



A Secure and Reusable Artificial Intelligence Platform for Edge Computing in Beyond 5G Networks

D6.4 Second Dissemination, Impact Assessment and Exploitation Report



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101015922

D6.3 First Dissemination, Impact Assessment and Exploitation Report	
WP	WP6 – Dissemination, standardization, and 5G roadmapping
Responsible partner	INRIA
Version	v1.2
Editor(s)	Jérôme François (INRIA)
Author(s)	Jérôme François (INRIA) George Avdikos (8Bells) Mauro Boldi (TIM) Irene Facchin (FBK) Nicola di Pietro (ATH) Estefanía Coronado (i2CAT) Antonino Albanese (ITL)
Reviewer(s)	Marco Marchetti (CRF) Lara Lopez Muñoz (ATOS)
Deliverable Type	R
Dissemination Level	PU
Due date of delivery	01/02/2023
Submission date	01/02/2023

Version History				
Version	Date	Author	Partner	Description
0.1	24/11/2022	Jérôme François Mauro Boldi Irene Facchin Nicola di Pietro Estefanía Coronado Antonino Albanese	INRIA TIM FBK ATH i2CAT ITL	Document structure and first contributions
0.2	09/12/2022	George Avdikos	8BELLS	Completing session on IPR and exploitation
0.3	12/12/2022	Irene Facchin	FBK	Adding information in the Dissemination and Communication activities session
0.4	15/12/2022	Jerome François	INRIA	Completing standardisation session
0.5	02/01/2023	Jerome François	INRIA	Checking document for revision
1	18/01/2023	Irene Facchin	FBK	1st document revision
1.1	21/01/2023	Lara Lopez Muñoz	ATOS	Document revision
1.2	01/02/2023	Irene Facchin	FBK	Final version of the document

Disclaimer

The information and views set out in this deliverable are those of the author(s) and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

Table of Contents

EXECUTIVE SUMMARY	7
1 INTRODUCTION	8
2 DISSEMINATION AND COMMUNICATION ACTIVITIES	9
2.1 AI@EDGE DISSEMINATION STRATEGY	9
2.2 COMMUNICATION TOOLS AND MATERIALS	10
2.1.1 Newsletters.....	10
2.1.2 Project media pack	11
2.3 AI@EDGE ONLINE PRESENCE	11
2.1.3 LinkedIn.....	12
2.1.4 Twitter.....	12
2.1.5 YouTube	13
2.4 SCIENTIFIC PUBLICATIONS.....	13
2.5 THIRD-PARTY EVENTS AND WEBINARS	15
2.6 EVENTS AND WEBINARS ORGANISED BY AI@EDGE.....	17
2.7 OPPORTUNITY-BASED DISSEMINATION	18
2.8 REVIEW RECOMMENDATIONS	20
2.9 PLANNED FUTURE ACTIVITIES	20
3 CONTRIBUTION TO STANDARDS.....	23
3.1 IRTF NETWORK MANAGEMENT RESEARCH GROUP.....	24
3.1.1 Year 1.....	24
3.1.2 Year 2.....	25
3.2 ITU-T FG AUTONOMOUS NETWORKING.....	25
3.2.1 Year 1.....	25
3.2.2 Year 2 (Discontinuation)	25
3.3 ETSI PLUGTESTS	26
3.3.1 Year 1.....	26
3.3.2 Year 2.....	26
3.4 ETSI ISG MEC.....	27
3.4.1 Year 2.....	27
3.5 3GPP SA WG2.....	27
3.5.1 Year 1.....	27
3.5.2 Year 2.....	27
3.6 ORAN WG1 AND WG2.....	28
3.6.1 Year 1.....	28
3.6.2 Year 2.....	28
4 CONTRIBUTION TO 5G-PPP AND COLLABORATION WITH OTHER PROJECTS.....	30
4.1 INTERACTIONS WITH WORKING GROUPS	30
4.2 INTERACTIONS WITH OTHER 5GPPP PROJECTS	30
5 IPR MANAGEMENT	31
5.1 INTELLECTUAL PROPERTY RIGHTS IN AI@EDGE	31
5.2 MANAGEMENT OF IPR	33
5.3 ALIGNMENT WITH THE LEGAL FRAMEWORK	33
5.4 PROTECTION OF THE RESULTS	33
5.5 TOOL FOR CALCULATION OF IPR PERCENTAGE BASED ON PMS	34
6 IMPACT ASSESSMENT AND EXPLOITATION	36
6.1 INITIAL EXPLOITATION PLANS	36

6.2	MARKET RESEARCH/POTENTIAL FOR USE CASES, THE IMPACT OF THE PANDEMIC AND THE ROLE OF AI/ML	37
6.2.1	<i>Vehicle Cooperative perception: market penetration (UC1)</i>	37
6.2.2	<i>Industrial IoT market (UC2)</i>	37
6.2.3	<i>BVLOS drone market (UC3)</i>	38
6.2.4	<i>In-flight entrainment services (UC4)</i>	38
6.3	EXPLOITATION PLANS (AFTER SECOND YEAR)	38
6.4	FINAL EXPLOITATION PLANS INCLUDING THE ACADEMIA/RESEARCH CENTERS	41
7	CONCLUSION	42

List of Tables

Table 1.	KPIs table.	9
Table 2.	List of scientific publications – 2021	13
Table 3.	List of scientific publications – 2022	14
Table 4.	Participation to events 2022	16
Table 5.	Opportunity-based dissemination activities 2021	18
Table 6.	Opportunity-based dissemination activities 2022	18
Table 7.	AI@EDGE interactions with 5G-PPP/IA and related Working Groups	30
Table 8.	AI@EDGE interactions with other projects.	30

List of Figures

Figure 1.	AI@EDGE Newsletter #2.	11
Figure 2.	AI@EDGE website main page	12
Figure 3.	AI@EDGE account on LinkedIn.	12
Figure 4.	AI@EDGE account on Twitter.	13
Figure 5.	Joint workshop @ CLOUDNET 2022.	17

Glossary	
AI	Artificial Intelligence
CA	Consortium Agreement
DMP	Data Management Plan
ETSI	European Telecommunications Standards Institute
FG-AN	Focus Group on Autonomous Networks
FRMCS	ETSI Future Railway Mobile Communication Systems
GA	General Assembly
IA	Infrastructure Association
IBN	Intent-Based Networking
IETF	Internet Engineering Task Force
IPR	Intellectual Property Rights
IRTF	Internet Research Task Force
ITU-T	ITU Telecommunication Standardization Sector
KPI	Key Performance Indicator
LCM	Latent Class Model
NM	Network Management
NMRG	Network Management Research Group
SDA	Standards Developing Association
SDO	Standards Developing Organization
SNS	Smart Networks and Services
UC	Use-Case
WG	Working Group
WP	Work package

Executive Summary

This deliverable reports the complete set of activities performed during the second year of the project related to dissemination, standardisation, contribution to 5G-PPP, collaboration with other projects, as well as IPR, open access and data management. It also provides a revised exploitation plan focusing on selected industry partners and based on use cases. IPR management calculation is also documented. These deliverable reports communication, dissemination, and standardization activities in an incremental manner from year one for sake of clarity. It will be completed by a final deliverable (D6.5) at the end of the project.

1. Introduction

This deliverable reports the activities in relation to WP6 tasks, which have been realized during the second year of the project. It follows the first deliverable version (D6.3). All these tasks are continuous over the project lifetime. They are monitored on a regular basis to assess the impact and visibility of the project regarding different communities and the public through a project Dissemination tracker.

Section 2 presents the activities of T6.1 for the dissemination and communication of the knowledge and results produced by the project. This is a key enabler to promote the project realizations and create potential synergies and relations with various actors from academia or industries. Alongside with updating the online presence with news and update, we produced a media pack containing a project leaflet, a roll-up banner, a project poster and a project video. After the pandemic, project partners also had the opportunity to participate in conferences and seminars to present the project results.

Section 3 is about standardization and reports the activity of T6.2. Although an initial plan has been setup at the time of the proposal writing, we continued to refine the latter. Two priority contributions at IRTF NMRG and ETSI Plugtests have been already identified and well advanced. Two other contributions to 3GPP SA WG2 and ORAN WG2 are expected to support normative documents.

T6.3 reported in Section 4 ensures interaction with other projects and WG from 5G Infrastructure Association (5G IA). To manage a proper exploitation and eventual commercialization of project results, IPR must be carefully managed and this objective of T6.4 is presented in Section 5. A tool for calculating the IPR percentage of joint results have been developed.

Section 6 reviews the feedback received from several partners based on a shared exploitation questionnaire. It allows us to assess the potential exploitation of project results. A particular attention was given to revise the market potential of each use case, in particular because of the pandemic crisis.

2. Dissemination and Communication Activities

The activities around dissemination and communication within T6.1 were initiated with the creation and maintenance of the plan for the dissemination and use of knowledge of the project. It has since continued with actions taken to ensure the project's visibility through online channels, such as a project website and social media outlets, as well as the outcomes of the project consortium's dissemination efforts in various scientific events and scientific publications.

2.1 AI@EDGE dissemination strategy

The AI@EDGE dissemination strategy has been prepared within WP6 and has already been illustrated in D6.1. It will be kept regularly updated and managed.

To monitor all the dissemination activities carried out by the AI@EDGE partners, the consortium has decided to make use of a **dissemination tracker**, available online in the project repository hosted by FBK. The file keeps track of all relevant activities that the partners are carrying out and where they are disseminating the progress and results of AI@EDGE. The **dissemination tracker** collects information about:

- Scientific publications
- Communication activities
- 5G-PPP meetings
- Scientific Dissemination activities
- Participation to conferences / events (organized by third parties)
- Organisation of conferences / events (by the AI@EDGE Consortium)

Partners are requested to update the tracker continuously.

At the beginning of the project, some KPIs related to WP6 were defined. These are presented in the table below. Green KPIs are already reached. Orange KPIs are those which are in good track regarding project progress. In red, we highlight those which will require a larger attention in the third year. Events to (co-)organize are already planned which will lead to increase the number of participants to our events. With mature results to obtained in the last year, videos showcasing concrete results could be made available. At the same time, more effort is devoted to the preparation and dissemination of scientific papers and publications.

Table 1. KPIs table.

Key Performance Indicators for WP6	Project targets	Achieved until M18	Achieved until M24
Number of events organized by AI@EDGE (webinars, workshops, etc.)	3	0	2
Number of press releases	3	1	1
Number of participants to webinars and workshops	300	0	35
Number of attendees in dissemination campaign, webinars, peer networking events	> 1.000	34	39
Size of the community (incl. Twitter followers, mailing list subscribers, website visitors)	> 1.000	2.628	3.697
Number of unique website visits	> 1.000	3.018	5.461
Number of scientific/technical publications	> 30	14	17
Number of conference presentations	> 20	12	14
Number of newsletters	3	2	2
Number of views on YouTube	> 300	47	177

2.2 Communication tools and materials

As foreseen in the AI@EDGE project proposal, and further defined in the 6.3, the project will make use of a series of communication tools and materials.


2.2.1 Newsletters

One electronics newsletter in which to present the project main achievements and training activities is expected to be released each year, but the consortium agreed to produce more newsletters if needed to provide updates on the project outcomes.

The 1st newsletter has been published on the 28th of June 2021 and is available on the project website at the following [link](#).

The 2nd newsletter has been published on May 9th, 2022, and presents an overview of the project first year of activities. The newsletter can be read [herewith](#).

A 3rd newsletter is being prepared and will be released at the beginning of 2023 and will show the project main achievements for the 2nd year.



D2.2 Preliminary assessment of system architecture, interfaces specifications, and techno-economic analysis


This deliverable details the intermediate AI@EDGE system architecture, describing its main components, interfaces and workflows. Together with D3.1 and D4.1, it provides a complete view of the key technical challenges and contributions of the AI@EDGE project and defines the scope of the software prototypes to be used in the trials. This deliverable also reports on the preliminary techno-economic analysis and impact assessment and extends the use case related KPIs, introduced in D2.1, to present a consolidated draft of AI@EDGE KPIs.

[Full D2.2](#)

D3.1 Initial report of systems and methods for AI@EDGE platform automation

This is an initial report on the systems and methods developed for the automation of the AI@EDGE connect-compute platform. The achievements reported in this document are the progress towards a general-purpose network automation framework capable of supporting flexible and reusable pipelines for the end-to-end creation, utilisation, and adaptation of secure and privacy-preserving AI/ML models. Initial descriptions of the internal design of the Network and Service Automation Platform (NSAP) have been provided, and an initial collection of methods and algorithms for automation and learning for network management purposes are described, with some preliminary results.

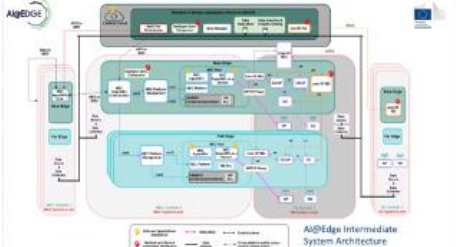
[Full D3.1](#)



The AI@EDGE Project update

Year 1

AI@EDGE addresses the challenges of harnessing the concept of 'reusable, secure, and trustworthy AI for network automation'. In AI@EDGE European industries, academics and innovative SMEs commit to achieving an EU-wide impact on industry-relevant aspects of the AI-for-networks and networks-for-AI paradigms beyond 5G systems.



AI@EDGE Intermediate System Architecture

D4.1 Design and initial prototype of the AI@EDGE connect-compute platform

The report summarises the work carried out towards the design, prototype and early validation of a connect-compute platform supporting perceived zero-latency services using a mix of computing and connectivity resources. The analysis and results provided within this report belong to the first phase of the AI@EDGE connect-compute platform roadmap, which includes initial elicitation of technical requirements and architecture design, together with a description of the computational environments provisioned for the development of the platform.

[Full D4.1](#)

D5.1 Testing and Validation Methodology, Planning and Preparation

D5.1 focuses on the development of the activities that allow the demonstration of the four AI@EDGE Use cases. It introduces preliminary applications and a per-use case integrated platform, as well as preliminary trial test plans. Each Use case's connection with the ongoing AI@EDGE system-wide architecture design, as well as the mapping with the ongoing design of the Connect-Compute platform, is provided, and the required testbed implementation roadmap toward equipment and services development, integration, logistics and validation activities is presented.

[Full D5.1](#)

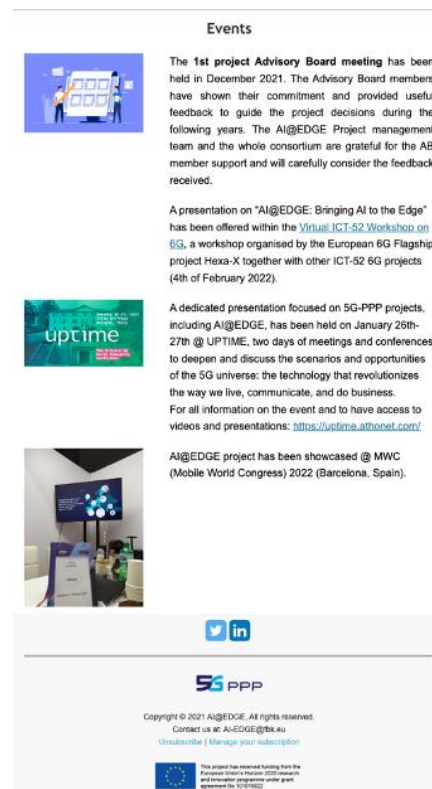


Figure 1. AI@EDGE Newsletter #2.

2.2.2 Project media pack

As it has already been presented within D6.3, a project media pack has been prepared to offer a common visual identity. This media pack contains:

1. A **project leaflet** providing general information on the project and its expected outcomes and impacts, as well as an overview of the project 4 use cases.
2. A **roll-up banner** in 85 x 210 cm format.
3. A **project poster**.
4. A **video** of the project available in [Youtube](#).

2.3 AI@EDGE online presence

The AI@EDGE website, available at <https://aiatedge.eu/>, is the main showcase of the project to the broadest audience and external institutions. The website is the prime public dissemination tool, making available the content derived from the development activities, and it also provides access to other informative material such as project technical reports, posters, and presentations. The website is kept up to date with the latest project achievements and dissemination activities. A section called “Publications” reporting the project deliverables marked as Public and other interesting publications is being updated so as to include the list of scientific publications.

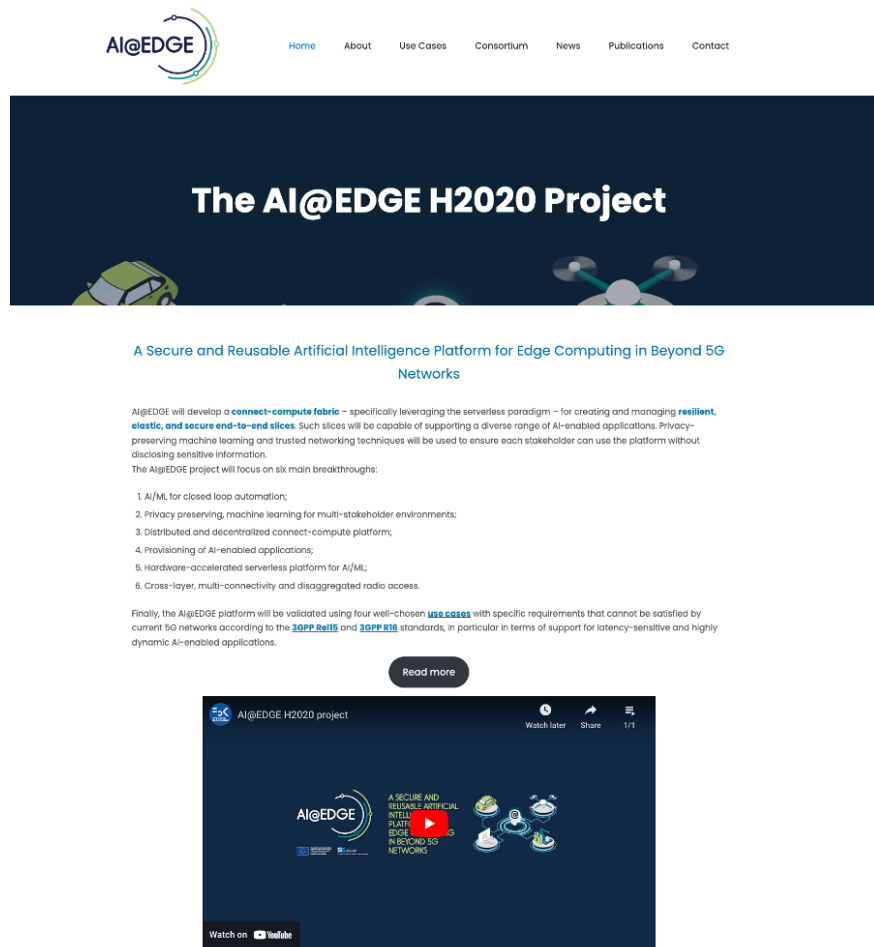


Figure 2. AI@EDGE website main page.

The website statistics as of December 31, 2022, shows 3.506 users, with 5.461 unique website visits.

2.3.1 LinkedIn

The project's LinkedIn page, available at <https://www.linkedin.com/company/aiedge>, has 123 followers as of December 31, 2022.



Figure 3. AI@EDGE account on LinkedIn.

2.3.2 Twitter

The project's Twitter account, available at <https://twitter.com/AIatEdgeH2020>, has posted 80 tweets and has 191 followers as of December 31, 2022.

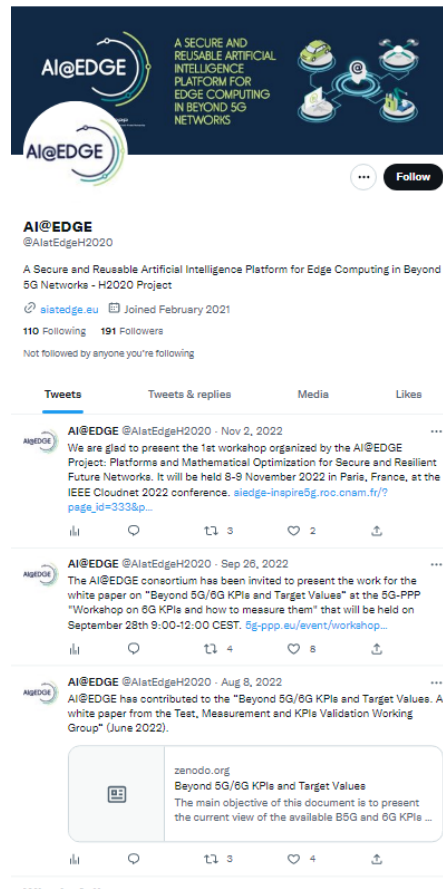


Figure 4. AI@EDGE account on Twitter.

2.3.3 YouTube

A [Youtube playlist](#) is available for the project within the official YouTube channel of FBK, the AI@EDGE project coordinator. It has been decided best to have a playlist instead than a dedicated channel. As also reported within D6.1 “Project website, dissemination channels and social media communications”, the decision has been taken to capitalise on the subscribers of followers already available in the FBK channel, thus maximising the outreach potential of AI@EDGE videos.

As of December 31, 2023, the video has received 177 views.

2.4 Scientific publications

The scientific publications of 2021 and 2022 are listed below.

Table 2. List of scientific publications – 2021.

Title of the Journal / Proceedings / Books series / Book	Title	Authors / Affiliation	Peer-reviewed publication (yes/no)?	Status ^[1]
2021 EuCNC & 6G Summit - 6GV	AI@EDGE: A Secure and Reusable Artificial	Roberto Riggio [RISE], Estefanía Coronado [I2CAT], Neiva Linder	YES	A

	Intelligence Platform for Edge Computing (https://doi.org/10.1109/ECNC/6GSummit51104.2021.9482440)	[ERICSSON], Adzic Jovanka [TIM], Gianpiero Mastinu [POLIMI], Leonardo Goratti [SAFRAN], Miguel Rosa [AEROTOOLS], Hans Dieter Schotten [DFKI], Marco Pistore [FBK]		
International Supercomputing Conference - High Performance (ISC) 2021, Workshop VHP'21	FaaS and Curious: Performance implications of serverless functions on edge computing platforms (https://doi.org/10.1007/978-3-030-90539-2_29)	Tzenetopoulos A. et al. [ICCS] Achilleas TzenetopoulosEmail authorEvangelos ApostolakisAphrodite TzomakaChristos PapakostopoulosKonstantinos StavrakakisManolis KatsaragakisIoannis OroutzoglouDimosthenis MasourosSotirios Xydis, Dimitrios Soudris	YES	A
Int'l Mediterranean Conf. on Communications and Networking (meditcom 2021), Workshop 1 on Acceleration for Edge Computing	Towards sharing one FPGA SoC for both low-level PHY and high-level AI/ML computing at the edge (https://doi.org/10.1109/MeditCom49071.2021.9647576)	Stratakos I. et al. [ICCS] Ioannis Stratakos; Elissaios Alexios Papatheofanous; Dimitrios Danopoulos; George Lentaris; Dionysios Reisis; Dimitrios Soudris	YES	A
1st International Workshop on Network Programmability (NetP 2021) co-located with CNSM 2021	Delay-Sensitive Wireless Content Delivery: An Interpretable Artificial Intelligence Approach (https://doi.org/10.23919/CNSM52442.2021.9615533)	Estefanía Coronado (i2CAT), Blas Gómez (UCLM), José Villalón (UCLM), Antonio Garrido (UCLM), Shuaib Siddiqui (i2CAT), Roberto Riggio (UNIVPM)	YES	A

Table 3. List of scientific publications – 2022.

Title of the Journal / Proceedings / Books series / Book	Title	Authors / Affiliation	Peer-reviewed publication (yes/no)?	Status ^[2]
RESSI (Rendez-Vous de la Recherche et de l'Enseignement de la Sécurité des Systèmes d'Information)	Auto-configuration des systèmes de détection d'intrusions grâce aux expériences passées	Omar Anser (INRIA), Jerome Francois (INRIA), Isabelle Chrisment (INRIA)	YES	A
IEEE Transactions on Network and Service Management	An AI-empowered framework for cross-layer software-defined infrastructure state assessment	Alessio Diamanti (Cnam), José Sanchez Vilchez (Orange), Stefano Secci (Cnam)	YES	A
IEEE Transactions on Network and Service Management	Robust Access Point Clustering in Edge Computing Resource Optimization	Nour Elhouda Yellas (Cnam), Selma Boumerdassi (Cnam), Bilal Maaz (Cnam), Alberto Ceselli	YES	A

6GNET conference	2022	A Lightweight Southbound Interface for Standalone P4-NetFPGA SmartNICs	Mario Patetta, Sami Taktak, Stefano Secci (Cnam)	YES	A
6GNET conference	2022	An Open Dataset for Beyond-5G Data-driven Network Automation Experiments	Chi-Dung Phung, Nour El-houda Yellas, Salah Bin Ruba, Stefano Secci (Cnam)	YES	A
6GNET conference	2022	Anomaly Detection for 5G Softwarized Infrastructures with Federated Learning	Nour El-houda Yellas, Salah Bin Ruba, Stefano Secci (Cnam)	YES	A
HIPEAC 2022 (WRC workshop)		AI at the extreme edge: the role of FPGAs for enabling onboard AI in space missions	George Lentaris, Vasileios Leon, Dimitrios Soudris [ICCS]	YES	A
SAMOS 2022		LSTM acceleration with FPGA and GPU devices for edge computing applications in B5G MEC	D. Danopoulos, I. Stamoulias, G. Lentaris, D. Masouros, I. Kanaropoulos, A. K. Kakolyris, D. Soudris [ICCS]	YES	A
IEEE NOMS 2022		Roadrunner: O-RAN-based Cell Selection in Beyond 5G Networks	E. Coronado [i2CAT], S. Siddiqui [i2CAT], R. Riggio [UNIVPM]	YES	A
IEEE CLOUD 2022		Sequence Clock: A Dynamic Resource Orchestrator for Serverless Architectures	I. Fakinos, A. Tzenetopoulos, D. Masouros, S. Xydis, D. Soudris [ICCS]	YES	A
IEEE Communications Surveys and Tutorials		Zero Touch Management: A Survey of Network Automation Solutions for 5G and 6G Networks	E. Coronado [I2CAT], R. Behravesch [FBK], T. Subramanya, A. Fernández-Fernández, [I2CAT] S. Siddiqui [I2CAT], X. Costa-Pérez [I2CAT], and R. Riggio [UNIVPM]	YES	A
IFIP CNSM 2022		Function Placement and Acceleration for In-Network Federated Learning Services	Nour El-houda Yellas (Cnam), Bernardetta Addis (Univ. Lorraine), Roberto Riggio (UNIVPM), Stefano Secci (Cnam)	YES	A
5G-PPP White report		Beyond 5G/6G KPIs and Target Values. A white paper from the Test, Measurement and KPIs Validation Working Group”	Beyond 5G/6G KPIs and Target Values Zenodo	YES	A

2.5 Third-party events and webinars

During 2022, the consortium participated in more events, both virtual and in person.

Table 4. Participation to events 2022.

Title of the event	Date and Venue	Link / Notes	In presence (P) / Virtual (V)
UPTIME 2022	26-27/01/22, Bologna, Italy	Event dedicated to the private 5G world community. A dedicated presentation has been made with a focus on 5G-PPP projects, including AI@EDGE.	P (presentation by ATH)
Virtual ICT-52 Workshop on 6G	04/02/22, Online	Workshop organised by the European 6G Flagship project Hexa-X together with other ICT-52 6G projects, in which AI@EDGE has been presented: “AI@EDGE: Bringing AI to the Edge”.	V (presentation)
Mobile World Congress (MWC) 2022	28/02-03/03/22, Barcelona, Spain	https://www.mwcbarcelona.com/	P (in booth)
RESSI 2022a French conference on Information System Security	10-12/05/22, Paris, France	A poster entitled “Auto-configuration of Intrusion Detection Systems Based on Past Experiences” has been presented by INRIA at RESSI 2022 (https://ressi2022.sciencesconf.org/)	P
5G Networks in Action – The Private Mobile Era	11/05/22, 5G Academy, Federico II University, Naples, Italy	Seminar for master and PhD students including ideas and results from the project.	V
5G Networks in Action – The Private Mobile Era	13/05/22, Bicocca University, Milan, Italy	Seminar for university students including ideas and results from the project.	V
1st Open Annual Workshop on Future ICT	25/05/22, Athens, Greece	Presentation on “Future ICT: a new approach from research to innovation”	P (presentation)
European Conference on Networks and Communications (EuCNC) & 6G Summit	07-10/06/22, Grenoble, France		P
ETSI ISG MEC plenary #30	13-17/06/22, Venice, Italy		P (project presentation to ETSI standardization group)
5G-PPP “Workshop on 6G KPIs and how to measure them”	28/09/22, online	The work produced by the AI@EDGE consortium for the white paper on “Beyond 5G/6G KPIs and Target Values” has	V

		been presented at this workshop.	
EXPODRONICA AIR SHOW	27-28/09/22	https://www.worldatmcongress.org/home	P (booth and project presentation)
IEEE CloudNet 2022 - IEEE International Conference on Cloud Networking	7–10/11/22, Paris, France	https://cloudnet2022.ieee-cloudnet.org/	P (ATH gave one of the conference's keynote speeches)
ICT-52 Workshop on 6G 2023	19/01/23, Online	“AI@EDGE Network Architecture and Automation of Future Telecom networks” Hexa-X – ICT 52 Workshop on 6G 2023	P (EAB presentation)

2.6 Events and webinars organised by AI@EDGE

Apart from two plenary meeting, the 1st held online in February 2022 and the 2nd in presence in Milan in November, and the review meeting held in September, during 2022 the project consortium organised:

- [1st Open Annual Workshop on Future ICT](#), 25/05/22, Athens, Greece. A workshop organized by EIGHT BELLS focused on exploring the state of the art related to ICT, covering aspects such as 5G/6G, Cybersecurity, Quantum Computing, IoT and Cloud.
- [Joint INSPIRE-5G and AI@EDGE workshop – Platforms and Mathematical Optimization for Secure and Resilient Future Networks](#) has been held in Paris, France, on November 8-9, 2022, within the IEEE conference. The workshop has been co-organised with the [INSPIRE-5G PLUS](#) project and has seen the participation of 30+ people.

IEEE CLOUDNET 2022
Joint workshop INSPIRE-5G and AI@EDGE
8-9/11/2022, Paris (France)

08/11/2022

TIME	TOPIC	LEAD
8.30-9.15	Registration	
9.15-10.15	Opening Keynote: <i>Tackling “the identity problem”</i>	Radia Perlman Dell, USA
10.15-11.00	Coffee Break and networking	
11.00-11.25	Presentation of INSPIRE-5G project	Jean-Philippe Wary, Orange
11.25-11.50	Presentation of IAI@EDGE project	Roberto Riggio, UNIVPM
11.50-12.15	Malware propagation in mobile device-to-device networks ⁱ	Benedikt Jahnel, WIAS-Berlin (webex)
12.15-14.00	Lunch Break	
14.00-15.00	Keynote: <i>Issues in Cloud Security</i>	Charlie Kaufman Dell, USA
15.00-15.25	Dynamic counter-measures placements for network security: a hybrid AI/OR approach ⁱⁱ	Yann Dujardin, Orange
15.25-15.50	Quantum Technologies for securing communications at the edge ⁱⁱⁱ	Paolo Comi, Italtel ²
15.50-16.15	What are responsibility graphs and what can they teach us about responsibility repartition?	Gaber Chrystel, Orange
16.15-17.00	Coffee Break and networking	

09/11/2022

TIME	TOPIC	LEAD
8.30-9.15	Registration	
9.15-10.15	Keynote: <i>Cloud deployments of 5G core networks: unleashing the power of private 5G</i>	Nicola Di Pietro Athonet, Italy
10.15-10.45	Coffee Break and networking	
10.45-11.00	Scheduling algorithms in the service of routing computational processes in MEC servers ^{iv}	Stylianios Koumoutzelis, 8Bells research
11.00-11.25	ML-based applications at the edge of aeronautical networks ^v	Babak Mafakheri, SPI
11.25-11.50	End-to-end Security Problems in the Heterogeneous Multi-Party IoT-Cloud Infrastructure ^{vi}	Du Xiaojiang, Stevens Institute of Technology
11.50-12.15	AI@Edge Network Architecture and Automation of Future Telecom networks ^{vii}	Neiva Linder, EAB
12.15-14.00	Lunch Break	
14.00-15.00	Keynote: <i>Moving Target Defense (MTD) in Future Telco Networks: Design, Implementation and Challenges²</i>	Dr G. Gur, University of Zurich
15.00-15.30	Influence of transients on end-to-end network availability and resilience ^{viii}	Christian Tanguy, Orange
15.30-16.00	Formal Proof Metrics : the Developer's Guide to Formal ^{ix}	Gaber Chrystel, Orange (Webex)
16.00-16.15	Placement of Artificial Intelligence Functions for Anomaly Detection ^x	Yellal Nour El-houda, CNAM
16.15-17.00	Coffee Break and networking	

Figure 5. Joint workshop @ CLOUDNET 2022.

2.7 Opportunity-based dissemination

Opportunity-based dissemination takes place through partners' and other websites, as well as partners' and other newsletters, news press, publications, press releases, etc.

Table 5. Opportunity-based dissemination activities 2021.

Type of publication	Title	Authors / Affiliation	Information	Notes
5G-PPPPublication	AI@EDGE description	FBK	European 5G Annual journal	Available in EN
5G-PPP Publication	A Secure and Reusable Artificial Intelligence Platform for Edge Computing in Beyond 5G Networks	FBK	5G-PPP Projects Phase 3, June 2021.	Available in EN
News	AI@EDGE: the artificial intelligence of the future - safer, faster, more open	INRIA	INRIA's website, March 2021. FBK was interviewed and cited.	Available in both FR and EN
News	AI@EDGE : une super IA au service des réseaux de communication de demain	CNAM	CNAM's website, April 2021.	Available in FR
News	REUSABLE, SECURE AND TRUSTWORTHY AI SOLUTIONS IN THE NETWORK EDGE	FBK	FBK Magazine, May 2021.	Available in EN and IT
News	TIM Group Edge Computing and AI for the mobile networks of the future (gruppotim.it)	TIM	TIM's website, July 2021.	Available in EN and IT
News	i2CAT participates in AI@EDGE	i2CAT	i2CAT's website + twitter, August 2021.	Available in EN/SP/CAT
Newsletter	Introducing AI@EDGE: A secure and reusable Artificial Intelligence platform for Edge computing in beyond 5G Networks	ICCS	Hipeac Newsletter 63, May 2021.	
Press release	Italtel among the partners of AI@EDGE	ITL	ITL's website + Twitter + LinkedIn + established communication press channels.	Available in EN and IT

Table 6. Opportunity-based dissemination activities 2022.

Type of publication	Title	Authors / Affiliation	Information	Notes
News	AeroTools-UAV drones in large infrastructures	AERO	LinkedIn+website+twitter	

	monitoring is one of the planned Use Cases.			
News	The H2020 Project AI@EDGE brings Intelligence to the Edge of the Mobile network following the paradigms of AI-for-networks and networks-for-AI in Beyond 5G systems.	AERO	LinkedIn+website+twitter	
News	Sesiones de calibración de sensores y de generación de datasets para proyectos de Inteligencia Artificial	AERO	LinkedIn+website+twitter	
News	Participation in Webinar "Fondos Europeos Sesión #4: Financiación de la UE para proyectos de I+D+I" organizado por CEIM - Confederación Empresarial de Madrid-CEOE	AERO	LinkedIn	
Paper	Roadrunner: O-RAN-based Cell Selection in Beyond 5G Networks	I2CAT, UNIVPM	IEEE NOMS 2022	
News	RT of Video prepared by AI@EDGE	AERO	LinkedIn+Twitter	
News	Plenary Meeting at Grenoble	AERO	LinkedIn+Twitter	
News	Workshop ICT	AERO	Twitter	
News	RT Newsletter	AERO	Twitter	
News	RT Poster INRIA at RESSI 2022	AERO	Twitter	
News	AI@EDGE showcased at MWC2022	AERO	Twitter	
News	Function Placement and Acceleration for In-Network Federated Learning Services	AERO	LinkedIn	
Paper	AI@EDGE at the 5G-PPP "Workshop on 6G KPIs and how to measure them"	CNAM, UNIVPM, UL/INRIA	CNSM 2022	
News	1st workshop organized by the AI@EDGE Project	AERO	Twitter	

2.8 Review recommendations

During the September 2022 review meeting, some recommendations have been made regarding dissemination and exploitation activities of the project. We plan to provide a first reply to these recommendations herewith, also adding a plan to take them into account in the future work.

<i>Recommendation 1</i>	<i>“Work on improving quality of scientific output/publications”</i>
The Consortium has discussed this recommendation and is working towards achieving it. As it can be seen below (Section 2.9), a series of publications are being prepared and will be published within 2023.	
<i>Recommendation 2</i>	<i>“Keep the project web site up to date and active” and “There is a website, but results cannot be downloaded from there. Webinars, presentations, schools, tutorials, etc. are not yet reported. The project has published a whitepaper on KPI for example.”</i>
The project website is being revised with the adding of a devoted session in which to upload the project scientific publications. Additionally, this revision considers the need to make it more accessible and to present the key findings of the project in a clearer way.	
<i>Recommendation 3</i>	<i>“The number of publications so far is not sufficient. Open access repositories are not available. It is not clear if EU funding is referenced in the four publications. The dissemination of project results is one of the main weak aspects of the project.”</i>
The project has made 16 publications until the end of year 2. Plans are being made to increase the scientific awareness of the project towards the academia, industrial, and scientific sectors. In particular, the highlighted main project innovations will be disseminated within focused papers and whitepapers during the next year. Key events are being selected in which to disseminate the project results. To achieve these results, we are in the process of improving the connections with other 5G-PPP projects and to build on synergies with them. According to the Green open access requirement for the scientific publications, AI@EDGE is preparing a devoted section on the project website in which to put pre-printed versions of the approved papers made by the project.	

2.9 Planned future activities

The project AI@EDGE has developed a plan of activities to be carried out within WP6 for disseminating and exploiting the project results. Events are being organised and scientific publications are being planned. Our aim for next year is to foster synergies and cooperation with other projects through the following actions:

- AI@EDGE has acquired a booth at the Mobile World Congress 2023, co-hosted with the 5G-PPP [DAEMON](#) project. The main aim of this booth is to present the AI@EDGE project latest results with demos and to collect feedback from the industrial sector present at the event. It will also be the occasion to collect useful information on the latest trends on 5G and 6G.
- AI@EDGE has also acquired a booth at the IEEE ICC 2023 in Rome, co-hosted with the 5G-PPP [DAEMON](#) project. The focus of this conference is “Sustainable Communications for Renaissance”.
- At the EUCNC & 6G Summit 2023, to be held in June in Gothenburg, AI@EDGE has proposed a workshop entitled “Exploring the Intersection of 6G and Artificial Intelligence: Unleashing the Potential of Next-Gen Technologies”. The main aim of the workshop will be to explore the intersection of artificial intelligence (AI) and 6G technology and the potential of AI and 6G to work together to create new business opportunities and support new application verticals. The

latest research and developments in these areas will be shown, as well as the challenges and opportunities that lie ahead. This workshop is being organised together with other projects, i.e., [DAEMON](#), [5G-IANA](#), and [HEXA-X](#).

- AI@EDGE has also been invited to participate with a presentation to “the 6G series workshop by Hexa-X and Hexa-XII”, a workshop being proposed at the EUCNC & 6G Summit 2023. The proposed presentation is entitled “AI@EDGE Intelligent Network Architecture”.

As for what concerns the scientific publications, the partners are working to showcase the project results on key venues. The plan for the scientific publication is the following:

Partner	Provisionary title (if available)	Envisaged venue for submission
EAB	“An architecture for scalable end-to-end management of AI-based network applications towards AI-Native network”, a paper presenting the AI@EDGE architecture.	EuCNC & 6G summit
EAB	The title is not yet available, yet this will be an extended abstract (2 pages) in which to describe a demo introducing the model reusability concept.	EuCNC & 6G summit
CNAM	CNAM is preparing a paper on NetFPGA acceleration	Conference venue not yet identified. Planned journal submission around June 2023
CNAM	CNAM is preparing a paper on placement of AD-FL AIF	Journal submission to be identified
CNAM	CNAM is preparing a paper on AD-FL AIF accuracy analysis	Journal submission to be identified
CNAM	CNAM is preparing a paper on RL framework for automation of reconfiguration actions	A presentation is planned for March-April 2023 (venue to be identified) Conference venue to submit the paper is being defined (target May-June 2023)
CNAM	CNAM is preparing a paper on predictive scheduling	Conference venue to submit the paper is being defined (target May-June 2023)
INRIA	Inria has submitted a paper on autoconfiguration of ML-based NIDS	ANNET workshop at IEEE/IFIP NOMS 2023 (May)
ICCS	“Performance evaluation of heterogeneous HW clusters for AI acceleration in MEC applications” (tentative title). Abstract: Towards tackling the resource allocation problem in MEC clusters of very heterogeneous compute nodes, the paper performs an extensive benchmarking of various AI functions on multiple diverse HW accelerators. The work considers far- and near-edge nodes, i.e., server and embedded systems, such as FPGA, GPU, and CPU. Methodically, we select AI benchmarks, HW devices, development tools, deployment frameworks, and we proceed to an extensive comparative analysis of AI performance. The results	Identified journal: ACM Transactions on Modeling and Performance Evaluation of Computing Systems

	show that the accelerators can altogether improve the AI execution by orders of magnitude, however, SW and HW heterogeneity pose a new challenge in optimal assignment of tasks to MEC nodes.	
SPI	<p>“Edge Intelligence in B5G Aeronautical Network with LEO Satellites Backhaul”</p> <p>Abstract: This work sheds light onto a test bed development and initial experimental results obtained to enable airlines’ passengers onboard an aircraft with broadband connectivity as a development toward a ubiquitous access. Particularly, we detail our research activities around a 5G network and edge-cloud built on top of aviation-certified hardware and off-the-shelf servers.</p>	EuCNC & 6G summit
I2CAT	<p>The tentative topic of the publication is RAN Slice SLA Assurance / Traffic Steering in multi-connectivity scenarios.</p> <p>Abstract: We will demonstrate the capabilities of the non-RT RIC/SMO to monitor and manage different RAN technologies, focusing on a rAPP, which dynamically adjusts the RAN resources of multi-RAT slices or UEs.</p>	Conference venue to be defined

^[1] A = accepted; S = submitted.

^[2] A = accepted; S = submitted.

3. Contribution to Standards

In T6.2, the AI@EDGE project aims to monitor and contribute to relevant standardization organizations. This is an important task to ensure the potential integration and interoperability of solutions developed by AI@EDGE with other solutions and projects. To maximise the impact of AI@EDGE regarding standardisation, a three-step strategy has been established from the beginning of the project:

1. Identification of relevant standards AI@EDGE can rely on.
2. Identification of gaps. The project will analyse relevant standards and identify gaps in current state of standards development to fulfil the project objectives and so refine technical and scientific contributions.
3. Contributions to standards in different forms. Not all the project's developments necessarily have to be included into standard documents. However, it is also important to disseminate the project's activities towards the different organizations and groups, that will increase the awareness of the whole community. Therefore, attending to standardization-related meetings, participating in discussions, presenting the project outcomes are also relevant contributions in addition to writing standards whose adoption is also a long-term process and can span over the project duration.

Steps 1 and 2 are done along works performed in technical WPs 2-5 while step 3 is focused in T6.3 and documented here. As standardization activities are continuous work, we decided to adopt an incremental structure in this document by identifying for each standardization activities, the work done in each year. So, year 1 corresponds to D6.3 but it helps to see how the activities evolve each year.

Especially, in D6.3 we have identified different groups AI@EDGE could contribute to. After refinement, the list is now quite stable, and the AI@EDGE standardization plan has been aligned accordingly.

At the beginning of the project, some KPIs related to WP6 were defined also in relation to standardisation. These are presented in the table below.

Key Performance Indicators for WP6	Project targets	Achieved until M18	Achieved until M24
Number of contributions to standards	> 3	2	2

To reach our KPI (Number of contributions to standards > 3), we have identified **two priority activities**:

- **AI challenges in Network Management:** AI@EDGE deals with the automation of network management using AI. This is a core topic of IRTF NMRG co-chaired by INRIA. A document about AI challenges in this area is currently under review to be adopted by the group as a group document. Our priority is thus to provide support and answers to ensure its adoption before the end of the project. Once adopted, the goal would be to enhance its content and quality with the help of NMRG participants with possible publication as an informational RFC (probably after the end of the project due to the timeline of RFC publication process). In addition, this document supports the demonstration and presentation of AI-based solution during NMRG meetings where AI@EDGE partners can attend.
- **5G core network of ATH** is deployed and tested during ETSI Plugtest events. This is a unique opportunity to test and validate in standard-compliant environments the 5G core network solution brought to AI@EDGE's use cases.

In addition, two more activities have been identified as very relevant for the project and where AI@EDGE involvement is clearly identified with contributions to be delivered:

- TIM is involved in the edition of **two technical reports related to 3GPP Release 18**: study of Enablers for Network Automation for 5G System (5GS), study on 5G System Support for AI/ML-based Services that are in-line with the work performed in AI@EDGE. From these reports, it is expected to derive the normative work in 2023.
- ORAN WG2 launched a new WI (AIML in O-RAN) with a focus on AI/ML-related functionalities and services inside the non-RT RIC framework. TIM is actively involved in drafting sessions about this topic. The final objective is to produce **O-RAN specifications regarding AI/ML functionalities and services**.

3.1 IRTF network management research group

Jérôme François (INRIA) is co-chairing NMRG from IRTF, a parallel organization of IETF. Like other research groups of IRTF, the group of NMRG is to foster collaborations between researchers and engineers. Indeed, through the proximity with IETF, application of research proposals to practical problems can be discussed in-depth and, sometimes, when research is mature enough (with prototype and good validation), transfer to a standardization working group can occur. In a nutshell, the NMRG facilitates cooperation between academia and industry interested in network management. The current research agenda of the group has been defined around three themes. The first one is overarching as it continues the effort of the group towards more automation in the network (autonomous network, self-driving networks...). Two themes have been then derived: Intent-Based Networking (IBN) to ensure the interface between a self-driving network and the humans managing the network and the coupling between AI and network management, a critical component to support automated decisions in an autonomous network. Therefore, automation and AI for managing networks are topics fully aligned with AI@EDGE objectives and expected contributions.

In addition to co-chairing the group, INRIA is particularly leading the activities about the AI topic by organizing technical presentations and leading an effort to write a joint document on challenges of AI and network management. This document partially covers topics related to the application of AI for network management like resource allocation and network security including intrusion detection or collaborative security. All these topics are linked to the work done in the project and is based on the partner expertise.

3.1.1 Year 1

In March 2021, NMRG organized a session at IETF 110 (<https://datatracker.ietf.org/doc/agenda-110-nmr/>). We invited two presenters for technical talk on AI: Stefan Schneider (Self-Driving Network and Service Coordination Using Deep Reinforcement Learning) and Matthews Jose (Problems and Strategies implementing in-network AI).

In May 2021, NMRG organized an interim meeting virtually co-located with the IFIP/IEEE IM 2021. INRIA presented the activities of the group and invite newcomers to the group to contribute to the different topics. For instance, we introduce the research challenge on AI document under progress. In addition, Mon5G H2020 project was presented. It is about automating the creation of network slices and started one year before AI@EDGE. There are some similarities between the two projects and so this NMRG meeting allowed identifying this project for potential future synergies.

In June 2021, INRIA organized an interim NMRG meeting to resume the activity about the documentation of AI challenges in Network Management (NM). The goal was to free the main challenges and to define a common template to reach the same level of details for all challenges. It has also been presented during the NMRG session at IETF 111 in July 2021.

3.1.2 Year 2

In March 2022, INRIA co-chaired the NMRG session at IETF 113 and presented an update of the AI challenges. The document was reorganized to classify challenges according to 4 types: challenges purely related to AI techniques applied to network management, challenges related to underlying data used by ML algorithms and challenges about acceptability of using AI for network management. We also decided to not include use cases in this document as they will be focused on other ones produced potentially by NMRG. Also, in introduction we explicitly mention existing problem in NM through 5 main criteria:

- C1: A very large solution space, eventually infinite
- C2: Uncertainty and unpredictability of the context the solution
- C3: The need to deliver a solution in a constrained or deterministic time
- C4: Data-dependent solutions
- C5: Need to be integrated with human processes

In July 2022, INRIA co-chaired the NMRG session at IETF 114 and presented the AI challenges document formatted as an individual draft (<https://datatracker.ietf.org/doc/draft-francois-nmr-ai-challenges/>). The editorial team has been fixed to 5 editors. A 6th constraint has been added to classify the challenges:

- C6: Solutions **MUST** be cost-effective as resources (bandwidth, CPU, human, etc.) can be limited, notably when part of processing is distributed at the network edge or within the network.

In November 2022, INRIA co-chaired the NMRG session at IETF 115. Minor updates were made to the challenge document based on received feedback after IETF 114. Inria asked for a call for adoption to make this document a group draft rather an individual draft as most of the group now consider it as rather stable. This call was sent out in January 2023 with expected result by February 2023.

3.2 ITU-T FG autonomous networking

The ITU-T Focus Group on Autonomous Networks has as main objective to define an exploratory road on the requirements of future networks, real-time responsive experimentations and draft technical reports and specifications of autonomous future networks. Moreover, as a results of these specifications, the focus group aims to provide an open platform for experimentation where to perform pre-standards activities related to the topics of the groups.

3.2.1 Year 1

In April 15 2021, the FG-AN organized a session where RISE and I2CAT presented the AI@EDGE project, putting special attention to the autonomous networking concepts that the project results would provide as output. On this basis, collaborations with the working group, PoC sharing and reproduction on the context of the working group.

In June 3 2021, RISE and I2CAT participated to a special session of the working group upon request of the FG-AN chairs to present the accepted paper in IEEE Communications Magazine entitled “AI-Empowered Software-Defined WLANs”, where the taking as a basis de ITU-T Rec. Y3172 document on architectural framework for machine learning in future networks, an interpretable ML model is designed and deployed on an O-RAN architecture for wireless networks.

3.2.2 Year 2 (Discontinuation)

The ITU-T working group was more interested in the use cases demonstration, rather than on specific highlights or innovations of the project. Therefore, after presenting an initial paper cited in D6.2, we did not follow that focus group given the limited participation in the use cases.

3.3 ETSI Plugtests

For more than two decades, ETSI Plugtests have proved to be a valuable tool in the development of global standards. Plugtests events serve two main purposes:

- They provide essential feedback to ETSI technical committees to help improve standards and to accelerate the standards-making process.
- They enable engineers to get together to test the interoperability of their implementations – which can reduce a product's time-to-market.

The benefits of such events include:

- improving the interoperability of products and services
- supporting the deployment of new technologies
- enabling networking between partners, competitors and other experts
- validating ETSI standards

Plugtests are organized by ETSI's Centre for Testing and Interoperability (CTI). The CTI offers a wide range of services for testing and interoperability and organizes an average of 12 Plugtests events every year, covering diverse technologies and offering a program of events that responds to market demand.

3.3.1 Year 1

From June 14th to 18th 2021, Athonet participated in the ETSI FRMCS (Future Railway Mobile Communication System) Plugtests that focused on interoperability and mission critical service harmonization, which are critical challenges for the successful deployment and operation of Mobile Communication System for various sectors. Athonet brought to the plugtests its most recent release of the 5G core network, which is now part of AI@EDGE connect-compute platform and will serve the project's use cases.

Link to the event's report:

https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/1st_ETSI_FRMCS_Plugtests_Report_v1.0.0.pdf

From November 8th to 19th 2021, Athonet participated in the ETSI 6th MCX Plugtest event, held in hybrid mode. Athonet's core network deployed at the University of Malaga was used to support some demos and the plugtests' interoperability test sessions.

Link to the event's report:

https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/6th_ETSI_MCX_Plugtests_Report_V100.pdf

3.3.2 Year 2

From May 16th to 20th 2022, Athonet participated in the 2nd ETSI FRMCS Plugtests. As in the previous similar occasions, Athonet brought to the event (held online) its core network and made it available for interoperability tests with other vendor's solutions. The core network was also presented to observers in a dedicated demo session.

Link to the event's report:

https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/2nd_ETSI_FRMCS_Plugtests_Report_v1.0.0.pdf

From November 7th to 11th 2022, Athonet participated in the ETSI 7th MCX Plugtest event, hosted by the University of Malaga with both in-person and remote participation of more than 100 attendees. Athonet's 5G core network was used during the event to support mission-critical services (MCX) and demonstrate the interaction of Application Functions with the 5G control plane for quality-of-service management.

Link to the event's report:

https://portal.etsi.org/Portals/0/TBpages/CTI/Docs/7th_ETSI_MCX_Plugtests_Report_V100.pdf

3.4 ETSI ISG MEC

ETSI's Industry Specification Group (ISG) on Multi-Access Edge Computing (MEC) aims at standardizing an open environment for multi-vendor MEC platforms, as a reference to the work of telecommunications equipment vendors, IT service providers and vendors, system integrators, and application developers. The MEC ISG specifies the necessary elements for the deployment and operations of MEC platforms and applications, including their integration with 5G access technologies. In this perspective, ETSI MEC is an important reference for AI@EDGE, because one of its ambitions is to effectively deploy AI Functions (AIFs) at the edge of the mobile telecommunication network. Leveraging the standard MEC architecture, AIFs will be able to exploit at best the seamlessly integrated 5G (and beyond) access network and edge computing facilities, providing ubiquitous low-latency services to mobile users. Maximizing the compliance of the project's reference architecture and of AIFs with the MEC framework will also improve the opportunities of exploitation of the project's results beyond the project's scope and lifetime.

3.4.1 Year 2

From June 13th to 17th, Athonet hosted the 30th ETSI ISG MEC plenary meeting, which took place in Venice, Italy. During the event, a presentation on the AI@EDGE project was given by Cristina Costa from FBK.

3.5 3GPP SA WG2

Within the 3GPP Technical Specification Group Service and System Aspects (TSG SA), the main objective of 3GPP TSG SA WG2 (SA2) is to develop the overall 3GPP system architecture and services including User Equipment, Access Network, Core Network, and IP Multimedia Subsystem. SA2 has a system-wide view and defines the main entities of the system architecture, and how these entities are linked to each other. SA2 also defines the main functionality and the information exchange between these entities.

While Rel-17 5GS supports AI/ML training and inference within the 5G Core via NWDAF for network automation purposes, the support at the application AI/ML service client level running on the UE is not yet specified. Hence, an evolution of the 5GS is required to provide intelligent transmission support for application AI/ML-based services as proposed in the SA1 Release 18 study - *Study on traffic characteristics and performance requirements for AI/ML model transfer in 5GS*.

Further investigation and completing support for Edge Computing in 5GS together with the 5GS architectural and functional extensions where service providers can leverage 5GS as the intelligent transmission platform to support AI/ML-based services, are of particular interest for AI@EDGE project.

3.5.1 Year 1

TIM provided support for the approval of Release 18 3GPP Study Items relevant to the AI@EDGE Project activities:

- Study on 5G System Support for AI/ML-based Services ([SP-211648](#))
- 5G System Enhancements for Edge Computing ([SP-211638](#))

3.5.2 Year 2

TIM participated on behalf of AI@EDGE in the SA2 group discussions in the definition of the Key Issues for the above study activities.

TIM attended the following 3GPP SA WG2 online meetings:

- SA2 #149-e 14 - 25 February 2022
- SA2 #150-e 6 - 12 April 2022
- SA2 #151-e 16 - 20 May 2022

TIM participated in the discussions on the 3GPP Release 18 study activities with particular interest on:

- Study of Enablers for Network Automation for 5G System (5GS); Phase 3 (draft Technical Report 23.700-81)
 - This study focuses on solution to achieve further enhancement for network automation (i.e., Network Data Analytics and Data Collection), as documented in 3GPP TS 23.288.
- Study on 5G System Support for AI/ML-based Services (draft Technical Report 23.700-80)
 - This Technical Report will study 5GS assistance to support Artificial Intelligence (AI) / Machine Learning (ML) model distribution, transfer, training for various applications, e.g., video/speech recognition, robot control, automotive, etc.

The Technical Reports will be finalized by the end of the year and in 2023 will be done the corresponding normative work (e.g., new specifications).

3.6 ORAN WG1 and WG2

O-RAN WG1 is responsible for development of the overall O-RAN architecture, identification of key O-RAN use cases and deployment scenarios. The three task groups under O-RAN WG1 are Architecture Task Group (ATG), Network Slicing Task Group (NSTG) and Use Case Task Group (UCTG). TIM is particularly active in WG1.ATG that has the following objectives:

- Specify the overall architecture of O-RAN.
- Provide high level description of the O-RAN functions and the associated interfaces that connect them.
- Illustrate relevant implementation options, as and when needed, to explain the O-RAN architecture.
- Facilitate and arbitrate the cross-WG architectural topics/discussions.

O-RAN WG2 is responsible for the non-RT RIC and the A1 interface. The primary goal of non-RT RIC is to support non-real-time intelligent radio resource management, higher layer procedure optimization, policy optimization in RAN, and providing AI/ML models to near-RT RIC and other RAN functions. The A1 interface supports communication & information exchange between non-RT RIC and near-RT RIC, key objective of A1 interface is to support policy-based guidance of near-RT RIC functions/use-cases, transmission of enrichment information in support of AI/ML models into near-RT RIC, and basic feedback mechanisms from near-RT RIC.

TIM is active in WG2 where AI/ML related features and support are one of the core innovative aspects.

3.6.1 Year 1

TIM participated in ORAN WG2 regular weekly on-line meetings and provided support for the specification of the Non-RT RIC Architecture and R1 interface specifications (R1 – the interface between non-RT RIC and rApps) for March, July and November 2021 releases of specifications.

In ORAN WG1, TIM, together with other players, initiated and supported the new work item (WI) "Decoupled SMO Architecture", the study on how to decouple Service Management and Orchestration (SMO) Architecture, with the objective to recommend the grouping of various SMO functionalities in components that could be integrated in multi-vendor context via standardized interfaces.

3.6.2 Year 2

TIM continuously participated in ORAN WG2 regular weekly on-line meetings and provided support for the group discussions and for the specifications of the Non-RT Architecture and R1 interface. In the last quarter of 2022, O-RAN WG2 launched a new WI (AIML in O-RAN) with particular focus on

AI/ML-related functionalities and services inside the non-RT RIC framework. TIM supported this new WI and actively participate in dedicated on-line meeting and drafting sessions. This activity is particularly related to the AI@EDGE project for the part regarding LCM of AI/ML models embedded in rApps and/or in non-RT RIC framework. Moreover, the AI/ML supporting functionalities such as AI/ML Model Performance Feedback and Monitoring, AI/ML Model Training are also topics to be addressed in this activity. The final objective is to produce O-RAN specifications regarding AI/ML functionalities and services.

In the first quarter of 2022, in ORAN WG1-ATG, activities on new WI (Decoupled SMO) started. TIM continuously participated in regular on-line meetings related to the grouping of various SMO functionalities, actively participating in the discussions, evaluating contributions. This activity is particularly related to the emerging discussions in the AI@EDGE project, particularly related to NSAP components and interfaces.

TIM participated in face-to-face meeting of O-RAN community, held in Madrid, from 17th to 21st of October 2022.

4. Contribution to 5G-PPP and Collaboration with Other Projects

As in the first year, the project has been active in the interactions with 5G-PPP/IA and with the other projects of the other calls, and especially those belonging to the call ICT-52. In this chapter the interactions are summarized in form of tables.

4.1 Interactions with Working Groups

AI@EDGE interacted with 5G-PPP and 5G-IA and with some of the working groups therein.

Table 7. AI@EDGE interactions with 5G-PPP/IA and related Working Groups.

5GPPP/IA Group	Participants	Role/Notes
SB	FBK	Participation to the Steering Board calls and meetings.
TB	UNIVPM	Participation to the Technical Board activities, especially for the White Paper on the Beyond 5G/6G evolution.
WG Arch	ICCS, ATOS, FBK	INRIA has participated at workshop (October 13 th). Overall attendance at the calls and participation to the activities of the WG.
SW Netw	8BELLS, CNAM	CNAM interacted
Auto ²	8BELLS	Attendance and participation to the overall activities.
Network Management and QoS	I2CAT, CNAM	Attendance and participation to the overall activities.
Security	DFKI, INRIA	Initial contact to join has been made.
Vision	FBK, ATOS, WI3, SPI	FBK participates to the “Needs and Value Creation” subgroup.
Open SNS	TIM, CNAM, FBK	The WG has just started but it is of potential wide interest for AI@EDGE especially for the disaggregation of the architectures. INRIA has participated at SNS Webinar for Verticals webinar
WG Trials	TIM, SPI	Potential interest for the Trials activities being carried on at European level.

4.2 Interactions with other 5GPPP Projects

AI@EDGE has a clear objective to exchange views and information with the other projects that are dealing with concurrent and similar topics. A detailed list of the interactions is reported in the following. The activity in the Task has continued and progressed as in Year 1, with good relations with the H2020 projects in the context of 5GPPP and the first preliminary interactions with 6GIA and the new Phase 1 projects of the JU SNS in Horizon Europe. For this aspect, more contributions are expected in the next year, when these projects will enter an active phase. AI@EDGE will leverage on the presence in the main groups previously in 5GPPP and now in 6GIA, as reported in Section 4.1, to interact with the new projects.

Table 8. AI@EDGE interactions with other projects.

Project Name	AI@EDGE partners	Interactions with AI@EDGE
5G-DAEMON (H2020 5G-PPP)		With the DAEMON project, AI@EDGE is organising a series of activities in the next period: <ul style="list-style-type: none"> - Joint Booth at the MWC 2023, Barcelona, Spain - Joint Booth at the IEEE ICC 2023, Rome, Italy

		- Joint workshop to EUCNC 2023, Gothenborg, Sweden (proposal submitted)
Hexa-X, Rise-6G (ICT-52 Projects)	TIM EAB	Joint initiatives with the other projects of the same call of AI@EDGE are possible. TIM leads the dissemination and impact creation activities in Hexa-X, the “flagship” project in this phase of Beyond5G activities in Europe. EAB is the Hexa-X technical manager. AI@EDGE is organising a joint workshop together with HESA-X project at EUCNC 2023, Gothenborg, Sweden (proposal submitted).
5GENESIS, 5G-VICTORI, 5GVINNI, 5G EVE, 5G Tours, 5G SOLUTIONS, 5Growth (H2020 5G-PPP Phase 3)	I2CAT ATH SRS TIM	Until these projects will be active, they represent the European platform to run extensive trials on 5G and beyond, and as such they could be a good opportunity of cooperation for AI@EDGE. INRIA participated in the 5G GROWTH workshop.
5G-DIVE https://5g-dive.eu/	RISE EAB ULUND	5G-DIVE is an end-to-end Platform-as-a-Service (PaaS) build on top of an Edge and Fog computing platform (developed by the project 5G-CORAL). 5G-DIVE aims to enhance the management and automation of business processes of the 5G-CORAL platform using data analysis and Artificial Intelligence (AI) to maximize the value proposition of 5G for different type of vertical industries. 5G-DIVE targets end-to-end 5G trials aimed at proving the technical merits and business value proposition of 5G technologies in two vertical pilots, namely (i) Industry 4.0 and (ii) Autonomous Drone Scout. These trials will put in action a bespoke end-to-end 5G design tailored to the requirements of the applications targeted in each vertical pilot, such as digital twinning and drone fleet navigation applications. INRIA has participated at 5G-DIVE exploitation workshop in autumn 2021.
5G-ACIA		INRIA has participated at 5G-ACIA webinar
5G-PPP - SNS		INRIA has participated at SNS Webinar for Verticals webinar
5G-PPP 8th Global 5G Event		INRIA has participated at the "5G empowers the digital economy" webinar
5G-HEART and 5G TOURS		INRIA has participated at the Workshop on "Tele-Health Solutions Powered by 5G"
ESA and PSCE		INRIA has participated at the Online Workshop: “Satellite Applications for Public Safety”
5G-SMART		INRIA has participated at the Online webinar “Demystifying 5G and Industrial Networks slicing, from theory to practice”

5. IPR Management

The aim of this section is to define the measures and methodologies for managing exploitation activities, including the management of the Intellectual Property Rights (IPR), to ensure adequate exploitation of project outcome. Within this context and considering the exploitation reports/plans (in D6.2, D6.3) and AI@EDGE business models presented in D2.3, as well as the Consortium Agreement (CA), this deliverable targets at deploying a preliminary protection plan and ensure that all project results will be formulated and compiled into a protectable form.

5.1 Intellectual Property Rights in AI@EDGE

The following glossary consists of definitions of terms relevant to the IPR management in the Horizon 2020 context. The terms have been obtained through the combination of various

sources, including the glossary of the European Commission Research & Innovation Participant Portal and the glossary available by the European IPR Helpdesk.

Term	Definition
Access rights	The H2020 grant agreements set out specific obligations to give other parties (e.g., other beneficiaries, affiliated entities of another beneficiary, EU bodies, etc.) access to use results or background related to the project.
Action (also: project)	Beneficiary activities funded by the EU (via grants, procurement, prizes or financial instruments). In the present deliverable is used as a synonym for the term "project".
Background	Any data, know-how and/or information, whatever its form or nature (tangible or intangible) – including any rights such as Intellectual Property Rights – which is: (i) held by participants prior to their accession to the action; (ii) needed for carrying out the action or for exploiting the results of the action; and (iii) identified by the participants.
Beneficiary	Legal person, other than the European Union or a funding body, who is a party in the Grant Agreement.
Communication	A strategically planned process that starts at the outset of the action and continues throughout its entire lifetime, aimed at promoting the action and its results. It requires strategic and targeted measures for communicating about the action and its results to a multitude of audiences, including the media and the public and possibly engaging in a two-way exchange.
Confidential information	Any data, documents or other material (in any form) of a confidential nature that may include information of a personal, scientific, industrial, business, or commercial nature, that is not available to the public.
Consortium	A group of institutions or companies acting together in the same project under common interest. In Horizon 2020 it refers to all the participants in the same project.
Dissemination	The public disclosure of the results by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications via any medium.
Exploitation	The use of results in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardization activities.
Foreground	The tangible and intangible results which are generated within a given project, including pieces of information, materials and knowledge and whether they can be protected. It includes intellectual property rights (e.g., copyrights, industrial designs, patents, plant variety rights), similar forms of protection (e.g., rights for databases) and unprotected know-how (e.g., confidential material). Results generated outside a project are not foreground.
Intellectual Property (IP)	The creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce. Intellectual Property also includes patents, patent applications, copyrights, trademarks, trade secrets, and any other legally protectable information, including computer software. It is the rights of the Background and the rights of the Foreground.
Intellectual Property Rights (IPRs)	The private legal rights that protect the creation of the human mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. They are commonly divided into two categories: Industrial Property Rights (e.g., patents, trademarks, industrial designs, geographical indications), Copyright (e.g., rights of the authors/creators), and Related rights (e.g., rights of performers, producers and broadcasting organisations).

Owner	A party, public or private, holds legal title to Intellectual Property, consistent with national or international laws and regulations.
-------	---

5.2 Management of IPR

AI@EDGE project is committed to providing open access to new research data resulting from the project, thus addressing one of H2020's main objectives. In this respect, using open access repositories connected to the tools suggested by the EU Commission, we intend to provide open access to data generated by the project following FAIR (Findable, Accessible, Interoperable, Reusable) principle. Therefore, the AI@EDGE Consortium will openly make available the content and data produced within the project where possible.

In this sense, all partners are encouraged to share their knowledge in order to improve the quality of AI@EDGE work. Most of this sharing will normally be unproblematic, but sometimes the knowledge may represent a significant value for the owner and in these cases, one needs to consider the IP ownership issues.

Ownership can then be established as one of the following types:

- *Background knowledge* is brought into the project from other activities. The background has already been registered in the CA. The owners of the IP are registered together with the IP. It is normally a good idea to register the background knowledge as such before it is disclosed to anyone in the project. Note also that registration as background can be denied if it is thought that its ownership is unclear or that the knowledge is not necessary for the project. Registration of background knowledge should be denied for knowledge that can be proven to be already part of the public domain.
- *Results (or foreground)* are produced in the project, alone or in cooperation with other partners. Generally, the partners that have contributed to the development will have **joint ownership of the IP**.

5.3 Alignment with the legal framework

Knowledge and IPR management objectives, principles, and roles are generally foreseen in the Grant Agreement as well as in the Consortium Agreement. All knowledge and IPR management measures have been defined by AI@EDGE Consortium in pursuance of provisions contained in the Grant Agreement and in the Consortium Agreement, which are the main references in terms of legal framework. The Grant Agreement is the legal implementation of the project as agreed between the European Commission and the Consortium partners. All partners are signatories to the Grant Agreement. An important part of the Grant Agreement defines the rules for handling Intellectual Property Rights.

In specific areas, the Grant Agreement allows consortia to agree on their own rules. These individual rules are then included in the Consortium Agreement. As part of such an agreement, Consortium members specify or supplement – before the project commences – binding commitments among themselves in terms of roles, responsibilities and mutual obligations.

5.4 Protection of the results

There are a few routes available to AI@EDGE partners to protect the Intellectual Property they have generated on the project. The most relevant to AI@EDGE are patents, copyright and license.

- **Patent:** A patent is an exclusive right granted for the protection of inventions (products or processes) offering a new technical solution or facilitating a new way of doing something. The patent holder enjoys the exclusive right to prevent third parties from commercially exploiting their invention for a limited period. In return, the patent holder must disclose the invention to the public in the patent application.

Patent registration can be performed at three different levels: national, regional and international (through the Patent Cooperation Treaty (PCT) System [8]). The best route usually depends on the territories where a company intends to exploit the patent. A European patent can be obtained for all the European Patent Convention (EPC) contracting states by filing a single application, under a single set of fees with the European Patent Office (EPO).

The exclusive right conferred by a patent allows its owner to prevent others from making, using, offering for sale, selling or importing a product or a process based on the patented invention, without the owner's prior permission.

- **Copyright:** Copyright (or author's right) is the term used to describe the rights that creators have over their literary, scientific and artistic works. There is not an exhaustive list containing the works that can be protected by copyright. However, there is several works usually covered by copyright at international level (the examples most relevant to AI@EDGE are highlighted in bold):
 - literary works such articles;
 - **computer programs, databases;**
 - films, musical compositions, and choreographies;
 - artistic works such as paintings, drawings, photographs,
 - and sculptures;
 - architecture; and
 - advertisements, maps, and **technical drawings.**
- **License:** For a license to be valid it must be granted by the owner of the work's intellectual property rights. Under the policies of most research institutions and commercial companies, developers who have created a piece of software are unlikely to own full rights to their work. Instead, the organization generally holds or shares legal rights to develop software. Policies on IPR ownership vary, but in most cases the organization will be the legal rights owner and will be the entity that grants the license chosen for the produced software.

Colloquially speaking, the spectrum of software licensing strategies can be divided into three categories: "free and open source", "proprietary" or a hybrid of the two.

- *Free and Open-Source Software (FOSS)* Licensing: Free and open-source software (FOSS) represents a fundamentally different approach from proprietary software licensing. The primary intent of FOSS is to give the licensor the ability to maximise the output of their software by breaching barriers to software use, dissemination, and follow-on innovation. There are some of the most used FOSS licenses, each with small but significant changes, but all grant free (as in freedom), open, and non-discriminatory access and rights to modify licensed software and associated source code. A common misconception is that FOSS is synonymous with "non-commercial." In fact, as described by the two most influential definitions of FOSS, "non-discriminatory" means that no category of user or distributor can be prohibited, including for-profit commercial entities. Due to this, FOSS-licensed software can be, and often is commercially exploited. Due to the simplicity of the FOSS licenses and their non-discriminatory nature, they offer continued development and collaboration when researchers switch organisations, and when they collaborate across organisations. FOSS can also help to extend the useful lifetime of a piece of software beyond the direct involvement of the creators.

5.5 Tool for calculation of IPR percentage based on PMs

We are getting back to the issue of **joint ownership to the IP**. 8Bells has developed a tool which calculates the IPR percentage of each partner which contributes to new IP generated in one task based on the PMs spent for each partner in this task. Below we are showing a screenshot of the tool (excel file).

No.	Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total PMs	PMs Dev	% Dev	% Total PMs	Platform IPR % - Step 1	Platform IPR % - Step 2	Total (Step 1 + 2)	Lead Developer	Component IPR %	Component
1		20	1	5	3	14	8	11	62			9.88%		4.94%	4.94%			
2		7	9	18	12	2	3	3	54	54	14.36%	8.60%	7.18%	4.30%	11.48%	x	100%	
3		1	2	0	3	24	13	7	50	50	13.30%	7.97%	6.65%	3.98%	10.63%	x	100%	
4		1	4	2	8	14.57	3.5	5	38.07	38.07	10.12%	6.07%	5.06%	3.03%	8.09%	x	100%	
5		1	5	0	0	17	4	10	37			5.90%		2.95%	2.95%			
6		1	2	14	0	2	4	4	27	27	7.18%	4.30%	3.59%	2.15%	5.74%	x	100%	
7		1	3	0	0	0	7	3	14			2.23%		1.12%	1.12%			
8		1.15	10.35	0	2.3	1.15	6.9	14.95	36.8			5.86%		2.93%	2.93%			
9		1	3.5	4.5	17	11.5	7.5	5	50	50	13.30%	7.97%	6.65%	3.98%	10.63%	x	100%	
		0.49	1.23	0.15	1.13	2	0	0	5	5	1.33%	0.80%	0.66%	0.40%				
10		1	5	10	6	4	4	5	35	35	9.31%	5.58%	4.65%	2.79%	7.44%	x	100%	
11		1	2	10	13	2	4	4	36	36	9.57%	5.74%	4.79%	2.87%	7.65%	x	100%	
12		1	12	11	2	7	5	5	43	43	11.43%	6.85%	5.72%	3.43%	9.14%	x	100%	
		1	6	1	5.5	2.6	4.5	1.3	21.9			3.49%		1.74%				
13		0.9	0	0	0.4	0.4	16.5	0	18.2			2.90%		1.45%	3.19%			
14		1	8	1	5	2	10.67	4	31.67			5.05%		2.52%	2.52%			
15		1	5	1	5	1	12	5	30			4.78%		2.39%	2.39%			
16		0.51	0.77	0.85	22.87	4	5	4	38	38	10.10%	6.05%	5.05%	3.03%	9.14%	x	100%	
		42.05	79.85	78.5	106.2	111.22	118.57	91.25	627.64	376.07	100%	100%	50%	50%	100%			
													% of the total IPR goes to the Tool Owners, weighted according to %PMs amongst tool owners (column L)		The rest % is distributed to the 16 partners, weighted according to their %PMs (column M)			
													(Total IPR = 100)					
													Parameter 50%		50%			
													Change field N30 to the % you intend for development					

It assumes that:

1. 50 % of the total IPR goes to the Tool Owners, weighted according to %PMs amongst tool owners (column L)
2. The rest % is distributed to the 19 partners, weighted according to their %PMs (column M)

As soon as there is a new IP generated in one task in the year 2023, this tool could provide estimations of IPR percentage per partner. Of course, this should be discussed as a priory between the partners based on the rules and agreements mentioned in Section 4 and in the CA.

6. Impact Assessment and Exploitation

Exploitation is an ongoing, dynamic process and it depends not only the progress in the project (technological issues) but also on the current market status and projections which are highly affected by factors like the pandemic case, the energy crisis, the delays in the supply of the components. We review the initial exploitation plans of the use case leaders, we review the current market' status and projections, the role of AI/ML and communication technology and the revised exploitation plans of some use case leaders. It is expected that academia and research centers will contribute to the exploitation and disseminate their results as soon as there are available outcomes of the use cases.

6.1 Initial exploitation plans

In D6.3 Section 6.1 we included the initial exploitation plans for the Use Case Leaders, namely CRF, DFKI and SPI. We briefly review them.

Stellantis-CRF sees the AI@EDGE project as an important step forward on the following topics related to connected vehicles: (i) facilitate the design and development of new connected services; (ii) reduce physical testing (cost and time) and reduce time to market; and (iii) assess KPIs (latency, reliability, mobility, device density, type of traffic). CRF, acting as STELLANTIS Advanced Technology Centre, will take care of transferring the project results to the relevant STELLANTIS engineering teams for their exploitation.

DFKI plans to transfer and adapt the AI@EDGE outcomes, especially new security insights, to other application areas, such as industrial networks and Cyber Physical Production Systems. AI@EDGE results will also serve as input for the development of new technologies in forthcoming projects. The results can also be commercialized, e.g., through new start-ups (56 currently running DFKI spin-offs). Results of AI@EDGE will also be exploited at the academic level and be integrated in teaching and training courses at the University of Kaiserslautern as well as help to educate PhD students. Also, the dissemination of the results through the publication of scientific articles in relevant journals and international conferences is an important aspect.

EAB Ericsson Research drives technology leadership for Ericsson Mobile Networks impacting product design in the 3-5 years perspective. Ericsson's leading market position is based on providing world-class system concepts, technology innovations, and methodologies. The rapidly increasing demands for mobile broadband access in combination with needs for new technology and solutions for the digitalization of industries and societies create challenging and exciting opportunities. Within AI@EDGE, the Research Area Networks - Management and Automation intends to explore AI-based operations and "AI by design" network architectures, applying, e.g., reinforcement learning towards automation of network operations. To strengthen Ericsson's position in the competitive global market, AI@EDGE's outcomes should support new service offerings over existing commercial products and solutions, but particularly pave the way edge computing-based service offerings on future edge infrastructure. The project results are also to be used as input to relevant standardization organizations' work, such as 3GPP, ONAP, O-RAN, etc., where EAB is an active contributor.

SPI is a worldwide leading company in In-flight Entertainment & Connectivity solutions to aircraft. To ensure continued leadership in this market segment SPI intends to trial full-fledged 5G technology and network slicing capabilities. Therefore, SPI will leverage the knowledge gathered through AI@EDGE to scout the next generation of connectivity solutions trailing URLLC and eMBB services for the purpose of in-flight entertainment and on-flight work. This will allow SPI to put IFEC devices aeronautically certified with 5G connectivity in the product roadmap and on the market.

6.2 Market research/potential for use cases, the impact of the pandemic and the role of AI/ML

Because of the pandemic and the energy crisis in the last two years, it would be useful to reexamine the potential of the markets for all use cases. Exploitation plans of the companies might be affected due to the slowdown and the decreased growth rate (or CAGR) compared with plans two and a half years ago. We have also examined the role of AI/ML.

6.2.1 Vehicle Cooperative perception: market penetration (UC1)

The Worldwide Autonomous Driving Market's value in 2021 was roughly 23 million euro, and by 2030 will reach USD 185 million Euro. Autonomous cars use cameras, sensors, artificial intelligence and radar to travel without human drivers.

The vehicle sensors are responsible for perceiving the surrounding environment and a set of actuators that control its longitudinal and lateral movements, but they have limitations that might degrade the performance of automated vehicles (e.g., in adverse weather conditions, sensor's field of vision blocked by other vehicles or buildings...) To overcome these limitations and improve the perception capabilities of the vehicles, cooperative perception enables the wireless exchange of sensor information between vehicles and between vehicles and infrastructure nodes.

Vehicle-to-everything (V2X) is an important technology for realizing the cooperative perception of automatic driving. Information interaction between autonomous vehicles and edge nodes is the basis for realizing cooperative perception. The transmission of cooperative perception messages (CPMs) between vehicles and edge nodes requires a certain bandwidth and has strict latency constraints, which sets higher requirements for network performance. Vehicle mobility and market penetration have a great negative impact on cooperative perception effectiveness and network communication quality. In addition, a reasonable CPM-sharing strategy is also very important, which defines how often vehicles share perception data and which perception data to share. Therefore, reasonable network communication technology and sharing strategies are necessary. Usually, it is necessary to select an appropriate communication network and traffic scenarios.

At present, the penetration rate of intelligent networked vehicles is low, and the deployment of intelligent equipment and infrastructure construction still needs continuous efforts. Therefore, market penetration is an important factor that cannot be ignored for synergistic perception effects and communication quality. When the penetration rate is too low, the communication link supporting data transmission may be unstable due to the distance, and it may even be difficult to match a suitable edge node. Using cooperative perception information interaction, the impact of the low penetration rate can be effectively reduced, and the range of perception can be improved. When the market penetration rate is 50%, the estimated accuracy of vehicle positioning, and speed is 80–90%.

6.2.2 Industrial IoT market (UC2)

The Industrial IoT Market was valued at USD 76.7 billion in 2021 and it is expected to reach USD 106.1 billion by 2026, at a CAGR of 6,7%. The growth of the IIoT industry is driven by factors such as technological advancements in semiconductor and electronic devices, increased use of cloud computing platforms, standardization of IPv6 and support from governments of different countries for R & D activities related to IIoT.

Increased use of the [industrial IoT market](#) due to the adoption of artificial intelligence (AI) and machine learning (ML) in the end-user industry, it is also driving the market's growth. The higher probability of device theft and data breaches is expected to restrain the industrial IoT market. Growing internet penetration and digitalization across the globe are an opportunity for the industrial IoT market. High installation costs and difficulties in integrating IoT devices are challenging the global industrial IoT market.

6.2.3 BVLOS drone market (UC3)

The autonomous BVLOS drones' market is projected to register a CAGR of more than 10% during the forecast period (2022 - 2027). The demand for BVLOS drone operations in the commercial sector is growing sharply, and over the past five years, several commercial drone operators received approval from their respective airspace governing agencies for BVLOS operation. The COVID-19 pandemic initially slowed the BVLOS approvals, but the companies are resuming their plans to continue work on long-term BVLOS operations.

Currently, several drone operators are robustly expanding their BVLOS operations to cater to the demand of various end-users, which will enhance efficiency and industrial productivity. This is expected to propel the growth of the market during the forecast period. The law enforcement and armed forces have been using unmanned aerial vehicles (UAVs) for long-range intelligence, surveillance, and reconnaissance, and combat applications.

Also, the armed forces are collaborating with companies to increase the autonomous capabilities of the UAVs with the introduction of [artificial intelligence](#), big data, and other technologies. Despite the high levels of growth, the lack of comprehensive regulatory standards for the use of these drones in civilian airspace is challenging the widespread adoption of these drones.

6.2.4 In-flight entertainment services (UC4)

The global In-flight entertainment & connectivity market size was valued at USD 5.2 billion in 2021 and is anticipated to witness substantial growth, registering a CAGR of 9.0% between 2022 and 2030. Technological advancements in terms of wireless connectivity have enabled passengers to use personal electronic devices in airlines, consequently driving the growth of the in-flight entertainment & connectivity market. The ever-increasing customers' need for bug-free connectivity onboard is one of the important factors driving the market growth.

The aviation sector is experiencing a massive technological transition, making it necessary for market players to onboard updated solutions and services. In-flight entertainment and connectivity (IFEC) systems play an important role in delivering customers updated onboard wireless connectivity solutions and services, substituting the traditional seatback screens and presenting a restricted entertainment range with a moderately personalized model catering to individual passenger needs. Furthermore, advancements in seat design, connectivity, and real-time data positively influence the market for in-flight entertainment and connectivity. The major players are concentrating on improvising the broad range of delivery services, further increase in demand.

The in-flight entertainment & connectivity market has been severely impacted and is expected to face difficult times soon. Governments across the globe enforced lockdown restrictions to curb the spread of coronavirus, resulting in a sharp decline in airline flights. The airline industry has seen significant losses in revenue throughout 2020 and 2021. The companies operating in the in-flight entertainment & connectivity market were adversely affected by inactive markets and unstable economic conditions on the global level owing to the Covid-19 scenario throughout 2020 and 2021.

6.3 Exploitation plans (after second year)

Based on the exploitation questionnaire that was sent to AI@EDGE partners (focusing mainly on the commercial exploitation of the outcomes of the project), after the 2nd year of the project, the individual partner exploitation strategies have been revised as follows:

Stellantis-CRF

"AI@EDGE story"	Create a new validation environment for 5G Connected Vehicles Telematic Boxes.
-----------------	--

<i>Business opportunities</i>	As an Automotive OEM the company sees a new field of applications for connected vehicles, as validation platforms for 5G are essential in the development process of connected vehicles.
<i>Potential products and services</i>	Project outcome for Stellantis-CRF is a new in LAB validation platform for 5G, correspondingly it is not a product to be deployed on vehicles rather an essential tool and enabling methodology that can accelerate the deployment of 5G connected vehicles.
<i>Credible path</i>	Beyond project activities, the new in LAB validation platform and methodology will be exploited in the Company, namely it will be made available for the 5G connected vehicles tests allowing the related enabling technology to ramp up the Technology Readiness Level scale.
<i>Technology for near term applications</i>	Yes, with relation to the validation of new connected services.
<i>Total Addressable Market (TAM)</i>	Not Available (NA)
<i>Position in the market</i>	Stellantis-CRF will deploy project outcome internally, as the outcome is an in-LAB validation platform and methodology.
<i>Market standing</i>	NA in terms of estimated revenues and market standing, as the impact on the Company is related to the development process itself.
<i>Roadmap</i>	NA as Stellantis-CRF project outcome is not a product, and the validation platform and methodology will be ready to be deployed internally to the Company after the project ends.
<i>Targeted fields</i>	Totally (10%)
<i>AI@EDGE Technologies</i>	Stellantis-CRF core activities in AI@EDGE are in the WP2, WP5, WP6 workpackages focusing on use case design development and test.
<i>State of the art</i>	5G Emulators are available on the market, and Stellantis-CRF is using a 5G Emulator as part of the validation platform. Other OEMs and automotive suppliers are creating similar validation platforms, given the importance of LAB testing.
<i>Competitor organizations</i>	About the validation platform and related methodology, the information related to other OEMs and automotive suppliers in terms of “competition” is not made available.
<i>Standards</i>	NA
<i>Application environment</i>	NA
<i>Opportunities or threats</i>	Opportunities are related to the Company internal development process, no threats, IP, standardization issues have been identified yet.

Safran Passenger Innovations (SPI)

<i>“AI@EDGE story”</i>	An Edge/Cloud environment for In-Flight Entertainment and Connectivity (IFEC) system (UC4).
<i>Business opportunities</i>	As one of the worldwide leading companies in IFEC, is currently involved in an enduring Research & Technology program to scout and trial new connectivity solutions. This embraces the ongoing endeavor of the digital transformation of the aviation sector. SPI is also member of the Seamless Air Alliance, an organization of vendors for aviation that aims to develop guidelines for new products, well in line with the scope of AI@EDGE. In a landscape of a post-COVID 19 fast changing market, AI@EDGE stands thus as one of the key projects to enable the next generation of IFEC systems. One goal of SPI is to unravel all the potential of 5G technology in an aircraft

	cabin. If successful, SPI can plan the development of a new generation of connectivity products, which thus expand the existing offer portfolio for the airlines.
<i>Potential products and services</i>	The AI/ML-based applications that run in the aircraft edge-cloud can potentially lead SPI to develop a first generation of software products around predictable maintenance and content recommendation systems to be offered as software bundles to airlines and aircraft OEMs like Airbus and Boeing. Moreover, the onboard 5G if combined with new satellite constellations such as LEO can potentially lead to a new generation of connectivity system.
<i>Credible path</i>	The Aviation market exhibits peculiarities that are unlike to be found in the mass market. The complex certification process typically extends the Time-To-Market compared to other sectors. Anyway, it can be expected that after a preliminary design toll gate, there will follow a critical design review and first prototype development (both software and hardware wise). Afterwards, a complex qualification process shall follow against line fit and retrofit aircraft programs.
<i>Technology for near term applications</i>	The AI@EDGE Use Case 4 led by SPI brings into the picture aero certified, SPI manufactured cabin servers and seatback screens to enable the computational power required by the 5G system and edge-cloud. Despite some key components are already available a necessary repurpose will be required, including new aeronautical qualifications. In addition, feedback from airlines and OEMs is still required, which is not practical to obtain a short timeframe. Therefore, they cannot expect a new generation of products in the near term.
<i>Total Addressable Market (TAM)</i>	The SPI Business Unit has two main offices located in Wessling (Germany) and in Brea (California). The market to be addressed is those of airlines in post COVID-19 peak of pandemic.
<i>Position in the market</i>	SPI, part of the Safran Group, stands with Panasonic and Thales as the largest provider of IFEC systems and one of the aviation companies in the target market segment that is most awarded with new programs.
<i>Market standing</i>	Given the leading position of SPI in the related market segment, SPI can continue reinforcing its position towards airlines and OEMs, thus with a potential revenue of several million. A more exact projection would require a forecast about the market uptake. (e.g., recent EU announcement about 5G on-board airplanes in November 2022).
<i>Roadmap</i>	The project helps the R&T team to develop a PoC to investigate the possibility of using the outcomes in future aviation products. It is expected that the outcomes of AI@EDGE will be demonstrated to the SPI management, as well as to the management of the Safran group. Anyway, they should not expect a TRL level higher than 4/5 since the above TRLs are developed by the company when doing the final products.
<i>Targeted fields</i>	The tasks of people who work on AI@EDGE in SPI are perfectly aligned with our R&T roadmap, and the project fits well with future business perspectives that sought after by the Business Unit.
<i>AI@EDGE Technologies</i>	SPI is developing edge-cloud infrastructures, two IFEC applications that are served within the edge-cloud, 5G RAN and 5G core UPF in the cabin, as well as MPTCP. Their contribution is mostly on WP5, while they also are involved in WP2, WP4, and WP6.
<i>State of the art</i>	In the field of aviation, for IFEC, they should notice a quite conservative approach and a market in which connectivity is dominated by WiFi on-board and by Geostationary connectivity offboard. None of the technologies

	currently developed within AI@EDGE has predecessors in the market, apart for an aero certified 3G cell that SPI still offers to airlines.
<i>Competitor organizations</i>	<p>Thales Group, Panasonic, Intelsat</p> <ul style="list-style-type: none"> a) In-flight Entertainment and Connectivity Market b) Reliable, affordable, and very easy IFEC system for both airlines and passengers. c) By investigation on the new technologies such as AI/ML, B5G/6G, LEO satellite communication, etc. <p>Participation in AI@EDGE was extremely helpful the take advantage of the new technologies mentioned above while exchanging knowledge with the experienced partners of the project.</p>
<i>Standards</i>	ARINC standard series are the most relevant in aviation. 5G has been tackled until now by the Seamless Air alliance (SAA).
<i>Application environment</i>	A monolithic, single-purpose IFEC infrastructure can become a self-driving, self-healing network open to host third-party services in App store fashion.
<i>Opportunities or threats</i>	While this questionnaire is exhaustive, SPI will continue monitoring the IFEC market and will continuously consider airlines and OEMs feedback about 5G technology and its evolution applied to aviation.

DFKI and **Ericsson** are working on the revised exploitation plan and their final exploitation plan will be reported in D6.5. DFKI as a research institute is focusing mainly on the dissemination of the results through presentations in conferences and publications in journals. Ericsson has contributed a lot to the architecture of the Connect-Compute Platform (presented in D2.3) and as soon as some results are produced in the third year of the project's execution, they will revise their exploitation plan. The focus from Ericsson is also on the contribution to standards and it is expected that the company will contribute to the year 2023.

6.4 Final exploitation plans including the academia/research centers

Final exploitation plans will be reported in deliverable D6.5 and will also include the dissemination/exploitation from academia/research centers as well.

7. Conclusion

The second year (M13-M24) was mostly dedicated to (1) increase our participations to events and scientific publications as project results have been obtained; (2) focus our standardization effort to priority SDO/SDA groups identified based on project outcomes; (3) be more selective on cooperation with other projects while the first year was helpful to enhance our awareness about many other projects and (4) revise the exploitation plan. Our strategy for dissemination and communication was supported and accelerated thanks to results and outcomes of the projects. To continue to improve this aspect, we decided to foster this aspect in conjunction with higher interactions with a few but selected collaborative 5G-PPP projects, namely DAEMON, 5G-IANA, and HEXA-X. Through joint event organization, already planned for 2023, we thus expect to improve our visibility towards a large audience through the attractiveness of each project.

With more focused effort in standardization, two main contributions with high visibility in academia and industry communities have been well settled from the starting of the project. First, a set of well-articulated challenges of using AI for network management has been documented and proposed in IRTF NMRG. Feedback received so far from this research group is very positive and it is expected the document to be accepted as a research group document in the upcoming months, which is the first step towards a possible publication in RFC series. Second, the continuous participation to ETSI plugtest is helpful to validate and test standards. As a result, it is also a relevant activity to showcase the developed technologies that have received the support from AI@EDGE, namely ATH core network. These standardization activities will by nature go beyond the lifetime of the project.

In regards with exploitation of results, all methods and procedure have been set. Revision of the exploitation plan occurs on a regular basis, but the year will be focused on documenting all results and knowledge produced or updated by the project to ensure a proper exploitation, even after the project lifetime.