



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

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Deliverable D7.6

Standardisation, Innovation, Exploitation and Technology Transfer Activities (Final)

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GLOSSARY

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

EXECUTIVE SUMMARY

EVOLVED-5G builds around the potentials seen through the development of Network Applications and the supporting ecosystem Industry 4.0 applications mandate. The purpose of this deliverable, D7.6, is to shed the spotlight on the research and business impact of the respective project technology and development propositions. It is produced by Work Package 7 “Innovation, Exploitation, Standardisation and Outreach Activities” and especially the Tasks 7.3 “Innovation Shaping and Standardization Alignment” and 7.4 “Exploitation activities, Technology Transfer and IPR Management” and is the third and last in a sequence of three deliverables aiming to provide the full final results of the project in a synoptical manner, while providing an analytic account of the actions performed in the last project year which is the target reporting period. The document provides a detailed account on the progress for the four key topics in scope, namely standardisation, innovation, exploitation, and technology transfer and is a self-standing document that where appropriate references to the analytic work produced in the preceding D7.2 “Standardisation, Innovation, Exploitation and Technology Transfer plan” and D7.4 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Intermediate)” documents.

Regarding standardisation activities, the deliverable reports the profound achievement of the foundation of a new Software Development Group within ETSI, named OpenCAPIF, as part of the project’s partners efforts to promote the respective developments. Furthermore, thirty-seven (37) contributions have been submitted to 3GPP SA2 & SA6 Working Groups, nineteen (19) of which achieved in the last project year, while all related SDOs in the field of 5G, IoT and Industry 4.0, such as GSMA, 5G ACIA and AIOTI have been closely monitored in parallel. In terms of **innovations**, overall, the project has identified seven (7) candidates that are retouched in this document inspired by the EU Innovation Radar constructs and methodology. As an important project accomplishment, during the previous reporting period the two fundamental project concepts, the NEF Emulator, and the Open-Source CAPIF Core Function have been published in the EU Innovation Radar as high potential innovations.

The **exploitation** methodology devised by the project, that had followed a stepwise approach, targeted for the last year activities the preparation of the Value Proposition Canvas analysis for the more mature outcomes. In total, eight (8) platform-level exploitable outcomes and 12 SME-related network applications prototypes and associated turn-key demonstrators, have been identified and appropriately prioritised for VPC analysis. Beyond the project-level exploitation methodology, the document delivers the partners individual exploitation plans highlighting the relevance of the project’s work in line to the vision, mission and specifics of the participating company and organization.

Significant effort has also been put in developing a **technology transfer** plan to support the project partners in selecting the appropriate course for commercialization for their developments. Especially for the third year’s activities, the effort has been put in the execution of the IP Commercialisation Blueprint Tool, and feedback and recommendations for its effective wider execution.

Overall, the EVOLVED-5G results have been proven impactful in terms of research and business impact and concrete plans, proliferating beyond the project’s lifespan have been devised, creating promising expectations both in terms of building an innovation paradigm as well as revealing new monetization opportunities for the SMEs and industrial partners.

TABLE OF CONTENTS

LIST OF FIGURES.....	8
LIST OF TABLES	9
1 INTRODUCTION	10
1.1 DOCUMENT STRUCTURE.....	10
1.2 AUDIENCE	11
2 STANDARDIZATION ACTIVITIES & ACHIEVEMENTS	12
2.1 OVERVIEW.....	12
2.2 INVOLVEMENT IN STANDARDS DEVELOPMENT ORGANISATIONS (SDOs) & INDUSTRY ASSOCIATIONS	12
2.2.1 3GPP SA2, SA6 and other WGs	13
2.2.2 5G-PPP Pre-standardization WG	17
2.2.3 GSMA.....	18
2.2.4 ETSI OpenCAPIF SDG.....	19
2.2.5 ETSI-OSM	20
2.2.6 ETSI-MEC ISG	21
2.2.7 TM FORUM.....	21
2.2.8 IEEE TSN.....	21
2.2.9 5G-ACIA	22
2.2.10 Alliance for IoT Innovation (AIOTI) WG6, WG11	23
2.2.11 Data, AI and Robotics (BDVA/DAIRO)	23
2.2.12 EFFRA (European Research Factories Association).....	23
2.3 INVOLVEMENT IN OPEN-SOURCE PROJECTS	24
3 PROJECT INNOVATIONS.....	27
3.1 OVERVIEW.....	27
3.2 NETWORK APPLICATIONS CONTAINERISED & CLOUD NATIVE.....	28
3.3 NEF EMULATOR UTILIZING 3GPP'S EXPOSURE SERVICES	29
3.4 OPEN-SOURCE IMPLEMENTATION OF THE 3GPP CAPIF CORE FUNCTION	30
3.5 MARKETPLACE FOR NETWORK APPLICATIONS	30
3.6 CERTIFICATION PROCESS FOR NETWORK APPLICATIONS	31
4 EXPLOITATION ACTIVITIES	32
4.1 OVERVIEW.....	32
4.2 EVOLVED-5G EXPLOITABLE OUTCOMES.....	33
4.3 PROJECT LEVEL EXPLOITATION ACTIVITIES	34
4.3.1 EVOLVED-5G Platform Exploitable Outcomes	34
4.3.2 EVOLVED-5G Network Applications/SME Exploitable Outcomes	54
4.4 INDIVIDUAL EXPLOITATION PLANS	78
4.4.1 Telefónica I+D.....	78
4.4.2 National Centre for Scientific Research Demokritos.....	79
4.4.3 Maggioli SPA	79
4.4.4 ATOS IT solutions and services Iberia SL.....	80
4.4.5 INTRASOFT International SA.....	81
4.4.6 COSMOTE Mobile Telecommunications SA	82
4.4.7 Lenovo (Deutschland) GmbH.....	83
4.4.8 Impact Entrepreneurship Award Ltd.	84
4.4.9 Universidad de Málaga	84
4.4.10 Universitat Politècnica de Valencia	85
4.4.11 GMI-AERO-SAS	85

4.4.12	<i>Internet Institute Ltd.</i>	87
4.4.13	<i>Cafatech</i>	88
4.4.14	<i>InQbit Innovations S.R.L</i>	88
4.4.15	<i>FOGUS Innovations & Services P.C.</i>	89
4.4.16	<i>INFOLYSiS</i>	89
4.4.17	<i>EIGHT BELLS LTD.</i>	91
4.4.18	<i>PAL-Robotics</i>	91
4.4.19	<i>ZORTENET</i>	92
4.4.20	<i>Immersion</i>	92
4.4.21	<i>UM Autonomous Systems Ltd</i>	93
5	COMMERCIALIZATION OF INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER ACTIVITIES	94
5.1	OVERVIEW	94
5.2	TOOLS & METHODOLOGY	94
5.2.1	<i>Intellectual Property Guide for Commercialisation</i>	94
5.2.2	<i>IP Commercialisation Blueprint</i>	95
5.3	TECHNOLOGY TRANSFER WORKSHOPS & WEBINARS	95
5.3.1	<i>Lessons learnt from using the EVOLVED-5G IP Commercialisation Blueprint</i>	97
6	CONCLUSIONS	104
7	REFERENCES	106
8	ANNEX A: INNOVATION RADAR METHODOLOGY	107
9	ANNEX B: VALUE PROPOSITION CANVAS	108

LIST OF FIGURES

Figure 1: CAMARA alignment with SDOs	19
Figure 2: EVOLVED-5G Exploitation Strategy Steps	32
Figure 3: A) Stand-Alone and B) Non-Stand-Alone Network Application Modes	54
Figure 4: 5G PPP Network Applications classification.....	55
Figure 5: ANITA 4.0 Hot Bonder (Extract from GMI Aero commercial brochure).....	86
Figure 6: Digital – Physical Twin using ANITA 4.0 (Extract from GMI commercial brochure).....	87
Figure 7: Value Proposition Canvas.....	108

LIST OF TABLES

Table 1: SDOs in EVOLVED-5G Target.	13
Table 2: EVOLVED-5G Activities in 3GPP	13
Table 3: Open-Source Projects Adopted by EVOLVED-5G	24
Table 4: EVOLVED-5G Open-Source Contributions	25
Table 5: EVOLVED-5G Innovations.	28
Table 6: Network Applications Containerised & Cloud Native Innovation	28
Table 7: EVOLVED-5G Platform Exploitable Results	33
Table 8: Network Applications/SME Exploitable Outcomes	34
Table 9: EVOLVED-5G Facility Outcome Description	35
Table 10: EVOLVED-5G Facility Outcome Gap Analysis.....	35
Table 11: EVOLVED-5G Network Applications Service Package Outcome Description	38
Table 12: EVOLVED-5G Service Package Outcome Gap Analysis	39
Table 13: EVOLVED-5G SDK Tools Outcome Gap Analysis	41
Table 14: Network Applications Validation Tools Outcome Gap Analysis.....	44
Table 15: Network Applications Certification Environment Outcome Gap Analysis	46
Table 16: Network Applications Marketplace Outcome Gap Analysis	48
Table 17: NEF Emulator Outcome Gap Analysis.....	50
Table 18: CAPIF Certification Tool Outcome Gap Analysis	52
Table 19: Autonomous Service Adaptation Outcome Gap Analysis	58
Table 20: Intelligent Network Traffic Management Outcome Gap Analysis	60
Table 21: NetMapper Outcome Gap Analysis.....	62
Table 22: Global Localisation Outcome Gap Analysis	64
Table 23: Teleoperation Outcome Gap Analysis.....	68
Table 24: Smart Irrigation 5G Agriculture Outcome Gap Analysis.....	70
Table 25: Chatbot Assistant Outcome Gap Analysis	72
Table 26: Network Monitoring & Anomaly Detection Outcome Gap Analysis.....	74
Table 27: Security Information and Event Management (SIEM) Systems Outcome Gap Analysis	75
Table 28: Assured 5G QoS and Integrated SLA/SLS Monitoring Outcome Gap Analysis	77
Table 29: Identity and Access Control Outcome Gap Analysis	78
Table 30: Technology Transfer Workshops.....	96
Table 31: UMS Technology Transfer Blueprint Tool Execution Preparation Process	99
Table 32: UMS Technology Transfer Blueprint Tool Execution Planning Process.....	99
Table 33: UMS Technology Transfer Blueprint Tool Execution Delivery Process	100
Table 34: UMS Technology Transfer Blueprint Tool Execution Review Process.....	101
Table 35: Innovation Description Template	107

1 INTRODUCTION

The fundamental concepts of EVOLVED-5G build around the potentials foreseen through the development of Network Applications in the Industry 4.0 ecosystem. The core objective of Work Package 7 and the angle set for all the resulting deliverables is to explore the effect of the technology delivered by EVOLVED-5G, both in terms of impact on the prevailing standards as well as in respect to anticipated opportunities for market advancements and business exploitation.

To achieve these goals, the project has set in the first deliverable of the sequel, D7.2 [2], an analytical methodology that has been consistently followed in the subsequent D7.4 [3] and current D7.6 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Final)” deliverables to address the following topics:

- **Standardisation Activities**, identifying and focusing on the pivotal SDOs (Standards Development Organisations) either to monitor or to contribute to, including the Open-Source Community.
- **Project Innovations**, referring to core project results that create value for the broader ecosystem.
- **Exploitation Plans**, both project-wide and individual per partner.
- **Technology Transfer**, putting emphasis on the establishment of a support framework for the SMEs of the project to select the appropriate route for commercialisation.

This document, building upon the concept and methodology of D7.2 [2] is the third and last in a sequence of three deliverables and provides the full final results of the project in a synoptical manner, nonetheless, providing an analytic account of the actions performed in the target reporting period namely the last project’s year.

The projects results’ business analysis has stemmed from the evaluation of the final technical developments of WP3 “Overall Framework Development and Integration Activities” for the platform-side outcomes and WP4 “Network Apps Development and Verification” for the SME’s delivered Network Applications. The integration activities performed in WP5 “Overall Evaluation Process, Network Application Validation, Certification and Release” have been decisive in the appropriate Technology Readiness (TRL) placement of the Network Applications as well as the exploration of project’s innovative concepts such as the Network Applications Certification and Marketplace. The work performed in WP6 “Business Acceleration and Developers Community Building” and especially of Task 6.4 “Technoeconomic analysis and Stakeholders engaging” is considered complementary to the work described herein for Task 7.4 on Exploitation activities, especially in setting as common ground the market and stakeholder analysis detailed in WP6 deliverables.

1.1 DOCUMENT STRUCTURE

The deliverable is structured as follows:

- **Section 2** presents the standardisation activities and achievements, with an summary report of the project’s involvement in the SDOs and Open-Source Community, and analytic presentation of the third-year achievements.

- **Section 3** discusses the project's innovations using the template-driven format of the EU Innovation Radar
- **Section 4** details the exploitation activities, providing the full list of all identified outcomes during the projects course (see 4.3) and the individual per partner exploitation plans (see 4.4).
- **Section 5** provides the actions performed in respect to the Commercialisation of Intellectual Property and Technology Transfer initiatives.
- **Section 0** concludes the deliverable with key take aways.

1.2 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 Network Applications, 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 STANDARDIZATION ACTIVITIES & ACHIEVEMENTS

2.1 OVERVIEW

Standardization activities, either in the form of participation or through actual contributions to SDOs, as well as contributions to the open-source community, have been deemed fundamental for achieving long term sustainability for the project and ensuring the widest possible exploitation of the EVOLVED-5G results. EVOLVED-5G partners appreciate the advantages of standardization towards technology interoperability, rapid consumer access to the latest and best technologies, promotion of competition and innovation, as well as collaboration of global R&D organizations, and as such, have been committed from the beginning of the project to a specific plan of involvement, that is detailed in D7.2. The active engagement of the consortium members to standards through successful contributions did not only highlight the project's impact and added value, but also validated the quality and relevance of its output. The intermediate period's standardization activities (M11-M24) have been incorporated into Deliverable D7.4, which presents the achievements of the respective period with the adoption of EVOLVED-5G contributions to standards. Conversely, the close collaboration of the consortium members with the standardization community secured the compliance of our development activities with the applicable standards.

The final report on standardization achievements, which is presented hereinafter into D7.6 (M1-M36), contains many and salient contributions. The main highlight has been the foundation of a new Software Development Group (SDG) within ETSI, named **ETSI-SDG OpenCAPIF** (see 2.2.4). The establishment of this new SDG is a significant achievement, rarely seen among the various ICT projects. EVOLVED-5G managed to formulate its vision on a Common Application Programming Interface (API) Framework as defined by 3GPP, to an outstanding development outcome which has been initially published in the **Innovation Radar** and subsequently led to the initiation of **OpenCAPIF SDG** within **ETSI**. This tremendous achievement is additional evidence of EVOLVED-5G project's commitment to succeed, going beyond its formal objectives and contributing with tangible results to the overall Industry 4.0 realization over 5G networks.

The overall **standardization activities**, including those pertinent to the final year of the project, as well as those already reported in the previous deliverable (D7.4), are presented within the two main categories identified: "*Monitoring*" and "*Contributing*", which reflect the SDOs the project monitored to align and comply with applicable standards, and respectively those the project actively contributed to, leaving its mark to the standards' ecosystem.

The complete list of standardization achievements is depicted hereinafter, structured around the associated SDOs, with explicit reference to the partners involved.

2.2 INVOLVEMENT IN STANDARDS DEVELOPMENT ORGANISATIONS (SDOs) & INDUSTRY ASSOCIATIONS

The standardization of EVOLVED-5G results has focused on relevant standards development organizations (SDOs) pertinent to the areas of Mobile System Standards and 5G Software Networks orchestration. The EVOLVED-5G team, through an initial analysis performed in the beginning of the project and depicted in deliverable D7.2 [2], has identified the most promising SDOs and the relevant committees to contribute to, the complete results of which, are presented in this section. The consortium partners with strong expertise and experience in the

field had been committed to perform standardization efforts constantly. The project focused on participating and contributing in 3GPP SA2 & SA6 WGs (LNV & TID), 5G-PPP Architecture (FOG, NCSRD, LNV) and Pre-standardization WGs (LNV), GSMA (TID), ETSI OpenCAPIF SDG (FOG, NCSRD, TID, UMA, LNV), ETSI-OSM (ATOS), ETSI-MEC ISG (LNV), TM FORUM (MAG), IEEE TSN (UMA), and other SDOs related to Industry 4.0 and FoF bodies, such as the Alliance for IOT Innovation (INTRA & UPV), BDVA/DAIRO (INTRA), EFFRA (INTRA), and 5G-ACIA (LNV). The relevant actions and contributions of each partner in the identified SDOs are provided in detail hereinafter.

Table 1: SDOs in EVOLVED-5G Target.

Group	Partners Representative(s)	Higher Type of Interaction
3GPP SA2, SA6 & other WGs	LNV,	Contributing
5G-PPP Pre-standardization WG	LNV	Contributing
GSMA	TID	Monitoring
TM FORUM	MAG	Monitoring
ETSI OSM	ATOS	Monitoring
ETSI MEC	LNV	Monitoring
IEEE TSN	TID, UMA	Monitoring
5G-ACIA	LNV	Contributing
Alliance for IoT Innovation (AIOTI), WG6, WG11	UPV, INTRA	Contributing
Data, AI and Robotics (BDVA/DAIRO)	INTRA, UPV	Monitoring
EFFRA (European Research Factories Association)	INTRA, UPV	Monitoring

2.2.1 3GPP SA2, SA6 and other WGs

With 3GPP being the most important SDO in cellular communications standards' specification, the project has provided numerous contributions throughout its 3-year period. LNV and TID have undertaken the role of representation and contribution to 3GPP on behalf of EVOLVED-5G, and the significant results achieved, reveal the standardization impact of the project both to the cellular standards' community and at 5G-PPP programme level. Below is a detailed list of contributions to the 3GPP SA2, SA5 and SA6 working groups.

Table 2: EVOLVED-5G Activities in 3GPP

EVOLVED-5G Work	Status	Contribution	Group	Period
New features to enable support of DN performance analytics by NWDAF.	Agreed	3GPP/TSG SA2/eNA_Ph2 Rel.17 Contribution: "Support of DN performance analytics by NWDAF" // S2-2101388	SA2	Y1 (D7.2)
New study item on data analytics enablement for vertical scenarios.	Revised to S6-212488 (Agreed)	3GPP/TSG SA6/FS_ADAES Rel.18 Contribution:	SA6	Y1 (D7.2)

EVOLVED-5G Work	Status	Contribution	Group	Period
		"Study on Application Data Analytics Enablement Service" // S6-212396		
New study item to support new services, such as requesting communication via specific network slices.	Agreed	3GPP/TSG SA6/FS_NSCALE Rel.18 Contribution: "Study on Network Slice Capability Exposure for Application Layer Enablement" // TR 23.700-99	SA6	Y1 (D7.2)
Enhance 3GPP specifications so that a new type of Network Application can be supported, which allows vertical apps to perform network slice provisioning, dimensioning, etc. based on the preferences of vertical apps.	Agreed	3GPP/TSG SA6/NSCALE Rel.18 Contribution: "Key Issue on support for trust enablement" S6 - 211967	SA6	Y2 (D7.4)
		3GPP/TSG SA6/NSCALE Rel.18: Contribution "Solution to KI #8 on API translation" S6-212400	SA6	
Initiate a New Study Item in 3GPP SA6 for app-layer analytics, related key issues and solutions to support Network Applications which can create app-layer analytics & predictions and provide insights into the operation and performance of vertical applications.	Agreed	3GPP/TSG SA6/FS_ADAES Rel.18: Proposal for a New Study Item, "Application Data Analytics Enablement Service (FS_ADAES)" SP-211509	SA6	Y2 (D7.4)
Enable API related analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.	Postponed	3GPP/TSG SA6/FS_ADAES Rel.18 KI Contribution: "Key Issue (KI) on API related analytics" // S6-220642	SA6	Y2 (D7.4)
Enable slice-related analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.	Agreed	3GPP/TSG SA6/FS_ADAES Rel.18 KI Contribution: "Key Issue on support for analytics related to slicing" // S6-220644	SA6	Y2 (D7.4)
Enable CAPIF enhancements to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.	Postponed	3GPP/TSG SA6/FS_ADAES Rel.18 KI Contribution: "Key Issue on CAPIF enhancements" // S6-220645	SA6	Y2 (D7.4)
Enable DN-related energy analytics to support the Application Data Analytics Enablement Service (FS_ADAES) for verticals.	Revised to S6-220860 (Postponed)	3GPP/TSG SA6/FS_ADAES Rel.18 KI Contribution: "Key Issue on DN related energy analytics" // S6-220646	SA6	Y2 (D7.4)
This paper provides a solution to Key issue #1: Support for application performance analytics. Two procedures are proposed (FS_ADAES)	Agreed	3GPP/TSG SA6/FS_ADAES Rel.18 Contribution: "Solution to KI #1 - support for application	SA6	Y2 (D7.4)

EVOLVED-5G Work	Status	Contribution	Group	Period
		performance analytics” // S6-220819		
Solution to KI #2 - support for edge analytics (FS_ADAES)	Agreed	3GPP/TSG SA6/FS_ADAES Rel.18 Contribution: “Solution to KI #2 - support for edge analytics” // S6-220972	SA6	Y2 (D7.4)
This contribution proposes an update to ADAE layer functional architecture.	Agreed	3GPP/TSG SA6/FS_ADAES Rel.18 Contribution: “ADAE layer architecture update” // S6-221349	SA6	Y2 (D7.4)
This paper proposes a solution to Key #12 (Network slice capability exposure in the edge data network) for supporting service continuity in scenarios where UEs are moving towards a different EDN area supported by different NSCE server.	Agreed	3GPP/TSG SA6/FS_NSCALE Rel.18 Contribution: “Solution on predictive slice modification in edge based NSCE deployments” // S6-221863	SA6	Y2 (D7.4)
DP on the relationship of CAMARA and SA work on capability exposure.	Endorsed	3GPP/TSG SA5 Discussion Paper: “DP on the relationship of CAMARA and SA work on capability exposure” // S5-222574	SA5	Y2 (D7.4)
This paper proposes solutions for Network Slice Management Capability Exposure via CAPIF.	Agreed	3GPP/TSG SA5 “pCR28.824 Describe possible solution for EGMF” // S5-222756	SA5	Y2 (D7.4)
Discussion paper on 5G exposure	Agreed	3GPP/TSG SA5 “DP on 5G exposure” // S5-222723	SA5	Y2 (D7.4)
This paper targets the completion of specification document (TS28.541) by providing Network Slice Subnet Provider Capabilities IOC. This aims to host the capabilities of the provider in terms of subnet it can provide/manage.	Agreed	3GPP/TSG SA5 Rel.17 Contribution: “CR 28.541 Network slice subnet provider capability IOC” // S5-223742	SA5	Y2 (D7.4)
This paper aims to correct specifications of TS28.531 clarifying the capabilities query procedure and its relation to the allocation procedure.	Agreed	3GPP/TSG SA5 Rel.17 Contribution: “CR 28.531 Network slice subnet capabilities” // S5-223743	SA5	Y2 (D7.4)
This paper proposes a new feature related to slice API configuration and translation in SEAL NSCE.	Agreed	3GPP/TSG SA6/FS_NSCALE Rel.18 Contribution: “Slice API translation and configuration” // S6-222146	SA6	Y3 (D7.6)
This paper proposes a new solution in EDGEAPP about	Agreed	3GPP/TSG SA6 Rel.18 Contribution:	SA6	Y3 (D7.6)

EVOLVED-5G Work	Status	Contribution	Group	Period
using edge analytics for triggering an EAS migration.		"Solution on interaction with SEAL / ADAES" // S6-222425		
New work item proposal for ADAES (led by Lenovo)	Revised to S6-222427 (Agreed)	3GPP/TSG SA6/FS_ADAES Rel.18 Contribution: "New WID for application data analytics enablement service" // S6-222154	SA6	Y3 (D7.6)
This paper proposes a solution for C2 mode feasibility checking (checking whether PC5 is available for drone to controller communication).	Agreed	3GPP/TSG SA6 "pCR 23.700-55 Support for C2 direct mode feasibility reporting" // S6-222424	SA6	Y3 (D7.6)
This paper proposes a mechanism for mapping a TSN topology to a network topology and resources.	Agreed	3GPP/TSG SA6 FFAPP Rel. 18 "Support for deterministic traffic requirements translation" // S6-221863	SA6	Y3 (D7.6)
This paper proposes a NSCE capability for OAM service discovery and exposure.	Revised to S6-223449 (Agreed)	3GPP/TSG SA6 FS_NSCE Rel.18 Contribution: "Discovery of management service exposure" // S6-222945	SA6	Y3 (D7.6)
This paper provided generic requirements for ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Generic architecture requirements" // S6-222942	SA6	Y3 (D7.6)
This paper introduced the architecture of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "ADAE functional architecture" // S6-223494	SA6	Y3 (D7.6)
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Support for VAL performance analytics" // S6-223235	SA6	Y3 (D7.6)
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Support for UE-to-UE session analytics" // S6-223455	SA6	Y3 (D7.6)
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution:	SA6	Y3 (D7.6)

EVOLVED-5G Work	Status	Contribution	Group	Period
		"Support for slice related performance analytics" // S6-223237		
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Support for location accuracy analytics" // S6-223456	SA6	Y3 (D7.6)
This paper adds ADAES as part of SEAL.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "ADAE functional model in SEAL architecture" // S6-223495	SA6	Y3 (D7.6)
This paper proposes an enhancement to service continuity planning in EDGEAPP.	Merged	3GPP/TSG SA6 FS_EDGEAPP Rel.18 Contribution: "ACR update in service continuity planning" // S6-230114	SA6	Y3 (D7.6)
This paper proposes a feature on predictive slice LCM change.	Agreed	3GPP/TSG SA6 FS_NSCE Rel.18 Contribution: "Predictive slice modification in edge based NSCE deployments" // S6-230360	SA6	Y3 (D7.6)
This paper added the business models for NSCE.	Agreed	3GPP/TSG SA6 FS_NSCE Rel.18 Contribution: "Business models and relationships for NSCE" // S6-230460	SA6	Y3 (D7.6)
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Support for service API analytics" // S6-230363	SA6	Y3 (D7.6)
This paper proposed an enablement capability for dynamically changing USS for a UAS.	Agreed	3GPP/TSG SA6 FS_UASAPP_Ph2 Rel.18 Contribution: "Support the USS re-mapping for a UAS" // S6-230364		Y3 (D7.6)
This paper proposed a new analytics capability of ADAES.	Agreed	3GPP/TSG SA6 FS_ADAES Rel.18 Contribution: "Support for edge load analytics" // S6-231048		Y3 (D7.6)

2.2.2 5G-PPP Pre-standardization WG

The 5G-PPP Pre-Std WG holds biweekly meetings where constant monitoring and discussions around 5G-PPP projects' standardization results take place. LNV has been actively participating

in all meetings on behalf of EVOLVED-5G, presenting and promoting the project's activities pertinent to standards. This active engagement ensured alignment of the project with the relevant SDOs, as well as cross-project coordination, allowing the EVOLVED-5G consortium members to promptly identify standardization opportunities and the respective organizations to follow up and contribute to, securing in parallel the project's roadmap. Indicatively, we may refer to the "2022 Q4 SDO Impact Report" where EVOLVED-5G officially included all the standardization achievements up to 2022 Q4, in an attempt from the Pre-standardization WG to collect input from all 5G-PPP projects and analyse the standardization impact at programme level.

2.2.3 GSMA

The GSMA is a global organization unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Telco operators participate in GSMA activities and working groups (Telefónica, COSMOTE).

Recently, GSMA has launched an Open API initiative called Open Gateway [6]. The goal of this initiative is to publish APIs for Developers to build applications that leverage 5G Networks. An initial set of APIs has been defined in the CAMARA Project [5], including Quality-On-Demand that maps with NEF capabilities exposed in EVOLVED-5G using the QoS management NEF API.

In more detail, CAMARA, launched by GSMA, is an open-source project within Linux Foundation to define, develop and test the APIs. CAMARA works in close collaboration with the GSMA Operator Platform Group to align API requirements and publish API definitions and APIs. The scope of this project is limited to telco APIs, that means APIs in the domain of telco mobile networks, telco fixed line networks, telco edge cloud, etc. or supporting these (e.g., for authentication). CAMARA only works on customer-facing northbound APIs. East-west federation / roaming APIs are out of scope for CAMARA. The initially supported (launched) network APIs are the following:

- SIM Swap
- Quality on Demand (QoD)
- Device Status (Connected or Roaming Status)
- Number Verify
- Edge Site Selection and Routing
- Number Verification (SMS 2FA)
- Carrier Billing – Check Out
- Device Location (Verify Location)

Deutsche Telekom has launched commercially the first CAMARA defined network APIs in the German market in a close partnership with Ericsson & Vonage¹.

¹ <https://www.vonage.com/about-us/vonage-stories/dt-partnership/>

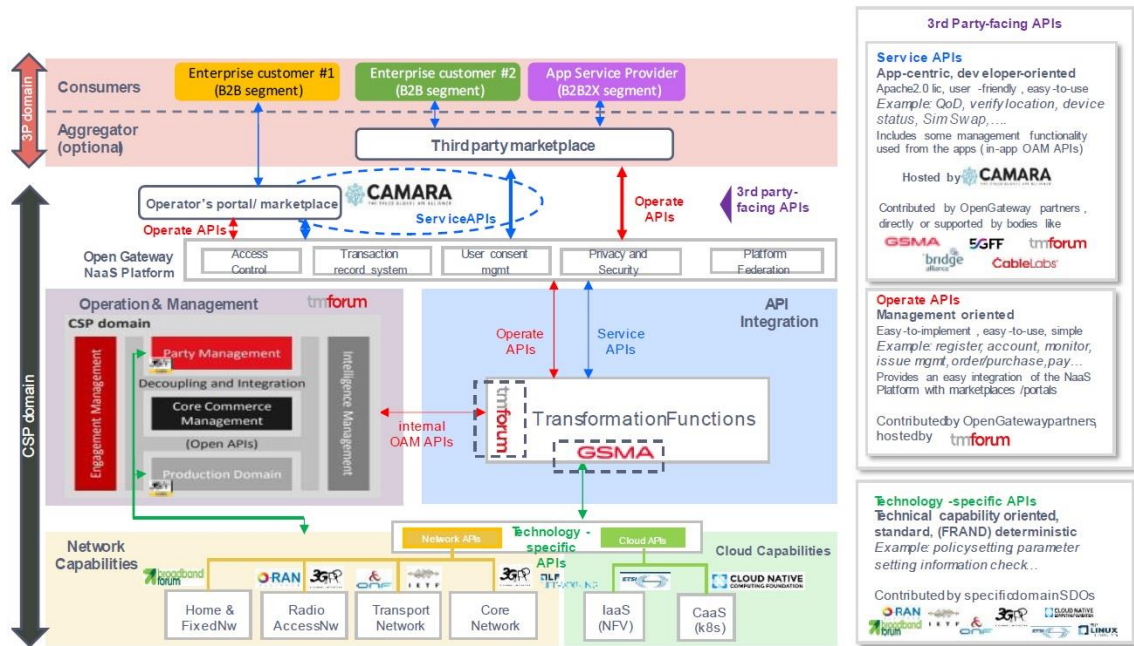


Figure 1: CAMARA alignment with SDOs

CAMARA project is defining a high-level Northbound API interface to expose Network capabilities to Developers through 3GPP APIs, such as NEF using CAPIF API Framework, which maps with the approach taken in EVOLVED-5G from the very beginning. It is therefore obvious that this initiative is closely associated with the work carried out within EVOLVED-5G, and key partners such as Telefónica (Premier Member) and NCSR Demokritos and INFOLYSIS (Participating organizations), have joined CAMARA project to follow closely the activities performed.

2.2.4 ETSI OpenCAPIF SDG

ETSI has announced the establishment of a new Software Development Group² called OpenCAPIF [7], which is driven by the EVOLVED-5G efforts to promote an open-source Common CAPIF API Framework, as defined by 3GPP, allowing for secure and consistent exposure and use of APIs. EVOLVED-5G partners Fogus Innovations and Services, National Centre for Scientific Research Demokritos, Telefónica SA, University of Málaga and Lenovo (Motorola Mobility) are founding members of the group. The implementation of OpenCAPIF is an integral part of the EVOLVED-5G development and the Network Applications lifecycle, SDK, and tools delivered by the project.

Beyond 3GPP APIs, OpenCAPIF can be leveraged by third-party APIs and will support other standardization activities by enabling Proof-of-Concepts, Plug tests, and API testing, to contribute feedback to standardization work. For instance, OpenCAPIF can support Network Function Virtualization (NFV) deployments by enabling consistent API exposure by Network Functions, and it can also contribute to network automation scenarios in ZSM. Plus, at the edge, it can be used not only to expose Multi-access Edge Computing (MEC) APIs (see 2.2.6) but also to validate the mapping between ETSI MEC APIs and those defined for the Edge Computing Enabling Layer as specified by 3GPP. SDG OpenCAPIF is expected to collaborate with other ETSI

² <https://www.etsi.org/newsroom/press-releases/2292-etsi-announces-new-software-development-group-for-common-api-framework>

software and open-source projects, such as the Open Source MANO (see 2.2.5), TeraFlowSDN³ and OpenSlice⁴, in order to share best practices and find synergies, joint activities, and opportunities for component reuse.

The code developed by SDG OpenCAPIF supports specifications from 3GPP SA6 and SA3 Release 17, and it will seek to align and provide feedback for future releases. The newly created ETSI group shall enable developers to test their network applications using CAPIF to publish and consume APIs, reducing the friction and accelerating time-to-market for the deployment of these applications in 5G Networks. ETSI OpenCAPIF builds on code seeds developed by European Research.

The OpenCAPIF community seeks synergies and collaboration with external fora and open-source projects developing and exposing APIs, such as TM Forum (see 2.2.7), GSMA, CAMARA (see 2.2.3), and Linux Foundation Europe i.e. the Sylva⁵ project. For example, the code developed by SDG OpenCAPIF can be used as CAPIF Core Function (CCF), a cornerstone for the facilitation and testing of interactions among various functions and applications exposing and consuming APIs. This would be key to ensure alignment between the Linux Foundation and GSMA-backed CAMARA project and 3GPP Specifications. SDG OpenCAPIF will find collaboration and code reuse with CAMARA, to minimise code duplication and potential misalignments.

2.2.5 ETSI-OSM

Open-Source Mano (OSM) [10] is an ETSI-hosted initiative developing an open-source Management and Orchestration (MANO) stack aligned with ETSI NFV Information Models. As a community-led project, OSM delivers a production-quality MANO stack that meets operators' requirements for commercial NFV deployments. The ETSI-OSM community has established cadence of two releases per year, alternating between LTS releases (2 years support) and Standard releases (6 months support), latest being the OSM Release FOURTEEN in July 2023 [11].

Orchestration is a pivotal capability of the EVOLVED-5G platforms, relevant for both Malaga and Athens EVOLVED-5G infrastructure, and it is important for the project to follow the community to be aligned with its latest updates.

ATOS has been an active member for several years now, following the discussions, analysing every new release, and contributing whenever possible through the work developed in 5G PPP projects. The main goal is, on the one hand, being aware of the topics / trends that may be of interest for the project, and, on the other hand, giving visibility to the work done by the project. During the project time plan, ATOS has evaluated how EVOLVED-5G could contribute to the community. An initial plan, as stated in deliverable D7.4 [3], was evolving the “dispatcher”, a component developed by ATOS as part as the ICT-17 project 5GENESIS [20] and that was adopted by the OSM community at the time [11]. However, the majority in the consortium has decided to use a CI/CD solution based on Jenkins therefore, it was not possible to further contribute to OSM in the context of the project.

³ <https://tfs.etsi.org/>

⁴ <https://www.etsi.org/component/tags/tag/openslice>

⁵ <https://www.linuxfoundation.org/press/linux-foundation-europe-announces-project-sylva-to-create-open-source-telco-cloud-software-framework-to-complement-open-networking-momentum>

2.2.6 ETSI-MEC ISG

The Multi-access Edge Computing (MEC) initiative is an Industry Specification Group (ISG) within ETSI. The purpose of the ISG is to create a standardised, open environment which will allow the efficient and seamless integration of applications from vendors, service providers, and third parties across multi-vendor Multi-access Edge Computing platforms.

EVOLVED-5G, through LNV's participation in ETSI-MEC, monitored the latest advances in standards and the respective technologies related to Multi-Access Edge Computing. Even though the Network Apps developed by the project do not entail any specific requirements for the consumption of MEC APIs, monitoring the outcomes of ETSI-MEC community assisted the consortium members in identifying possible means to extend the capabilities of their vertical applications in general, beyond the project's scope and lifetime. This way, the project secured its future compliance with the applicable ETSI-MEC standards and came up with useful insight on how vertical applications could benefit from the advanced functionality offered by MEC APIs.

2.2.7 TM FORUM

TM Forum⁶ is an alliance of 800+ global companies working together to break down technology and cultural barriers between digital service providers, technology suppliers, consultancies, and systems integrators. A key project of TM Forum is TM Forum Open APIs [8] that have been widely adopted by the industry as a standard interoperability method, with more than 640,000 downloads by 39,000 software developers from 2,500 organizations.

The TM Forum OpenAPIs are the basis for the implementation of the EVOLVED-5G Marketplace, whose purpose, in alignment to TM Forum's business focus, is to provide support for SMEs and other interested stakeholders or Network Applications users on the use of Network applications, as well as in related topics such as the creation of Network applications or the development of an EVOLVED-5G Network applications ecosystem. MAG, the core developer of the EVOLVED-5G Marketplace is closely monitoring and conforming to the developments of TM Forum and OpenAPIs initiative.

2.2.8 IEEE TSN

IEEE Time-Sensitive Networking (TSN) is a set of standards defined by IEEE 802.1 Working Group, specifically IEEE TSN Task Group [16]. TSN emerged as an evolution from the Audio Video Bridging (AVB). The main objective is to provide deterministic communications (bounded low-latency, low jitter, low packet loss) over IEEE 802 networks such as Ethernet. In this way, it provides a toolset to support the main TSN elements. Note that there are more techniques, mechanisms, and standards to support these main TSN elements. Especially, it considers:

- Time synchronization: accurate time synchronization (less than 1ms) shared among the devices.
- Timing and synchronization – 802.1AS
- Bounded low latency: mechanisms to guarantee the delivery of packages within a certain time frame.
- Scheduled traffic – 802.1Qbv
- Credit Based Shaper (CBS) – 802.1Qav
- Frame pre-emption – 802.1Qbu
- Ultra-reliability: techniques to ensure packet loss and reliability requirements.
- Frame Replication and Elimination (FRER) – 802.1CB

⁶ <https://www.tmforum.org/about-tm-forum/>

- Path Control and Reservation – 802.1Qca
- System configuration: configuration to satisfy the traffic flow requirements.
- TSN configuration – 802.1Qcc
- Stream Reservation Protocol – 802.1Qat

The use of deterministic communications has been increasing in the industrial environment in recent years and the role of TSN in the Network Applications development is very important. Based on these specifications, UMA has implemented a TSN over 5G Application Function proof-of-concept in the framework of the EVOLVED-5G project to evaluate the potential of some of the TSN features presented above and has developed the enablers for the combination of both technologies, TSN and 5G networks. The proof-of-concept ((see D3.1[17] and D3.3 [18]) includes a first approximation of the time synchronization using the same GPS signal divided into two TSN grandmasters and the TSN Frontend allows users to request certain QoS (delay, jitter, etc.) for their traffic sessions. Moreover, a Zero-Touch approach has been implemented for automatic reconfiguration of the 5G network based on the above traffic requirements, which is based on Automata Learning.

2.2.9 5G-ACIA

The contemporary industrial ecosystem, represented in EVOLVED-5G through its diverse consortium members, requested for advanced solutions in industrial environments leveraging 5G technology. In this direction, the project identified the necessity not only to follow, but to affect the technology advancements related to industrial applications through its participation and contributions to the 5G-ACIA.

The 5G Alliance for Connected Industries and Automation (5G-ACIA) was established to serve as the main global forum for addressing, discussing, and evaluating relevant technical, regulatory, and business aspects of 5G for the industrial domain. 5G-ACIA's main goal is to promote the benefits and evaluate the results of 5G networks' utilization in the industrial domain.

LNV has been leading the work in 5G-ACIA on identifying use cases and requirements for the use of 5G sidelink (aka device-to-device) communication for industrial factory and process automation applications. The work aimed to identify how factory use cases can benefit from the deployment of 5G NR sidelink communication. An example has been the study on how to address the requirement for supporting time sensitive communication over sidelink. 5G-ACIA's work on sidelink has been just recently concluded (September 2023), leading to the publication of a whitepaper titled **"Using 5G sidelink in industrial factory applications"**. This whitepaper revolves around the potential benefits and challenges of using 5G sidelink in factory applications, enumerates the use cases that could benefit from 5G Sidelink in factory automation (i.e., motion control, controller-to-controller communication, carrying mobile robots, relative positioning in smart factories), presents the general considerations for spectrum use in 5G Sidelink deployment, and finally identifies the requirements for using 5G Sidelink in factory applications.

This solid collaboration with 5G-ACIA community did not only ensure the project's alignment with the standardization decisions produced by this SDO, but most importantly allowed EVOLVED-5G to stay in the forefront and leave its mark on connected industry and process automation decisions, through its own contributions to standards.

2.2.10 Alliance for IoT Innovation (AIOTI) WG6, WG11

The AIOTI Alliance⁷ initiated by the European Commission in 2015, 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. Several Working Groups of the Alliance for IoT Innovation (AIOTI) are related to the EVOLVED-5G activity, in particular “5G and Beyond and its relation to IoT” Standardization Task Force, “Computing Continuum” and “IoT Landscape”. EVOLVED-5G partners UPV, LNV and INTRA are members of AIOTI. They monitored on behalf of the project the standardization and pre-standardization activities and proposed relevant EVOLVED-5G innovations and topics to be addressed in the innovation strategic agenda of these working groups, also contributing to AIOTI reports and whitepapers in regard with its innovations in the field of 5G and beyond 5G. Specifically, UPV has contributed with an article describing the potential of Network Apps in M2M communications for the next whitepaper of the TF “IoT and Edge Computing impact on Beyond 5G” to be published February/March 2024.

2.2.11 Data, AI and Robotics (BDVA/DAIRO)

Data, AI, and Robotics (DAIRO), formerly known as the Big Data Value Association (BDVA), is an association that aims to boost European research, development, and innovation in the fields of Artificial Intelligence (AI), Data, and Robotics. This evolution of the association reflects a broadening of its mandate and scope of activities, aligning with the key disciplines of Data, AI, and Robotics.

DAIRO plays a significant role in collaborating with other communities to engage in these intersecting key disciplines. This collaboration is crucial for working with the European Commission on important agendas like the Europe fit for a Digital Age, the Green Deal, and the Data Strategy. In this context, DAIRO is committed to delivering the vision of the AI, Data, and Robotics Partnership, contributing to the European Data Strategy and the EuroHPC Joint Undertaking, and supporting the digital and environmental transformations of Europe.

EVOLVED-5G, through INTRA’s participation in DAIRO, monitors all the relevant Tasks forces. These task forces include fundamental task forces like the Roadmap, Strategic Agenda and Programme Task Force, and the Community/Ecosystem Task Force. More specifically, EVOLVED-5G has monitored Task force 6 TF6 (Technical) that focuses on monitoring and collecting information about ongoing and emerging technical trends in technical priority areas: i) TF6-SG1: Data technology architectures and ii) TF6-SG3: Data Science and AI; both include all related data management aspects from an EU perspective, generating a relevant state of the art and providing input to European policies.

2.2.12 EFFRA (European Research Factories Association)

The European Research Factories Association (EFFRA) is a non-profit, industry-driven association dedicated to the development of new and innovative production technologies. It plays a pivotal role as the official representative of the private side in the “Made in Europe” partnership. EFFRA's focus is on shaping, promoting, and supporting the implementation of the ‘Factories of the Future’ partnership and the Factories of the Future community. This involves a strong and growing network of industrial, university, research, and other related stakeholders who share an interest in transforming production technologies in Europe. EFFRA is recognised as the official

⁷ <https://aioti.eu/>

representative of the manufacturing research community engaged in the European Union's 'Factories of the Future' partnership.

EFFRA has recognised the significant impact that 5G technology can have in the manufacturing sector. 5G is seen as a key enabler for advancing the capabilities of modern factories, particularly in the context of digital transformation and smart manufacturing.

EVOLVED-5G, through INTRA's participation in EFFRA, monitors all the relevant activities and proposes EVOLVED-5G innovations and topics, highlighting the potential of 5G to revolutionise manufacturing industries by providing higher connection speeds, reduced latency, improved information visibility, and increased efficiency. The ability to utilise cloud technology for machines and robots, access programs from the cloud, and minimise downtime are among the key benefits of integrating 5G into manufacturing processes. Additionally, 5G can support mobile workers on the shop floor, enabling wireless communication with machines and ICT systems, and enhancing occupational safety through better monitoring.

2.3 INVOLVEMENT IN OPEN-SOURCE PROJECTS

The EVOLVED-5G Consortium understands the importance of the Open-Source community, both as a source of valuable tools and expertise useful for the project developments, and to increase the impact of the project achievements, by providing them to the community. The interaction of the project with Open-Source projects is respectively described in the tables below.

Table 3: Open-Source Projects Adopted by EVOLVED-5G

Open-Source Project	Description	Used In EVOLVED-5G
Cloud Native Computing Foundation (CNCF) [4] Kubernetes Prometheus	open source, vendor-neutral hub of cloud native computing, hosting projects like Kubernetes and Prometheus to make cloud native universal and sustainable. Kubernetes: provides the infrastructure for managing containers. https://kubernetes.io/ Prometheus: open-source monitoring tool https://prometheus.io/	Validation and Certification Environments
Docker	Industry/academia renowned tool for creating containers. https://www.docker.com/	Validation/Certification Pipeline, Network App development
Jenkins	DevOps tool, used for automating processes related to building, testing, and deploying applications, as well as facilitating continuous integration and continuous delivery (CI/CD). https://www.jenkins.io/	Validation/Certification Pipeline
JFrog	Part of CI/CD services – Artifactory used for binaries/packages storage – enables DevOps process. https://jfrog.com/	Validation/Certification Pipeline
Trivy	Security scan analysis tool for detecting vulnerabilities in the static code and containers. https://trivy.dev/	Validation/Certification Pipeline
SonarQube	Tool for guaranteeing quality in the source code repositories. https://www.sonarsource.com/products/sonarqube/	Validation/Certification Pipeline

Open-Source Project	Description	Used In EVOLVED-5G
Robot Framework	Test case automation framework. https://robotframework.org/	Verification/ Validation/ Certification
License Check	Licensing scan tool assisting the operation of the certification process. https://pypi.org/project/licensecheck/	Certification process
NMap	Tool for analyzing port connectivity - assists application developers to early identify any unnecessarily open ports and fix issues to further enhance application security and prevent intrusion. https://nmap.org/	Validation/Certification Pipeline
Helm	Tool that manages Continuous Deployment of several Kubernetes applications and also includes version management. https://helm.sh/	Validation/Certification Pipeline
Open-Source MANO (OSM)	MANO stack. https://osm.etsi.org	Athens & Malaga Platforms
Open API Generator	API definition (YAML) files to create client/server baseline code. https://github.com/OpenAPITools/openapi-generator	CAPIF development
FAST APIs	Framework to build RESTful APIs. https://github.com/tiangolo/fastapi	NEF emulator development
TM Forum's Open API	Product Catalog Management API. https://www.tmforum.org/oda/open-apis/	Marketplace

Table 4: EVOLVED-5G Open-Source Contributions

Open-Source Project	Description	Contributions by EVOLVED-5G
OpenTAP	Test automation framework / used in platforms https://github.com/opentap/opentap	Enhancements as part of its use in the certification pipeline.
Open5GENESIS	Orchestration tool /used in Validation environment https://github.com/5genesis	Enhancements as part of its use in the certification pipeline.
Network Apps v4.1 (Final prototype)	The main project outcome // Innovation in D7.2 (Y1) // Open-Source in D7.4 (Y2) https://github.com/EVOLVED-5G	Entirely developed by the project // Release of generic purpose Industry 4.0 Network Apps to the open-source community
SDK libraries	Set of tools assisting developers to create their Network Apps. It comprises: <ul style="list-style-type: none"> • Instructions on how to develop Network Apps • Pre-defined templates assisting the dev process. • A Command Line Interface (CLI) tool assisting creation of the repository of each Network App from the template. • Several libraries assisting developers by simplifying the integration of their Network Apps with the 5G emulated and actual 5GC APIs. https://github.com/EVOLVED-5G/SDK-CLI	Entirely developed by the project // Release of the SDK to the open-source community

Open-Source Project	Description	Contributions by EVOLVED-5G
Marketplace	Developed by the project and used for public listing of the available Network Apps https://github.com/EVOLVED-5G/marketplace	Entirely developed by the project // Release of the Marketplace (where certified Networks Apps can be hosted) to the open-source community

3 PROJECT INNOVATIONS

3.1 OVERVIEW

Besides the numerous standardization achievements cited in the previous section, this final deliverable contains an extensive reference to the project innovations, all those important outcomes developed and unveiled by the project. The innovation activities have also leveraged or contributed to the Open-Source community, either by incorporating open-source code and tools into its development and testing activities, or by contributing its outcomes as open sourced, which will further foster their development progress and adoption.

As thoroughly analysed in our previous deliverables, “innovation” mainly refers to the process of creating value by applying novel solutions to meaningful problems. Innovation can be further materialised into different types, such as products and services, processes, and business models.

- **Products – services innovation** is referred to the development of novel products and services, as well as to the introduction of new features in existing products/services. On this area, EVOLVED-5G has made outstanding contributions, developing the **CAPIF Core Function** and the **NEF emulator** based on the respective 3GPP standards. Both software entities have been recognised by the **EU Innovation Radar** as high potential innovations and the relevant partners as innovators in EU-funded research. Innovative products may be also considered the **Containerised Network Apps** and the assisting **Auxiliary Network App**, which are considered integral part toward the realization of the project’s objectives in the direction of researching common applications to support industrial use cases and process automation under the support of 5G network.
- **Processes innovation** is related to the continuous evolvement and improvement of existing processes or creation of new ones. To this direction EVOLVED-5G devised the Network Apps’ **Certification process** and developed the Certification pipeline to evaluate any third-party network application developed according to the EVOLVED-5G formal instructions and standards. The EVOLVED-5G Certification process, materialised following the two-step certification methodology which has been thoroughly analysed in D7.4 (**Certification Creation & Certification Execution process**), opens up a new ecosystem where third parties and verticals can access and exploit 5G network capabilities in a standardised and trusted way, unlocking the network intelligence to them and their vertical applications. The process itself not only pioneers how Network Apps, as primarily third-party software interworking with the network, shall be certified in the proposed EVOLVED-5G ecosystem, but also expands traditional certification practices in mobile networks, mainly focused nowadays on devices interoperability and conformance.
- **Business model innovation** is connected to the definition of disruptive business models and new revenue streams. The EVOLVED-5G **Marketplace** is identified both as an innovative product and at the same time as a business model innovation, also addressing the business-related aspects. As a product innovation, the Marketplace leverages state-of-art techniques based on the solutions provided by the Blockchain technology, to secure the upload procedure and exploitation of the Certified Network Apps, respectively to and from the EVOLVED-5G Marketplace. As a business model innovation, D7.4 illustrates in detail the evolution of Marketplaces and how most recent

technological and business advancements have created new business models for CSPs using Marketplace platforms.

An overview of the innovations identified and materialised through the EVOLVED-5G project from its start and as shaped to the project's end, are summarised in Table 5.

Table 5: EVOLVED-5G Innovations.

Innovation Title	First Reported	Status
Network Applications	Y1	Merged with the Containerised Cloud-Native Network Applications as a single proposition
NEF Emulator utilizing 3GPP's exposure services	Y1	Maintained
Open-Source implementation of the 3GPP CAPIF Core Function	Y1	Maintained
Containerised Cloud-Native Network Applications	Y1	Merged with the Network Application as a single proposition
Auxiliary Network Application	Y1	Merged with the Network Applications as a single proposition
Marketplace for Network Applications	Y2	Maintained
Certification Process for Network Applications	Y2	Maintained

The project has followed the EU Innovation Radar Methodology [1] and has already submitted by the second project year, the two core innovations of the project, NEF Emulator and Open Source CAPIF. The final innovations are thereafter described in the subsequent paragraphs, following the concise, template-driven format of the EU Innovation Radar as presented in Annex A: Innovation Radar Methodology.

3.2 NETWORK APPLICATIONS CONTAINERISED & CLOUD NATIVE

Table 6: Network Applications Containerised & Cloud Native Innovation

Network Applications Containerised & Cloud Native		Reported in Y1
Description	<p>The EVOLVED-5G developed Network Apps can be considered as one of the core innovations of the project, because they provide 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 Network Apps are containerised applications following the state-of-art Cloud-Native approaches on developing applications as microservices, with the well-known advantages this technology offers in terms of distributed deployment, scalability, adaptability, ease of migration and application resilience. The EVOLVED-5G containerised Network Apps have been verified to conform to modern containers' orchestration platforms, such as the Openshift and Kubernetes. The full list of the Network Apps that have been developed within EVOLVED-5G is the following:</p> <ul style="list-style-type: none"> • Digital/physical twin Network App • 5G enabled intent-driven chat-bot Network App for human-machines interaction Network App • Network Monitoring and Anomaly Detection of I4.0 5G NPN Network App 	

	<ul style="list-style-type: none"> Trusted event management Network App Autonomous 5G network monitoring for AR/VR usage Network App Authentication and authorization management towards 5G APIs Network App FoF IoT System Network App Identity and access management Network App Occupational safety analysis Network App Teleoperation Network App Global Localization Network App <p>Beyond the above-mentioned Network Apps which have been among the project's official commitments, an additional proof-of-concept has been developed by Lenovo as part of their own research activities, that is the "Auxiliary Network App" which follows the same state-of-art development principles as the aforementioned Network Apps, and realises a data collection and prediction analysis loop based on feeding (through standardised APIs) the Network Data Analytics Function (NWDAF) with vertical application measurements in order to resolve the "best vertical application server selection" problem.</p>		
Innovation Level	Very Innovative	Innovation Type	New Product/Service
Market Creation Potential level	Very high	Innovation Maturity	Tech Ready
Market Maturity	Already existing market		
How will the innovation be exploited?	Introduced as new to the market	When could be commercialised?	1-2 years
Market Dynamics	Growing	Competition	Established, but none with similar proposition

3.3 NEF EMULATOR UTILIZING 3GPP'S EXPOSURE SERVICES

NEF Emulator utilizing 3GPP's exposure services			Reported in Y1
Description	<p>Network programmability is one of the core technologies to be leveraged by the EVOLVED-5G project towards the Network Application implementation according to its principles. The exposure of APIs by the underlying network allows programmable access to network functionalities and resources in general.</p> <p>In the light of the above, NEF emulator is a software component that emulates the 5G NEF APIs of 5GS Rel. 17 (3GPP). At its core, it implements a REST API approach to provide data. More specifically, the emulator emulates the basic functionality of the control plane flow between the NEF and a Network Application, by providing tools for emulating events, acting according to realistic scenarios (i.e., mobility aware event, using real life data). The fact that at this stage there are no commercial solutions implementing the entire service-based architecture and the southbound interfaces that NEF requires to offer the standardised APIs and the communication with network functions, highlights the significance and the innovative aspects that NEF Emulator.</p>		
Innovation Level	Very innovative	Innovation Type	New Product/Service
Market Creation Potential level	Very high	Innovation Maturity	Tech Ready

Market Maturity	Market-creating: The market is not yet existing, but the innovation has clear potential to create a new market		
How will the innovation be exploited?	Introduced as new to the market	When could be commercialised?	Between 1 and 3 years
Market Dynamics	Growing	Competition	Established, but none with similar proposition

3.4 OPEN-SOURCE IMPLEMENTATION OF THE 3GPP CAPIF CORE FUNCTION

Open-Source implementation of the 3GPP CAPIF Core Function			Reported in Y1
Description	<p>The implementation will serve as an enabler for secure interaction of third parties with the mobile network native functions, such as the interaction of a third-party application with the core network APIs of a 5G network (i.e., the APIs exposed by the Network Exposure Function – NEF). It considers all the related 3GPP specifications to guarantee maximum interoperability and reusability in real systems and is supported by automated ready-to-use test cases as well as auxiliary components that make the development fully functional when a real API provider system (e.g., the 5G core) is not available.</p> <p>Upon its finalisation it will be the first open-source implementation of the Core Function of the Common API framework (CAPIF) as specified by 3GPP Release 17 in TS 23.222. The implementation is expected to serve as a continuously developing project that will support and accelerate the introduction of network-interacting applications, the Network Applications as they are defined by the EVOLVED-5G project.</p>		
Innovation Level	Very innovative	Innovation Type	New Product/Service
Market Creation Potential level	Very high	Innovation Maturity	Tech Ready
Market Maturity	Market-creating: The market is not yet existing, but the innovation has clear potential to create a new market		
How will the innovation be exploited?	Introduced as new to the market	When could be commercialised?	Between 1 and 3 years
Market Dynamics	Growing	Competition	Established, but none with similar proposition

3.5 MARKETPLACE FOR NETWORK APPLICATIONS

Marketplace for Network Applications			Reported in Y1
Description	The EVOLVED-5G Marketplace is a Software as a product marketplace (SaaS) which allows its users, such as SMEs to publish, search, discover, acquire and deploy Network Apps that were developed with pre-configured network slices. The Marketplace allows the users to engage in various ways, and thanks to the certification process/mechanism ensures that the published services and Network Apps are compliant with the marketplace rules. The marketplace also implements dashboards for publishers and buyers to track the revenue/balances, view consumption of analytics, and monitor API and services performance.		
Innovation Level	Very innovative	Innovation Type	Software as a product

Market Creation Potential level	High	Innovation Maturity	Market-Ready
Market Maturity	New to the market, this will create a disruption, and first mover advantage in the market.		
How will the innovation be exploited?	By introducing the solution to different SMEs, and making it available	When could be commercialised?	Between 1 and 3 years
Market Dynamics	Growing market	Competition	No similar marketplace solution at the time being

3.6 CERTIFICATION PROCESS FOR NETWORK APPLICATIONS

Certification Process for Network Applications			Reported in Y2
Description	EVOLVED-5G is proposing an entirely new ecosystem for Network Applications where third parties, verticals and MNOs collaborate so that applications can exploit 5G network capabilities in a standardised and trusted way, leveraging the network intelligence to boost their performance. The role of mobile network operators (MNOs) is key in this new ecosystem, either as the authority that exercises control over a public network infrastructure, or as the administrator in charge of operating a campus private network.		
	In this extended ecosystem, well-established coordination work is necessary to ensure interoperability and integration of the 3 rd party Network Applications with the deployed mobile networks to achieve smooth operation with guaranteed quality performance. Building upon the concepts of the devices’ certification paradigm already in use by the MNOs, a new process is proposed for the Certification of Networks Applications, presenting a detailed methodological approach for the whole certification lifecycle, from the certification creation to the certification execution and revocation process.		
Innovation Level	Obviously innovative and easily appreciated advantages to customer	Innovation Type	New Process
Market Creation Potential level	High	Innovation Maturity	Tech Ready
Market Maturity	Market-creating: The market is not yet existing, but the innovation has clear potential to create a new market		
How will the innovation be exploited?	Introduced as new to the market	When could be commercialised?	Between 1 and 3 years
Market Dynamics	Growing	Competition	Patchy, no major players

4 EXPLOITATION ACTIVITIES

4.1 OVERVIEW

As part of the project results' exploitation study, in the first year of EVOLVED-5G, the baseline methodology to explore the business development potentials was formalised, as thoroughly described in D7.2[2]. The methodology considered a stepwise approach, each step planned for execution per each project's year, as depicted in Figure 2, and reported in the respective deliverables, D7.2[2] for Step 1, D7.4 [3] for Step 2, while the current document presents the developments for Step 3.



Figure 2: EVOLVED-5G Exploitation Strategy Steps

Executing the methodology, an extended list of project outcomes was identified, including non-profit related outcomes. The list was further distilled and prioritised with special focus on exploitable results, and the appropriate categorisation per outcome category (e.g., business development, product development) and type (e.g., prototype or demonstrator), including Technology Readiness Level (TRL), and customer segment analysis. The outcomes were related to Target Markets and End Customers, with a short reference to the competition foreseen already from the first year of the project, while a concise gap analysis was studied in the second year. In the third year, the core subject of this document, apart from the continuous revision of key exploitable outcome characteristics, has been to analyse the Value Proposition Canvas for all outcomes of higher maturity (TRL > 5).

The following sections present the final and complete list of exploitable outcomes of the project, identified both from the perspective of the platform enhancements to appropriately integrate the Network Applications (see 4.3.1), as well as from the Network Applications per se, as delivered by the SMEs of the project (see 4.3.2).

The focus of work for the last year, reflected in this deliverable, is to re-visit the identified project outcomes, taking into consideration the final developments of the project as well as the overall ecosystem, as reflected in 5G PPP [13], especially in relation to the Network Applications' exploitation potentials. In respect to the platform-related results, a split of the 5G Facility outcome to two separate outcomes, the turn-key running platform, and the all-encompassing software service package that it instantiates has been made, which led to extensive analysis, including SWOT, for the new outcomes. Additionally, for all the platform-related outcomes, Value Proposition Canvas analysis has been performed, as described in D7.2[2] and briefly

presented in ANNEX B: Value Proposition Canvas. In respect to the Network Applications and SMEs related results, special attention has been put on the Network Application classification and deployment approach defined by 5G PPP [13] that has resulted to a shortlist of the most prominent Network Applications to be further analysed with the Value Proposition Canvas analysis as presented in Section 4.3.2.

4.2 EVOLVED-5G EXPLOITABLE OUTCOMES

EVOLVED-5G has worked for the development of the appropriate 5G and beyond ecosystem to support the implementation of intelligent Network Applications, exploiting the 5G openness by producing the necessary systems, toolchains, and automation processes. The prototypes that implement the EVOLVED-5G Facility concepts become a distinct set of outcomes, presented in Table 7 below, which reflects the updates of previous work with the delineation between the EVOLVED-5G Facility and its corresponding Facility Service Package.

Table 7: EVOLVED-5G Platform Exploitable Results

	Platform-level Exploitable Result	LEAD
1A	EVOLVED-5G (Network Application Development, Validation, Certification & Execution etc.) Facility	NCSRD
1B	EVOLVED-5G Service Package	ATOS
2	SDK tools for Network Application Development	ATOS
3	Network Application Validation Tools	UMA
4	Network Application Certification Environment	TID
5	Network Application Marketplace	MAG
6	NEF Emulator	NCSRD
7	CAPIF Core Function Tool	TID

Building upon the delivery of the platform-related outcomes, the project has proceeded to implement selective Network Applications, prioritised by the participating SMEs to target specific markets and application gaps. Furthermore, the Network Applications delivered have been integrated with the respective vertical applications to produce turn-key solutions for the final services to be leveraged by the vertical industries. Overall, the Network Application *Prototype* and the corresponding Integrated Solution *Demonstrator* are considered different outcomes -not only because of their different types but primarily as they are targeting different customers - non-the-less interlinked as the successful implementation of the integrated solution is highly dependent to the suitable Network Application implementation. Table 7 provides a synthetic view of the Network Applications prototyped and the related integrated solutions that exploit them.

It must be clarified that while previous work has focused individually on the Network Application and the respective integrated with the vertical application solution, the priority of the analysis for the last year was shifted on the Network Applications per se, with attention on the Non-Stand-Alone Network Applications because these can be reused in various applications, and thus can be more clearly individually marketed. A pragmatic exploitation analysis of the Network Application and Vertical Application Integrated Solution, is subject to the individual exploitation

analysis per partner, understanding that for all the identified integrated solutions a clear Intellectual Property ownership has been identified, in the name of the Lead Partner presented in Table 8 below.

Table 8: Network Applications/SME Exploitable Outcomes

	Network Application	Lead	Integrated Turn-key Solution
1	Digital/Physical Twin for the Aircraft Business Network Application	GMI	Composite Repair Physical / Digital Twin in the Aircraft Business
2	Chatbot Assistant Network Application	INF	Location-aware Chatbot for Precise Maintenance in a 5G/Network Application-enabled Industry 4.0 Manufacturing Environment
3	Network Monitoring and Anomaly Detection of I4.0 5G NPN Network Application	ZORTE	Network Monitoring and Anomaly Detection for the Factory of the Future
4	SIEM Network Application	FOGUS	Security Information and Event Management
5	Remote Assistance in AR/VR Usage Network Application	IMM	Autonomous Adaptation to Network Performance and User Needs
6	Intelligent Network Traffic Management Network Application	8BELLS	Programmable Next-Generation Firewall
7	Assured 5G QoS with Integrated SLA/SLS Monitoring Network Application	ININ	5G IOT System
8	Identity and Access Management Network Application	IQB	Authentication and Authorization Management for Accessing the northbound 5G APIs
9	NetMapper Network Application	CAF	Occupational Safety Analysis
10	Global Localization Network Application	PAL, UML	Global Localization for Common Workforce
11	Teleoperation Network Application	PAL	Teleoperation Services
12	Smart Irrigation 5G Agriculture Network Application	UMA	Smart Irrigation 5G Agriculture System

4.3 PROJECT LEVEL EXPLOITATION ACTIVITIES

Based on the exploitation concepts analysed above, there is a logical separation between project developments around the EVOLVED-5G components, that are analysed in 4.3.1 as platform exploitable outcomes, and Network Applications implementations presented in 4.3.2.

4.3.1 EVOLVED-5G Platform Exploitable Outcomes

The following sections present the final analysis of the platform related exploitable outcomes including the Value Proposition Canvas that has been the focus of the third-year work.

4.3.1.1 EVOLVED-5G Facility

The EVOLVED-5G facility is a fundamental result of the project. During the last year's business analysis it has been made clear that the facilities developed in Athens and Malaga to serve as open 5G NPN experimentation testbeds, can stand as business entities offering turn-key services to the SMEs developing applications for 5G markets, separately from the enabling EVOLVED-5G environments, the software packages containing toolchains, automation pipelines and libraries, that can be bundled as a separate unique product offering, targeting other platforms that tend

to implement the EVOLVED-5G approach. This paragraph is thus focusing on the running/integrated testbeds analysis, while the service package is presented in the following paragraph.

Table 9: EVOLVED-5G Facility Outcome Description

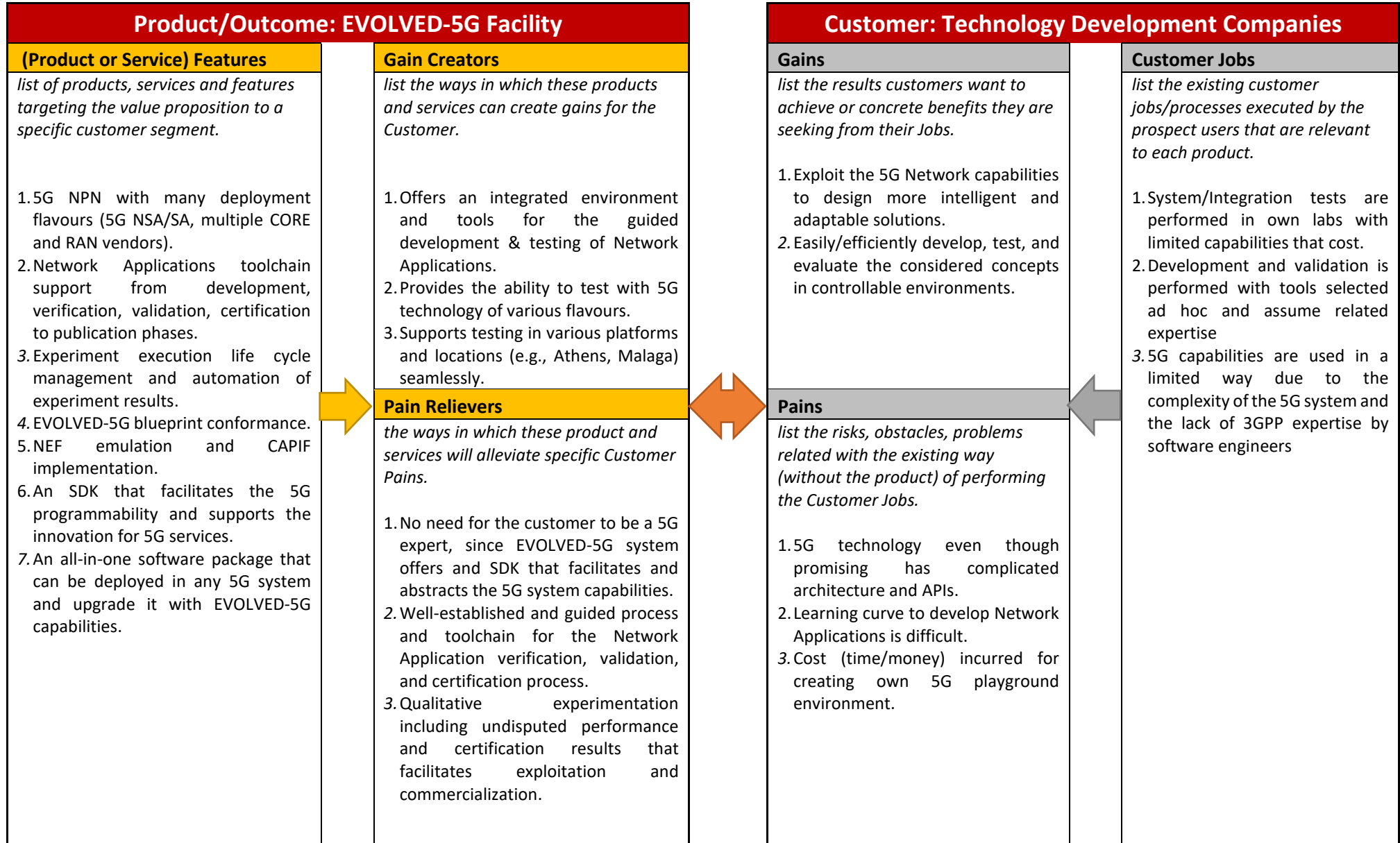
Description	The EVOLVED-5G Platform is a configurable, manageable, and controllable 5G testbed, fully integrating all the necessary components towards the development, validation, and certification of 5G Network Applications while flexibly incorporating various 5G deployment setups. The platform offers experimentation as a service to SMEs that are interested to test and validate their 5G solution under various controllable conditions.			
	Outcome Type	Demonstrator	Outcome Category	Business Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	<p>Digital Innovation Hubs & Technology Development Companies that seek to experiment with specific 5G deployments and Non-Public Networks (NPN) and/or validate their prototypes in configurable & manageable 5G testbeds.</p> <p>Also, the platform can be used for training purposes, supporting the development of new skills for the design and implementation of 5G-enabled applications and services.</p>			
Target Markets	All Vertical Industries			
Innovations	<ul style="list-style-type: none">• NEF Emulator for Network Applications verification• CAPIF services for Network Applications certification• Containerised Network Applications for Cloud-native solutions• CAPIF/NEF for Network Programmability• Development of a Network Application validation environment (tools)• Availability of a Marketplace where to expose the Network Applications			
Product Competition	Relevant services have started being offered through open calls from the SNS Stream C and D projects. Moreover, there are also Competence Centres and Digital Innovation Hubs that may offer similar competitive 5G testbeds, without however the programmability additions and the Network APP lifecycle automation that EVOLVED-5G offers.			

Table 10: EVOLVED-5G Facility Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Supports the full lifecycle of a Network Application, from development to certified operation in an automated way. • Is based on a multi-tier and modular architecture, to be flexibly adopting and adapting new components based on the needs of each experiment and service under testing. • Introduces several innovative tools for development, management & testing automation. • It is a vertical industry agnostic facility. • Cumulative expertise of partners with different background. 	<ul style="list-style-type: none"> • The performance of the 5G system may depend on the specific 5G hardware that is used for executing the experiment, which may result to different performance assessment and results. • Highly depends on experimental 5G deployments due to the lack of enterprise-level 5G rel. 16 platforms exposing open APIs and advanced capabilities (e.g., NEF, NWDAF). • Multi-tenancy requires scheduling assistance. • A charging methodology has not been defined yet. • Some functionalities are emulated.

(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • The Network Applications is a developing concept that has attracted the interest of SMEs. • There are few related services available with tight resources and funding plans. • Through the implementation of the EVOLVED-5G blueprint, offers the seamless ability to execute experiments across all the platforms that implement it (e.g., Athens and Malaga). • A Network App marketplace offered by EVOLVED-5G can be used for boosting the business impact of the 5G market. • Disruptive innovative solutions can be tested in a real operational 5G system, without the risk of accident or malfunction. 	<ul style="list-style-type: none"> • Slow adoption of 5G technology in industry and enterprises. • Competition from major hyperscalers. Amazon (AWS), Microsoft (Azure) and Alphabet (Google Cloud), taking advantage of their cloud computing capabilities, have expanded their portfolios with their own flavours of private 5G, and most have completed strategic acquisitions and hired from the mobile industry. • General negative opinion of the public against 5G technology, which may affect the customer acceptance rate of the new 5G services and solutions. • Legal restrictions, currently unforeseen, related to the use of personal data that can be exposed from the 5G system (such as the location) to support innovative 5G services and applications. • Security risks related to the network exposure of the 5G system that may result in new and unforeseen security and privacy risks.

4.3.1.1.1 EVOLVED-5G Facility Outcome Value Proposition Canvas



4.3.1.2 EVOLVED-5G Network Applications Service Package

The EVOLVED-5G Service Package is the bundle of the EVOLVED-5G deliveries relevant to the development, and verification, validation, and certification of Network Applications. Practically, it has the form of a virtual machine (VM) downloadable package to be installed for local use. Hosted in the EVOLVED-5G repository, developers can reach and download the image from a link shared in the Wiki (<https://wiki.evolved-5g.eu/>) and import it to their preferred hypervisor.

Table 11: EVOLVED-5G Network Applications Service Package Outcome Description

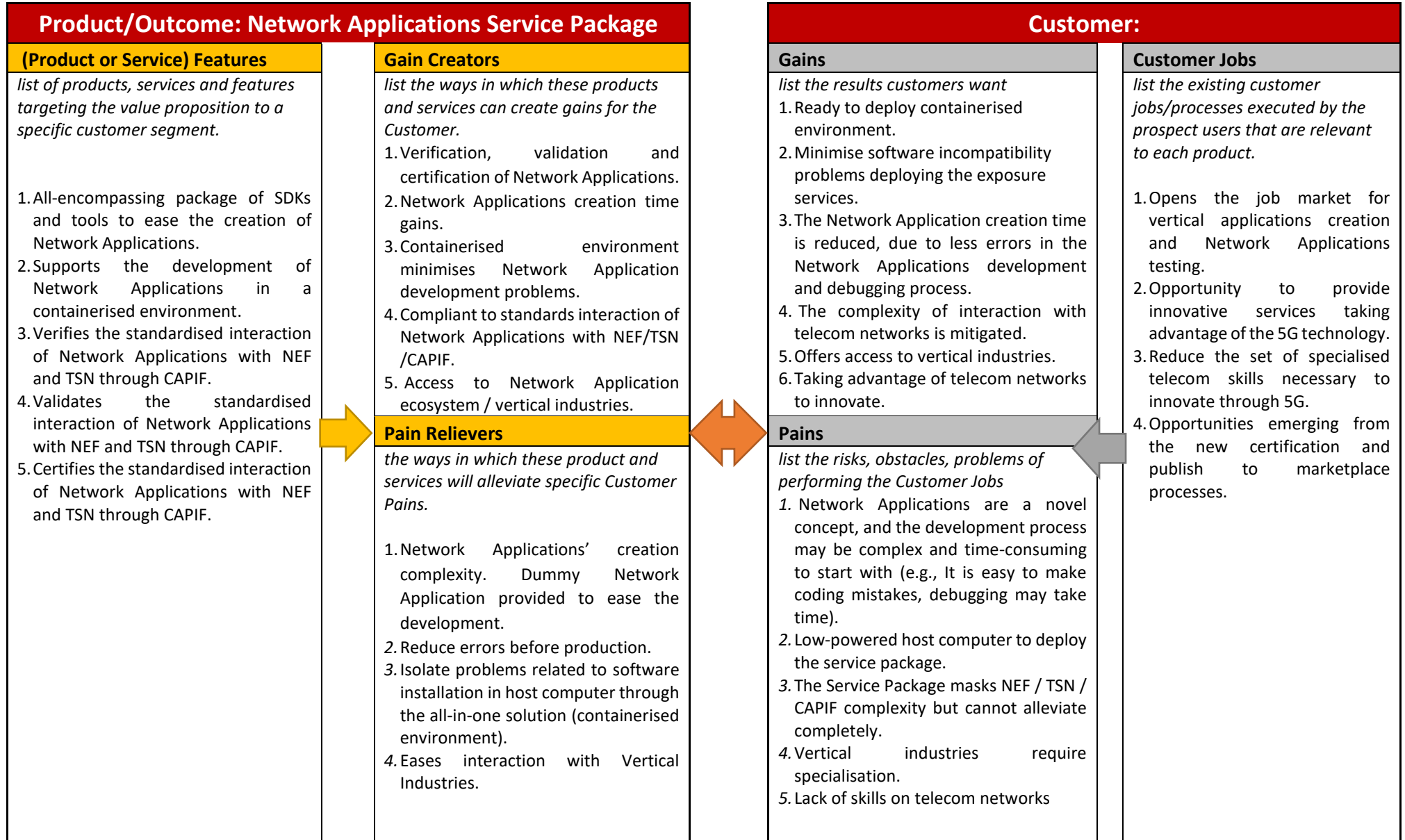
Description	The EVOLVED-5G Service Package is a software bundle to facilitate developers for the creation, verification, validation and certification of Network Applications. It includes:		
	<div><div>1)</div><div>An SDK including libraries and a Command Line Interface (CLI) tool, that enables developers for:<div><div>a)</div><div>The creation of a Network Application repository where they can create their own code / Network App by making use of the SDK libraries.</div><div>b)</div><div>The generation of Network Applications from a template using the CLI tool.</div><div>c)</div><div>Verify, in a virtualised environment using the CLI tool by launching different pipelines, the Network Application interaction with NEF and the TSN service exposure through CAPIF.</div></div></div></div>		
	<div><div>2)</div><div>Dummy Network Application, an example of Network Application that illustrates the behavioural functionalities that a Network App must have in the EVOLVED-5G environment. Developers can view and change the code of the Dummy Network App to create their own. They can also run the different verification pipelines against the Dummy Network Application.</div></div>		
	<div><div>3)</div><div>NEF services, that emulate the Northbound APIs of 3GPP’s Network Exposure Function (NEF) so developers can check the Network App interaction with NEF. Three APIs have been implemented to be used by Network Apps: Location, Connection monitoring, and QoS Awareness.</div></div>		
	<div><div>4)</div><div>CAPIF services, that implement REST APIs accepting API requests from API invokers (e.g., NEF), so developers can check the Network Application interaction with CAPIF.</div></div>		
	<div><div>5)</div><div>TSN Frontend, that exposes an API to request network configurations related to TSN and deterministic communication. There is a set of pre-defined configurations which can then be customised by developers.</div></div>		
	Outcome Type	Prototype	<div><div>Outcome Category</div><div>Product Development</div></div>
	Target TRL category	Market Launch & Commercialisation (7)	
End Customer	Network Application Developers/Software Developers		
Target Markets	All vertical Industries		
Innovations	<div><div><div>•</div><div>Novel Network Applications concept</div></div><div><div>•</div><div>Containerised Apps for Cloud-native solutions</div></div><div><div>•</div><div>5G network openness</div></div><div><div>•</div><div>CAPIF Core Tool integration to discover NEF APIs</div></div><div><div>•</div><div>NEF Emulator</div></div><div><div>•</div><div>TSN Frontend and CAPIF Core Function for Network Application verification</div></div></div>		
Product Competition	Network Application is a novel concept that started to be tackled by 5G-PPP ICT-41 projects. Although, as stated in [19] one of the common key drivers of the concept is how the MNOs expose the capabilities of the 5G/B5G network to others (mainly verticals); the truth is that every project has addressed the concept in a different way and through diverse vertical use-cases, so there is no standard definition yet.		

	As we say, there are currently different ICT-41 projects working on similar tools but, as far as we are aware, there is no similar product in the market at the time of writing.
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Table 12: EVOLVED-5G Service Package Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Free software. • Downloadable package for local use. • Eases the creation of Network Applications. • Dummy Network Application available as example. • Facilitates access to the virtualised 5G environment provided by EVOLVED-5G for Network Applications verification. • Provides free libraries for the Network Application to interact with different 5G APIs discovered through CAPIF (e.g., NEF and TSN APIs). 	<ul style="list-style-type: none"> • Specific installation requirements must be satisfied: OS Linux minimum 20.04, Windows 10, Python3, git and pip3 pre-installation, Docker (v.23.0.1), Docker Compose (v2), build-essential and is required in local computer or virtual machine. • No user-friendly front-end (GUI) available. To be run from a terminal. • Process to be started by developer: email needs to be sent to GitHub organization. • Some additional exposure services (apart from the already implemented: Location, Connection monitoring, and QoS Awareness) may be required by the developers.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • Network Application is a new concept with a lot of potential. • Creation of Network Application ecosystems. • Opens vertical markets to new actors, including SMEs. • No identified competition. • Containerised Network Applications to run in any cloud-native environment. • Libraries may be reusable by other projects. • It exploits the 5G network openness. 	<ul style="list-style-type: none"> • Network Application is a novel concept in the market that might not be adopted. • No standard definition of Network Application (even among ICT-41 projects). • Operators are reluctant to open the networks.

4.3.1.2.1 EVOLVED-5G Network Applications Service Package Outcome Value Proposition Canvas



4.3.1.3 SDK Tools for Network Application Development

The Software Development Kit (SDK) Tools contain all the project developments that support the Network Applications development and verification cycle as described in the paragraphs that follow.

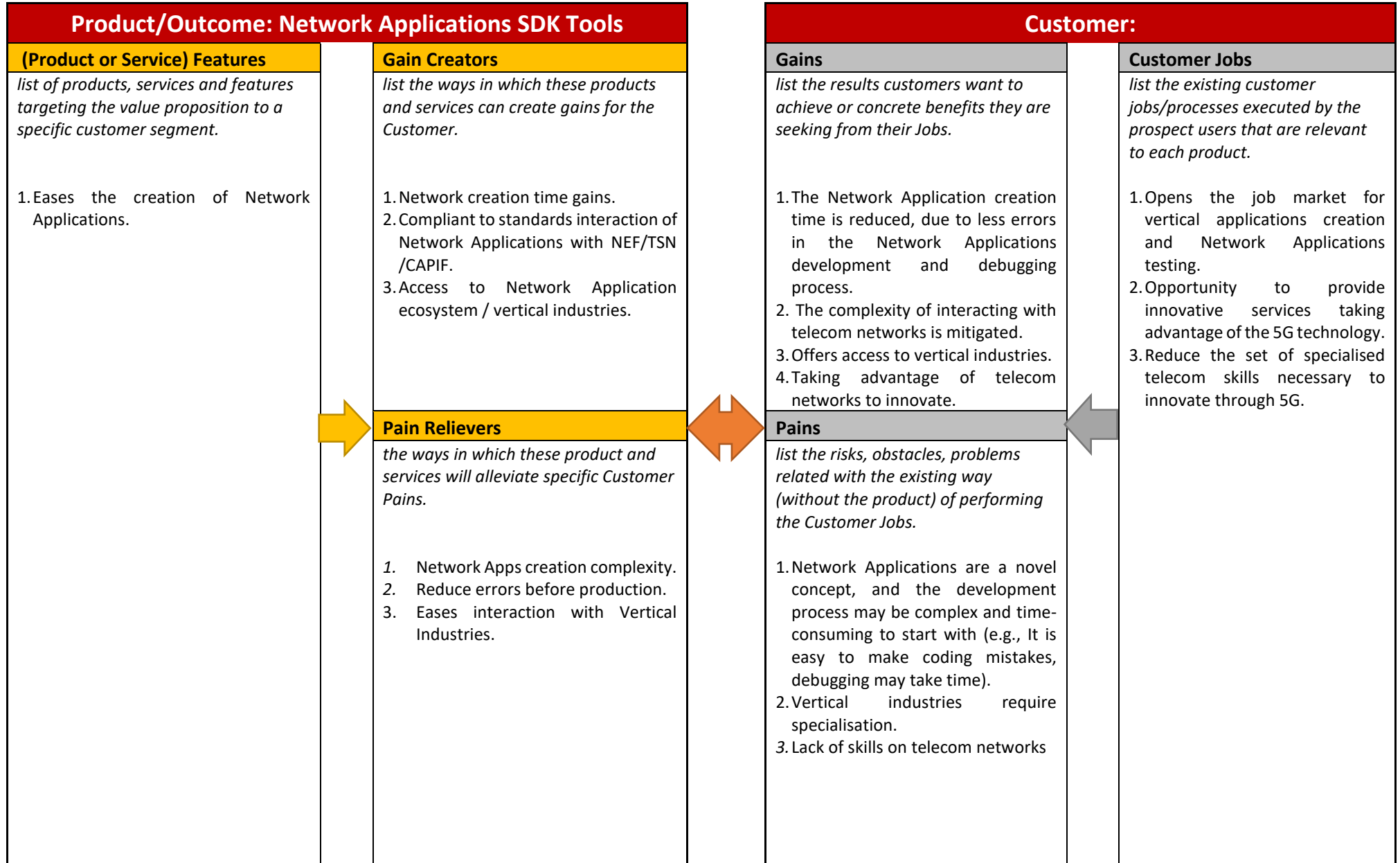
Description	The SDK is a software bundle to facilitate developers in the creation, verification, and validation of Network Applications. It includes libraries and a CLI tool, for: a) The creation of a Network App repository where they can create their own code / Network Application by making use of the SDK libraries. b) The generation of Network Apps from a template using the CLI tool c) Verify, in a virtualised environment using the CLI tool by launching different pipelines, the Network App interaction with NEF and the TSN service exposure through CAPIF. d) Validation, using the CLI tool, to start the validation process. The Network App will interact with real 5G components and architecture. The SDK is delivered in the form of a downloadable package for local use. Hosted in the EVOLVED-5G repository, developers can reach it from a link shared in the Wiki (https://wiki.EVOLVED-5G.eu/en/WORKSPACE/SDK/SDK-Installation).			
	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 Network Application capabilities			
Innovations	<ul style="list-style-type: none">• Containerised Network Applications for Cloud-native solutions• NEF Emulator and CAPIF Core Function for Network Application verification• CI/CD integration for Network Application validation• CAPIF Core Tool integration to discover NEF APIs			
Product Competition	As Network App concept is something new, this kind of tools are being developed now. Although competition is expected, currently, there are no similar products in the market. Even though other SDK tools from other research projects can be found, they are more focused on the creation of Virtual Network Functions (VNFs) and Network Services (NSs). None of them are related to the novel Network App concept and exploit the 5G network openness trend.			

Table 13: EVOLVED-5G SDK Tools Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Free software. Downloadable package for local use. Eases the creation of Network Applications. Dummy Network Application available as example. Facilitates access to the virtualised 5G environment provided by EVOLVED-5G for Network Applications verification. Provides free libraries for the Network Application to interact with different 5G APIs discovered through CAPIF (e.g., NEF and TSN APIs). 	<ul style="list-style-type: none"> Specific installation requirements must be satisfied: OS Linux minimum 20.04, Window 10, Python3, git and pip3 pre-installation, Docker (v.23.0.1), Docker Compose (v2), build-essential and is required in local computer or virtual machine. No user- friendly front-end (GUI) available. To be run from a terminal. Process to be started by developer: email needs to be sent to GitHub organization. Some additional exposure services (apart from the already implemented: Location, Connection monitoring and QoSawareness) may be required by the developers.

(External) Opportunities	(External) Threats
<ul style="list-style-type: none">• Network Application is a new concept with a lot of potential.• Creation of Network Application ecosystems.• Opens vertical markets to new actors, including SMEs.• No identified competition.• Containerised Network Applications to run in any cloud-native environment.• Libraries may be reusable by other projects.• It exploits the 5G network openness.	<ul style="list-style-type: none">• Network Application is a novel concept in the market that might not be adopted.• No standard definition of Network Application (even among ICT-41 projects).• Operators are reluctant to open the networks.

4.3.1.3.1 EVOLVED-5G Network Applications SDK Tools Outcome Value Proposition Canvas



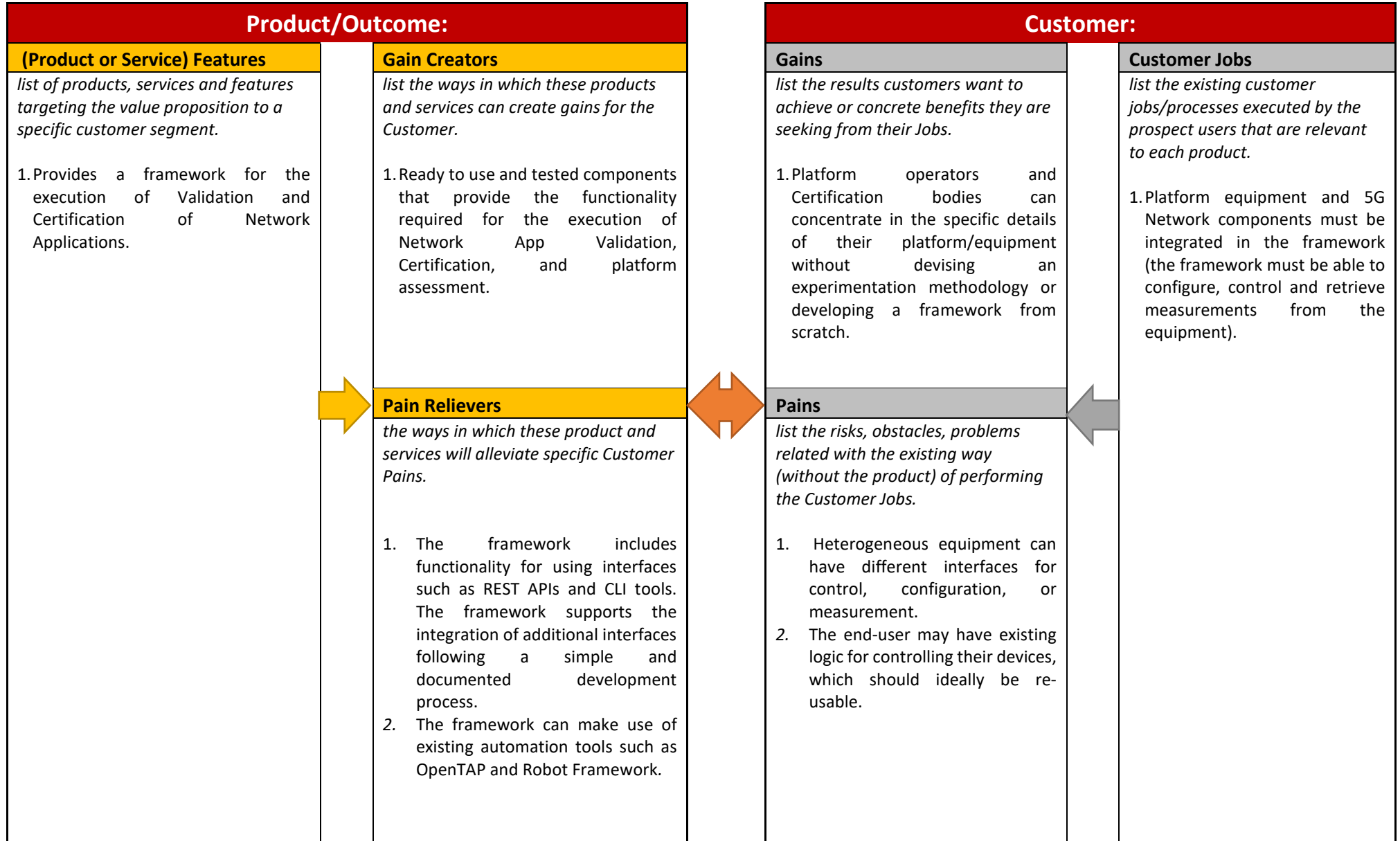
4.3.1.4 Network Applications Validation Tools

Description	The Network Application Validation Tools is a set of components that provide the functionality required for the Validation and Certification of a Network Application, including the assessment of the correct functionality of the Network App along with a selected Vertical App, and the assessment of the performance of the platform and 5G network in which the Validation and Certification processes are executed.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototypes (5,6)		
End Customer	Platform owners.			
Target Markets	Certification bodies and platform operators involved in the Validation and Certification of Network Applications.			
Innovations	Improvements and extensions of the Open5Genesis Framework, fine-tuned for the needs of Network App Validation and Certification: <ul style="list-style-type: none">• Additional support for complex test-case implementation logic.• Integration with Robot Framework for additional support of functional and performance testing.• Northbound integration with CI/CD services.			
Product Competition	Related testing automation solutions, which in many cases can be integrated, can also act as competitors.			

Table 14: Network Applications Validation Tools Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Free, open-source software, licensed under Apache 2.0. • Modular, where many components are optional and can be replaced with similar solutions. • Extensible but with the functionality required for controlling heterogeneous hardware and software already included. 	<ul style="list-style-type: none"> • Deployment complexity due to modularity, where each component has its own requirements and configuration procedures. • Lack of unified graphical user interface, overreliance on text configuration files.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • All components are open-source and free. End-user can download, deploy, and try without prior authorization. • Fine-tuned and tested for Network App Validation and Certification, but able to manage and orchestrate general experimentation. • Can integrate with existing automation solutions that the end-user already has access to. 	<ul style="list-style-type: none"> • With enough work

4.3.1.4.1 Network Applications Validation Outcome Value Proposition Canvas



4.3.1.5 Network Applications Certification Environment

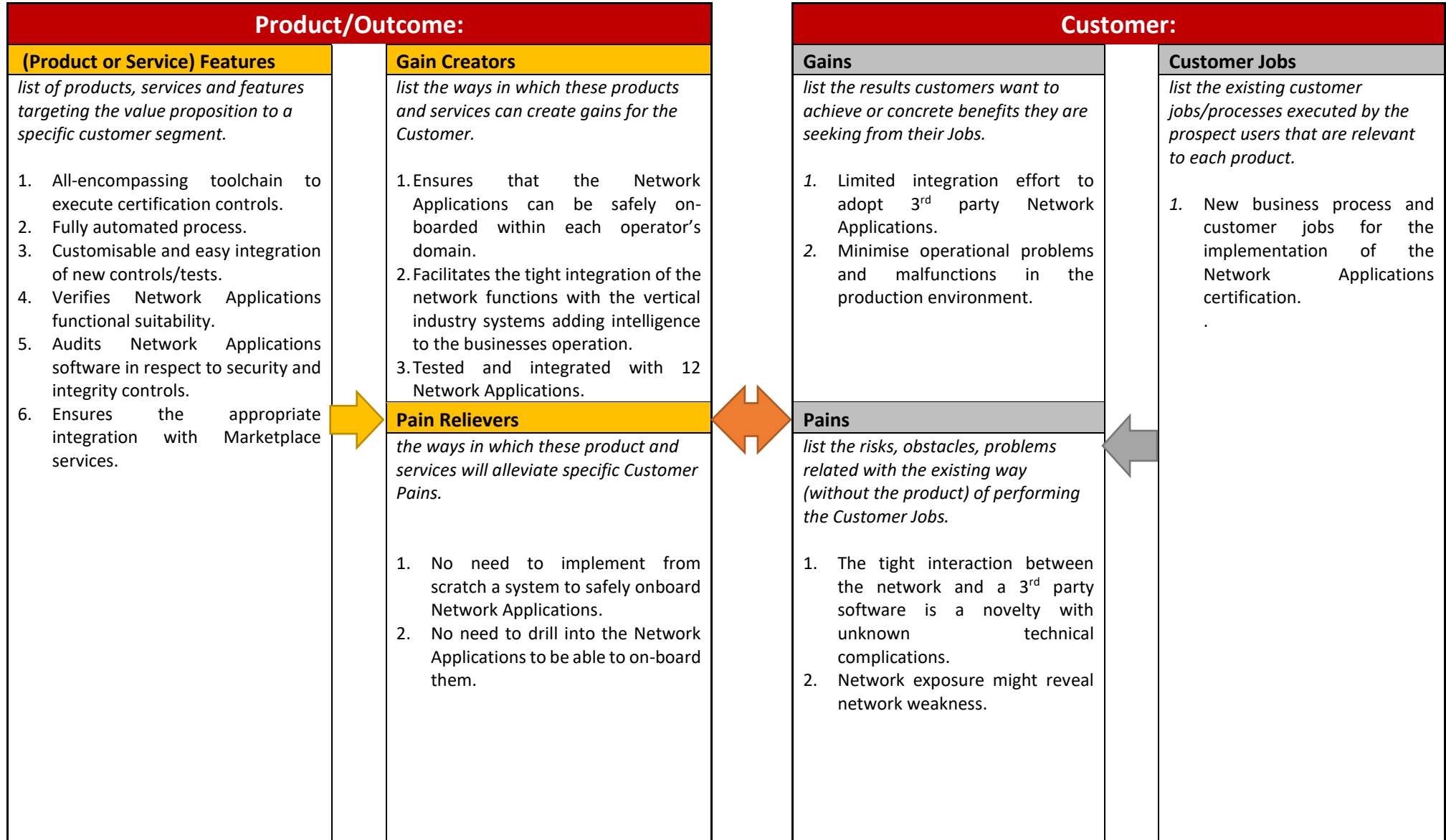
Description	The Network Applications Certification Environment is an all-encompassing tool-based environment, incorporating the automation pipeline to be executed by accredited certification labs that need to verify that the Network Applications developed and validated, are conforming to Functional Suitability (and appropriately interfacing through NEF, CAPIF), Security, and Marketplace publication prerequisites.			
	Outcome Type	Demonstrator	Outcome Category	Business Development
	Target TRL category	Technology Development and Prototypes (5,6)		
End Customer	Certification Authorities/Accredited Labs, MNOs.			
Target Markets	<ul style="list-style-type: none">• Mobile Operators.• Certification Business for Telecommunications.			
Innovations	<ul style="list-style-type: none">• Network Application Certification is an innovative concept first introduced by the project.			
Product Competition	No relevant solution for Certification of Network Applications is known. A related initiative comes from TM Forum Open API Compliance Certification ⁸ that can be considered complementary.			

Table 15: Network Applications Certification Environment Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> The environment is highly automated and self-contained in terms of the necessary toolchain to execute controls. Functional suitability tests are based on 3GPP standards. Cyber security controls are incorporated. 	<ul style="list-style-type: none"> Integration with accredited Certification Authorities yet to be implemented. The implementation is not fully open source, and some licensing fees must be considered.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> The environment is a turn-key solution for onboarding Network Applications in the MNO network alleviating security and functionality concerns. The tests are extendable and adaptable to the processes and best practices of each MNO. Certification authorities targeting devices compliance can incorporate the proposed environment since the processes followed are compatible. 	<ul style="list-style-type: none"> Slow adoption of Network Applications from MNOs. Slow adoption of 5G SA technologies in Industry 4.0.

⁸ <https://www.tmforum.org/conformance-certification/open-api-conformance/>

4.3.1.5.1 Network Applications Certification Environment EVOLVED-5G Outcome Value Proposition Canvas



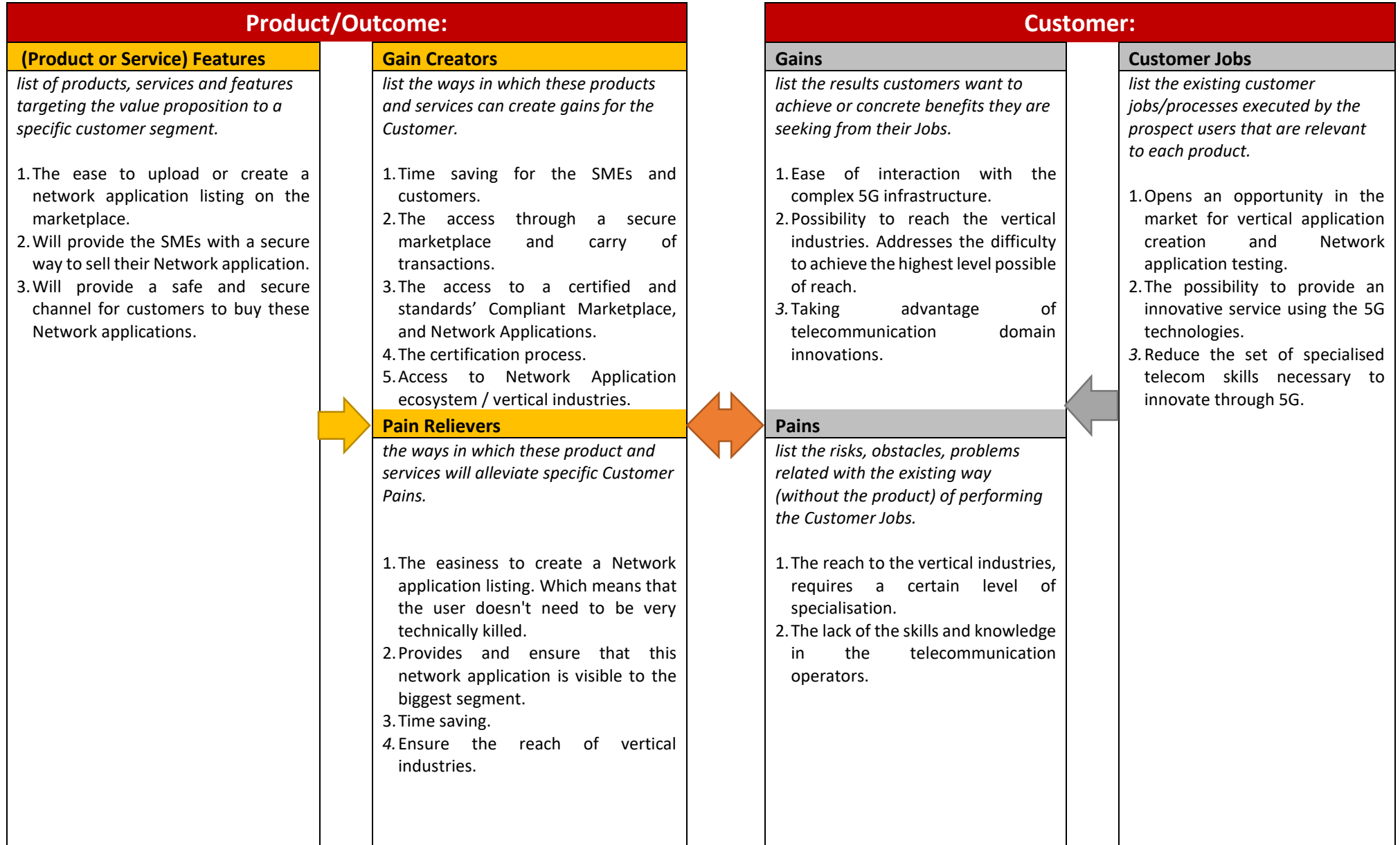
4.3.1.6 Network Applications Marketplace

Description	The EVOLVED-5G Marketplace is a Software as a product marketplace (SaaS) which allows its users such as SMEs to publish, search, discover, acquire, and deploy Network Apps that they developed and pre-configured network slices. The Marketplace allows the users to engage in various ways. And thanks to the certification process/mechanism that ensures that the published services and Network Apps to be compliant with the marketplace rules. The marketplace also implements dashboards for publishers and buyers to track the revenue/balances, view consumption of analytics and monitor API and services performance.			
	Outcome Type	Prototype	Outcome Category	Product development
	Target TRL category	Technology Development and Prototypes (5,6)		
End Customer	Network applications developers, system integrators, Communication Service Providers.			
Target Markets	<ul style="list-style-type: none">• Network operators, and communication service providers acting both as suppliers and buyers of Network applications.• Vertical Industries, acting both as suppliers and buyers of Network applications.• Network applications developers and system integrators.			
Innovations	<ul style="list-style-type: none">• Network applications validation environment and tools.• CAPIF implementation for Network application certification.• Marketplace as a business model innovation.			
Product Competition	No similar service/Marketplace in the market at the time of writing.			

Table 16: Network Applications Marketplace Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • One of a kind Network application. • Efficiency in the usage of the marketplace. • Capable technical and technological background. • User-friendly interface. • Business model integration in the marketplace. • Maggioli Group potentially to test the marketplace with subsidiaries of the group. 	<ul style="list-style-type: none"> • Dependent on the connectivity to 5G access. • Access to the certification environment is needed. • Requires a certain level of knowledge on how to create/upload a network application.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • New opportunity to exploit a new segment of the market. • First mover advantage. • No to low competition in providing a marketplace in the 5G environment. • Helps the SMEs to reduce costs and generate additional revenue. • Helps the SMEs to reach more segments in the market. • Poses a new important solution for the SMEs. 	<ul style="list-style-type: none"> • it might trigger the telecom operators to create a marketplace for themselves instead of having this service from a third party. • The availability of the know-how might push other players in the market to develop a similar solution.

4.3.1.6.1 EVOLVED-5G Network Applications Marketplace Outcome Value Proposition Canvas



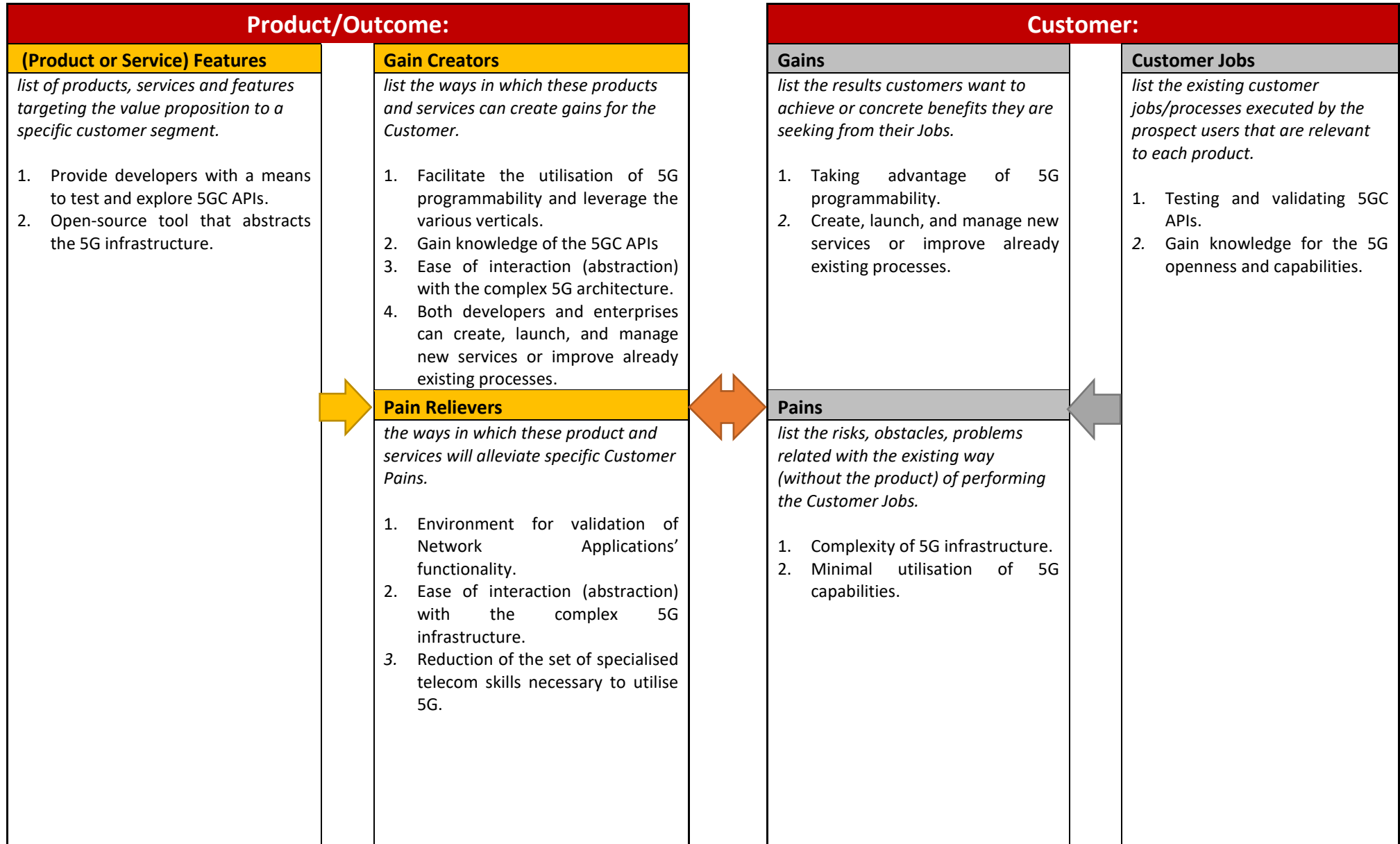
4.3.1.7 NEF Emulator

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 to provide data. Specifically, the Emulator emulates the basic functionality of the control plane flow between the NEF and a Network App, by providing tools for emulating events and the option to create realistic scenarios (i.e., mobility aware event).			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototypes (5,6)		
End Customer	<ul style="list-style-type: none">• Certification bodies interested in testing the compliance of a Network App with 3GPP specifications.• Network applications developers, system integrators.• Communication Service Providers, Telco vendors.			
Target Markets	<ul style="list-style-type: none">• Network operators, and communication service providers acting both as suppliers and buyers of Network applications.• Vertical Industries, acting both as suppliers and buyers of Network applications.• Network applications developers and system integrators.			
Innovations	<ul style="list-style-type: none">• Tool for exploring and testing Network Programmability.• Environment for validating Network Applications.• Provision of standardised APIs.			
Product Competition	NEF implementation from vendors does not exist yet, some commercial products already exist, however not in the emulated framework.			

Table 17: NEF Emulator Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Containerised solution. • Free software under Apache 2.0 license. • Local installation for testing. • Restful APIs implementation. • Support of multiple actors within a scenario (complexity). • UI with functionalities. • Support of various use cases and scenarios. • Scalability. 	<ul style="list-style-type: none"> • Additional APIs based on the upcoming 3GPP Releases need to be developed for a full-scale solution. • Dependencies on open-source software. • Need for continuous monitoring on potential bug fixes/updates of the open-source software.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • No open commercial solutions implementing the entire service-based architecture and the southbound interfaces. • Both developers and enterprises can create, launch, and manage new services or improve already existing processes. • The adoption of SBA architecture by telecom vendors may last longer than expected. 	<ul style="list-style-type: none"> • The exposed APIs must be compliant with the standards set by 3GPP. • Since the APIs of 3GPP are publicly available, similar solutions can be implemented.

4.3.1.7.1 EVOLVED-5G NEF Emulator Outcome Value Proposition Canvas



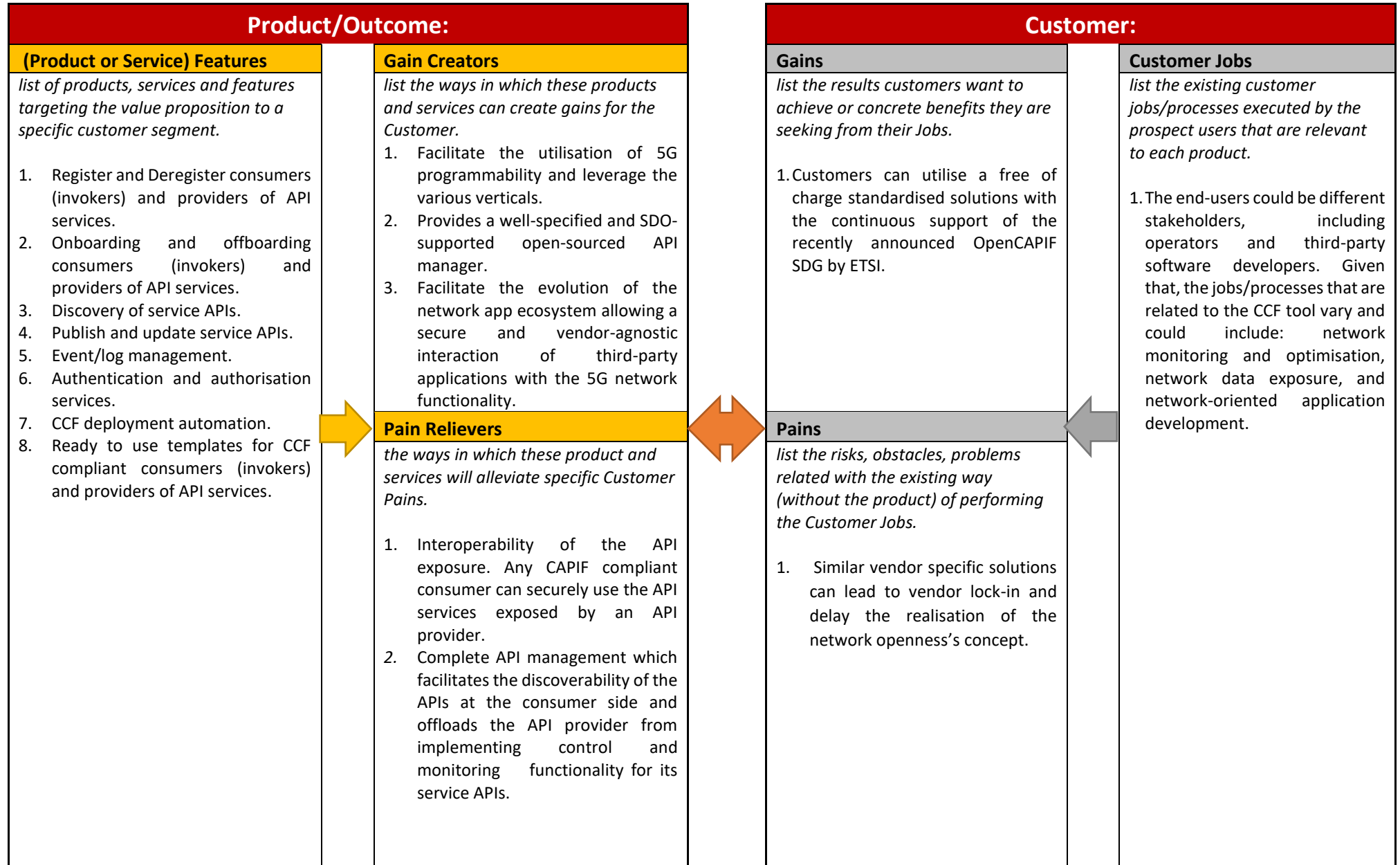
4.3.1.8 CAPIF Core Function Tool

Description	CAPIF Core Function Tool is the first available implementation of the Common API Framework specified by 3GPP. The specification started in Release 15 but EVOLVED-5G has performed an implementation of Release 17, taking the API definitions from this release. The implementation covers TS 23.222, TS 29.222 and TS 33.122. The implementation is fully functional and includes more than 70 automated tests. It has been implemented y Python using OpenAPI generator with the YAML files from 3GPP. CAPIF has been used to integrate EVOLVED5G NEF Emulator and TSN Application Function, and all the Network Applications developed in the project have integrated it successfully.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototypes (5,6)		
End Customer	Network applications developers, system integrators, Communication Service Providers, Telco vendors.			
Target Markets	<ul style="list-style-type: none">• Network operators, and communication service providers acting both as suppliers and buyers of Network applications.• Vertical Industries, acting both as suppliers and buyers of Network applications.• Network applications developers and system integrators.			
Innovations	First Open-Source implementation of Common API Framework from 3GPP Release 17.			
Product Competition	CAPIF implementation from vendors, commercial products do not exist yet.			

Table 18: CAPIF Certification Tool Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • First implementation available for CAPIF Release 17. • Promoted to ETSI Software Group / approved by ETSI Board. • Open-Source licensing model will make it available for the community. • Tested and integrated with 12 Network Applications. • Tested and Integrated with NEF Emulator and TSN Application Function. 	<ul style="list-style-type: none"> • Functional Implementation with no focus on Performance. • Multiple CAPIF instances model yet to be implemented. • Integration with external Certification Authorities yet to be implemented.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • ETSI Open CAPIF community will ensure continuity of the development and support. • Release 18 is introducing new features in CAPIF such as Resource owner-aware Northbound API Access (RNAA). 	<ul style="list-style-type: none"> • CAPIF Roadmap is defined by 3GPP SA6 WG. • Telco vendors will provide their own CAPIF implementations. • Standards Gaps/Out of Scope can introduce differences between CAPIF implementations that will make them incompatible.

4.3.1.8.1 EVOLVED-5G CAPIF Core Function Tool Outcome Value Proposition Canvas



4.3.2 EVOLVED-5G Network Applications/SME Exploitable Outcomes

Based on the technical definition of Network Applications presented in D2.2 [15] there exist two Network Application modes, as shown in Figure 3:

- the **Stand-Alone** (A) that is directly integrated into a vertical application as an SDK, and
- the **Non-Stand-Alone** (B), clearly exposing Business APIs, as an intelligent wrapper of the network Northbound APIs (NEF).

The main advantages of the NSA mode from the business perspective is that it achieves reusability of Network Applications among different applications in the same field and that the vertical applications and Network Applications can be upgraded autonomously and without changing essential parts if they are compatible with the interface exposed by the Business APIs.

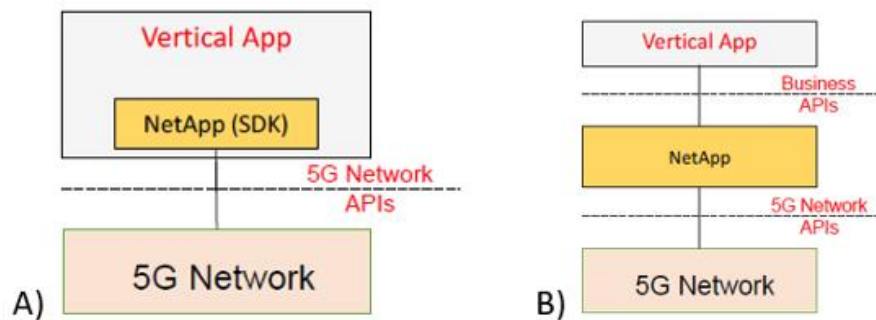


Figure 3: A) Stand-Alone and B) Non-Stand-Alone Network Application Modes

Furthermore, the 5G PPP whitepaper [13] on Network Applications, classifies them to:

- **aaS Model**, where the vertical application consumes the Network Applications as a service and the API is offered by the (Mobile / Communication) Service Provider (CSP) or a Vertical (Sector).
- **Hybrid**, where the vertical instantiates its associated Network Application a part of its Vertical Application in the operator domain like the EDGE, while the other part remains in the vertical domain.
- **Coupled/delegated**: it is the model where the vertical delegates its application (in short app) to the operator. The Network Applications will be composed and managed by the CSP.

As part of the EVOLVED-5G analysis, the “aaS Model” and “Hybrid” are pointing to the EVOLVED-5G NSA mode and leave space for independent development and exploitation of the Network Applications outside the CSP domain. The “Coupled” class maps to the EVOLVED-5G SA mode and leaves small room for independent exploitation as it is clearly related to the CSPs strategy for adoption.

It is evident that within this view, the EVOLVED-5G Network Applications implemented with NSA mode have higher priority to be exploited in the short-term as independent products and as such, they become the focus of the third-year analysis by implementing the Value Proposition Canvas.

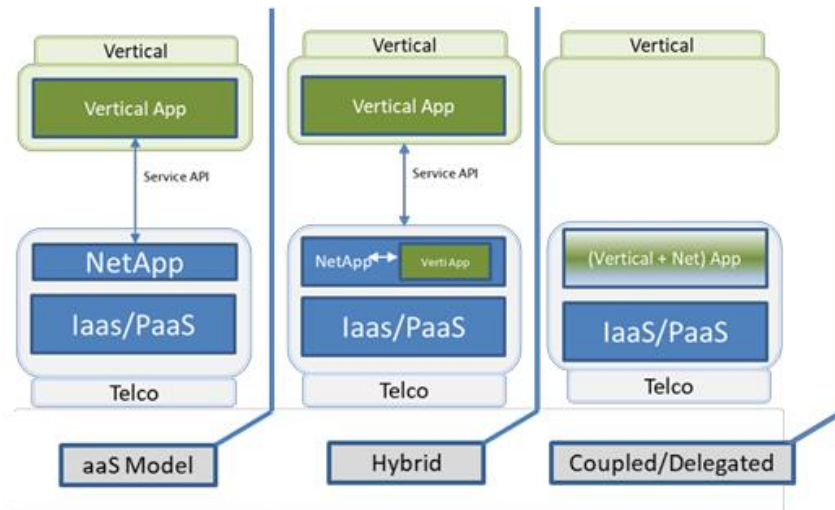


Figure 4: 5G PPP Network Applications classification

4.3.2.1 Prioritised (Non-Stand-Alone) Network Application Prototypes

This section extensively describes the Network Applications that have been prioritised for further analysis with the Business Value Proposition Canvas. For reasons of completeness, the description and gap analysis of these Network Applications performed in the previous years, is revisited and is presented in the beginning.

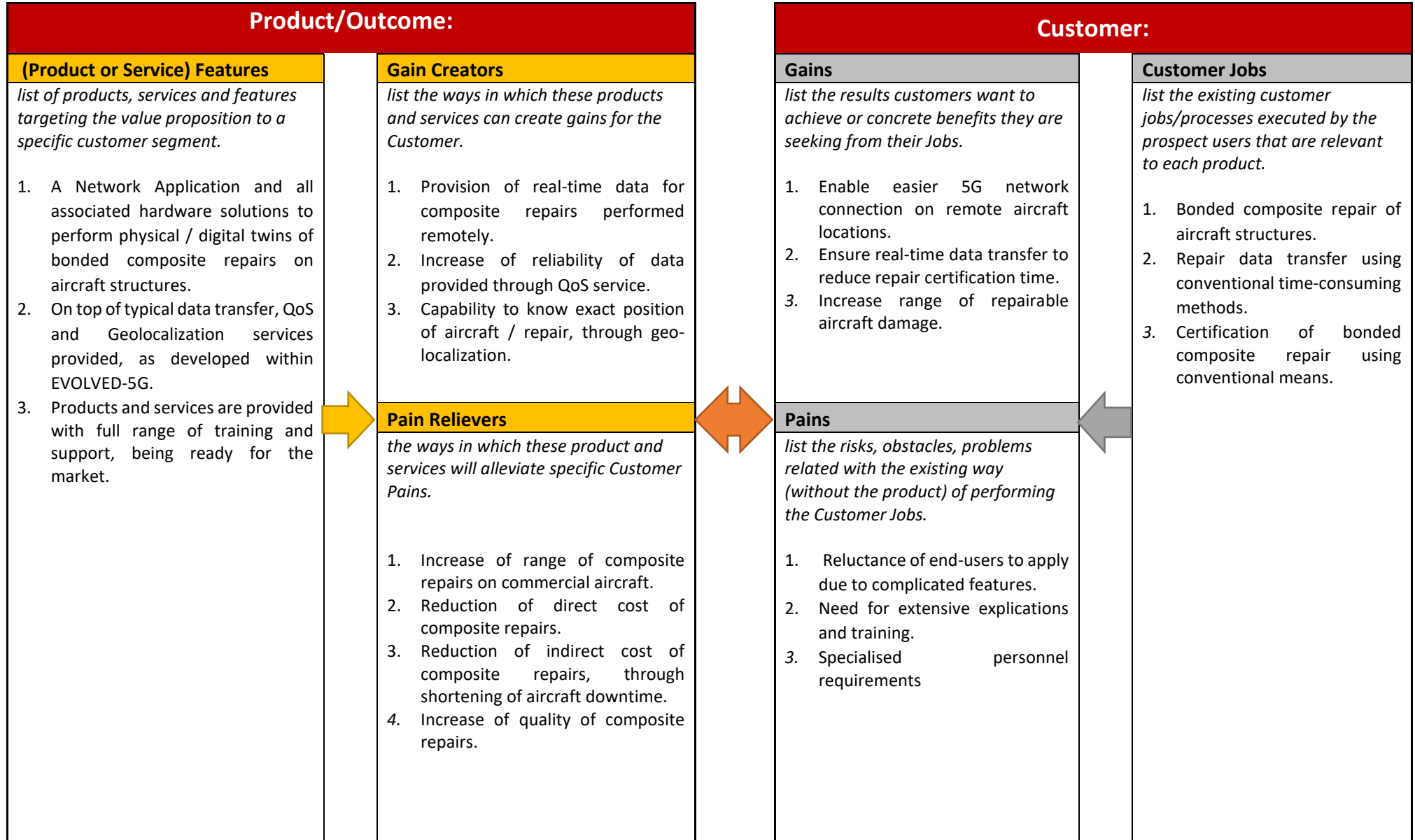
4.3.2.1.1 Digital/Physical Twin for the Aircraft Business Network Application

Description	The Digital / Physical Twin Network Application 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 “Replica” repair using a second bonding console, identical to the “Source” repair (Physical-Twin) or to use such data for calculation of the Degree of Curing (DoC) applying corresponding material curing equations (Digital Twin).			
	Outcome Type	Prototype, Demonstrator or	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 inabilities 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 Network Application 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.			

Table 16: Digital/Physical Twin for the Aircraft Business Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Innovative development. • Sound technological background. • No direct competition. 	<ul style="list-style-type: none"> • Design on a case-by-case basis. • Manufacturing on a case-by-case basis. • Difficult to explain to end-users. • Need for continuous update.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • Important reduction of costs. • Increase of repair applications. • Adoption by MROs. • Totally new market. • Adoption by regulatory authorities. 	<ul style="list-style-type: none"> • Reluctance of end-users to apply. • Need for extensive explications. • Specialised personnel requirements. • Need for extensive demonstrations. • Specialised personnel requirements.

4.3.2.1.1.1 EVOLVED-5G Digital/Physical Twin for the Aircraft Business Outcome Value Proposition Canvas



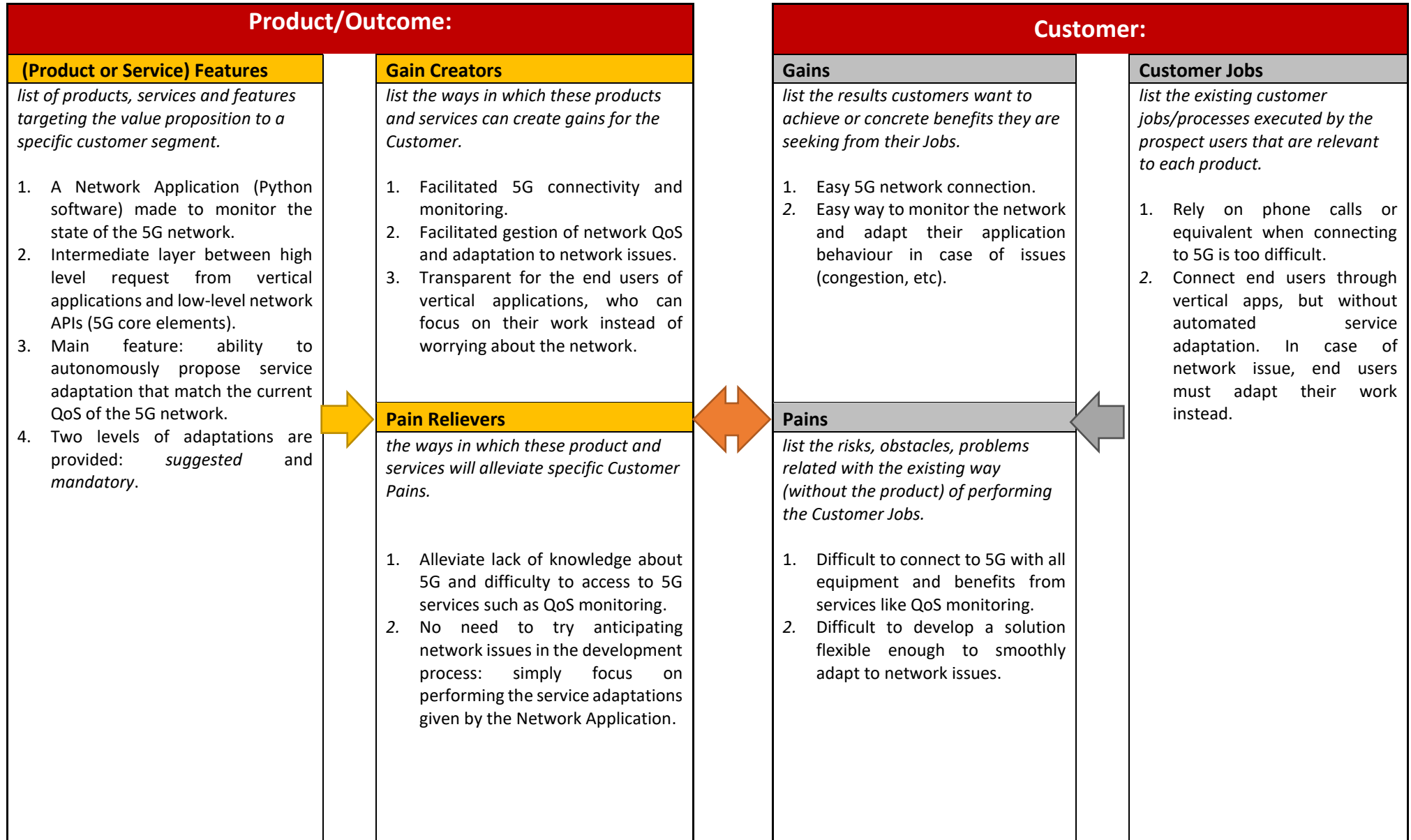
4.3.2.1.2 Autonomous Service Adaptation Network Application

Description	The Autonomous Service Adaptation Network Application from IMM was made to monitor the QoS of the 5G network and propose service adaptations related to this QoS. This way, any vertical application can benefit from suggestions about which features should be enabled or disabled with respect to the current state of the 5G network.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrators, Vertical Industries.			
Target Markets	Smart factories, Remote assistance services, Real-time collaboration services.			
Innovations	<ul style="list-style-type: none">Facilitated 5G connectivity and request to 5G network components.The ability to monitor the QoS of the 5G network to propose service adaptations. Such adaptations represent compromises between the current QoS and the available features.Two types of service adaptations: mandatory ones and suggested ones.			
Product Competition	Other Network Applications may also offer QoS monitoring for 5G, but do not propose the autonomous service adaptations.			

Table 19: Autonomous Service Adaptation Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Strong consortium about 5G during the project. IMM expertise on one of the target markets (remote assistance). 	<ul style="list-style-type: none"> No strong AI expertise within the project to optimise service adaptations.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> Growing interest for 5G services and AI. Can be of interest for a large range of markets. Adaptable to many use-cases. Current lack of deployed applications taking advantage of 5G services and not just 5G performance. 	<ul style="list-style-type: none"> As Network Applications are public, other integrators could develop a similar application with different adaptations for a given application domain. Reluctance of end users to use 5G.

4.3.2.1.2.1 EVOLVED-5G Autonomous Service Adaptation Outcome Value Proposition Canvas



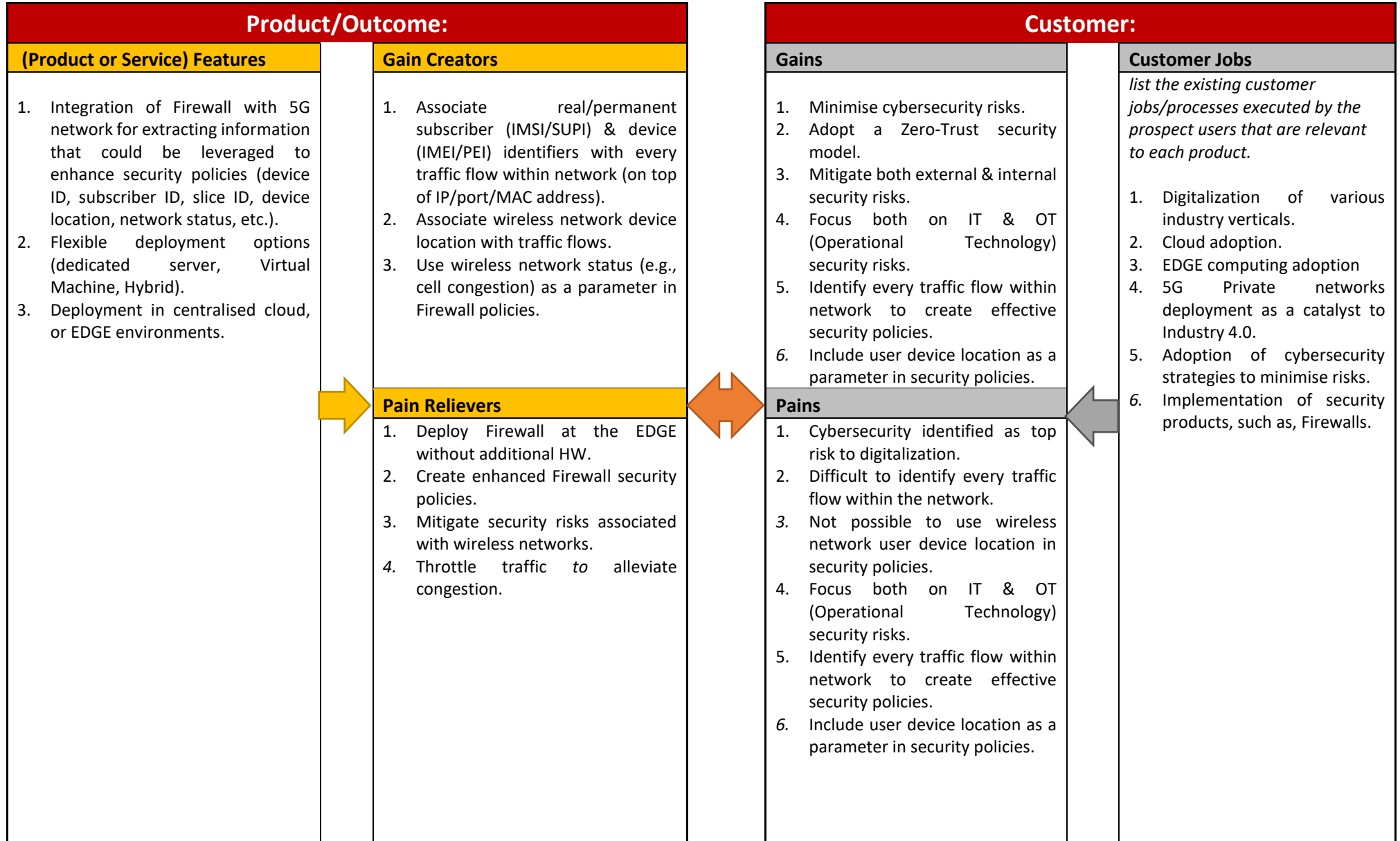
4.3.2.1.3 Intelligent Network Traffic Management Network Application

Description	Programmable Next-Generation Firewall that can consider not only IPs, ports, and MAC addresses to identify user devices, but also any parameters that can be exposed by the 5G network, including subscriber location, thus allowing enhanced security policies.			
	Outcome Type	Prototype	Outcome Category	Product development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrators, Vertical Industries			
Target Markets	Any 5G private network deployment, Factories of the future			
Innovations	<ul style="list-style-type: none">Integration with 5GC allows inclusion of any 5G exposed information (identifiers, parameters, KPIs, UE location, etc) to be incorporated in the creation of firewall security policies.Virtual & containerised support for cloud deployment.			
Product Competition	Products from established companies that specialise in cybersecurity, e.g., Palo Alto Networks.			

Table 20: Intelligent Network Traffic Management Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Flexible deployment options (dedicated server, Virtual Machine, Hybrid). Centralised cloud or EDGE deployment. Inclusion of 5G parameters in security policies. Enhanced subscriber identity capability (using 5G subscriber/device identifiers). 	<ul style="list-style-type: none"> Integration with 5GC effort needed for different network vendors (if 5GC does not expose standardised APIs).
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> Digitalization of various industry verticals. Industry focus on cybersecurity. Private 5G network deployments. EDGE deployments. Common API initiatives. 	<ul style="list-style-type: none"> Competition from established companies developing similar products.

4.3.2.1.3.1 EVOLVED-5G Intelligent Network Traffic Management Outcome Value Proposition Canvas



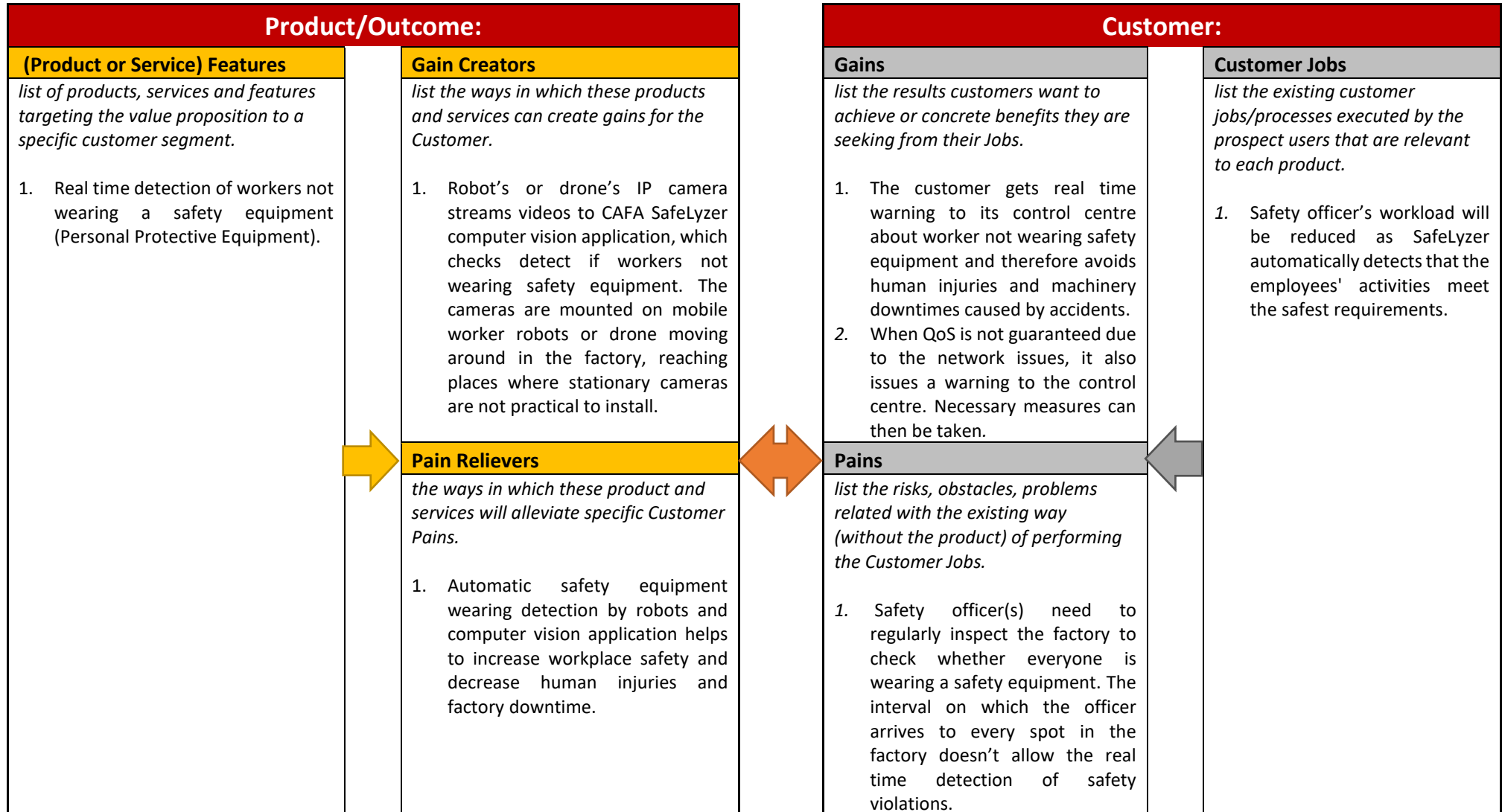
4.3.2.1.4 NetMapper Network Application

Description	NetMapper subscribes to CAPIF and NEF and forwards QoS and Connectivity state information of the network to the vApp (CAFA SafeLyzer) which adapts its data feeds from cameras computer vision processing behaviour to ensure its reliable operation.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototype (5,6)		
End Customer	Factories with automatic processes and personnel on site with obligation to wear Personal Protection Equipment (PPE) control (Factory of Future).			
Target Markets	Large manufacturing industries with potentially dangerous processes where manual or ad hoc Personal Protection Equipment control is not practical nor immediate enough.			
Innovations	<ul style="list-style-type: none">• Binding computer vision application with 5G network state information.• Both Network Applications and vApp are containerised.			
Product Competition	Companies who developing computer vision software to check compliance with obligation to wear PPE.			

Table 21: NetMapper Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Computer vision expertise. • Knowledge in containerization process both on Kubernetes and Docker containers. • Experiences to integrate cameras from robots and drones. • Experiences to work on 5G networks. 	<ul style="list-style-type: none"> • Selection of right dataset and trained model is crucial for the reliable computer vision operation. • Limited customer base which affects the availability of AI training data.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • Deployment of private 5G networks. • Growing interest for AI. • Flexibility to adapt to many use-cases. 	<ul style="list-style-type: none"> • Competition from companies providing similar solutions.

4.3.2.1.4.1 EVOLVED-5G NetMapper Outcome Value Proposition Canvas



4.3.2.1.5 Global Localisation Network Application

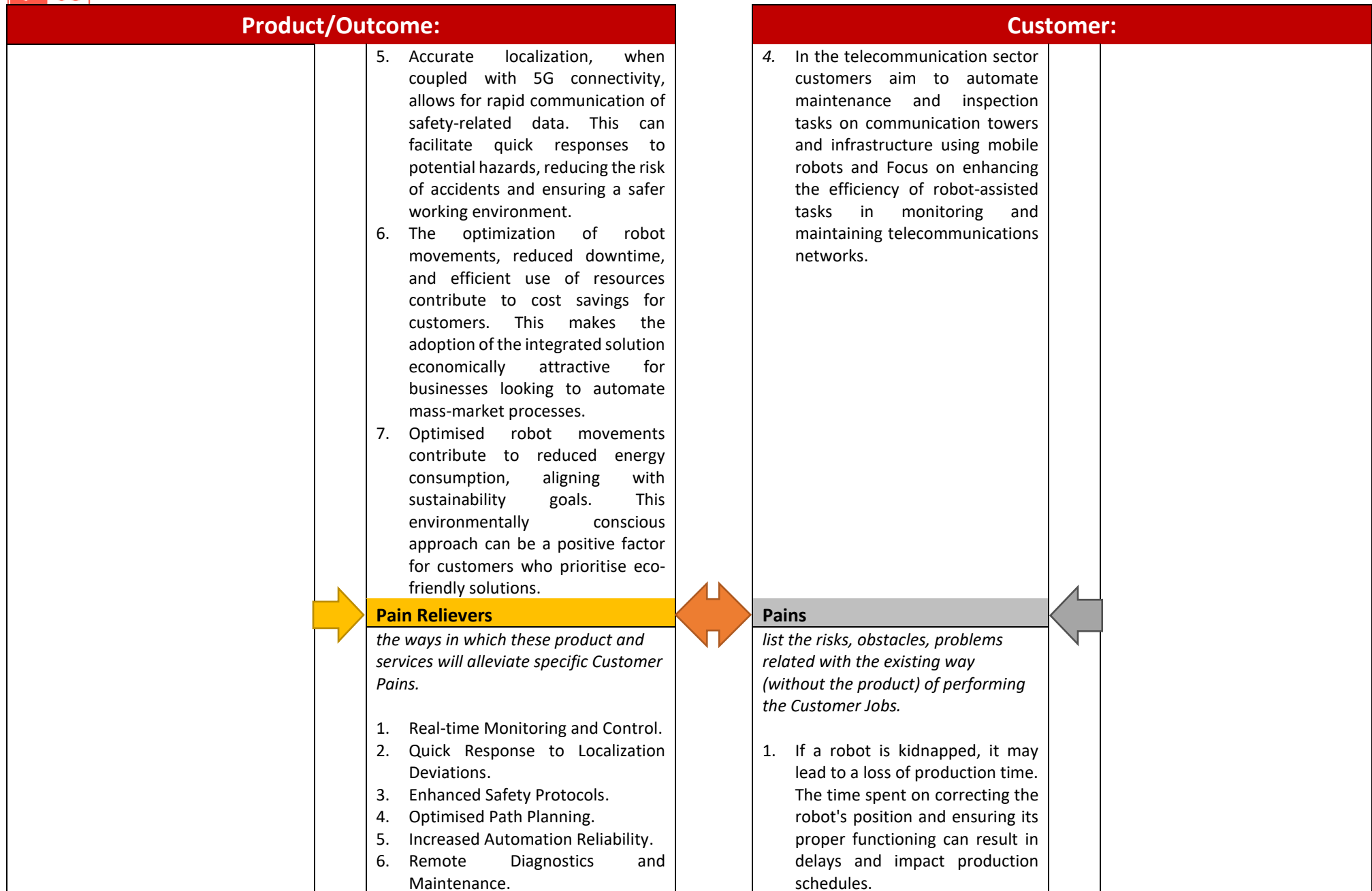
Description	A Network Application aimed at factories' automation purposes. This Network Application, developed by UMS, when installed on robots, gives networking information regarding the 5G cell to which the robot is connected (what cell id it is connected to, how good is the signal, etc.).			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototype (5,6)		
End Customer	Integrators, Vertical Industries.			
Target Markets	Industry 4.0, Factory of the Future, Industrial Internet of Things (IIoT).			
Innovations	<ul style="list-style-type: none">• Localization accuracy improvement when GPS support is missing.• Robot localization using the distance between the robot and the cell ID.			
Product Competition	There is no commercialised solution yet although research is undergoing in a number of both public and private entities.			

Table 22: Global Localisation Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Enables a new level of autonomy, as the holistic approach to positioning means larger fleets of robots can be effectively used. • Internal Innovation, as previously unavailable developments start to arise around working on larger scales within factories. • Builds on internal products, especially around indoor logistics and orchestration. 	<ul style="list-style-type: none"> • 5G Infrastructure dependent. • Requires high density of small cells per factory for high greater accuracy. • Accuracy is not yet high enough for assuring a safe and effective navigation.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • High demand of robotic scalability within a singular factory, as localization means that fleets of robots can recognise their positioning and adapt behaviour as a result. • High-precision and robust localization demand overcoming the limits of laser and artificial landmarks drawbacks. 	<ul style="list-style-type: none"> • Other enterprises researching similar localization methods with 5G. • Current slow 5G adoption within factories and enterprises.

4.3.2.1.5.1 EVOLVED-5G Global Localisation Outcome Value Proposition Canvas

Product/Outcome:		Customer:	
(Product or Service) Features	Gain Creators	Gains	Customer Jobs
<p><i>list of products, services and features targeting the value proposition to a specific customer segment.</i></p> <ol style="list-style-type: none"> 1. A 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. 	<p><i>list the ways in which these products and services can create gains for the Customer.</i></p> <ol style="list-style-type: none"> 1. Ensuring precise navigation for mobile fleet robots is crucial for creating detailed and accurate maps of the environment, leading to efficient and error-free robot movements. 2. Accurate localization minimises the risk of the kidnapped robot problem, reducing instances of downtime caused by localization errors. This results in increased productivity and operational efficiency in mass-market automation scenarios. 3. With precise localization, mobile fleet robots can optimise their paths and avoid unnecessary detours. This leads to better resource utilization, such as improved battery life for robots and more efficient use of time and energy. 4. Leveraging 5G technology provides high-speed, low-latency communication for the mobile fleet robots. This enables real-time data exchange, remote monitoring, and quick decision-making, enhancing the overall responsiveness of the automation system. 	<p><i>list the results customers want to achieve or concrete benefits they are seeking from their Jobs.</i></p> <ol style="list-style-type: none"> 1. In the manufacturing industries customers seek to enhance the precision and efficiency of automated assembly lines, ensuring high-quality vehicle production without interruptions and aim for accurate robot movements to optimise the assembly of delicate electronic components and improve overall manufacturing efficiency. 2. In the logistics and warehousing customers want to streamline warehouse operations, reduce fulfilment times, and enhance the accuracy of order picking and packing and focus on optimizing the movement of goods within warehouses and ensuring timely and accurate order fulfilment. 3. In the energy and utilities sector customers focus on automating routine maintenance tasks and ensuring the safety of robotic systems within power generation facilities, and Aim to enhance the efficiency of inspections and maintenance tasks in remote or hazardous locations using autonomous robots. 	<p><i>list the existing customer jobs/processes executed by the prospect users that are relevant to each product.</i></p> <ol style="list-style-type: none"> 1. Automotive Manufacturers. 2. Electronics manufacturers. 3. E-Commerce companies. 4. Third party logistics providers. 5. Power plants operators. 6. Oil and Gas providers. 7. Telecom Infrastructure Providers. 8. Network Operations Centers.



Product/Outcome:		
		<ol style="list-style-type: none"> 7. Efficient Resource Utilization. 8. Compliance with Quality Standards. 9. Continuous Operation and Productivity. 10. Data Security and Integrity.

Customer:		
		<ol style="list-style-type: none"> 2. Inaccurate robot localization can lead to errors in manufacturing or assembly processes. This can result in defective products and impact the overall quality of the industrial output. 3. Dealing with the kidnapped robot problem may require additional maintenance and troubleshooting efforts. Industrial customers may incur extra costs in terms of technician time, spare parts, and resources needed to address these issues. 4. Some industries (automotive, aerospace, pharmaceutical) have strict regulations regarding safety and quality standards. Issues related to the kidnapped robot problem may lead to compliance challenges, potentially resulting in fines or penalties. 5. Human operators or technicians may need to divert their attention from other critical tasks to address the kidnapped robot problem. This can strain human resources and impact the overall efficiency of the workforce.

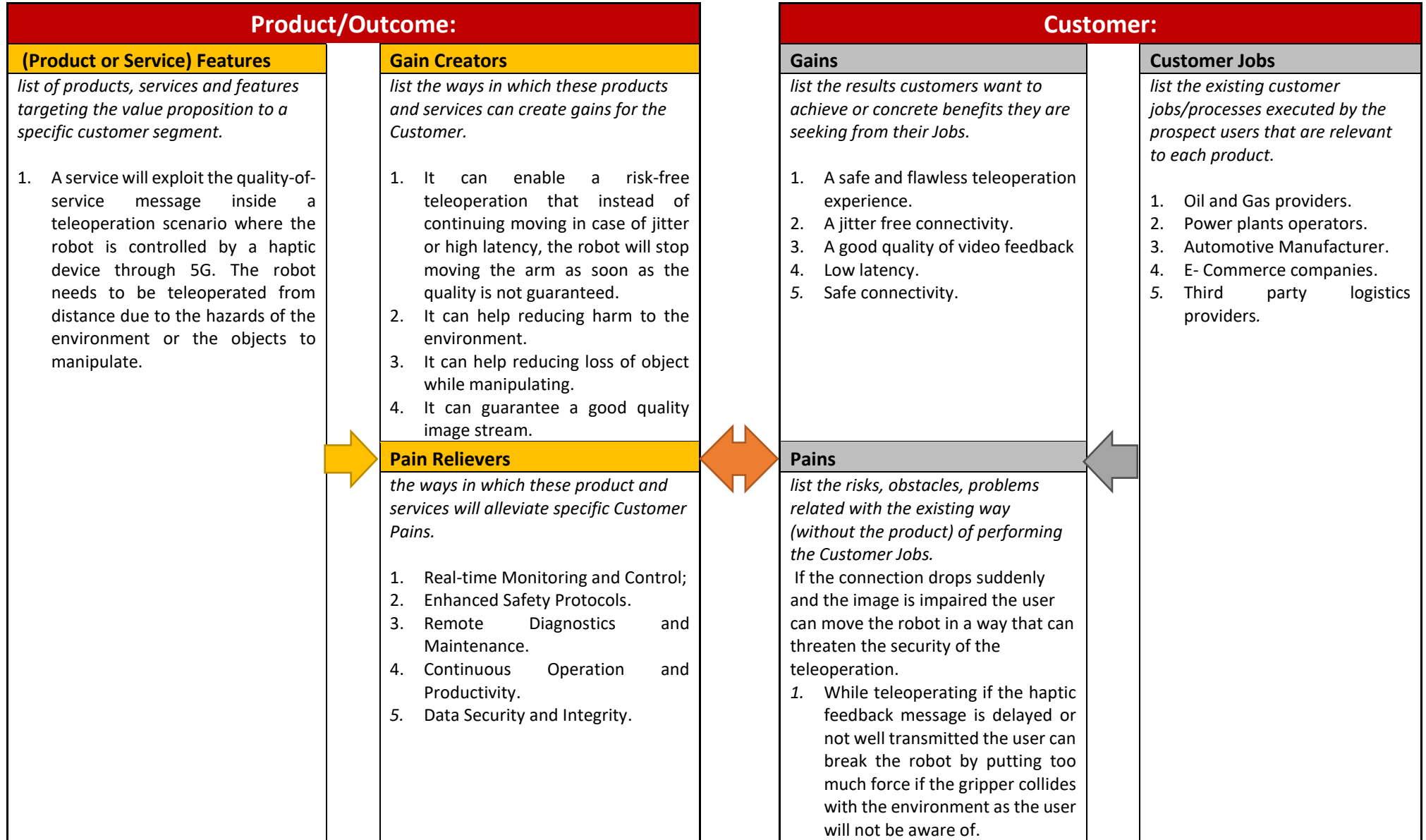
4.3.2.1.6 Teleoperation Network Application

Description	This network application is aimed at applications that require a quality of connection that needs to be always guaranteed, like teleoperation.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototype (5,6)		
End Customer	End Customer Integrators, Vertical Industries.			
Target Markets	Industry 4.0, Factory of the Future, Industrial Internet of Things (IIoT), Robotics.			
Innovations	<ul style="list-style-type: none">• Better monitoring of the quality of service.• Easy to use for robotics user using ROS.			
Product Competition	There is no commercialised solution yet although research is undergoing in a number of both public and private entities.			

Table 23: Teleoperation Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Enables a safe teleoperation experience. Avoid risks to the environment than could happen due to jitter and latency. 	<ul style="list-style-type: none"> 5G Infrastructure Dependent Only 2 states Guaranteed or Not Guaranteed
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> Enables safe remote for long distance remote control. 	<ul style="list-style-type: none"> Current slow 5G adoption within factories and enterprises. Not homogenous distribution of 5G in the world.

4.3.2.1.6.1 EVOLVED-5G Teleoperation Outcome Value Proposition Canvas



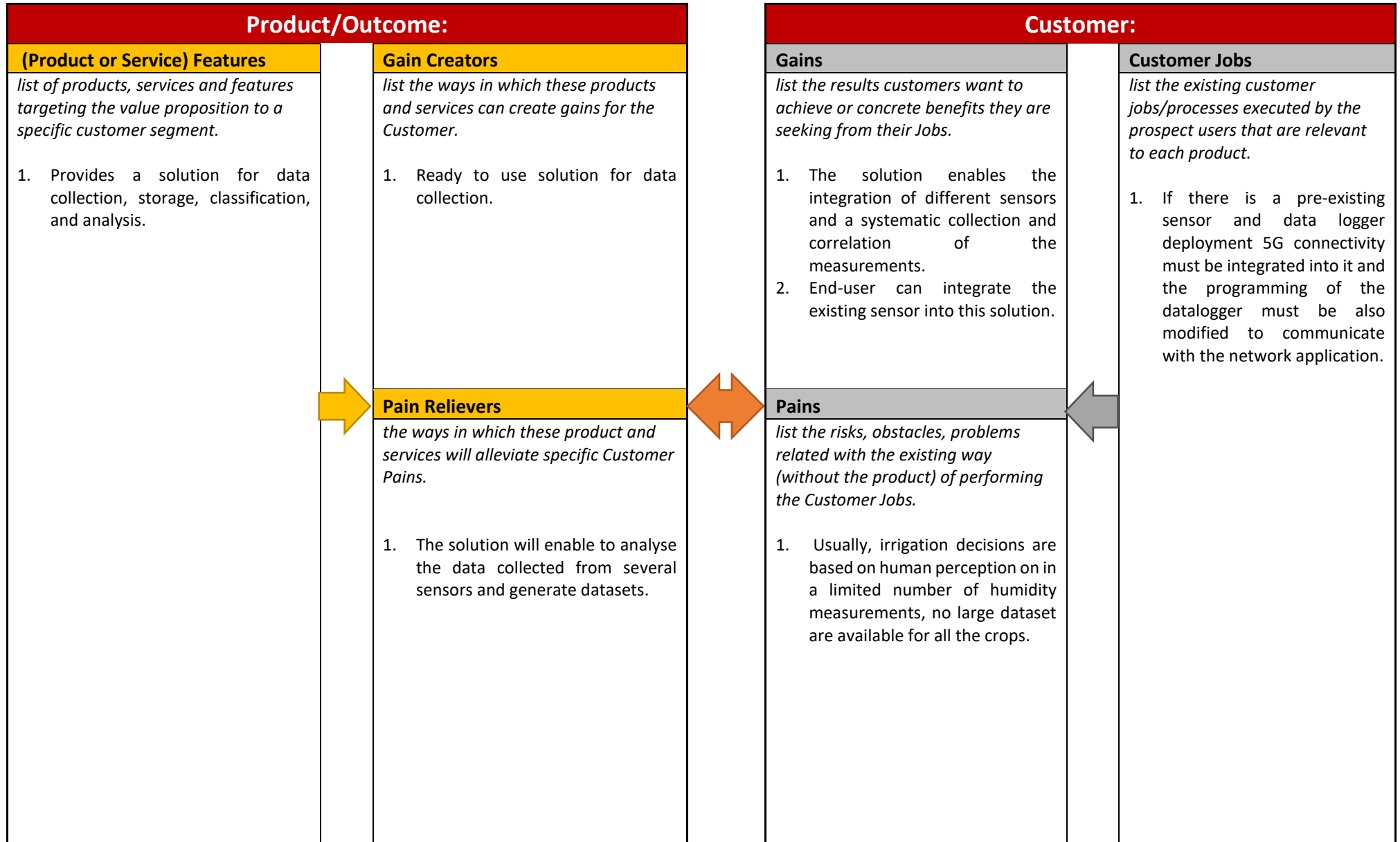
4.3.2.1.7 Smart Irrigation 5G Agriculture Network Application

Description	The smart irrigation network solution has two parts, a software for collecting measurement embedded in a datalogger and a containerised server to store, classify, and analyse the data.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and Prototype (5,6)		
End Customer	Agricultures and third-party companies interested on datasets for developing smart irrigation solutions.			
Target Markets	Data analytics in the context of agriculture use case.			
Innovations	<ul style="list-style-type: none">• Integration of 5G technology into dataloggers.• Containerised solution for easy deployment.• CAPIF and NEF integration.			
Product Competition	Agricultural solutions integrating 5G technology.			

Table 24: Smart Irrigation 5G Agriculture Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Developing partner (CSIC) has large experience in the experimentation with crops. UMA has a large experience in software development. This experience has been applied to develop the network application and accelerate the experimentation work done by CSIC. 	<ul style="list-style-type: none"> Limited background in machine learning techniques to analyse the data collected but we are working on it.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> The network application is a containerised solution that facilitates its deployment. 5G connectivity enable the usage of commercial 5G networks, it is not needed to use specific or private network deployments. 	<ul style="list-style-type: none"> Similar solutions can be competitors using alternatives developments.

4.3.2.1.7.1 EVOLVED-5G Smart Irrigation 5G Agriculture Outcome Value Proposition Canvas



4.3.2.2 Embedded (Stand-Alone) Network Application Prototypes

This section presents the SA Network Applications, that are based on a tighter integration with each Vertical Application and as such are more relevant for empowering the combined solution, whose value is considered as part of the individual exploitation plans of each SME.

4.3.2.2.1 Chatbot Assistant Network Application

Description	Chatbot Network App utilises location services, providing helpful information about the specific area to the user, user authentication restricts access to unauthorised personnel to specific areas, and offers relative material or manuals about equipment in those. Also, notifies available specialised technicians to solve a pending issue.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry, Integrator			
Target Markets	Smart Factory - Manufacturing industries, Automotive Industry, Healthcare, Smart Agriculture, Production Lines, Factories with machine - human interaction			
Innovations	The service currently leverages the capabilities of the 5G system to offer precise indoor location information. This information is employed by the location-aware Chatbot for accurate maintenance within a 5G/Network App-enabled Industry 4.0 manufacturing environment. It plays a crucial role in authenticating and identifying workers based on their real-time location within the factory. This system grants access authorization to specific areas within the factory for authorised personnel. Additionally, it provides real-time guidance for navigating these locations and can promptly contact authorised personnel for assistance when needed in the nearest vicinity.			
Product Competition	Currently, the market lacks products that specifically cater to providing location-aware services and information to factory workers in the manufacturing industry. While Chatbots are being used as online assistant apps, they do not have a dedicated focus on addressing this need.			

Table 25: Chatbot Assistant Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Innovative Technology: Leveraging 5G for precise indoor location information. • Efficient Maintenance: The Chatbot streamlining maintenance tasks through a pre-defined questionnaire is an efficient feature that can reduce downtime in factories. • Providing Essential documentation directly to the Chatbot device improves maintenance procedures and ensures workers have easy access to relevant information. • Access Control: The ability to authenticate and identify workers based on their real-time location, granting access authorization. 	<ul style="list-style-type: none"> • Competition: There is a market gap, we may face challenges in building brand recognition and market presence in this specialised segment.

(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> Industry 4.0 Adoption: The increasing adoption of Industry 4.0 technologies in manufacturing creates a significant opportunity for Chatbot to be integrated into smart factory environments. Vertical Industries: The product can expand its reach by targeting various vertical industries such as healthcare, automotive, and smart agriculture. Machine-Human Interaction: With more factories embracing machine-human interaction, there's a growing demand. Market Gap: The lack of dedicated location-aware services for factory workers presents a significant market opportunity. 	<ul style="list-style-type: none"> Rapid Technological advancements may render our 5G-based solution less competitive or even obsolete in the future. Regulatory Changes: Evolving regulations related to data privacy, location tracking, and worker safety could introduce compliance challenges that affect product viability.

4.3.2.2.2 Network Monitoring & Anomaly Detection Network Application

Description	The Network Monitoring and Anomaly Detection Network Application provides a monitoring toolset for network traffic data in generic and security related services, with special focus on the anomaly detection outlook to timely detect and prevent malicious and suspicious activity. The extended Network Application within EVOLVED-5G provides support for real time 5G monitoring through NEF integration.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Vertical Industry, Telco NPN operators.			
Target Markets	Smart Factory, 5G NPN infrastructure, Production Lines.			
Innovations	A key feature of this application is its integration with the 5G Network Exposure Function (NEF), a cornerstone of the EVOLVED-5G environment. This integration allows for real-time monitoring and management of 5G networks, a critical requirement given the dynamic and complex nature of modern network infrastructures. The application's ability to interact seamlessly with NEF enables more than just surveillance; it facilitates a proactive approach to network management, where potential issues can be addressed before they escalate.			
Product Competition	The market for network monitoring and anomaly detection applications is highly competitive, particularly with the growing reliance on 5G technology in various sectors. In this landscape, the Network Monitoring and Anomaly Detection Network Application, especially within the EVOLVED-5G framework, distinguishes itself through its specialised integration with the 5G Network Exposure Function (NEF). This unique feature provides it with a competitive edge, as it allows for more seamless and effective monitoring and management of 5G networks, a capability that is increasingly in demand in the era of Industry 4.0. However, it faces competition from other established network security solutions that offer similar monitoring capabilities, perhaps with different technological focuses or pricing strategies. These competitors might emphasise aspects like artificial intelligence-driven anomaly detection, user-friendly interfaces, or scalable solutions adaptable to various business sizes.			

Table 26: Network Monitoring & Anomaly Detection Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Advanced Anomaly Detection: The application's sophisticated algorithms for detecting anomalies in network traffic provide a robust defense against cyber threats, ensuring enhanced network security. • Real-Time Monitoring: Its capability for real-time monitoring, especially in dynamic 5G environments, allows for prompt detection and response to network issues, minimizing downtime and improving overall network reliability. • Integration with 5G NEF: The seamless integration with 5G Network Exposure Function (NEF) offers a unique advantage, allowing for efficient and effective management of 5G network functionalities and services. • Specialization in Security: The focus on both general and security-specific network traffic data positions the application as a specialised tool in network security, catering to the growing needs of secure network infrastructures. 	<ul style="list-style-type: none"> • Complexity of Technology: The advanced technology behind the application, while a strength, can also be a weakness if it leads to complexity that makes it difficult for users without specialised knowledge to understand or operate. • Resource Intensiveness: High-level monitoring and real-time analysis may demand significant computational resources, which can be a constraint for organizations with limited IT infrastructure. • Dependency on 5G Infrastructure: The application's heavy reliance on 5G technology means that its performance is contingent on the availability and reliability of 5G networks, which may not be uniform across different regions.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> • Growing Demand for 5G Solutions: As more industries adopt 5G technology, there's an increasing market for tools that can monitor and secure these networks, providing a significant opportunity for growth and expansion. • Partnerships with 5G Providers: Collaborating with 5G service providers could offer mutual benefits, such as enhanced service offerings for the providers and increased market penetration for the application. • Expansion into Emerging Markets: Developing and emerging markets are rapidly adopting modern network technologies, presenting an opportunity to introduce the application in these new markets. 	<ul style="list-style-type: none"> • Rapid Technological Changes: The fast-paced evolution in network technologies can render existing solutions obsolete quickly, requiring constant updates and innovations to stay relevant. • Intense Market Competition: The market for network monitoring and cybersecurity tools is highly competitive, with numerous established and emerging players offering similar or advanced solutions. • Cybersecurity Threats: As the complexity and frequency of cyber-attacks increase, there's a continuous threat of failing to keep up with new types of cyber threats, potentially undermining the application's effectiveness.

4.3.2.2.3 Security Information and Event Management (SIEM) Systems Network Application

Description	The FOGUS 5GSIEM Network App is a supplementary middleware designed to facilitate the integration of information/data from a 5G network into the existing Security Information and Event Management (SIEM) system commonly used in the industrial sector. This integration aims to provide support for 5G-enabled industrial infrastructures. The FOGUS 5GSIEM Network App will be bundled with the FOGUS SIEM system.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	<ul style="list-style-type: none">Integrator, Vertical IndustrySIEM system developers			
Target Markets	<ul style="list-style-type: none">ICT market and integrators who are interested in incorporating the security monitoring and alerting capabilities offered by the product into their OT/IT management solutions.Digital security systems market, particularly in the context of event management and analysis when multiple types of private networks, including 5G, are in use. Smart Factory, Manufacturing, Healthcare, Energy & Utilities.			
Innovations	The primary innovation of the prototype lies in its utilization of standardised 5G exposure APIs to enhance the monitoring and event management functionalities of a SIEM system for 5G NPNs. This prototype plays a significant role in advancing the broader innovation of integrating 5G-NPN into industrial environments.			
Product Competition	There are no relevant products in the market.			

Table 27: Security Information and Event Management (SIEM) Systems Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> It is developed according to contemporary principles. It supports scalability and elasticity in response to system requests and demands. It offers user-friendly usage for an easily accessible and pleasant user experience. It can be tailored to meet users' specific requirements, providing support for various features and enabling updates. It provides real-time monitoring and event management capabilities, allowing users to stay informed about their system's status through notifications and alerts at any given moment. 	<ul style="list-style-type: none"> A 5G NPN is required. Not a standalone product: For this application to be fully operational and meaningful, it relies on a SIEM system. Specifically, it is designed to work in conjunction with the FOGUS SIEM system and has undergone exclusive testing with this system. There haven't been any tests conducted using a different SIEM system thus far.
	(External) Threats
<ul style="list-style-type: none"> It is compatible with various types of private networks, enabling users to maintain their existing infrastructure. It is compatible with 5G devices and networks. Expanding the borders of the existing 5G NPN Security and instantaneous event management. 	<ul style="list-style-type: none"> An increasing number of security risks. The adoption of 5G NPN networks is progressing at a gradual pace, and there is a degree of caution.

<ul style="list-style-type: none"> For this application to achieve full functionality and purpose, it relies on a SIEM system. It is specifically designed to collaborate with the FOGUS SIEM system and has undergone exclusive testing with this system. This ensures both security and efficiency, eliminating the need for further actions to integrate these two components. 	
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4.3.2.2.4 Assured 5G QoS and Integrated SLA/SLS Monitoring Network Application

Description	The solution provides industrial grade 5G connectivity with assured QoS for the IoT and M2M devices connected to the 5G IIoT Gateway, i.e., IoT/M2M devices can be connected to the 5G IIoT GW via various physical interfaces (e.g., serial, USB, Ethernet). The 5G IIoT GW has integrated SLA/SLS monitoring capabilities and local computing capabilities which, in combination with newly introduced support for 5G NEF capabilities, enables creation of priority lists to meet distinctive SLA/SLS requirements for each device and/or traffic type served by the 5G IIoT system. Novel features of the solution include, but are not limited to:			
	<ul style="list-style-type: none">providing 5G SA connectivity from the IoT devices (connected to the 5G IIoT GW) to the application components deployed in the cloud or in the edge,enabling fast and scalable local pre-processing and storage (Docker based packaging formats) of the data collected from the deployed IoT devices (e.g., video streams and local sensor data),assuring the concept of IoT OAM (Operations, Administration, and Maintenance) supporting continuity check of the network path and applications, connectivity verification (based on emulation of the network and transport services and applications) and to provide performance measurement and monitoring of the network/transport paths and applications.			
	Outcome Type	Demonstrator	Outcome Category	Business development
	Target TRL category	Technology Development and prototypes (5-6)		
End Customer	Vertical industries, as well as 5G NPN providing services to vertical industries.			
Target Markets	Targeted vertical markets are all emerging sectors, such as Industry 4.0, ports, critical communications, and other vertical industries targeting reliable and resilient (5G) communications.			
Innovations	<ul style="list-style-type: none">Reducing 5G IIoT System and corresponding services deployment time.Extending the network performance monitoring capabilities of the 5G IIoT System to support collection of network and application specific metrics relevant for targeted industry verticals, e.g., Industry 4.0.Extending the capabilities of the 5G IoT Gateway and backend components to support 5G NEF capabilities.Technological and operational validation, interoperability check and verification of the system’s operational use in the Industry 4.0 environments based on 5G NPN systems with NEF capabilities.			
Product Competition	To the best of our knowledge, there are no relevant products in the market so far. Current baseline technologies used in similar products support 5G capabilities but are controlled with monolithic back-end system and do not support NEF.			

Table 28: Assured 5G QoS and Integrated SLA/SLS Monitoring Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> Improved operability for the end customers Interoperability (due to the common 5G global standards) Beyond state-of-the-art technology Scalability Digital innovation. 	<ul style="list-style-type: none"> Considerable infrastructure investments for 5G Commercial availability of 5G UEs supporting specific functionalities Certain target users may not be yet ready or willing to adopt new technologies. New approaches may require some adaptation/learning time for end users. Technology (5G NEF) not mature yet. 5G commercial equipment lacks NEF support.
(External) Opportunities	(External) Threats
<ul style="list-style-type: none"> Expanding business as the solution allows for building new services and adapt/digitalise existing ones. Expanding business globally due to common 5G standards. Specialised technology demands and demands for the digitalization increases the potential of utilizing the solution into multiple industrial verticals. Potential to build strategic alliances with established but less innovative players in Industry 4.0. 	<ul style="list-style-type: none"> Market entrance barriers Specific regulation requirements in different regions.

4.3.2.2.5 Identity and Access Control Network Application

Description	The IQB Network Application is a CAPIF-compliant middleware layer that handles authentication and authorization and includes SSO capabilities. The application can be utilised as an enhancement of CAPIF's IAM offering OIDC on top of CAPIF's OAuth2.0, or as an authentication proxy between CAPIF instances that effectively provides SSO through OIDC, allowing clients to access multiple network infrastructures without having to repeat the onboard process.			
	Outcome Type	Prototype	Outcome Category	Product Development
	Target TRL category	Technology Development and prototypes (5,6)		
End Customer	Integrators, Communication Service Providers			
Target Markets	<ul style="list-style-type: none">• Network operators and communication service providers acting as buyers and suppliers of Network Applications.• Service providers meaning to be interconnected with SSO.• Network operators aiming to use OpenID Connect or connect multiple network providers with SSO.			
Innovations	<ul style="list-style-type: none">• Innovative Use of Technology: The application's integration of OpenID Connect with the CAPIF Framework's proposed OAuth 2.0 signifies a forward-thinking approach to authentication and identity management.• Single Sign-On (SSO) Implementation: Offering SSO capabilities provides seamless user experiences and enhances interoperability between different network providers and services.			
Product Competition	The contributions and functionality of this product are unprecedented.			

Table 29: Identity and Access Control Outcome Gap Analysis

(Internal) Strengths	(Internal) Weaknesses
<ul style="list-style-type: none"> • Increased Security. • Improved operability for the end customers. • Interoperability (due to the common 5G global standards). • Beyond the standard CAPIF-compliant robust solution. • Scalability. 	<ul style="list-style-type: none"> • Commercial availability of 5G UEs supporting specific functionalities. • Technology maturity level of the 5G NEF is low. • Complexity of technology integration. • Dependent on open-source software (Keycloak).
(External) Strengths	(External) Threats
<ul style="list-style-type: none"> • Adaptable to many cases where multiple providers offer different coverage and SSO would allow clients to have network access on all areas despite their provider. • Adoption by mobile providers would enhance their services. • Growing market demand for robust identity and access management solutions. • Competitive edge due to unprecedented contributions and functionality. • OIDC identity data can be used for AI applications. 	<ul style="list-style-type: none"> • Dependence on external partners such as network operators, service providers, integrators for adoption. • Reluctance of adoption since the Network Apps can operate without additional security. • Requires Keycloak client configuration.

4.4 INDIVIDUAL EXPLOITATION PLANS

4.4.1 Telefónica I+D

TID aims to exploit the project research results in Telefónica, with the goal of promoting the achievements and ideas inside the strategic roadmap of the relevant Telefónica business units in Europe and the world. In particular, TID plans to communicate and promote the EVOLVED-5G results within the Telefonica Group units working in network evolution and management automation (GCTIO). This will include internal proofs of concept, and training, with the goal of making these units incorporate the results and learnings to their technology stack. In parallel with these actions towards commercial exploitation, other initiatives will also be undertaken. Internal evangelisation, through the dissemination of the main project results, across the entire organization, using Telefónica Excellence School, internal communication channels (workplace, ThinkBig blog, etc.), Telefónica Design Councils and TID demonstration rooms. Presentation of the main innovations developed in the project to the entrepreneurship initiatives of Telefónica (Wayra and Telefónica Open Future) with the goal of facilitating their application by the start-ups nurtured by these initiatives. Contributions to standardization bodies (ETSI, IETF, ONF, 3GPP) and EC initiatives (6G-AI, Cybersecurity PPPs, and other future initiatives), whenever applicable. TID is interested as well in possible patents for the services and system pieces derived from the EVOLVED5G project and in influence on standards and on the development of new related commercial solutions. For these goals, the EVOVLED-5G concept consolidation is considered a key aspect in providing protection for future 6G network systems deployments. Parallel to these exploitation objectives, TID plans to involve its industrial partners in the 5G community and stakeholders in the design of technically feasible and scalable commercial products from the above concepts and then cooperate in the transfer process to the industry.

4.4.2 National Centre for Scientific Research Demokritos

The overall participation in EVOLVED-5G can be seen by DEMOKRITOS as a direct step toward establishing a strong research and scientific position in the field of future network architectures and management systems. Based on the experience acquired by EVOLVED-5G integration activities, NCSR Demokritos has gained experience and expertise in novel 5G network infrastructures and related technologies (NEF APIs, 5G Programmability, Network Apps lifecycle etc., K8s deployment and metrics monitoring) leading to the development of an automated experimentation framework for KPI assessment on top of its 5G infrastructures.

Such experimentation tools developed by NCSR Demokritos within EVOLVED-5G are planned to be further exploited as services offered by NCSR Demokritos to external SMEs in the framework of the digital innovation hub Ahedd⁹ that operates within NCSR Demokritos premises. Furthermore, DEMOKRITOS is home to the "Lefkipos" Technical Park, which houses many private companies and startups in the fields of IT and telecommunications, where the results of the Athens platform trials will be promoted, looking for possible synergies and joint ventures.

Moreover, NCSR Demokritos foresees further exploitation opportunities of the expertise gained in 5G and Network Apps through the signed partnership with 5G Ventures SA responsible for the establishment and management of Phaistos Investment Fund. The objective of the Phaistos Investment Fund is the public investment in businesses that are actively involved in 5G-related research and/or development of products and/or services in Greece, in sectors such as transport and logistics, manufacturing, public goods and utilities, health, tourism, information and media. As a result, NCSR Demokritos, by exploiting the EVOLVED-5G Athens Platform through this collaboration, will be able to support further development of services and products for the 5G Network App ecosystem.

Finally, NCSR Demokritos plans to exploit further the Network App/5G expertise gained within the project, by conducting innovation activities related to entrepreneurship, and for that purpose has proceeded to a collaboration agreement with the Municipality of Egaleo, and more specifically with the Entrepreneurship hub for fostering further the development of innovative products and services related to 5G and Network Apps by startups and young teams that are willing to get involved in the field.

Within the academic sphere, NCSR Demokritos is set to capitalise on and integrate paradigms, knowledge, and technical assets from EVOLVED-5G into ongoing educational initiatives, encompassing MSc's and PhD programs, along with online practical training courses.

4.4.3 Maggioli SPA

Maggioli is positioned as leader in integrated solutions for the Public Administration, in the field of information and communication technologies (in the ranking list of the TOP 100 Data Manager IT Software and Service Companies, Maggioli came 7th in the PA sector). Maggioli was characterised by the timely development of new products and specific services to support Public Administrations and private individuals in the management of an emergency and a new reality, accompanied by an intensification of technical assistance and advisory services. Maggioli is one of the biggest ICT integrators in Italy with more than 1,500 dedicated highly qualified personnel,

⁹ <https://ahedd.demokritos.gr/>

while the Maggioli Group has more than 2800 employees around the globe and is serving thousands of municipalities not only in Italy but also Spain (ca. 6000 municipalities and 1500 SMEs in Italy, and 1500 cities in Spain) including municipal police in Italy and Spain. Moreover, Maggioli provides services and solutions to more than 3,800 museums and 1,500 SMEs. The exclusive value proposition combines and integrates design capability, product knowledge, and 35 years of experience in the sector. Maggioli aims to exploit the project's results as follows:

1. APKappa S.r.l is a subsidiary and 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 Network Apps to augment its vertical solutions in the manufacturing industry and IoT domains.
2. The possibility of testing the marketplace with the other subsidiaries under the group to test the efficiency and possible improvements and usages.
3. As a system integrator, Maggioli is currently exploring ways to embed the EVOLVED-5G security/privacy Network application into its broad portfolio of products (industry, smart cities, digital twins etc.).
 - Maggioli will encourage internally, in its R&D department and on the group level, the development of applications using the results obtained by EVOLVED-5G.
 - Maggioli will investigate possible exploitation opportunities of the project results with its R&D partner network, also through EU funded projects.

4.4.4 ATOS IT solutions and services Iberia SL

Participation in R&D EU projects is a key pillar to boost the innovation process in an organization like ATOS and, therefore, ATOS is committed to obtain most of the project results, both tangible and intangible ones. In D7.4, the different potential paths to exploit the outcomes resulting from the project were presented by ATOS Research and Innovation (ARI) Team. All of them have been somehow explored during the project lifetime and will continue being exploited after the project ends:

- **Knowledge transfer:** Knowledge is an intangible result from the project, but critical for ATOS to be strategically positioned at the market and at the forefront of the latest technology and industry trends. The knowledge acquired thanks to our participation in the project has been and will keep being transferred within and outside the organization. Internally, several meetings have already taken place with the different Business Units during the project lifetime; externally, ATOS participated in different training sessions, webinars, papers, etc.
- **Contribution to standardization:** During the project lifetime, ATOS followed the OSM to be aware of the topics of interest being discussed in the open-source community with the goal of being aligned with the standards. Some ideas being explored by the project (i.e., Network Apps concept) were also presented to the community to try to influence its direction and foster collaboration.
- **Enhancement of the ATOS TMT portfolio:** The major goal of ATOS participation in R&I projects is to enhance the portfolio of products and technologies offered to its customers. With this purpose, there is an internal process in ATOS to ensure that results coming from R&I projects with the most business potential, are evolved to become part of the organization portfolio. In EVOLVED-5G, ATOS led the development of the workspace (composed of an SDK, an open repository (GitHub) and CI/CD services) the main goal of which is to support developers in the creation of Network Apps. ATOS will

look for different potential ways to keep working on the evolution of the asset with the goal of reaching the commercial market.

- **Technology Transfer:** The project assets, especially those in which ATOS was directly involved, were presented in different internal and external fora. The fact that they offer a set of functionalities through different open-source tools, facilitates their use and potential extension.
- **Integration in future research projects:** ATOS participates regularly in national and European R&I projects. Whenever possible, the technical results derived from EVOLVED-5G will be reused and /or evolved to grant their sustainability.

4.4.5 INTRASOFT International SA

Netcompany-Intrasoft is a leading European IT Solutions and Services Group with strong international presence and expertise, offering innovative and added-value solutions of the highest quality to a wide range of international and national public and private organizations.

Netcompany-Intrasoft employs more than 3,200 highly skilled professionals, representing over 50 different nationalities and mastering more than 30 languages. With headquarters in Luxembourg, Netcompany-Intrasoft operates through its operational branches, subsidiaries, and offices in 10 countries: Belgium, Cyprus, Greece, Jordan, Luxembourg, Romania, RSA, Scandinavia, UAE, and USA.

More than 500 organizations in over 70 countries worldwide (Institutions and Agencies of the European Union, National Government Organizations, Public Agencies, Financial Institutions, Telecommunication Organizations, and Private Enterprises) have chosen the company's services and solutions to fulfil their business needs.

Netcompany-Intrasoft's expertise and strength lie in its proven capacity and successful track record in undertaking and delivering, complex, mission-critical projects. Netcompany-Intrasoft's professionals have developed the ability to combine their technical expertise with thorough understanding of each customer's individual business needs. The company consists of a highly skilled, efficient, and flexible human resources base, with an international culture.

With the participation in EVOLVED-5G, INTRA is expecting to:

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

4.4.6 COSMOTE Mobile Telecommunications SA

COSMOTE is the leading mobile operator of Greece with a striking record of very important firsts, including the 5G network launch in Greece in accord with its clear business strategy to be the pioneer in the Greek Telecommunications market. This strategy is not only supported by noteworthy investments in next generation networks, leading to the 5G SA commercial launch in 2024, but also through strong commitment in research and development, leveraging the European research ecosystem through the participation in more than 120 research projects in the past 10 years.

The company's marketing objective is to promote the adoption of next generation connectivity and monetise the state-of-the-art network technologies deployed, by exploiting the opportunities foreseen for verticals and, with particular focus on the industrial domain, COSMOTE has already taken early steps to deploy campus networks through various projects with Greek industries¹⁰. Additional to the potential of private networks, the network openness introduced in 5G SA creates new, very attractive business opportunities, capitalizing on the data that the network already owns (such as user authentication, location, behavioral characteristics, and traffic patterns) that can be valuable for the vertical business development. EVOLVED-5G elevates both concepts of private networks and network openness, and as such, there is a clear fit of the project developments with COSMOTE's exploitation targets in the following dimensions:

- **Network Applications to boost Vertical Use Cases:** The interactions with the wide representation of SMEs in the project from four different industrial pillars, has helped clarify the requirements so that to establish the appropriate marketing culture, understand the constraints and limitations to be smoothed for the facilitation of the quick adoption of the technology in practice. Indicatively, the EVOLVED-5G lifecycle methodology and Network Applications integration has been showcased to the engineering teams, as well as the marketing, business-to-business departments so that to exhibit the ease of integration of 3rd party software in the MNO's premises as well as to demonstrate the qualitative gains from the applications, or in other words the customers, perspective.
- **Network Openness and openCAPIF:** In response to the participation in the project, COSMOTE, follows as member of the DT Group the developments in the CAMARA project, that encapsulates the OpenCAPIF project result, and through this activity is prioritising the deployment of NEF in the 5GC commercial network, targeting use cases with global interest for the DT Group such as the support of the automotive industry, through the realisation of the DT "MagendaBusinessAPI"¹¹
- **Network Applications Certification Process and Tools:** Critical to proceed with the tight integration of the network with the 3rd party applications, is the assurance of interoperability, security, and functional suitability, which in the traditional business is achieved through a well-established certification process that nevertheless is currently executed for devices only. Extending and automating this process to onboard Network

¹⁰ <https://www.telcotitans.com/deutsche-telekomwatch/cosmote-works-ericsson-ties-for-campus-network-debut/2757.article>,
https://www.cosmote.gr/cs/otegroup/en/5g_campus_network.html,
https://www.cosmote.gr/cs/otegroup/en/campus_network.html,
https://www.cosmote.gr/cs/otegroup/en/smart_manufacturing.html

¹¹ <https://www.fiercewireless.com/tech/ericsson-strikes-api-pact-deutsche-telekom>

Applications, a clear target of the project, is mandatory to ensure the quality of experience promised to the customers, and through EVOLVED-5G, COSMOTE has shaped the way this can be achieved.

In conclusion, COSMOTE, has leveraged the experience gained, the methodology developed, as well as, the technologies delivered, to be a step ahead in the 5GC services adoption from the competition. At the same time, through the interaction with the SMEs, the market/business challenges for the appropriate collaboration with the vertical industries and 3rd party application providers have been identified and a plan of actions has been set. COSMOTE as part of the project activities has evaluated the technical transformations and associated investments and risks so that to deploy and manage 5G SA NPN networks while implementing Network Exposure to its public network, incorporating these propositions in the 2024 commercial plans (beyond the project's end). Finally, COSMOTE has exploited all opportunities to share the project results internally and within the Deutsche Telecom (DT) Group, to maximise the project's visibility and impact.

4.4.7 Lenovo (Deutschland) GmbH

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

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

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

- Lenovo intends to exploit the business development in 5G and TSN integration, as well as the native APIs exposure of the 5G Core (5GC) to contribute to the standardization activities of 3GPP in SA6 and other relevant groups.
- Lenovo product line end-devices incorporating the Industry 4.0 Network App 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 Network Apps.
- Lenovo's development of a prototype system (Auxiliary Network App) through their own research activities in the context of EVOLVED-5G, is anticipated to enable scientific experiments around vertical industry scenarios and promote the company's standardization activities in 3GPP SA6.

- Lenovo will also consider exploitation of the technological advances offered by the project implementation actions, such as the CAPIF and NEF emulator, to expand their enterprise products' capabilities towards efficient interaction with 5G public or private networks, enabling disruptive use-case-tailored applications.

4.4.8 Impact Entrepreneurship Award Ltd.

Envolve/IEA is a business support organisation and an innovation agency based in Cyprus with a subsidiary in Greece. IEA undertook the provision of practical tools and capacity building programmes, including the EVOLVED-5G Accelerator and the EVOLVED-5G Library (as part of WP6) on the benefits that transitioning to a 5G model will bring to startups and SMEs across verticals, in terms of high value job creation and the identification of new business growth opportunities, as well as support the ecosystem building and the promotion of collaboration. IEA seeks to build a relationship complementary to the project networks to facilitate continuous knowledge exchange and advancement in 5G for the Industry 4.0 domain. Where it was possible and appropriate to do so, opportunities to directly collaborate on tool development, technology transfer activities and guides, policy recommendations, community building, or dissemination activities have been seized (WP6 and WP7). Collaborating with other related projects and initiatives supported the continuous expansion and exposure of the EVOLVED-5G multi-actor networks and the community. As the project outputs have been developed, tested and validated, a series of policy recommendations has been 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.

4.4.9 Universidad de Málaga

UMA is a public university in the Spanish Autonomous Region of Andalusia with about 40,000 students and over 3,000 research and teaching staff. The main technical degrees at undergraduate and graduate levels are those offered in Industrial/Mechanical Engineering, Telecommunications Engineering and Computer Science.

MORSE group comprises a team of professors and researchers the headquarters of which are at the Instituto de Tecnología e Ingeniería del Software (ITIS Software). The group's activities are geared towards both basic and applied research, along with significant dedication to technological transference. MORSE has successfully collaborated with several companies in the wireless sector, contributing to the development of conformance testing tools, protocol stacks, deployment of pilots and more. Some previous partners are Alcatel-Lucent, Adif, Keysight Technologies, Dekra, Optimi (now part of Ericsson), Abengoa Water, or Telefonica. Its technology transfer capabilities are widely recognised.

The exploitation plans are the following:

- Technology transfer and knowledge transfer with companies interested in integrating 5G technology and validation tools developed in the project.
- Enhancement of the testbed to offer an updated portfolio of novel 5G and 6G features.
- Participation in future projects to continue improving the experimentation framework via collaboration with other European partners and to continue offering the project platform for advanced testing of new cases.

4.4.10 Universitat Politècnica de Valencia

UPV is a reputable technical university in Spain, recognised 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 Network Apps 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 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 had led the creation of courses for introducing and providing training for the creation and use of 5G Network Apps, specific FoF applications and exploitation of 5G networks. These courses are publicly accessible online to any stakeholder following a Freemium strategy, allowing some degree of commercial exploitation. Some of them would belong to UPV's individual exploitation plan (introductory courses 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.

4.4.11 GMI-AERO-SAS

GMI Aero SAS (www.gmi-aero.com) 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 in 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, to certify that the overall process has been performed according to specifications and confirm the physical and mechanical properties of the repaired part (especially the composite patch and the adhesive bond). However, several repairs take place “on-wing” and remotely (maybe even outside of hangars) at challenging environmental conditions, due to geographical location (extremely low temperature, increased humidity, very high altitude etc.). In addition, increased geometrical complexity of contemporary all-composite aircraft (e.g., A350, B787) may lead to extensive Temperature variations during curing, well beyond specified limits (usually $\pm 5^{\circ}\text{C}$), which may affect the curing degree and / or the mechanical properties of the produced repair. This may lead to ambiguities on the evaluation of the repair results and subsequently delay or even prohibit the authorization of aircraft to resume flight operations, especially when repairs on safety critical structures are performed.



Figure 5: ANITA 4.0 Hot Bonder (Extract from GMI Aero commercial brochure)

Within the frame of EVOLVED-5G the ANITA 4.0 hot bonder(s) used for repair will be using 5G network and corresponding Network Applications at the repair area, in order to transmit in real-time all related data for the creation of physical or digital twins at the end-user’s (airline) engineering HQ and / or at the certification authority (EASA, FAA etc.). 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.

DIGITAL-PHYSICAL TWIN

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

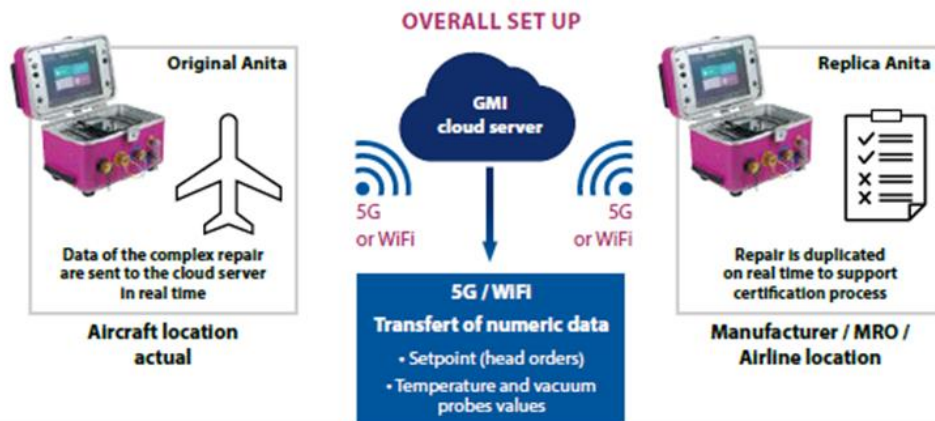


Figure 6: Digital – Physical Twin using ANITA 4.0 (Extract from GMI commercial brochure)

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

4.4.12 Internet Institute Ltd.

INTERNET INSTITUTE Ltd. (ININ) is positioning itself as a highly innovative SME focusing on business opportunities within the area of Industry 4.0, telecom operators, critical communications, public safety organizations, infrastructure, and utility companies. In EVOLVED-5G, ININ is developing a critical communications solution, i.e., a NetworkApp and a vertical application, enabling industrial grade 5G connectivity with assured QoS for IoT and M2M devices. The solution itself has been developed, deployed and demonstrated facilitating ININ's 5G IoT Gateway, which has been already in use for several PoCs, including a use case on enhancing logistical processes in a seaport (i.e., H2020 project 5G-LOGINNOV). On the other side, ININ's network performance testing and monitoring tool qMON, which serves for assuring QoS in ININ's EVOLVED-5G solution, is in use in an Industry 4.0 use case entitled "Drone assisted network performance and coverage monitoring for industrial infrastructures" (i.e., H2020 project 5G-INDUCE).

To remain innovative, ININ's exploitation plan, stemming out of its EVOLVED-5G outcomes and experiences, includes introducing Network App approach and adding support for 5G NEF into its products, and adding IoT and M2M related products with 5G NEF and Network App features into its technological and business portfolio where applicable. These products' main benefits, according to ININ's expertise, stem from latest advances in network monitoring, and evidence-

based decision support tools. Besides exploitation among potential industrial customers, the activities and associated results are expected to generate knowledge, experience, and insights in 5G and cloud technologies exploitable in further research projects.

For the future, the ININ's individual exploitation plan focuses in particular to:

- Conducting piloting activities and building knowledge and experience related with Industry 4.0 and Smart Factories.
- Shaping its product roadmap in 5G and cloud-native support for deployment and management orchestrations in industrial environments, as well as applying novel business opportunities and models.
- Establishing partnerships with relevant stakeholders in the EU research and industry domain and hence pursue new R&D partnerships and commercial opportunities with recognised stakeholders.

4.4.13 Cafatech

CAFA Tech OÜ is an Estonian robotics and technology company that develops mobile Worker Robots, 5G cellular drones, and is involved in international projects of telecommunication, energy, and defence technologies.

From the EVOLVED-5G project CAF learned to use the 5G network applications deployment architecture – CAPIF, NEF and function of Network Applications to forward the network state information, such as Quality of Service (QoS) and Connectivity to vApps.

CAF team learned the use of Docker and Kubernetes for 5G network applications' deployment and Flask server for developing a simple user interface to our Network Application and vApp.

CAF vApp CAFA SafeLyzer is a computer vision app that finds persons from the video feed of the camera installed on the CAFA Worker Robot or drone moving in the factory environment. The SafeLyzer detects whether a person is wearing Personal protective Equipment (helmet and other protective equipment) and generates a warning to the factory control centre if they're not. It will be a fast and automated way to increase workplace safety.

CAF will continue to develop CAFA SafeLyzer, to which additional functions will be added. Considering CAF's experience in deploying applications in 5G networks, it is planned to use these skills in deploying applications necessary for the operation of CAF robots and drones in the networks of 5G operators. CAF sees good potential in 5G networks as a communication solution for Uncrewed vehicles, because 5G mid-band and 700MHz band will cover most of the territories of EU countries within two years.

4.4.14 InQbit Innovations S.R.L

IQBT has developed an identity and access management solution for network applications that features OpenID Connect (OIDC) on top of the CAPIF framework's proposed OAuth2.0 protocol, as well as Single Sign-On (SSO) capabilities between mobile providers. This results in a robust, CAPIF-compliant solution. IQBT has been further developing the detailed exploitation plan covering immediate and long-term goals mentioned in D7.4. The IQB Network Application is available in the EVOLVED-5G Marketplace for consumption by SMEs and mobile operators that may be interest in enabling SSO, therefore fulfilling goals for the present. Following the project's completion, IQBT will use the exploitable outcomes of the project to further fortify security and privacy solutions developed with OpenID Connect and Single Sign-On, which covers the intermediate goals. Regarding long-term exploitation, IQBT aims to capitalise on the Network Application and the expertise on Authentication, Authorization and Access Management to

develop an innovative cloud-based solution that also handles onboarding and offboarding processes. IQBT is focusing on exploiting other EVOLVED-5G outputs such as the Northbound APIs to develop solutions for trust management in IoT environments. Furthermore, InQbit is always developing new business activity such as consulting services, cybersecurity training, data management etc. that are enhanced by the robust OpenID Connect & SSO implementation, and the expertise gained along the duration of the project.

4.4.15 FOGUS Innovations & Services P.C.

FOGUS is currently in the process of developing new software products and optimising the existing ones, that focus on risk analysis and security management for 5G networks. More specifically, FOGUS's plans involve re-designing and advancing the functional algorithmic components of these products to integrate the potential for data monitoring and content analysis within Industry 4.0 environments. This plan is vital for FOGUS sustainability and competitiveness in the current era. The progress and advancement of Industry 4.0 are pivotal in the creation of monitoring systems, the detection of abnormal behaviours, and the implementation of self-healing mechanisms for connected devices and sensors in 5G network. These systems hold significant potential and are of utmost importance in FOGUS priorities to harness this evolution and development.

The FOGUS 5GSIEM Network App developed in the context of the EVOLVED-5G project has a specific aim: to simplify the process of integrating information from a 5G private network into an existing Security Information and Event Management (SIEM) system. Given that 5G NPNs amplify the demand for a robust security and control system, particularly because network management is deemed the responsibility of the network owner and not a third party. This application can facilitate and streamline the transition from a public 5G network to a 5G NPN, which is more adaptable, customised, and notably more secure, especially in use cases like Industry 4.0.

Simultaneously, FOGUS will expand its testbeds and simulation infrastructure to align with 5G and FoF (Factory of the Future) standards. Embracing the contemporary trend of software-based infrastructure and achieving maximum remote control is of great significance to FOGUS. This approach allows FOGUS to minimise geographical barriers and mitigate potential threats. Furthermore, FOGUS proactive oversight of activities within the 5G-PPP and EFFRA associations will enhance its contributions to this initiative.

Overall, FOGUS participation in the EVOLVED-5G project is expected to bolster the company's competitive position in the fields of experimentation and benchmarking. Furthermore, since FOGUS places emphasis on investing in training and consulting services, the knowledge gained through the EVOLVED-5G project will be leveraged by FOGUS training and consulting sector to develop new courses and training materials.

Moreover, engaging with Accelerator communities that cater to small and medium-sized enterprises (SMEs) aiming to advance their expertise in SIEM systems within the realm of 5G networks can be highly advantageous. This participation can serve to disseminate knowledge, facilitate the exchange of mutually beneficial ideas, and potentially enhance the evolution of our own application and overall approach.

Ultimately, the Research field presents a realm brimming with opportunities and a productive ground for both enhancing the existing application and exploring new ideas for further development and refinement.

4.4.16 INFOLYSIS

As already stated in D7.4., INFOLYSIS will capitalise on EVOLVED-5G results by increasing INFOLYSIS' presence and penetration in the respective areas of research, as well as facilitating

processes to ensure the project's maximum visibility and impact within the business and scientific communities, as well as within the chatbot apps commercial market, in order to ensure quick adoption of project outputs and easier commercialization of its chatbot-based services. Following the project completion, INFOLYSIS will focus on the exploitation and potential commercialisation of the two main developments/outcomes it achieved in the project lifetime namely:

- Chatbot Assistant Network Application leveraging the capabilities of the 5G system to offer precise indoor location information.
- Location-aware Chatbot for Precise Maintenance in a 5G-enabled Industry 4.0 Manufacturing Environment.

INFOLYSIS participation in the EVOLVED-5G project, in particular through 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/IoT related projects (6G-SANDBOX, aerOS, 5GENESIS and 5G!Drones) will further:

- Enrich its chatbot services and products.
- Leverage 5G for precise indoor location information.
- Plan the development of additional network applications that may increase the functionality/features of chatbot apps, reduce downtime in factories and improve cost efficient operations.
- Improve the capacity of existing services on authenticating and identifying workers based on their real-time location, granting access authorization.
- Take advantage of the existing opportunity for chatbot apps to be integrated into smart factory environments and processes.
- Encourage the development of additional Industry 4.0 chatbot based applications using the 5G network capabilities and indoor location features.
- Create new chatbot based products and services targeting new markets and sectors by offering friendlier, more cost efficient and environmentally friendly business solutions.
- Foster INFOLYSIS IoT and 5G R&D activities coupled with chatbot technologies.
- Enrich the know-how and the research expertise of the company in 5G technologies under Industry 4.0 environments.

In parallel, INFOLYSIS will take advantage of its role as Communication and Dissemination leader and use its expertise to gain full exposure and influence within the business, scientific and 5G communities to ensure that the project's outputs are easily and quickly adopted even after the project's end.

Within these communities, INFOLYSIS through its corporate communication channels, will communicate project outcomes and opportunities, explore future expansion and exploitation in current markets, products, and services, enrich its collaboration with IT-related SMEs and industries. Post-project dissemination activities will focus on relevant markets and industries to fully leverage the novel business opportunities generated by EVOLVED-5G, related activities and business processes.

In specific, INFOLYSIS will:

- Exploit EVOLVED-5G results within scientific communities and chatbot apps markets.
- Enhance its participation in the evolving SMEs ecosystem and chatbot apps markets.
- Contribute to the newly formulated 5G/6G, chatbots market landscape and societal impact.
- Participate in new SME accelerator communities and incubator programs through which INF will further disseminate EVOLVED-5G developments, results and experimentation opportunities.

- Use expertise gained in the research activities of ongoing 5G related projects in which INFOLYSIS participates for further enriching and promoting EVOLVED-5G project's outcomes.
- Target new research opportunities for further enriching INFOLYSIS portfolio with new innovative services.

4.4.17 EIGHT BELLS LTD

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

Cybersecurity is one of the major focus areas for the R&D activities of the company, through participation in several relevant projects, such as, HORSE, REWIRE, AlInception, Acting, ENCRYPT, ELECTRON, SECANT, and others.

In addition to the H2020 projects, the company is also focusing in developing a portfolio of products in the security space. Such initiatives include: (i) an AI enabled Security Information and Event Management (SIEM) product, (ii) a Situational Awareness monitoring platform for ICT ecosystems that takes into consideration the variety of the deployed services and devices, (iii) a Cyber Range solution that ensures proper training and keeps cybersecurity awareness at high level, thus avoiding attacks relying on human behaviour.

Through its involvement in the EVOLVED-5G project, 8BELLS has obtained significant insight from the results which has reinforced the company's position in cybersecurity and 5G networks programmability.

With regards to products, by participating in this project, the company has further developed the prototype of an innovative Next-Generation Firewall that is integrated with the 5G network. This integration is key in unlocking advanced security policies towards a Zero-Trust approach, by incorporating network parameters & KPIs that are not visible from normal Firewalls. The company is following the industry developments with regards to standardised 5GC APIs that will further enhance the integration with the 5G network. Leveraging additional parameters as they become exposed by the 5G network APIs, could create more complex security policies to cater to any Industry 4.0 use case. Such use cases could for example consider the user device location within the 5G network in applying customised security rules.

The company will therefore further enhance the functionality of the product and is currently seeking some friendly users that could serve as proof-of-concept demonstrators for the innovative use cases unlocked by this product.

In addition, based on the experiences gained in the project the company is seeking to develop other novel ideas that could be the focus of further research & development activities (EU-funded or sponsored by other sources).

4.4.18 PAL-Robotics

PAL Robotics mission is to create disruptive service robots that enhance society's quality of life and solve daily problems. Robotics can make a difference by collaborating with humans, providing support for domestic tasks and increasing efficiency in industrial workflows. We develop customizable, tailor-made platforms and modular robotic parts that adjust to people's needs. We design and manufacture highly integrated and reliable solutions for service industries and research institutions worldwide.

As part of the Evolved-5G project, PAL contributed to the development of a Network APP together with UMS to allow AMR fleet to localise in an indoor environment over 5G. PAL also

developed a Network APP for Teleoperation that allows a Teleoperation process to run seamlessly.

Some of the outcomes and benefits PAL sees for future features:

- Use of the Quality of Service to be able to guarantee a risk-free teleoperation and add a security layer to the actual process.
- Use of TSN to request a specific bandwidth and latency without jitter that can always be guaranteed for a seamless teleoperation experience.
- Use of the localization Network App to be able to recover the position in case the robot is no more properly localised.

4.4.19 ZORTENET

For ZORTENET, developing a cohesive exploitation plan for their Network Monitoring and Anomaly Detection Network Application involves a series of strategic steps aimed at maximizing the product's market potential. Initially, the company should engage in comprehensive market research to identify target industries, with a focus on sectors like telecommunications, manufacturing, and IT services. Positioning the product as a leading solution in 5G network monitoring and security, particularly highlighting its unique capabilities and integration with the 5G Network Exposure Function (NEF), is crucial. Continuous product development and innovation are key. ZORTENET should invest in updating the application to incorporate the latest advancements in network technology and cybersecurity. This includes innovating new features to address emerging network challenges, especially in the realms of 5G and Industry 4.0. Forging strategic partnerships will also play a pivotal role. Collaborations with 5G service providers, Industry 4.0 technology firms, and cybersecurity organizations can expand the application's reach and enhance its capabilities. Additionally, partnerships with academic institutions and research organizations can facilitate cutting-edge research and talent acquisition. An effective marketing and sales strategy is essential. ZORTENET should develop a comprehensive marketing strategy, utilizing digital marketing, industry events, webinars, and whitepapers to educate potential customers about the benefits of the application. A dedicated sales team, well-versed in the complexities of 5G networks and cybersecurity, will be crucial in effectively communicating the product's value proposition.

4.4.20 Immersion

IMM is focusing on an Industry 4.0 use-case based on Augmented Reality (AR). During the EVOLVED-5G project, the company has achieved the following milestones:

- IMM has developed its Network Application focused on autonomous service adaptations corresponding to the current QoS of the 5G network. This Network Application was designed to be easily adapted to a large range of markets and customers interested into 5G.
- IMM has adapted its vertical application for remote assistance in AR to make it compatible with 5G. The resulting demonstrator showcases the benefits of 5G for remote assistance in AR, especially on real-time aspects and autonomous adaptation to network QoS.

Besides generating internal knowledge and experience about the 5G connectivity of current AR devices, the EVOLVED-5G project was also the opportunity for scientific publications on remote assistance with AR. The inclusion of 5G also led to the production of several videos to disseminate the progress performed during the project to new prospects.

The current goals for IMM are built around encouraging the development of Industry 4.0 AR/VR applications using the 5G network capabilities. The company will take advantage of the assets developed during the project to attract new customers interested in the benefits of 5G, such as integrators and vertical industries. While IMM will prioritise markets related to AR/VR as it is closer to its initial expertise, the company will also use the demonstrator to consider new markets. Moreover, IMM will expand this demonstrator to expand the range of service adaptations provided by the Network Application and triggered with the vertical applications.

Finally, IMM will leverage its experience and new assets to participate into new academia and industry collaborations on concrete scenarios.

4.4.21 UM Autonomous Systems Ltd

UM Autonomous Systems Ltd (Unmanned Life) (UMS) has developed a software platform to deploy, control, and orchestrate heterogeneous robots to work as autonomous fleets. The command and control, as well as any other real-time data transfers, are done from the robots over cellular networks, for which 5G provides the greatest value.

As part of the EVOLVED-5G project, UMS contributed to the development of a Network App that allows an AMR fleet to localise in an indoor environment over 5G. The triangulation of a robot's positioning through 5G cells is the next step in extending Factory of the Future (FoF) applications, as we will be able to run fleets of centralised robots safely and efficiently with minimal latency.

Some of the outcomes and benefits UMS sees as part of the future commercialisation of the project include:

- Streamlined extraction of Quality of Service from the cell networks, including bandwidth, latency, and network information based on geographical position, which is applicable not only for similar commercialised projects, but all future products developed as extensions of the platform.
- Extension of Hardware Abstraction Layer to abstract robot behaviours independently of the robot type, contributing to the scalability and flexibility of the platform across all clients. This will be assessed through decreased integration cycles to new robots.
- Enriched knowledge on the commercialisation of complex products.
- In relation to the exploitation plan for UMS, this focuses on:
 - Finding and conducting commercial pilot projects for customers that have onboarded 5G networks in factory environments to solve pain points around complexity in managing robotic fleets.
 - Shaping internal product development around 5G localisation in indoor environments, to utilise competitive advantage gained as part of the EVOLVED-5G initiative.

In conclusion, EVOLVED-5G has propelled us forward with opportunities in extending the UMS platform for indoor environments, exploring new products that exploit the technology developed, as well as general commercialisation strategies around the software.

5 COMMERCIALIZATION OF INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER ACTIVITIES

5.1 OVERVIEW

The Commercialization of Intellectual Property (IP) is the focus of the Technology Transfer Methodology of the EVOLVED-5G with an emphasis on the translation of the project research inventions to commercial products and startup companies. EVOLVED-5G technology transfer plan consists of three main elements:

- The Commercialization of Intellectual Property Guide.
- The IP Commercialization Blueprint Tool.
- Hands-on workshops for the partnership on how to use the Tool and other elements of the Guide.

This compendium of information (the Guide) and the IP Commercialization Blueprint (Tool) were designed and tested to help guide the development of research findings and guide the appropriate pathway to a license, startup, or spin-off company. The Guide defines the terms, process, and methodologies for the commercialization of EVOLVED-5G inventions, research results and know-how by the members of the EVOLVED-5G to make them successful. The EVOLVED-5G IP Commercialization Blueprint supported the members of the consortium, targeting especially the SMEs of the Project, 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 on the basics of intellectual property and how to use the tool were organised for the EVOLVED-5G consortium members during the project, and the last two were executed in the third project year and are reported in this deliverable.

While the definition of the Guide, Tool and workshops has been introduced in D7.2 [2] and concluded in D7.4 [3], a continuous improvement process has been followed to validate and adapt the contents based on the project's partners interest and in alignment with the technological results. Of particular focus for the third project year, it has been to see the Tool and Guide tested in practise, sharing the lessons learnt with the consortium. As such the delivery of the two final workshops scheduled for the Technology Transfer can be considered the key achievements in the reporting period for this activity.

5.2 TOOLS & METHODOLOGY

The technology transfer methodology of the project is dependent on the two produced instruments, the Guide, and the Tool, that can systemically support the process of selecting the appropriate route for commercialisation for the EVOLVED-5G concepts. While these are extensively analysed in previous work [2][3], their brief description can be found in the following paragraphs.

5.2.1 Intellectual Property Guide for Commercialisation

The Intellectual Property Guide for Commercialization is envisioned as primary resource for the EVOLVED-5G consortium partners in moving from discovery to commercialization of ideas and

technologies developed under the project. Emphasizing on the translation of the project research inventions to commercial products and startup companies, EVOLVED-5G produced a guide, that is thoroughly documented in D7.4 [3]. The Guide builds upon the concept of Intellectual Property as a potential commercial opportunity for companies, especially for those with extensive research, tech-based services and products. IP commercialization should be considered early during the first steps of a business's strategy. IP commercialization strategy is categorised with ownership status, dependent on the transfer of property to another entity or granting to another entity the right to use the underlying intellectual property. There is no solid recipe a business should take to commercialise its IP, however there are steps to consider during its commercialization journey.

5.2.2 IP Commercialisation Blueprint

The IP Commercialization Blueprint is a tool and methodology developed by the project to help the EVOLVED-5G partners to:

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

The IP Commercialization Blueprint has been tested through technology transfer workshops on use cases to assist SMEs in their digitalization journey, leading to an updated version according to SMEs needs, processes and available resources.

In the third year, the EVOLVED-5G IP Commercialization Blueprint was tested in an interactive workshop with UM Autonomous Systems with interesting results, rich material for reflection and feedback for targeted updates to be made to the tools. This tool was conceived to help the consortium identify potential issues in IP Commercialization related to the technological outcomes of the EVOLVED-5G Project and serves as tool for all startups and SMEs who are planning for IP commercialization.

5.3 TECHNOLOGY TRANSFER WORKSHOPS & WEBINARS

Technology Transfer Workshops were scheduled to direct and support the project partners in engaging with the technology transfer instruments. Their focus has been to cover the importance of IP commercialisation and the methodologies for it, relevant to take place in projects such as the EVOLVED-5G.

Details of the organised workshops can be found in Table 30. In summary, the first workshop covered the fundamentals of technology transfer and IP commercialization, the second workshop presented the EVOLVED-5G IP Commercialization Blueprint, while the third workshop served as a feedback session on how the IP Commercialization Blueprint is used in practice by an SME from the EVOLVED-5G Project, and the final and fourth workshop advanced into more specific terms of IP commercialization, negotiation and the different license agreements.

Table 30: Technology Transfer Workshops

Workshop #1 Understanding the fundamentals of technology transfer and the IP commercialization process			Y1
Description	The basic training webinar is designed to provide to the EVOLVED-5G consortium members and especially the SMEs with well-structured information and knowledge on the legal basis, as well as, on practice in European patent and IP law. The webinar has been organised by Envolve/IEA and had a key note speaker from the Hellenic Industrial Property Organisation, Mr George Asimopoulos		
Status	Completed	Date: Thursday 26 of May 2022 at 15.00 CET Place: Digital MS Teams Participants: EVOLVED-5G Consortium	
Workshop #2 How to use the Evolved 5G IP Commercialization Blueprint			Y2
Description	This workshop is designed to provide an overview of the value of the Commercialization Blueprint Tool. It represents a methodology tailored by EVOLVED-5G on how an organization can bring a programme to the market by co-creating an in-depth plan and evaluation framework for the new products' commercial routes and value but also an assessment of the internal capabilities and feasibility for executing the new plan. The one-hour workshop is made up of one exercise. The exercise has been developed to explore the stages of planning, implementing, and reviewing the commercialization process by working through a series of questions on posters of the tools in small groups. As a result of this exercise, workshop participants have now an understanding of how to use this tool internally. The workshop was delivered and facilitated by Envolve/IEA.		
Status	Completed	Date: Thursday 15 of December 2022 at 12.00 CET Place: Malaga, Spain Participants: EVOLVED-5G Consortium	
Workshop #3 Feedback session for SMEs: Lessons learnt from using the EVOLVED-5G IP Commercialization Blueprint			Y3
Description	This workshop was delivered by UMS in cooperation with IEA, sharing the key learnings implementing and using the EVOLVED-5G IP Commercialization Blueprint. To transfer technology and awareness in a deep tech/innovative SME, as a first step to test this tool, it was important to spread basic knowledge of Intellectual Property and its importance at the business level amongst the team. Introducing such a methodology and tool to team members not familiar with such methodologies and workshops, required further preparation and information to overcome engagement challenges. The importance of engaging the appropriate team members and/or department for this tool and methodology was highlighted as a result of the workshop, to catalyse the process.		

Status	Completed	Date: Wednesday 21 st of June 2023, 15:00 – 16:00 GMT +1:00 Place: London (The Office Group, Tintagel House) Participants: EVOLVED-5G Consortium
Workshop #4 Advancing IP commercialization processes: Negotiation, IP Transfer and License Agreements		Y3
Description	Hosting Giacomo Lusardi, senior lawyer at DLA Piper, an expert in IP management ¹² , offered a fantastic opportunity to the the SMEs of the EVOLVED-5G Project to gain practical insights and engage in an interactive Q&A session on IP commercialization, negotiation, IP transfer and agreements. The workshop covered the basics of IP and why it matters for businesses, tips for businesses who are starting, respective contracts to protect IP, IP monetization and commercialization, and more. The workshop was attended by the EVOLVED-5G consortium as well as the EVOLVED-5G Accelerator Cohort, in an effort to offer additional tools to the Accelerator’s members.	
Status	Planned	Date: Thursday, 14 th of December 2023, 10:00 – 11:00 CET Place: MS Teams Participants: EVOLVED-5G Consortium and EVOLVED-5G Acceleration Cohort

As the key focus on technology transfer activities for the third year has been the execution of the IP Commercialisation Blueprint Tool, the key achievements are detailed in the following section.

5.3.1 Lessons learnt from using the EVOLVED-5G IP Commercialisation Blueprint







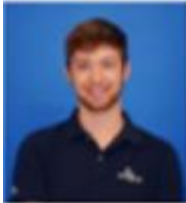
The EVOLVED-5G IP Commercialisation Blueprint has been executed by the partner UMS, around the network application concept developed as part of the project in collaboration with PAL Robotics for factories’ automation purposes. This Network Application developed by UMS, analysed also in 4.3.2.1.5, when installed on robots, provides networking information regarding the 5G cell to which the robot is connected (what cell ID it is connected to, how good is the signal, etc.). A robot moving in an indoor environment (e.g., factory) doesn’t have GPS support. Thus, the robot needs to have a different way of knowing where it is or to localise itself. Usually, cameras and lasers are used but there are a lot of drawbacks in this kind of approach, amongst which are errors in localization. The robot perceives it is somewhere but, it is not. Information from the cell ID could improve the accuracy of the localization.

Following the process methodology, defined by IEA in workshop#2 and depicted in Table 31, to apply technology transfer and awareness in a deep tech/innovative SME, it is first required to appropriately prepare the team to execute the process and spread basic knowledge of Intellectual Property and its importance at the business level, introduce the methodology and tool to team members not familiar with such methodologies and workshops, and appropriately

¹² Giacomo Lusardi is a senior lawyer at DLA Piper’s Intellectual Property & Technology department, and he is based in Milan, Italy. He is mainly experienced in Information Technology and commercial law matters, including outsourcing and license agreements, as well as in data protection and intellectual property related issues. He regularly assists national and foreign clients in complex cross-border transactions as to the drafting and negotiation of commercial contracts, as well as by giving advice in his areas of expertise. He collaborates with the University of Milan, and lectures in several post-graduate courses held by universities and training schools.

inform the execution team so that to overcome engagement challenges. The execution of the Blueprint has been performed with an internal workshop physically hosted at UMS offices, with the participation of the entire in-target UMS team, as intended. The importance of engaging the appropriate team members and/or department for this tool and methodology was highlighted as an outcome of the workshop, to catalyse the process.

In the case of UMS, the engagement of the appropriate team members required two separate sessions, to address all the sections of the tool, and the team members participating are introduced in the table below.

1 st Session – 12 th July 2023 : Planning & Delivery (Segment 1 & 2)		
		
Ivano Manfredonia Project Manager	Gian Patrizio De Zordo Project Manager	Samantha Brindle Senior Business Development Officer
		
Daniele Camino Business Intern	Bianca Bendris Senior Robotics Engineer	
2 nd Session: Review (Segment 3)		
		
Management, Business Development, Finance & Accounting	Product Development, Marketing & Sales	

Team members engaged in the overall process representing all necessary UMS departments: Nicholas Zylbergajt, Ivano Manfredonia, Idan Dagon, Carlos Tirado, Bianca Bendris, Gian Patrizio De Zordo, Samantha Brindle, Dominic Morris, and Daniel Camino.

Table 31: UMS Technology Transfer Blueprint Tool Execution Preparation Process

Task 7.4 IP Commercialization Blueprint

Intellectual Property serves as a potential commercial opportunity for companies, especially for those with extensive research, tech-based services and products.

IP commercialization should be considered early during the first steps of a business's strategy.

IP commercialization strategy is categorized with ownership status, dependent on the transfer of property to another entity or granting to another entity the right to use the underlying intellectual property: IP commercialization by its owner; assignment; license.

Practicalities:

Time: 2-3 hours

Materials: Blueprint worksheet, marker pens and post-it notes and a camera.

Facilitation: A senior member of your project team should facilitate this session, ensuring that the key points are captured and documented.

Before you start:

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

1: Get into a creative mindset. Observe people, pretend you don't know the answers and focus on what they do rather than what they say they do or think they do.

2: Be collaborative. The ideal team size is 5-8 people; make sure your core team has commitment, right skills and authority to get things done. As a project lead, remember to be open and encourage different points of view.

Steps:

Print the poster (Blueprint).

Invite all your core stakeholders (senior management, service delivery, support staff, researchers, etc) to a co-creation workshop and discuss all the Blueprint boxes.

Think about what happens chronologically over time – before setting the strategy, during and after its use.

Having captured all the Blueprint elements, it will be possible to produce a visual representation of how the proposed IP commercialization strategy should work and the assets required to enable this.

Approaching the “**Planning**” segment, to effectively develop the tool, interconnections of the different company departments are imperative to track strategic planning decisions. Specifically, when addressing “context aims” and “actions” that are planned to take place, such as organisation priorities for innovation, benefits of IP commercialization, internal/external resources, partnerships, processes, budget, and decision-making, different departments play a crucial role: R&D and Innovation Department, Management, Tech Department, Product Development, Business Development, Finance & Accounting, Supply Chain, Operations, etc. The results of the “Planning” segment of UMS execution are presented in Table 32.

Table 32: UMS Technology Transfer Blueprint Tool Execution Planning Process

Planning: Context Aims	
What are the organization's priorities for innovation?	Security represents currently one of the sectors where priorities focus. Another important one is factory automation; just in this latter sector the following priorities have been highlighted: <ul style="list-style-type: none"> Extension of Hardware Abstraction Layer to support AMR in order to abstract robot behaviors independently on the robot type. Assessment of Quality of Service of the cell networks gathering bandwidth, latency, and mobile network information based on geographical position.
How will the company benefit from the commercialization of the IP generated from the development of a new Network Application?	The commercialization of the network application developed will allow the company to: <ul style="list-style-type: none"> Go deeper in another sector (factory automation) currently not widely explored. Enrich the company knowledge related to this part of the process for the commercialization of a product/service which, for a software product/service is not so simple.
What are the internal capabilities/resources?	Unmanned Life currently boasts a team of 30 people, including a group of 10 engineers specialised in IA, 5G, edge computing, and robotics to assure continued development, integration & testing of the main elements of its solutions, as well as 3 skilled project managers and 4 strong business/marketing profiles for financial controlling and commercialization.
What external resources are needed?	It is expected for short-term development to hire new profiles across quality assurance, cloud network engineering, product managers, full-stack engineers, and business development.

Planning: Actions	
What is the budget? What approval is needed?	Based on the experience of the company we can't fix a number at this stage because there is a complex process behind a commercialization strategy we use to implement, as we need to carry out a customer segmentation, the geography, and the industry sectors we want to focus on. From that we can draft a list of the potential companies and decide how to reach them, decide if we want to go on our own or with some partners. A preliminary version of the budget must keep in consideration a pre-sell stage, a commercialization campaign. There are person months to spend from different departments (basically business, tech, and management) and to assess the availability of the resources needed. Considering the time plan a period of six months could be acceptable since also tech aspects must be kept in consideration and a good risk analysis to avoid repeated delays. The approvals needed should come from the top management (CEO, VP for business and marketing, CTO, product manager).
What are the key stakeholders? What activities should be conducted?	The main departments involved basically are business, tech, and management.

This interconnection amongst different departments was also crucial when approaching the next segment of the tool, “**Delivery**”. Addressing “setup” and “management”, items such as implementation ownership, commercialization issues, client adoption and relations, resources needed, product readiness, processes and reporting, the most engaged departments are Business Development, Legal/IP Management, Sales and Marketing, Product Development, Management, Supply Chain and Operations. The results of the “Delivery” segment of UMS execution are presented in Table 33.

Table 33: UMS Technology Transfer Blueprint Tool Execution Delivery Process

Delivery: Setup	
Who will develop the content?	People who develop the content are from the same departments as above.
Are there any IP issues?	Taking advantage of previous experience, this kind of topic is constantly under evaluation, and it will potentially involve a specialised firm that supported Unmanned Life in other similar circumstances. Periodically analysis of Google patents is carried out and some discussions will be arranged between the business and tech teams to assess eventual infringements.
Will you prototype a service?	Based on the experience of the recent business we have developed we could use a hybrid business model selling the network application as a service.
Delivery: Management	
What are the key milestone?	Starting from the development of the market analysis and commercialization plan and considering that we have a prototype now the milestones could be: <ul style="list-style-type: none"> • Design of the infrastructure needed to sell the new product/service. • Design of the architecture where we want this app to work. • Application of the changes. • Testing, validation, and optimization of the structure. • Security issues. • Develop pilots with potential customers. • Launch of the Network App with customer support.

What are the key stakeholders? What activities should be conducted?	After the different phases of evaluations coming from the business and product departments and the approval needed from the top management, the project manager can lead the project considering the different milestones mentioned above.
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For the final segment of the EVOLVED-5G IP Commercialization Blueprint, “**Review**”, the engagement is more focused on decision making departments of the organization. For the “evaluation” and “sustainability” sections of the tool, when addressing questions such as KPIs, efficiency, processes, benefits, future planning, future commercialization projects, the departments deemed relevant to engage were Product Development, Management, Business Development, Finance and Accounting, R&D and Innovation. The results of the “Delivery” segment of UMS execution are presented in Table 34.

Table 34: UMS Technology Transfer Blueprint Tool Execution Review Process

Review: Evaluation	
What indicators could be part of the evaluation?	KPIs around the commercialization of the network application in the context of our project, that are: <ul style="list-style-type: none"> • Speeding up time to integrate to new hardware, considering the maturity of the devices + software. • Time spent doing network QoS tests as part of project/product deliveries. • % Availability of connected devices. • Capacity for receiving and delivering projects.
Measuring the efficiency of the commercialization process	Business and Management level factors, including tickets raised as part of project support, and % pipeline conversion as a comparison to current figures
When will the evaluation take place? Who will do it?	Business: Monthly evaluation based on automated pipeline to assess conversion rates. <ul style="list-style-type: none"> • Tech: Every 3-6 months, understanding if the integration cycle of robots has decreased, and checking the benefits of the Network Application in a factory automation environment. • PMs: On a per-contract basis to realise the ongoing reduction of time spent doing QoS assessments and integrations.
What metrics will be used for evaluation?	<ul style="list-style-type: none"> • Generic units of time. • Story points as part of technical sprints.
What information should the organization use for the evaluation?	<ul style="list-style-type: none"> • Software uptime/downtime using a variety of technical sources. • Customer reviews. • Sprints. • Pipeline software to measure velocity.
Review: Sustainability	
How can the organization prepare for future funding changes?	Monitoring funding sources: <ul style="list-style-type: none"> • Future calls across a more diverse range of public funds, including co-funding opportunities to dive into specific platform elements. • Customer-funded projects to drive engagement, feedback, and market fit. • Private Investment.
How should the organization plan for future R&D?	<ul style="list-style-type: none"> • Continue to monitor market movement to build roadmap. • Look into innovative uses of network application.
How will the commercialization benefit the organization?	<ul style="list-style-type: none"> • Increase the number of projects specific to factory automation. • Increase project velocity with reduced time spent doing integration tasks.

What resources are necessary for the sustainability of the project?	<ul style="list-style-type: none"> • Trained personnel in monetising the network application and associated technologies. • Research in the growth of the robotics and 5G ecosystem. • More engineers to meet capacity for an increasing number of projects.
How can the organisation prepare the management process for future projects?	<ul style="list-style-type: none"> • Standardisation of technical project elements. • Continued communication between stakeholders to prevent plateau in development.

The experience of UMS and lessons learnt from the execution of the IP Commercialisation Blueprint through these sessions has been the subject of the third Technology Transfer Workshop (#3) that took place in London and was orchestrated by UMS and IEA.

The process was documented and highlights of both sessions were uploaded on the EVOLVED-5G YouTube Channel: <https://www.youtube.com/watch?v=PR4yL8zUTrw>.

During workshop #3, reflecting on the workshops' outcomes UN Autonomous Systems highlighted the challenges and benefits of this methodology and tool. The challenges highlighted were mainly focused on the complexity of the process, requiring the presence, and engaged input of different departments. The complexity of the IP commercialization and technology transfer process requires a prior relevant information session, introducing the basics of Intellectual Property and preparation for organizational priorities. An additional complexity to this method, is the requirement of the simultaneous presence of all relevant members, at the same time, at the same place, fully engaged. Understanding the importance and relevance of such a methodology is key prior to entering such a session. Additionally, some key impact numbers were difficult to estimate and project at the level required by the tool.

The benefits highlighted by UMS were again focused on the team engagement, specifically regarding the awareness and knowledge enrichment on such topics and how interconnected several company processes are, as well as combining perspectives. This workshop also put a light on the eventual needs in Human Resource, as well as the workflow needed to practice technology transfer.

This workshop allowed UMS to learn several lessons, on one hand regarding network application development and on the other hand regarding the IP Commercialization Blueprint:

- Regarding the network application development, subject to market demand around the localization of robotics with 5G cells, it will be important to hire profiles that add depth to the factory automation applications developed through the platform. This includes cloud network engineers that recognise the importance of scalability across customer sites and using a modular approach to integration. From a business perspective, it will be important to maintain and track KPIs around monetizing the network application, as well as use knowledge gained through content development in the EVOLVED-5G to explain the value of the Network Application to customers (and hence increase pipeline velocity).
- Regarding the IP Commercialization Blueprint tool, the exercise was useful in bringing together all sides of a project (Business, Technical, Management, and Project Managers) to combine perspectives. The tool served as a starting point to pinpoint weaknesses in their market approach, without bias, as well as focusing on the most valuable sections of the application to all parties. The "Planning" segment of the Blueprint facilitated the

identification of the next steps in commercializing the Network Application that could still be scaled across UMS platform, and other applications in general. Some of the questions on the Blueprint might be considered too early to answer, especially the questions referring to the “Evaluation” segment, especially around an innovative idea/project, when the development stage is not mature and deserves more time dedicated to the effort of commercialization.

As a conclusive remark, the execution of IP Commercialization Blueprint Tool has been found an interesting activity to perform within the environment of an innovation project in UMS, and UMS advised all the SMEs partners of the EVOLVED-5G Project to test it separately in their own environments.

6 CONCLUSIONS

This deliverable D7.6 “Standardisation, Innovation, Exploitation and Technology Transfer Activities (Final)”, is the third and last document in a sequence of three and provides the full and results of the project in terms of research and business impact. It addresses the advancements of the project regarding standardisation activities, innovations, exploitation, and technology transfer in a synoptical manner, nonetheless, providing an analytic account of the actions performed during the project’s final year. The key highlights and take aways of the progress reported in the final year can be listed as follows:

- Significant achievements can be reported in the **standardisation** task, with the foundation of a new Software Development Group within ETSI, named OpenCAPIF being outstanding. While all relevant SDOs in the field of 5G, IoT and Industry 4.0, such as 3GPP & ETSI, GSMA, 5G ACIA and AIOTI have been closely monitored by the project’s partners, many contributions have also been performed. Especially in the work of 3GPP SA2 & SA6 Working Groups, thirty-seven (37) contributions have been submitted, more than half of which were achieved in the third project year, while the vast majority of these have already been agreed. The project has also been highly active in engaging with the open-source community, it has incorporated in the components implemented more than fourteen (14) projects and has contributed with three (3) new entirely EVOLVED-5G developed open-source projects, the Network Applications Prototype, the SDK libraries, and the Network Applications Marketplace.
- In terms of **innovations**, during the previous reporting period the two fundamental project concepts, the NEF Emulator, and the Open-Source CAPIF Core Function have been published in the EU Innovation Radar as high potential innovations. Overall, the project has identified seven (7) candidates that have been analysed in the last project year using the EU Innovation Radar constructs and methodology.
- Early in the project’s course a concrete **exploitation** methodology had been agreed, following a stepwise approach, focused to deliver a subtle analysis of high-potential project outcomes in the form of Value Proposition Canvas analysis, that has been the new core subject reported for this aspect in this document. Practically, eight (8) platform-level exploitable outcomes have been identified, all of which with intermediate TRL, targeting technology development & prototypes. In respect to prototype network applications and associated turn-key demonstrators, 12 SME-related outcomes have been identified. While for all of them the preliminary analysis has already been performed in previous work, in this document it has been revisited based on last year’s WP3, WP4 and WP4 developments. Specifically, the two distinct types of Network Applications, the Stand-Alone and Non-Stand-Alone, have been found to significantly affect the level of readiness for individual exploitation, and the NSA Network Applications have been subsequently prioritised for the Value Proposition Canvas analysis. It must be noted, that beyond the project-level exploitation methodology followed in WP7, each partner executes the business strategy in line to the vision, mission and targets of the participating company and organization, and the relevance of the project’s work with this strategy is also presented separately in the form of individual exploitation plans.
- Understanding that the project’s fundamental concept of Network Applications and the surrounding ecosystem create opportunities through new classes of products and processes, significant effort has been put in developing a **technology transfer** plan to

support the project partners in selecting the appropriate course for commercialization for their developments. During the first two project years, the Intellectual Property Guide and IP Commercialisation Blueprint Tool have been devised and tuned for relevance through a series of workshops and webinars attended by the project consortium. As part of the final year's activities, the effort has been put in the execution of the IP Commercialisation Blueprint Tool, where feedback and recommendations for its effective wider execution has been produced and shared as part of the 3rd organised workshop.

Overall, the concepts developed and prototyped by EVOLVED-5G have certainly been proven impactful in terms of research and business impact and concrete plans, proliferating beyond the project's lifespan have been devised, creating promising expectations both in terms of building an innovation paradigm as well as revealing new monetization opportunities for the SMEs and industrial partners.

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8 ANNEX A: INNOVATION RADAR METHODOLOGY

The description of the project's innovations is based on the methodology proposed by the EC Innovation Radar detailed in [1]. This methodology addresses various aspects, and in this document, we have shortlisted the most indicative related parameters, in the Innovation Template Below.

Table 35: Innovation Description Template

Innovation Title		Reported in Y1	
Description			
Innovation Level	<ol style="list-style-type: none"> 1. Very innovative 2. Obviously innovative and easily appreciated advantages to customer 3. Innovative but could be difficult to convert customers 4. Minor improvements over existing products 	Innovation Type	<ol style="list-style-type: none"> 1. New <ol style="list-style-type: none"> a) Product, b) Process, or c) Service d) 2. Significantly improved <ol style="list-style-type: none"> a) Product, b) Process, or c) Service d) Marketing method e) Organisational method
Market Creation Potential level	Is derived as a combination of Innovation Level (IL) + Innovation Type (IT) <ol style="list-style-type: none"> 1. Minor (IL4, IT2) 2. Moderate (IL3, IT2), (IL4, IT1) 3. Noteworthy (IL2, IT2), (IL3, IT1) 4. High (IL1, IT2) (IL2, IT1) 5. Very high (IL1, IT1) 	Innovation Maturity	<ol style="list-style-type: none"> 1. Exploring 2. Tech Ready 3. Business Ready 4. Market Ready
Market Maturity	<ol style="list-style-type: none"> 1. The market is not yet existing and is not yet clear that the innovation has potential to create a new market 2. Market-creating: The market is not yet existing but the innovation has clear potential to create a new market 3. Emerging: There is growing demand and few offerings are available 4. Mature: The market is already supplied with many products of the type proposed 		
How will the innovation be exploited?	<ol style="list-style-type: none"> 1. Introduced as new to the market 2. Only deployed as new to the organisation/company 3. No exploitation planned 	When could be commercialised?	<ol style="list-style-type: none"> 1. Less than 1 year 2. Between 1 and 3 years 3. Between 3 and 5 years 4. Between 5 and 10 years 5. More than 0 years
Market Dynamics	<ol style="list-style-type: none"> 1. In decline 2. Holding steadily 3. Growing 	Competition	<ol style="list-style-type: none"> 1. Patchy, no major players 2. Established, but none with similar proposition 3. Several major players with strong competencies

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 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.

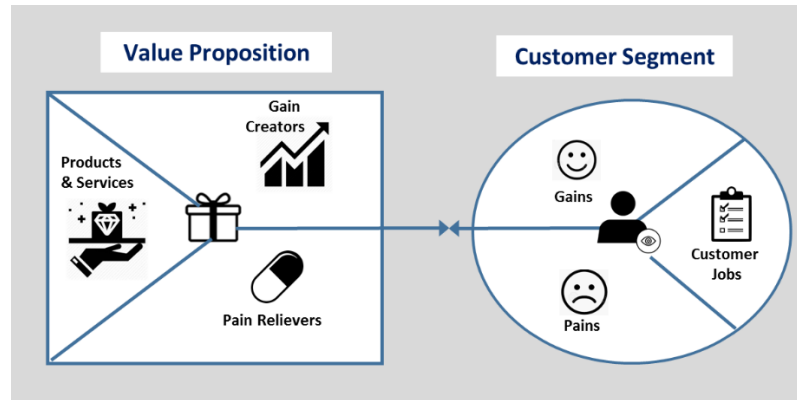


Figure 7: Value Proposition Canvas

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.