partner and Outcome Types

- **Product development**, which includes the introduction of new products/features (together with a roadmap definition) and the product validation that increases the technology readiness level (TRL) towards a successful deployment. This outcome category is related mostly to commercial companies and SMEs.
- **Business development**, which includes enhancement of existing processes/services and/or the creation of new services/activities. This outcome category is also related mostly to commercial companies and SMEs.
- **Standardization** is a process through which the commercialization and sustainability of a project's results can be supported. Partners that are actively involved in standardization and regulatory activities may promote the results of the project to provide technical contributions to relevant standards bodies.

- **Research achievements**, including publications, IPRs and prototypes and can be produced by all partners.
- **Other Achievements** – Activities/Tools aiming at enhancing processes/services related to the introduction/deployment of the project results
- **Start-Up companies**, Companies or ventures that are focused on a single product or service that is project's exploitable outcome and indirectly pursue a product development outcome. Start-ups can be new established entities or spinouts from big companies or spin-offs from Universities and Research Centres.

Trying to fit the EVOLVED-5G results in the above classification, and taking into account that as a European-funded research project the contributions from partners are of varying focus, the outcome types of primary focus are the following :

- **Demonstrators** – Demonstrations of one or more project results/products in the field or in lab environment; either as a service proposition or an end-to-end solution addressing specific end-user needs. Demonstrators are usually joint results of more than one partners and partner types.
- **Prototypes** - Stand-alone, modular products, which have been either developed or enhanced in the context of the project. Prototypes may be developed by commercial companies and SMEs or by academic or research initiatives with no direct commercialization capability.
- **Validation Activities** – Activities aiming at validating the functionalities of specific products; these can be considered as exploitation activities aiming at increasing the technology readiness level of the associated products.
- **Contributions to standardization and publications** – Indirectly exploitable results delivered to the industry through standardization and dissemination paths.
- **Other** – such as studies, algorithms, techno-economic tools, knowledge transfer etc.

### 3.1.2 Exploitation Methodology

Having set the basic definitions, the process to be followed encompasses the following steps:

1. As a first step, during the regular WP7 meetings the project members discuss and agree on the list of joint exploitable outcomes. This list is semantically structured, associating the Outcome with a Category, and Type as well as target Customer..
2. Subsequently, each Exploitable Outcome in the list gets associated with the target Horizon 2020 TRL (Technology Readiness Level) [4] and broad classification, graphically depicted in Figure 4, as part of an elementary maturity assessment.

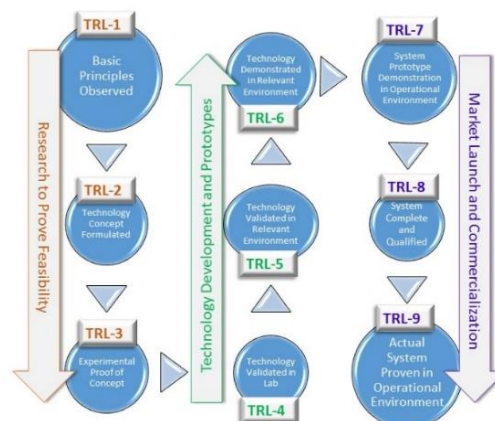


Figure 4: Maturity Assessment Model based on Horizon 2020 TRL Definitions [4]

3. As a next step, for each project outcome in the list, taking into account the evolution of project's technical work and early findings, a basic gap analysis is performed, considering the most promising customer segment. In conjunction with the feedback from the technology transfer activities and the market analysis, the refined list of project outcomes that are candidates for business case development will be finalised.
4. For those Exploitable Outcomes that are beyond the 'Research to Prove Feasibility' TRL category, and whose potential for business exploitation is mature based on the technology transfer plan and market analysis conclusions, the Value Proposition Canvas (see ANNEX B: VALUE PROPOSITION CANVAS) is filled.
5. For the Outcomes with promising Value Propositions, the Lean Canvas/Business Canvas methodology [6] (see ANNEX C: LEAN CANVAS) is used to further develop the exploitation potential and identify the key parameters to build the business case.

### 3.2 INITIAL EXPLOITATION RESULTS

During the reporting period for D7.2, the project partners have completed the first two steps of the exploitation methodology. These activities have concluded with the detailed list of the perceived results, as presented in Table 1 below.

During the process, the project outcomes have been categorised as defined in 3.1.1, and the lead partner to orchestrate further analysis has been assigned. The identified results, were grouped in three main segments:

- **Non-business results:** Outcome types such as university publications and project training courses are considered having low business impact in the quest for innovative products with market potentials and are segmented separately as non-business related.
- **EVOLVED-5G Platform results:** 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, a task very relevant 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.
- **EVOLVED-5G SME results:** The project involves a large variety of SMEs that utilising the capabilities of the EVOLVED-5G framework and facility, plan during the project to develop innovative NetApps to support the business of their specialisation. These NetApps, are built in conjunction with other project partners, and have a more target market-specific value. During the preliminary analysis of the results, the partners have made an explicit separation of the NetApp outcome, a prototype that can be marketed individually as a software artefact, and the relevant Use Case, a demonstrator that can stand as a fully integrated, ready to be used service, as the target markets and potentials of exploitation are significantly different.

Table 1: EVOLVED-5G Outcomes

EVOLVED-5G	Outcome	Type	Category	Lead Partner
<b>Non-Business Results</b>	Educate the audience towards 5G, smart manufacturing & FoF	Publication	Other	TID
	Training courses for the use of EVOLVED-5G technology assets (SDK, verification, validation, certification obtaining, testing facilities, FoF developed APPs, available 5G NetApps, etc.)	Training	Other	UPV
	Inclusion of EVOLVED-5g related technology concepts, knowledge and assets in University programs and Innovation Labs	Knowledge Transfer	Other	UPV,
	Publications to standards, such as 3GPP SA6 so as to standardise new enablers for verticals	Publication	Standardisation	LNv
	Community partners network	Knowledge Transfer	Other	IEA
	Start-up acceleration program	Knowledge Transfer	Other	IEA
	Netapp Certification Procedure	Knowledge Transfer	Other	COS
<b>EVOLVED-5G Exploitable Platform Results</b>	EVOLVED-5G (NetApp Development, Validation, Certification & Execution etc.) Facility	Prototype	Product Development	NCSRd
	SDK tools for NetApp Development	Prototype	Product Development	ATOS
	NetApp Validation Tools	Prototype	Product Development	UMA
	NetApp Certification Environment	Prototype	Product Development	TID
	NetApp Marketplace	Prototype	Product Development	MAG
	NEF Emulator	Prototype	Product Development	NCSRd
	CAPIF certification tool	Prototype	Product Development	TID
<b>EVOLVED-5G SME Exploitable Results</b>	Digital/physical twin NetApp in the aircraft business	Prototype	Product Development	GMI
	Composite repair physical / digital twin in the aircraft business	Demonstrator	Business Development	GMI
	5G enabled intent-driven chatbot NetApp for human-machines interaction NetApp	Prototype	Product Development	INF
	Location-aware chatbot for precise maintenance in a 5G/NetApp-enabled Industry 4.0 manufacturing environment	Demonstrator	Product Development	INF



EVOLVED-5G	Outcome	Type	Category	Lead Partner
	Network Monitoring and Anomaly Detection of I4.0 5G NPN NetApp	Prototype	Product Development	QUCOMM
	Network Monitoring and Anomaly Detection	Demonstrator	Business Development	QUCOMM
	Trusted event management NetApp	Prototype	Product Development	FOGUS
	Network event monitoring	Demonstrator	Business Development	FOGUS
	Autonomous 5G network monitoring for AR/VR usage NetApp	Prototype	Product Development	IMM
	Autonomous adaptation to network performance and user needs	Demonstrator	Business Development	IMM
	Enhancing 5G Smart Functions NetApp	Prototype	Product Development	8BELLS
	Accurate measurement of "unregistered" traffic over the 5G network	Demonstrator	Business Development	8BELLS
	FoF IoT System NetApp	Prototype	Product Development	ININ
	Industrial grade 5G connectivity with assured QoS and integrated SLA/SLS monitoring capabilities	Demonstrator	Business Development	ININ
	Identity and access management NetApp	Prototype	Product Development	IQB
	Authentication and authorization management for accessing the northbound 5G APIs	Demonstrator	Business Development	IQB
	Occupational safety analysis NetApp	Prototype	Product Development	CAF
	Occupational safety analysis	Demonstrator	Business Development	CAF
	Common workforce - Global Localization NetApp	Prototype	Product Development	PAL, UML
	Common workforce - Global Localization	Demonstrator	Business Development	PAL
	Common workforce Teleoperation NetApp	Prototype	Product Development	PAL
	Common workforce Teleoperation	Demonstrator	Business Development	PAL

In the next paragraphs, the first analysis of the reported outcomes is presented. This analysis, focused on the classification of each outcome based on the described methodology, identifying respectively the project result category, the exploitable type and the target TRL category, as well as an initial understanding of the outcome, by addressing the following questions:

- Who is the end customer?
- What is the product? (Description)
- What are the target markets for this outcome? (Markets)



- What are the project innovations used by the outcome? (Innovations)
- Are there equivalent products? Are the competitors known? (Competition)

### 3.2.1 EVOLVED-5G Exploitable Platform Results

#### 3.2.1.1 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 Emulator for NetApp certification k8s NetApps for Cloud-native solutions CAPIF/NEF/SEAL 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			

#### 3.2.1.2 SDK tools for NetApp Development

Description	EVOLVED-5G SDK is a set of tools to support developers in the creation of NetApps in the form of downloadable package for local use. These tools include: (1) Instructions (2) Templates (3) CLI tools (3) Configuration scripts (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	k8s NetApps for Cloud-native solutions NEF Emulator for NetApp verification			
Product Competition	There are no relevant products in the market. As of today, other SDK tools from other research projects can be found, but they are more focused on the creation of VNFs and NSs. None of them are nearly related to the novel concept of NetApp concept.			

#### 3.2.1.3 NetApp Validation Tools

<b>Description</b>	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.			
	<b>Outcome Type</b>	Prototype	<b>Outcome Category</b>	Product Development

	<b>Target TRL category</b>	Technology Development and prototypes (5,6)
<b>End Customer</b>	Integrator, Platform owner	
<b>Target Markets</b>	Certification bodies that are interested in validation of NetApps. Platform operators involved in the NetApps validation.	
<b>Innovations</b>	k8s NetApps for Cloud-native solutions CAPIF/NEF/SEAL for Network Programmability Extension of the existing 5Genesis framework for the management of NetApps	
<b>Product Competition</b>	There are no relevant products in the market	

#### 3.2.1.4 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 for 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 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.			

#### 3.2.1.5 NetApp Marketplace

Description	The EVOLVED-5G Marketplace is a SaaS (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 through a certification mechanism that the published services conform to the marketplace rules. It also implements Dashboards for publishers and buyers to track (virtual) revenue/balances, view consumption 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 Emulator for NetApp certification			

<b>Product Competition</b>	There are no relevant products in the market
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### 3.2.1.6 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/SEAL for Network Programmability NetApp validation environment (tools)			
Product Competition	There are no relevant products in the market			

### 3.2.1.7 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 through CAPIF. It is delivered as working software component containerised 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.			

## 3.2.2 EVOLVED-5G SME Exploitable Results

### 3.2.2.1 Digital/physical twin NetApp

<b>Description</b>	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
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	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			

### 3.2.2.2 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			

### 3.2.2.3 5G enabled intent-driven chat-bot NetApp for human-machines interaction 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			

<b>Target Markets</b>	Smart Factory - Manufacturing industries, production lines, factories with machine-human interaction
<b>Innovations</b>	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.
<b>Product Competition</b>	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.

3.2.2.4 *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 authorisation 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 ability of the 5G system to provide precise indoor location information that will be used by 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). It will authorise access in specific location in the factory for an identified worker, provide guidance for that location, call authorised 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.			

3.2.2.5 *Network Monitoring and Anomaly Detection of I4.0 5G NPN 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	<ul style="list-style-type: none"><li>ICT market and integrators that seek to include the monitoring/alerting provided by the product with their OT/IT management solutions.</li><li>Smart Factory, to be incorporated as a standalone deployable component that enables anomaly detection</li></ul>			
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 digitised 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.
<b>Product Competition</b>	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.

### 3.2.2.6 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 analysed for certain patterns/parameters (e.g. colour, 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.			

### 3.2.2.7 Trusted event management NetApp

<b>Description</b>	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.			
	<b>Outcome Type</b>	Prototype	<b>Outcome Category</b>	Product Development

	<b>Target TRL category</b>	Technology Development and prototypes (5,6)
<b>End Customer</b>	Integrator, Vertical Industry SIEM system developers	
<b>Target Markets</b>	<ul style="list-style-type: none"> <li>ICT market and integrators that seek to include the security monitoring/alerting provided by the product with their OT/IT management solutions.</li> <li>Digital security systems market for event management and analysis when multiple types of private networks (including 5G) are used.</li> </ul>	
<b>Innovations</b>	The key innovation of the prototype is that it leverages standardised 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.	
<b>Product Competition</b>	There are no relevant products in the market	

### 3.2.2.8 Network event monitoring

Description	The service refers to the FOGUS SIEM with the FOGUS 5GSIEM NetApp integrated. The system encompass all the key functionalities of a SIEM system, including the following: <ul style="list-style-type: none"><li>• Vulnerability Assessment: Authenticated and (is some cased) un-authenticated scan can be applied towards a network or host of the industrial infrastructure.</li><li>• 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).</li><li>• Behavioural Monitoring: The identified anomalies (any statistical anomaly or malware detected) are analysed through the behavioural monitoring process, to reveal the cause behind. Host-availability and service availability monitoring is provided as well.</li><li>• Security intelligence: Chained events are examined through correlation rules.</li></ul>			
	Outcome Type	Demonstrator	Outcome Category	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Smart Factory -Manufacturing industries with 5G NPN deployments			
Target Markets	Network management for manufacturing industries.			
Innovations	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 standardised 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 behaviour analysis.			
Product Competition	There are no relevant products in the market. The current SIEM solutions ignore the potential of monitoring a 5G-NPN.			

### 3.2.2.9 Autonomous 5G network monitoring for AR/VR usage NetApp

<b>Description</b>	The NetApp is able to autonomously negotiate with the 5G network, monitor its state and propose QoS adaptations. 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
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	NetApp and targets to support vertical use-cases about remote assistance in Augmented Reality (AR) and Virtual Reality (VR).			
	<b>Outcome Type</b>	Prototype	<b>Outcome Category</b>	Product Development
	<b>Target TRL category</b>	Technology Development and prototypes (5,6)		
<b>End Customer</b>	Integrator, Vertical Industry			
<b>Target Markets</b>	AR/VR and video streaming applications market.			
<b>Innovations</b>	Developers in the AR/VR market may be interested in the capabilities of the 5G network, but do not necessarily know how to access to them. The NetApp will allow 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 adapted QoS in case of network issue.			
<b>Product Competition</b>	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.			

### 3.2.2.10 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. It will focus on the application domain of remote assistance for Industry 4.0. More precisely, it will consider a machine maintenance scenario conducted in Augmented Reality (AR). The system 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. In this way, the monitoring is offloaded to the NetApp and the application can focus on the optimal adaptations for the end-users.			
	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 adapted QoS 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.			

### 3.2.2.11 Enhancing 5G Smart Functions NetApp

<b>Description</b>	The NetApp builds upon 8Bells White Box Switch and targets an intelligent traffic steering mechanism that optimise 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.			
	<b>Outcome Type</b>	Prototype	<b>Outcome Category</b>	Product Development



	<b>Target TRL category</b>	Technology Development and prototypes (5,6)
<b>End Customer</b>	Integrator, Vertical Industry	
<b>Target Markets</b>	AR/VR industry, manufacturing industry referring to the needs of detection and analysis.	
<b>Innovations</b>	Full value is showed in NFV or containerised (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 avoid some unnecessary VNF stages This is expected to be highly beneficial for service deployment time, end-to-end service latency and overall energy consumption	
<b>Product Competition</b>	There are no relevant products in the market.	

### 3.2.2.12 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: <ul style="list-style-type: none"><li>Monitoring Event Configuration</li><li>Reporting of Network Status</li><li>Communication Pattern Parameters Provisioning</li><li>Packet Flow Description Management</li><li>Network Parameter Configuration</li><li>Application Server (AS) session setup with required QoS</li></ul>			
	Outcome Type	Demonstrator	Outcome Category	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	AR/VR and manufacturing industries with 5G NPN deployments			
Target Markets	Network management for AR/VR manufacturing industry.			
Innovations	<p>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.</p> <p>Furthermore, enabling an application-aware programmable data plane will allow high accurate service function chains, through avoid 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</p>			
Product Competition	There are no relevant products in the market.			

### 3.2.2.13 FoF IoT System Netapp

<b>Description</b>	The FoF IoT System NetApp will assure required industrial-grade service as specified by SLA/SLS by leveraging certain capabilities available in the 5G network and exploiting monitoring data collected and processed. It builds on the anticipation that IoT devices used for FoF require a stable communication environment with certain prerequisites (e.g., latency, bandwidth, local processing capabilities, internet access, security policy, etc.)			
	<b>Outcome Type</b>	Prototype	<b>Outcome CategoryType</b>	Product Development

	<b>Target TRL category</b>	Technology Development and prototypes (5,6)
<b>End Customer</b>	Integrator, Vertical Industry. The NetApp targets stakeholders involved in integration and operation of reliable and resilient 5G communications services (e.g., private 5G networks vendors, integrators, operators)	
<b>Target Markets</b>	Vertical industry, such as ports, Industry 4.0, critical communications and others	
<b>Innovations</b>	Reduced IoT/M2M system/service deployment time. Extending the network performance monitoring capabilities to support collecting of Industry 4.0 network and application specific metrics. Technological and operational validation, interoperability check and verification of the system operational use in the Industry 4.0 environments.	
<b>Product Competition</b>	There are no relevant products in the market.	

### 3.2.2.14 Industrial-grade 5G connectivity with assured QoS and integrated SLA/SLS monitoring capabilities

Description	The service provides for the IoT and M2M devices connected to it, industrial grade 5G connectivity with assured QoS, integrated SLA/SLS monitoring capabilities and local compute capabilities, i.e., IoT/M2M devices can be connected to the IoT Gateway via various physical interfaces (e.g. serial, USB, Ethernet). Novel features of the FoF IoT solution include, but not limits to: <ul style="list-style-type: none"><li>providing 5G SA connectivity from the IoT devices to the application components deployed in the FoF cloud,</li><li>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 ),</li><li>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.</li></ul>			
	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 IoT/M2M Gateway and backend components to support 5G NSA, 5G SA and NEF capabilities. Extending the network performance monitoring capabilities of the system to support collecting of Industry 4.0 network and application specific metrics. Technological and operational validation, interoperability check and verification of the system 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 supports only 2G/3G/4G capabilities and are controlled with monolithic back-end system.			

### 3.2.2.15 Identity and access management NetApp

<b>Description</b>	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
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	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 behaviour detection and the consequent 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	<ul style="list-style-type: none"><li>ICT market and Integrators</li><li>Security systems market</li></ul>			
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 behaviour detection and protection, these are general solutions for any case. In 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.			

### 3.2.2.16 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 behaviour of NetApps, in addition to the IAM mechanisms, does not exist in competition.			

### 3.2.2.17 Occupational safety analysis NetApp

Description	The NetApp is designed for the factory environment and interacts with Autonomous Mobile Robots (AMR) that carry 360-degree stereo cameras. The robots communicate over 5G to transmit the videos, and through the 5G MEC-based NetApp a safety analysis of surrounding occupational hazards is autonomously performed.			
	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 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			

<b>Product Competition</b>	There are no relevant products in the market
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### 3.2.2.18 Occupational safety analysis

Description	The service is supporting factories safety officers to detect whether or not Personal Protective Equipment (PPE) such as hardhat, 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 AMR 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 device that transmits the videos exploiting the 5G MEC-based NetApp, to analyse whether workers are wearing PPE.			
	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 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 the NetApp, are essential to assess safety.			

### 3.2.2.19 Common workforce - Global 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 localise indoor better by using centralised command centre			
	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 the NetApp exploits information from the 5G network and GPS coordinates with 5 m accuracy or lower.			
Product Competition	There is no commercialised solution yet although research is undergoing in a number of both public and private entities.			

### 3.2.2.20 Common workforce - Global Localization

<b>Description</b>	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.
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	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 institution experimenting with similar solutions			

### 3.2.2.21 Common workforce 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 application in healthcare , space exploration, IoT			
Innovations	<ul style="list-style-type: none"><li>• 5G based teleoperation achieved with NetApp with the use of UDP</li><li>• Video and haptic feedback transfer with high bandwidth and QoS, Setting up VPN channels,</li><li>• Adaptive Management and Security System,</li><li>• Robot condition monitoring services with high frequency,</li><li>• Channels configuration and management for data transfer</li></ul>			
Product Competition	There is no commercialised solution yet although research is undergoing in a number of both public and private entities as for example 5g-ppp project for 5G blueprint and the Robotic System Lab developments or The Scotland 5G centre that are making trials for teleoperations of a robotic arm over 5G			

### 3.2.2.22 Common workforce Teleoperation

Description	The service focuses on industrial internet tele control architecture over 5G for robots combining high bandwidth, extreme reliability, and ultra-low latency communications that is expected to enable highly interconnected systems and processes, leading to unprecedented workflow mechanisation.			
	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	<ul style="list-style-type: none"><li>• 5G based teleoperation achieved with NetApp with the use of UDP</li></ul>			

	<ul style="list-style-type: none"> <li>• Video and haptic feedback transfer with high bandwidth and QoS, Setting up VPN channels,</li> <li>• Adaptive Management and Security System,</li> <li>• Robot condition monitoring services with high frequency, Channels configuration and management for data transfer</li> </ul>
<b>Product Competition</b>	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

### 3.2.3 Initial Individual Exploitation Plans

#### 3.2.3.1 *Telefónica I+D (TID)*

Telefónica I+D is the Research and Development company within Telefónica group. TID mission is to bring innovations to the business units inside the company, identify key technologies, ideal partners, and develop further technological capabilities.

In the context of EVOLVED-5G, TID plays a key role in the certification of NetApps. This is a critical activity for Telefónica to extend the commercial portfolio of solutions that we can bring to our customers. With the recent creation of Telefónica Tech, Telefónica is setting up the commercial, technical, and operative forces to accelerate Cloud and IoT digital business adoption for our customers, and solutions like the NetApps developed in EVOLVED-5G will have a perfect fit to exploit commercial opportunities.

Technological pieces like Emulator and CAPIF Core Function tools, will be evaluated to enhance the capabilities of Telefónica facilities like The Thinx Lab where many IoT are tested and certified.

#### 3.2.3.2 *National Centre for Scientific Research Demokritos (NCSR)*

NCSR sees the participation in EVOLVED-5G as a clear step for the establishment of a high research and scientific status towards the convergence of 5G (NPN 5G) with the needs of vertical industries and more specifically with the FoF applications. EVOLVED-5G will be the vehicle to leverage the experience and excellence on 5G network infrastructure and relative technologies, acquired by the participation of NCSR in numerous EU funded projects, as well to extend this knowledge to the concepts of 5G NetApps by native APIs' exposure of the 5GCore, that the project addresses.

Moreover, the exploitation plan of EVOLVED 5G results for NCSR, includes positioning Athens 5GENESIS Platform as one of the reference Platforms to support the validation activities by SMEs and researchers towards verticals and more specifically Industry 4.0 applications. NCSR will also make use of the project's results, and especially the NEF emulator, in its research activities and in introducing new topics for PhD theses and dissertations for new graduate students interested to deepen the knowledge on the main topics addressed by the project. Last but not least, NCSR hosts the Technological Park of "Lefkippos" and the digital innovation hub Ahead- in which several private companies in the field of IT and Telecommunications are established and are testing new services and products. EVOLVED 5G results, and especially NEF emulator and EVOLVED-5G training material for 5G programmability, will be disseminated to these two innovation entities, allowing to already hosted (but also external) companies to get benefited from the EVOLVED-5G ecosystem. This reusability of the project results will establish mutually beneficial collaborations and transfer the knowledge that has been obtained by the Project.



#### 3.2.3.3 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: i) Information Technology, ii) Services & Technologies, iii) Publishing, Training and Education, iv) Document Management, and v) 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 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:

- APKappa S.r.l is a member of Maggioli Group applying smart technologies to public services and is specialised 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.
- 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.).
- Maggioli also aims to foster its internal R&D activities at Group level, and encourage the development of applications using the EVOLVED-5G results
- Last, Maggioli will investigate potential exploitation opportunities of the project results with its R&D partner network, also through EU funded projects

#### 3.2.3.4 ATOS IT solutions and services Iberia SL (ATOS)

Atos is a global leader in digital transformation with 110,000 employees and annual revenue of € 12 billion. European number one in cybersecurity, cloud and high-performance computing, the group provides tailored end-to-end solutions for all industries in 73 countries. The purpose of Atos is to help design the future of the information space. Its expertise and services support the development of knowledge, education and research in a multicultural approach and contribute to the development of scientific and technological excellence. Across the world, the group enables its customers and employees, and members of societies at large to live, work and develop sustainably, in a safe and secure information space.

*Atos Research & Innovation department (ARI)* is the R&D pillar of emerging technologies and source of innovative ideas coming from EU and national funded projects. Replicating the global organization of the company and with the goal of facilitating the integration of research and innovation activities, ARI is divided into 6 industries, being the *Telecommunications Media and Technology (TMT)* one of them. It is this group, in concrete the *Smart Networks and Services (SN&S)* team, which participates in the EVOLVED-5G project. Its expertise revolves around technologies that enable the development of the next generation telco networks: software networks, telco service-based and micro services management architectures, Multi-Access Edge Computing (MEC), v-RAN (virtual Radio Access Network), smart network management, etc.

The results from the R&D EU projects play a vital role to booster the innovation process within the organization and enhance the portfolio of products and technologies offered to its customers. ARI holds regular meetings with the TMT Industry. These meetings are bidirectional: on the one hand, ARI team learns about the company's strategy, the global TMT portfolio, and the partners and customers' demands; on the other hand, ARI team provides insight about the latest European research trends, the projects and consortia the ARI team is involved in and the

results coming out of the projects. Both sides discuss convergence and ways of collaboration, developing a roadmap to accomplish agreed objectives.

In EVOLVED-5G, the SN&S team is leading the development of one of the key elements of the EVOLVED-5G framework, the workspace, which main goal is to support developers in the creation of NetApps by offering a set of functionalities through different open-source tools. The workspace is composed of an SDK, a repository and CI/CD services. As WP3 leader, the SN&S team will also overview the different tasks related to NetApps validation and certification and the development of the marketplace. Keeping all this in mind, but also the other outcomes that will result from the project (i.e.: Industry 4.0 NetApps), Atos' team foresees the following exploitation scenarios:

- enhancement of the Atos TMT portfolio,
- contribution to Open Source MANO (OSM),
- Integration in other existing and future research projects,

as the most suitable to be explored during the project lifetime.

#### 3.2.3.5 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 WPX augments the rate of knowledge sharing in the field of telecommunications, broadens the field of NetApp development. One other aspect of the participation is the collaboration with the SME's and the broadening of the horizon for future collaborations. INTRA will monitor the development phase in WP4 and the evaluation and validation processes in WP5 from the manufacturing perspective. INTRA will also participate in WP6, assisting in the development of the ecosystem for start-ups and SMEs and in the Industry 4.0 stakeholders engaging. Furthermore, within the frame of WP3 and WP4, INTRA will assist in the establishment of a secure software development lifecycle. Security practices and processes will be identified for the implementation, testing and release phases of the developed NetApps. Furthermore, within the frame of WP3 and WP4, INTRA will assist in the establishment of a secure software development lifecycle. Security practices and processes will be 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 specialised 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.

#### 3.2.3.6 COSMOTE Mobile Telecommunications SA (COS)

COSMOTE is the leading mobile operator of Greece, with a striking record of very important firsts, including the 5G Network launch in Greece. The company business objective to exploit the 5G potentials for verticals with special focus on the Industry 4.0 is certain, with early steps already taken to deploy campus networks in Greece<sup>11</sup>.

By participating in the project, COSMOTE, aims to leverage the experience gained, the methodology developed, as well as, the technologies delivered, to be a step ahead in the NPN infrastructure deployments from the competition. At the same time, through the interaction

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<sup>11</sup> <https://www.telcotitans.com/deutsche-telekomwatch/cosmote-works-ericsson-ties-for-campus-network-debut/2757.article>



with the SMEs, the opportunity is offered to address the anticipated market/business challenges of the new 5G business models and be able to successfully orchestrate the collaboration with the vertical industries and third party application providers. COSMOTE will evaluate the technical transformations and associated investments and risks so that to deploy and manage NPN networks, and prepare to properly and timely include Industry 4.0 offerings into COSMOTE's commercial plans (beyond the project's end). Obviously, through the innovative use cases addressed by EVOLVED-5G, COSMOTE will be able to investigate the way to monetise the prospects offered by the collaboration with the participant SMEs. Finally, COSMOTE will share the results with the Deutsche Telecom (DT) Group to maximise the project's visibility and impact.

#### 3.2.3.7 *Lenovo (Deutschland) GmbH (LNV)*

Lenovo has always been committed to pushing forward the development of information technology, smart devices and services, by delivering cutting-edge technologies incorporated into its own high-tech products. Lenovo will be driving the "Innovation Shaping and Standardization Alignment" work task and will serve as the key interface between EVOLVED-5G and the 3GPP standardization community. In this context, Lenovo will bring the key results of the project to the 3GPP working groups and will propose standards enhancements to fulfill the objectives of EVOLVED-5G.

Through its partnership in the EVOLVED-5G project, Lenovo plans to strengthen its current position in the global mobile communications research and standardisation organisations. More specifically, Lenovo's participation 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 design and apply novel solutions to address such gaps and at the same time bring its solutions to standardisation fora so as to enhance global standards and promote the company's interest in research and standards area.

To this direction, the exploitation plans of Lenovo for 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 5GCore in order to contribute in 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.

#### 3.2.3.8 *Impact Entrepreneurship Award Ltd. (IEA)*

EA is a business support organisation based in Cyprus. 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 creating new business growth opportunities. IEA will seek to build a relationship with existing project complementary project networks to facilitate continuous knowledge exchange and advancement in the 5G for 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.

### 3.2.3.9 *Universidad de Málaga (UMA)*

UMA is a higher education center and contributes in EVOLVED-5G project as infrastructure owner (the 5GENESIS Málaga platform) and validation expert (in public and private-founded projects). Currently, Málaga platform is supporting the trials of the Broadport consortium, in the public procurement Broadway (H2020), to evaluate solutions for mission critical communications in Europe<sup>12</sup>. In addition, Málaga platform has been used to evaluate the Genasys National Emergency Warning System<sup>13</sup> (NEWS) Cell Broadcast Center (CBC). Both trials provide insides regarding the use of the APIs of the core network to provide advance services to users.

The UMA exploitation plan includes the following goals:

- To extend and use Málaga platform to support new use cases and technologies. UMA efforts in EVOLVED-5G are focused on zero touch configuration of the 5G network to support TSN. In addition, UMA as part of AFFORDABLE project, is addressing the problem of the TSN translators at both sides UE and UPF. Thus, UMA goal is to develop a testbed for TSN over 5G that can be used in both projects.
- To position Málaga platform as a reference to support testing, validation and certification activities by SMEs, researchers and verticals.
- To define the access/business model of the Málaga platform. The business model has to consider different user profiles based on the user requirements and/or funding approaches. Currently, Málaga platform defines a business model per partner or trial.
- To collaborate with stakeholders in academia and industry to define international and national projects that can benefit from UMA experimentation facilities, in particular, projects that address deterministic communications that will benefit from the TSN testbed.
- To provide training material and activities to potential users of Málaga platform.
- To use scientific results in higher academic courses, MsC thesis and PhD thesis.

### 3.2.3.10 *Universitat Politecnica de Valencia (UPV)*

UPV is a major technical university in Spain, recognized in prestigious international rankings, and it is 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 and will 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 5G potential and the advantages of the EVOLVED-5G netApp approach and 5G solutions. 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

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12 <https://www.frequentis.com/en/pr/eu-project-broadway-broadport-consortium-led-frequentis-successfully-completed-first-europe-wide>

13 <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.htm>

EVOLVED-5G solutions in the middle term once they start their work life in IT areas, and spread by word of mouth their usefulness for 5G exploitation.

- EVOLVED-5G online courses: as a part of the activity performed in T6.1, UPV will lead the creation of courses for introducing and provide training for the creation and use of 5G NetApps, specific FoF applications and exploitation of 5G networks. These courses will be publicly accessible online to any stakeholder following a Premium strategy, allowing some degree of commercial exploitation. Some of them would belong to UPV's individual exploitation plan (introductory courses related that could be related to academic programs), and many of them would be part of the EVOLVED-5G joint exploitation plan.
- 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.

#### 3.2.3.11 GMI-AERO-SAS (GMI)

GMI Aero SAS () 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 off 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.

Within the frame of EVOLVED-5G the ANITA EZ hot bonder(s) used for repair curing to the Wi-Fi or 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.

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.

### 3.2.3.12 Internet Institute Ltd. (ININ)

Within the project, ININ is focusing on FoF operations support, therefore its exploitation plan within FoF perspectives is associated with its technological and business portfolio in the domain of 5G M2M sensing and advanced industrial network monitoring, and evidence-based decision support tools and services. The activities and associated results are expected to generate knowledge, experience and insights in exploitation of 5G and cloud technologies which can inform and steer further development of their commercial rMON product and services portfolio not only for the FoF operations, but potentially also for logistics and critical communication sectors.

ININ's individual exploitation goals are:

- To conduct piloting activities and build knowledge and experience related with Industry 4.0 and Smart Factories.
- To inform further technological product roadmap in the area of 5G and cloud-native support for deployment and management orchestrations in industrial environments and hence inform investigation of novel business opportunities and models.
- To establish partnerships with relevant stakeholders in the EU research and industry domain and hence pursue new R&D partnerships and commercial opportunities with recognised stakeholders.

### 3.2.3.13 Cafatech (CAF)

Within the project, CAFA Tech is developing CAFA Analyzer computer vision software for FoF operations. CAFA Analyzer is supporting factories safety officers to detect whether or not Personal Protective Equipment (PPE) such as hardhat, 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 AMR 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 device that transmits the videos to the 5G MEC-based CAFA Analyzer NetApp, which is used to analyze whether workers are wearing PPE.

The CAF exploitation plan includes the following goals:

- Introduce the benefits of the CAFA Analyzer system to factories in manufacturing and specific business sector fairs (materials processing, energy, mining, metal processing etc.).
- Design a complete CAFA Analyzer system consisting a mobile robot as a camera carrier platform, stereo cameras, a 5G communication solution, an appropriate GPU (s) and machine vision software running in Edge/ Cloud.
- Commercialise the components of the CAFA Analyzer system separately and as a whole.

### 3.2.3.14 InQbit Innovations S.R.L (IQBT)

In EVOLVED-5G, IQBT as a partner focuses on the cybersecurity aspects of 5G, as well as the legal aspects and the data management of EVOLVED-5G as a framework and as a project. More specifically, firstly, the NetApp that is being developed by IQBT in the context of EVOLVED-5G will focus on the authentication, authorization and access management (AAA) of other NetApps / API invokers within 5G environment, and will enrich this functionality with advanced analytics capabilities for the purposes of suspicious and potentially malicious behaviour detection and prevention. In simple terms, if other NetApps, which were granted certain access rights previously, start behaving suspiciously, their access rights may be revoked. Secondly, IQBT is responsible for making sure that legal requirements of EVOLVED-5G are covered, as well as that the data used and produced from the project are managed properly.

Therefore, the initial exploitation plans from IQBT will target these two characteristics. These plans for EVOLVED-5G are the following:

- Encourage IQBT research activities related to the authentication, authorization, and access management of devices and entities inside 5G environments.
- Develop the know-how in order to move forward in the area of security of the cloud and 5G networks and mechanisms.
- Encourage the development of AAA mechanisms/applications within the 5G environment for research or commercial purposes/solutions.
- Create new partnerships in the EU research domain with the purpose of initiating new opportunities with the project's stakeholders.

### 3.2.3.15 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 optimise 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 5GPPP 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 in FOGUS to devise new courses and training material.

### 3.2.3.16 INFOLYSIS (INF)

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 to maximise 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

- Enrich the know-how and the research expertise of the company in 5G technologies under Industry 4.0 environments
- Foster INFOLYSiS R&D activities coupled with chatbot technologies
- 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

#### 3.2.3.17 EIGHT BELLS LTD (8BELLS)

BELLS is a start-up company specialising in modelling and analysis for businesses as well as in selected parts of Information and Communication Technologies (ICT), based in Nicosia, Cyprus. The company has been established recently by ICT researchers and analysts pursuing the application of their research expertise and innovations in the ICT related arena. 8BELLS delivers customisable solutions that enhance modern communications relevant to the area of 5G Mobile Technology, Network Function Virtualisation (NFV) and also management solutions for Cloud infrastructures. 8BELLS participates in 5G-PPP Phase-3 5G CARMEN project that brings together automotive companies, road operators, 5G vendors, and telecom operators towards making Connected and Automated Road Mobility a reality. Additionally, 8BELLS participated in the recently finished H2020 5G-PPP Phase 2 project 5G-ESSENCE, which addressed the paradigms of Edge Cloud computing and Small Cell as a Service.

8BELLS participates in the project with its L7-aware whitebox switch with SFC capabilities with scope to further upgraded towards the 5G with the respective NetAPP development, which will allow to the switching solution to integrate TSN-aware deterministic switching, allowing to the switch to better support industrial environments with NPN-5G deployments. The main contribution of 8Bells is focused in WP2, WP4, WP5, WP6 and W7.

8BELLS technical capabilities include Systems and Network engineering, Cloud Computing and Everything-as-a-Service, Privacy, Security and Data Protection, and Software development. 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 virtualised 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.

#### 3.2.3.18 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 realise 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 our position in the research sector.

#### 3.2.3.19 QUCOMM Private Company (QCOM)

QUCOMM is focusing on cybersecurity solutions and brings upfront its expertise in anomaly detection and zero touch security management. Anomaly detection is a topic that is picking up fast due to the proliferation of AI algorithms and closed loop automation solutions that are possible in software networks. The introduction of 5G in the I4.0 inevitably brings forward a new domain for the application of network anomaly detection, only this time based on the specificities of the factory and its operational technology and information technology convergence. In this context the solutions offered by QUCOMM will attempt to bring validated and tested frameworks for anomaly detection in network domain and adapt them in order to provide a prototype solution that will be suitable for the factory network environment and its requirements as well as attack surface based on available assets in premises.

QUCOMM sees the EVOLVED-5G project as the perfect vehicle in order to transform its solution in a more versatile application that will be possible to be used in a variety of industrial environments. It will also give the opportunity to test the application under a realistic 5G environment, allowing further enhancement and optimisation of the detection modules used by the proposed solution. The EVOLVED 5G marketplace, will provide the means to liaise with the Market 4.0 initiative. Finally, given the consortium expertise and the large number of SMEs building NetApp solutions, opportunities for collaborations will be sought in order to further increase the solutions portfolio of the company with new PoCs and integrated solutions. Finally, the company is strongly focused on its personnel research profile, so it will seek to exploit results for scientific publications and further enrich its personnel expertise into I4.0 ecosystem.

#### 3.2.3.20 Immersion (IMM)

IMM is focusing on an Industry 4.0 use-case based on Augmented Reality (AR). AR is a promising but recent technology: it is thus difficult to have precise data about the corresponding market. Nonetheless, some predictions have already been made. For instance, AR market is estimated to grow from USD 10.7 billion in 2019 and project to reach USD 72.7 billion by 2024 (Market and Market, 2018). More and more brands are investing into AR technology, including GAFAMS.

Within the EVOLVED-5G project, IMM has the following individual exploitation plan goals:

- To develop a vertical application for remote assistance in AR. This application will be based on state of the art and internal research results. Our goal is to foster IMM R&D efforts on Augmented Reality and achieve scientific publications in international Human-Computer Interaction conferences.
- To couple this vertical application with an autonomous NetApp focused on monitoring network performance by discussing with the 5G core network. We aim at proposing a



NetApp on the marketplace that could be adapted to a large range of AR/VR usages. The goal is to encourage the development of Industry 4.0 AR/VR applications using the 5G network capabilities and academia-industry collaborations on concrete scenarios.

#### 3.2.3.21 *Unmanned Systems ÖÜ (UNM)*

Unmanned Life is the leading software platform for seamless orchestration of autonomous robotics. We are changing the way autonomous robotics is being deployed by large corporations thanks to our autonomy-as-a-service technology powered by AI and 5G. With a mission to become the go-to-software platform for autonomous robotics, we are collaborating with a consortium of 21 partners from Europe that will come together to contribute towards the 5G penetration in smart manufacturing by designing, developing, validating and publishing innovative Net Apps. The goal of this exploitation is to ensure sustainability of the project and to highlight how Unmanned Life has influenced and played its part in this consortium led project. Therefore, to exploit the project we will target the following characteristics:

- **Presence at key events:** International conferences, workshops, exhibitions, competitions and speaking opportunities are one of the most effective communication actions to reach the different stakeholders. We will talk about factories of the future and our contribution in every key event we attend.
- **Social Media Channels:** Twitter is a platform to instantly share information and connect with people while LinkedIn is the primary business network in the world. Unmanned Life's social media accounts are updated regularly to reach multi geographic audience. We will mention all the updates related to the project in our Social Media posts (LinkedIn and twitter) which will increase the visibility and impact of the results attained in the project.
- **Visual Presentation:** we will create a graphic material to be shared in events and private meetings. This will provide clarity to non-tech audience as well which will generate interest from a wider audience.
- **Communication:** we will make use of every communication and dissemination channel to spread out the news and update of this project. Newsletters, website section, social media posts and digital and print brochures.
- **Product development / Commercialisation of Net Apps:** Once UML and PAL Robotics develop the Global Localization NetApp, the objective is to provide this as a service to other robotics organisations who are looking for robot localization solutions in indoor environments. We plan to utilise the marketplace within this project and other go-to-market strategies to generate revenue from this R&D effort.

## 4 IPR MANAGEMENT

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For the success of the project, it is essential that all partners agree on explicit rules concerning IP ownership, access rights to any Background and Foreground IP for the execution of the project and the protection of intellectual property rights (IPR) and confidential information. Effectively exploiting research results depends highly on the proper management of IPR, and in the project, it is considered thoroughly as part of the overall management of knowledge. For the success of the EVOLVED-5G project, it is essential that all project partners agree before the project starts on explicit rules concerning IPR ownership, access rights to any Background and Foreground IPR for the execution of the project and the subsequent protection of IPRs.

Overall, the proper handling of the ownership, protection and granting of knowledge inside the Consortium is essential to fulfil the following purposes:

- Stimulate an effective cooperation among the Parties during the Project implementation;
- Encourage an innovative contribution from all the Parties independently from their workshare;
- Protect the commercial interests of the Parties;
- Facilitate further research developments and commercial exploitations.

### 4.1 IPR MANAGEMENT ACTIVITIES BEFORE THE START OF THE PROJECT

A Consortium Agreement (CA) has been agreed and signed among consortium partners before the project starts to establish a legal framework for the project in order to minimise any internal issues within the consortium related to the work, IP-Ownership, Access Rights to Background and Foreground IPR for the duration of the project and any other matters of the consortium's interest.

In terms of definitions, the following hold:

- Management of “Pre-existing know-how” (**Background**), relates to any information owned by the Parties before the CA is signed and any intellectual property rights owned by the Parties relating to such information. Within the CA, all partners will determine any Background IP they are willing to provide to the project and detailed rules for access rights. The granting of access rights may be made conditional on the conclusion of specific agreements aimed at ensuring that they are used only for the intended purpose and of appropriate undertakings as to confidentiality. Access rights for commercial exploitation shall be granted under fair and non-discriminatory conditions to be regulated by case-by-case agreements among the Parties.
- Management of “Knowledge” (**Foreground**), relates to any information generated as a result of carrying out the project; and any intellectual property rights (such as copyrights, patents, and pending application for patents) arising from that information. Foreground IPR shall be owned by the project partner carrying out the work leading to such Foreground IPR. Where several Parties have jointly carried out work generating the knowledge and where their respective contribution to the work cannot be ascertained, they shall have joint ownership of such knowledge. The principle is that the ownership of joint knowledge belongs to the Parties that generate it according to their share of participation to the common work. The Parties shall agree among themselves how that joint ownership will be exercised. Any details concerning the exposure to jointly owned

Foreground IPR, joint inventions and joint patent applications will be addressed in the Consortium Agreement. A party shall not publish foreground generated by another party or any background of such other party without the other party's prior written approval. Prior written notice of the final version of any planned publication shall be given to the other Parties at least thirty (30) days before the planned publication submission date.

With respect to the software prototypes of the upgraded Industry 4.0 Apps and Services that each SME of the consortium contributes to the project, it will be up to the owner to decide on the license under which the upgraded Industry 4.0 App/software will be available to the market. However, for the developed associated NetApps, EVOLVED-5G will be oriented, as the call mandates, to be released as open-sourced under a FOSS license (e.g. Apache, GPL) in EVOLVED-5G Marketplace in order to enable the further evolution and sustainability of the NetApps by the EVOLVED-5G community. In case of jointly created software prototypes, open-source release will be done provided that unanimous agreement among all owners is reached. The license under which the project Public deliverable reports will be released (e.g. Proprietary, Creative Commons) will be decided ad hoc among the contributing partners and shall be commonly agreed. If unanimous agreement is not reached, the deliverable will be released as Proprietary. As part of Task T7.4, the identification of Background IPR is being addressed, as well as other intellectual property issues.

## **4.2 AUDITING OF GENERATED IPR DURING THE PROJECT LIFETIME**

Auditing and managing of generated IPR will be performed in collaboration with the Research and Management staff of the project in order to provide an objective audit and reporting on the title and ownership of the IPR generated during the project lifetime. This is done via periodic reports using the Intellectual Property and Foreground Control questionnaire that is presented in

ANNEX D: Report Template on Generated Foreground and IP Control. An initial IPR Audit is planned at the end of the first period M16, and a final audit will be carried out again in M36 at the end of the project.

The different sections of the Audit, based on the Intellectual Property and Foreground Control questionnaire, are as follows:

1. Control of access rights needed for the implementation of the project
  - a. Control of access rights to party background needed for the implementation of the project
  - b. Control of access rights to party foreground needed for the implementation of the project
2. Control of third owners software used in the implementation of the project
  - a. Control of commercial software license
  - b. Control of open-source software license
3. Control of commercial hardware used in the implementation of the project
  - a. Control of commercial hardware acquired using projects funds
  - b. Control of commercial hardware acquired without using projects funds
4. Control of third owner intellectual property (IP) rights used in the implementation of the project
5. Control of party background used in the implementation of the project
6. Control of party foreground generated in the project
7. Control of party exploitable (industrial, commercial) foreground generated in the project
8. Observations – comments

Therefore, these IPR audits identify the Foreground IP generated by the project, its dependencies on and External IP or Background knowledge, and recommend actions to be taken by the consortium for its protection. All the Individual IPR Reports will be provided as Annex to the next releases of this deliverable, and a summary report for EVOLVED-5G as a whole will be included in the Final Report of the project. Within EVOLVED-5G, the Task 7.4 leader will act as Intellectual Property Supervisor, in collaboration with the Project Coordinator and the Technical Manager, advising on protection and access rights to Foreground based upon the Grant Agreement and Consortium Agreement.

## 5 EVOLVED-5G TECHNOLOGY TRANSFER PLAN

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Technology transfer is by default the intersection of research, innovation and entrepreneurial ecosystem. Globalization of production networks and markets, internationalization of research and technology as well as intensification of global competition have given technology transfer a decisive role in innovativeness and competitiveness of both industry and research. Technology Transfer is a multi-stage process, originating mainly in the idea generation and resulting in the capitalization of the technology transfer object or process transferred by the receiving organization.

It is evident that Intellectual Property (IP) is a corner stone for the technology transfer process as it represents the potential commercial opportunity for companies, especially for those with extensive research, tech-based services and products. While as part of the project's IPR management process, defined in Section 0 above, the IPs of the project are identified unilaterally by the consortium, as part of the technology transfer process, their path for commercialization is further analysed. It is important to stress that IP commercialization should be considered early during the first steps of a business's strategy, and clarify ownership status, dependent on the transfer of property to another entity or granting to another entity the right to use the underlying intellectual property. Overall, Intellectual Property may be commercialised by sale or assignment, or by entering into various types of contractual business relationships such as licensing. The business vehicle to achieve this is some way of partnership, a joint venture or a spin-off company.

IPRs play a crucial role as the legal vehicle through which either the transfer of knowledge or the contractual relationship is effected. 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 [10]. We define the commercialization of intellectual property as a continuum of activities and actions that provide for the 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.

The Commercialization of Intellectual Property (IP) focus of the EVOLVED-5G Technology Transfer Methodology puts emphasis on the translation of the project research inventions to commercial products and startup companies and the establishment of a support framework for the SMEs of the project to select the appropriate route for commercialisation. To achieve this, the plan consists of three main elements:

- The **Commercialisation of Intellectual Property Guide**: The creation of a document Guide is envisioned, as a glossary of necessary artefacts to support the consortium partners in moving from discovery of ideas and technologies developed under the project to commercialization. The guide defines the terms, process, and methodologies for the commercialization of EVOLVED-5G inventions, research results and expertise to make them successful.

- The **IP Commercialisation Blueprint (Tool)**: A blueprint will be defined to be used as a tool to 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.
- Hands-on **workshops**: Targeting the EVOLVED-5G SME partners, workshops shall be organised on how to appropriately use the Blueprint and the Guide.

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, start-up or spinoff company. It is anticipated that four hands-on workshops on how to use the methodology will be organised during the project lifecycle to better guide the execution of the methodology. In the below sections an overview of the Technology Transfer elements is presented.

## 5.1 COMMERCIALIZATION OF INTELLECTUAL PROPERTY GUIDE

This guide aims to present the possible routes of IP commercialisation for the EVOLVED-5G project outcomes. For the commercialisation of outcomes, different paths exist, and each of these paths or modes of commercialisation take place against a backdrop of legal rules. Typically legal rules are 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), and who has the power to act on behalf of a company or partnership [8]. Most modes of commercialisation 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 [9].

Through this guide, it is expected that EVOLVED-5G partners will be able to choose the right path for commercialisation of the IP developed during the project lifespan. The guide, that shall be based on the “Your Guide to IP Commercialisation” developed by the European IP Helpdesk [7], shall be completed in the second year of the project to be documented in D7.4 and will target the following aspects:

- Routes for IP Commercialization, including IP Commercialization by its owner and IP assignments from seller to buyers
- Confidentiality and Non-Disclosure Agreements (NDAs)
- Due diligence and risk management
- Licensing
- Joint ventures
- Spin-offs

## 5.2 IP COMMERCIALIZATION BLUEPRINT

There is no solid recipe a business should take to commercialise its IP, however there are steps to consider during its commercialization journey. The purpose of the Blueprint developed in EVOLVED-5G is to become a tool that can help the 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.

The IP Commercialisation Blueprint is inspired by the Service Blueprint Tool, a tool that is used in Service Design methodology. Service Design methodology is a user driven methodology that can help companies turn problems into tangible service, strategy or solutions. Service design is deeply influenced by user centred design and is based on generating a deep understanding of user needs and jointly designing with service users and staff [11]. This approach to design-driven innovation is often called ‘Design Thinking’ and was recognised as one of the top trends in the ‘Global Human Capital Trends 2016’ report by Deloitte University Press [12].

The service blueprint is the archetypal service design tool. As a tool, the service blueprint is relatively straightforward, but its content needs plenty of consideration. It allows you to break down complex processes to individual stages and plan your resources and actions to implement and sustain your idea. Respectively, the IP Commercialization Blueprint outlines the process and series of steps for undertaking and managing IP commercialization projects. The blueprint provides everyone involved in the process, whether at front of house or in the back office, with understanding of their contribution and responsibility and ensures a coherent commercialization strategy.

In EVOLVED-5G the Blueprint shall be delivered as a Poster, to highlight key questions that need to be addressed during the technology transfer process. An initial idea for the content of the Blueprint is provided in Table 2 below.

Table 2: First Draft of the IP Commercialisation Blueprint

Planning		Delivery		Review	
Context Aims	Actions	Set up	Management	Evaluation	Sustainability
What are the organization priorities for innovation?	What is the budget?  What approval is needed?	Who will develop the content?  Are there any IP issues?  How will you ensure client readiness?	What are the key milestones?	What indicators could be part of the evaluation?	How can we prepare for future funding changes?
What are the internal capabilities/ resources?	What are the key stakeholders?  What activities will be conducted?	Will you prototype a service?	How will the project be managed?	When will the evaluation take place and who will do it?	



The process to be followed once the blueprint is finalised involves the following steps to be executed individually per all SMEs of EVOLVED-5G:

1. Print the poster (Blueprint).
2. Invite all the core stakeholders (senior management, service delivery, support staff, researchers, etc.) to a co-creation workshop and discuss all the Blueprint boxes.
3. Think about what happens chronologically over time – before setting the strategy, during and after its use.
4. 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.

Note that the process shall be supported by hands-on workshops organised by the Technology Transfer lead partner (IEA), so that to appropriately train the involved SMEs in the methodology.

## 6 CONCLUSIONS

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Having identified at an early stage the key technological innovations to pursuit, the project, in the scope of the standardisation activities seeks to liaise with appropriate standardisation activities to pursue bilateral collaboration. It has defined a step-wise approach to monitor the most relevant groups in a continuous manner with the target not only to ensure alignment, but also to maximise the project's influence with contributions to developing work. To this direction, EVOLVED-5G is already bringing contributions to 3GPP SA6 to standardise new enablers for verticals, such as enablers for "App-Layer Analytics" and for "Network Slice Capability Exposure".

In respect to the commercialisation 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. The plan considers the following phased approach:

- Phase-1: In the first ten months of the project, and as reported in this document (D7.2) the focus is to establish the appropriate commercialisation and exploitation methodologies, guiding principles, and tools. Based on this, the implementation activities were kicked-off and through four project-wide workshops, the initial list of project's exploitable outcomes was delivered.
- Phase-2: In the next phase, targeting the 2<sup>nd</sup> year of the project, to be reported in M24 with D7.4, and as the project's work progresses, the focus is shifted to the analysis of the IPR status per outcome and its associating partners. At the same time, the IPR guide for commercialisation and the blueprint tool shall be revised appropriately to support the technology transfer activities, and targeted workshops will take place, so that to conclude on the most realistic approach per case. The results of phase-2, taking also into consideration early feedback from WP6 work on market analysis, shall reveal a more targeted list of exploitable results where further business-case analysis can be performed.
- Phase-3: During the last year of the project, the attention will be put on selective exploitable outcomes as resulting from the previous analysis, to execute the Value Proposition and Lean Canvas methodologies for the preparation of a business case study. This work will be discussed in D7.6, expected at the end of the project.

As the project results mature, potential amendments in the methodology and provided plans will be reported in the next deliverable D7.4 "Standardisation, Innovation, Exploitation and Technology Transfer Activities (Intermediate)" due M24 of the project.

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## 8 ANNEX A: STANDARDIZATION GROUPS STRUCTURE & OBJECTIVES

### 8.1 3GPP



The 3rd Generation Partnership Project (3GPP)<sup>14</sup> unites [Seven] telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as “[Organizational Partners](#)” and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies. The project covers cellular telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system description for mobile telecommunications. The 3GPP specifications also provide hooks for non-radio access to the core network, and for interworking with non-3GPP networks.

3GPP specifications and studies are contribution-driven, by member companies, in Working Groups and at the Technical Specification Group level.

The three [Technical Specification Groups](#) (TSG) in 3GPP are:

- Radio Access Networks ([RAN](#)),
- Services & Systems Aspects ([SA](#)),
- Core Network & Terminals ([CT](#))

The Working Groups (WG) each TSG is divided, are presented in Figure 5 below:

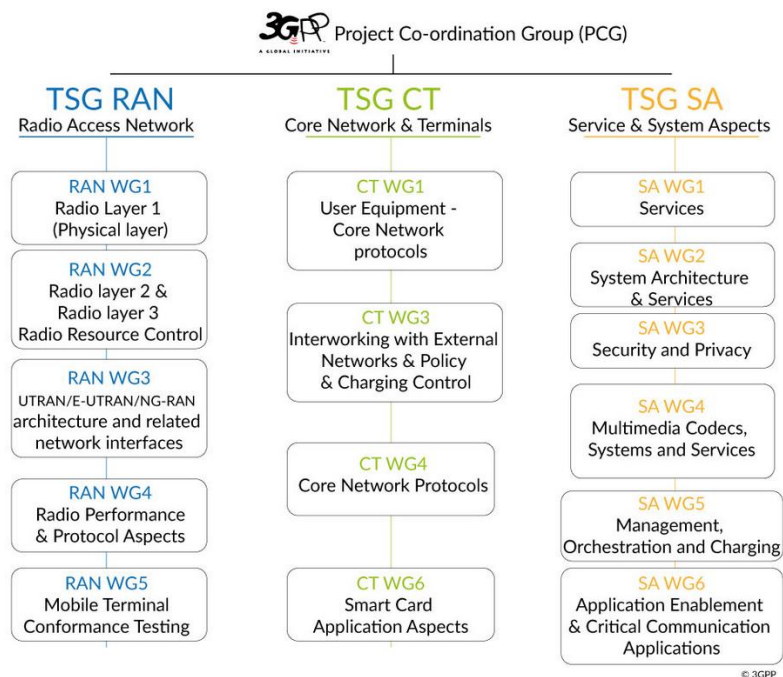


Figure 5: 3GPP Working Groups

<sup>14</sup> <https://www.3gpp.org/>

## 8.2 5G-PPP



The 5G Infrastructure Public Private Partnership (5G PPP)<sup>15</sup> is a joint initiative between the European Commission and European ICT industry (ICT manufacturers, telecommunications operators, service providers, SMEs and research Institutions). The 5G PPP will deliver solutions, architectures, technologies and standards for the ubiquitous next generation communication infrastructures of the coming decade. The challenge for the 5G Public Private Partnership (5G PPP) is to secure Europe's leadership in the particular areas where Europe is strong or where there is potential for creating new markets such as smart cities, e-health, intelligent transport, education or entertainment & media. The 5G PPP initiative will reinforce the European industry to successfully compete on global markets and open innovation opportunities. It will "open a platform that helps us reach our common goal to maintain and strengthen the global technological lead". Key challenges for the 5G Infrastructure PPP are:

- Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010
- Saving up to 90% of energy per service provided. The main focus will be in mobile communication networks where the dominating energy consumption comes from the radio access network
- Reducing the average service creation time cycle from 90 hours to 90 minutes
- Creating a secure, reliable and dependable Internet with a "zero perceived" downtime for services provision
- Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people
- Ensuring for everyone and everywhere the access to a wider panel of services and applications at lower cost

The 5G PPP Work Groups are listed as follows:

- Open Smart Networks and Services WG
- Pre-Standardization WG
- Spectrum WG
- 5G Architecture WG
- Software Networks WG
- Vision and Societal Challenges WG
- Security WG
- SME WG
- Trials WG
- 5G for Connected and Automated Mobility (CAM) WG
- Test, Measurement and KPIs Validation WG

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<sup>15</sup> <https://5g-ppp.eu/>

### 8.3 OPEN SOURCE MANO (OSM)



Open Source Mano<sup>16</sup> is an ETSI-hosted initiative to develop an Open Source NFV Management and Orchestration (MANO) software stack aligned with ETSI NFV. Two of the key components of the ETSI NFV architectural framework are the NFV Orchestrator and VNF Manager, known as NFV MANO. Additional layers, such as service orchestration are also required for operators to enable true NFV services. Open Source software can facilitate the implementation of an ETSI aligned NFV architecture, provide practical and essential feedback to the ETSI ISG NFV and increase the likelihood of interoperability among NFV implementations.

ETSI OSM complements the work of ETSI NFV and vice versa. In particular, ETSI OSM provides an opportunity to capitalise on the synergy between standardization and open source approaches by accessing a greater and more diverse set of contributors and developers than would normally be possible. This approach maximises innovation, efficiency and time to market and ensures a continuing series of true (conformant) reference implementations.

### 8.4 ETSI



ETSI is the European Telecommunication Institute<sup>17</sup>, a European Standards Organization recognised by the European Union, and focused on producing global standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and Internet technologies. ETSI has more than 900 member organizations in 65 countries all over the world. ETSI acts as the rooting organization for other global industry standardization partnerships like 3GPP and OneM2M.

#### 8.4.1 ETSI MEC ISG

##### **Industry Specification Group (ISG) on Multi-Access Edge Computing (MEC)**

ETSI Industry Specification Group (ISG) on Multi-Access Edge Computing (MEC) unites the telco and IT-cloud worlds creating a standardised, open environment allowing the efficient and seamless integration of applications from vendors, service providers, and third-parties across multi-vendor MEC platforms. MEC also enables applications and services to be hosted 'on top' of the mobile network elements, i.e. above the network layer allowing them to be placed near the customer and receive local radio-network contextual information. MEC work benefits several entities within the value chain, such as mobile operators, application developers, Over the Top players, Independent Software Vendors, telecom equipment & IT platform vendors, system integrators, and technology providers; who are all interested in delivering services based on MEC concepts.

MEC ISG develops normative specifications, informative reports and white papers in an attempt to ease the implementation path for vendors, operators and application developers by providing SW implementation of its APIs; developing a testing and compliance framework and a sandbox environment to be used in application development.

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<sup>16</sup> <https://www.etsi.org/technologies/open-source-mano>

<sup>17</sup> <https://www.etsi.org/about>

#### 8.4.2 ETSI NFV ISG

##### **Industry Specification Group (ISG) on Network Functions Virtualisation (NFV)**

Industry Specification Group (ISG) on Network Functions Virtualisation (NFV) has developed multiple specifications and reports for the virtualization of network functions, with focus on the management and orchestration of virtualised resources.

From an architectural point of view, NFV specifications describe and specify virtualization requirements, NFV architecture framework, functional components and their interfaces, as well as the protocols and the APIs for these interfaces. Another set of NFV specifications define the structure and format of deployment templates and how to package all artefacts which are used by the NFV management and orchestration framework.

ISG NFV also studies VNF performance, reliability, and resiliency matters, analyzes the security challenges linked to virtualization (trust, attestation, regulation) and specifies associated requirements. In support for 5G deployments, the ISG NFV specifications include support for multi-site and multi-domain deployments, as well as network slicing. New virtualization technologies such as support for containerised VNFs and container infrastructure management are tackled in studies and on-going normative specifications work. In addition, The ISG NFV specifies requirements for hardware acceleration, multi-tenancy, autonomous networks, etc.

#### 8.4.3 ETSI INT

##### **Technical Committee (TC) on Core Network and Interoperability Testing (INT)**

ETSI INT develops test specifications to test interoperability, conformance, performance and security. The methodology used is end-to-end and includes verification of both the control and user plane. The test specifications are based on 3GPP specifications which enable network operators to test their network for services for both fixed and mobile customers.

INT produces test purposes, test descriptions, and test cases to enable interoperability testing of the core network elements, interconnect and roaming scenarios. Use Cases and requirements specified by ETSI for Automated and Autonomic Management and Control (self- management) of Networks and Services are tested via “industry standards-anchored” Proof of Concepts (PoC) events.

### 8.5 IEEE TSN



Time-Sensitive Networking (TSN)<sup>18</sup> is a set of standards specified by IEEE 802. The Time-Sensitive Networking (TSN) Task Group (TG) is a part of the IEEE 802.1 Working Group (WG). The charter of the TSN TG is to provide deterministic connectivity through IEEE 802 networks, i.e., guaranteed packet transport with bounded latency, low packet delay variation, and low packet loss. The TSN TG has been evolved from the former IEEE 802.1 Audio Video Bridging (AVB) TG. The TSN TG includes the former IEEE 802.1 Interworking TG. The original work on AVB was done as part of the “Residential Ethernet Study Group” of IEEE 802.3.

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<sup>18</sup> <https://1.ieee802.org/tsn/>



## 8.6 5G-ACIA



5G-ACIA<sup>19</sup> is the central global forum for shaping 5G in the industrial domain. On one platform, various industries from all over the world jointly create a new ICT and OT ecosystem and set the frameworks for a highly attractive emerging market.

The overriding objective of 5G-ACIA is to maximise the applicability of 5G technology in connected industries, in particular the manufacturing and process sectors. 5G-ACIA works to ensure that 5G standardization and regulation efforts adequately consider the interests and unique characteristics of the industrial domain.

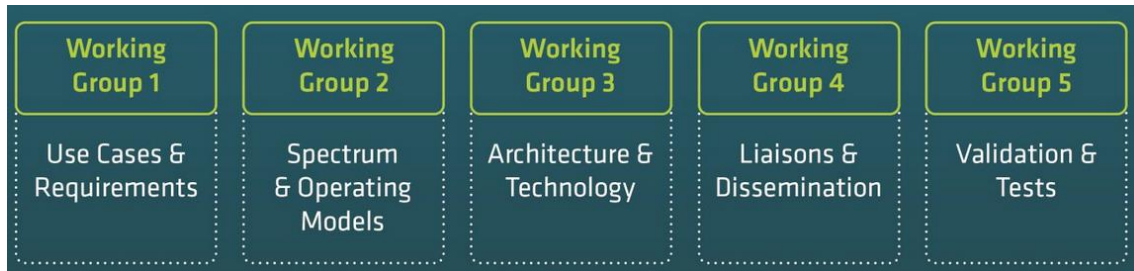


Figure 6: 5G-ACIA Working Groups

## 8.7 ALLIANCE FOR IOT INNOVATION



The AIOTI<sup>20</sup> was initiated by the European Commission in 2015. The Alliance aims to create and master sustainable innovative European IoT ecosystems in the global context to address the challenges of IoT

technology and applications deployment including standardisation, interoperability and policy issues, in order to accelerate sustainable economic development and growth in the new emerging European and global digital markets. AIOTI has at the moment 11 Working Groups (8 horizontal and 7 vertical groups) and 4 Interest Groups.

## 8.8 BDVA/DAIRO



The Big Data Value Association – BDVA<sup>21</sup>, (from 2021, DAIRO - Data, AI and Robotics), is an industry-driven international not-for-profit organisation with more than 230 members all over Europe and a well-balanced composition of large, small, and medium-sized industries as well as research and user organizations.

BDVA/DAIRO focuses on enabling the digital transformation of the economy and society through Data and Artificial Intelligence by advancing in areas such as big data and AI technologies and services, data platforms and data spaces, Industrial AI, data-driven value creation, standardisation, and skills. BDVA/DAIRO has been the private side of the H2020 partnership Big Data Value cPPP, it is a private member of the EuroHPC JU and is also one of the founding

<sup>19</sup> <https://5g-acia.org/>

<sup>20</sup> <https://aioti.eu/>

<sup>21</sup> [www.bdva.eu](http://www.bdva.eu)

members of the AI, Data and Robotics Partnership. BDVA/DAIRO is an open and inclusive community and is always eager to accept new members who share these ambitious objectives.

The mission of the BDVA is to develop the Innovation Ecosystem that will enable the data and AI-driven digital transformation in Europe delivering maximum economic and societal benefit, and, achieving and sustaining Europe's leadership on Big Data Value creation and Artificial Intelligence.

## 8.9 EFFRA



The European Factories of the Future Research Association <sup>22</sup> (EFFRA) is a non-for-profit, industry-driven association promoting the development of new and innovative production technologies.

It was the official representative of the private side in the 'Factories of the Future public-private partnership and nowadays of the Made in Europe partnership under the newest European framework programme "Horizon Europe".

The key objective of EFFRA is to promote pre-competitive research on production technologies within the European Research Area by engaging the European Commission through the partnerships.

The Made In Europe partnership will be the voice and driver for sustainable manufacturing in Europe. It will boost European manufacturing ecosystems towards global leadership in technology, towards circular industries and flexibility. The Partnership will contribute to a competitive, green, digital, resilient and human-centric manufacturing industry in Europe. It will be at the center of a twin ecological and digital transition, being both a driver and subject to these changes

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<sup>22</sup> <https://www.effra.eu/>

## 9 ANNEX B: VALUE PROPOSITION CANVAS

The Value Proposition Canvas is used to depict and identify information regarding the features of a product or service targeting a specific Customer. The Value Proposition Canvas [5] has two sides, the Customer Profile (on the right) and the Value Proposition (on the left) and is graphically depicted in Figure 7. Through the identification of gains, pains and opportunities, a clear and structured value proposition statement for the outcome is provided.

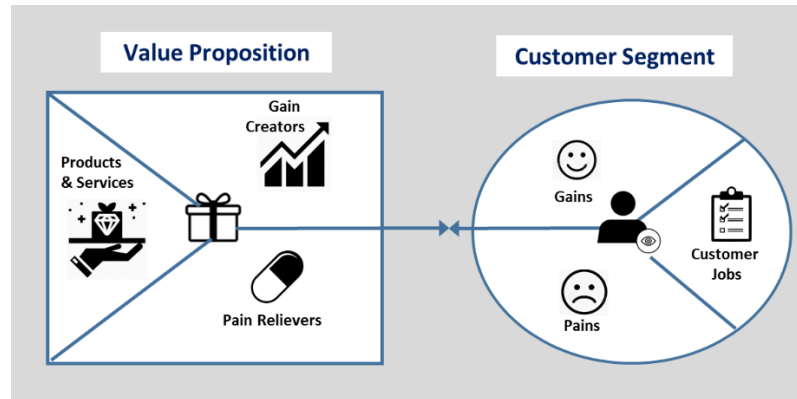


Figure 7: Value Proposition Canvas

The Value Proposition is broken down into:

- **Products and services:** the list of 5GENESIS products and services targeting the value proposition to a specific customer segment.
- **Pain relievers:** the ways in which these product and services will alleviate specific Customer Pains.
- **Gain creators:** the ways in which these products and services can create gains for the Customer.

The Customer Segment describes the target customer profile and relevant key information to understand the expected value to be provided by 5GENESIS results:

- **Customer Jobs:** the existing customer jobs and business processes executed by the prospect (corporate) users that are relevant to each 5GENESIS product.
- **Pains:** the risks, obstacles, problems related with the existing way (without the 5GENESIS product) of performing the Customer Jobs.
- **Gains:** the outcome customers want to achieve or concrete benefits they are seeking from their Jobs.

## 10 ANNEX C: LEAN CANVAS

The Lean Canvas Model is a business case development method that is based on the graphic representation of a number of variables that show the values of a business and/or organisation. Lean Canvas is adapted from The Business Model Canvas [2][3] and can be applied at for direct exploitable assets of a commercial initiative. The Canvas is presented in the table below:

Table 1: Lean Canvas Model

PROBLEM	SOLUTION	UNIQUE VALUE PROPOSITION	UNFAIR ADVANTAGE	CUSTOMER SEGMENTS
	KEY METRICS		CHANNELS	
EXISTING ALTERNATIVES				EARLY ADOPTERS
COST STRUCTURE		REVENUE STREAMS		

The key parameters foreseen in the Lean Canvas Model are explained in detail as follows:

- **Problem:** The top problems that can be addressed from the product/service, addressing the jobs that are affected, why, how and who is concerned.
- **Existing Alternatives:** Other solutions solving the same or similar problem currently.
- **Solution:** A brief description of what the solution does and how, with special focus on the main features that differentiate it from the alternatives.
- **Key Metrics:** Key activities that will be measured to track the success (e.g., units sold, users registered)
- **Unique Value Proposition:** The critical success factors of 5GENESIS's product proposition towards satisfying customers' needs especially in comparison to the alternatives. The statement should underline the product's uniqueness and provide numbers to explain performance gains.
- **Unfair Advantage:** Identify advantages compared to the competition, such as acquisition, switching and maintenance costs
- **Channels:** Detail the channels to be used to contact customers, promote and deliver the value promised.

- **Customer Segment:** The customer segment in focus, who has the problem and would be interested in buying the solution. The customer segment can be split in vertical segments to identify the strongest vertical to target for.
- **Early Adopters:** A small niche that is having the biggest problem, the ones who suffer the most and could become early adopters. In the process of identifying early adopters, geographic location, industry and connection to the problem are important aspects.
- **Cost Structure:** The main costs as soon as the solution is ready for the market (e.g., customer acquisition costs, distribution costs, hosting, human resources costs, etc.). To build a subtle business case the costs should be estimated in the short term (six months) and longer-term (three years).
- **Revenue Streams:** The main revenue streams when the solution is ready for the market in the short-term (six months) and longer-term (three years).

## 11 ANNEX D: REPORT TEMPLATE ON GENERATED FOREGROUND AND IP CONTROL

### 11.1 CONTROL OF ACCESS RIGHTS NEEDED FOR THE IMPLEMENTATION OF THE PROJECT

#### CONTROL OF ACCESS RIGHTS TO PARTY BACKGROUND NEEDED FOR THE IMPLEMENTATION OF THE PROJECT

According to the GA and the CA, "background" means information which is held by beneficiaries prior to their accession to this agreement, as well as copyrights or other intellectual property rights pertaining to such information, the application for which has been filed before their accession to this agreement, and which is needed for carrying out the project or for using foreground.

IDENTIFICATION OF BACKGROUND	OWNER PARTY	RECIPIENS PARTY	ACCESS DATE	FOREGROUND RESULTING	IDENTIFICATION OF BACKGROUND

#### CONTROL OF ACCESS RIGHTS TO PARTY FOREGROUND NEEDED FOR THE IMPLEMENTATION OF THE PROJECT

According to the GA and the CA, "foreground" means the results, including information, whether or not they can be protected, which are generated under the project. Such results include rights related to copyright; design rights; patent rights; plant variety rights; or similar forms of protection.

OWNER PARTY	IDENTIFICATION FOREGROUND TRANSFERED	ACCESS DATE	RECIPIENS PARTY	FOREGROUND RESULTING	OWNER PARTY

### 11.2 CONTROL OF THIRD PARTY OWNERS SOFTWARE USED IN THE IMPLEMENTATION OF THE PROJECT

Parties are not owners of the software USED in the implementation of the EVOLVED-5G project. Parties are the rightholders of a commercial license (2.1.) or and open source license (2.2)

#### CONTROL OF COMMERCIAL SOFTWARE LICENSE

IDENTIFICATION COMMERCIAL SOFTWARE AND LICENSOR	PARTY LICENSEE LICENSE OWNER	LICENSE	IDENTIFICATION COMMERCIAL SOFTWARE AND LICENSOR

#### CONTROL OF OPEN SOURCE SOFTWARE LICENSE

IDENTIFICATION OF OPEN SOURCE SOFTWARE AND LICENSOR	PARTY LICENSE OWNER	IDENTIFICATION OF LICENSE	IDENTIFICATION OF FOREGROUND RESULTING

### 11.3 CONTROL OF COMMERCIAL HARDWARE USED IN THE IMPLEMENTATION OF THE PROJECT

HARDWARE means all kinds of MACHINERY, TOOLS, COMPUTERS (excluded software) ACQUIRED for the implementation – performance of the Project. Parties are the owners of the hardware and it has been acquired using Projects funds (3.1.) or without using Project funds (3.2).

#### CONTROL OF COMMERCIAL HARDWARE ACQUIRED USING PROJECTS FUNDS

IDENTIFICATION OF COMMERCIAL HARDWARE	PARTY LICENSE OWNER	LICENSE DATE	IDENTIFICATION FOREGROUND RESULTING

#### CONTROL OF COMMERCIAL HARDWARE ACQUIRED WITHOUT USING PROJECTS FUNDS

IDENTIFICATION OF COMMERCIAL HARDWARE	PARTY LICENSE OWNER	LICENSE DATE	IDENTIFICATION FOREGROUND RESULTING

### 11.4 CONTROL OF THE THIRD OWNER INTELLECTUAL PROPERTY (IP) RIGHTS USED IN THE IMPLEMENTATION OF THE PROJECT

For any other material or immaterial not included in the above section 2 and section 3 used in the implementation of the EVOLVED-5G Project and the Party using that material or immaterial is NOT the owner.

PRODUCT	IP CLASSIFICATION						THIRD OWNER	LICENSE IDENTIFICATION	
DENOMINATION	Patent	UM	SP/T	ID	©	KH	IDENTIFICATION	EVOLVED-5G PARTY	DATE

(UM= Utility Model; SP/T= Semiconductor Product/ Topography; ID = Industrial Design; © Copyright; KH = Know How).



## 11.5 CONTROL OF PARTY BACKGROUND USED IN THE IMPLEMENTATION OF THE PROJECT

IDENTIFICATION BACKGROUND	CLASSIFICATION				OWNER PARTY		AUTHORS	INVENTORS
	S	H	F	O (SPECIFY)	OP	JO	FN, N	FN, N

[S= software, H= Hardware, F=Firmware, O=Other (if Other, complete specify (ex. Database))  
(OP = One Party; JO = Joint Ownership) (FN = Family Name, N =Name).

## 11.6 CONTROL OF PARTY FOREGROUND GENERATED IN THE PROJECT

IDENTIFICATION FOREGROUND	CLASSIFICATION				OWNER PARTY		AUTHORS	INVENTORS
	S	H	F	O (SPECIFY)	OP	JO	FN, N	FN, N

[S= software, H= Hardware, F=Firmware, O=Other (if Other, complete specify (ex. Database))  
(FN = Family Name, N =Name) Owner Party: (OP) means one Party owns Independent Work (IW),  
(JO) means Joint Ownership of the exploitable Foreground identified. The E-Foreground has  
been created by two or more Parties and the contributions of each Party to the specific  
Foreground are inseparable - that is, they are not separately identifiable in the Foreground  
identified.

## 11.7 CONTROL OF PARTY EXPLOITABLE (INDUSTRIAL, COMMERCIAL) FOREGROUND GENERATED IN THE PROJECT

### IDENTIFICATION OF PARTY EXPLOITABLE FOREGROUND

Exploitable Foreground means that the results could be exploitable in:

- (1) Further Research
- (2) Developing, creating and marketing a product/process
- (3) Creating and providing a service
- (4) In Standardisation activities
- (5) Others (Joint Venture, Spin-off, ...)

IDENTIFICATION FOREGROUND	CLASSIFICATION				EXPLOITATIONS				
	S	H	F	O (SPECIFY)	(1)	(2)	(3)	(4)	(5) SPECIFY

Classification: [S= software, H= Hardware, F=Firmware, O=Other (if Other, complete specify (ex. Database))].

## 11.8 OBSERVATIONS-COMMENTS