



*“5G for Drone-based Vertical Applications”*

## D6.5 – Annual report, year 3

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#### Approvals

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Management Committee	Project Management Team	FRQ, AU, THA, UMS, AIR, UO	31.05.2022

#### Document History

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## Executive Summary

The aim of this Annual report, year 3, the 5G!Drones Deliverable 6.5, is to deliver the progress of 5G!Drones, as achieved during the months M25 – M36 of the project (June 1<sup>st</sup>, 2021 – May 31<sup>st</sup>, 2022). The deliverable describes the overall activities of the project between M25 and M36 and subsequently portrays the technical activities conducted at each Work Package, drilling down to individual Task level and contribution of each Beneficiary of the project.

The report addresses the main achievements of the project between June 2021 and May 2022 including significant changes in the project Consortium that occurred during the period. It elaborates the submitted deliverables and captures the activities taken by the various project internal bodies together with their contributions towards the objectives of the project. The document does not include financial figures, or statements of use of resources, but it provides an estimate of personnel resources expended in terms of person months at project overall, as well as, at Work Package levels.

To elucidate the progress, the actual work carried out in Work Packages is described in detail. The description starts, in each Work Package and per Task, with recapturing on what has been stated in the Description of Action (DoA) followed with the main achievements of each Work Package, the significant results obtained, and deviations from DoA. Subsequently the report addresses each Task of the Work Packages and each Beneficiary's specific contributions to the Tasks. The report also details the dissemination and exploitation activities taken by the project Beneficiaries during the period. This deliverable further details the 5G!Drones project's achievements at 5G-PPP Programme level through participation to various bodies including Working Groups of interest where project has appointed representatives.

This document is intended mainly, as the summary of the 5G!Drones project activities during its M25 to M36 implementation for the EC to review. It also serves for the interested reader to gain an overview of the advances of the project in that period. The Deliverable follows a format similar to that of Deliverables D6.2, D6.3, and D6.4, which covered the periods M1 – M12, M13 – M18, and M19 – M24, respectively.

## Table of Contents

EXECUTIVE SUMMARY .....	3
TABLE OF CONTENTS .....	4
TABLE OF FIGURES .....	6
TABLE OF TABLES.....	6
LIST OF BENEFICIARIES .....	7
LIST OF ABBREVIATIONS AND DEFINITIONS .....	8
1. INTRODUCTION .....	11
1.1. MAIN ACHIEVEMENTS .....	11
1.1.1. Changes in the Consortium .....	12
2. RESOURCE UTILISATION .....	15
2.1. ESTIMATED OVERALL RESOURCE USE .....	15
3. DELIVERABLES .....	19
4. MILESTONES .....	20
5. PROJECT BODIES AND MEETINGS.....	21
5.1. GENERAL ASSEMBLY / PLENARY MEETING.....	21
5.2. PROJECT MANAGEMENT TEAM .....	21
5.3. FACILITY COORDINATION TEAM .....	21
5.4. EXTERNAL ADVISORY BOARD.....	22
5.5. INNOVATION MANAGEMENT TEAM.....	22
6. GENDER BALANCE.....	24
7. PROGRESS OF TECHNICAL WORK AND ACHIEVEMENTS .....	25
7.1. SUMMARY AND PROGRESS TOWARDS PROJECT OBJECTIVES.....	25
8. PROGRESS AND ACHIEVEMENTS OF THE WORK PACKAGES .....	34
8.1. WP1 USE CASE REQUIREMENTS AND SYSTEM ARCHITECTURE .....	34
8.1.1. Progress towards objectives and details for each Task [FRQ] .....	34
8.1.2. Task 1.1 Analysis of the UAV business and regulatory ecosystem and the role of 5G technology (M01-M42) [CAF] .....	35
8.1.3. Task 1.2 Use case assessment and refinement (M01-M06) [UMS] .....	37
8.1.4. Task 1.3 Detailed description of 5G facilities and mapping with the vertical use cases (M1-M12) [UO].....	38
8.1.5. Task 1.4 System architecture for the support of the vertical use cases (M1-M24) [ORA] .....	38
8.2. WP2 TRIAL CONTROLLER .....	38
8.2.1. Progress towards objectives and details for each Task.....	38
8.2.2. Task 2.1 Trial execution APIs for verticals and experimenters (M3-M30) [INV] .....	39
8.2.3. Task 2.2 Trial scenario execution engine (M3-M30) [EUR] .....	41
8.2.4. Task 2.3 Trial architecture management plan (M6-M30) [NCSRD].....	44
8.2.5. Task 2.4 Tools for experiment data analysis and visualization (M3-M30) [FRQ] .....	46
8.3. WP3 ENABLING MECHANISMS AND TOOLS TO SUPPORT UAV USE CASES .....	50
8.3.1. Progress towards objectives and details for each Task.....	50
8.3.2. Task 3.1 Scalable end-to-end slice orchestration, management and security mechanisms (M3-M32) [OPL].....	51
8.3.3. Task 3.2 MEC capabilities for the support of 5G!Drones trials (M3-M32) [EUR] .....	54
8.3.4. Task 3.3 Infrastructure abstraction and federation of 5G facilities (M3-M32) [AU]..	57

8.3.5.	Task 3.4 Development of UAV use case service components (M3-M33) [ALE] .....	59
8.4.	<b>WP4 INTEGRATION AND TRIAL VALIDATION .....</b>	<b>63</b>
8.4.1.	Progress towards objectives and details for each Task [UMS] .....	63
8.4.2.	Task 4.1 Software integration and 5G!Drones architecture validation (M6-M36) [DRR] .....	65
8.4.3.	Task 4.2 Preparation and execution of trials (M12-M42) [CAF] .....	71
8.4.4.	Task 4.3 Evaluation of trial results (M26-M42) [COS] .....	78
8.5.	<b>WP5 DISSEMINATION, STANDARDIZATION AND EXPLOITATION .....</b>	<b>82</b>
8.5.1.	Progress towards objectives and details for each Task .....	83
8.5.2.	Task 5.1 Communication activities (M1-M42) [INF] .....	84
8.5.3.	Task 5.2 Standardisation, exploitation and IPR management (M1-M42) [AIR] .....	87
8.5.4.	Task 5.3 Showcasing and dissemination activities (M1-M42) [RXB] .....	91
8.5.1.	Exhaustive list of dissemination and exploitation activities performed between M25 and M36 .....	95
8.6.	<b>WP6 PROJECT MANAGEMENT .....</b>	<b>112</b>
8.6.1.	Progress towards objectives and details for each Task .....	112
8.6.2.	Task 6.1 Administrative, financial and contractual management (M1-M36) [UO] ..	113
8.6.3.	Task 6.2 Risk and quality management (M1-M42) [UO] .....	114
8.6.4.	Task 6.3 Technical coordination and innovation management (M1-M42) [THA] ....	115
8.6.5.	Task 6.4 5G facility relationship management (M1-M36) [NCSRD] .....	117
9.	<b>5G-PPP CROSS-PROJECT CO-OPERATION .....</b>	<b>119</b>
9.1.	<b>5G-PPP STEERING BOARD .....</b>	<b>119</b>
9.2.	<b>5G-PPP TECHNOLOGY BOARD .....</b>	<b>120</b>
9.3.	<b>SME WG .....</b>	<b>120</b>
9.4.	<b>5G-PPP COOPERATION ON 5G SECURITY .....</b>	<b>120</b>
9.5.	<b>5G ARCHITECTURE WG .....</b>	<b>121</b>
9.6.	<b>PRE-STANDARDIZATION WG .....</b>	<b>121</b>
9.7.	<b>SOFTWARE NETWORKS WG .....</b>	<b>122</b>
9.8.	<b>VISION AND SOCIETAL CHALLENGES WG .....</b>	<b>122</b>
9.9.	<b>TRIALS WG .....</b>	<b>122</b>
9.10.	<b>5G AUTOMOTIVE WG / 5G-CAM WG .....</b>	<b>122</b>
9.11.	<b>IMT 2020 EVALUATION WG .....</b>	<b>123</b>
9.12.	<b>TEST, MEASUREMENT &amp; KPIS VALIDATION .....</b>	<b>123</b>

## Table of Figures

FIGURE 1: 5G!DRONES WEBSITE STATISTICS/DASHBOARDS, JUNE 2021 – APRIL 2022. ....	96
FIGURE 2: 5G!DRONES TWITTER STATISTICS/DASHBOARDS, JUNE 2021 – APRIL 2022.....	97
FIGURE 3: 5G!DRONES FACEBOOK STATISTICS/DASHBOARDS, JUNE 2021 – APRIL 2022. ....	98
FIGURE 4: 5G!DRONES LINKEDIN STATISTICS/DASHBOARDS, JUNE 2021 – APRIL 2022. ....	99
FIGURE 5: 5G!DRONES INSTAGRAM STATISTICS/DASHBOARDS, JUNE 2021 – APRIL 2022.....	100

## Table of Tables

TABLE 1: ESTIMATED RESOURCE USE IN PMS BETWEEN M25 AND M36.....	15
TABLE 2: ESTIMATED CUMULATIVE RESOURCE USE IN PMS BETWEEN M1 AND M36 .....	17
TABLE 3: DELIVERABLES DUE DURING THE REPORTING PERIOD .....	19
TABLE 4: MILESTONES DURING THE REPORTING PERIOD .....	20
TABLE 5: IMT TOPICS IN 2022 .....	22
TABLE 6: GENDER BALANCE OF THE 5G!DRONES PROJECT AT M36 .....	24
TABLE 7: 5G!DRONES TABLE OF DISSEMINATION AND EXPLOITATION ACTIVITIES.....	101
TABLE 8: 5G!DRONES PROJECT 5G PPP & IA REPRESENTATIVES .....	119

## List of Beneficiaries

Participant No.	Part. Short name	Participant organisation name	Country
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	Finland
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	France
3	ALE	ALERION	France
4	INV	INVOLI SA	Switzerland
5	HEP	Hepta Group Airborne OÜ	Estonia
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	Greece
7	AU	AALTO KORKEAKOULUSAATIO SR	Finland
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	Greece
9	AIR	AIRBUS DS SLC	France
11	INF	INFOLYSIS P.C.	Greece
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	Finland
13	RXB	ROBOTS EXPERT FINLAND Ltd	Finland
14	EUR	EURECOM	France
15	DRR	DRONERADAR Sp z o.o.	Poland
16	CAF	CAFA TECH OÜ	Estonia
17	FRQ	FREQUENTIS AG	Austria
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	Poland
19	MOE	MUNICIPALITY OF EGALEO	Greece
20	ORA	ORANGE SA	France
21	UMS	UM AUTONOMOUS SYSTEMS LIMITED	United Kingdom

## List of Abbreviations and Definitions

API	Application Programming Interface
BTS	Base Transceiver Station
C2	Command and Control
CA	Consortium Agreement
C-V2X	Cellular Vehicle to Everything
DoA	Description of Action
E2E	End-to-End
EAB	External Advisory Board
EASA	European Union Aviation Safety Agency
ELK	Elasticsearch, Logstash, and Kibana
EPC	Evolved Packet Core
FCT	Facility Coordination Team
FSB	Functional Breakdown Structure
GA	General Assembly
GCS	Ground Control Station
GUI	Graphical User Interface
IAM	Identity Access Management
IE	Information Element
IMT	Innovation Management Team
IMU	Inertial measurement unit
IP	Intellectual Property
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LBO	Local Break Out
LCM	Life-Cycle Manager
LiDAR	Light Detection and Ranging
M#	Month of the implementation of the project action since June 1st, 2019
MANO	Management and Orchestration
MCS	Mission Critical Services
MEC	Multi-access Edge Computing



MS	Milestone
NF	Network Function
NFZ	No Fly Zone
NSA	Non-Stand Alone
NSD	Network Service Descriptor
NST	Network Slice Template
NWDAF	Network Data Analytics Function
O-RAN	Open Radio Access Network
OSM	Open-Source MANO
PC	Project Coordinator
PEP	Policy Enforcement Point
PKI	Public Key Infrastructure
PM	Person Month
PMT	Project Management Team
PoC	Proof of Concept
RACI	Responsible, Accountable, Consulted, Informed (responsibility assignment matrix)
REST	Representational State Transfer
RNIS	Radio Network Information Service
RTM	Requirements Traceability Matrix
RTMP	Real-Time Messaging Protocol
RTSP	Real Time Streaming Protocol
SA	Stand-Alone
SDO	Standards Development Organisation
SLAM	Simultaneous Localisation And Mapping
SORA	Specific Operations Risk Assessment
TM	Technical Manager
ToC	Table of Contents
ToR	Terms of Reference
Traficom	Finnish Transport and Communications Agency
U2U	UAV-to-UAV
UAS	Unmanned Aerial Systems

UAV	Unmanned Aerial Vehicle
UC	Use Case
UCxScy	Use Case Number x Scenario y
UE	User Equipment
UGC	UAV Ground Control
UTM	UAS Traffic Management
UWB	Ultra Wideband
V2X	Vehicle-to-Everything
vEPC	Virtualised EPC
VNFD	VNF Descriptor
VR	Virtual Reality
WF	Workforce
WP	Work Package
WPL	Work Package Leader
WUI	Web User Interface

**Definitions:**

Q9: The period of the implementation of the action between June 1<sup>st</sup>, 2021 and August 31<sup>st</sup>, 2021 (M25 – M27).

Q10: The period of the implementation of the action between September 1<sup>st</sup>, 2021 and November 30<sup>th</sup>, 2021 (M28 – M30).

Q11: The period of the implementation of the action between December 1<sup>st</sup>, 2021 and February 28<sup>th</sup>, 2022 (M31 – M33).

Q12: The period of the implementation of the action between March 1<sup>st</sup>, 2022 and May 31<sup>st</sup>, 2022 (M34 – M36).

Reporting Period: Implementation of action from June 1<sup>st</sup>, 2021 to May 31<sup>st</sup>, 2022 (M25 – M36).

U-Space: U-Space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient, and secure access to airspace for large numbers of drones.

## 1. INTRODUCTION

This Deliverable summarises the key topics addressed, achievements and open issues for the period from June 1<sup>st</sup>, 2021 to May 31<sup>st</sup>, 2022 of the 5G!Drones project, hereafter termed as Reporting Period. The previous Reporting Periods have been covered in the Deliverable D6.2, D6.3, and D6.4 spanning the project timeframe from June 1<sup>st</sup>, 2019 to May 31<sup>st</sup>, 2020; June 1<sup>st</sup>, 2020 to November 30<sup>th</sup>, 2020; and December 1<sup>st</sup>, 2020 to May 31<sup>st</sup>, 2021, respectively. This Deliverable D6.5 is a continuation of them and together provide a complete description of the state and advances of the project during the first three years of the project. The Chapter 7 also recaptures the work done during the period from June 1<sup>st</sup>, 2019 to May 31<sup>st</sup>, 2021, in addition to this Reporting Period, in order to provide a more complete understanding the 5G!Drones project's progress towards its overall objectives. Otherwise, repetition of the activities described in D6.2, D6.3, and D6.4 is minimised.

### 1.1. Main achievements

The main achievements of the project for the Reporting Period are described as follows. The project's main Milestone MS3 – Final architecture and initiation of trials was reached on time in July 2021 (M26) by submission of Deliverables D3.2, D4.2, and D4.3. Overall, also the Deliverables D1.6, D2.2, and D2.3 contributed towards reaching the Milestone. The Milestone MS4 was also completed on time in May 2022 by submission of Deliverable D3.4 in addition to the Deliverable D2.5, D2.6, and D3.3 submitted, on time, earlier during the Reporting Period.

The project also conducted its first set of trials during the fall of 2021. Trials were conducted at EUR in June, and physically at NCSR D in July, and at AU and at UO in August. In addition, EUR physical trials involving all the scenario leaders were performed from 16th to 18th of December 2021, because of the alleviation of Covid-19 related restrictions at EUR.

The WP1 work has focused on collection of potential content for its only remaining Deliverable D1.7. The work for completing the WP1 has consisted of schedule for D1.7 creation, table of content and contributors defined for deliverable D1.7, and first round of content creation by several partners of D1.7. The work is still in progress as the Deliverable is due at the end of the project at M42.

WP2 worked on supporting the integration of the different enablers of the work package and performing the maintenance of these enablers based on the integration feedbacks carried out in WP4. WP2 demonstrated its enablers during the Period 1 review. Furthermore, all the enablers are currently developed, deployed and subject to integration in T4.1. The focus during the final quarter of the WP2 focused on the last Deliverables, D2.5 and D2.6 of the WP. The two deliverables were submitted on time. In parallel, since its enablers were already been finalised, WP2 also focused on supporting release 2 of WP4, which covered the integration of the trial controller enablers. The WP2 was concluded successfully at the end of February 2022.

The WP3 continued its work on end-to-end slicing. Also, network data analytics function (NWDAF) was identified as an interesting topic and partners addressed the area in the Reporting Period. Activities related to the MEC enablers, MEC requirements of UAV services, MEC availability at the four facilities, Mobility Management, and Network Slicing of Task 3.2 were finalized During the Reporting Period. The Abstraction layer, developed within Task 3.3 was finalised, integrated, and tested with all facilities. The WP3 facility enablers have been completed and documented in the Deliverable D3.3. The respective UAV enablers, developed in the scope of Task 3.4 are available for integration and have been reported in the Deliverable D3.4. The WP3 was completed successfully at the end of May 2022.

The WP4 has carried out integration and testing through Releases. Release 1 testing were conducted at EUR, DEM, AU, and UO During Q9. In addition, successful trials were conducted at all four trial facilities with multiple partners involved. The Deliverables D4.2 and D4.3 were submitted to the Commission. The integration tests workshops for Trial Controller Release 2 were performed from

November 2021 to January 2022. EUR physical trials were performed from 16<sup>th</sup> to 18<sup>th</sup> December 2021. The Release 3 Trial controller testing execution successfully completed during the last quarter of the Reporting Period and the final Release 4 is well on its way. The completion of Release 4 is expected in June 2022.

The communication aspects WP5 of Task 5.1, all the channels that have been built during the project (including inter alia Website, social media channels and newsletters) have been kept updated with all the activities carried on in the project and monitored through statistical dashboards made available in this deliverable. The 5G!Drones project partners have made significant effort to increase project visibility, especially preparing small videos captured at each trial event and reporting different aspects including lessons learnt and conclusions. The Consortium also tried to extend the dissemination of the results to several standardisation organisations and associations through a constant involvement in ASTM WG 69690 Supplemental Data Service Provider, ASTM F3411-19 Standard Specification for Remote ID and Tracking, GSMA/GUTMA/ACJA, and SUSI the Swiss U-Space Implementation (Switzerland is indeed the most active country in Horizon Europe to tackle regulation for the use of drone and drones on 5G) to name a few.

The Consortium is also actively preparing after project exploitation. The Consortium's partners are preparing business plans according to the specific methodology that was defined in order to report this activity and that will feed two deliverables D5.5 and D5.6 according to the nature of targeted outcome (commercial or not commercial). 5G!Drones partners have been involved in many events including EuCNC and Amsterdam Drone week. Several publications have been released mentioning 5G!Drones. Finally, European DG CNECT has recognised 5G!Drones as a key innovator in the so-called Innovation Radar platform, highlighting 2 innovations: The "flying base station" (from ORA, AIR and COS), and "Management of drone flights using 5G" (from THA, AIR and UMS).

With regards to project management, Period 1 reports were delivered on time and Period 1 review was completed successfully. Milestone MS3 was achieved by the submission of D3.2, D4.2, and D4.3. Amendment AMD-857031-24 was completed during Q10. The Technical Manager was changed from Farid Benbadis to Ehsan Ebrahimi-Khaleghi. Submission of D6.8 – Information on cumulative expenditures incurred, M30 was completed on time. The Amendment AMD-857031-27 was accepted during early February 2022 and the Amendment AMD-857031-33 is currently under preparation.

The Reporting Period included the submission of nine project Deliverables:

- D2.5 – Trial controller software final release (M33; O; CO; NCSRD),
- D2.6 – Data analysis and visualisation software implementation (M33; O; CO; NOK),
- D3.2 – Report on vertical service-level enablers for 5G!Drones (M26; R; PU; EUR),
- D3.3 – 5G!Drones Enablers Software Suite (M35; O; CO; UO),
- D3.4 – UAV use case service components (M36; O; CO; ALE),
- D4.2 – Integration status and updated integration plan (M26; R; PU; DRR),
- D4.3 – Trial plan (M26; R; PU; CAF),
- D6.8 – Information on cumulative expenditure incurred, M30 (M30; R; CO; UO), and
- D6.5 – Annual report, year 3 (M36; R; PU; UO).

#### **1.1.1. Changes in the Consortium**

The project had three Consortium initiated Amendments during the Reporting Period: Amendment AMD-857031-24, -27, and -33.

The AMD-857031-24 main changes were as follows.

- The Technical Coordinator has been changed from Pascal Bisson to Farid Benbadis.

- Updated the Gantt chart to reflect the following changes. Extended WP durations: WP2 has been extended by three months from M30 to M33 and WP3 has been extended by three months from M33 to M36. Extended Task Durations: T2.1 (M30 to M33), T2.2 (M30 to M33), T2.3 (M30 to M33), T2.4 (M30 to M33), T3.1 (M32 to M35), T3.2 (M32 to M35), T3.3 (M32 to M35), and T3.4 (M33 to M36). Shifts in Deliverable due months: D2.5 (M30 to M33), D2.6 (M30 to M33), D3.3 (M32 to M35), and D3.4 (M33 to M36). Shifts in Milestones: MS4 (M33 to M36) and MS5 (M36 to M37).
- UO change of Person Month cost. As a result UO Distribute the 197 PMs among the project WPs as: WP1 from 11 to 18; WP2 from 21 to 40; WP3 from 38 to 50; WP4 from 33 to 43; WP5 6 (no change); and WP6 from 16 to 40.
- THA includes a linked-third party ERCOM to the project. ERCOM is a THALES subsidiary located in France, Paris area, specialized in the development of cutting edge telecom and cybersecurity solutions. THA transfers a part of its resources to Ercom and Ercom will contribute to the project as follows. WP3: workload 6 PM for Ercom. WP4: workload 2 PM for Ercom.
- ALE change of Person Month cost. As a result ALE PMs are increased from 55 PM to 65 PM (WP3: from 14 to 20; WP4: from 27 to 31). ALE also transfers a part of its travel budget to equipment.
- NCSRDR resource shifts between WPs and updated Table 3.4b.
- AU change of Person Month cost and transfer of a portion of direct other costs to direct PM costs. As a result AU distributes 172 PMs among the project WPs as: WP1 10 (no change); WP2 from 29 to 45; WP3 from 30 to 45; WP4 from 21 to 58; and WP5 from 8 to 14.
- UNMANNED SYSTEMS LIMITED replaced as a Beneficiary by UM Autonomous Systems Ltd due to a partial takeover. UM Autonomous systems shifts its PMs between WPs.
- RXB resource shifts from other WPs to WP5.
- FRQ shifts PMs between WPs.

The Amendment AMD-857031-27 main changes are as follows.

- The Technical Coordinator has been changed from Farid Benbadis to Ehsan Ebrahimi-Khaleghi.
- UO shifts 2 PMs from WP6 to WP3 and transfers a portion of its other direct costs to direct personnel costs adding WP3 and WP4 PM efforts.
- INV change of Person Month cost and transfer of a portion of other direct costs to direct personnel costs. As a result, INV PM allocation is as follows: WP1: original plan 8 PM, change it to 12 PM; WP2: original plan 13 PM, change it to 22 PM; WP3: original plan 6 PM, change it to 8 PM; WP4: original plan 27 PM, change it to 30 PM; Total effort: original plan 69 PM, change it to 87.
- HEP change of Person Month cost and shift 3 PMs from WP2 to WP3. As a result, HEP PM allocation is as follows: WP2: original plan 10 PM, change it to 7 PM; WP3: original plan 5 PM, change it to 13 PM; WP4: original plan 40 PM, change it to 50 PM; Total effort: original plan 60 PM, change it to 75.
- NCSRDR shifted 50.000 EUR from other direct cost (equipment) to WP4 (Personnel cost), which is equivalent to 10 PMs. In specific, NCSRDR added the 10 PMs to WP4 (8 PMs in T4.2 (new total 20 PMs) and 2 PMs in T4.3 (new total 5 PMs)).
- INF shifted 30,450 Euro (equivalent to 7 PMs) from Other Cost (travel/equipment) to Direct Personnel cost. As a result, INF PM allocation is as follows: WP4 is affected: initial plan 10 PMs changed to 14 PMs; WP5 is affected: initial plan 14 PMs changed to 17 PMs; Total INF effort: 43 PMs changed to 50 PMs.
- NOK shifted 4 PM from WP2 to WP3 work.
- FRQ transferred effort to its linked third party FSO. FRQ transferred 4 PMs (40,000 EUR) to its linked third party FSO within WP4. As a result, FSO will receive 4.6 PMs for WP4. FRQ transferred 13,000 EUR from its "Other Direct Costs" (travel) to "Direct Personnel Costs" of FSO for WP4 activities. As a result, FSO received 1.4 PMs for additional WP4 work. In summary, changes for FRQ: WP4: current plan 18 PM, change it to 14 PM; Total effort: current plan 54

PM, change it to 50 PM. Direct personnel costs: reduction of 40,000 EUR. Other direct costs: reduction of 13,000 EUR. Summary of changes for FSO: WP4: current plan 6 PM, change it to 12 PM. Total effort: current plan 18 PM, change it to 24 PM. Direct personnel costs: increase by 53,000 EUR. The total estimated eligible costs of FRQ and its linked third party FSO remains unchanged.

- OPL shifted 17,500 EUR from "Other Direct Costs" (travel) to additional "Direct Personnel Costs". This translated to additional 5 PMs to be allocated as follows. WP3: original plan 22 PM, change it to 25 PM; WP4: original plan 10 PM, change it to 12 PM; Total effort: original plan 60 PM, change it to 65.
- MOE transferred costs from the "Other Direct Costs" category to "Direct Personnel Costs" category for more PMs. Precisely, a total amount of 15.000,00 € was transferred from the "Other Direct Costs" category to "Direct Personnel Costs" category. Specifically, three (3) more PMs were added in WP4 (Integration and Trial Validation) raising the planned effort from 15 PM to 18 PM. As a consequence, the total PM effort of MOE raises from 40 PM to 43 PM.

The Amendment AMD-857031-33 main changes will be as follows.

- The Technical Coordinator has been changed from Ehsan Ebrahimi-Khaleghi to Farid Benbadis.
- HEP is requesting for a new partner, OÜ Flaperon (FLA), to be included as a full partner to the Consortium on the following grounds. HEP Group Airborne has made a strategic business decision to end the in-house drone development, therefore our drone engineers are transferring to another legal entity. Due to this business decision, HEP does not have the required competencies to fulfil some of the work planned in WP4. HEP requests to accept the following contribution transfer from HEP to FLA: T4.1 FLA will lead the integration testing for HEP's enablers and all up testing for HEP's led UC3 scenario. T4.2 FLA will handle some technical preparations for the UC3 and UC4 trials HEP is involved in as well as attend the trials. T4.3 FLA will assist in results evaluation for UC3 HEP's led scenario. In total HEP request to transfer 12 PMs of WP4 effort to Flaperon WP4 effort. The transfer in in total 12 PM. The PM cost of HEP and Flaperon are the same. In terms of budget HEP requests to transfer total 73 500 €: 48 000 € direct person costs (12 PMs); 10 800 € other direct costs (travel and helicopter transportation costs); and 14 700€ indirect costs.
- FLA inclusion as a new partner to the Consortium with the effort described above.
- Extension of Task 4.1 by one month. There are currently multiple integration issues not yet solved within Task 4.1:
  - KPI collection into KPIC is not yet tested for all KPI sources.
  - KPI visualisation is not yet solved for all KPI sources.
  - Time synchronisation for all KPI sources is not yet solved for all trial scenarios.
  - All UAV enablers have not yet finished integration and all-up testing.
  - All scenario descriptions have not yet materialized in their final form.

Task 4.1 is currently scheduled to end in May 2022. As the leader of T4.1 Release 4 and on behalf of partners involved with release 4, HEP requests extending Task 4.1 by one month until the end of June 2022 (M37). This would give Task 4.1 time to map the situation thoroughly and finish needed actions to solve the mentioned issues or, as a minimum, set up prerequisites to solve these issues before the trials.

- Resource transfer from AU to UO. AU has experienced significant changes as majority of the Mosaic group working at Aalto University for the 5G!Drones project has transferred to UO. As a result Aalto University is in the process for preparing a transfer request of a part of its budget and responsibilities to UO.



## 2. RESOURCE UTILISATION

The resource utilisation table provided here are indicative estimates of the Beneficiaries. Accurate figures shall be provided in the context of periodic reports at M24 and M42. In addition, estimates of costs have been provided in 'Information on cumulative expenditure incurred' Deliverables at M18 (D6.7) and M30 (D6.8).

### 2.1. Estimated overall resource use

The Table 1 depicts the project and its Beneficiaries resource use during the Reporting Period. The year 3 has seen a lot of activity from Partners. Overall, around a third of the total PM effort of the project has been used during the Reporting Period reflective the intensive activity in finalising WP2 and WP3 activities and carrying out integration Releases for the project.

**Table 1: Estimated Resource Use in PMs between M25 and M36**

M25 - M36				Reported effort in PMs							Partner % from total PM declaration
Participant No.	Part. Short name	Participant organisation name		WP1	WP2	WP3	WP4	WP5	WP6	Total	
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	QMRs	0,15	4,68	21,66	44,63	1,17	14,74	87,03	42 %
			Total from GA	18,00	40,00	53,00	50,00	6,00	38,00	205,00	
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	QMRs	1,80	1,45	4,94	3,92	2,40	5,36	19,87	23 %
			Total from GA	10,00	10,00	24,00	13,00	10,00	20,00	87,00	
2.1	ERC	ENGINEERING RESEAUX COMMUNICATIONS	QMRs	-	-	3,25	0,10	-	-	3,35	42 %
			Total from GA	-	-	6,00	2,00	-	-	8,00	
3	ALE	ALERION	QMRs	1,26	-	9,34	16,14	1,62	-	28,36	44 %
			Total from GA	10,00	-	20,00	31,00	4,00	-	65,00	
4	INV	INVOLI SA	QMRs	0,30	4,93	1,90	13,50	2,05	-	22,68	26 %
			Total from GA	12,00	22,00	8,00	30,00	15,00	-	87,00	
5	HEP	Hepta Group Airborne OÜ	QMRs	-	0,40	5,94	21,55	-	-	27,89	37 %
			Total from GA	5,00	7,00	13,00	50,00	-	-	75,00	
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH	QMRs	4,22	11,49	9,05	11,71	1,62	1,11	39,20	42 %
			Total from GA	16,00	24,00	15,00	33,00	4,00	2,00	94,00	
7	AU	AALTO KORKEAKOULUSAATIO SR	QMRs	-	10,53	10,59	14,39	1,01	-	36,52	21 %
			Total from GA	10,00	45,00	45,00	58,00	14,00	-	172,00	
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	QMRs	0,10	-	-	4,80	0,50	-	5,40	18 %
			Total from GA	9,00	-	-	16,00	5,00	-	30,00	
9	AIR	AIRBUS DS SLC	QMRs	-	2,60	-	11,40	6,00	-	20,00	28 %
			Total from GA	13,00	12,00	-	26,00	21,08	-	72,08	

11	INF	INFOLYSIS P.C.	QMRs	3,08	0,68	-	6,78	4,89	-	15,43	31 %
			Total from GA	16,00	3,00	-	14,00	17,00	-	50,00	
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	QMRs	0,05	4,51	4,70	3,96	1,82	-	15,04	17 %
			Total from GA	11,00	20,00	18,00	26,00	11,00	-	86,00	
13	RXB	ROBOTS EXPERT FINLAND Ltd	QMRs	0,24	0,33	0,28	1,83	9,19	-	11,87	24 %
			Total from GA	5,00	3,00	2,50	12,00	27,50	-	50,00	
14	EUR	EURECOM	QMRs	-	1,07	10,61	10,75	3,71	0,29	26,43	27 %
			Total from GA	12,00	18,00	38,00	18,00	10,00	2,00	98,00	
15	DRR	DRONERADAR Sp z o.o.	QMRs	0,02	4,20	5,43	6,83	-	-	16,48	33 %
			Total from GA	7,00	16,00	11,00	16,00	-	-	50,00	
16	CAF	CAFA TECH OÜ	QMRs	-	3,50	10,30	7,80	0,40	-	22,00	28 %
			Total from GA	13,00	10,00	23,00	27,00	6,00	-	79,00	
17	FRQ	FREQUENTIS AG	QMRs	1,78	6,44	0,81	4,29	2,02	-	15,34	31 %
			Total from GA	13,00	12,00	7,00	14,00	4,00	-	50,00	
17.1	FSO	FREQUENTIS SOLUTIONS SRO	QMRs	-	1,97	3,95	2,28	-	-	8,20	34 %
			Total from GA	-	6,00	6,00	12,00	-	-	24,00	
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	QMRs	3,50	-	16,51	4,18	4,36	-	28,55	44 %
			Total from GA	16,00	-	25,00	12,00	12,00	-	65,00	
19	MOE	MUNICIPALITY OF EGALEO	QMRs	-	0,48	1,16	6,36	1,00	0,59	9,59	22 %
			Total from GA	9,00	4,00	6,00	18,00	4,00	2,00	43,00	
20	ORA	ORANGE SA	QMRs	-	-	2,50	0,60	0,70	-	3,80	19 %
			Total from GA	4,00	2,00	8,00	3,00	3,00	-	20,00	
21	UMS	UM AUTONOMOUS SYSTEMS LIMITED	QMRs	1,30	2,40	9,60	12,25	2,65	-	28,20	34 %
			Parner Total from GA	11,00	12,00	22,00	30,50	6,50	-	82,00	
QMRs				17,80	61,66	132,52	210,05	47,11	22,09	491,23	31 %
Total effort from Description of Action				220,00	266,00	350,50	511,50	180,08	64,00	1 592,08	
Percentage used from total based on QMRs				8 %	23 %	38 %	41 %	26 %	35 %	31 %	
Definitions											
GA		Grant Agreement									
QMR		Quarterly Management Report									

The cumulative estimated resource use since the project start (M1 – M36) is presented in Overall, the project's estimated resource use in PMs follows well the stage and the timeline of the project. The average project resources used reflect quite well the state of the project. WP2 and WP3 resources have been completely used reflecting their completion. WP1 is nearly used in terms of resources and the last remaining activity is Deliverable D1.7 drafting and submission. Several Partners have already consumed all their total PM resources but are still committed on delivering the contractual obligations for successful trials and their evaluations. Also, a few Partners are currently underspending with a likelihood of not being able to use up all the resources within the duration of the project.



Table 2. Overall, the project's estimated resource use in PMs follows well the stage and the timeline of the project. The average project resources used reflect quite well the state of the project. WP2 and WP3 resources have been completely used reflecting their completion. WP1 is nearly used in terms of resources and the last remaining activity is Deliverable D1.7 drafting and submission. Several Partners have already consumed all their total PM resources but are still committed on delivering the contractual obligations for successful trials and their evaluations. Also, a few Partners are currently underspending with a likelihood of not being able to use up all the resources within the duration of the project.

Table 2: Estimated Cumulative Resource Use in PMs between M1 and M36

M1 - M36				Reported effort in PMs								
Participant No.	Part. Short name	Participant organisation name		WP1	WP2	WP3	WP4	WP5	WP6	Total	Partner % from total PM declaration	Partner % from D6.8
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	FS + QMRs	17,77	40,00	58,00	56,87	2,63	39,08	214,35	105 %	
			From FS	17,62	35,32	36,34	12,24	1,46	24,34	127,32	62 %	
			Partner									
			Total from GA	18,00	40,00	53,00	50,00	6,00	38,00	205,00		80 %
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	FS + QMRs	8,10	9,05	27,04	10,12	8,40	17,26	79,97	92 %	
			From FS	6,30	7,60	22,10	6,20	6,00	11,90	60,10	69 %	
			Partner									
			Total from	10,00	10,00	24,00	13,00	10,00	20,00	87,00		69 %
2.1	ERC	ERCOM ENGINEERING RESEAUX COMMUNICATIONS	FS + QMRs	-	-	3,25	0,10	-	-	3,35	42 %	
			From FS	-	-	-	-	-	-	-	0 %	
			Partner									
			Total from	-	-	6,00	2,00	-	-	8,00		6 %
3	ALE	ALERION	FS + QMRs	9,51	-	19,99	26,67	3,35	-	59,52	92 %	
			From FS	8,25	-	10,65	10,53	1,73	-	31,16	48 %	
			Partner									
			Total from	10,00	-	20,00	31,00	4,00	-	65,00		52 %
4	INV	INVOLI SA	FS + QMRs	11,20	22,38	7,75	22,80	11,30	-	75,43	87 %	
			From FS	10,90	17,45	5,85	9,30	9,25	-	52,75	61 %	
			Partner									
			Total from GA	12,00	22,00	8,00	30,00	15,00	-	87,00		64 %
5	HEP	Hepta Group Airborne OÜ	FS + QMRs	4,30	6,42	13,45	32,99	-	-	57,16	76 %	
			From FS	4,30	6,02	7,51	11,44	-	-	29,27	39 %	
			Partner									
			Total from GA	5,00	7,00	13,00	50,00	-	-	75,00		57 %
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	FS + QMRs	16,13	25,21	15,61	21,44	2,93	1,44	82,76	88 %	
			From FS	11,91	13,72	6,56	9,73	1,31	0,33	43,56	46 %	
			Partner									
			Total from GA	16,00	24,00	15,00	33,00	4,00	2,00	94,00		70 %
7	AU	AALTO KORKEAKOULUSAATIO SR	FS + QMRs	9,17	39,49	44,13	25,18	6,36	-	124,33	72 %	
			From FS	9,17	28,96	33,54	10,79	5,35	-	87,81	51 %	
			Partner									
			Total from GA	10,00	45,00	45,00	58,00	14,00	-	172,00		46 %
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	FS + QMRs	9,00	-	-	15,30	3,80	-	28,10	94 %	
			From FS	8,90	-	-	10,50	3,30	-	22,70	76 %	
			Partner									
			Total from GA	9,00	-	-	16,00	5,00	-	30,00		77 %
9	AIR	AIRBUS DS SLC	FS + QMRs	12,00	11,60	-	23,40	19,00	-	66,00	92 %	
			From FS	12,00	9,00	-	12,00	13,00	-	46,00	64 %	
			Partner									
			Total from	13,00	12,00	-	26,00	21,08	-	72,08		95 %
11	INF	INFOLYSIS P.C.	FS + QMRs	15,18	3,25	-	9,79	14,50	-	42,72	85 %	
			From FS	12,10	2,57	-	3,01	9,61	-	27,29	55 %	
			Partner									
			Total from	16,00	3,00	-	14,00	17,00	-	50,00		68 %

12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	FS + QMRs	10,17	19,44	14,72	12,77	4,73	-	61,83	72 %	
			From FS	10,12	14,93	10,02	8,81	2,91	-	46,79	54 %	
			Parner Total from GA	11,00	20,00	18,00	26,00	11,00	-	86,00		74 %
13	RXB	ROBOTS EXPERT FINLAND Ltd	FS + QMRs	3,96	3,89	1,21	6,46	20,83	-	36,35	73 %	
			From FS	3,72	3,56	0,93	4,63	11,64	-	24,48	49 %	
			Total from GA	5,00	3,00	2,50	12,00	27,50	-	50,00		52 %
14	EUR	EURECOM	FS + QMRs	12,20	20,28	38,08	17,99	8,76	2,12	99,43	101 %	
			From FS	12,20	19,21	27,47	7,24	5,05	1,83	73,00	74 %	
			Parner Total from GA	12,00	18,00	38,00	18,00	10,00	2,00	98,00		85 %
15	DRR	DRONERADAR Sp z o.o.	FS + QMRs	6,95	14,25	12,09	19,39	-	-	52,68	105 %	
			From FS	6,93	10,05	6,66	12,56	-	-	36,20	72 %	
			Parner Total from GA	7,00	16,00	11,00	16,00	-	-	50,00		52 %
16	CAF	CAFA TECH OÜ	FS + QMRs	13,00	10,20	23,30	23,30	3,20	-	73,00	92 %	
			From FS	13,00	6,70	13,00	15,50	2,80	-	51,00	65 %	
			Parner Total from GA	13,00	10,00	23,00	27,00	6,00	-	79,00		71 %
17	FRQ	FREQUENTIS AG	FS + QMRs	11,63	13,81	7,82	12,90	4,21	-	50,37	101 %	
			From FS	9,85	7,37	7,01	8,61	2,19	-	35,03	70 %	
			Parner Total from GA	13,00	12,00	7,00	14,00	4,00	-	50,00		86 %
17.1	FSO	FREQUENTIS SOLUTIONS SRO	FS + QMRs	-	5,88	6,09	6,13	-	-	18,10	75 %	
			From FS	-	3,91	2,14	3,85	-	-	9,90	41 %	
			Parner Total from GA	-	6,00	6,00	12,00	-	-	24,00		63 %
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	FS + QMRs	13,29	-	24,75	7,45	8,65	-	54,14	83 %	
			From FS	9,79	-	8,24	3,27	4,29	-	25,59	39 %	
			Parner Total from GA	16,00	-	25,00	12,00	12,00	-	65,00		44 %
19	MOE	MUNICIPALITY OF EGALEO	FS + QMRs	9,00	4,00	6,00	15,00	3,46	1,73	39,19	91 %	
			From FS	9,00	3,52	4,84	8,64	2,46	1,14	29,60	69 %	
			Parner Total from GA	9,00	4,00	6,00	18,00	4,00	2,00	43,00		74 %
20	ORA	ORANGE SA	FS + QMRs	6,66	1,77	7,76	1,47	3,38	-	21,04	105 %	
			From FS	6,66	1,77	5,26	0,87	2,68	-	17,24	86 %	
			Parner Total from GA	4,00	2,00	8,00	3,00	3,00	-	20,00		93 %
21	UMS	UM AUTONOMOUS SYSTEMS LIMITED	FS + QMRs	9,90	12,00	21,90	27,65	4,00	-	75,45	92 %	
			From FS	8,60	9,60	12,30	15,40	1,35	-	47,25	58 %	
			Parner Total from GA	11,00	12,00	22,00	30,50	6,50	-	82,00		76 %
FS + QMRs				209,12	262,92	352,94	395,17	133,49	61,63	1 415,27	89 %	
Total used from Financial Statement				191,32	201,26	220,42	185,12	86,38	39,54	924,04		
Total effort from DoA				220,00	266,00	350,50	511,50	180,08	64,00	1 592,08		
Percentage used from total from FS + QMRs				95 %	99 %	101 %	77 %	74 %	96 %	89 %		
Percentage used from total from Financial Statement				87 %	76 %	63 %	36 %	48 %	62 %	58 %		59 %
Definitions												
FS	Financial Statement at M24											
QMR	Quarterly Management Report											
DoA	Description of Action											
GA	Grant Agreement											

### 3. DELIVERABLES

Table 3 contains the list of deliverables that were due in the reporting period. The table presents the Deliverable number, the name of the Deliverable, its associated WP, responsible Beneficiary, Deliverable type, its dissemination level, its due delivery month from DoA, and its actual submission date to the Commission.

**Table 3: Deliverables due during the reporting period**

Del. #	Name of Deliverable	WP #	Lead Beneficiary	Type	Dissemination level	Contractual delivery	Actual Delivery date
<b>D3.2</b>	Report on vertical service-level enablers for 5G!Drones	3	EUR	Report	Public	M26	30.07.2021
<b>D4.2</b>	Integration status and updated integration plan	4	DRR	Report	Public	M26	30.07.2021
<b>D4.3</b>	Trial plan	4	CAF	Report	Public	M26	30.07.2021
<b>D6.8</b>	Information on cumulative expenditure incurred, M30	6	UO	Report	Confidential	M30	30.11.2021
<b>D2.5</b>	Trial controller software final release	2	NCSRD	Other	Confidential	M33	28.02.2022
<b>D2.6</b>	Data analysis and visualisation software implementation	2	NOK	Other	Confidential	M33	28.02.2022
<b>D3.3</b>	5G!Drones Enablers Software Suite	3	UO	Other	Confidential	M35	29.04.2022
<b>D3.4</b>	UAV use case service components	3	ALE	Other	Confidential	M36	31.05.2022
<b>D6.5</b>	Annual report, year 3	6	UO	Report	Public	M36	31.05.2022

## 4. MILESTONES

There were two Milestones, MS3 and MS4 due during the Reporting Period. The Table 4 presents the milestones. The two milestones are verified by the delivery of deliverables associated with them from the DoA. The table describes the Milestone identified, the actions related to it, the method of validation for the milestones, related WPs to validation, responsible Beneficiary, completion of Milestone from DoA, and actual submission dates of validation documents.

**Table 4: Milestones during the reporting period**

No	Name	Validation	WP #	Lead Beneficiary	Contr-actual completion	Actual completion
<b>MS3</b>	Trial plan available.	D4.3 (CAF)	4	THA	M26	30.07.2021
	5G!Drones architecture final design ready.	D1.6 (NCSRD)	1			28.05.2021
	Initial implementation of trial controller integrated in target facilities.	D2.2 (INV) and D2.4 (EUR)	2			30.04.2021 and 31.05.2021
	Initial implementation of infrastructure enablers suite integrated in target facilities.	D2.3 (FRQ) D4.2 (DRR)	2, 4			28.05.2021 and 30.07.2021
	Initial implementation of UAV service components integrated in target facilities.	D3.2 (EUR)	3			30.07.2021
	Permissions to execute UAV trials at selected facilities granted. Beginning of trials.	D4.3 (CAF)	4,6			30.07.2021
<b>MS4</b>	Trial controller final version released.	D2.5 (NCSRD)	2	THA	M36	28.02.2022
	Data analysis and visualisation software released.	D2.6 (NOK)	2			28.02.2022
	5G!Drones Enablers Software Suite released.	D3.3 (UO)	3			29.04.2022
	UAV use case service components fully implemented.	D3.4 (ALE)	3			31.05.2022

## 5. PROJECT BODIES AND MEETINGS

### 5.1. General Assembly / Plenary meeting

During the Reporting Period the 5G!Drones project held virtual Face-to-Face meetings on June 1<sup>st</sup> – 2<sup>nd</sup>, 2021; November 22<sup>nd</sup> – 23<sup>rd</sup>, 2021; February 21<sup>st</sup> – 22<sup>nd</sup>, 2022 and; May 24<sup>th</sup> – 25<sup>th</sup>, 2022 where General Assembly points were discussed and decided. Other General Assembly subjects were conducted through remote voting and consensus.

### 5.2. Project Management Team

The Project Management Team (PMT) consisting of the Project Coordinator (PC), Technical Manager (TM), and Work Package Leaders (WPLs) held regular meetings (24/06, 11/10, 23/11, 28/01, 25/02, 08/04, 29/04, 24/05) over the Reporting Period where the progress towards the objectives was reviewed to further drive the project according to the work plan defined. For each of these meetings minutes were produced and uploaded on the project's workspace. It has become customary that all partners of the project may partake and contribute to PMT activities, but it is the core PMT, which drives the activities leading to General Assembly matters.

### 5.3. Facility Coordination Team

During the reporting period NCSRD coordinated the Task activities in order the complementarity of the ICT-17 platforms with the 5G!Drones project to be properly reported in the integration activities and especially in D4.2. Special coordination effort was put on the QoE of the experimenter following the experiment initiation in web portal 1 and web portal 2, trying to combine the 5G!Drones project specificities needed for the initiation of the drone flight, but also the experiment details specified at platform level by web portal 2.

Towards this, the task close monitored the integration workshop progress in order to be reassured a smooth integration of the 5GDRONES trials controller on top of the 5G infrastructures, reassuring a common experimentation experience. Moreover, the ICT-17 platforms, considered specific extensions in their architectures in order to properly integrate with the UAS domain, such as extensions related to telemetry reporting etc. Various integration workshops were organized in order to maintain a well-understood connection to the 5G facilities of the project, reassuring a common experimentation experience across the 5G!Drones platforms.

Following this homogenization of the participating 5G facilities, 5GDRONES contributed in the 5G-PPP cartography, emphasizing on the capabilities and the support of 5GDRONES platforms to the respective KPIs and use-cases. Especially effort was consumed on the cross-facility KPI collection and monitoring work and agreeing on a common visualization tool for the needs of the 5G!DRONES trials among the platforms that participate in the project.

More specifically, NCSRD as task leader has coordinated the efforts for importing properly the data files from the various platforms to the elastic database and then KIBANA to properly visualize in a common and comparable way the stored data from the experiments. By this the comparison of the various results is feasible, even if the platforms that supported the experiments are different.

Towards this the involved 5G facility owners have performed the necessary updates to the trial enforcement abstraction layer in terms of the Trial-ID definition, as well as the Kibana data entry and visual representation of the results. In specific, the necessary updates have performed on the trial enforcement, abstraction layer, and facility adapters to enable Trial-ID as a parameter in the body request to create measurement jobs and provide it into the KPI data streaming sent to KPIC.

#### 5.4. External Advisory board

There were no External Advisory Board meetings during the Reporting Period. There was one change as Mr. Priit Rifk was replaced by Mait Rõõmus at the Department of Aviation Division at Ministry of Transport, Estonia. The Consortium made a General Assembly vote to disband the requirement for confidentiality agreement between the EAB member and the Consortium due to an impasse inside the Consortium.

The External Advisory board members are:

- Barbara Pareglio, Senior Director, IoT Technology, GSMA;
- Florian-Michael Adolf, Head of Autonomous Flight, Volocopter;
- Heidi Himmanen, Chief Specialist, Finnish Transport and Communications Agency (Traficom);
- Heikki Huhmo, Project Manager, Open innovation platforms spearhead project, BusinessOulu;
- JC Robert DelHaye, CEO, Drone Think Do;
- Jyrki Penttinen, Senior Technology Manager, North America, GSMA; and
- Mait Rõõmus, Senior Inspector of Flight Operations Department of Aviation Division at Ministry of Transport, Estonia.

#### 5.5. Innovation Management Team

The IMT Objectives are:

1. UAV vertical and Telecom Industry jointly drive innovation.
2. Monitoring of very fast evolving business environment.
3. Advise the PMT.
4. Guiding the project towards identifying emerging innovation.
5. Readjusting the project activities to better respond to opportunities.
6. Take care that the focus of the project is in line with:
  - Current technological developments and
  - Regulatory developments.

The IMT Team consists of members from CAF, RXB, DRR, ORA, FRQ, and OPL and responsibilities described in Table 5.

**Table 5: IMT topics in 2022**

Topic	Lead	Description
<b>1. UAV Business case developments</b>	RXB	Major drone services and developments related to 5G Drones activities.
<b>2. Regulation of UAV flights</b>	CAF	Updates of EU Regulation and further regulation developments
<b>3. U-Space regulation and roll-out</b>	FRQ	EU Regulation 2021/664, -665, -666 U-Space regulation updates and roll-out in EU.
<b>4. Regulation of cellular UAV's and commercially available cellular UAVs</b>	CAF	EU regulation to use 5G or other cellular devices onboard. Drones with cellular (incl. 5G) devices on board

<b>5. 5G roll-out and developments of the 5G eco-system incl. 5G IoT</b>	CAF	5G networks both 3.5GHz and 700MHz frequencies roll-out in EU and development of eco-system and functionalities (SA; MEC etc.)
<b>6. Standardization of 5G (3GPP etc.) and specific fields (Slicing, MEC, UAVs)</b>	OPL	3GPP technical studies and reports regarding 5G MEC, slicing and UAVs
<b>7. UAVs Altitude and Location Reference problems</b>	DRR	Altitude Reference problems and possible solutions
<b>8. Interference problems</b>	ORA	a)Between drones and base stations b)Between 5G and aviation radio altimeters

The IMT Team has prepared IMT Reports for each virtual Face-to-Face Meeting. The reports are in PowerPoint slide format and are uploaded to MS Teams.



## 6. GENDER BALANCE

The Table 6 describes the gender balance of the project in May 2022. The gender balance has not changed significantly from the previous Reporting Period to this one. The table describes not only the personnel who directly used the resources of the project but also the staff directly supporting 5G!Drones activities. As can be seen from the table the overall gender balance is 31% female, 69% male, and 0% other genders working for the project. The WP leader positions are dominated by male representation, whereas the support personnel are dominated by female representation. Overall, other project roles vary having 13% to 20% female representation.

**Table 6: Gender Balance of the 5G!Drones Project at M36**

Gender Balance				Number of personnel			WP Leader			Task Leader			Technical person / researcher			Project manager			Support staff (Admin, legal, financial)			Total			
				Female	Male	Other	Female	Male	Other	Female	Male	Other	Female	Male	Other	Female	Male	Other	Female	Male	Other	Total			
Participant No.	Part. Short	Participant organisation name	Country																			228			
1 (Admin. Coordin.	UO	OULUN YLIOPISTO	Finland		1					1	11					3			4	12	0	16			
2 (Tech. Coordinat	THA	THALES SIX GTS FRANCE SAS	France		1					3	8			1		4			7	10	0	17			
3 ALE		ALERION	France					1			1			1					0	3	0	3			
4 INV		INVOLI SA	Switzerland				1	1		1	6			1		3	1		5	9	0	14			
5 HEP		Hepta Group Airborne OÜ	Estonia								6			4		4	1		4	11	0	15			
6 NCSRD		NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	Greece					2			6			1					0	9	0	9			
7 AU		AALTO KORKEAKOULUSAATIO SR	Finland		1			1			7			1		4	3		4	13	0	17			
8 COS		COSMOTE KINITES TILEPIKOINONIES AE	Greece				1			3	6								4	6	0	10			
9 AIR		AIRBUS DS SLC	France		1					2	7					5	2		7	10	0	17			
11 INF		INFOLYSIS P.C.	Greece					1		6	6			1		1			7	8	0	15			
12 NOK		NOKIA SOLUTIONS AND NETWORKS OY	Finland							2	5			1		6	10		8	16	0	24			
13 RXB		ROBOTS EXPERT FINLAND Ltd	Finland					1			2								0	3	0	3			
14 EUR		EURECOM	France				1	1		1	4					1			3	5	0	8			
15 DRR		DRONERADAR Sp z o.o.	Poland					1			3					1	1		1	5	0	6			
16 CAF		CAFA TECH OÜ	Estonia					1			1			1					1	2	0	3			
17 FRQ		FREQUENTIS AG	Austria		2			1		2	7			1		1			4	10	0	14			
18 OPL		ORANGE POLSKA SPOLKA AKCYJNA	Poland							1	5			1		2			3	6	0	9			
19 MOE		MUNICIPALITY OF EGALEO	Greece							3	5			1		4	2		7	8	0	15			
20 ORA		ORANGE SA	France					1		1	3								1	4	0	5			
21 UMS		UM AUTONOMOUS SYSTEMS LIMITED	United Kingdom		1						5			1		1			1	7	0	8			
			Percentage	0 %	100 %	0 %	20 %	80 %	0 %	20 %	80 %	0 %	13 %	88 %	0 %	67 %	33 %	0 %	31 %	69 %	0 %				

## 7. PROGRESS OF TECHNICAL WORK AND ACHIEVEMENTS

This section reports on major work performed and achievements obtained for each of the 5G!Drones project objectives during the Reporting Period (M25 – M36). In order to provide context, the progress towards project objectives is recapped from Deliverables D6.2, D6.3, and D6.4 for each of the objectives, followed by this Reporting Period's contribution.

### 7.1. Summary and progress towards project objectives

**Objective 1 “Analysis of the performance requirements of UAV verticals”:** A deep analysis of the UAV use case requirements in terms of the needed network functionalities and the required application performance to validate. Business models will be also derived.

#### M1 – M12 (from D6.2)

5G!Drones UAV use cases as stated in DoA have been revisited, complemented, and confirmed in terms of both feasibility and market relevance perspective. Within each of the four broad UAV-based Use Case categories identified to benefit from the large-scale deployment of 5G networks, twelve scenarios (including three sub-scenarios) have been identified as candidates to be trialled over the available 5G testing facilities to test and validate 5G KPIs. D1.1 *Use case specifications and requirements* provides a description of each of the use case scenarios detailing hardware and software enabling components for the UAV trial to take place. It also provides information on the 5G network and drone requirements required to deploy the trials as well as lists the application performance requirements and vertical-service-level KPIs that are critical to be measured during the trials.

Further to this an initial analysis of the UAV market, the regulation and legislation to date vs. to come, as well as the role 5G technology could play was also performed. This has been fully documented in D1.4 “UAV business and regulatory ecosystem and the role of 5G”. This is used to ensure proper alignment of the whole (development & trial) work towards useful and usable results. This is also in favour to have results widely adopted and generate new business opportunities through provision of newly enabled UAV services.

Objective 1 has been worked out by WP1 mainly through Task 1.1 “Analysis of the UAV business and regulatory ecosystem and the role of 5G technology” and Task 1.2 “Use case assessment and refinement” which have respectively delivered D1.4 and D1.1.

#### M13 – M18 (from D6.3)

During the Reporting Period Objective 1 has mainly been addressed through WP1 Task 1.1. “Analysis of the UAV business and regulatory ecosystem and the role of 5G technology”, Task 1.4 “System architecture for the support of the vertical use-cases”, and Innovation Management Team (IMT) activities.

The IMT team has considered additional topics towards the Objective namely utilising Intelligent Transport Systems (ITS) vehicle-to-everything (V2X) communications solutions for inter-drone communications.

#### M19 – M24 (from D6.4)

During the Reporting Period Objective 1 has been addressed through WP1 mainly by the work performed:

- in Task 1.4., deliverable D1.6 as the deliverable provides now in its final revision, detailed information about functional and security requirements.
- In Task 1.1., deliverable D1.7 in the search, analysis, and collection of information for the

deliverable regarding potential UAV business models. Analysis of the UAV market, regulation and legislation to date (especially in the countries where the trials take place) has progressed. Information about the role of 5G technology to date and in the future for the UAV business models has been collected.

## M25 – M36

The effort regarding this Objective has ended at M24 with the submission of D1.6 5G!Drones system architecture refined design. No additional work has been performed since then.

**Objective 2 “Design and implementation of the 5G!Drones software layer (or system) to execute UAV trial”:** Design and implement the 5G!Drones trial system, which will be in charge of running the UAV trials using the ICT-17 facility components and 5G!Drones enablers developed during the project. The envisioned 5G!Drones system abstracts the low-level details on the usage of 5G facilities resources, by providing a high-level API to describe, run and obtain results on the specific KPIs.

## M1 – M12 (from D6.2)

Several significant progress steps have also been reported by key technical deliverables.

- **High-level design of 5G!Drones overall architecture** to support the UAV use cases over a federated, multi-domain 5G infrastructure, as well as to manage successful execution of their trials. This architecture fully documented in D1.3 has been produced by WP1 but most importantly has been shared and agreed by other WPs since made actionable from their side. Indeed the overall 5G!Drones architecture, while stressing structuring environmental concepts (e.g. 5G network slice, MEC as well as UTM & U-Space) and embracing relevant standardisation work, depicts the major building blocks needed to get it realised namely the Portal, the Trial Controller, the Abstraction Layer, the 5G Facility Infrastructure Monitoring, the U-Space entity and the U-Space Adapter. It also presents in detail the cornerstone of the envisaged architecture, the 5G!Drones Trial Controller its components and their interaction, as well as the UAV verticals and the 5G Facilities, in order to enforce the relevant UAV service logic. Last but not least it also stress some of the identified gaps at first supporting 5G Facilities level (i.e. X-Network, 5GEVE, 5GTN and 5GENESIS) and second, enablers level to cover the UAV use case requirements.
- **5G trial Facilities description:** description of 5G Facilities was provided initial on M6 through deliverable D1.2 with insights on each of the 5G trial facilities, namely: the 5GENESIS, Athens 5G site, the 5G-EVE, Sophia Antipolis 5G site, Aalto university X-network, and the University of Oulu 5G Test Network (5GTN). Initial description of 5G facilities was further refined and extended in the context of D1.5 (M12) that extensively describes each of the 5G facilities required to carry out trial experiments in the 5G!Drones adding some of the details which were missing in previous deliverables (e.g. radio and core network capabilities, edge computing technologies supported, interactions with the trial controller) while considering features upgrades as well as security mechanisms in place. Furthermore, the mapping of use case scenarios and facilities. The initial mapping of use-case scenarios and facilities (in D1.2) was advanced and made actionable since now expressed (in D1.5) as a set of functional components that will permit the deployment of a given scenario. These components are first mapped within architecture proper to each scenario deployment, and then categorized into UAV components, UAV operator components, UTM components, and 5G components.
- **Trial controller:** an initial version of the Trial Controller architecture, its mechanisms and APIs has been worked out by WP2 and fully documented in D2.1. This work leverages on overall design of 5G!Drones architecture from D1.3 and further details trial controller, its components (Trial Scenario Execution Engine, Trial Architecture Management Plane, KPI Assessment, Data

Gathering) their interaction as well as supporting mechanisms and/or algorithms. Further to this D2.1 also emphasizes on references points derived and that are key towards the definition of the Trial Controller APIs. Apart from paving the way towards the next release of the trial controller architecture, mechanisms and APIs (aka D2.4), D2.1 was also made actionable to other WP and more specifically WP4 to figure components to integrate, test and validate from Trial Controller perspective.

### M13 – M18 (from D6.3)

Objective 2 has mainly been addressed through Tasks 1.4, to be reported in D1.6 which is an evolution of D1.3, at M24, Tasks 2.1, 2.2, and 2.3, to be reported in D2.2 at M23, and Tasks 3.1, 3.2, and 3.3 reported in D3.1. The Task 1.4 activities focus on refining the high-level design of the overall architecture, which governs the Objective 2 software layer, whereas the WP2 Tasks focus on the detailed definition of Trial controller architectural part and its software and hardware development. WP3 Tasks focus on the infrastructure enablers that are accessed through the abstraction layer. The objective has been addressed through achievements in the following technical areas:

- **High-level design of 5G!Drones overall architecture:** During this period, 5G!Drones partners have been working on the final architecture and on the refinements of the technical design and updated specifications of the 5G!Drones platform, from what has been described in D1.3. This shall be documented in D1.6 that will present a global picture of the final architecture. D1.6 shall focus on the refined extensive list of the requirements relative to the final architecture design. It will provide an analysis of the updated 5G!Drones architecture including each for each component key functionalities and development progress over the federated, multi-domain 5G infrastructure. An early version of D1.6 was produced within the reporting period for project internal purposes.
- **Trial controller:** The work achieved during this period regarding the trial controller activities will be reported in D2.2. D2.2 will describe the trial engine, including modules and functions as introduced in D2.1.
- **Infrastructure enablers:** D3.1 describes some 5G!Drones infrastructure enablers needed to cover project's needs, which are not facility specific, and that results from the work of Task 3.1, Task 3.2, and Task 3.3, such as Abstraction Layer, NSD template, MEC capabilities, and security functions.

### M19 – M24 (from D6.4)

Objective 2 has mainly been addressed through Tasks 1.4, to be reported in D1.6 which is an evolution of D1.3, and due at M24, Tasks 2.1, 2.2, and 2.3, to be reported in D2.2 at M23 and D2.4 at M24, and Tasks 3.1, 3.2, and 3.3, already reported in D3.1.

In the scope of T1.4, the overall architecture has been refined, while in tasks 2.1, 2.2, and 2.3, we have worked on the initial implementation of the 5GDrones trial controller.

- **High-level design of 5G!Drones overall architecture:** During this period, 5G!Drones partners have been working on the final refinement of the overall architecture. This lead to slight updates of the specifications of the 5G!Drones platform. These modifications have been reported in D1.6.
- **Trial controller:** During this period, the project has been working on the trial controller which initial implementation has been provided as D2.2 at M23 and for which D2.4 has been submitted on M24. These deliverables contain the definition of the trial controller architecture, its mechanisms, and its APIs.
- **Infrastructure enablers:** After providing D3.1 in the previous period, The project has continued working on the abstraction layer and especially on the development of the facilities' parsers: EUR finished abstracting the interfaces required for the management of network slices and KPIs monitoring, AU and UO abstracted a subset of interfaces.

**M25 – M36**

During this period, the Consortium has worked on finalising the trial controller, which software has been released as D2.5 Trial controller software final release at M33, as well as finalising the data analysis and visualization software, released at M33 as D2.6.

On the enablers side, the Consortium has also released infrastructure enablers as D3.3 at M35 and UAV enablers at M36 as D3.4.

**Objective 3 “Design a high-level scenario descriptor language to run and analyse the results of the UAV trials”:** Design a high-level (or Northbound) API to allow a UAV vertical to configure a trial and run the test.

**M1 – M12 (from D6.2)**

This objective in scope of WP2 was mainly covered during the period by worked performed on T2.1 “Trial execution APIs for verticals and experimenters” and T2.3 “Trial architecture management plan”. Results achieved have been detailed and reflected in D2.1. With focus put on the provision of high-level scenario description languages and APIs, as well as mechanisms to translate scenarios to deployments using the APIs provided by facilities and the 5G!Drones enablers, a Functional Breakdown Structure (FBS) for Web Portals describing all the functions, required to be performed by the experimenter to specify his test was defined. From this FBS a Scenario Description Language was defined, with all the details and information elements, which are required to work with Web Portals 1 and 2, and to define the experiment. Based on this, the prototype APIs were designed. This initial work which has delivered will be continued and further detailed and documented in the context of implementations of the web portals.

**M13 – M18 (from D6.3)**

This objective is in scope of WP2 and was mainly covered during the period by work performed in T2.1 “Trial execution APIs for verticals and experimenters” and T2.3 “Trial architecture management plan”. The work during the Reporting Period has mainly focused on the design and implementation of the Life Cycle Manager (LCM) and the work was based on the trial process flows the project has worked on during the period.

The activities focus on trial execution management and trial monitoring aspects, while different management interfaces are being designed and provided to cover the project’s needs. This Objective has also been addressed in the scope of T2.3, responsible for building the Trial Enforcement component of the Trial Controller.

**M19 – M24 (from D6.4)**

This objective is in the scope of WP2. During this period, the WP has worked towards this objective in Tasks T2.1 “Trial execution APIs for verticals and experimenters” and T2.3 “Trial architecture management plane”. In particular, the Consortium has defined the operational flight plan which specifies the information required to describe a scenario. The operational flight plan has been defined in accordance with the European Commission draft document on a regulatory framework for the U-space to enable issuing UAS flight authorisation. This objective has also been supported by Task 2.2 “Trial scenario execution engine”, where a focus has been given to the blueprint of the facilities, exposed to the vertical to describe the network parameters of the scenario, and the mechanism of translating it to network slices understood by the target facilities. The Trial Controller software components



supporting 5G!Drones tests, which is the output of these tasks has been described in D2.2 submitted on M23.

#### M25 – M36

The design of the high-level scenario descriptor language has been finalised at M24 and thus, no additional work, regarding the design, has been performed during this period. However, partners have worked together to implement and enhance the software layer dedicated to this objective and the resulting system has been released in D2.5.

**Objective 4 “Design and implementation of 5G!Drones enablers for UAV trials and operations”:** 5G!Drones will use the 5G facilities provided by i) EURECOM (5G EVE–Sophia Antipolis, France), ii) NCSR Demokritos and the Municipality of Egaleo (5GENESIS, Athens, Greece), in addition to iii) the 5GTN platform available at the University of Oulu, Finland and iv) the X-Network facility available at the Aalto University, Finland. Based on the analysis of the target UAV use cases, 5G features of these platforms will be used, and, when deemed appropriate, additional software will be developed by the project, and additional UAV-relevant hardware will be acquired. These new components represent the 5G!Drones enablers. Particularly, 5G!Drones will focus on improving Network Slicing functionalities, as UAVs require at least two running network slices; one for command and control (type uRLLC) and one for the data plane (type eMBB or mMTC). The security of each of these network slices will be also investigated and duly addressed. Moreover, a UAV traffic management service based on virtual reality allowing control and/or supervision of multiple UAVs operating in the same area will be studied.

#### M1 – M12 (from D6.2)

Objective 4 has been worked out by WP2, WP3, and WP4 following technical progress achieved by WP1 ranging from the Use Cases detailed (D1.1), the High-level design of 5G!Drones overall architecture (i.e. D1.3), initial (M6/D1.2) and refined description of the 5G facilities (M12/D1.5). This has been performed while taking into consideration additional work performed in the context of D1.4. This has framed the work of WP2 and WP3. The former has delivered initial description of Trial Controller seen as one of the core enabler despite coarse-grained. The latter has been working on initial list of enablers (see D6.2 WP3 appendices for details from Section 9 to Section 14) under work (specification / development).

Based on information coming from the work performed by WP1, WP2, and WP3, WP4 has specified an initial integration plan which has been reported in D4.1. A 4-phased iterative process of Build-Deploy-Cycles per facility has been devised and the basic steps and involved interactions for each integration activity have been defined. This initial integration plan has been shared and agreed with other WPs and more specifically WP2 and WP4 that will deliver components/enablers to be tested integrated in the context of the test cases to be trialled.

#### M13 – M18 (from D6.3)

Objective 4 has been further developed in WP2, WP3, and WP4 following the technical progress achieved by WP1. During the Reporting Period, WP2 continued working mainly on the trial controller and the web portal (both Web Portal 1 and 2), while WP3 has been focusing on the design and implementation of the infrastructure enablers, including the ones required to provide end-to-end slicing and MEC capabilities. The abstraction layer, required to allow communication with the different facilities, is also carried out in the scope of WP3.

The main achievements towards this objective are reported in Deliverable D3.1 – Report on

infrastructure-level enablers for 5G!Drones (M18; R; PU; OPL).

#### **M19 – M24 (from D6.4)**

Objective 4 has been addressed through the development of many UAV enablers. Several of these UAV enablers are already finished and ready to be tested. A few enablers remain in status “in progress” but are expected to be finished in the next months. Release dates for them were provided and adjusted with respect to the Release plan (T4.1).

The main achievements of this objective will be reported in D3.2 due on M26.

#### **M25 – M36**

The UAV enablers have been considered since M3 of the project and several Partners have collaborated to identify, design, and implement them.

After identifying and describing the UAV enablers in D3.2 at M26, the project Partners have released the UAV use case service components (UAV enablers) hardware and software at M36 as D3.4.

#### **Objective 5 “Validate 5G KPIs that demonstrate execution of UAV use cases”:**

According to the envisioned UAV use cases and scenarios, several 5G KPIs need to be demonstrated and tested to validate UAV application requirements. As per the ambitious requirements of 5G, the most critical ones are: • End-to-end latency of < 1ms, (URLLC use cases) • 1000 times higher mobile data volume per geographical area, (eMBB use cases) • 10 to 100 times more connected devices (mMTC use cases)

#### **M1 – M12 (from D6.2)**

This objective is in scope of two Tasks of WP4 which have either barely started or not started at all, namely T4.2 “Preparation and execution of trials” (M12-M36) and T4.3 “Evaluation of trial results (M20-M36). As such there is no progress to report yet except preliminary discussions in view of 5G KPIs to validate coming from UAV use cases description as stated in D1.1.

#### **M13 – M18 (from D6.3)**

This objective is in scope of two Tasks of WP4 which, namely T4.2 “Preparation and execution of trials” and T4.3 “Evaluation of trial results”. The project partners have started working on those Tasks during the period by performing several feasibility tests, in Finland at Oulu 5GTN and Aalto X-Network, as well as in the 5GENESIS Greece facility in Athens. These tests were very useful and allowed the project to identify existing gaps in the approach and plan corrective actions. The tests also enabled to identify the components that do function as intended for the trials and the ones that require further development. The feasibility also enabled the project to collect both application and network data. These data are currently being analysed and the output will be reported during the next period.

#### **M19 – M24 (from D6.4)**

Many tests have been conducted by 5G!Drones partners during this period. Some of them have been conducted in Orange France premises in Lannion, about tests of interferences generated by cellular UAV on terrestrial UE in neighbor cells. The motivations of these tests were to achieve field measurements on interferences generated by cellular UAV on normal smartphones traffic in neighbor cells. Communications between base stations and UAV are line-of-sight.

The project has also conducted a set of tests in Eurecom premises during this period to test how 5G!Drones containers (C2+U-Space- and MCS containers) work in EUR servers and connections with these containers' client applications in smartphones to collect inputs for Physical Feasibility. These tests allowed to collect a set of gaps and conclusions shared with all partners in an internal report.

### M25 – M36

This Objective, mainly in the scope of WP4 and tasks T4.2 and T4.3 has been addressed through several tests that have been addressed by the partners, where field tests have been conducted according to the Integration status and updated integration plan released at M26 as D4.2 and the trial plan released at D4.3 also at M26.

**Objective 6 “Validate UAV KPIs using 5G”:** Many UAV applications, and particularly Unmanned Aerial Systems (UAS) traffic management (UTM), require very challenging KPIs such as low latency, security, coverage, high data rates, all of which are hard to attain in current networks. One advantage of 5G is its ability to ensure the aforementioned KPIs. Therefore, 5G!Drones will focus on validating the UAV use case application KPIs, carefully taking care of the UTM use case, as it is the main enabler of all other envisioned UAV use cases..

### M1 – M12 (from D6.2)

This objective is in scope of two Tasks of WP4 which have either barely started or not started at all, namely T4.2 “Preparation and execution of trials” (M12-M36) and T4.3 “Evaluation of trial results (M20-M36). As such there is no progress to report yet except preliminary discussions in view of UAV KPIs to validate coming from UAV use cases description as stated in D1.1.

### M13 – M18 (from D6.3)

The objective 6 is also in the scope of Task T4.2 and is being addressed by the feasibility tests that have been run during the Reporting Period. Several UAV KPIs using 5G were measured during these tests, including 5G data speed tests. The 5G data speed tests carried out on indicated upload quality is insufficient for streaming 4K camera or LiDAR data, and the challenges relates to the uplink/downlink fraction used in the available bandwidth. The insufficient uplink capacity has been identified as a typical challenge in to date commercial networks that aim at maximising downlink capacity.

### M19 – M24 (from D6.4)

The objective 6 is also in the scope of Task T4.2 and it is being addressed by the feasibility tests that have been run during the Reporting Period. The field trials conducted during this period allowed to collect some important 5G KPIs (latency, interference, bandwidth, etc).

### M25 – M36

This Objective has also been addressed in the scope of WP4, through tasks T4.2 and T4.3. The progress towards achieving this objective has been considered through the trial tests executed according to the trial plan released as D4.3 and submitted at M26. The evaluation of the trial results will be provided in D4.4 Trial evaluation report that will be submitted at the end of the project.



**Objective 7 “Advanced data analytics tools to visualise and deeply analyse the trial results, and provide feedback to the 5G and UAV ecosystem”:** By using data analytics tools, each use case scenario will be carefully studied in terms of performance, aiming at drawing conclusions and recommendations to the 5G and UAV ecosystems. The feedback can be used as input to standardisation bodies, such as 3GPP or ETSI MEC, in order to optimise or update 5G standards for UAV

### **M1 – M12 (from D6.2)**

This objective is mainly in scope of WP2 Task T2.4 “Tools for experiment data analysis and visualization” and WP4 Task T4.3. Due to the fact T4.3 from WP4 has not yet started, the progress comes mainly from WP2 and Task 2.4.

During the period several investigations, leading to some experimentations, of available tools for data aggregation, analysis and visualisation (e.g. Elasticsearch, Logstash, and Kibana) have been performed by partners and a survey was conducted. All results have been delivered and discussed in order to further converge towards selection of the most appropriate data analysis and visualisation tools to cover Use Cases requirements. Integration of those tools was also looked at and further progressed under overall trial architecture perspective (e.g. relation between the trial enforcement module and the data extraction and visualisation/analytics) in view of the refined 5G!Drones architecture.

### **M13 – M18 (from D6.3)**

Due to the fact Task 4.3 from WP4 has not yet started, the progress towards this Objective mainly comes from WP2 and Task 2.4. During the Reporting Period, 5G!Drones worked on the data collection and analysis tools. In particular, there has been work on the integration of storage, analysis, and visualization tools that were identified during the first period (namely the ELK suite). These tools have been installed and made available to Beneficiaries. In addition, the project has adapted offline data analysis algorithms to online and has integrated them into the selected tools.

### **M19 – M24 (from D6.4)**

This objective is mainly in scope of WP2 Task T2.4 “Tools for experiment data analysis and visualization” and WP4 Task T4.3. Due to the fact T4.3 from WP4 has not yet started, the progress comes mainly from WP2 and Task 2.4.

During this period, the project has worked on mechanisms for the management and analysis of the data that will be generated during the trials. These mechanisms will be applied in WP4 to allow visualisation and reporting which will be used both at trial execution time and for the post-trial evaluation of the results. This work includes description of the general approach and key aspects to data collection, analysis, and visualisation; an overview of tools and mechanisms used for data collection; and a description of different approaches on data visualisation and analysis including descriptions on machine learning principles. The work done in the scope of this objective during this period has been reported in D2.3 submitted on M24.

### **M25 – M36**

This Objective has been addressed mainly in WP2 in task T2.4. The algorithms mechanisms and tools for data analysis and visualisation have been described in D2.3 submitted at M24, while D2.6, submitted at M33 provides the Data analysis and visualisation software.

**Objective 8** “Dissemination, standardisation and exploitation of 5G!Drones Description Dissemination, standardisation and exploitation of all concepts and” : Dissemination, standardisation and exploitation of all concepts and technologies developed in the 5G!Drones project. A special focus is given to showcasing components of the project in UAV- and 5G-related events.

### **M1 – M12 (from D6.2)**

Initial plans for what concerns dissemination, showcasing, exploitation and standardisation have been started and reported in D5.1 “Communication, showcasing, dissemination, exploitation plan and standardization roadmap”. The project has performed and delivered according the plans despite it has to adapt to situation caused by Covid-19 (some dissemination events were cancelled or went virtual). 5G!Drones has been presented within private and public events on numerous occasions and has had very active online presence through website, social media, and updated newsletters issued. 5G!Drones has been very active at the 5G-PPP Programme through various bodies ranging from Steering Board and Technology Board but also Working Groups of interest for which the project had appointed representatives (see 5G-PPP devoted section for the details in Section 9).

### **M13 – M18 (from D6.3)**

During the Reporting Period, 5G!Drones consortium has established a complete landscape of the standards Development Organization (SDOs) as well as various associations relevant within 5G!Drones frameworks, including 3GPP, GSMA, GUTMA, ACJA, IEEE, CEPT/ECC, ASTM, ETSI, IETF, BNAE, Drone REGIM, 5G-PPP (Pre-standardization working group), FAA, SESAR JU, NASA, EUROCAE, EASA, ASD-STAN, ISO, LAANC, and ARC. The work performed during the period is reported in D5.3 – Report on contribution to standardization and international fora.

Partners, in the scope of this Task, have worked on identifying the organizations relevant for 5G!Drones standardisation activities and how they relate to the project's activities. Furthermore, they have worked on establishing a strategy to contribute to these organizations and specify the 5G!Drones representative role in the organization (contributor, attendance).

### **M19 – M24 (from D6.4)**

During this period, significant steps towards the broad range dissemination were undertaken. 5G!Drones will be presented at EuCNC2021 in June 2021 and at Commercial UAV Expo / Amsterdam Drone week in December 2021, both highly significant international conventions on cutting-edge solutions, one of which is the systemic solution of 5G!Drones.

Also, many papers have been submitted and accepted in many major journals and conferences, thus, disseminating and communicating the project activities' progress were performed.

The summary of these activities and description of the revised plan for communication, showcasing, dissemination and exploitation has been provided in D5.2 at M23.

### **M25 – M36**

During this Reporting Period, many scientific papers have been submitted and accepted in significant journals and conferences, which gives visibility to the project. Also, several internal demonstrations and presentations have been proposed by the partners within their companies or research labs.

5G!Drones partners have also worked together to demonstrate their achievement during the Period 1 review and have prepared to participate to EuCNC 2022, during which they will dissemination results of the project and run several demonstrations to the visitors.

Also, some 5G!Drones partners participated at panel discussion at the mainstage on the topic “Autonomous Drone Networks” on the 31st of March 2022 during the Amsterdam Drone Week. 5G!Drones project was represented sharing insights about the role of network related to autonomy, BVLOS & certification standards.

## 8. PROGRESS AND ACHIEVEMENTS OF THE WORK PACKAGES

The following sections provide a detailed description of the work carried out in the Work Packages of the project during the Reporting Period. The description starts by listing the Work Package objectives, as found in the Description of Action and, and continues with the main achievements and progress over the reporting period. It details the work carried out per Task, along with the individual Beneficiary contributions to each Task.

### 8.1. WP1 Use case requirements and system architecture

#### 8.1.1. Progress towards objectives and details for each Task [FRQ]

##### WP1 Objectives

- Objective 1: “**Analysis of the performance requirements of UAV verticals’ applications and business models in 5G**”
- Objective 2: “**Design and implementation of the 5G!Drones software layer (or system) to execute UAV trials**”
- Objective 3: “**Design a high-level scenario descriptor language to run and analyse the results of the UAV trials**”
- Objective 4: “**Design and implementation of 5G!Drones enablers for UAV trial and operations**”.

##### WP Tasks and interrelations:

- T1.1: Analysis of the UAV business and regulatory ecosystem and the role of 5G technology (M01-M42)
- ~~T1.2: Use case assessment and refinement (M01-M06)~~
- ~~T1.3: Detailed description of 5G facilities and mapping with the vertical use cases (M1-M12)~~
- ~~T1.4: System architecture for the support of the vertical use cases (M1-M24)~~

##### Main Progress in the period:

During Q9 there was preparation of the Period 1 review meeting with detailed descriptions of the work performed in T1.1 and T1.4. The process for the last remaining deliverable of WP1, for D1.7, goes on as agreed - specific folders have been created in MS Teams for collecting potential articles and resources for topics focused on UAVs, legislations and 5G advances. Inputs have already been added by several partners. Important for D1.7 will be the close monitoring of pre-trials/trials for extracting potential business impact to be reported. During Q10 work on deliverable D1.7 in Task 1.1 has taken place considering the recommendations from the review meeting. Q11 and Q12 continues the work on the last deliverable of WP1: D1.7.

##### Significant results

As D1.7 is due in M42, the collection of information is currently in our focus. The results of WP1 have been reported in the presentation for the Period 1 review meeting with descriptions of the work performed in T1.1 and T1.4. Otherwise the work has focused on collection of potential content for D1.7, schedule for D1.7 creation, table of content and contributors defined for deliverable D1.7, and

first round of content creation by several partners of D1.7.

**Deviations from Annex I and impact on other Tasks, available resources and planning**  
None.

### 8.1.2. Task 1.1 Analysis of the UAV business and regulatory ecosystem and the role of 5G technology (M01-M42) [CAF]

#### Task Objectives:

A basic premise of the 5G!Drones project is that 5G technology will provide the technical means and thus provide new opportunities for the provision of enhanced UAV services. The purpose of this Task is thus to provide a detailed analysis of the current state of the UAV market with a particular focus on the role of 5G technology in it. This analysis will identify key application areas where 5G technology can help provide new or enhanced services, and how each stakeholder in the UAV-service-related value chain (UAV equipment vendors, vendors of telecommunications equipment, network operators, UAV service providers, regulatory bodies), and the society at large, can benefit from these developments. At the same time, this Task will pay particular attention to regulatory aspects, since the related legislation to perform UAV flight operations is currently subject to significant changes and may have impact on both how UAV vertical services should operate (e.g., necessitating UAS Traffic Management modules onboard), and how the 5G!Drones trials will be executed. The activities of this Task and their outcomes, which will be reported in **D1.4**, will provide input to T1.2 for the refinement and detailed descriptions of the target use case scenarios. Before the end of the project, and after the trial results get evaluated, the analyses of this Task will be reassessed, taking into account also the changes in the market, regulatory and technological landscape that will have taken place after the delivery of D1.4. This study will deliver an updated version of D1.4, using insight from the results of the trials to provide recommendations and study market perspectives (deliverable **D1.7**).

#### Task Activities during the period:

During Q9 the process for the last remaining deliverable of WP1, for D1.7, goes on as agreed - specific folders have been created in MS Teams for collecting potential articles and resources for topics focused on UAVs, legislations and 5G advances. Inputs have already been added by several partners. Important for D1.7 is currently the close monitoring of pre-trials/trials for extracting potential business impact to be reported. During Q10 preparation activities and rehearsals for Period 1 review. Addressing review comments in dedicated WP1 telcos. Collected materials for D1.7. Links between T1.1 and T4.2 have been created for defining and interpreting valid business KPIs, metrics, trial results and business impact for further use in D1.7. Q11 and Q12 has seen work on the last deliverable of WP1: D1.7. Table of content and contributors defined for deliverable D1.7. Time schedule for the contributions to D1.7 defined. First content creation by several partners for D1.7. Time schedule for further contributions to D1.7 defined.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. recurring partner activities, such as participation to teleconferences will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-UO does not participate in this Task. Although UO does not participate in Task 1.1 it reports minor amount of hours for WP1 for the preparation work done in WP1 for the Period 1 review. During Q12 UO provided Skycam text for the Deliverable D1.7.

2-THA During Q9 THA had no activity on the Task. During Q10 technical discussions were pushed. After Period 1 review and the recommendations received from our reviewers, THA identified four recommendations directly related to the WP1's activities and they should be addressed within WP1

activities (R3, R6, R7 and R9). THA tried to highlight the technical aspects related to the business analysis of project activities. This WP is well aligned with the technical ongoing activities of the project. Between Q11 and Q12 THA collaborated with partners in the edition of D1.7.

3-ALE did content collection for D1.7 during Q9. During Q10 to Q12 ALE had no activity on the Task.

4-INV collected materials which can be useful for D1.7 during Q9. During Q10 INV stored in the Teams WP1/D1.7 preparatory folders some interesting materials, which can be useful as reference when writing this document. In Q11 INV reviewed the ToC for D1.7 and communicated the comments to the editor. INV also proposed to add the new chapter, named “Closing the service gaps in 5G cellular networks”, where we plan to describe our concept based on the Remote ID broadcast signals reception. During Q12 INV observed the changes in the market situation, specially related to the recent exits of the major industry players, like AirMap and Skyward. INV has been updating the list of interesting articles, which are relevant for drone business. In this period, we have also contributed to D1.7 - we submitted the draft version of the chapter 4.4.1 – “Closing the service gaps in 5G cellular networks”.

5-HEP does not participate in this Task.

6-NCSRDC contributed in the preparation of the slides for the Period 1 review during Q9, as well as with contributions in PPR. Based on the experienced gained from July trials in Athens, analysis has started towards D1.7 for identifying the business opportunity and novel models of the use-case. In Q10 NCSRDC participated in the preparations of the Period 1 review, providing material for the review presentation. Participation in the discussions for the preparation of D1.7, focusing on the business and market aspects of the project. During Q11 NCSRDC analyzed and provided comments on the ToC of D1.7 and has agreed also on the business impact approach that will be followed based on the trials of the project. In Q12 NCSRDC contributed in the preparation of D1.7 activities and provided comments on the ToC early release. NCSRDC also contributed to Section 1 and Section 4 of the deliverable.

7-AU had no planned activity during Q9 and Q10. During Q11 AU has reviewed the ToC of D1.7. More precisely, AU interacted with the editor of the deliverable of the contribution of Aalto University, which is related to the use case 3, scenario 2 of the project. In Q12 AU worked on preparing inputs related to its use case scenario for the deliverable D1.7. The inputs will be included in the next version of this deliverable.

8-COS had no specific activity on the Task between Q9 and Q11. During Q12 COS contributed to D1.7 activities by supporting the D1.7 preparation activities and the finalisation of the ToC and partners allocation and is preparing a contribution on the 5G spectrum allocation ecosystem in Greece.

9-AIR does not participate in this Task.

11-INF is leading D1.7 activities and hence had internal processes for continuous D1.7 actions planning and initial contributions. Linking T1.1 and T4.2 trial activities for defining and interpreting valid business KPIs, metrics, trial results and business impact for further use in D1.7. Use of repository locations/files in Teams for D1.7 initial documentation of potential resources and references. Communication of business and market aspects through 5G!Drones social media channels and website. During Q9 INF had preparation activities and slides for Period 1 review. During Q10 INV made preparation activities and rehearsals for Period 1 review. In addition to ToC preparation INF was addressing review comments in dedicated WP1 telcos. During Q11 INF used the repository locations/files in Teams for D1.7 initial documentation of potential resources and references. The table of contents and the contributing partners to each chapter have been defined for deliverable D1.7 and released in December, 2021. A time schedule for the contributions to D1.7 has been defined until submission of D1.7 in M42. Early February, 2022 D1.7 v01 was released and contributions started.



During Q12 a ToC has been released and contributions rounds started as per D1.7 plan. A table with all contact persons and optional contributions timing has been fulfilled by all partners. A full-time schedule for the contributions to D1.7 has been defined until submission of D1.7 in M42. End of March, 2022 D1.7 v0.2 was released and contributions continue during Contribution Round #2. March meeting took place and D1.7 progress discussed. Contributions related to Sections 2 (Market) and Section 4 (5G, UAVs and Use cases impact) have been made. New version (v0.3) will be released end of May.

**12-NOK** collected data and analysed both general business and regulation impact from UAV side to 5G during Q9. Between Q10 and Q12 no activities were reported.

**13-RXB** During Q9 RXB supported business and regulation impact from UAV & 5G side. It contributed to D1.7 development. During Q10 RXB made preparation activities for Period 1 review, participated in 5G-PPP working groups and reported back to WP1 activities, and actively worked on KPIs and data visualisation. Between Q11 and Q12 RXB contributed to D1.7 and participated in workshops related to T1.1.

**14-EUR** had no activity on the Task during the Reporting Period.

**15-DRR** does not participate to this Task.

**16-CAF** had preparations for the Period 1 review meeting during Q9 with detailed descriptions of the work performed in T1.1. Collection of references for D1.7. During Q10 CAF prepared presentation and rehearsals for the review. It made contributions to addressing review comments in dedicated WP1 telcos. CAF contributed to collecting materials for D1.7. Links between T1.1 and T4.2 have been created for defining and interpreting valid business KPIs, metrics, trial results and business impact for further use in D1.7. During Q11 and Q12 CAF collected materials on EU drone regulation and business use cases for D1.7 and contributed to the Innovation Management Team activities.

**17-FRQ** has been leading the WP1 regular meetings and has taken care of the preparation, distribution and tracking of agenda, Minutes of Meetings, and Action Points. During Q9 and Q10 ongoing activities in WP1 were the work on D1.7 in task 1.1 and the preparations for the Period 1 review meeting. During Q11 and Q12 the table of content and the contributing partners to each chapter have been defined for D1.7. In addition, the time schedule for the contributions to D1.7 has been defined until submission of D1.7 in M42. In Q12 FRQ monitored contributions from several partners in the first round.

**18-OPL** has been following the development of the 3GPP documents relevant to support of UAV services during Q9 and Q10. During Q11 OPL reviewed the ToC of D1.7 and gave feedback on declared OPL contribution. Monitoring of the 3GPP 5GS standardisation and preparation of the talk on the topic (presented during the project plenary meeting in February 2022) took place. During Q12 OPL participated in D1.7 related activities, searching for source materials for the OPL contribution, proofreading, editing and commenting the existing text, adding the contribution to the agricultural section.

**19-MOE** does not participate in this Task.

**20-ORA** does not participate in this Task.

**21-UMS** worked internally to assist the preparation of D1.7 during the Reporting Period.

### 8.1.3. Task 1.2 Use case assessment and refinement (M01-M06) [UMS]

The Task has ended.

#### 8.1.4. Task 1.3 Detailed description of 5G facilities and mapping with the vertical use cases (M1-M12) [UO]

The Task has ended.

#### 8.1.5. Task 1.4 System architecture for the support of the vertical use cases (M1-M24) [ORA]

The Task has ended.

### 8.2. WP2 Trial controller

#### 8.2.1. Progress towards objectives and details for each Task

##### WP2 Objectives

This WP will work towards the following high-level project objectives:

- Objective 2: “**Design and implementation of the 5G!Drones software layer (or system) to execute UAV trials**”
- Objective 3: “**Design a high-level scenario descriptor language to run and analyze the results of the UAV trials**”
- Objective 7: “**Advanced data analytics tools to visualize and deeply analyze the trial results, and provide feedback to the 5G and UAV ecosystem**”

##### WP Tasks and interrelations:

- Task 2.1: Trial execution APIs for verticals and experimenters (M3-M30)
- Task 2.2 Trial scenario execution engine (M3-M30)
- Task 2.3: Trial architecture management plane (M6-M30)
- Task 2.4: Tools for experiment data analysis and visualization (M3-M30)

##### Main Progress in the period:

Q9 was characterised by a vacation break. Nevertheless, WP2 worked on supporting the integration of the different enablers of the work package and performing the maintenance of these enablers based on the integration feedbacks. During Q10 WP2 has presented its achievement in the Period 1 review meeting, where different WP2 enablers have been demonstrated. The reviewers' comments related to D2.3 have been addressed during this period. Furthermore, all the enablers are currently developed, deployed and subject to integration in T4.1. During Q11 WP2 has focused on the last deliverables of the work package, D2.5 and D2.6. The two deliverables have been submitted in time. In parallel, since its enablers have already been finalised, WP2 has also focused during this period on supporting release 2 of WP4, which covers the integration of the trial controller enablers. These conclude WP2.

##### Significant results

During Q9 updating and maintenance of WP2 enablers based on the feedback from the integration. During Q10 all the enablers are developed, deployed, and subject to integration in T4.1. D2.3 has been resubmitted. The ToC of D2.5 and D2.6 have been prepared and agreed by all the partners. During Q11 was the submission of D2.5 and D2.6 and release of WP2 enablers.

**Deviations from Annex I and impact on other Tasks, available resources and planning**  
None.

## 8.2.2. Task 2.1 Trial execution APIs for verticals and experimenters (M3-M30) [INV]

### Task Objectives:

This Task will provide a high-level language and API for describing and executing trial scenarios. This language will allow the composition of UAV services, the definition of the KPIs to monitor, the specific requirements of the service in terms of 5G functionality (e.g., number and types of slices), and the selection of a mapping between service components and facilities where these should be deployed and executed. Moreover, it will allow to specify the trial duration and infrastructure resources to be leased per facility/region and per service component, using an abstracted view of the underlying facility infrastructure. Receiving early feedback from WP1, the activities of T2.1 will begin at M03 by creating an API model which will be representing all the entities that are relevant with the execution of the experiments (scenario, service component, KPI, network capability, physical/virtual compute/network/storage resource abstraction, etc.). The API model will be expressed following the OpenAPI Specification using a YAML or JSON syntax, which will facilitate the development of RESTful services for trial execution.

### Task Activities during the period:

During Q9 and Q10: Task 2.1 activities were moving from APIs design and Web Portal module development to testing and integration and as such are reported in T4.1 or T4.2. With AU leading the WP2 activities, the slides for Period 1 review meeting were prepared summarising work performed between M13 and M24. The Dashboard development was discussed and brainstorming was made during our WP2 meetings to find the best way to present the plan during the execution and for analysis in the post-processing phase. During Q11 Task 2.1 activities were focused on the Dashboard development (main work done by CAF). WP2 selected the solution based on iframe, which allows to visualise in one window/tab the collection of information coming from different applications – UAS Ground Control Station, UTM, Trial Engine modules and others.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-UO did definition of KPIs to monitor and measure using Nemo Handy tool during Q9. It continued testing of the Measurement Job API and KPI Measurement API working together at the 5GTN facility. The REST API (Facility Web Portal Oulu) was migrated to HTTPS and it was tested for redirection from Web Portal 1 to receive Trial ID and process NST accordingly. Some changes were made to the REST API to produce NST acceptable to 5GTN system. UO had no activity on the Task during Q10. During Q11 UO Modified the Web Portal 2 code for KPI configuration in trial repository. It Added navigation from Web Portal 1 to Web Portal 2 button in Web Portal 2 and Modified the Web Portal 2 code for NST configuration into Trial Repository. Contributed to D2.5 by adding development and documentation details of the trial controller software.

2-THA continued its participation to the technical discussions regarding the initial implementation of the security aspects of the trial controller during Q9. THA was also working on Web Portal 1 for the integration with IAM enabler on AU's X-Network facility (with help of AU's IT staff). During Q10 THA continued the implementation of the security aspects of the trial controller. THA has worked on Web Portal 1 integration with IAM enabler on AU's X-Network facility. THA had no activity on the Task during Q11.



3-ALE does not partake the WP2.

4-INV is not reporting anymore hours in Task 2.1 during the Reporting Period, as all further work related to APIs and Web Portal is considered as testing and integration, and reported in Task 4.1. During Q11 INV contributed to D2.5, giving the update about Web Portal 1 development in the past months (delta between status D2.2 and D2.5).

5-HEP does not partake in the Task 2.1.

6-NCSR D performed an integration of the 5G!Drones and 5GENESIS portal (Web Portal 1+Web Portal 2) in order to offer to the experimenter a unified and seamless experiment during Q9 and as part of the preparations of the Athens trial in July, 2021. Moreover, NCSR D contributed in the technical discussions of the trial execution APIs development in relevance to the complementarity to ICT-17 platforms. During Q10 NCSR D participated in the debugging process of the integration activities, which in turn resulted in improvements and contributions to the developments of this task. Further developments included the integration activities between Web Portal 1 and Portal 2 in view of the final phase trials. During Q11 NCSR D edited and coordinated the contributions for D2.5, which reported on the final version of the software components that consist the trial controller of the project. NCSR D contributed also on the web portal of Athens platform that has been properly integrated in the trial controller environment. The deliverable was properly completed, reviewed and submitted in time.

7-AU has worked on enabling the integration of its Web Portal (facility Web Portal) and Web Portal1 during Q9. This is implemented using HTTPS redirection. AU has also participated to several meetings (technical sessions) to evaluate the integration of its Web Portal and Web Portal1, especially the integration meeting that was held on August 19th 2021. Some bugs related to the current implementation have been reported and AU took the action to fix them. During Q10 AU has organised bi-weekly meetings to steer and monitor the progress of the task. AU has also presented the progress and the achievements of the task in the review meeting. In addition, AU was contributing to the integration sessions of release 2 with its Web Portal, where updates are being made based on the feedbacks. AU has also coordinated with INV to implement additional functionality in the trial repository enabler which will be used by Web Portal1. During Q11 AU also presented the status of the WP during the virtual face to face meeting. In addition, AU has contributed to D2.5 and edited the section 3.2.2 (Aalto Implementation of web portal 2). Furthermore, AU has also participated to technical sessions of release 2 integration (which covers the integration of the trial controller) to ensure the integration of its web portal with the different enablers.

8-COS does not partake in WP2.

9-AIR was developing APIs for collecting KPIs from Mission Critical Cloud Native platform application developed in the framework of the project during Q9. In Q10 the API allowing any consortium partner or any third party intending to enroll drone embedded components was completed and was made available. During Q11 the Mission Critical API was evolved to enroll third parties external drones (like DJI) directly through mirroring application. In parallel, the websocket mechanism was improved through new microservice architecture based on message broker.

11-INF does not partake in Task 2.1.

12-NOK analysed different GDPR requirements and did propose related updates to Web Portal 1 during Q9. A draft version of first-time usage privacy statement created. During Q10 NOK defined and implemented trial experimenter interaction between Web Portal and trial controller together with INV, DRR, and other partners. During Q11 NOK has finalised trial experimenter interaction between Web portal and trial controller together with INV, DRR, and other partners.

13-RXB During Q9 RXB participated in and supported activities related to Trial Validator, KPI Component, and Dashboard. RXB had no activity on the Task during Q10. During Q11 RXB contributed to D2.5, and workshops and calls related to WP2 Dashboard & Trial Validator.

14-EUR conducted integration tests of Web Portal 1 and Web Portal 2/trial translator of 5GEVE facility developed by EUR during Q9. During Q10 and Q11 EUR had no activity on the Task.

15-DRR had no activity on the Task during Q9 and Q11. During Q10 DRR did updates to process flow and implementation design of communication between LCM and Web Portal 1 in scope of pre-flight check and mission authorisation, discussion with INV; Preparation of corresponding test cases for integration testing (Releases 2). DRR was designing, updating, and discussing the Trial Controller process flow related to pre-flight checkings of UAV and take-off permission to be handled by Web Portal; Dashboard desing workshop and brainstorming (12.10.2021).

16-CAF has worked on developing Dashboard for drone operators in Web Portal 1 and supported the ongoing LCM discussions during Q9. During Q10 and Q11 CAF contributed to the Web Portal 1 Dashboard design and developoments - the concept of the Dashboard is based on the principle of modularity, i.e. the Dashboard can be used for collecting data streams from different drone operators and service providers' screen streams.

17-FRQ supported the ongoing TrialController integration (webportals, repository, Trial Validator) during Q9. In addition, FRQ contributed to the KPI handling and management using KPI component. During Q10 FRQ contributed to discussions on general integration topics (trial process flow), which lead to adaptions to Trial Validator and implemented these adaptions in Trial Validator. During Q11 FRQ continued contributing to discussions on adaptions to Trial Validator and implemented these adaptions in Trial Validator. A new release according to requests was provided.

17.1-FSO FSO supported the ongoing TrialController integration (webportals, repository, Trial Validator) during Q9. In addition, FSO contributed to the KPI handling and management using KPI component. During Q10 FSO contributed to discussions on general integration topics (trial process flow), which lead to adaptions to Trial Validator and implemented these adaptions in Trial Validator. During Q11 FSO continued contributing to discussions on adaptions to Trial Validator and implemented these adaptions in Trial Validator. A new release according to requests was provided.

18-OPL does not partake in WP2.

19-MOE does not partake in Task 2.1.

20-ORA had no activity on the Task during the Reporting Period.

21-UMS had no activity on the Task during the Reporting Period.

### 8.2.3. Task 2.2 Trial scenario execution engine (M3-M30) [EUR]

#### Task Objectives:

Requests for the execution of trial scenarios that are received over the northbound API of the trial controller need to be translated to an actual UAV service deployment on top of one or more trial sites, and the appropriate functionality should be in place to manage the execution of the trial. This is the purpose of T2.2. The trial execution engine needs to interface with the different facilities that will be used in the project using APIs exposed by the facilities, as well as the interfaces of the enablers that will be designed and implemented in WP3. Regarding the latter, particularly important is the work in T3.3, which provides an infrastructure abstraction offering the trial controller a unified view of the resources and the capabilities available across facilities. The execution engine is responsible for

extracting the requirements of each UAV trial in terms of 5G (and other) features and (i) establishing end-to-end network slices with the required performance, security and isolation characteristics using the APIs provided by the slicing enablers (see T3.1), (ii) if necessary, onboarding and instantiating application components at edge data centers by interfacing with Mobile Edge Application Orchestrators (see T3.2), (iii) configuring and launching UAV-service and connectivity-related components onboard the UAVs. The trial scenario execution engine thus manages the full “lifecycle” of a trial, from deployment to termination and result collection

#### **Task Activities during the period:**

During Q9 the activity of the task focused on the finalisation of the 5G!Drones Trial Engine architecture. A first release of LCM as well as U-Space adapter have been finalized. During Q10 all the objectives of the task have been achieved: the 5G!Drones Trial engine (Web Portal 2, LCM, Trial Validator and USpace adapter) definition and implementation has been done. The final version of the Trial Engine architecture has been detailed and validated in D2.4. The integration of the components with the different facilities and Web Portal 1 are being conducted in Task 4.1. During Q11 the task activities focused mainly on finalising the components of the LCM and trial validator. These activities were driven by the integration tests done in WP4.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

*1-UO* The Facility Web Portal was modified to be built over Windows 10 host to be placed outside 5GTN for direct communication with Web Portal 1 without the need for VPN during Q9. The communication between Web Portal 1 and Facility Web Portal, and between Facility Web Portal and Trial Repository was added and tested successfully. During Q10, after the integration tests release 1 held in Oulu, the Facility Web Portal UO code was modified to meet the new NST requirements. The modification was required to separate the trial ID part from the NST acceptable by Slice Orchestrator. There is now a separate installation of the Facility Web Portal on Windows, for integration with CAF's Web Portal 1 instance. This installation also required some changes in the code to run on a Windows host. In parallel, UO has developed Web Portal 1 locally (Ubuntu) at 5GTN facility and integrated it with Facility Web Portal UO in the 5GTN facility. During Q11 UO conducted bug fixing and code updates in the parser to uncompress Nemo Handy measurements, convert them to CSV files and then store them on the local KPIs database at the 5GTN facility. It added development and documentation details of trial controller software to deliverable D2.5. UO added Web Portal 2 to cloud (Heroku) for public access to allow communication between Web Portal 1 and Web Portal 2 and tested integration with Trial Repository.

*2-THA* pursued its technical participation to discussions about flight planning that involve its trajectory computation system during Q9. In Q10 THA continued its work on flight planning trajectory computation system. THA had no activity on the Task during Q11.

*3-ALE* does not partake in WP2.

*4-INV* was participating in discussion on refining the initially defined Trial Engine functions, clarification of the tasks assigned to each module and how they are practically implemented during Q9. INV also worked on the way of delivering the Remote\_ID data to the UTM and end user observing the flight progress in Web Portal. During Q10 INV was contributing to refining of the Trial Engine flows/functions (particularly LCM and Trial Validator), based on Release 2 integration tests results, noticed problems and change requests. New messages flow with proposed refinements for the flight execution were presented to partners and discussed particularly with Nokia, as LCM owner. Additionally, INV identified and added to the trial flows the information about the status changes written to trial repository by all modules along the trial lifecycle. INV had no activity on the Task during Q11.

*5-HEP* is not partaking Task 2.2.

*6-NCSR*D contributed in the technical discussion of the integration of LCM with Task 2.3 components during Q9. Moreover, it performed an analysis of the trial execution engine functionalities in order to map it to the 5GENESIS respective experimentation framework. During Q10 NCSR D was following the progress of the integration activities, and participated in the debugging process on the LCM and trial validation, contributing to the necessary updates and improvements needed for the release of the trial controller. During Q11 NCSR D edited and coordinated the contributions for D2.5, which includes also Task 2.2 and reports on the final release of the trial execution engine. NCSR D has also participated to technical sessions of release 2 integration (which covers the integration of the trial controller) providing some bug fixes and improvements with the different enablers.

*7-AU* has worked on the maintenance of the trial repository enabler during Q9. Indeed, INV, the responsible of Web Portal 1, has reported some bugs when querying the trial repository. The bugs occurred when using requests associated with attachment files (pilot license). AU then worked on identifying the cause of fixing them. AU also had exchanges and meetings with INV to discuss the implementation of endpoints for trial templates to be used by Web Portal 1. During Q10 AU has organized bi-weekly meetings to steer and monitor the progress of the task. AU has also presented the progress and the achievements of the task in the review meeting. In addition, AU was contributing to the integration sessions of release 2 with the trial repository enabler. Some feedbacks related to this enabler have been collected and reflected by AU. More precisely, a log functionality has been introduced to register the status changes captured by the trial repository. AU coordinated with INV to implement this functionality. During Q11 AU has also presented the status of the WP during the virtual face to face meeting. In addition, AU has contributed to D2.5 and edited the section 3.3 (Trial repository). Furthermore, AU has also participated to technical sessions of release 2 integration (which covers the integration of the trial controller) to ensure the integration of the trial repository enabler, developed by AU, with the different enablers.

*8-COS* does not partake WP2.

*9-AIR* does not partake Task 2.2.

*11-INF* does not partake Task 2.2.

*12-NOK* has been supporting AU and UO for integration of the LCM to their environment during Q9. In addition, NOK removed unnecessary privacy related information from the LCM. During Q10 NOK has updated the LCM implementation based on integration test feedback. During Q11 NOK has finalised the LCM implementation and provided tech support when needed.

*13-RXB* had no activity on the Task during Q9 and Q11. During Q10 RXB had close collaboration with FRQ for Trial Validator implementation, testing, and validation.

**14-EUR** has been working on the final architecture of the trial engine, which has been reported in D2.4 during Q9 besides leading the task. EUR was the editor of D2.4, where EUR defined the ToC of the deliverable, collected the contribution, and did several reviews of the document. During Q10 EUR coordinated the task 2.2 activities during the bi-weekly meeting. EUR has prepared the slides regarding task activities for the review meeting. During Q11 EUR coordinated the activities conducted in the task.

*15-DRR* had no activity on the Task during Q9 and Q11. During Q10 DRR prepared of proposal of test cases for testing LCM and Trial Repository in scope of testing Trial Controller main processes. DRR prepared initial versions of integration tests for Trial Controller (Release 2); Release 2 working

group meeting discussion (7.10., 21.10.), workshop (13.10.) - update of testing workshop agenda, preparing and coordinating preparatory activities.

16-CAF had no activity in the Task during Q9. During Q10 CAF was contributing to workshops related to the Trial Engine functions (especially related LCM and Trial Validator part) based on the drone operator experiences. During Q11 CAF contributed to the D2.5 document.

17-FRQ continued work on the Uspace adapter during Q9. Trial Validator was integrated and demonstrated. Also, extensions and improvement for the Trial Validator were collected and discussed. During Q10 FRQ was updating TrialValidator design and implementation, and supporting Uspace adapter integrations. FRQ had no activity on the Task during Q11.

17.1-FSO continued work on the Uspace adapter during Q9. Trial Validator was integrated and demonstrated. Also, extensions and improvement for the Trial Validator were collected and discussed. During Q10 FSO was updating TrialValidator design and implementation and Supporting Uspace adapter integrations. FSO had no activity on the Task during Q11.

18-OPL does not partake WP2

19-MOE does not partake Task 2.2.

20-ORA does not partake Task 2.2.

21-UMS had no activity on the Task during the Reporting Period.

#### 8.2.4. Task 2.3 Trial architecture management plan (M6-M30) [NCSRD]

##### **Task Objectives:**

The activities in this Task will focus on trial execution monitoring and management aspects. Different management interfaces will be provided to cover the needs of the different roles (verticals and experimenters, facility owners). In particular, T2.3 will design APIs for runtime monitoring of a trial and the collection of results. This interface is used by verticals/experimenters. This management component also uses the APIs provided by the 5G facilities and 5G!Drones enablers (WP3). The verticals will also be provided with a management interface to control the UAV applications at the vertical-service level and retrieve application-level KPIs, as the latter have been defined in the scenario description. Finally, the trial architecture management plan will provide interfaces to facility owners to enable the monitoring of the infrastructure during the execution of a trial and the collection of 5G KPIs. It should be noted that different facilities may have different mechanisms and interfaces to monitor their infrastructures, and there will be trial scenarios which will be spanning across different facility domains. The purpose of this Task is to unify these interfaces providing a common entry point for monitoring and management. This will also reduce the complexity of the data analysis and visualization mechanisms of T4.2, since the latter will not have to deal with the particularities of each underlying facility and each heterogeneous UAV service.

##### **Task Activities during the period:**

During the Q9 the Task performed integration and test activities towards the preparation of the project for the Period 1 review. An improved release version of the management plane was available for integration activities. During Q10, following the progress of the integration activities, NCSRD led the necessary advances needed in the management plane in order to reassure a successful integration. Therefore, during the reporting period test cases for the trial enforcement have been provided and the initial draft ToC of D2.5 has been released. Close collaboration between AU, DRR, and other partners for the trial controller interface with other elements is also a core activity of this period. During Q11



the main activities of the task focused on reporting at D2.5 on the final release of the trial architecture management plane, focusing on the interfaces to facility owners to enable the monitoring of the infrastructure during the execution of a trial and the collection of 5G KPIs.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

**1-UO** did integration of the LCM, Trial Enforcement and Abstraction Layer at the 5GTN facility merely for Oulu August trials during Q9. Presentation to the partners of the KPI measurement system from the 5GTN facility was made. UO had no activity on the Task during Q10. During Q11 UO did maintenance, bug fixing, optimising, adding missing functionalities at 5GTN Facility Adapter, specifically for the Measurement Job Controller, KPI measurement API, and Network Slice Parser.

**2-THA** continued its work on provisioning an API to access its trajectory computation enabler in order to be integrated with the trial controller during Q9. In Q10, except integration for the review demo, THA did not provide effort in this Task. During Q11 THA participated to technical sessions of Release 2 integration and participated to the edition of D2.5.

**3-ALE** does not partake WP2.

**4-INV** enabled the redirection between Web Portal 1 and Facility Web Portals for different facilities during Q9. Also link with Trial Validator was established. Work related to monitoring of the dFPL progress in Web Portal was started. During Q10 INV made comments on proposal of test cases for Trial Enforcement testing, in scope of testing Trial Controller main processes. INV reviewed and discussed the draft ToC of D2.5 prepared by NCSRD and proposed the parts where we can contribute. INV had no activity on the Task during Q11.

**5-HEP** had no activity on the Task during the Reporting Period.

**6-NCSRD** coordinated the task activities in order to release a revised version of the management plane API and contributed in the integration activities of it to the overall trial controller during Q9. During Q10 NCSRD released the initial ToC of D2.5 and based on the comments received the final ToC structure was agreed. Moreover, it provided the results of the integration activities, NCSRD has contributed in the improvements of the data management plane towards the integrated trial enforcement module. Close collaboration between AU, DRR, and other partners for the trial controller interface with other elements is also a core activity of this period. During Q11 NCSRD also participated to technical sessions of release 2 integration (which covers the integration of the trial controller) providing enhancements in the integration of the platforms with the trial architecture management plane of the project. Respectively, these activities were reported in D2.5, which was edited by NCSRD during the reporting period.

**7-AU:** The activities performed by AU during Q9 in this task are related to tasks T3.1 and T3.3, where AU is working on its network slicing platform and the underlying interfaces to be exposed to the trial enforcement enabler via the abstraction layer. During Q10: AU has organised bi-weekly meetings to steer and monitor the progress of the task. AU has also presented the progress and the achievements of the task in the review meeting. In addition, AU was contributing to the integration sessions of release 2 with the trial repository enabler. AU has also reviewed and discussed the draft ToC of D2.5 prepared by NCSRD. During Q11, as WP leader, AU organised bi-weekly meetings to steer the progress of the work package, including T2.3. AU has also steered the slot of the WP during the virtual face to face meeting.

**8-COS** does not partake in WP2.

9-AIR does not partake in Task 2.3.

11-INF does not partake in Task 2.3.

12-NOK contributed via LCM work in Q9, although it reported no actual effort in this quarter to this task. During Q10 NOK updated architecture and interface internal documentation and implementation between Trial Controller and other elements with NCSRD, AU, DRR, and other partners. NOK had no activity on the Task during Q11.

13-RXB had no activity on the Task during the Reporting Period.

14-EUR participated to the definition of the management plane API during Q9. It had no activity on the Task between Q10 and Q11.

15-DRR had no activity on the Task during Q9 and Q11. During Q10 DRR prepared a proposal of test cases for testing Trial Enforcement in scope of testing Trial Controller main processes.

16-CAF had no activity on the Task During Q9. During Q10 CAF reviewed and discussed the draft ToC of D2.5 prepared by NCSRD and in Q11 it contributed to the D2.5.

17-FRQ contributed by integration testing and demonstration of Trial Validator and Uspace adapter in cooperation with other partners during Q9. It had no activity on the Task during Q10. During Q11 FRQ contributed to and reviewed D2.5.

17.1-FSO contributed by integration testing and demonstration of Trial Validator and Uspace adapter in cooperation with other partners during Q9. It had no activity on the Task during Q10. During Q11 FSO contributed to and reviewed D2.5.

18-OPL does not partake WP2.

19-MOE During the Reporting Period, MOE contributed in the integration activities of the revised version of the management plane API to the overall trial controller with NCSRD and other partners.

20-ORA does not partake Task 2.3.

21-UMS was working on the development of exposing and embedding its GCS/visualization platform with the Web Portal 1 during Q9 so experimenters can visualise the trial progress/mission during the demonstrations. During Q10 and Q11 UMS continued the development to expose and embed its GCS/visualisation platform with the Web Portal 1. UMS also contributed on reviewing, adjusting, and addressing comments on the content provided by the Consortium partners within D2.5.

### 8.2.5. Task 2.4 Tools for experiment data analysis and visualization (M3-M30) [FRQ]

#### Task Objectives:

The goal of this Task is to provide sophisticated mechanisms for the management and analysis of the data that will be generated during the trials. These mechanisms will be applied in WP4. This Task will face important challenges. First, very large volumes of experimental data will be generated during the trials; these data pertain to both the UAV-service level (e.g., video traces, sensor readings, etc.) and the 5G facility level (e.g., packet-level measurements, signal coverage reports, latency measurements, etc.). Second, these data are often unstructured, have multiple dimensions, and

involve multiple KPIs to measure. The expected challenges pertain particularly to the management, analysis, and the visualization of the experimental data and call for (i) big data management techniques, (ii) the application of data analytics and/or machine learning techniques for the analysis of trial results, (iii) development of visualization tools which will be used both at trial execution time and for the post-trial evaluation of the results.

The work in this Task place efforts on data analysis and the intuitive representation of trials results. This feature is becoming essential to process and understand the volumes of data generated by automated trial systems. This Task will use and extend open-source tools (such as Elasticsearch, Logstash, Kibana, collectively known as the ELK stack [ELK18]) for real-time actionable insights on any type of unstructured data. Notably, partners in 5G!Drones already have significant experience applying this solution and plan to extend these tools with new features, such as new visualisation plugins relevant to 5G parameters and advanced statistical data analysis, correlation techniques, and machine learning algorithms. The algorithms, mechanisms and tools developed in T2.4 will be reported in **D2.3**, while the related software will be released in **D2.6**.

### Task Activities during the period:

During Q9 the work on software components for data collection, KPI management and visualisation continued. Partners conducted pre-tests individually as well as jointly. The coordination and integration activities from different partners to collect measurements from the distributed components into a centralised datastore were continued. In addition, preparations for D2.6 were started. During Q10 the deliverable D2.3 was reopened and reworked to integrate reviewers' feedback. An updated version was provided. Partners worked on structuring D2.6 by proposing and implementing the ToC as well as already starting to contribute content. The work on integrating the partners components (especially U-space adapter) into the centralised KPI tool continued. In addition, visualisation possibilities of different tools were explored and tested. During Q11 the main activity was the finalisation of D2.6. An updated version of D2.3 was submitted after input from multiple partners. In addition, integration tests of KPI related components like Trial Controller, U-space adapter and other enablers was conducted.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

*1-UO* did improvements and finalisation of software components related to data collecting, position analysis and VR visualisation during Q9. UO did offline and online test in pre trials. There were also some pre trials for visualisation using an indoor cable drone. During Q10 UO made improvements for visualisation software for Virtual Reality for showing various data collected from operation environment. During Q11 UO contributed to the D2.6 about Nemo Handy and Qosium tools used for data analysis and visualisation of network KPIs at the 5GTN facility. It made review comment corrections on behalf of UO contributions of the last version of the D2.6 document for submission.

*2-THA* still led the data analysis team and continued working on ML mechanism that will be used to compute UAVs trajectory to be integrated to both UGC and UAVs during Q9 and Q10. During Q11 THA participated to discussion regarding the gathering, storage, and analysis of data.

*3-ALE* does not partake WP2.

*4-INV* worked on visualisation tool for dFPL path planning on the map during Q9. INV was also in the process of discussion with other partners how to allow the end user the observation and analysis of the results during the on-going mission and after it's finished. During Q10 INV reviewed and discussed the draft ToC of D2.6 prepared by NOK. INV was trying to identify what measurement types are already stored into KPI database hosted by Frequentis and what logs and measurements can be added from



INV side. INV prepared presentation with proposal of Detailed Dashboard content and layout (including the mock-ups) and organised a session of brainstorming about the content, which should be present in the trial Detailed Dashboard, during the flight and for the analysis afterwards. During Q11 INV was studying the new D2.6 document, and what was needed for work during Release 3 (KPIs integration in T4.1, WP4).

5-HEP had no activity on the Task during Q9. During Q10 and Q11 HEP worked on UAV data visualisation with Grafana graphs and point cloud maps.

6-NCSR D participated in the technical discussions for integration the data management plane with the monitoring and analytics tools of T2.4 during Q9. Discussions were also made on the flow of the experiment process in terms of automation and repetition. Contributions in the preparation activities for the Period 1 review were made. During Q10 NCSR D contributed in the preparation of the review meeting and the integration sessions. Comments to the ToC of D2.6 released by NOK were also provided. During Q11 NCSR D contributed in D2.6 with the analytics and monitoring tools of the Athens platform, reassuring the proper support needed for the execution of the final trial event and the proper integration with the experimental components.

7-AU worked during Q9 on enabling the integration of its facility to send the collected KPIs to the KPIC enabler hosted at FRQ premises. To this end, AU had different exchanges with FRQ about the use of the endpoints provided by the KPIC and worked on the integration. Furthermore, during the integration sessions, which were held on August 19<sup>th</sup>, 2021, AU demonstrated the collection of some measurements and sending them to the KPIC. During Q10 AU organised bi-weekly meetings to steer and monitor the progress of the task. AU also presented the progress and the achievements of the task in the review meeting. In addition, AU was contributing to the integration sessions of release 2 with the trial repository enabler. AU also addressed some comments related to a section edited by AU in D2.3, which were received from the EC review. Furthermore, AU reviewed and discussed the draft ToC of D2.6 prepared by NOK. During Q11, as a WP leader, AU has organized bi-weekly meetings to steer the progress of the work package, including T2.4. AU has also presented the status of the WP during the virtual face to face meeting. In addition, AU has contributed to D2.6 and edited the section 3.3 (X-network monitoring). Furthermore, AU has also acted as a reviewer of this deliverable appointed by the PMT. During the technical integration sessions, AU was contributing with its monitoring tools to make sure that they are being integrated with the KPI component of the trial controller.

8-COS does not partake WP2.

9-AIR does not partake Task 2.4.

11-INF participated in WP2 internal actions and Period 1 review and its preparation during Q9 and Q10. Contributions made for potential business exploitation of specific business metrics and impact of data analysis and visualisation. Monitoring and analysing T2.4 activities from a business perspective, communicating the results through social media and website linking T2.4 activities to T1.1 (metrics/data analysis used as T1.1 business/market input) and T5.1 (communication of results and achievements). In Q10 INF made contributions for addressing review comments and D2.3 review. INF was monitoring and analysing T2.4 activities from a business perspective, communicating the results through social media and website linking T2.4 activities to T1.1, T4.3 and T5.1 during Q10 and Q11. In Q11 INF contributed to D2.6 with focus on 5GENESIS analytics tools and processes.

12-NOK created template for D2.6 deliverable during Q9. During Q10 NOK started to collect content to D2.6. In addition, NOK has started a thesis to analyse data with ML with GAN. During Q11 NOK finished writing and reviewing D2.6. In addition, NOK finished a thesis where data was analysed with ML with GAN.

**13-RXB** coordinated and supported multiple partners on topics related to KPIC, Trial Validator & Trial Engine during Q9. During Q10 RXB explored possibilities of visualising various plots on Kibana, Graphana, etc based on the KPIs that will be collected. During Q11 RXB Participated in Release 3 calls, meetings and workshops.

**14-EUR** had no activity on the Task during the Reporting Period.

**15-DRR** made planning of U-space adapter development and deployment and deep analyses for network coverage planning during Q9. Network coverage planning will be used to feed data to the UTM system. DRR did planning during Q9 and Q10 of U-space adapter development and deployment as well as planning and coordinating implementation and integration of U-space adapter between SmarstSIS and PansaUTM in scope of exchange of Operational Flight Plan and Telemetry data. During Q10 it prepared a proposal of test cases for testing KPI Monitoring and U-space adapter in scope of testing Trial Controller main processes. U-space adapter adoption to the CIS/USSP interface. It prepared and concluded Trial Controller integration workshops (workshop 3.11.); Testing Workshops (10.11., 17.11., 24.11.), and minutes. During Q11 DRR prepared and concluded Trial Controller integration workshops. It did coordination of SmartSIS - DRR/UTM integration, Pre-verification of tests, and Telemetry, Operational Flight Plan re-integration, with SmartSIS. DRR edited, adjusted and corrected the content for D2.5 and D2.6 after merging and first reviews. It prepared, facilitated, and concluded Trial Controller architecture adjustments introduced after integration workshops: Editing, adjusting, and correcting the content for D2.5 and D2.6 after final review by PM. DRR did Trial Controller architecture review and alignment.

**16-CAF** had no activity on the Task During Q9. During Q10 CAF reviewed and discussed the draft ToC of D2.6 prepared by NOK. CAF contributed to the Dashboard discussions related to data visualisation during the flight and afterwards. During Q11 CAF participated in Trial Controller workshops. Also contributed to the Dashboard functionality which is supporting to play drone flights recordings and visualise drone operators' screens.

**17-FRQ** continued work on KPI component and supported partners in integration efforts during Q9. During Q10 and Q11 FRQ re-opened deliverable D2.3 and coordinated contributions, inputs and feedback from partners to re-submit the document. FRQ continued work on KPI component and supported partners in integration efforts. Moreover, FRQ has contributed to structuring D2.6.

**17.1-FSO** continued work on KPI component and supported partners in integration efforts during Q9. During Q10 and Q11 FSO re-opened deliverable D2.3 and coordinated contributions, inputs and feedback from partners to re-submit the document. FSO continued work on KPI component and supported partners in integration efforts. Moreover, FSO has contributed to structuring D2.6.

**18-OPL** does not partake WP2.

**19-MOE** does not partake Task 2.4.

**20-ORA** does not partake Task 2.4.

**21-UMS** had no activity on the Task during Q9 and Q10. During Q11 UMS contributed on the D2.6 deliverable with content related to the “Data analysis and visualisation software implementation”, in particular contributing in chapter 3.6 “UML Data Collection”.

### 8.3. WP3 Enabling mechanisms and tools to support UAV use cases

#### 8.3.1. Progress towards objectives and details for each Task

##### WP Objectives:

WP3 aims to accomplish Objective 4: **“Design and implementation of 5G!Drones enablers for UAV trials and operations.”**

Based on the outcome of T1.3, which will identify which enabling mechanisms are necessary for the support of the use cases defined in T1.2 and for the execution of the respective trials, this WP, which will be carried out in parallel with WP2, has the following sub-objectives:

- Design and implementation of mechanisms for end-to-end orchestration, management and security of coexisting UAV slices, with a particular focus on scalability and performance isolation.
- Development of the necessary components for MEC support.
- Implementation of software tools and APIs for facility infrastructure abstraction and to enable the federation of 5G facilities.

##### WP Tasks and interrelations:

WP Tasks and interrelations: Breakdown structure of WP3 reflects the structuration of the work according the 5 thematic areas in scope. As such it is made of the following 4 Tasks:

- T3.1: Scalable end-to-end slice orchestration, management and security mechanisms (M3-M32)
- T3.2: MEC capabilities for the support of 5G!Drones trials (M3-M32)
- T3.3: Infrastructure abstraction and federation of 5G facilities (M3-M32)
- T3.4: Development of UAV use case service components (M3-M33)

##### Main Progress in the period:

During Q9 partners continue their work on end-to-end slicing. Also, NWDAF has been identified as an interesting topic and partners will address this area in the next months. Activities related to the two MEC enablers (MEC LORA service and MEC RNIS for UAV) were conducted. All the other sub-tasks (MEC requirements of UAV services, MEC availability at the 4 facilities, Mobility Management and Network Slicing) of Task 3.2 were finalised. Regarding the abstraction layer, the task efforts were mainly focused on integrating the facilities' parsers with the abstraction layer. EUR integrated its facility by establishing an SSH tunnel to the abstraction layer hosted in AU. OU was also working on the integration of its facility by establishing a VPN connectivity to AU network. During Q10 Task 3.1 partners were working on NWDAF features and development of slicing support at all trial platforms. Task 3.2 has been finalised and except support to the partners, no other common activity will be provided in this task. Abstraction layer, developed within T3.3 is finalised, integrated, and tested with all facilities. No additional effort, except support, will be provided in this task. UAV enablers, developed in the scope of T3.4 are almost all finalised, and most of them are already available for integration. During Q11 all the partners continued working on the implementation of the different enablers (infrastructure and UAV) and on the Abstraction layer. During this quarter, MEC and slicing activities were finalised and a stable release of the Abstraction layer was provided. Tasks T3.2 and T3.3 were closed. During Q12 all the partners have continued working on finalising the implementation of the different enablers (infrastructure and UAV). Discussions regarding NWDAF (network data analysis functions) activities were finalised. Tasks T3.1 and T3.4 were closed and Deliverables D3.3 and D3.4 were released.

##### Significant results

During Q9: NOK achieved a working SEP21 (the latest MEC SW setup for MEC) version in its lab and NOK can give advices to UO for setting up similar setup for UO. Trials took place during this period (see WP4) and, thanks to that, partners were able to get feedback on their enablers for a potential next release. Also, Deliverable D3.2 was submitted. During Q10 integration of WP3 with WP1, WP2,

and WP4 to provide a demonstration during Period 1 review was done. The demonstration was successful. Tasks 3.2 and 3.3 are finalised. Most of the enablers of Task 3.4 have been integrated or are ready to be. A group of partners was formed to think about contribution regarding NWDAF (network data analysis functions) activities in the scope of Task 3.1. A stable version of the Abstraction layer was provided, tested, and documented. This Abstraction layer has been integrated with the different platforms. Release of infrastructure enablers software suite as deliverable D3.3 at M35 and release of UAV enablers software suite as deliverable D3.4 at M36.

**Deviations from Annex I and impact on other Tasks, available resources and planning**  
None.

### 8.3.2. Task 3.1 Scalable end-to-end slice orchestration, management and security mechanisms (M3-M32) [OPL]

#### Task Objectives:

Task T3.1 will address challenges for network slicing to support emerging UAV-related use cases. It should be noted that the successful execution of the targeted use case trials depends on the capabilities of the underlying facilities to maintain different types of services (uRLLC, mMTC, eMBB), including the provision of performance isolation and resource sharing at the RAN, core, transport and compute levels. Following the identification of missing components for slicing support in the selected 5G facilities (T1.3) and the architecture design provided by T1.4, this Task will provide the slicing-related enablers.

In particular, it will develop components for end-to-end secure slice deployment and orchestration, with the support for managing slice components across administrative domains. This is necessary for the cases where the functionality of an end-to-end slice spans across facilities (e.g., one facility is providing RAN and MEC functionality, while UAV control functions are split between the trial site and the vertical's premises; UAVs are restricted to a single facility due to regulatory requirements, while core network components and other functions of the UAV slice are executed as virtual instances at another trial site/facility). Activities in this Task will be in close synergy with T3.3, where the necessary infrastructure abstractions will be developed to facilitate federation and multi-domain operation

The selected 5G!Drones use cases have as a typical feature the *coexistence of multiple network slices* with different performance requirements for the provision of a *single drone service*. For example, for a public safety scenario, apart from operation of UTM modules, which require a uRLLC slice to meet the strict timing and reliability requirements for safe and secure flight operations, video has to be streamed from the drones necessitating the deployment of an eMBB slice to support it. Taking into consideration that

- multiple slices for other services/“tenants” would be deployed simultaneously over the shared 5G infrastructure, and
- end-to-end slices may cross administrative domains,

raises significant concerns regarding *scalable slice management*.

Furthermore, critical services such as UTM and public safety related have important *security and performance isolation* requirements. For UAV services in general, *safety is linked with security*. For example, without appropriate protection mechanisms at various levels, a malicious actor might aim to disrupt the operation of UTM or tamper with the control of a UAV, bringing significant risks. Security aspects in network slicing are generally overlooked. T3.1 will put particular focus in this direction, studying network slicing security extensions and integrating them with the selected trial facilities. T3.1 will enable each of the network slices needed to achieve the UC trials to be adequately secured. To cope with specific security requirements from each of the network slices, software defined security (SD-Sec) and security as a service (SECaas) will be promoted. The advanced slicing mechanisms that will be contributed by this Task will be reported in **D3.1**, while the software components that will be implemented will be released with the whole 5G!Drones Enablers Software Suite (**D3.3**).



### Task Activities during the period:

During the Q9, the 5GC based on Open5GS has been successfully deployed at UO testbed and integrated with Nokia Air-scale 5G base station. The development of the 5G!Drones implementation of NWDAF has been continued. Continuation of works at Oulu and Athens trial sites on support of slicing. During the Q10, the following development achievements took place: NWDAF functionality, slice manager of 5GENESIS trial platform, 5G SA support at 5GTN and X-network platforms, RAN slicing. During Q11, the development of 5G!Drones testbeds was progressing as well as the NWDAF component. During Q12, the activities of Task 3.1 have been concluded, including the preparation of the task's contribution to D3.3, and the most significant achievements of the period are: (i) developments, improvements, adjustments, and testing of the trial sites' testbeds related to support of 5G NSA/SA, slicing, trial facility exposure, abstraction layer and management; (ii) delivery of the NWDAF component; and (iii) studies on RAN slicing algorithms and traffic steering in mobile networks supporting drones.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

*1-UO* plans and maintains University of Oulu WP3 implementation plan, schedule, and resources. During Q9 UO was preparing the University of Oulu test facility 5G Test Network (5GTN) for the August, 2021 Trials testing. There was ongoing work on creating slicing support to the 5GTN and work on the deployment of 5G Standalone (SA) core using the open-source tools. The SA core (Open5GS-5GC) is now ready and successfully running with the Nokia Air-scale 5G BTS. Work on the installation and setup of OpenStack (Canonical Microstack) environment for 5G!Drones purposes. During Q10 work on improving 5G SA and NSA support to the 5GTN/5G!Drones was done. UO did work on creating slicing support to the 5GTN. That work is still on-going. The features have been tested by using Open5GS-5GC and simulation-based UE and gNB called UERANSIM. At the first phase of slicing, the slicing capability by providing S-NSSAI information to the different UEs for different slices was tested. Then, the slicing capability for creating multiple sessions for a single UE by providing different SST and SD values. As the lead beneficiary of the deliverable D3.3, UO has initiated the ToC and documentation of the deliverable. During Q11 UO has been working on improving 5G Stand Alone and Non-Stand Alone support to the 5GTN/5G!Drones. Measurements for the cell coverage were done and analysed. UO has acted as the Deliverable D3.3 lead editor. During Q12 UO has been working on improving 5G Stand Alone and Non-Stand Alone support to the 5GTN/5G!Drones. Improved measurements for the cell coverage done and analysed. UO was the lead editor of D3.3.

*2-THA* participated to discussions related to slicing during Q9. THA was working on a mechanism for intra and inter slice scheduling. THA has also worked on a Python implementation of this mechanism. THA also contributed a list of security metrics and measurement data that should be collected and monitored by the NWDAF (Network Data Analytics Function). During Q10 THA continued its work on the new slicing scheduler (design and theoretical evaluation of a mechanism for intra and inter slice scheduling). THA has participated to discussions related to slicing. THA continued discussions about NWDAF (Network Data Analytics Function). Between Q11 and Q12 THA participated to the discussions regarding NWDAF activities, participated to the implementation of infrastructure enablers suite, and participated to the edition of deliverables D3.3.

*3-ALE* does not partake in Task 3.1.

*4-INV* does not partake in Task 3.1.

*5-HEP* does not partake in Task 3.1.

6-NCSR D prepared the slicing manager in Athens platforms in order to support the July trials, as well as the simulated testbed demo during Q9. In Q10 the following features of slice manager were performed: Prometheus Alertmanager; Prometheus alerts for NFV; API for receiving external alerts; Fixed Monitoring - Shared Functions Bug; Check for running slices before stopping SM; Location Registry; Jenkinsfile.kill for destroy pipeline; Version and Server URL on swagger; Updated binaries for building; deploying, stopping, and uninstalling Katana; Updated CI/CD pipelines; and Removed deprecated UI container. During Q11 NCSR D continued the development of Katana Slice manager, adding the following features: APEX policy engine integration and Slice D2 Operations: Stop Network Service; Add Network Service; and Restart Network Service with specific constraints. During Q12 NCSR D performed the necessary adjustments of Katana slice manager to support properly the final version of the trial validator and respective content for the deliverable has been prepared. Proper contributions to D3.3 have been performed.

7-AU investigated the possible solutions for upgrading its 5G facility from NSA to SA during Q9 and Q10. In Q11 AU has upgraded its network to the SA mode. New UEs that support this mode have been purchased. AU has been working during this period on connecting the new phones to current SA deployment. During Q12 AU has switched its network to the stand-alone mode and is continuing its activity of testing the current deployment. A routing issue related to connecting the user plane in the core network (UPF) with the data network (DN) has been detected, where AU has been addressing this issue. The activity conducted in this task is aligned with T4.1 and T4.2 aiming to prepare for the next trials. Furthermore, AU has also been working on a conference paper related traffic steering in cellular networks to serve UAVs. The paper will be submitted to Globecom 2022.

8-COS does not partake WP3.

9-AIR does not partake WP3.

11-INF does not partake WP3.

12-NOK does not partake Task 3.1.

13-RXB does not partake Task 3.1.

14-EUR was working on defining the NWDAF function compliant with the 5G-EVE facility during Q9. In addition, EUR has a proposed a data-driven solution to manage network slices in 5G. The solution has been accepted in IEEE Transactions of Network Service and Management (TNSM). During Q10 EUR was working on a new framework based on Deep Reinforcement Learning (DRL) to enforce network slicing in 5G NR. A paper has been submitted to IEEE ICC 2022. The work is being improved with an analytical model based on Integer Linear Program (ILP). The work is to be submitted to an IEEE Transactions. Meanwhile, EUR was testing the NDWAF function based on OAI for future integration to the trial platform. During Q11 EUR was working on different contributions related to 5G NR network slicing. These contributions focus on the slicing the 5G NR radio resources considering different numerology. We formulated the problem using Integer Linear Programming (ILP) showing that the problem is NP hard. Then we proposed a solution based on Reinforcement Learning (RL) and one heuristic. A journal is under preparation that present all these solutions. During Q12 EUR has been working on a new 5G NR RAN Slicing method using Reinforcement Learning (RL). The work has been validated via a simulator and an implementation on OAI is expected.

15-DRR had a workshop and conceptual design of merged UTM and NWDAF based planning and estimation services (using analytical data from UTM and 5G) - correlation of measured coverage quality with flight routes during Q9. In Q10 DRR prepared for review meetings. During Q11 DRR had NWDAF discussions - scoping and initial planning of integration between NDWAF and U-Space for exchanging data for analysis. During Q12 DRR did NWDAF designing the integration between

NWDAF and U-Space for exchanging data for analysis. It reviewed/adjusted the content for D3.3 (Trial Validator). DRR did Trial integration - development activities (flight plan) with FRQ and integration testing and SW preparation of U-space enablers (telemetry, flight plan, geo-zones).

16-CAF had no activity on the Task during Q9 and Q12. In Q10 it did preparation for review meetings. During Q11 CAF made contributions to NWDAF team workshop and integration between NWDAF to send 5G QoS data.

17-FRQ had no activity on the Task during the Reporting Period.

17.1-FSO had no activity on the Task between Q9 and Q11. During Q12 FSO was working on content for D3.3 (Trial Validator). It contributed in trial integration and development activities with partners and supported integration testing activities and SW preparation of U-space enablers.

**18-OPL** led the activities of T3.1. During Q9 it continued preparation of the NWDAF implementation as a 5G!Drones enabler and continued preparation of a tool to determine the estimated 3D coverage maps for test sites (initially for Sophia 5G-EVE site). During Q10 OPL worked on preparation of the NWDAF component. P2P discussion with DRR, CAF, and THA have been performed on the topic of NWDAF. During Q11 OPL worked on preparation of the NWDAF component. The solution for acquisition of data available at the OS APIs from the Android terminal (client-server architecture) was developed during the period. During Q12 OPL worked on preparation of the NWDAF component. Development of network slicing-related enablers: U-space Coverage Correlation (UCC) and Unmanned Aerial Vehicles - Network Data Analytics Function (UAV-NWDAF) has been concluded. Their description has been included as a contribution to D3.3.

19-MOE does not partake in Task 3.1.

20-ORA does not take part in Task 3.1.

21-UMS had no activity on the Task during the Reporting Period.

### 8.3.3. Task 3.2 MEC capabilities for the support of 5G!Drones trials (M3-M32) [EUR]

#### Task Objectives:

Edge computing comes with the promise of low latency, and this is critical for the delay-sensitive components that many of the 5G!Drones use case scenarios involve. This Task will focus on the integration of Multi-access Edge Computing in the 5G!Drones architecture and in the trial facilities. As described in Section 1.3, the ICT-17 and other facilities where the use cases will be trialled feature to some extent MEC features. However, these capabilities are heterogeneous. Therefore, following the requirements analysis of T1.2, this Task will ensure that a common subset of MEC capabilities necessary for the support of the defined use cases is present at all facilities that will be used in the trials, and will fill potential gaps by developing the missing components critical MEC components.

Building on existing MEC components provided by the partners, T3.2 will create the necessary support for the inclusion of MEC application instances and related network and compute resources into an end-to-end UAV slice. However, an overview of the current status of the standards in slicing and edge computing reveals that *slicing support for MEC is still at a very early stage*. Given that 5G!Drones makes heavy use of slicing in conjunction with edge computing, it is necessary to extend current MEC implementations for slice awareness so that the appropriate level of (performance and other) isolation among coexisting slices is also enforced at the MEC level. This Task will thus provide interface extensions and mechanisms for improved slicing awareness, resource isolation and security in a multitenant MEC environment for new UAV vertical use cases.



Finally, the research activities of this Task will address the challenges of UAV mobility by introducing a *mobility management component*, which will ensure that UAV service components that are deployed at the edge are appropriately migrated across edge clouds following UAV mobility in order to maintain the latency constraints of the respective slices. The contributions of this Task will be reported in deliverable **D3.1**, and the related software components will be released with the 5G!Drones Enablers Software Suite (**D3.3**).

#### Task Activities during the period:

During Q9 the only activities related to the two MEC enablers (MEC LoRa service and MEC RNIS for UAV) were conducted. All the other sub-tasks (MEC requirements of UAV services, MEC availability at the 4th facilities, Mobility Management and Network Slicing) of T3.2 are closed and finalised. During Q10 all the objectives of the task have been achieved. Two MEC enablers have been included in T3.4, while mechanisms to support MEC in the different facilities, MEC mobility management, and MEC security have been detailed and included in D3.1. Current activity is mainly between THA and EUR to add a new MEC enabler using RNIS. During Q11 the final actions are related to the MEC enabler that are reported in T3.4. During Q12 there is nothing to report in general. Refer to partners' reports.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-UO carried out knowledge transfer related activities for the mechanisms of vMEC including establishment of VLAN between vMEC and application VM on Openstack during Q9. Validation of vertical service enablers from CAF on the MEC Edge server (vMEC) deployed in Oulu for physical August trials was done. UO had no planned activity on the Task during Q10. During Q11 UO did work on vMEC preparing it for the upcoming trials. UO has acted as the Deliverable D3.3 lead editor. During Q12 UO has been working on Nokia SEP22 installations, that includes understanding of SEP22 system architecture, identifying the hardware requirements, and collaborating with colleagues from NOK to better understand the installation procedure for single server MEC only deployment. The SEP22 MEC installation is ongoing. UO was the lead editor of D3.3.

Deviation and corrective action: The 5G!Drones UO main responsible vMEC person left for industry during Q9 and hence taking actions on knowledge transfer was crucial, and unexpected task.

2-THA has worked with EUR to integrate this latter's RNIS API of the MEC platform in order to use it in its trajectory computation enabler during Q9. THA also made progress on supporting the deployment of performance-critical IAM and PKI services to the MEC, especially cloud-native/Kubernetes aspects. During Q10 THA started discussion with EUR in order to integrate their RNIS API of the MEC platform in order to use it in its trajectory computation enabler. THA has been working on enhancing PEP security enabler for deployment in a cloud-native MEC (based on Kubernetes), as a CNF (cloud-native VNF), in compliance with ETSI VNF standard. THA had no activity on the Task between Q11 and Q12.

3-ALE does not partake in Task 3.2.

4-INV does not partake in Task 3.2.

5-HEP does not partake in Task 3.2.

6-NCSR together with COS contributed in the MEC/LBO configuration for supporting the execution of the July trials in Athens. Further contributions during Q9 towards supporting the simulated testbed demo were made. During Q10 NCSR performed trials with Open5GS for deploying multiple UPFs

with a common core network to support LBO. During Q11 worked on the MEC setup for the final trial in Athens, considering the different 5G setups that will be used, such as the COS 5G Van or the Amarisoft 5G Callbox. This process and collection of requirements has resulted in the HW requirements of an INTEL NUC that will be used for this purpose. During Q12 new setup of Athens platform has been prepared to support Athens trial, where a portal edge configuration can support and properly configured on-site for the needs of the showcasing events and trials. Proper contributions to D3.3 were submitted.

**7-AU** successfully published a conference paper regarding MEC mobility for UAVs in GLOBECOM 2021 during Q9. Work on extending the conference paper to a journal paper is ongoing. During Q10 AU worked on the revision of a conference paper accepted in GLOBECOM 2021. The paper addressed MEC application mobility for UAVs. Furthermore, AU has actively participated to all the integration workshops of release 2, by preparing and providing access to its edge platform used to deploy vertical applications. During Q11 AU had no activity on the Task. During Q12 AU participated to the integration session of release 3 in WP4 with its edge-based server. The focus of this release is the KPI integration, where AU has been ensuring the integration of its cloud-based KPIs with the KPI component. Several meetings have been organised with INV for this end.

**8-COS** does not partake WP3.

**9-AIR** does not partake WP3.

**11-INF** does not partake WP3.

**12-NOK** was setting up its lab environment a SEP21 edge system next to existing 5G site during Q9. During Q10, NOK has been deploying a Nokia SEP21 MEC system to the local lab environment. In addition, NOK has been co-operating with UO to prepare SEP21 installation to UO side when the NOK side deployment is finished. NOK had no activity on the Task during Q11 besides assisting UO in SEP22 MEC installation. During Q12 NOK was helping with MEC integration, especially making sure that NOK and UO co-operation works smoothly.

**13-RXB** does not partake in Task 3.2.

**14-EUR** was working on the second release of its two MEC enablers: MEC LORA service and MEC RNIS for UAV during Q9 besides leading the task activities. The latter is improved with an algorithm to detect collisions among drones using only RNIS information. During Q10 EUR was coordinating, leading, and reporting the task activities during the Bi-weekly meetings of WP3. EUR was discussing with THA to have a new enabler for MEC based on RNIS. EUR has prepared the slides regarding task activities for the review meeting. During Q11 EUR led the activities of this task and in Q12 EUR has improved their MEC Edge Platform (MEP) to update the MEC RNIS service to interface with 5G NR.

**15-DRR** had no activity on the Task during the Reporting Period.

**16-CAF** had no activity on the Task between Q9 and Q10 and during Q12. During Q11 CAF adapted 5G QoS measurements script for MEC.

**17-FRQ** had no activity on the Task during the Reporting Period.

**17.1-FSO** had no activity on the Task between Q9 and Q11. During Q12 FSO participated in and supported the integration session of release 3. It was working on integration of different KPI sources and enabled and documented visualisation of geo based (Lat – long) KPIs as part of Kibana dashboards.

**18-OPL** did works on MEC slicing during Q9. OPL had no activity on the Task between Q10 and Q12.

19-MOE does not partake in Task 3.2.

20-ORA does not partake in Task 3.2.

21-UMS had no activity on the Task during the Reporting Period.

#### 8.3.4. Task 3.3 Infrastructure abstraction and federation of 5G facilities (M3-M32) [AU]

##### Task Objectives:

Given that 5G!Drones will trial services over heterogeneous 5G facilities, T3.3 is focused on providing a unified interface to expose facility capabilities and to deploy functions there. This interface will provide a single abstraction for network (e.g., RAN) and compute resources (e.g., those provided from a central or MEC datacenter). The API will be accessed by the trial controller to deploy and manage components of the vertical service and to orchestrate the execution of a trial. The abstraction layer that will be provided by this activity will in turn rely on the 5G facility interfaces. From a software design perspective, it can be seen as a plugin framework, where for each facility a plugin will be implemented, thus contributing to the system's extensibility.

Furthermore, this Task will ensure the necessary level of connectivity across facilities and, in turn, among the components of a vertical service deployed at different sites, as well as between the trial controller and the management and orchestration components of each facility. This activity involves all relevant authentication, authorization and access control issues (AAA), and will further enable features such as the interconnection of a partner site to a facility and the dynamic relocation of service components at trial runtime. It shall be noted that these AAA issues are relevant with access to the management planes of facilities and, although having implications to the slicing security issues studied in T3.1, are distinctly different. The activities of this Task will contribute towards achieving multi-domain orchestration of UAV slices, a topic also related with T3.1.

As a final note, since ICT-17 (and other complementary infrastructures that will be used by the project) will be still evolving during the course of 5G!Drones, this can significantly impact the activities in this Task. We will adopt an incremental design and development approach, which will follow closely the output of Task T1.3 (detailed description of 5G facilities). The abstraction and federation interfaces and mechanisms provided in this Task will be reported in **D3.1** and the produced software will also be released as part of the 5G!Drones Enablers Software Suite in **D3.3**.

##### Task Activities during the period:

During Q9, the task efforts were mainly focused on integrating the facilities' parsers with the abstraction layer. EUR integrated its facility by establishing an SSH tunnel to the abstraction layer hosted in AU. OU was also working on the integration of its facility by establishing a VPN connectivity to AU network. During Q10 an effort was given to establish a VPN connection between X-Network and 5GTN, to enable the connection to API gateway hosted at AU, which has successfully been achieved. As a consequence, all the parsers are currently integrated to the abstraction layer, which concludes this task. During Q11 and Q12 the task common activities have been closed. The outcome of this task (abstraction layer) has been reflected in D3.3.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-UO did Qosium Storage deployment during Q9. Implementation of PostgreSQL database views metrics was done at Qosium Storage to be populated by Qosium Probes. Tokenizer class

implementation was done at KPI Measurement API for automatic authentication at KPI Endpoint API from FRQ. UO did implementation of KPI Measurement API to get and push additional KPIs from Qosium system to the Trial Controller and implementation and configuration of the parser, uploader and DB view for Nemo KPIs collection and storing them at the DB server. UO did Docker containers deployments of Trial Enforcement and Abstraction Layer to enable working together of them and the container's network to Get, Post, Delete the measurement jobs at 5GTN from the Trial Enforcement. It did development of 5GTN Facility Parser/Adapter. UO worked on finalising the DRF based APIs to translate the upper layer's requests to communicate with the 5GTN facility, supporting Slice Creation, Slice Deletion, All Slice View, and A Slice View functionalities. During Q10 UO finalised the development of 5GTN Adapter for Network Slice Management. That included various bug fixes like saving the Network slice id from slice creation response into the database, following August Trials and Integration Workshops. During Q11 UO did minor bug fixes for 5GTN adapter for Abstraction Layer. UO has been coordinating D3.3 preparation as the deliverable responsible beneficiary. During Q12 UO was the lead editor of Deliverable D3.3 and in T3.3 it contributed on the D3.3, writing and reviewing about the 5GTN adapter that includes measurement job controller, network slice parser, and last-second KPIs tracker.

*2-THA, 3-ALE, 4-INV, and 5-HEP* do not partake in Task 3.3.

*6-NCSR*D contributed in the preparation of the 5GENESIS testbed for the execution of the July trials during Q9, considering the abstraction of the underlying systems. Moreover, contributions were made in the proper configuration of the simulated testbed. During Q10 NCSR D participated in the preparation of the review meeting during the reporting period. NCSR D contributed to the adaptation of the open5genesis layer of Athens platform to the UAV vertical needs of the 5GDrones project. During Q11 NCSR D contributed to D3.3 with the Katana slice manager functionalities and recent developments towards providing an abstraction of the underlying network, towards facilitating the experimental description during the trials of the project. During Q12 NCSR D participated in the integration meetings of the abstraction layer and contributed to the necessary updates needed by the introduction of the new domain name. Proper contributions to D3.3 have been made.

**7-AU** assisted the facilities' owners in integrating their parsers with the abstraction layer hosted in its premises during Q9 in addition to leading and coordinating the activities of this Task. During Q10, as T3.3 leader, AU worked on preparing the slides for the review meeting of September which reports the conducted activities and the achievements of the second year of the project. AU did also prepare the abstraction layer enabler, developed and hosted by AU, to be used in the review meeting and also during the different workshop sessions of release 2. Furthermore, AU worked on establishing a VPN connection between its facility and 5GTN, so to enable the connection between the API gateway of the abstraction layer and the parser of 5GTN. During Q11 AU contributed to the deliverable D3.3 by providing inputs related to the abstraction layer. The latter reflects the outcome of T3.3 and has been developed by AU. During Q12 AU has already contributed to the deliverable D3.3 by reflecting the outcome of T3.3 which is materialised in the abstraction layer developed by AU. Furthermore, AU had to update the current deployment of the abstraction layer along the domain name. The new domain name is <http://5gdrones.comnet.aalto.fi/abstractionlayer/swagger/>. The update was conducted smoothly without interrupting the services for the partners. All the partners have been updated about the new domain name set by AU. The abstraction layer remains ready for the trials.

*8-COS* and *9-AIR* do not partake in WP3.

*11-INF* does not partake in WP3.

*12-NOK* and *13-RXB* do not partake in Task 3.3.

*14-EUR* worked on the integration of the Abstraction layer NBI (Kong) hosted by AU with the 5GEVE parser hosted in EUR during Q9. It had no activity on the Task during Q10. During Q11 EUR worked

on improving the facility adapter of the abstraction layer according to the feedbacks received from the integration tests done in WP4. Also, EUR has participated to the D3.3 providing details on the facility adapter. During Q12 EUR updated the Abstraction layer to adapt the KPI collection according to FRQ monitoring module.

15-DRR had no activity on the Task during the Reporting Period.

16-CAF had no activity on the Task during the Reporting Period.

17-FRQ had no activity on the Task during the Reporting Period.

17.1-FSO had no activity on the Task during Q9, Q10, and Q12. During Q11 FSO contributed in ToC discussions for D3.3 and contributed content for D3.3.

18-OPL does not partake in Task 3.3.

19-MOE contributed in the preparation of the 5GENESIS testbed for the execution of the trials during Q9 and Q10. During Q11 and Q12 MOE contributed to the adaptation of the open5genesis layer of Athens platform to the UAV vertical needs of the 5G!Drones project as well as with the installation, deployment and configuration of the Katana Slice Manager with the NCSR team.

20-ORA: The Person Months have been shifted into Task 3.1 on a new security enabler.

21-UMS had no activity on the Task during the Reporting Period.

### 8.3.5. Task 3.4 Development of UAV use case service components (M3-M33) [ALE]

#### Task Objectives:

Based on the detailed specification of the use cases of T1.2, the goal of this Task is to enhance the existing UAV software or develop new software to support the use cases. This pertains both to onboard units and to software to be run remotely (e.g., as virtual instances on edge or remote clouds), and includes both control functionality and application level one. With the completion of the activities of this Task, all *target use case scenarios will be fully implemented*. Also, in another line of activities in this Task, the necessary software and hardware components for the integration of 5G technology on UAVs will be provided (e.g., installation and integration of UE equipment onboard). Deliverable **D3.2** is dedicated to the description of the activities of this Task, while the full software suite including all use case scenarios to be trialed is delivered in **D3.4**

#### Task Activities during the period:

During Q9 the main focus of each partner has been on developing the UAV enablers. Deadlines had to be met for UAV enablers releases as they were pivotal components for the various trials performed during the period (see WP4). During these trials, partners were able to get feedback on their enablers for a potential next release. Deliverable D3.2 was submitted. During Q10 the task efforts were focused on developing the enablers and on providing upgrades after the trials that occurred during the previous period. Most enablers are now completed. Discussions regarding D3.4 have been initiated. During Q11 and Q12 Task 3.4 contributors have carried on developing or improving their enablers based on partner-level and project-level tests feedback. Writing of D3.4 providing technical information on enablers has started, contributors have agreed upon a table of content and a template to report on the enablers. Partners contribution was collected and integrated. Writing of D3.4 providing technical information on enablers has been completed.



The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

**1-UO** conducted an internal review the Deliverable D3.2 during Q9. UO completed software components related to data collecting and position analysis and Virtual reality visualisation as well as successfully tested these on trials in August at Botanical garden using cable drone system. During Q10 UO tested developed components in different locations, botanical garden and OuluZone, and defined further improvements to modules. UO also did some preliminary tests with the cable drone in OuluZone. During Q11 and Q12 UO developed further the erections of the cable drones with and without trussels. The Virtual Reality based visualisation software was further developed for showing various data collected from operation environment. Data can be live streamed or loaded from prerecorded files stored in GLB format. UO also contributed to Deliverable D3.4 the section 2.11 as well as carried out an internal review of the document.

**2-THA** continued the development of its trajectory computation enabler during Q9. This enabler will get information from EUR MEC service and will be integrated with trial controller. During Q10 THA started the development of its trajectory computation enabler and discussion with EUR in order to establish a collaboration and use 5G-EVE. Between Q11 and Q12 THA participated to the implementation of UAV enablers suite and participated to the edition of deliverables D3.4.

**2.1-ERC** started the study of the Search&Rescue disaster victim's detection and localisation enabler during Q10, by using the radio signal transmitted by a mobile phone. Several scenarios for getting victim consent and generating radio transmission to be detected have been analysed. One option has been chosen for the project. The architecture of the solution has been defined accordingly, and first step of hardware and software integration has been performed. Real radio signal can already be displayed on a screen. The development of an algorithm for automatic detection is the next step of the work. During Q11 ERC carried out a study to list practical path loss estimation techniques used to model air-to-ground (e.g., drone/mobile) propagation channel, in the perspective of using the signal strength to evaluate the distance of the victim. Work on questions regarding the implementation (e.g., Python programming) of the chosen propagation channel and the performance measurements. ERC developed a radio detection algorithm able to provide relevant outputs in the context of sparse measurement data. This algorithm uses the typical transmission patterns of OFDMA signals to discriminate between noise and actual radio transmission. During Q12 ERC analysed 5G specifications to understand how cell (re)selection procedures work. Looking for the best solution/tool to simulate rescue use case in the case of the deployment of ad-hoc emergency network coverage provided by a drone. Simulation and performance evaluation of the detection of radio signal transmitted by the smartphone of a victim.

**3-ALE** completed the first release of its UAV enablers in Q9. Those were successfully tested during Oulu trials in August, 2021 (see WP4). An architectural adjustment has been required for the Ground Control Station enabler: telemetry forwarding is performed in the edge rather than on the field computer. ALE contributed to D3.2 by describing its enablers. During Q10 ALE provided an updated version of its Ground Control Station enabler, taking into account feedbacks from Oulu trials. ALE's main focus has been on a new version of the Hydradrone enabler, including a new way to connect the UAV to the 5G network. During Q11 ALE carried out work on the Hydradrone enabler and has now a deployable version of all its enablers. The Deliverable D3.4 has been initiated, providing structured template to partners to contribute to the document. Some contributions have already been integrated. During Q12 ALE has carried out work on the Hydradrone enabler. The Deliverable D3.4 has been completed.

**4-INV** still worked on addition of broadcasting feature to its LEMAN tracker device during Q9, which INV plans to use for UC1Sc1. It's planned that the tests with the new broadcast device will be possible

in mid of October 2021. During Q10 INV worked on finalisation of the new version of LEMAN tracker device, to be able to use it during the planned tests for UC1Sc1 in December, 2021. Works were delayed, but tracker was ready for these tests. In the latest released version, INV uses both modes described in ASTM standard for remote ID tracking (networked and local broadcast) and INV is capable to capture the locally broadcasted signal on commercially available mobile, like Samsung Galaxy S10. The new improvements and features were added to the INV surveillance data stream for Involi.live service. During Q11 INV installed and used its G-1090 receiver during the tests in EUR in December 2021. INV also prepared and used the new version of LEMAN Remote ID tracker, equipped with broadcast function. Both streams, using our REST APIs were exposed to FRQ, which integrated them and made visible in their UTM system. INV also provided the contribution to D3.4, containing the details about our enablers. During Q12 INV worked on issues related to the Remote ID tracker stability and GNSS fix. One tracker was shared with CAF to allow them its integration to their drone, which will be used during the tests in EUR. In this reporting period INV has officially launched the new version of the LEMAN Remote ID tracker with broadcasting function. It's now available for purchasing via INV web page. INV did the heavy analysis of our G-1090 receiver performance depending on three different receiving antennas. Other focus was also on creating the receiver coverage map, based on signal detections, to assess the receiver installation and emplacement quality.

5-HEP finalised the development of UAV operator VNF with its 1st release during Q9. HEP also continued the development of Data cloud enabler finalising the 1s release of photo uploading API to Hepta's cloud-based infrastructure inspection software. HEP also made good progress with the Hepta's GCS enabler with finalising the UTM connection graphical user interface for the "UAV operator VNF" and made good progress with GUI for controlling all on board software components needed to run our use cases. During Q10 HEP updated its "interface to autopilot" enabler based on the results from UO trial and also worked further on sensor data streaming, data cloud and GCS enablers. During Q11 HEP has done further development work on its GCS enabler and provided input to D3.4. During Q12 HEP has contributed in task 3.4 by updating the "interface with autopilot" enabler, bug-fixing the "data streaming" enabler and finishing the development of GCS enabler. Hepta has also contributed to D3.4.

6-NCSR D does not partake in Task 3.4.

7-AU conducted successful tests of the IoT-as-a-Service (IoTaaS) platform developed for UC3Sc2 during Q9. During Q10 AU worked on its platform for controlling drones and the underlying virtual flight controller. The new release supports micro-service architecture and can dynamically be deployed by its edge platform developed in T3.2. AU had no activity on the Task in Q11. During Q12 AU contributed to the deliverable D3.4. The contribution included the software suite used for its use case scenario. AU has also been preparing its drone for tests and trials, as the winter period is over. No issue was detected, which makes AU ready for the final trials of its use case scenario.

8-COS and 9-AIR do not partake in WP3.

11-INF does not partake WP3.

12-NOK contributed to D3.2 to chapters 4.2-4.5 during Q9. During Q10 NOK has been updating drone's 5G modem to work with 5G SA mode. NOK had no activity on the Task between Q11 and Q12.

13-RXB, apart from contributing to D3.4, had no activity on the Task During the Reporting Period.

14-EUR was the editor of D3.2. Therefore, EUR provided a ToC, collected contributions and did several reviews of the deliverable during Q9. During Q10 EUR was improving the two proposed MEC enablers. During Q11 EUR worked towards improving its two MEC enablers, which have been detailed in D3.4. During Q12 EUR finalised the tests and integration of their MEC enablers on top of the 5GEVE



facility. EUR contributed to D3.3 by providing information on the software suite of the two MEC enablers.

*15-DRR* was preparing and updating content for D3.2 - description of telemetry, geo-zones and operational flight planning services during Q9. It made planning of development and deployment of U-space services enablers (operational flight plan, telemetry, geo-zones). It was aligning 5G!Drones activities with EU regulation (ED-269, 664, 666) Geozones, telemetry operational flight planning API review. DRR was updating technical part of D3.2 after internal/technical reviews - description of telemetry, geo-zones and operational flight planning services. It made development of U-space enabler for Telemetry and Operational flight plan and Integration tests with FRQ. DRR carried out DevOps activities on 5G!Drones Gitlab and test environment. During Q10 DRR did coordination of development of customized DRR U-space enablers: Operational Flight Plan, Telemetry and Geozones, and coordination of U-space enablers design and development (telemetry, flight plan, geo-zones); Updating and preparing review presentation of U-space enablers for T3.4 status updates. DRR made SW alignment of U-space enablers design and development (telemetry, flight plan, geo-zones) - integration with FRQ. It carried out environment preparation, security and integration configuration with FRQ and made a review of current Adapters' functionality. DRR made verification of cohesion with other projects PJ.34 and GOF2. During Q11 DRR was preparing, reviewing and finalising the joint with FRQ presentation for U-space adapters implementation update. It provided input for U-space adapters implementation update and preparing and adjusting content for D3.4 after internal reviews (description of U-Space adapter component configuration). During Q12 DRR reviewed the content for D3.4 (description of U-Space adapter component configuration). It made integration testing of U-space enablers (telemetry, flight plan, geo-zones) and Auditing the content for D3.4 (U-space adapter). DRR made definition of ED-269 integration requirements and monitoring of integration tests.

*16-CAF* developed the CAFA cellular drone model with a 5G communication device during Q9. The CAFA cellular drone test was successfully passed in August 2021 on the AU and UO tests. A 3D map and a 5G QoS Analyser enabler were also developed to measure and visualise the 5G QoS results measured during the AU and UO drone flights. CAF also contributed to the writing of D3.2. During Q10 CAF made development and testing U-space enablers for Ground Control Station software: Operational Flight Plan, Telemetry, Geozones and Alerts and integration to FRQ SmartSIS. Caf made development and testing of the CAFA cellular drone components – video streaming and location logs to onboard computer. During Q11 CAF developed the CAFA cellular drone, as well as the CAFA 3D Analyzer, the CAFA Field, and the 5G QoS measurement enablers. The CAFA cellular drone was used in tests performed at EUR in December 2021. During Q12 CAF continued to develop UAV enablers - CAFA 5G QoS Analyzer, Video Analyzer and delivery sensor. It made contributions and reviewing the content for D3.4.

*17-FRQ* continued internal analysis of UTM network coverage service for UAV scenarios to enhance U-space integration during Q9. FRQ also contributed to D3.2 and reviewed the document. During Q10 FRQ was participating in U-space adapter enabler implementation and integration. Together with DRR, FRQ /FSO prepared a technical presentation for U-Space Enablers for the joint T3.4 presentation. FRQ had no activity on the Task between Q11 and Q12.

*17.1-FSO* continued internal analysis of UTM network coverage service for UAV scenarios to enhance U-space integration during Q9. FSO also contributed to D3.2 and reviewed the document. During Q10 FSO participated in U-space adapter enabler implementation and integration. Together with DRR, FRQ /FSO prepared a technical presentation for U-Space Enablers for the joint T3.4 presentation. During Q11 FSO prepared and provided inputs for D3.4. FSO contributed to enablers presentation with Drone Radar (DRR). During Q12 FSO provided content for D.3.4 U-space adapter – Telemetry, Operation Plan, Geozones. Participation and support to the integration session of release 3.

*18-OPL* is not partaking the Task 3.4.

19-MOE supported the Athens trials, by providing at the Egaleo stadium “Stavros Mavrothalassitis” the portable edge computing solution throughout the Reporting Period.

20-ORA did implementation of a software component for collecting radio signal KPI to be used by enablers on geo-location of UAV based on signal strength and UAV optimal trajectory during Q9. It submitted a paper the ‘trajectory enabler’ to a journal and did an implementation of the ‘attestation’ enabler. During Q10 ORA did validation of the Attestation Framework for Flexible Data Protection for Drone Systems. During Q11 ORA has provided a description of our enablers into D3.3 and D3.4. during Q12 the Morinant enabler finalised. Input for 2 enablers (Attestation, Morinant) was reported in D3.4.

21-UMS contributed to the deliverable D3.2 by providing input on its enablers and use-cases during Q9. UMS also worked on the continued development of its enablers and completed a Beta release with development of UAV interfaces API to interact with Trial controller and Mission monitoring task. Other feature development included a) integration with Drone from Hepta & installation of necessary payload b) APIs to integrate with U-Space Adapter c) Integration with 5G edge infrastructures, integration with UTM d) Multi-image analysis with live video feed. During Q10 UMS also worked on the continued development of its enablers. Several drone test flights has been conducted on UMS facilities. The new feature already developed in the previous quarter has been tested and validated. During Q11 UMS continued working on the development of its enablers. Several drone test flights have been conducted on UMS facilities. UMS also started to contribute to deliverable D3.4. During Q12 UMS continued working on the development of its enablers. Additional drone test flights has been conducted on UMS facilities. UMS also contributed to deliverable D3.4.

## 8.4. WP4 Integration and trial validation

### 8.4.1. Progress towards objectives and details for each Task [UMS]

#### WP4 Objectives

- Objective 5: “**Validate 5G KPIs that demonstrate execution of UAV use cases**”
- Objective 6: “**Validate UAV KPIs using 5G**”
- Objective 7: “**Advanced data analytics tools to visualise and deeply analyse the trial results, and provide feedback to the 5G and UAV ecosystem**”

To this end, the following specific objectives will be pursued:

- Integration of the developments of WP2 (trial controller) and WP3 (5G!Drones enablers) towards a full 5G!Drones architecture on top of the selected 5G trial facilities.
- Detailed design of trials.
- Execution of trials for the 5G!Drones use cases on the selected trial sites.
- Validation of the vertical service and 5G related KPIs.
- Evaluation of the performance of the use cases.

Identification of necessary enhancements in the used 5G facilities, and the 5G system in general and provision of recommendations.

#### WP Tasks and interrelations:

- T4.1: Software integration and 5G!Drones architecture validation (M6-M36) [DRR]
- T4.2: Preparation and execution of trials (M12-M42) [CAF]
- T4.3: Evaluation of trial results (M20-M42) [COS]

#### Description of work

This is the work package where most of the efforts of the project will be put. It involves all aspects that have to do with the execution of trials. T4.1 is responsible for the integration of the software and hardware components that will be developed in WP2 and WP3, leading to a fully functional 5G!Drones trial architecture on top of the selected 5G facilities. Task T4.2 is where the use case scenarios, defined in detail in T1.2, will be trialled, after a careful design of a trial plan and a preparation phase. T4.3 will use advanced data analysis tools produced in T2.4 to evaluate the results of the trials from the perspectives of both the UAV industry and the 5G system. These results will be fed back to T1.1 to re-evaluate the role of 5G technology in the UAV ecosystem and provide recommendations to the appropriate bodies and stakeholders.

#### **Main Progress in the period:**

Within Q9 Task 4.1 focused on two key activities: Integration testing for Release 1 and submission of D4.2. As part of the first activity, DRR made further improvements to the deployment architecture for use case scenarios. In addition, integration tests were conducted at EUR in June, 2021 followed by preparations for trials in AU and UO. Work on D4.2 was finalised and the deliverable was submitted to the Commission at the end of July. Task 4.2 primarily focused on conducting trials as a follow-up to the integration activities and preparing and submitting D4.3. Trials were conducted at EUR in June, NCSR in July and AU & UO in August. Although officially kicked-off in July, Task 4.3 had a slow start due to the holiday months. During Q10 Task 4.1 was mainly focused to plan, prepare, and execute the integration testing of Release 2, Trial Controller Release as already described in D4.2. Then three different integration tests have been performed during the month of November. Task 4.2 was mainly focused on the planning and preparation of the EUR physical trials involving all the scenario leaders, that has been planned to be performed within December 2021. Task 4.3 was mainly focused to identify the proper methodology towards the assessment of project results, that shall be executed with the final trials in 2022. In particular, many discussions were focused on the definition of the fundamental KPIs to be tracked. During Q11 Task 4.1 was mainly focused to execute the integration testing of Release 2, Trial Controller Release as already described in D4.2. Then two different testing workshops were performed in December 2021 and January 2022. Task 4.2 was mainly focused on the preparation and execution of the EURECOM physical trials involving all the scenario leaders that have been performed from 16th to 18th of December 2021. Then a new plan for the next trials to be performed has been drafted. Task 4.3 was mainly focused to identify and define the fundamental KPIs to be tracked in the execution of the final trials. During Q12 Task 4.1 was mainly focused to execute and evaluate the integration testing of Release 3, Trial Controller Release as already described in D4.2. Then the basis for the Release 4 integration testing has been started. Task 4.2 was mainly focused on the preparation of the new drafted plan for the next trials to be performed. It was also focused on checking and analysing the facilities 5G SA network capabilities. Task 4.3 was mainly focused to the identification of the test cases that are relevant for the evaluation of project results and the showcasing of the project's lessons learnt. In addition, the initial ToC for D4.4 has been proposed and agreed.

#### **Significant results**

Integration tests for Release 1 were conducted at EUR, DEM, AU & UO within Q9. In addition, successful trials were conducted at all four trial facilities with multiple partners involved. Finally, D4.2 and D4.3 were successfully submitted to the Commission. During Q10 three integration tests workshops for Trial Controller Release 2 has been performed in November, 2021 (10.11., 17.11., 24.11.). EUR physical trials has been planned to be performed from 16<sup>th</sup> to 18<sup>th</sup> December 2021. During Q11 EUR physical trials has been performed from 16th to 18th December 2021. Two integration tests workshops for Trial Controller Release 2 have been performed in December and January. During Q12 Release 3 Trial controller testing execution successfully completed.

#### **Deviations from Annex I and impact on other Tasks, available resources and planning**

None.

#### 8.4.2. Task 4.1 Software integration and 5G!Drones architecture validation (M6-M36) [DRR]

##### Task Objectives:

The role of T4.1 is to deliver a *fully-fledged trial system* including all the necessary components at the UAV service and the infrastructure levels for the execution of the selected trials over 5G facilities. It will *integrate the 5G!Drones trial controller and 5G!Drones enablers, including UAV-service-related software and hardware*. Given the *size and complexity* of the project, with lots of heterogeneous components that are to be implemented and integrated with existing ones in a manner compatible with the trial facilities, a detailed *integration plan* will be created early in the course of the Task, which will drive all integration activities in the project. This plan will define the integration and testing procedures and environment (including development and testing methodologies, tools, interfaces, and validation criteria) which will manage how the software and/or hardware modules that will be progressively delivered by WP2 and WP3 are *incrementally deployed and tested in the trial facilities*. Following the plan, the following activities will take place within this Task:

- Incremental deployment and unit tests in a laboratory environment.
- Deployment and individual component testing on the 5G facilities.
- Functional tests for the validation of the 5G!Drones architecture.
- Integration and testing of the UAV hardware in the target ICT-17 facilities and other supporting 5G facilities.
- Functional tests of the selected scenarios over the selected facilities.

This Task will work in close synergy with WP2 and WP3, providing continuous feedback from the integration activities for the refinement of the designed trial architecture and enablers. The integration plan will be reported in **D4.1** at M07 and refined in **D4.2** at M26.

##### Task Activities during the period:

The main focus during Q9 was to finalise and submit D4.2 deliverable. During that period missing content like Release 2-4 descriptions were provided, whole document received final shape, had been reviewed and submitted in time by the end of June, 2021. Detailed scope of Release 1 integration tests including tests specifications was prepared based on the approach described in D4.2. In June Release 1 integration tests during the trial in EUR were performed. Similar tests were also scoped and performed in August in AU and UO during the respective trial rounds. During Q10 the main focus was to plan, prepare and execute the integration testing of Release 2, Trial Controller Release. The scope of Trial Controller integration tests (Release 2) covered following processes: Initial creation and validation of the trial, Setup of 5G services for the trial, Trial activation, Trial execution (from UAV take off to landing), KPI measurement job creation and execution and Service decommissioning. Detailed scope of Release 2 integration tests, including tests specifications (44 test cases), were prepared based on the approach described in D4.2. Integration testing was planned in the form of integration workshops involving all partners developing Trial Controller and all facilities. In November 3, 2021 integration tests workshops (10.11., 17.11., 24.11.) were performed. During workshops we performed defined tests, gathered valuable input and feedback for further adjustments and corrections of the Trial Controller system. During Q11 the main focus was to execute and finalise the integration testing of Release 2, Trial Controller Release. The scope of Trial Controller integration tests (Release 2) covered following processes: Initial creation and validation of the trial, Setup of 5G services for the trial, Trial activation, Trial execution (from UAV take off to landing), KPI measurement job creation and execution and Service decommissioning. Detailed scope of Release2 integration tests, including tests specifications (44 test cases), were prepared based on the approach described in D4.2. Integration testing was planned in the form of integration workshops involving all partners developing Trial Controller and all facilities. In December, 2021 and January, 2022 two testing workshops were performed. During workshops we performed defined tests, gathered valuable input and feedback for further adjustments and corrections of the Trial Controller system. Besides workshops involved partners performed also dedicated testing session aimed on validating patches and fixes to the Trial Controller's components. In February, 2022 we have completed full scope of tests and retests of the Trial Controller. During Q12 the main focus was to execute the integration testing of Release 3, KPI



Integration Release. The scope of KPI integration tests (Release 3) covered following processes: defining KPIs sets to be provisioned per different facilities, provisioning KPI measurement jobs on facilities during trial commissioning, receiving KPI data streams, uploading data to KPIC. Detailed scope of Release 3 integration tests were prepared based on the approach described in D4.2. Integration testing was performed in the form of series of integration testing sessions. During sessions we performed defined tests, gathered valuable input and feedback for further adjustments and corrections of the KPI handling process. We tested on-line KPI data streaming from AU, OU, and EUR. The NCSR facility related KPI data was uploaded off-line through files.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-*UO* plans and maintains University of Oulu integration and test plan, schedule, and resources. *UO* contributed to document D4.2 creation and made *UO* review sessions for the D4.2 during Q9. Active contributions in 5G!Drones project integration plan creation were made. *UO* did 5GTN integration activities: update of Qosium Storage application and database at the 5GTN facility; Software integration of LCM; Trial Enforcement; Abstraction Layer; KPI Measurement; Measurement Job and Slice Parser APIs for August 2021 Trials. *UO* made contributions on the integration approach at 5GTN facility, updated integration plan for capabilities delivery plan, use case enablers and release 3 of KPI release on the Deliverable D4.2. During Q10 *UO* Actively participated in 5G!Drones project integration plan creation and execution. Acquiring, configuring, and taking into use new test equipment for 5GTN/5G!Drones. *UO* had internal discussions of the integration plan for the KPI system at the 5GTN facility. For the Integration Test Workshop, the 5GTN facility adapter was communicated, tested, and integrated to the Trial Controller components like Abstraction Layer (API Gateway) via VPN and Trial Enforcement hosted at Aalto University. *UO* Updated Qosium Storage application and database at the 5GTN facility for further tests using the 5GTN Facility Adapter during the Integration Test Workshop and further trials. Significant work was done for configurations and tests of the communication between the Docker subnet from X-Network in Aalto University and the subnet from 5GTN at the University of Oulu using the VPN connection. Testing Aalto's API Gateway of Abstraction Layer can send the related requests to the 5GTN Facility Adapter via the VPN for measurement jobs control, KPI measurements collection/posting and network slice creation. *UO* did creation of Integration Tests Specification in detail for Measurement Job creation and collection/posting KPI measurements from the 5GTN facility components towards the KPI Monitoring Component hosted at Frequentis. Successful tests for integration of Trial Enforcement (Demokritos/Aalto University), Abstraction Layer (Aalto Univ.) and 5GTN Facility Adapter (University of Oulu) to perform network slice and measurement job creation at 5GTN facility were made. Continuous work with the Nokia team to complete the integration of the LCM with 5GTN Adapter to create network slices and measurement jobs using the Trials created at the Trial Repository (Aalto University) to be used in next Integration Test Workshops were being done. During Q11 *UO* has actively participated in 5G!Drones project integration plan creation and execution. *UO* integrated and tested 5GTN Adapter with Abstraction layer. Additionally, *UO* attended Integration workshops to test the end-to-end system integration that was followed by minor bug fixes. *UO* made contributions by reviewing and adding comments and parameters for the first document definition that contains timestamp data, UAV data, UTM data, GCS data, payload data, and data analysis defined initially by RXB. Technical discussion with Keysight team to get details of current capabilities of Nemo Handy, Nemo Cloud, and Nemo Analysis to use them to provide collected data to the 5G!Drones platform. During Q12 *UO* has been acquiring, configuring and taking into use new equipment for 5GTN/5G!Drones. *UO* actively participated in 5G!Drones project integration plan creation and execution. *UO* worked with AU's team to re-establish the communication between AU's abstraction layer and *UO*'s 5GTN facility adapter by executing the Iptables rules. *UO* worked with the Keysight team to enable Nemo Handy to send radio-related measurements to Dropbox and thus the 5GTN facility. *UO* improved the measurement collection and publishing from the 5GTN adapter to sync faster radio-related measurements collected each second

by Qosium Probes in the 5GTN facility. Also, UO updated and tested the new domain (<http://5gdrones.comnet.aalto.fi>) and new subdomains from AU's facility to enable 5GTN to interconnect with them. UO performed with the INV team end-to-end trials from the web portals 1 & 2 by scheduling and creating a trial, network slice, and measurement job of KPIs at the 5GTN network and sending results toward the KPIC. UO coordinated with AU, EUR, and the NCSR platform teams to update the trial enforcement, abstraction layer, and facility adapters to enable Trial-ID as a parameter in the body request to create measurement jobs and provide it into the KPI data streaming sent to KPIC. UO performed tests of Qosium Probe on One Plus 9 pro, Samsung 21, and Huawei P40 Pro to measure and collect the RSRP, RSRQ, and SINR metrics using Qosium and provide them to the KPIC. UO has improved the 5GTN facility adapter for radio-related data collection and publishing.

2-THA contacted the platform owners to enquire about opportunities to integrate them for upcoming trials as a provider of several enablers defined in WP3 during Q9. In this reporting period, essential technical aspects of integration of security and trajectory planning enablers have been discussed with partners. The architecture of trials and their flowchart has been updated regarding security enablers. For the second-year review of the project, THA prepared a demo session in order to show the status of technical features and web-portals. With different scenarios, THA tried to highlight the potential of integration and architecture validation of the project towards final use-cases. THA integrated the IAM security enabler with the Trial Controller's Web Portal (INV) to be used in the trials and deployed the PKI security enabler on Aalto servers to be made available for the Trial Controller (or trials) as well. THA contributed to deliverable D4.2 (security requirements). During Q10 THA participated actively to every Release 2 test workshops and helped testing its security enablers integrated in the Web Portal. Support has been provided for the IAM security enabler when needed. THA also started discussions with EUR in order to integrate its trajectory planning enabler to the 5GEVE facility. Details of this integration were still being discussed. During Q11 THA carried out integration of the IAM security enabler with the Trial Controller's Web Portal to be used in the trials and deployed the PKI security enabler on AU servers to be made available for the Trial Controller (or trials) as well. During Q12 THA discussed with platform owners to discuss integration in trials of the different enablers it has defined in WP3. THA also worked on the update of the architecture of trials and their flowchart regarding security enablers. THA also continued the integration of the IAM security enabler with the Trial Controller's Web Portal and deployed the PKI security enabler on Aalto servers to be made available for the Trial Controller.

2.1-ERC presented the architecture of the Search&Rescue radio signal detection defined in T3.4 along with high level requirements for the integration with the drone (power supply and data link) during Q9. ERC had no activity on the Task between Q11 and Q12.

Deviation and corrective action: Testing will be done in lab only and in standalone mode as a simplification. ERC will use a relevant testing environment with real radio signals along with software simulation capabilities.

3-ALE has ensured that the interfaces of its enablers of WP3 were ready for integration during August, 2021 Trials in Oulu during Q9. Between Q10 and Q12 ALE has worked towards the integration of its enablers into the Use-Case scenario. Local tests have been performed to assess the integration between ALE's software enablers and the hydradrone enabler.

4-INV was performing its internal Web Portal module tests during Q9 as well as integration tests with all already available modules: IAM from THA, repositories (managed by AU), Trial Validator (RXB and FRQ), and Facility Web Portals (NCSR, EUR, AU). The open item was the access to Facility Web Portal of UO. INV internally keeps the list of the found bugs and corrections, things to do with priorities and integrations to be performed and verified. During Q10 INV was participating to several Release 2 testing sessions, as Web Portal 1 module owner. The reports from these tests were made to document the results, problems found and change requests. After each session INV was working on implementing the fixes and adding new functions, which were identified. INV has added the GPRD



statement to users accessing Web Portal 1, to be compliant with legal requirements. New requirements related to the flight execution were also defined (interworking with LCM, Trial Validator and repositories). INV keeps and constantly updates the list of the found bugs and corrections, things to do with priorities and integrations to be performed and verified. During Q11 INV was participating in Release 2 integration meetings, removing identified bugs and modifying Web Portal 1, according to the approved change requests. INV agreed and updated the flows for mission planning and execution with the relevant statuses. INV, as a leader of Release 3 integration activities, proposed the scope of work, objectives and lead the activities related to this release. Work is on-going. INV also worked on the REST APIs to upload our traffic data stream to KPI Component hosted by FRQ. INV had no activity on the Task during Q12.

5-HEP contributed further to deliverable D4.2 creation and worked on integrating our software and hardware components with the trial architecture during Q9. This included installation and experiments with Qosium, PTPd, ensuring that our software enablers interface well - integrating on-board computer software with Hepta cloud. HEP also integrated the sensors, on-board computers and other hardware needed in the trials onto H19 helicopter drone. During Q10 HEP participated in release 2 working group meetings, had internal discussions on the structure and organisation of release 4, did work on integrating our enablers for our use case – test design, implementing PTP. HEP also contributed to Web Portal 1 testing. During Q11 HEP has done work on UAV and GCS logs integration to KPI component. During Q12 HEP participated in release 3 meetings and done release 4 planning. HEP has also done planning for conducting technical integration tests in Oulu prior to June 2022 testing. HEP has also completed a script for converting UAV and GCS logs into a format fit for uploading to KPIC. Furthermore, HEP has done work to replace our previous IPv6 based VPN software against an IPv4 alternative that would work with Qosium for taking measurements during the trial.

Deviation and corrective action:

HEP was missing from some bi-weekly meetings due to reorganisations in the company during Q11. HEP has assigned a new project manager and reorganised the work and solved this problem. During Q12 HEP skipped some WP4 meetings due to re-arrangements in the company. Participation was resumed to normal and no further corrective action is needed.

6-NCSR D contributed in the integration activities of Web Portal 1 and Web Portal 2 during the July, 2021 trials in Athens. Moreover, integration activities were taken place for the provision and execution of the simulated testbed demo, during the Period 1 review meeting. Contributions to D4.2 were made during Q9, showing the complementarity of the 5G!Drones system with Open5GENESIS framework. During Q10 NCSR D participated actively to every Release 2 test workshops and helped testing its management layer/trial enforcement controller and documented also the results. Problems found and change requests were properly fed to WP2. All the enablers have been maintained/updated based on the feedbacks from these integration sessions. During Q11 NCSR D has participated to the various integration activities and sessions performed, providing updates and enhancements of the abstraction layer, as well as contributing with the Athens platform web portal. Work is on-going. During Q12 NCSR D participated in all the integration sessions of the third release, especially considering the KPIs assessments needed for the final showcasing events in Athens platforms.

7-AU worked towards the preparation of the integration tests planned and performed on August 19th 2021. The integration concerned the redirection from Web Portal 1 to Web Portal 2 of AU and also the integration of the different enablers with the trial repository. A bug related to Web Portal 2 of AU was reported during Q9 where AU took the action to fix it. In addition to this, AU also worked on the integration of its facility to send the collected KPIs to the KPIC enabler hosted at FRQ premises. This integration has been tested during the integration session. AU is also hosting different enablers developed as part of WP2, including web portal1, trial repository, trial enforcement, and the LCM. AU has therefore been dealing with requests from the developers of the enablers to provide and maintain the computing/storage resources (i.e., providing access to virtual machines, opening ports, etc.). During Q10 AU participated and contributed to all the workshop session of release 2 dedicated to trial

controller integration. To this end, AU prepared it enablers from WP2, represented by the trial repository and its web portal, and WP3, represented by its edge platform. All the enablers have been maintained/updated based on the feedbacks from these integration sessions. Furthermore, AU is hosting most of the enablers of WP2, in addition to the abstraction layer, and has continuously dealing with technical requests from the involved partners (e.g., VPN connection, access resources, ...). During Q11 AU has heavily contributed to the integration of task the project throughout the different integration sessions. From WP2 enablers, AU was contributing with its Web Portal and the trial repository enabler developed by AU. As from WP3, AU has contributing with the abstraction layer, also developed by AU. Furthermore, AU hosts in its infrastructure most of the enablers developed in the project, and has been constantly dealing with technical requests (e.g., maintaining VPN connection to 5G-EVE and 5GTN, maintaining and updating firewalls in the different virtual machines provided to the partners, etc.). During Q12 AU participated to several integration sessions of release 3. The focus of the release is the KPI integration, where AU has been evaluating the integration of its measurement jobs (from both edge-server and UEs) with the KPI component. Several meetings have been organized with INV, leader of this release. In addition, AU had to update the current deployment of the services provided by its facility, along with the domain name. the updates were conducted smoothly without interrupting the services. All the partners have been updated about the new domain name. Furthermore, AU hosts in its infrastructure most of the enablers developed in the project, and is constantly dealing with technical requests (e.g., maintaining VPN connection to 5G-EVE and 5GTN, maintaining and updating firewalls in the different virtual machines provided to the partners, etc.).

8-COS had no activity on the Task during the Reporting Period.

9-AIR integrated Mission Critical Collaboration Platform into 5G infrastructure provided by EUR during Q9. AIR integrated CCP with plugins and applications provided by partners involved in Public Safety use case. During Q10 AIR implemented and released new version of Mission Critical Collaboration Platform for 5G infrastructure that will be demonstrated during next physical trial on EUR infrastructure planned in December, 2021. During Q11 AIR has coordinated with UC2Sc1 partners integration tasks ensuring December trial session on 5G-EVE platform. During Q12 AIR has released drone specific version for Mission Critical Platform and released the package for integration with 5G infrastructure.

11-INF made monitoring and analysing Task 4.1 activities from a business perspective, communicating the results through social media and website, linking Task 4.1 activities to Task 4.2, Task 4.3, Task 1.1 and Task 5.1 for evaluating business impact. INF did preparation for Period 1 review in Q9. During Q10 and Q11 INF was addressing review comments. During Q11 and Q12 INF was verifying enablers that have been maintained/updated based on the feedback from integration sessions in 5GENESIS Athens platform. During Q12 special consideration was put on the 5G CPE integration and KPIS assessment for Athens trials.

12-NOK contributed to D4.2 related UC3Sc3 and Release 2 part during Q9. It helped AU and UO to integrate LCM to their environment. NOK participated in integration test session (release 1 content) during UO trials. During Q10 NOK created practices for T4.1 Release 2, like status reporting, contacts etc. together with DRR, INV and other partners. NOK participated to integration workshop from Release 2 and LCM perspective. NOK had no activity on the Task between Q11 and Q12.

13-RXB contributed to activities related to Trial validator & KPIC during Q9. During Q10 RXB actively took part in the integration test workshops. During Q11 RXB provided support and clarifications on topics related to Trial Validator & KPIC. During Q4 RXB partook in workshops for Releases 2 and 3.

14-EUR conducted several integration sessions during Q9 to validate: (1) the integration of the Web Portal 2 with the Web Portal 1 and with the Trial Repository; (2) the integration of the Abstraction layer and the 5GEVE facility through the parser developed in T3.3; (3) the KPI collector of the parser with the KPI Monitoring module hosted at FRQ. Besides, EUR has worked on the Period 1 demo by developing a light LCM to ensure an end-to-end deployment of a trial on top of the 5GEVE facility that

has been demonstrated live during the review meeting. During Q10 EUR was supporting the 5G!Drones trial Engine components integration on the 5GEVE facility. Besides WP4 meetings, EUR was participating in the 3hours weekly meeting on integration. During Q11 EUR took part to the integration plan, and provided support for the integration of EUR Web Portal 2, Abstraction layer, and the integration of KPI measurement to FRQ portal. During Q12 EUR contributed the validation process of Release 2 and 3. EUR validated the new abstraction layer that is compliant with KPI model of FRQ.

**15-DRR** did preparation of status update of T4.1 (15.06., 29.06.); Reviewing, merging and updating D4.2, finalization and submission during Q9. It did preparation of integration tests for trials in AU and UO and scoping of tests, defining test case specifications. During Q10 DRR did preparation of T4.1 summary slides for Period 1 review. It made planning, preparing, and rehearsal of integration demos for Period 1 review. DRR did release 2 planning discussion with NOK, drafting test scopes and test scenarios for Release 2, and release 2 working group meeting discussion. During Q11 DRR coordinated integration tests for Release 2. It coordinated resolving found issues and bugs during tests and prepared plan and scope for Release 3 (KPI release). DRR did data integration log preparation (Operational Flight Plan), T4.1 status preparation (integration tests summary), and coordinating integration tests for Release 2 (fixes validation). During Q12 DRR did testing, coordinating resolving found issues and bugs during tests of Release 3 - final tests with AU, UO and EUR. It did T4.1 status preparation for bi-weekly review meetings of WP4, provided tests support, reviewed known issues, tests on flight plans and geozones data exchange, and SW patches for found bugs.

**16-CAF** contributed to writing and reviewing deliverable D4.2 during Q9. CAF prepared and participated in integration tests for trials in EUR (in June, 2021 remotely) and AU and UO (in August, physically). During Q10 CAF participated actively to every Release 2 test workshop and helped testing Web Portal 1 components and contributed feedback from the drone operator. During Q11 CAF participated in regular Integration workshops and contributed to the test cases. For December 2021 EUR trials CAF led the preparations to define integration test cases. During Q12 CAF has worked towards the integration of its enablers into the use cases and scenarios in which CAF participates. CAF participated in the Release 3 integration workshops and activities.

**17-FRQ** contributed to deliverable D4.2 during Q9. During Q9 and Q10 FRQ worked with different partners on integrating the UTM system via the U-Space adapter, especially the drone flightplan integration towards Trial Controller as well as UTM synchronisation to DRR. During Q11 FRQ participated in regular Integration workshops with partners, U-Space adapter as well as Trial Validator and KPI Component. It contributed to clarification sessions in regard to general KPI topics, KPI harmonisation and visualisation. During Q12 FRQ participated in and supported release 3 activities. It updated provided components based on findings. Supporting test runs for U-space adapter and Trial Validator component were done.

**17.1-FSO** contributed to deliverable D4.2 during Q9. During Q9 and Q10 FSO worked with different partners on integrating the UTM system via the U-Space adapter, especially the drone flightplan integration towards Trial Controller as well as UTM synchronisation to DRR. During Q11 FSO participated in regular Integration workshops with partners, U-Space adapter as well as Trial Validator and KPI Component. It contributed to clarification sessions in regard to general KPI topics, KPI harmonisation and visualisation. During Q12 FSO participated in and supported release 3 activities. It updated provided components based on findings. Supporting test runs for U-space adapter and Trial Validator component were done.

**18-OPL** contributed to and made final review of D4.2 during Q9. OPL had no activity on the Task between Q10 and Q12.

**19-MOE** contributed in the integration activities which were taken place for the provision and execution of the simulated testbed demo in Athens, during the Period 1 review meeting during Q9 and Q10.

During Q11 and Q12 MOE participated in the integration activities and sessions performed, as well as contributing with the Athens platform Web Portal.

20-ORA had no activity on the Task during the Reporting Period.

21-UMS expended efforts in providing required contribution in D4.2 during Q9. It also engaged with EUR to integrate its software modules on their MEC infrastructure. In addition, UMS as WP leader oversaw work on D4.2 and ensured that it was delivered on time. During Q10 UMS expended efforts to integrate its software modules on the EUR MEC infrastructure. During Q11 UMS expended efforts to analyze the proper solution to integrate the software modules on the EUR MEC infrastructure after the EUR trials results. During Q12 UMS contributed to the Release 3 testing definition and execution providing input and contributions when needed. UMS as the WP4 leader, organized and participated at WP4 tasks meeting.

#### 8.4.3. Task 4.2 Preparation and execution of trials (M12-M42) [CAF]

##### Task Objectives:

In this Task, the scenarios defined in T1.2 will be trialled over the 5G!Drones architecture which integrates the different 5G trial facilities. The activities of this Task are split in two phases:

- **Preparation phase:** Following an evaluation of the evolution and status of the available ICT-17 and other 5G facilities to which use cases have been mapped in T1.3, and the requirements of the use cases, as identified in T1.2, a detailed *trial plan* will be drafted for all use cases, including the 5G facilities for the execution of the trials, the interconnection of the trial sites, the KPIs to extract and the partners responsible for managing the trials. The trial plan will include *experiments of varying scales*, ranging from *small-scale, single-site trials* focusing on studying particular use case features which do not necessitate extensive deployments and lots of resources to *large-scale showcasing events*. The preparation phase also includes full *functional tests* of the selected scenarios over the selected facilities and preparations for showcasing trials. A critical aspect of trial preparation is planning the timing of trials: *Trial scheduling* should take into account the availability of facilities (and the amount of resources thereof for the execution of experiments) and the expected trial duration.
- **Trial plan execution and collection of trial results:** This is the main phase of the experiments, where the trial plan is executed. The orchestration of this activity and the collection of its results will take place using the interface of the trial controller. We remark that depending on the decisions that will be taken during the specification of the trial plan, multiple trials may take place simultaneously, potentially on top of a shared facility. Trials will commence after the delivery of the trial plan, marking **MS3** (M26).

An activity that will take place in parallel with trial execution is *trial demonstration*. Part of the trials specified in the trial plan will be on live showcasing events. For example, the plan will include showcasing the use case scenario that demonstrates enhanced connectivity during crowded events at the trial facility of the Municipality of Egaleo (municipal stadium). This is linked with specific communication and dissemination activities of WP5 and has as its focus not only to demonstrate the UAV-related use case scenarios, but also to demonstrate the operation and capabilities of the overall trial architecture and experimental methodologies. The trial plan (deliverable **D4.3**) will be delivered in M26. The trial results will be directly channelled to T4.3 as they become available.

##### Task Activities during the period:

All 5G!Drones partners contributed to the compilation of D4.3 during Q9. The CAF led the preparation, editing and review process of the D4.3 Trials plan document. D4.3 The Trials plan describes how the consortium is planning to conduct Trials 1st Round (2021), Trials 2nd Round (2022) and Showcasing Event (May 2022). D4.3 was submitted on July 30, 2021. At the same time, the following trials were



conducted by Task 4.2 taskforce partners: EUR remotely tests on June 17-18; physical tests at NCSR and COS premises on June 29-30; on August 20, physical tests at AU; and physical tests at the UO on August 24-31. The tests consisted of both integration tests and drone flights and were performed in collaboration with Task 4.1 and Task 4.2 partners. During Q10 the activities of Task 4.2 in September were mainly related to the preparation of reports of the trials executed in AU and UO in August 2021. A demonstration of UC2Sc1 was also conducted during the 2nd year Review meeting on September 9<sup>th</sup>. Preparations for EUR's 1st Round trials began in October. The UO was configuring their 5G SA base station so that technical tests could be carried out in early 2022, before the physical trials. In November, Task 4.2's main focus was on preparing for EUR's 1st Round trials. The planning of Task 4.2 activities was closely related to the activities of Task 4.1 (Integrations) and Task 4.3 (Results collection), so that the trials would maximally support both the collection of results and help to test the results of Integration Release 2. During Q11, in December 2021, EUR trials were prepared. Trials were conducted in physical presence on December 17-18. A total of 3 scenarios were tested and very good experience was gained from the cooperation of the partners as well as the readiness of the technical enablers for the final trials in 2022, and feedback was received, which needs to be further developed. Preparations and planning for the final trials in 2022 began in January and February. During Q12 the purpose of Task 4.2 was to have all the necessary technical resources and appropriate permits from the competent national authorities to carry out the tests scheduled for June-September 2022. All partners were involved in the preparation for the field tests to be trialed in June-September 2022. This included separate meetings and preparations with partners based on different facilities (5GEVE, 5GENESIS, 5GTN, AU X-network). The main focus was to ensure that the facilities are ready to provide a 5G SA network and that the 5G devices used by 5G!Drones partners could be connected to it. The 5GTN team in Oulu was configuring the 5G SA network to ensure sufficient coverage on UO Botanical Garden. The 5GTN team also worked to measure QoS parameters. The 5GEVE team worked on the components for measuring 5G Network QoS parameters. The 5GENESIS team performed several tests and configurations on the SA network and 5G devices. The AU team received new 5G devices, which achieved connectivity with the 5G SA X-network. In summary, as of May 2022, all four facilities will be able to provide 5G!Drones trials June-September 2022 with the 5G SA network. Drone operators (CAF, HEP, ALE) tested enablers and applied for legal permits. Telecommunications companies ORA and OPL, COS made preparations to measure 5G QoS parameters. Scenario leaders defined and prepared experiments descriptions.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

1-UO was planning how to do KPI measurements in University of Oulu during Q9. Contribution to document D4.3 content creation, scope revision, and methodology discussion was done. UO was planning and acquiring measurement tools for KPI measurements in Oulu. UO had active participation in August Pre-Trials planning and testing execution. It made contributions about trials evaluation objectives, KPIs, measurement methodology and tools at Section 3.4 of Deliverable 4.3. Organization of KPI workshop series with the NOK team to discuss network service KPIs, UAV/UAS side KPIs, and business KPIs. UO did configuration of Qosium Probes on devices (cell-phones, laptops, servers, UAVs) involved in measurements and central server for measurements IDs control on 5GTN components, and LCM installation at 5GTN with the help of the NOK team. UO did LCM configuration to work with the endpoint of the Trial Repository located in Aalto University and Trial Enforcement and Abstraction Layer installed at the University of Oulu. UO did initial configuration with Aalto partners to work over the VPN/SSL IKEV1 connectivity among the UO and AU networks, and initial integration and enabling for Trial Enforcement work together Abstraction Layer at 5GTN with the help of NCSR. UO planned and coordinated with partners (CAF, HEP, NOK, and ALE) for KPIs measurement of involved equipment (laptops, mobile devices, UAV) with Qosium at August 2021 Trials. UO did Trial Enforcement and Abstraction Layer integration at 5GTN to enable both works together for KPI measurements during August trials. Tests of cell phones using Qosium Probes by sending the KPIs

to the Qosium Storage DB and storing the KPI measurements during August 2021 trials. Support to CAF, HEP, NOK, and ALE teams during the August 2021 trials. Documentation and description of Oulu integration tests result for creation and deletion of Measurement Jobs and receiving KPI data at Kibana datastore from FRQ. During Q10 UO took part in integration activities, such as integrating 5GTN Adapter with Abstraction Layer and Testing the Functionality of 5GTN adapter with other Trial controller components like Trial Enforcement, LCM and Trial Repository. UO continued planning and acquiring measurement tools for KPI measurements in Oulu. UO did provision and explanation to Hepta team about KPI measurements collected during the 5G!Drones Oulu trials in August using Qosium and Nemo tools for further analysis. UO conducted tests using Nemo Handy on 5G smartphones connected to Nokia Radio Equipment at Botanical Garden and subscribed to SA 5G core software to collect signal strength network KPIs for integration with the 5G!Drones platform. This with the aim of collecting the Nemo Handy measurements in a unique DB to provide them to the Trial Controller of the 5G!Drones platform. During Q11 UO has been testing Aalto's API Gateway to manage the measurement jobs, collection and posting KPIs. Tests using 5G smartphones with Nemo Handy installed and connected to the 5GNR to measure the signal strength and store measurements at the KPIs DB of the 5GTN. Integration tests of Trial Enforcement, Abstraction Layer and 5GTN Facility Adapter to create network slice and measurement jobs were made. Parser implementation was done for radio Nemo Handy measurements collection at 5GTN. Maintaining, bugs fixing, optimizing, troubleshooting, adding missing functionalities at 5GTN Facility Adapter, specifically for the Measurement Job, KPI measurement, and Network Slice. Reestablishment communication among Abstraction Layer server in AU and 5GTN Facility Adapter by executing the Iptables rules. During Q12 UO has been planning how to do KPI measurements at the University of Oulu. Also, UO has continued defining, planning and acquiring measurement tools for KPI measurements in Oulu. It made contribution to 2022 test planning. UO coordinated with each use-case leader to obtain a technical description of the requirements and enablers that will run the next technical tests. UO has worked on preparing the 5GTN facility to support the requirements and enable run the enablers of each partner to execute their use case during the next trials. UO has carried out tests to measure, collect, and publish KPIs from the network and radio devices at the 5GTN facility. UO has tested by measuring signal strength and interference using Nemo Handy installed on 5G smartphones (One Plus 9 pro and Huawei 40 pro) connected to the 5GNR from the ground and to store them as KPIs measurements. UO coordinated with each partner to run pretests of use-cases to validate the collection of required KPIs from the network, radio, and even UAV and thus be prepared to run suitably the next trials per test case in the 5GTN facility.

2-THA enriched the ongoing discussions to prepare the pre-trials of august 2021 during Q9. Feasibility and technical propositions have been suggested to show the maximum interaction between WP3 and WP2 components. Monitoring mechanisms and validation scenarios have been defined and discussed deeply for the result and KPI validation of trials. These actions helped THA to prepare the second-year review of the project. Also THA provided some support on the IAM enabler instance (Aalto server) that is integrated with INV's Web Portal, in order to prepare the pre-trials and trials at Aalto and Oulu. Set up the web server security (HTTPS reverse proxy and PKI certificate) for Internet access. During Q10 THA participated to the different preparatory meetings and discussions for December's physical trials in Eurecom (EUR). THA also provided some support on the IAM enabler. During Q11 THA participated to the discussions regarding the preparation of the final trial in Athens and at AU as well as discussing about the scenario to be demonstrated. During Q12 THA participated to the discussion regarding the experiences to be run in EUR and to the analysis of the outputs of these experiments.

2.1-ERC has not yet contributed to this Task in waiting for further progress with the development of the Search&Rescue radio signal detection enabler.

3-ALE took part in August 2021 Trials in Oulu with both local and remote participation. As a sub-scenario leader, ALE had an active role in trials preparation. During the trials, ALE WP3 enablers were deployed, integrated and tested, providing end-to-end feedback on ALE's enablers. During Q10 ALE



has processed the data collected during the previous period Trials in Oulu. ALE's conclusions regarding these trials have been presented to partners. During Q11 and Q12 ALE has been working towards the integration of its use-case in the new UAV legislation that is henceforth in application in Finland.

4-INV participated to the preparatory meetings and remote pre-trials in EUR in June, 2021. INV was testing the first release of the Web Portal and its integration with EUR Facility Web Portal. The report was filled and submitted after the tests. In August, 2021 INV participated to all preparatory meetings for pre-trials in AU and UO and to trials. During the Finland's pre-trials, the Web Portal was used for UAV definition and Operational Flight Planning and no major problems were detected. Minor errors were removed during the trial's time. INV filled and submitted the trial report for all tests performed in August. We were also working to prepare the demo for P1 review meeting. Since September, 2021 INV participated to several preparatory meetings for physical trials in EUR. INV was using Web Portal 1 and preparing its enablers to be used during the tests planned for December, 2021. INV was working to make accessible INVOLI.live stream to the UMT systems used during the trials: FRQ and DRR. INV also shared with partners description of our telemetry data from our networked Remote ID tracker. During Q11 INV was participating to the on-site tests in EUR, as a leader of UC1Sc1. INV met with all other participants of this use case, performed the tests and performed the analysis, which will be useful for conducting the next round of tests in 2022. During Q12, For Task 4.2, INV was focusing its activities on the tests we will perform this summer in EUR. Having the experience from tests INV performed in December 2021, INV analysed the outcomes and drew the conclusions, which will be taken into account in the next round. We are preparing to the technical tests, which will be performed physically in the beginning of June, 2022. With other partners of UC1Sc1 INV was working on the test description and methodology, for trials in September, 2022.

5-HEP has consulted with Traficom on flight permits for Oulu trials during Q9, done further flight testing of UC3Sc1 Sub-Scenario 2 enablers in preparation for UO trial flights, constructed a mock-up power line for UC3Sc1 Sub-Scenario 2, has done administrative preparations for UO trials, participated in planning meetings for trials in UO and took part in UO trials. During Q10, HEP has prepared a trial report following the UO trial and did internal planning for May 2022 showcasing event. During Q11 HEP has done preparatory work for UC4 trial and UC3Sc1 Sub-Scenario 2. These works have been reinforcing the power tether to comply with 10x MTOW tensile strength requirement and research and preparatory work to obtain flight permits for trials involving H19 helicopter. During Q12 HEP has taken part of Athens trial preparatory meetings and drafted a new operations manual which includes H19 specifics to obtain pre-defined risk assessment (PDRA) based licence for flying at the trials.

6-NCSRDC contributed to D4.3 by describing the planning and the use-cases trials that will be performed during the last period of the project during Q9. Moreover, NCSRDC contributed to the proper configuration of the core network and the optical link between NCSRDC and COS for the execution of the July trials. Contributions in the configuration of the simulation testbed were also made by NCSRDC team during the reporting period. During Q10, following the July trials in COSMOTE campus, NCSRDC proceeded with the analysis of the trials and the production of measurements and visualisation charts. NCSRDC supported also the execution of the simulation demo executed remotely as part of the Period 1 review at COS premises. NCSRDC has also contributed in the planning in September 2022 final trials in Athens. During Q11 NCSRDC has initiated a dedicated telco for the preparation of the final trial in Athens. The focus during the reporting period was the definition of the drones that will be used for the needs of the trial, the use of new 5G CPEs, which are lighter than the originally planned, making easier feasible the implementation of NTN-5G by the use of drones. During Q12 NCSRDC has initiated a bi-weekly dedicated telco for the preparation of the final Athens trial. In collaboration with all the involved partners, NCSRDC has properly defined the tests and experiments to be conducted, considering also the involvement of additional 5G equipment provided by partners INF and COS. The Open5GENESIS experimentation framework has been properly configured and updated, in order to be adapted to the 5G-hat UEs that will be also used as measuring nodes. Additional support in

5GENESIS platform in order to be reassured its proper functionality and operation for the execution of the final showcasing events.

7-AU worked on the preparation of the trials planned and performed on August 20<sup>th</sup>, 2021. AU was therefore coordinating with CAF who is responsible for one of the scenarios which was trialed at AU facility. Several meetings were held to prepare the trials, where AU reported on the target locations to host the trials, the network quality, etc. During the trial day, two scenarios were successfully conducted, which are UC1Sc3, owned by CAF, and UC3Sc2, owed by AU. During Q10 AU has been in continuous discussion with CAF to fixing the dates of the next trials. It has been agreed that the next trials will be physical, and AU is discussing internally on the preparation for hosting the trials. During Q11 AU has been interacting with Task 4.2 leader to agree on the next trials that will be held at Aalto University. As preparation to the next trial, AU has conducted several internal discussions to ensure a good organisation of the next trials. These include, ensuring the availability of the SA network, ensuring the availability of the adequate UEs and working on connecting them to the network. During Q12 AU was continuing the preparation tasks for the next trials planned in June and August 2022. The conducted activity includes coordinating with Task 4.2 leader (CAF), ensuring the availability of the SA network, ensuring the availability of the adequate UEs and working on connecting them to the network. On the other hand, the preparation tasks also included preparing the drones for field trials related to the scenario led by AU.

8-COS prepared the 5GENESIS MEC environment at OTE Academy premises for the 2<sup>nd</sup> year trials and supported the pretrial preparation, and installed an outdoor 5G antenna to ensure appropriate coverage of the 5GENESIS 5G NSA network on the field of flight during Q9. During Q10 COS supported the execution of the simulation demo executed remotely as part of the Period 1 review at COS premises. COS contributed to the preparation plan for the execution of the final year trials. During Q11 COS has initiated the preparations of the final showcasing event. The involvement of the commercial COS network securing premium QoS, for this event has been secured. During Q12 COS was contributing to the final trial and demo of USC4Sc1 to be executed in Athens by participating in the design and planning of the trial activities. As part of the final demo COS is preparing a specialised Mobile RAN Unit (as a van) offering connectivity extension for the commercial network.

9-AIR contributed to first global trial implementing integration between 5G!Drones Portal 1, Portal 2 and vertical application (MCX application in this case) in the context of UC2Sc1 during Q9. This demonstrator illustrating a complete chain of 5G!Drones system was shown as reference during first period review in September, 2021. During Q10 AIR demonstrator application has been completed and it has been selected and demonstrated during first period review live demonstration illustrating the complete chain of 5G!Drones system. During Q11 AIR has contributed to December, 2021 trial execution on 5GEVE platform. A deep video demonstration is available on YouTube channel detailing the use case and innovative deployment tested through AIR 5G native mission critical platform developed. During Q12 AIR has contributed to next trial execution on 5GEVE platform with a new release of mission critical application. This new trial was expected to be held in May but is postponed to July, 2022.

11-INF INF analyses Task 4.2 activities from a business perspective, communicating the trial results through social media and website, linking Task 4.2 activities to Task 1.1 and Task 5.1. It participated to dedicated Task 4.2 telcos (following trials and tests) and Period review preparation during Q9 and Q10. It participated and documented Athens trials (5 days: 28 June to 2 July 2021). It also supported the rest pretrials by short reporting and communication material preparation (AU and UO). It made contributions for linking technical KPIs and metrics to business KPIs and impact. During Q10 INF participated to rehearsals and preparation for Period 1 review. It made pretrials short reporting and communication material preparation (website update and posts). It took action on reviewers' comment for short debriefing videos after trials (arrangements made with Task 4.2 participants for upcoming trials). During Q11 INF did pretrials reporting and communication material preparation (website update and posts) for latest trials in EUR. It made a trials debriefing video from EUR trials released in YouTube

channel. INF contributed to the preparation plan for the execution of the final year trials with focus on the planning in September 2022 final trials in Athens while ensuring with rest Greek partners the continuous operation of 5GENESIS Athens platform even after the end of 5GENESIS project. Participation to the dedicated telco for the preparation of the final trial in Athens and technical provision to be made on drones and 5G equipment to be used. During Q12 INF did website updates and posts related to trials and Task 4.2 activities. It participated in planning final trials in Athens in September 2022 and participated to bi-weekly dedicated telcos for Athens trials. INF made arrangements for provision of 5G CPE box equipment to be used onboard UAVs and planning of related tests and more specifically to be used as a coverage extension module on a moving node (e.g. drone). Ensuring with rest Greek partners the continuous operation of 5GENESIS Athens platform and Open5GENESIS even after the end of 5GENESIS project. Related updates have been made.

**12-NOK** designed and made preparations to Oulu trial tests for UC3Sc3 related parts during Q9. NOK participated to trials and testing NOK UAV enablers and UO 5G network. During Q10 NOK has tested and co-operated with UO to get Nokia's UC3Sc3 trial working in 5G SA mode. NOK had no activity on the Task between Q11 and Q12.

**13-RXB** supported partners to prepare for trials and ongoing tests during Q9. During Q10 RXB actively worked with all partners for trial preparation and coordination. During Q11 RXB provided AIRBOSS support for trials conducted and during Q12 it supported partners in trial preparation activities.

**14-EUR** conducted remote pre-trial tests in June, 2021 in EUR. For one week, three persons for full time and for one week have worked on integrating CAF UGS, AIR, and UMS simulator in the 5GEVE Openshift Cluster. Several live meetings have been conducted to test the software deployment and the pre-trial scenarios. During Q10: EUR has prepared a live demo of UC2Sc2 shown during the review meeting. EUR participated in all preparation meetings outside the WP4 bi-weekly slot. During Q11 EUR has hosted a pretrial test in December, 2021. To that end, EUR has dedicated three persons to prepare and coordinate the 5GEVE facility. This consisted in booking the facility, integrating the different software of the partners needed for UC1Sc1 and UC1Sc2. The trials took two days of tests, where EUR supported INV, CAF, AIR to run UC1 scenarios. During Q12 EUR worked on upgrading and testing the MCS application on the 5GEVE facility, as a new version has been provided by AIR. EUR is coordinating with CAF to host another physical pre-trial tests in the beginning of June, 2022.

**15-DRR** made preparation for EUR tests meetings. It prepared integration test plan and test specification documentation for EUR remote tests; Remote tests in EUR - completion of integration tests (17-18.06.) and preparation of integration tests for trials in AU (19-20.08.) and OU (24-27.08.): scoping of tests, defining test case specifications. During Q10 DRR had no activity on the Task. During Q11 DRR made preparation of integration (Trial Controller, U-space) and support during the field trials in EUR and preparation of DevOps environment for tests. DRR performed necessary updates and provided remote support of tests (on back stage). During Q12 DRR has made preparation planning for UC4Sc1 showcase, preparatory workshops.

**16-CAF** led the preparation, editing and review process of the D4.3 Trials plan document during Q9. D4.3 was submitted on July 30, 2021. The following trials were led by CAF where CAF also participated as drone operator: EUR remotely tests on June 17-18; On August 20, physical tests at AU; Physical tests at the UO on August 24-31. The tests consisted of both integration tests and drone flights and were performed in collaboration with T4.1 and T4.2 partners. During Q10 CAF led the activities of Task 4.2. In September, the UO and AU trials reports were prepared. CAF also participated in the preparation and conduct of the demonstration during the Period 1 review. Preparatory meetings and technical tests were held with the Eurecom team in October and November to conduct Eurecom's 1st round trials in December 2021. During Q11 CAF as Task 4.2 leader organised preparations for December 2021, EUR trials. Trials were conducted in physical presence on December 17-18. A total of 3 scenarios were tested and very good experience was gained from the cooperation of the partners as well as the readiness of the technical enablers for the final trials in

2022, and feedback was received, which needs to be further developed. CAF led preparations and planning for the final trials in 2022 which started in January and February. During Q12 CAF led the activities of Task 4.2. In addition, the CAF was involved in the preparation and planning of field tests for June-September 2022. This included meetings with partners, mapping of existing technical options and updating the Trials 2022 time schedule. The aim of the preparations is to have all the necessary technical resources and appropriate permits from the competent state authorities to carry out the tests in June-September 2022.

17-FRQ remotely supported the August 2021 UO Trial activities. FRQ provided input and content for D4.3 as well as a review of D4.3. During Q10 FRQ worked with various partners to prepare the upcoming EUR trials in December 2021, including datastreams from Involi tracker. During Q11 FRQ continued work on KPI harmonisation and supported partners in integration efforts. FRQ participated in discussion on KPI data provisioning. During Q12 FRQ supported the Trial preparations and according workshops.

17.1-FSO remotely supported the August 2021 UO Trial activities. FSO provided input and content for D4.3 as well as a review of D4.3. During Q10 FSO worked with various partners to prepare the upcoming Eurecom trials in December 2021, including datastreams from Involi tracker. During Q11 FSO continued work on KPI harmonisation and supported partners in integration efforts. FSO participated in discussion on KPI data provisioning. During Q12 FSO supported the Trial preparations and according workshops.

18-OPL did preparations for the review of D4.3. It started the preparation of the report on 5G coverage conditions at Sophia Antipolis testbed. During Q10 OPL continued working on methodology of prediction of 5G coverage in trial sites. It provided the preliminary internal report for Sophia site for analysis by partners. The results in the report to be validated in Sophia in December, 2021. During Q11 OPL participated in meetings on organisation of trials. During Q12: OPL did initial preparations of stand-alone field trialling of the UCC and UAV-NWDAF framework developed by OPL in WP3 and reported in D3.3, which will not be integrated with the 5G!Drones architecture.

Deviation and corrective action:

Between Q9 and Q11 travelling abroad was still banned in OPL due to the coronavirus situation. More active participation to trials will be possible once the ban is recalled.

19-MOE did contributions in the configuration of the simulation testbed made by NCSR and COS teams during the reporting period during Q9 and Q10. During Q11 and Q12 MOE contributed to the preparation plan for the execution of the final year trials with focus in the planning (5 to 9 September 2022) final trials in Egaleo.

20-ORA did UAV connectivity measurements on service continuity and quality of service over an area of 600 m × 150 m perimeter at CTDO (safe zone in Lannion). Results analysis were on-going during Q9. During Q10 results of real measures on the impact of mobility and handovers on the RTT experienced by drones have been double-checked with Matlab simulations using a model for realistic antenna gain pattern. During Q11 ORA has revisited the test methodology for interferences measurements planned mid-2022. During Q12 ORA had no activity on the Task.

21-UMS provided necessary inputs to relevant sections within D4.3 during Q9. In addition, as a follow-up to integration discussions with EUR, UMS tested the feasibility of conducting trials with the existing setup. Finally, as WP4 leader, UMS oversaw work on D4.3 and provided guidance where required. During Q10, as a follow-up to integration discussions with EUR, UMS defined a solution to conduct next trials physically, using the existing setup and making the first step to integrate with EUR infrastructure. In particular in this first phase, UMS adapted some of the software modules to fit the EUR infrastructure. UMS, as the WP4 leader, organised and participated at WP4 tasks meeting. During Q11 UMS participated physically to the EUR test trials conducted in December 2021. During



Q12 UMS expended additional effort to analyse and try different solutions to integrate the software modules on the EUR MEC infrastructure. UMS has also attended and contributed to the UC4Sc1 meetings.

#### 8.4.4. Task 4.3 Evaluation of trial results (M26-M42) [COS]

##### Task Objectives:

The responsibility of this task is the evaluation and interpretation of the trial results. The task will begin from M20, i.e., two months after the start of the trials, to give enough time for potential unforeseen delays at the beginning of the experiments. At the same time, it will begin in a manner such that the early trial results can be evaluated as they are becoming available by the activities of T4.2, making early use of the visualisation tools of T2.4 to get a qualitative insight on the performance of the trialled service. The following activities will be carried out during this task:

- Performance evaluation of vertical applications and validation of KPIs from a vertical service and 5G system perspective.
- Identification of necessary enhancements to the facilities to support the UAV use cases and provision of the necessary feedback to facility owners.
- Identification of necessary enhancements for the 5G system architecture in general to support the UAV use cases and provision of relevant recommendations.

T4.3 together with T2.4 are the main contributors towards project Objective 7. By using data analytics tools, each use case scenario will be carefully studied in terms of performance, aiming at drawing conclusions and providing recommendations to the 5G and UAV ecosystems. Furthermore, as per activities of WP5, these recommendations can be channelled towards standardisation bodies, such as 3GPP or ETSI MEC, in order to optimise or update 5G standards with a view to better support the emerging UAV services market.

Eventually, the conclusions drawn in this task will be fed back to task T1.1, in order to provide a better understanding of the market perspectives and the potential of 5G to successfully support the envisioned UAV-related vertical service and create space for new ones. A report on the evaluation of trial results will be provided at the end of the project in deliverable **D4.4**.

##### Task Activities during the period:

The Task has started in the middle of the Q9 and basic agreements between the partners have been achieved on the evaluation scope and activities that need to be performed. The focus of the first months of the Task is to clarify the full list of KPIs (network, UAV, application) that are important to be evaluated. It is expected that this work will be completed in Q10 and involves the co-operation and alignment of all Use Case Scenarios and Trial Site leaders. During Q10 the main activities has been to identify the proper methodology towards the assessment of project results, that shall be executed with the final trials in 2022. Specifically, the objectives of the assessment have been identified and agreed by the task members. The prerequisites were also defined and have revealed the need to explore further the following topics: conclude on the final network and UAV KPIs that need to be measured per use case scenario; verify that the necessary logs are appropriately collected and processed for graphical depiction. The Task achieved alignment with Task 4.2 forthcoming trials planning and agreed on the need to share common templates for test cases definition and execution/results collection, that shall be defined later in the course of the task. Achieved alignment with Task 2.4 and Task 4.1 to support the activities of assessment data collection and processing. During Q11 identification of the business KPIs that will be targeted for the forthcoming 3<sup>rd</sup> year trials. There was clarification of the sources of information (log files) that will be used for the evaluation of the trial results. The development and integration related activities for this are tightly monitored as part of the Task 3.1 third integration release. Definition of the test cases templates that will need to be filled for each use case trial. During Q12 the main activity has been put to the identification of the test cases that are relevant for the evaluation of project results and the showcasing of the project's lessons learnt. As part of this work, the test cases template has been finalised and the

use case leaders are in the process of filling in the respective content. In cooperation with Task 4.1, the task verifies that the log data necessary for the systemic evaluation of the project KPIs are successfully collected and processed. The initial ToC for D4.4 has been proposed and agreed.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are described next. Regular partner activities, such as participation to teleconferences and face-to-face meetings will not be reported independently as they are considered the default a Beneficiary partaking a Task would do.

*1-UO* participated in KPI related activities, like KPI definition and target values and also measurement methodology during Q9. During Q10 UO participated in KPI related activities like KPI definition and target values, and also measurement methodology. UO had active contribution to further KPI and measurement planning for Releases 2 to 4. It did coordination with Use Case leader to provide information about UAV Data collected for UC1Sc2 to use it on the Task 4.3. UO added the list of relevant KPIs (QoS and Traffic statistics) in the Facility Web Portal UO blueprint. This was being tested by sending the information to Trial repository. During Q11 UO made contributions on UAV-related parameters and KPIs during the trials of each use case, where use-case leaders add related information. UO contributed to the definition of the test case template by sending a first version based on the integration test specification defined for collection network KPIs at the 5GTN facility. Specification of integration tests in detail for measurement job creation and collection/posting network KPIs. UO contributed on T4.3 document about the network KPIs and time sync according to the use case to be executed on the 5GTN facility for trials. UO did coordination with use-case leaders to provide information about UAV data, and coordination with ALE, NOK, CAF, HEP and UO use case leaders for pretests and collection of network KPIs using Qosium for the related-use case scenarios during the June trials at the University of Oulu and 5GTN facility. During Q12 UO worked on troubleshooting and improving the KPI system at the 5GTN (i.e., Qosium Probes, Nemo Handy, Qosium Storage, KPI database, and 5GTN adapter) to collect the KPIs from the network, radio access, and UAVs. UO proposed a new approach for the use-case leaders to describe the test cases per use-case that will evaluate the correlation between 5G and UAV KPIs in the subsequent trials, and these will be detailed in the D4.4. UO encouraged the use-case leaders to provide the test-cases description by adding the network setup at the 5GTN common for all the partners. UO has been coordinating with use-case leaders from ALE, NOK, CAF, HEP and UO to perform pretests of KPIs (from the network, radio and UAV) collection using Qosium according to each test case.

*2-THA* defined the needed KPIs for its own enablers during Q9. More generally, in the Ecosystem of 5G!Drones, specific mechanisms have been considered to evaluate the initial KPIs compared to those obtained in the real scenarios in which UAVs are in action. THA pushes the technical discussions on this matter to define technical KPIs and their validation procedures. Moreover, in relation to this task and validation scenarios, 5G!Drones architecture, use-case scenarios, 5G components, and different enablers have been analysed separately. Mechanisms for the evaluation of trial results towards the use cases are currently in discussion. During Q10 THA participated to the technical discussions on this matter to define technical KPIs and their validation procedures. THA is participating to the different meetings on T4.3 and actively following discussions and exchanges on the KPI definition and collection. During Q11 THA participated to the definition and discussions regarding the monitoring mechanisms and validation scenarios and for KPI validation of trials. During Q12 THA participated to discussions about definition of the KPIs and their collection.

*2.1-ERC* has not yet contributed to this task because the Search&Rescue radio signal detection enabler is not currently integrated in on-going trials.

*3-ALE* has contributed during KPI workshops to UAV business KPI definition during Q9. During Q10 ALE has contributed to the definition KPIs. ALE has provided information regarding its scenario-specific parameters. During Q11 and Q12 ALE has contributed to the definition and collection of



KPIs. ALE has taken part in discussions with each partner involved in its use-case sub-scenario to specify KPIs gathering.

4-INV started work related to the Task 4.3 during Q9. It didn't participate to the meetings organised by NOK, but INV looked at the outcomes of these sessions. During Q10 INV was analysing and commenting the methodology proposed by COS. INV responded to their request to provide the inputs and we were actively participating in number of workshops with other partners and stressing the importance of this task for Dashboard being a part Web Portal 1. INV sees dependencies of Task 4.3 with 2.4 and 4.1 and tries to get the most value from all ongoing work and discussions. During Q11 INV has submitted the description of the INV logs, how the data is synchronised in time and how its applications are hosted. INV was also collaborating with other partners in the light of the tasks, which will be performed in Release 3. INV triggered a discussion how the logs will be analysed after tests and if we will make a Dashboard presenting the results. During Q12 INV was leading the work for Release 3. In March 2022 we had 5 weekly meetings for testing the collected data load to KPI Component. During these tests some bugs and issues were identified and corrected, in Web Portal 1, Trial Controller and facilities. Corrections were verified in many one-to-one sessions between involved partners. INV was also collecting the specification of the data streams from each partner submitting the data to KPI Component. This is a good input for other T4.3 activities.

5-HEP has participated in discussions and planning for detailed definitions of KPIs to be measured led by NOK. HEP has also held internal discussions on key take-aways from August 2021 Oulu trial and prepared materials for the trial report. During Q10 HEP participated in the KPI measurement related meetings and discussed how to define and measure specific UAV KPIs. HEP also analysed the measured results from UO trials. During Q11 HEP has analysed the logs that UAV and GCS capture and has identified data that would be relevant to the trials and determined the means to extract them. During Q12 HEP has created a dashboard for visualising the data gathered during HEP's led scenario. HEP has also done work on correctly visualising collected geodata in Kibana. HEP has also reassessed and documented the KPIs we find necessary to collect during the trial of our scenario.

6-NCSRDP prepared a documentation with the results and findings of the July trials following the July 2021 trials. This document will be distributed within the consortium for evaluation and analysis, while it will be also documented in D4.4. During Q10 NCSRDP has provided comments and has actively participated in the discussion led by COS on the definition of the trials' execution methodology, emphasising on the importance of vertical KPIs. During Q11 NCSRDP has actively contributed in developing an appropriate software for collecting the logs from the different platforms and injecting them to the Elastic database in order then the visualization of the by Kibana to be feasible and common for all the platforms. By this way, it is reassured in the project a common data analysis and visualisation for the all the involved platforms. During Q12 NCSRDP contributed to the proper configuration of KIBANA in order to consider proper data input and then proper visualisation of the results in a coherent and comparable way. Feedback to D4.4 ToC and structure has been provided. Appropriate configurations of the Open5GENESIS experimentation framework have been made in order to be reassured the proper communication with Kibana.

7-AU has collected some network measurements while flying drones during the trials of August 20th, 2021. The measurements have been communicated to CAF. Further trials are expected in the coming months. During Q10 AU was following the discussion on the methodology on evaluating the results. AU has also responded and clarified the set of KPIs that can be captured from its facility. During Q11 AU has participated to release 3 of WP4, which covers KPIs. More precisely, AU has provided details on the components providing KPIs from Aalto University's side (these components are AALTO-CLOUD and AALTO-UE). Furthermore, AU has also been evaluating the creation of adequate dashboards in Kibana so to better visualise the KPIs captured from its facility. AU has also updated to format of data sent to KPI component to align with some required specifications. During Q12, in addition to the participation to release 3 of WP4 (which covers KPIs), AU has addressed requests formulated by T4.3 leader related to test cases. The latter constitutes the basic procedure for collecting

KPIs during the trial of the use case scenario led by AU. An initial ToC for the deliverable D4.4 has been released, where AU is reviewing its contribution.

**8-COS** is the Task leader and has led the kick off Task 4.3 discussions, in the bi-weekly WP4 calls during Q9. COS has provided the approach for the activities to be performed as part of T4.3 with the 1<sup>st</sup> milestone being the identification of the target KPIs to be measured per use case scenario. During Q10 COS prepared the task's execution methodology which has been presented in number of workshops and has been agreed by the partners. Key dependencies with Tasks 2.4 and 4.1 whose achievements for the project are critical were identified. During Q11 COS was leading T4.3 activities and has orchestrated all technical workshops for the identification of the target KPIs and results collection. COS has prepared the Evaluation Test Case Template to be used for the Results collection and assessment. During Q12 COS and has contributed with the proposal of the Test Cases Template, as well as D4.4 Table of Contents, as the D4.4 lead editor.

**9-AIR:** The new library released during last Quarter#8 has been validated by EUR with AIR support during Q9. KPIs interface developed in T2.1 allowed to check that reached performance is compliant with expectations in lab environment. During Q10 a new KPI service version with additional data has been implemented and released. During Q11 AIR has managed a baseline test campaign on 4G networks. AIR has also contributed to collecting results from December 2021 trial execution on 5GEVE platform. During Q12 AIR has established a first version for test plan that will support validation of 5G!Drones developments for UC2Sc1.

**11-INF** established, during Q9, internal processes for preparation of activities related to T4.3 and link of T4.3 activities and results as input to WP1/T1.1 for defining the current UAV business and market status as well as preparation of the communication approach for T4.3 outcomes through T5.1. During Q10, Q11, and Q12 INF provided input on business KPIs and evaluation of results. It made preparation actions towards upcoming deliverable D4.4. During Q11 and Q12 INF provided comments and actively participating in the discussion led by COS on the definition of the trials execution and evaluation methodology, emphasising on the importance of vertical KPIs with focus on 5GENESIS Athens platform and scheduled trials in September 2022. INF runs internal processes for preparation of activities related to T4.3 and link of T4.3 activities and results as input to WP1/T1.1 for defining the current UAV business and market status. Preparation of the communication approach for T4.3 outcomes through T5.1.

**12-NOK** has kept with many project partners KPI related workshops to make sure, that collected data is easy to analyse, report, and creates some value for both UAV and 5G industry. During Q10 NOK has participated and contributed proposals for COS and RXB lead KPI definition activities. NOK had no activity on the Task between Q11 and Q12.

**13-RXB** significantly contributed to the KPI & data visualisation activities and led various workshops to support partners during Q9. During Q10 RXB collaborated with NOK, COS, and other partners to come up with KPI definitions and possible data analysis methods. During Q11 RXB led the efforts towards KPIs and visualisation and supported COS on this effort. During Q12 RXB contributed to KPIs, methodology, and evaluation. It made a proposal to measure interference prior to the trials and capture interference data.

**14-EUR** had no activity on the Task during Q9 and Q12. During Q10 EUR put strong efforts to implement RAN KPI measurement for 5G SA, as the 5GEVE facility is supporting only 5G SA deployment. During Q11 EUR participated to all KPI workshops, and has adapted the facility adapter to fulfil the new KPI specifications.

**15-DRR** did KPI review and participation in KPI discussion meetings/workshops during Q9. During Q10 and Q12 it had no activity on the Task. During Q11 DRR had discussions on KPIs (workshops 6.12. and 13.12.)- definition (gathering available logs), implementation and testing. It did preparation

of testing template for KPI tests, updated KPI sheet, and discussion on KPIs: defining and coordinating UTM log file preparation. DRR did synchronizing scope of KPIs identified by T4.3 with scope of KPI release (tools, technical capabilities, etc).

16-CAF has collected Trials results in August 2021 when trials conducted in Finland (AU and UO physical trials). During Q10 CAF actively participated in KPI measurement meetings and provided input to the drone operator's view. In addition, the KPIs of the UO and AU trials were analysed. During Q11 CAF contributed to the definition of KPIs and developed integration to send automatically KPI data directly to the FRQ KPIs collector. During Q12 CAF has done work to send CAFA drone telemetry data via KPI API to Kibana platform developed by FRQ. CAF has added to Task 4.3 documents descriptions which KPIs and data could be collected and how they could be collected in the scenarios led by the CAF.

17-FRQ supported the August 2021 Oulu Trial reporting activities. During Q10 FRQ continued work on KPI component and supported partners in integration efforts. FRQ participated in discussion on KPI data provisioning. During Q11 FRQ continued work on KPI harmonisation and supported partners in integration efforts. FRQ participated in discussion on KPI data provisioning. During Q12 FRQ contributed to the KPI related clarifications and discussions. It provided and documented capability to visualise geo based KPIs within Kibana.

17.1-FSO supported the August 2021 Oulu Trial reporting activities. During Q10 FSO continued work on KPI component and supported partners in integration efforts. FSO participated in discussion on KPI data provisioning. During Q11 FSO continued work on KPI harmonisation and supported partners in integration efforts. FSO participated in discussion on KPI data provisioning. During Q12 FSO contributed to the KPI related clarifications and discussions. It provided and documented capability to visualise geo based KPIs within Kibana.

18-OPL participated in periodic meetings on organisation of trial results evaluation during Q10. Otherwise, it had no activity on the topic during the Reporting Period.

Deviation and corrective action:

In OPL travelling abroad during Q10 was still banned due to the coronavirus situation. More active participation to trials will be possible once the ban is recalled.

19-MOE contributed in the preparation of the documentation with the results and findings of the July 2021 trials. Between Q10 and Q12 MOE contributed in the preparation of the physical site of the trials in week 5 - 9 September 2022, in municipal stadium "Stavros Mavrothalassitis". Electrical installations and settings are still in progress.

20-ORA does not partake in Task 4.3.

21-UMS provided support and info when needed to support T4.3. In addition, as the WP4 leader, organised and participated at WP4 tasks meeting. It had no activity on the Task during Q9. During Q10 In particular, UMS provided some telemetry log data files and gave its suggestion to the definition of key KPIs to be measured in the trials. During Q11 UMS provided updated telemetry log data files based on the shared requirements and participated on defining the best KPIs to be measured in the use cases. During Q12 UMS participated on defining the test cases template to be used during trials experiments, providing also some test cases for the scenario where UMS is involved. UMS participated on the definition of the D4.4 ToC.

## 8.5. WP5 Dissemination, standardization and exploitation

### 8.5.1. Progress towards objectives and details for each Task

#### WP Objectives

This WP contributes towards the following high-level project Objectives

- Objective 8: “**Dissemination, standardization and exploitation of 5G!Drones**”

For these to be attained, the following specific objectives will be pursued within this WP:

- Communicate project outcomes to a wide audience
- Showcase the activities and results of the project in large events
- Disseminate results to industrial and academic communities, as well as standardization and regulatory bodies
- Cross-fertilize within 5G-PPP and beyond
- Exploit the results of the project by various means: Improve 5G facilities, provide recommendations for the 5G system, improve UAV products to take full advantage of the 5G potential, etc.
- Produce and manage intellectual property and perform activities towards commercialization.

#### WP Tasks and interrelations:

- T5.1: Communication activities (M1-M42)
- T5.2: Standardization, exploitation and IPR management (M1-M42)
- T5.3: Showcasing and dissemination activities (M1-M42)

#### Main Progress in the period:

Concerning communication aspects of T5.1, during the reporting period, all the channels, that have been built all project lifelong (including inter alia Website, social media channels and newsletters), have been kept updated with all the activities carried on in the project and monitored through statistical dashboards made available in this deliverable.

5G!Drones project partners have made significant effort to increase project visibility, especially preparing small videos captured at each trial event and reporting different aspects including lessons learnt and conclusions. The Consortium also tried to extend the dissemination of the results to several standardisation organisations and associations through a constant involvement in ASTM WG 69690 Supplemental Data Service Provider, ASTM F3411-19 Standard Specification for Remote ID and Tracking, GSMA/GUTMA/ACJA, and SUSI the Swiss U-Space Implementation (Switzerland is indeed the most active country in Horizon Europe to tackle regulation for the use of drone and drones on 5G) to name a few.

The Consortium is also actively preparing after project exploitation. In conformance with updated exploitation plans established at the end of the previous period, Consortium's partners are preparing business plans according to the specific methodology that was defined in order to report this activity and that will feed two deliverables D5.5 and D5.6 according to the nature of targeted outcome (commercial or not commercial).

On the dissemination chapter, 5G!Drones partners have been involved in lots of events including among other last EuCNC forum, or Amsterdam Drone week. Lots of publications have been released mentioning 5G!Drones and reported under ECAS portal. In parallel, the Consortium actively prepared large scale trial that will be demonstrated during the very beginning of next period (first target is next EuCNC from 7<sup>th</sup> to 10<sup>th</sup> of June 2022, the following target is in August in Aalto University premises on their 5G infrastructure).

Finally, European DG CNECT has recognised 5G!Drones as a key innovator in the so-called Innovation Radar platform, highlighting 2 innovations: The "flying base station" (from ORA, AIR and COS), and "Management of drone flights using 5G" (from THA, AIR and UMS).

#### Deviations from Annex I and impact on other Tasks, available resources and planning

None.



## 8.5.2. Task 5.1 Communication activities (M1-M42) [INF]

### Task Objectives:

The main objective of this Task is to devise and deploy a sound communication strategy plan, required to make the project achieve maximum visibility and to maximize the impact within the business and scientific communities, so to guarantee a fast dissemination and adoption of the project outputs. Planned activities will be monitored throughout the project lifetime and periodically amended, so to ensure long-term effectiveness and attainability. Communication activities will target related markets and industries with the objective of fully exploiting the novel business opportunities that are raised from related market activities and business functions. To this Task belong activities such as setup of a public website, file sharing and collaboration tool, keep social channels/networks updated, and communicate project achievements to the broadest possible audience through events, conferences, etc. This Task will also rely on facilities offered at 5G PPP programme level to communicate (e.g. 5G PPP newsletter).

### Task Activities during the period:

All communication channels were kept updated with news and activities. Website and social media channels kept posting news and dissemination activities on a weekly basis (a min. average of 2 posts per week). Statistical dashboards were issued and circulated on a monthly basis. During Q9 Newsletter issue No. 8 was released in June and the issue No.9 is under editing (to be released early Sept). Special statistical dashboards were developed for the reporting period (M1-M24 and M13-M24). 5G-PPP latest activities, events, newsletters and newsflashes were communicated internally to the consortium and over 5G!Drones communication channels. Supporting T5.3 to various dissemination activities with highlight the participation of 5G!Drones at EuCNC 2021 with a virtual booth where T5.1 provided communication material in digital format (leaflet, poster, video, pdf informative files etc.) Several T5.1 partners attended the booth as exhibitors answering questions of several visitors either through chat or live conf. Preparation for Period 1 review, addressing comments by Year 1 review, slides preparation, WP5 rehearsal organised and attended. During Q10: Newsletter issue No. 9 was released in September and the issue No.10 was under editing (to be released early Dec). Special statistical dashboards were developed for the reporting period (M1-M24) for the review. WP5 pre-review rehearsal organised and attended. Special WP5 telco attended for addressing review comments. 5G-PPP latest activities, events, newsletters, and newsflashes were communicated internally to the consortium and over 5G!Drones communication channels. Supporting T5.3 to various dissemination activities with highlight the 5G!Drones book preparation and dissemination events communication. New videos released at YouTube channel. During Q11 Newsletter issue No. 10 was released in December and the issue No.11 was under editing (to be released mid March). Special WP5 telco attended for addressing review comments. 5G-PPP/6G-IA latest activities, events, were communicated internally to the consortium and over 5G!Drones communication channels. Supporting T5.3 to various dissemination activities and dissemination events. New videos released at YouTube channel from Eurecom trials. During Q12 Newsletter issue No. 11 was released in March and the issue No.12 was under editing (to be released mid June). Special WP5 telcos attended for addressing review comments and upcoming deliverables preparation. 5G-PPP/6G-IA latest activities, events, were communicated internally to the consortium and over 5G!Drones communication channels. Supporting T5.3 to various dissemination activities and dissemination events. Communication material and actions related to EuCNC and upcoming trials.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are:

1-UO had no reported effort during Q9. UO did contribute in the discussions and to the ToC of the 5G!Drones BOOK during dedicated remote meetings. During Q10 UO had a publication of a journal paper on IEEE Transactions on Communications "The Effect of Concurrent Multi-priority Data Streams on the MAC Layer Performance of IEEE 802.11p and C-V2X Mode 4". During Q11 UO had no activity on the Task. During Q12 UO has been working on a major revision of the paper "PERFORMANCE



ENHANCEMENT OF C-V2X MODE 4 UTILIZING MULTIPLE CANDIDATE SINGLE-SUBFRAME RESOURCES”, submitted to IEEE Transactions on ITS.

2-THA was organising an internal workshop where outputs of 5G!Drones project will be presented during Q9. During Q10, After Period 1 review and the recommendations received from our reviewers, THA identified four recommendations directly related to the WP5’s activities and they should be addressed within WP5 activities (R1, R4, R6 and R8). THA tried to clarify how it would be possible to increase the visibility of the project. THA proposed that 5G!Drones’ participation in the EUCNC 2022 event is very important for the whole project; therefore, demonstrations should be planned in relation to our ongoing activities. THA highlighted the importance of having virtual sessions for the public; these sessions can be organised after each trial or release. During Q11 THA continued internal dissemination and submission of a scientific paper. During Q12 THA participated to the dissemination of the 5G!Drones project results internally where its trajectory planning software has been demonstrated. THA is also participating to EUCNC 2022 where 5G!Drones is presenting its activities.

3-ALE did communication on social media, especially regarding August 2021 trials activities conducted in UO during Q9. Otherwise, it had no activity on the Task during the Reporting Period.

4-INV was participating to EuCNC 2021 virtual event in June. INV was also active in social media and informing our business partners about 5G!Drones project. During Q10 INV made several posts in social media and mentioning about 5G!Drones project during the contacts (meetings, mails exchange) with commercial partners. During Q11 INV discussed internally and with its commercial partner the possibility to organize the 5G!Drones public demonstrations in Switzerland. In March we got back a positive decision. We made several posts in social media, specially mentioning about the tests performed in December 2021 in EUR. INV also mentioned about 5G!Drones project during the contacts (meetings, mails exchange) with other commercial partners. During Q12 INV was present during ADW, our CEO Manu Lubrano was a speaker at the Global UTM Association (GUTMA)'s panel discussion "The Future of Aviation has arrived! The next steps to build the drone service ecosystem". INV was also present at AUVSI XPOTENTIAL 2022 event in Orlando. INV was also present during GUTMA's "Harmonised Skies" event. INV did a special presentation about 5G!Drones project to our new employees.

5-HEP does not partake in WP5.

6-NCSRDC communicated the 5G!Drones project activities at the FESTOS 5G FUND, the national newly established authority for funding 5G innovation activities in Greece during Q9. A MoU was signed between the two organisations in order to collaborate further of communicating the research outcomes of Demokritos to the relevant 5G stakeholders. During Q10 NCSRDC contributed one book chapter and has arranged also a presentation of the 5G!Drones projects/Lessons learnt at IEEE Globecom. Moreover, a 5G!Drones paper was prepared and presented by NCSRDC at IEEE Meditcom. During Q11 Dr. Koumaras from NCSRDC joined as panelist on 8/12/2021 the IEEE GlobeCom Industrial panel on 5G-PPP Project results, presenting the lessons learnt of 5G!Drones project. During Q12 NCSRDC has communicated the project by participating in the 5G-PPP/6G-IA activities, as well as by participating at the EuCNC conference with a research paper. Moreover, a book chapter has been also accepted for publication.

7-AU has performed a small showcasing on 27<sup>th</sup> May 2021 despite the current pandemic restrictions related to covid. The showcasing was for the benefit of first grand students from the international school of Espoo, Finland. During Q9 AU did present its current works related to cellular drones and virtual reality (VR). AU did also present a demo for streaming a 360 video from a flying drone. The event has been reported in the following link <http://www.mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c>. Between Q10 and Q11 AU had no activity on the Task. During Q12 AU has been evaluating the possible communication actions

that can be taken by AU during the next trials planned in its campus, so to increase the visibility of the project. AU is also willing to make these trials open to the public.

8-COS had no activity on the Task during the Reporting Period.

9-AIR has supervised this task as WP leader. AIR has presented 5G!Drones initiative and results for Dutch police during Q9. During Q10 AIR has presented 5G!Drones during Milipol event. During Q11 AIR has presented 5G!Drones in internal so-called kick-off events. During Q12 AIR has trained commercial representatives to communicate about 5G!Drones results in future forums.

**11-INF** does coordination of T5.1 activities and participation in the dedicated WP5 telcos and actions. It maintains the project website and News section (updates, content creation, news, posts, uploads). It runs all social media accounts (Twitter, LinkedIn, Facebook, Instagram, YouTube) - updates, posts, videos, reply to comments etc. and does development of monthly statistical dashboards for monitoring the performance of web site and social media (June, July, August). INF maintains in Teams the communication activities repository. INF does communication of 5GPPP newsletters, newflashes, publications and activities and tag of 5G-PPP in all our communication activities. It monitors all running WP1, WP2, WP4 and WP5 tasks for reporting and communicating activities and results.

During Q9 INF was editing and releasing newsletter issue No. 8 (Mar-May) at the middle of June 2021. It was preparing and editing newsletter issue No. 9 (June-Aug) (to be released middle of September). Monthly statistical dashboards released internally to the consortium (M25, M26, M27) for additional reporting. INF provisioned of digital communication material for the 5G!Drones EuCNC2021 virtual booth and attendance at the booth as exhibitors. It did preparations for Period 1 review (T5.1 slides, rehearsals and statistical dashboards). In specific, special statistical dashboards development for Period 1 review (M1-M24 and M13-M24). During Q10 INF was attending and presenting T5.1 at the review. Follow up discussions on four recommendations directly related to the WP5's activities (R1, R4, R6 and R8) was done. Special analysis to the recommendation related to impact creation through short trials videos was given by INF (as part of T5.1). Arrangements were made with T4.2 partners. INF did editing and release of newsletter issue No. 9 (Jun-Aug) at the middle of September 2021. It was preparing and editing newsletter issue No. 10 (Sept-Nov) (to be released middle of December). During Q11 INF did follow up actions on four recommendations directly related to the WP5's activities (R1, R4, R6 and R8). Arrangements were made with T4.2 partners and debriefing video recorded during EUR trials. INF was editing and releasing newsletter issue No. 10 (Sept-Nov) at the middle of December 2021. It prepared and edited newsletter issue No. 11 (Dec-Feb) (to be released middle of March). INF communicated of 5GPPP/6G-IA events, publications and activities and tag of 5G-PPP in all our communication activities. During Q12 INF was editing and releasing of newsletter issue No. 11 (Dec-Feb) at the middle of March. It was preparing and editing newsletter issue No. 12 (March-May) (to be released middle of June). Monthly statistical dashboards released internally to the consortium (M33, M34, M35) and special ones for Year 3 period (M25-M35) for additional D6.5 reporting. INF was following, communicating and supporting 5G!Drones presence in EuCNC. Communication of 5GPPP/6G-IA events, publications and activities and tag of 5G-PPP in all our communication activities.

12-NOK was active on social media promoting the progress of the project during Q9. During Q10 NOK discussed and created concepts for papers to the EUCNC 2022. NOK had no activity on the Task between Q11 and Q12.

13-RXB has coordinated the organisation and operation of the virtual booth representation of the project at EUCNC2021. The virtual booth was well visited and contributed seriously to the broader project visibility in Europe – among experts and the broader audience. At the social media the RXB team was active as well, and the UO trials were well reflected by the team at LinkedIn. During Q10 RXB participated in several conferences, workshops and communication activities and reported them to Task 5.1. During Q11 RXB supported AIR and other partners in communication activities. During

Q12 RXB participated in communication activities in several in-person and online events, and also on social media.

14-EUR had no activity on the Task during Q9, Q11, and Q12. During Q10 EUR has published on the Eurecom blog an article on 5G!Drones.

15-DRR does not partake in WP5.

16-CAF was participating to EuCNC2021 virtual event in June. During Q10 CAF published the activities of the 5G!Drones project on its website and on social media channels. During Q11 CAF prepared video about December 2021 EUR trials. During Q12 CAF had no activity on the Task.

17-FRQ featured the 5G!Drones Project on new Project & Innovation Website during Q9. Otherwise, it had no activity on the Task during the Reporting Period.

18-OPL and 19-MOE do not partake in Task 5.1.

20-ORA had no activity on the Task during Q9. During Q10 ORA presented a paper at IEEE WiMob 2021 acknowledging 5G!Drones. During Q11 ORA provided contribution to 5G Book on interferences and radio access networks sections. During Q12 ORA has proposed a ToC for D5.5 and a roadmap. Two papers acknowledging 5G!Drones have been published, respectively in IEEE Transactions on Mobile Computing and IEEE Transactions on Vehicular Technology.

21-UMS was active on social media promoting the progress of the project during Q9. During Q10 UMS was also active on social media promoting the progress of the project. It made a preparation to report on physical trials to be conducted on December 2021. During Q11 UMS was also active on social media promoting the progress of the project and in particular the test trials activities conducted in EUR in December 2021. During Q12 UMS was also active in social media and various physical events attended promoting the project.

### 8.5.3. Task 5.2 Standardisation, exploitation and IPR management (M1-M42) [AIR]

#### Task Objectives:

This Task is mainly focusing on three activities:

- Contribution to standards bodies,
- IPR management, and
- Commercialisation activities

First, this Task will contribute to various standardization bodies. The contributions to standardization will ensure that the research outcome of 5G!Drones will obtain broader recognition and also its results are utilized by a wide industry community. The consortium members have long history of standardization experience in various standardization bodies including ITU-T, IETF, IRTF, ETSI and 3GPP. For instance, **AIR, ORA, NOK, and THA** are contributing to ITU-T, IETF ETSI and 3GPP working groups. These partners will disseminate the results of 5G!Drones within these standards development bodies and support the translation of key results into potential recommendations. Partners representing the UAV ecosystem will be contributing to UAV-relevant standards bodies (e.g., ISO/TC 20/SC 16 Unmanned aircraft Systems, NASA's Unmanned Aircraft System (UAS) Traffic Management (UTM) ecosystem, EUROCAE Working Groups on Unmanned Aircraft Systems (UAS), and RTCA). **AU and UO** will also determine standardization opportunities for the findings of the 5G!Drones project and launch pre-standardization research groups, study groups and/or working groups in the areas of the project under IEEE Standards Association and IEEE IoT Community. Standards' relevant results of the project will be also promoted within the IEEE Conference on

Standards for Communications and Networking, founded by AU. **FRQ** is a member of several relevant international fora, which focus on bringing industry, research and end-users together. Examples are the PSCE (Public Safety Communications Europe), the EENA (European Emergency Number Association), the British APCO, and the TCCA Tetra and Critical Communications Association. In several of these fora, **FRQ** is providing an official role such as chairing a workgroup. In addition, the active involvement of consortium members in the standardization process will bring their knowledge of standardization to the project and make the consortium aware of any standardization results that can be applied to the project. WP Leaders will monitor the respective R&D activities in 5G!Drones and stimulate the standardization of their outcomes. This Task involves a continuous awareness of possible standardization opportunities and development within relevant standards identified during proposal preparation. This Task will also take advantage of the 5G-PPP Pre-standardization Working Groups active at 5G IA level and so liaise with it.

Second, this Task will be focusing on management of IPRs. Intellectual property (IP) management is important to safeguard investment from the partners but also to maximize commercial exploitation the potential of the resources invested in the project. ***IPR will be protected by an agreement, in alignment with the policies and context for EU funded projects***, that specifies how and under which conditions partners get access to existing and created IP owned and generated by other partners and specifies the conditions of access to such IP in the case of exploitation beyond the scope and duration of the project. The agreement will cover specification and handling of the types of intellectual properties, mechanisms to identify and to brand them and definition of the roles of the partners and the individual usage rights of the intellectual properties. A Consortium Agreement (CA) based on the EICTA (European Information, Communications and Consumer Electronics Technology Industry Association) model will be signed between all partners before the start of the project, specifying among other things the internal organization of the consortium reflecting rules for dissemination, internal disputes settlement and IPR arrangements.

Third, this Task will be also focusing on the exploitation of project results. It will be focusing on three primary goals:

- **Sustainability.** The project's efforts will be made sustainable in the immediate term beyond the project's lifetime. This will ensure that exploitation of the project's results can be made smoothly towards the end of the project and will continue after the project's funding period ends.
- **Exploitation of results.** The project's results, particularly those that fulfill the objectives as described in Section 1.1, will be directly exploited by the consortium and individual partners.
- **Long-term viability.** Long-term exploitation of objectives will be explicitly considered in view of the market. For this purpose, this Task will be focusing on the creation of both partner-level and consortium-level exploitation plans. Moreover, it will include an impact assessment that prioritizes the highest-impact exploitation methods. Based on these results, post-project business plans will be generated. In addition, this Task will organize workshops inviting a range of target stakeholders that will provide feedback and assist in exploiting the project results in the best possible way.

#### **Task Activities during the period:**

During Q9 and Q10 the Consortium carried on its activities both on 5G and drone sides, following and contributing to 3GPP (in particular RAN2, RAN3, SA6), ASTM (WK69690), GUTMA WT2, ACJA, NASA, EASA, Eurocontrol, IEEE, and CEPT. In parallel, the Consortium is more and more active on the exploitation chapter preparing the work for future business plans. During Q10 the Consortium has contributed to ETSI ETR in the context of 5G-PPP Pre-standardization work group. The Consortium has also contributed actively to ASTM Detect & Avoid working group standards activity, ASTM UTM-USS Interoperability working group in coming up with standards for integration of UTM and USS services, contributed to EUROCAE WG-105 & WG-114 activities, and lead the EASA U-space Expert Working group in coming up with Acceptable Means of Compliance & Guidance Material. Finally, the Consortium has carried on work on patent submission for relay connectivity in ETSI SmartBAN. During



Q11 the Consortium mainly contributed to ASTM, ACJA WT1 to WT4 (several partners involved), SUSI initiative, and 6G IA Pre Standardization WG (replacing 5GPPP Pre Standardization WG). During Q12 5G!Drones Consortium focused on driving procedures to report exploitation activities, updating list of commercial and commercial outcomes and preparing business plans establishments in conformance with exploitation strategy defined in previous period.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are as follows.

**1-UO** had no activity on the Task during Q9 and Q11. During Q10 UO was drafting and submitting a response to European Patent Office search report for invention disclosure “METHOD FOR ESTABLISHING RELAY CONNECTIVITY IN ETSI SMARTBAN”. During Q12 there have been small advances in feeding the relay functionality in ETSI SmartBAN standardisation. Also, feedback to D5.5 and D5.6 exploitable outcomes and partnerships has been provided to the editors.

**2-THA** continued to follow closely the evolution of standards and pursues the monitoring of standardisation activities at 5G-PPP Arch WG, RAN2 and RAN3 working groups between Q9 and Q10. Between Q11 and Q12 THA continued to follow closely the evolution of standards and pursued the monitoring of standardisation activities at RAN2 and RAN3 working groups.

**3-ALE** has carried on national standardisation monitoring activities during the Reporting Period.

**4-INV** a part of SUSI initiative (meetings taking place twice per month) and providing the solution to other Swiss partners related to Networked Remote ID solution. INV provided the report about the SDO impact activities as requested by THA during Q9. INV was participating in the weekly ASTM meetings for WK69690 – the document was released for voting. INV was also participating to the GUTMA WT2 meetings and plenary meetings. The first nationwide network remote identification service for drones was launched in August 2021. During Q10 INV participated in the weekly ASTM meetings and GUTMA WT2 meetings and plenary meetings. During Q11 INV participated in the weekly ASTM meetings and ACJA WT2, and plenary meetings. During Q12 INV continued its engagement to ACJA WP2 work and meetings. Currently the work in WP2 is focused on the document named “Reference Method for Measuring and Characterizing the Cellular RF Environment”. Manu Lubrano is still involved in ASTM meetings for ASTM WK69690.

**5-HEP** does not partake in WP5.

**6-NCSR**D does not partake in Task 5.2.

**7-AU** had no activity on the Task during the Reporting Period.

**8-COS** had no activity on the Task between Q9 and Q11. During Q12 COS supported the activities of this Task by evaluating the project’s declared outcomes in respect to the exploitation strategy. COS has made specific proposals for the studies to be performed and reported as part of D5.4 and D5.6 deliverables whose preparation was initiated.

**9-AIR** has contributed to 3GPP discussions around UAS in 3GPP SA6 which was 80% complete during Q9. During Q10 AIR has contributed to ETSI ETR (ETSI Technology Radar) in the context of 5GPPP Pre-standardization work group. AIR has contributed to prioritization task force in 3GPP CT1. During Q11 AIR has contributed to new 6G-IA Pre-standardisation WG. During Q12 AIR has contributed to 3GPP SA6. Discussions about Drone app are now closed on Release 17 and will be tackled in Release 18 with no significant progress expected by the end of the project. AIR has undertaken work related to results exploitation that will feed D5.5 and D5.6 and related to Drones enabled Mission Critical platform.



11-INF is not partaking in Task 5.2.

12-NOK had internal activities by sharing info how 5G!Drones's insights and found needs at the trials could impact via NOK to different standards. During Q10 NOK has followed CEPT ECC SE21 and continued co-operation to with Nokia Standard team to point up UAVs and UASs business potential and learning from 5G!Drones for coming 3GPP releases. NOK has followed 5G PPP TMV WG work. NOK had no activity on the Task between Q11 and Q12.

13-RXB team has actively worked on several standardisation documents at several committees and WG at well-known organisation: ASTM, NASA, EASA, Eurocontrol and VDI. The activities during Q9 have always been focused on the safe and secure operations of Unmanned Aircrafts in complex urban environments, being enabled by 5G communication systems in the context of UTM and other systems towards achieving a successful U-space design and integration. During Q10 RXB contributed to multiple 5G-PPP white paper publications. It actively contributed to ASTM Detect & Avoid working group standards activity, ASTM UTM-USS Interoperability working group in coming up with standards for integration of UTM and USS services, contributed to EUROCAE WG-105 & WG-114 activities, actively lead the EASA U-space Expert Working group in coming up with Acceptable Means of Compliance & Guidance Material. During Q11 RXB contributed to EUROCAE WG-105 activities, ASTM UTM working group, ASTM DAA working group, and provided feedback to EASA on the U-space draft as part of the Expert Committee. During Q12 RXB reviewed standards related to Remote ID, CE Marking from EASA, contributed to EUROCAE WG-105, and ASTM UTM & DAA working groups.

14-EUR made two publications that have accepted during Q9. One in IEEE Transactions on Network Service and Management (TNSM) on data-driven RAN slicing, and another paper in IEEE Globecom 2021 on the usage of RNIS for UAV. One paper is in preparation and will be submitted to IEEE TNSM on the 5GEVE monitoring platform used in 5G!Drones. EUR had no activity on the Task between Q10 and Q11. EUR had no activity on the Task during Q12.

15-DRR does not partake in WP5.

16-CAF has carried on CEPT standardisation monitoring activities during Q9. During Q10 CAF contributed to the 5G-PPP Security and 5G-CAM working groups activities. It had no activity on the Task during Q11. During Q12 CAF made contribution to Deliverable D5.6 based on CAF's commercially exploitable outcomes.

17-FRQ does not partake in Task 5.2.

18-OPL had no activity on the Task during Q9 and Q11. During Q10 OPL initiated work on preparation of D5.6 - discussions with partners on relations with earlier WP5 deliverables and setting borderlines with D5.4 and D5.5. During Q12 the activities around preparation of D5.6 in the coordination with D5.5 leader were performed. The approach to the document (commercially exploitable outcomes and partnerships/collaboration within the scientific communities and with the international innovation communities in the area of 5G communication) has been discussed with the WP5 partners, including the complementarity with D5.5. The individual communication to the partners' representatives dedicated to D5.5/D5.6 has been sent to validate the outcomes declared in D5.2, declare them as commercially/non-commercially exploitable outcomes and report partnership/collaboration activities. Based on the findings during this round of survey, the exact ToC of D5.6 will be defined.

19-MOE does not partake in Task 5.2.

20-ORA has been following activities at 3GPP, CEPT, and ACJA during Q9. During Q10 it has been following of new study item on UAV in 3GPP rel. 18 in order to evaluate its priority, and active participation ACJA calls. During Q11 ORA participated to ACJA Work Tasks {1, 2, 3, 4} meetings, and

3GPP progress on UAV (Rel. 18). Discussions with French regulator on frequencies (ANFR) about 'no-transmit-zones'. During Q12 ORA has contributed to ECC PT1 UAS, and is following ACJA, and 3GPP SA2 work progress.

21-UMS had no activity on the Task during the Reporting Period.

#### 8.5.4. Task 5.3 Showcasing and dissemination activities (M1-M42) [RXB]

##### Task Objectives:

During the runtime of this Task, the consortium partners will establish a showcasing and dissemination plan for presentation of the project results to stakeholders and public. First, we plan to set up an initial plan for showcasing and dissemination. The plan will be refined at M18. Results that seem to be relevant for the European industry will be advertised and made public for a deeper analysis of their commercial and sociological potential. Designated "public use" results will be shared with the public and made open source wherever it is possible. All partners will contribute to a frequent update of the project's dissemination channels: Website (to come online in M03), community forming platforms (Facebook, Twitter, YouTube, blogs), scientific publications, open access publications, conferences, topic-related community, open-source software, general media publications, exhibitions, etc.

The consortium partners will participate in large showcasing events related to both UAV (i.e. Amsterdam Drone Week, UAS TAAC Conference etc.) and 5G (i.e. 5G Summits, MWC etc.) to demonstrate the results of the project and the acquired 5G knowhow. Moreover, 5G!Drones targets publication in selected and high-impact journals and magazines on communications/networking (e.g. IEEE Communication Magazine, IEEE JSAC, IEEE Network, IEEE Internet of Things), and reputed international conferences (e.g. Globecom, ICC, WCNC, Infocom, EuCNC) as well as vertical-oriented publications (Journal of Unmanned Aerial Systems, International Journal of Intelligent Unmanned Systems). Finally, this Task will be focusing on organization, presentation and participation in the organization of events (e.g., panels, targeted workshops, workshops co-located with relevant conferences, special sessions) and participation in these same kind of sessions as keynote speakers, panelists, etc.

Furthermore, 5G!Drones will take advantage of 5G-PPP Programme to liaise and disseminate results to 5G-PPP or 5G-IA Working Groups of interest among which, (already mentioned) Pre-standardization, Architecture WG and Security WG.

##### Task Activities during the period:

During Q9 of the project several crucial activities have been performed, towards the better visibility of the project advancements and achievements. The initiation, coordination and operation of the project premium virtual booth within the EUCNC2021/6G Summit in Porto, Portugal (8. - 11. June 2021), has marked an important step among this process since it is worldwide a key event in the thematic domain. At Q9 also the project representation at the IEEE International Mediterranean Conference on Communications and Networking (MeditCom 2021), 7–10 September 2021 was planned and coordinated. The organisation of the project representation of both key events in the Unmanned Aviation domain - Amsterdam Drone Week 2021 and Commercial UAV Expo 2021 (Amsterdam, January 2022) - has been started. The organisation of the project representation at ITS Congress Hamburg 2021 (October 2021) was performed. The project consortium has initiated and started active work collaborative work on the 5G!Drones BOOK, aiming to optimally present the project aims, developments, outcomes and strategic trends and directions, identified and elaborated during the project work, in the context of the evolving interdisciplinary market and business models. This action was initiated and coordinated by RXB. It is to be published as open access e-book by Summer 2022, at a well-established publishing house. Further intensive work at relevant 5G-PPP, EASA, Eurocontrol and NASA Working groups has been performed. Further intensive showcasing and dissemination work has been operated and brought further. During Q10 the focus of this task for this period has

been on forums such as Dubai Airshow, and other similar virtual and face to face conferences organised across the EU, participation in 5G-PPP activities to share insights from 5G!Drones perspective. During Q11 the Consortium members participated in UAS TAAC Conference, MWC, 5G Summit, and several other relevant dissemination activities. Several publications were accepted for publication in IEEE JASC, IEEE Network, and other reputable journals during this period. During Q12 the work focused on several partners participating in ADW 2022, and preparation work for conferences such as EuCNC 2022.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are:

*1-UO* had no reported effort between Q9 and Q10. UO held three host slots at the EuCNC virtual booth in June 2021. During Q11 UO contributed to the Sections 3.1, 3.1.1, and 3.1.2 of the BOOK. During Q12 UO has made preparations for EuCNC 2022 stand. It has also participated to and contributed in the discussions for the alternative large-scale showcasing event.

*2-THA* has disseminated internally results of the 5G!Drones project through meetings and technical discussions during Q9 and Q10. During Q11 THA participated to prepare the showcasing and dissemination at EuCNC 2022. During Q12 THA had internal presentation of the project results and demonstration of the trajectory planning software. THA was also actively participating to EuCNC 2022 preparation.

*3-ALE* had no activity on the Task during the Reporting Period.

*4-INV* was participating in the discussion triggered by RXB about possibility to write a book describing the outcomes of the 5G!Drones project and committed to be responsible for one of the chapters (Stakeholders Analysis) during Q9. INV was also participating to EUCN2021 virtual event as an exhibitor. During Q10 UO has actively been participating in the creation of 5G!Drones book. Together with INF, INV has written the chapter about “Stakeholders analysis” for 5G!Drones book. INV participated to the meetings and discussions about the book. This work is still ongoing. During Q11 INV was actively participating to the meetings for 5G!Drones book. We took a part in the discussion about the content and status of the book. INV has written a chapter 6.2.1 “Ecosystem stakeholders”. This work is still ongoing. After the F2F meeting in February, when it was announced that the 5G!Drones demonstrations can’t be organised in Estonia, INV started talks with our local partners about possibility to organise such event in Switzerland. INV was also making preparations to ADW in March 2022. During Q12 INV was proposing to make the 5G!Drones public demonstration in Switzerland with our commercial partner, large MNO operating existing 5G network. This event was intended to replace the cancelled event in Tallin. We invested time to discuss this with our partner and describe what experiments and tests can be performed during the show. Unfortunately, after initial expression of interest, our partner didn’t react on time and we had to decide to cancel further preparations. INV was also following the work and discussion about 5G!Drones book. INV chapters are ready for the review.

*5-HEP* does not partake in WP5.

*6-NCSR*D supported the virtual booth of the project at the EUCNC2021. NCSR D presented and published in the conference proceedings of IEEE MEDITCOM 2021, three research papers related to the project results during Q9. During Q10 NCSR D contributed in the 5G!Drones book. Moreover, it has prepared a video of the June 2021 trials in Athens in collaboration with INF and the video will be uploaded at the Youtube channel of the project. During Q11 NCSR D participated in workshop proposals for the forthcoming EUCNC, where the progress of 5G-PPP projects will be presented and discussed. During Q11 NCSR D contributed to the 5G!Drones book to sections that were asked from the editors to support. During Q12 NCSR D submitted a research paper at the EuCNC, which was also

accepted for presentation. Moreover, the preparation of a journal paper has started which will be based on the results collected during the showcasing event in Athens trial (September 2022).

7-AU is continuing its dissemination activities in the form of scientific contributions. AU has been working during Q9 on the revision of a journal paper accepted for a magazine. The scope of the paper is related to WP3. Furthermore, AU has also submitted 2 conference papers related to the activities of 5G!Drones to GLOBECOM21, which have accepted. During Q10 AU has published two papers acknowledging 5G!Drones in GLOBECOM 2021. In addition, AU is preparing extension versions of these papers to be submitted to journals. During Q11 AU has submitted a conference paper related to WP3 activity (localization of a UAV using cellular networks) to IEEE IWCMC. An extension version is currently under preparation to be submitted to a journal. During Q12 AU has submitted three conference papers related to UAV communications in cellular networks to IEEE Globecom 2022.

8-COS supported the 5G!Drones virtual booth for EUCNC2021. Also, on the preparation of G. Makropoulos, H. Koumaras, S. Kolometsos, A. Gogos, T. Sarlas, T. Järvet, G. Srinivasan and F. Setaki, Field Trial of UAV flight with Communication and Control through 5G cellular network, presented in IEEE International Mediterranean Conference on Communications and Networking (MeditCom), 7-10 September 2021 reporting the work done on field trials in Athens platform. COS had no activity on the Task between Q10 and Q11. During Q12 COS was supporting the task activities through dissemination activities within the organisation and has started planning the showcasing event for the UC4SC1 demo to be held in Athens.

9-AIR has supervised this task as WP leader and has contributed to drive September 2021 presentations. AIR supported the 5G!Drones virtual booth for EUCNC2021. During Q10 AIR has supervised this task as WP leader and has contributed to preparation work for defining content of last deliverables in this task. During Q11 AIR has supervised this task as WP leader and has set up and contributed to several meetings in order to define roadmap for last deliverables. During Q12 AIR has participated to common effort on Milestone 5 completion (large scale trial) planning several opportunities (Swisscom trial, EUCNC trial, Aalto University trial campaign).

11-INF maintains in Teams the dissemination activities repository and excel tracking file. It updates and maintains dissemination activities via website and social media channels (latest presentations, journal papers, conference papers, participation to conferences/workshops/events, 5G-PPP WG white paper releases). INF monitors SME WG activities: Reporting to 5G!Drones consortium on SME WG participation and latest activities. Communicating 5G!Drones activities through 5G-PPP and 6G-IA channels. During Q9 INF contributed to EuCNC 5G!Drones virtual booth with preparation and provision of digital communication material (photos, leaflet, poster, videos etc.). It had attendance at EuCNC 2021 as exhibitors at 5G!Drones virtual booth. INF participated in the 5G!Drones book preparation meetings (attending meetings and contributing to various chapters). It monitors SME WG activities: Contributing to the update of Find your SME web page (released end of August 2021), updating related section to SMEs brochure (released end of August 2021), reporting to 5G!Drones consortium on SME WG participation and latest activities. INF also attended, as 5G!Drones representative, the NetworkEurope SME Working Group and the SME WG-European Digital SME Alliance workshop on 5G, Edge Computing and IoT topics on 16 September 2021. During Q10 INF participated in the 5G!Drones book preparation meetings (attending meetings and contributing to various chapters). SME WG general assembly meeting took place online on Monday 15 November 2021. Attended by INF on behalf of 5G!Drones. During Q11 INF Participated in 5G!Drones book preparation meetings (attending meetings and completing agreed high level contributions to various sections as per RXB agreed request). During Q12 INF contributions have already been made to various sections of book preparation. INF has been supporting EuCNC 2022 preparation activities for 5G!Drones presence.

12-NOK did a presentation "Coverage aspects in 5G experimentation results" in "Practical insights from 5G Test, Measurement and KPI Validation with vertical applications" 5G-PPP seminar during



Q9. During Q10 NOK presented during the 26th Finnish National Conference on Telemedicine and eHealth the role of telcos and latest technologies in eHealth. NOK had no activity on the Task between Q11 and Q12.

**13-RXB** team has performed the coordination of the preparation and operation of the project premium virtual booth within the EUCNC2021/6G Summit in Portugal (8. - 11. June 2021), which has marked an important step among the project public visibility increase process, since it is worldwide a key event in the thematic domain. The organisation of the project representation of both key events in the Unmanned Aviation domain - Amsterdam Drone Week 2021 and Commercial UAV Expo 2021 (Amsterdam, January 2022) - has been started, operated by RXB. The organisation of the project representation at ITS Congress Hamburg 2021 (October 2021) was performed by RXB. Dr. Georgi Georgiev from RXB has initiated and started active collaborative work, supported by the entire project team, on the 5G!Drones BOOK. It is aiming to optimally present the project aims, developments, outcomes and strategic trends and directions, identified and elaborated during the project work, in the context of the evolving interdisciplinary market and business models. It is to be published as open access e-book by Summer 2022, at a well-established publishing house. Further intensive work at relevant 5G-PPP, EASA, Eurocontrol and NASA, as well as VDI WGs has been performed. The active work at WG Vision of 5G-PPP was started, aiming to collaboratively work towards innovative business models for 5G-applications, in the project's case for UAS operations. RXB has been involved at the intensive showcasing and dissemination work. During Q10 RXB Participated in a 5G panel in Dubai Airshow, participated in 5G Techritory conference, contributed to several articles focusing on 5G. During Q11 RXB led the efforts towards 5G-Book, and several other dissemination activities related to EuCNC, ADW, etc. During Q12 RXB participated in ADW in three different panels and one presentation representing 5G!Drones Consortium. It coordinated with partners to prepare for large scale showcasing activities in AU, and to prepare for a booth in EuCNC 2022.

**14-EUR** had no activity on the Task During Q9. During Q10 EUR has participated in the journées Cloud (French event), where the 5G!Drones/5GEVE monitoring platform has been presented. The event was organised physically. EUR has submitted a paper to IEEE ICC 2022 on the 5G NR network slicing (Task 3.1). EUR has reported two papers accepted in IEEE Globecom 2021 and two papers in ELSEVIER Computer Communications and IEEE Transactions on Network and Service Management (TNSM). During Q11 EUR has published three papers acknowledging the project. Two in IEEE ICC 2022 on activities related to WP3 (MEC orchestrator) and 5G NR RAN slicing. One journal paper in IEEE Open journal of the communications society. During Q12 EUR has submitted two papers accepted in IEEE ICC 2022 on activities related to MEC and 5G NR RAN slicing. Two other papers have been submitted to journals extending the work on 5G RAN Slicing and MEC.

**15-DRR** does not partake WP5.

**16-CAF** supported the 5G!Drones virtual booth for EUCNC2021. Also, on the preparation of G. Makropoulos, H. Koumaras, S. Kolometsos, A. Gogos, T. Sarlas, T. Järvet, G. Srinivasan and F. Setaki, Field Trial of UAV flight with Communication and Control through 5G cellular network, presented in IEEE International Mediterranean Conference on Communications and Networking (MeditCom), 7-10 September 2021 reporting the work done on field trials in Athens platform. During Q10 CAF presented 5G!Drones project and CAF cellular 5G drone capacities at the Smart City Expo 2021 (16.-18. Nov in Barcelona, physical event). CAF had no activity on the Task during Q12.

Deviation to description of action:

CAF began preparations for showcasing trials in early January 2022 (Q11). The plan was to conduct 5G!Drones tests in Tallinn. The basis was the possibility to use the 5G commercial network or the 5G base station of the Estonian Defense Forces. In February, it became clear that the Estonian 5G band auction would be postponed again. The latest information as of April 7, 2022 is as follows: The Estonian Communications Board plans to invite telecom companies to auction 5G frequency licenses at the end of April-May. The availability of the commercial 5G network can be expected at the earliest from August 2022. Alternatively, the Estonian Defense Forces were contacted, from whom information



was received in mid-February 2022 that they did not have the permission of the Communications Board to set up their 5G base station and use it in the planned location on the territory of the Estonian Academy of Internal Affairs. However, drone flights cannot be carried out in the territory of the Defense Forces. Therefore, it is not possible to conduct 5G!Drones showcasing trials in Tallinn in May 2022, as originally planned.

17-FRQ contributed to preparation and distribution of EUCNC Material and actively participated in EUCNC & 6G Summit 2021. FRQ contributed in first discussions and preparatory work on 5G!Drones book. During Q10 FRQ participated on discussions and preparatory work on 5G!drones book. During Q11 FRQ participated in discussions on the 5G!Drones book. During Q12 FRQ prepared contribution to D5.5. in chapter 4.6.

18-OPL had no activity on the Task during Q9. During Q10 it did work on 5G!Drones book (section 2). During Q11 OPL organised discussions on led sections of the 5G!Drones BOOK, writing the contribution to the 5G!Drones BOOK. During Q12 OPL prepared a conference paper acknowledging the 5G!Drones project “Application of mobile networks (5G and beyond) in precision agriculture”, submitted to the IFIP AIAI 2022/5G-PINE conference. After acceptance of the review draft, the camera-ready version has been prepared for Springer Verlag (the editor of the proceedings of the conference).

19-MOE supported the 5G!Drones virtual booth for EUCNC2021. During Q10 MOE presented during the 23th Infocom World 2021 the smart city applications in the City of Egaleo and the participation and the role of the City of Egaleo in European H2020 programs (5G!Drones, 5GENESIS, RESPOND-A etc.). During Q11 MOE participated in meetings and in the discussions regarding the 5G!Drones book. During Q12 MOE has started planning the showcasing event for the UC4Sc1 demo to be held in Egaleo, Greece.

20-ORA does not partake in Task 5.3. During Q10 ORA had three Papers related to 5G!Drones enablers accepted in resp. IEEE WiMob 2021, DIVANet’21, IEEE Transactions on Vehicular Technology.

21-UMS engaged with RXB to discuss potential contributions to the 5G!Drones Book. Following this engagement, UMS initiated internal processes to ensure adequate support could be provided for contributions to the book. Representatives from UMS participated in the EUCNC 2021 conference. UMS also represented the project in other events like MWC Barcelona. UMS had no activity on the Task between Q10 and Q12.

### **8.5.1. Exhaustive list of dissemination and exploitation activities performed between M25 and M36**

This subsection describes the dissemination and exploitation actions carried out during the Reporting Period. Social media dashboards are only available up until the end of April 2022 at the submission of this deliverable.

#### **8.5.1.1. Social Media**

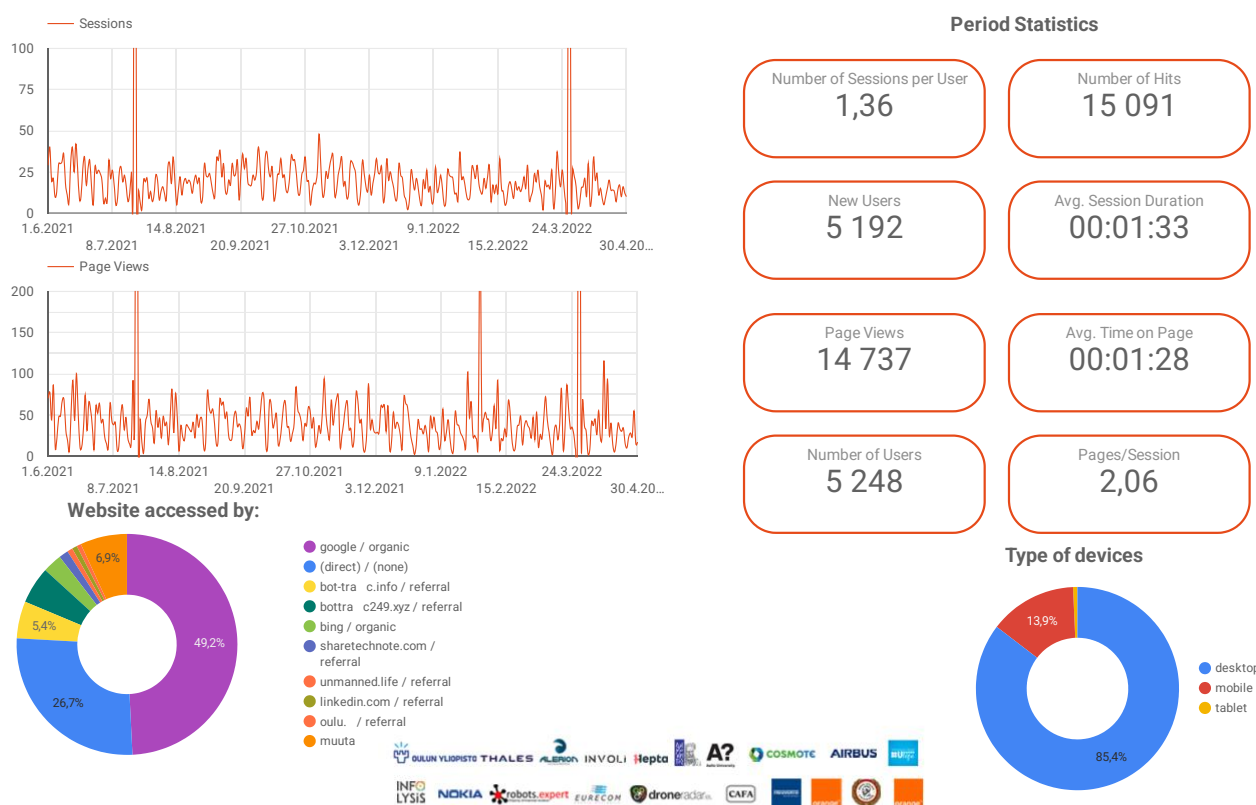
The 5G!Drones project tracks its social media impact on a monthly basis. The project social media links have been defined in Deliverable D5.1 and D5.2. In the following, an overview of the various social media channels is shown during the period from June 2021 to April 2022 (reporting also May is not feasible as its statistics will be available only after the submission of this Deliverable). The overviews are in a form of dashboard reports. They are live data updated regularly. The Website, Twitter,

Facebook, LinkedIn, and Instagram use statistics are illustrated in Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5, respectively.

The 5G!Drones project has established its official website available at [www.5gdrones.eu](http://www.5gdrones.eu), serving as a portal where informative details and relevant 5G and drone data are published, sustaining the ICT-19 project's scope across multiple vertical industries. The Website dashboard data regarding Figure 1 can be found at <https://datastudio.google.com/reporting/6af4ed32-1cbc-434e-9de2-8f0aad862fda>.



## 5G!DRONES Website June 2021 - April 2022 Analytics



**Figure 1: 5G!Drones Website Statistics/Dashboards, June 2021 – April 2022.**

5G!Drones is present in all popular social media networks. In specific, the following 5G!Drones social media accounts are open and have been actively used since the beginning of May 2019: Twitter, LinkedIn, Facebook, Instagram, and YouTube and their access links are the following:

**Twitter:** <https://twitter.com/5gdrones>

**LinkedIn:** <https://www.linkedin.com/in/5gdrones/>

**Facebook:** [www.facebook.com/5gdrones](http://www.facebook.com/5gdrones)

**Instagram:** [https://www.instagram.com/5gdrones\\_project/](https://www.instagram.com/5gdrones_project/)

**YouTube:** <https://www.youtube.com/channel/hPj4gQ5P5go7Fer6NJxGOQ>

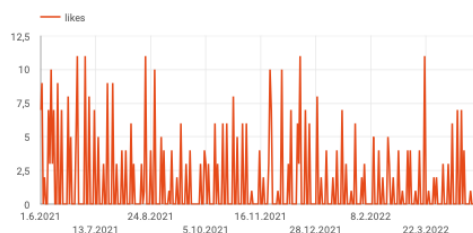
5G!Drones social media posts are oriented towards promoting the project's news as well as the dissemination activities in which the partners participate. Dissemination activities cover a wide spectrum of events, publications, presentations, workshops, demonstrations, call for papers and other relative activities communicated via the social media accounts. The Twitter dashboard data regarding Figure 2 can be found at <https://datastudio.google.com/reporting/b1eab1a6-cbe9-45ea-85a5-d843563760fe>.



### 5G!DRONES Twitter Dashboard June 2021 - April 2022 Statistics



#### Number of Likes per Total Tweets/Date



#### Top Rated Tweets

	Tweet text	Date	likes	impressions	engagements
1.	#LearnAbout5G...	5.7.2021 klo 9.0...			
2.	#LearnAbout5G...	29.6.2021 klo 9...			
3.	#LearnAbout5G...	21.3.2022 klo 9...			
4.	The last 5GENE...	16.12.2021 klo ...			
5.	#LearnAbout5G...	23.11.2021 klo 9...			
6.	#LearnAbout5G...	2.12.2021 klo 9...			
7.	#LearnAbout5G...	27.8.2021 klo 7...			
8.	#LearnAbout5G...	9.6.2021 klo 8.1...			
9.	#LearnAbout5G...	14.6.2021 klo 8...			
	Do you want to...	22.7.2021 klo 5...			

#### Period Statistics

Number of Tweets	106	Number of Retweets	59
Total Impressions	18 662	Total Engagements	1 102
Mentions	48	Total Likes	492
User Profile Clicks	56	Average Engagement Rate	0,06

#### Total Statistics

Following	265	Followers	743
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### 5G!DRONES Twitter June 2021 - April 2022 Statistics

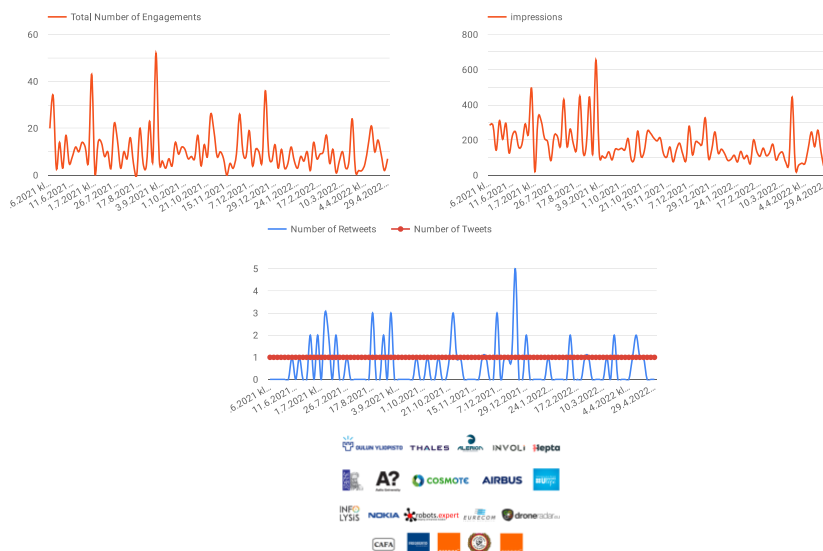


Figure 2: 5G!Drones Twitter Statistics/Dashboards, June 2021 – April 2022.

In the 5G!Drones Facebook profile page users can find the latest 5G!Drones posts, get informed on the latest news of the project and send an immediate message to the 5G!Drones team. The Facebook dashboard data regarding Figure 3 can be found at <https://datastudio.google.com/reporting/0b9ff65f-7465-4ba5-be8b-9b62fb2c278d>.

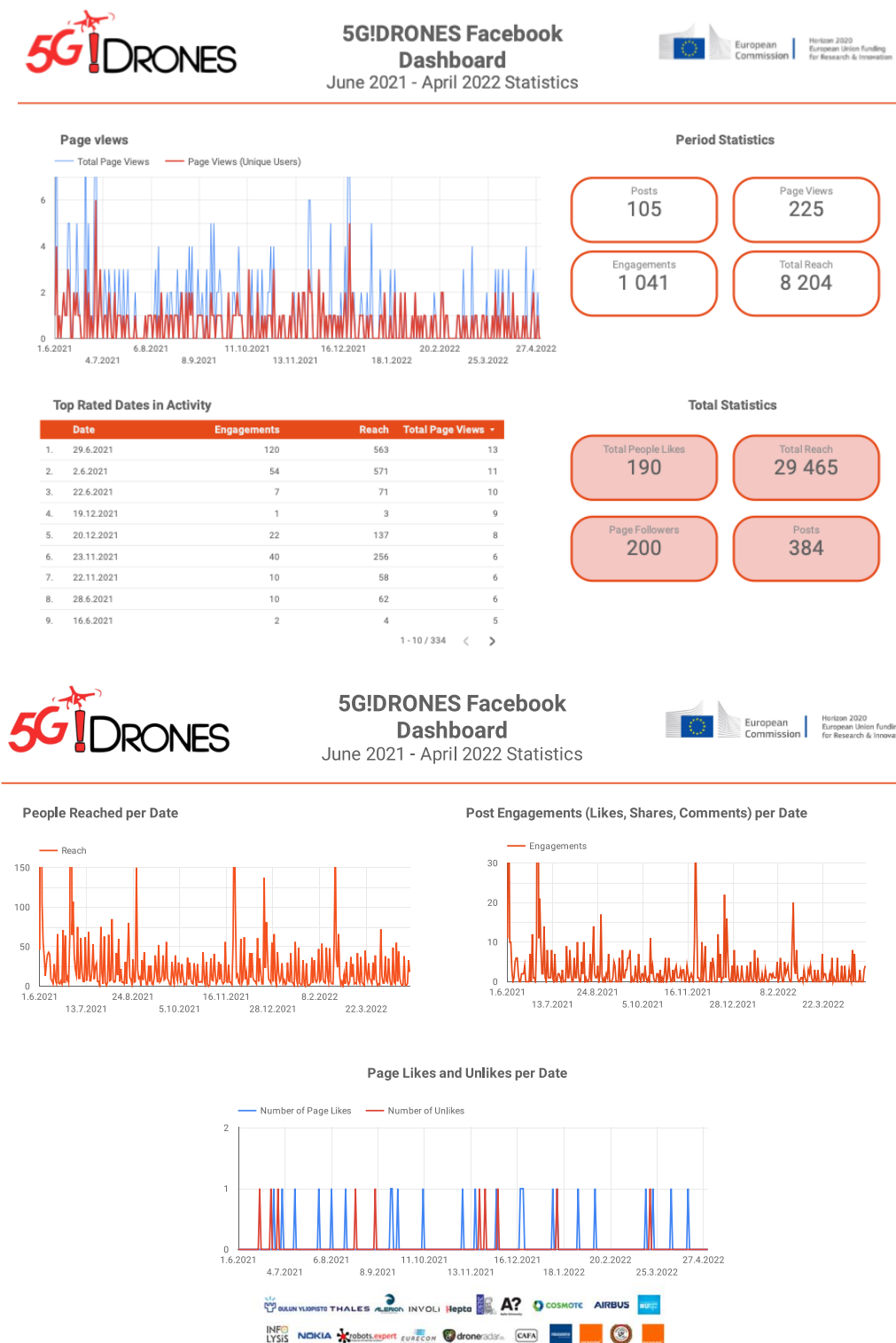


Figure 3: 5G!Drones Facebook Statistics/Dashboards, June 2021 – April 2022.

There is a short bio of the project including its objectives and quantitative details in the official 5G!Drones LinkedIn profile. The audience can easily check the latest project posts and communicate directly with the 5G!Drones team in case of any queries. The LinkedIn dashboard data regarding Figure 4 can be found at <https://datastudio.google.com/reporting/8b7895a8-92a1-4299-8c92-3018ad6f9594>.

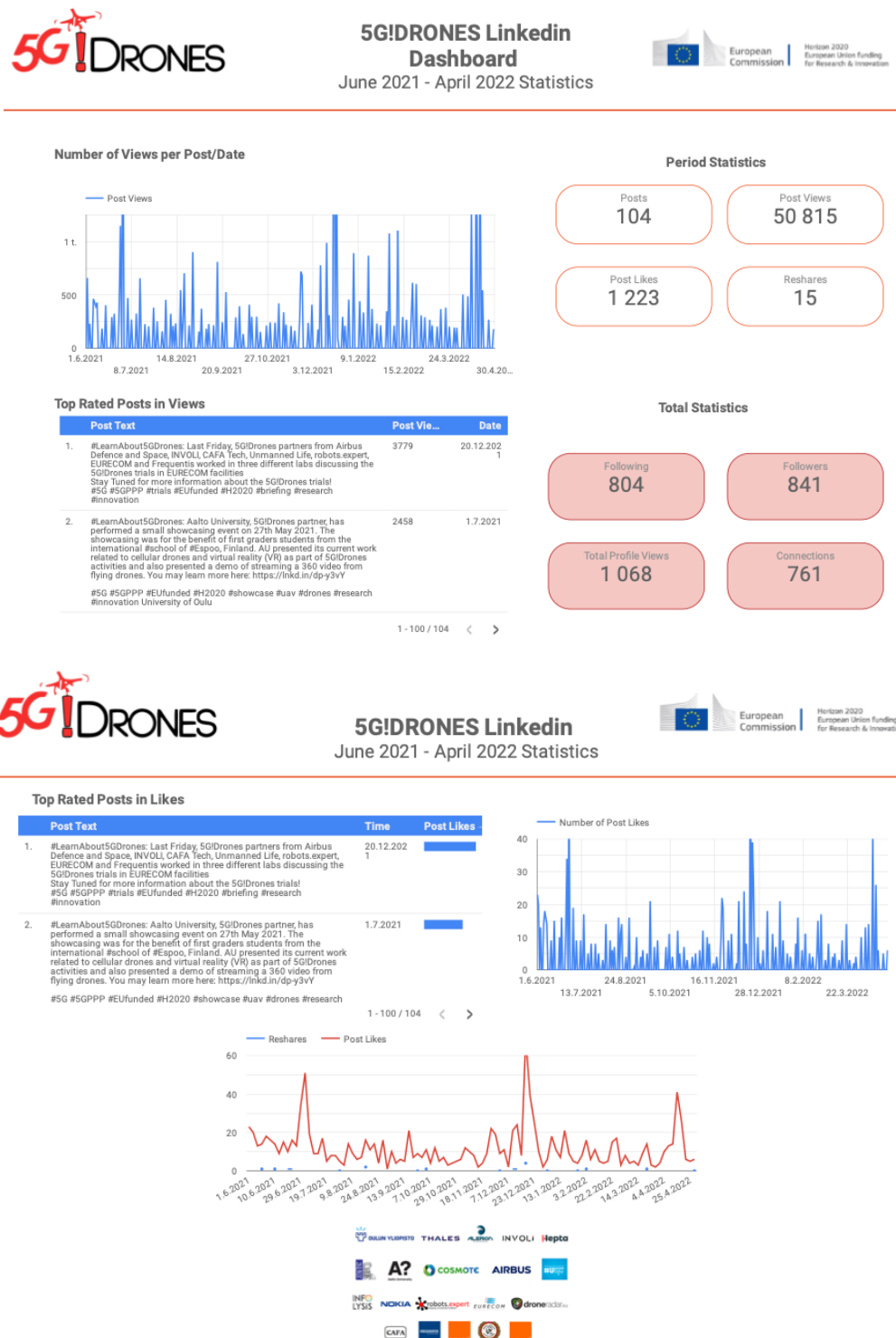
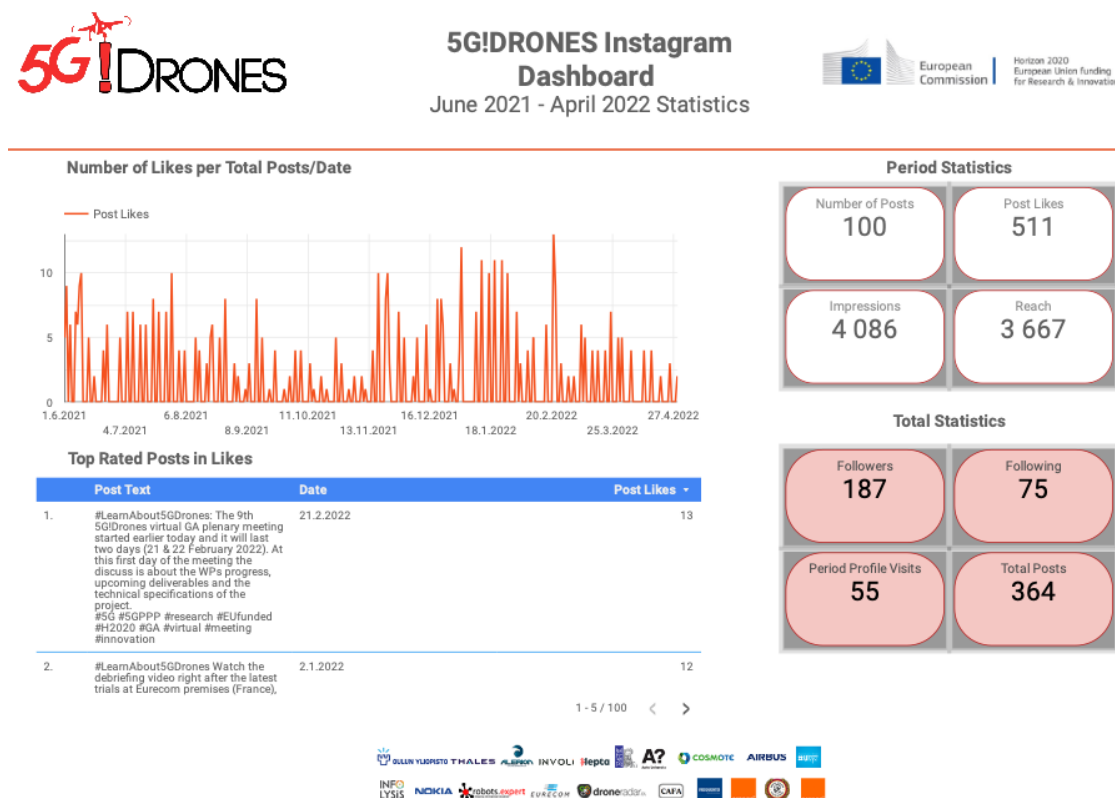


Figure 4: 5G!Drones LinkedIn Statistics/Dashboards, June 2021 – April 2022.



In the official 5G!Drones Instagram profile and posts/pictures, users can be also redirected to the official 5G!Drones website when clicking on the relevant link included in the profile page. The Instagram dashboard data regarding Figure 5 can be found at <https://datastudio.google.com/reporting/371740bd-66f1-4b70-8720-df807f472d54>.



**Figure 5: 5G!Drones Instagram Statistics/Dashboards, June 2021 – April 2022.**

The project also published newsletters. During the Reporting Period (M25 – M36), four newsletters have been published and one is almost ready to be released. They are available on the project website at <https://5gdrones.eu/newsletter/>.

#### 8.5.1.2. Dissemination and exploitation activities

The specific WP5 dissemination and exploitation activities during the Reporting Period (M25 – M36) are listed in more detail in Table 7. The table describes the authors and Partners involved, the title of the activity, the target of the activity, and a brief description of the activity.

Table 7: 5G!Drones table of dissemination and exploitation activities

#	Authors / Partners	Activity	Target (Event, Location, Date)	Description
<b>April – May 2021</b>				
73	Aalto University	Showcasing Event	international school of Espoo, 27th May 2021	Aalto University, 5G!Drones partner, has performed a small showcasing event on 27th May 2021. The showcasing was for the benefit of first graders students from the international school of Espoo, Finland. AU presented its current work related to cellular drones and virtual reality (VR) as part of 5G!Drones activities and also presented a demo of streaming a 360 video from flying drones. More info available at <a href="http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c">http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c</a>
74	Aalto University	Article	international school of Espoo, 27th May 2021	Aalto University, 5G!Drones partner, has performed a small showcasing event on 27th May 2021. The showcasing was for the benefit of first graders students from the international school of Espoo, Finland. AU presented its current work related to cellular drones and virtual reality (VR) as part of 5G!Drones activities and also presented a demo of streaming a 360 video from flying drones. More info available at <a href="http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c">http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c</a>
75	Athens remote-emulated tests (23 April)	Athens remote pretrials	Athens remote pretrials	Athens remote-emulated tests on 5GENESIS Athens 5G experimental platform at NCSR campus on 23 April 2021. Focus paid on measurements, connectivity, KPIs and Athens UC4 details. Involved partners: NCSR, COS, UMS, INF.
76	5GPPP	5GPPP 5G Annual Journal	The sixth issue of the European 5G Annual Journal was released at the end of May 2021	<a href="https://5g-ppp.eu/the-5g-european-annual-journal-2021-is-out/">https://5g-ppp.eu/the-5g-european-annual-journal-2021-is-out/</a>
<b>M25 – M36</b>				
1	NCSR/Harilaos Koumaras	5GPPP White Paper	The 5G Infrastructure Association (5G IA) publishes the White Paper	5G-PPP white paper, European Vision for the 6G Network Ecosystem, June 2021 link <a href="https://5g-ppp.eu/wp-content/uploads/2021/06/WhitePaper-6G-Europe.pdf">https://5g-ppp.eu/wp-content/uploads/2021/06/WhitePaper-6G-Europe.pdf</a>

			'European Vision for the 6G Network Ecosystem'	
2	EuCNC2021	Booth		
3	5GPPP	Publication-Brochure	5G PPP, Phase 3 Projects Brochure	5G PPP, Phase 3 Projects Brochure, June 2021 <a href="https://5g-ppp.eu/wp-content/uploads/2021/06/5GPPP_Phase3_Brochure_v7.2-web.pdf">https://5g-ppp.eu/wp-content/uploads/2021/06/5GPPP_Phase3_Brochure_v7.2-web.pdf</a>
4	Ilkka Kansala (Nokia) Ole Grøndalen, (Telenor)	Presentation	Practical insights from 5G Test, Measurement and KPI Validation with vertical applications	#LearnAbout5GDrones: 5G!Drones Partner, Ilkka Kansala (Nokia) Ole Grøndalen, (Telenor) participated and presented in 5G-PPP TMV event: "Practical insights from 5G Test, Measurement and KPI Validation with vertical applications", on June 18. The presentation title is: "Coverage aspects in 5G experimentation results", You may learn more here: <a href="https://5g-ppp.eu/event/practical-insights-from-5g-test-measurement-and-kpi-validation-with-vertical-applications/">https://5g-ppp.eu/event/practical-insights-from-5g-test-measurement-and-kpi-validation-with-vertical-applications/</a>
5	Harilaos Koumaras and George Makropoulos /NSCR "Demokritos	Online Article	What will the drones of the future look like? <a href="https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html">https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html</a>	#LearnAbout5GDrones: A very interesting article (in Greek) was released in News 24/7 website by 5G!Drones partners, Harilaos Koumaras and George Makropoulos (NSCR "Demokritos), explaining the drones of the future. They also shared details about 5G!Drones project. You may access the article here: <a href="https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html">https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html</a>
6	Eurecom remote tests and pretrials on 17 June 2021	Eurecom remote tests and pretrials	Eurecom remote tests and pretrials	Eurecom remote tests and pretrials on 17 June 2021, for testing 5G!Drones Integration Release1 components and UC1Sc1 and UC2Sc1, UC2SC2 scenarios and collecting feedback for physical tests in Sep-Oct 2021. Involved partners: EUR, CAF, INV, DRR, UMS, AIR.
7	Athens trials (28 June-2 July 2021)	5G!Drones Athens trials on 5GENESIS Athens platform	5G!Drones Athens trials on 5GENESIS Athens platform	Joint trials of 5GENESIS and 5G!Drones projects! 5G!Drones UC4 (Connectivity during crowded events) is tested on the 5GENESIS Athens 5G experimental platform at COSMOTE Academy premises in Athens (28 June-2 July 2021). Involved partners: NCSR, COS.

8	Nokia	White Paper	D1.1 – Use case specifications and requirements	#LearnAbout5GDrones: A White paper entitled "Controlling drones over cellular networks" has been released by Nokia (5G!Drones partner), referencing 5G!Drones "D1.1 – Use case specifications and requirements", June 2021. You may learn more here: <a href="https://www.bell-labs.com/institute/white-papers/controlling-drones-over-cellular-networks/">https://www.bell-labs.com/institute/white-papers/controlling-drones-over-cellular-networks/</a>
9	Eurecom - Sihem Bakri, Pantelis A. Frangoudis, Adlen Ksentini and Maha Bouaziz	Journal paper	Data-Driven RAN Slicing Mechanisms for 5G and Beyond, IEEE Transactions on Network and Service Management journal	Sihem Bakri, Pantelis A. Frangoudis, Adlen Ksentini and Maha Bouaziz, "Data-Driven RAN Slicing Mechanisms for 5G and Beyond", IEEE Transactions on Network and Service Management journal, 1-15 pages, Online ISSN: 1932-4537, DOI 10.1109/TNSM.2021.3098193 ( <a href="https://ieeexplore.ieee.org/document/9490293">https://ieeexplore.ieee.org/document/9490293</a> )
10	Srinivasan, Gokul; Kansala, Ilkka;	White Paper	Understanding the Numbers – Contextualization and Impact Factors of 5G Performance Results	Srinivasan, Gokul; Kansala, Ilkka; 5G!Drones partners, participated in the 5GPPP white paper entitled: "Understanding the Numbers – Contextualization and Impact Factors of 5G Performance Results". You may access the white paper here: <a href="https://5g-ppp.eu/wp-content/uploads/2021/08/TMV-Results-Explanation-White-Paper-V1.0.pdf">https://5g-ppp.eu/wp-content/uploads/2021/08/TMV-Results-Explanation-White-Paper-V1.0.pdf</a>
11	Pretrials (Aalto)	Pretrials	Pre-trials were executed at Aalto University on Friday 20 August 2021	Pre-trials were executed at Aalto University on Friday 20 August 2021 as part of 5GDrones project. Involved 5G!Drones partners validated use cases with 5G flights including scenarios where the remote pilot (not the PIC) takes over the control and pilots the aircraft with a tethered joystick. The pilot used the video stream from the aircraft's onboard camera, streamed over 5G network. The team also validated C2 link over 5G, and UTM over 5G. Many thanks to all involved partners!

12	Trials (Oulu)	Trials	Trials at Oulu, Finland (24-26 August 2021)	5G!Drones trials at Oulu, Finland (24-26 August 2021). Integration Rel.1 tests in Oulu (Web Portal1 and UO Web Portal 2 components). Setting up and testing 5G network coverage and Edge server solutions in Botanical Garden area. 4 operators connecting to the network and sharing the 5G network and the airspace, video streaming over 5G for near real-time search, UTM over 5G, C2 link over 5G, and several other system critical functionalities were tested Participants: UO, NOK, CAF, HEP, ALE. Remotely: DRR, INV, FRQ.
13	Dimitrios Fragkos and Georgios Makropoulos (NCSR Demokritos, Greece); Panteleimon Sarantos (National Centre of Scientific Research, Greece); Harilaos Koumaras (NCSR Demokritos, Greece); Anastasios-Stavros Charismiadi s (National And Kapodistria n University of Athens, Greece); Dimitris Tsolkas (Fogus Innovations and Services, Greece)	5G Vertical Application Enablers Implementation Challenges and Perspectives Conference paper	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	5G Vertical Application Enablers Implementation Challenges and Perspectives  Dimitrios Fragkos and Georgios Makropoulos (NCSR Demokritos, Greece); Panteleimon Sarantos (National Centre of Scientific Research, Greece); Harilaos Koumaras (NCSR Demokritos, Greece); Anastasios-Stavros Charismiadi s (National And Kapodistria n University of Athens, Greece); Dimitris Tsolkas (Fogus Innovations and Services, Greece) <a href="https://meditcom2021.ieee-meditcom.org/program/special-sessions/">https://meditcom2021.ieee-meditcom.org/program/special-sessions/</a>



14	Georgios Makropoulos, Harilaos Koumaras, Stavros Kolometsos, Anastasios Gogos and Thanos Sarlas (NCSR Demokritos, Greece); Tanel Järvet (CAFA Tech Ltd, Estonia); Gokul Srinivasan (Robots Expert, Finland); Fotini Setaki (COSMOTE Mobile Telecommunications S.A. Greece, Greece)	Field Trial of UAV flight with Communication and Control through 5G cellular network Conference paper	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	Field Trial of UAV flight with Communication and Control through 5G cellular network  Georgios Makropoulos, Harilaos Koumaras, Stavros Kolometsos, Anastasios Gogos and Thanos Sarlas (NCSR Demokritos, Greece); Tanel Järvet (CAFA Tech Ltd, Estonia); Gokul Srinivasan (Robots Expert, Finland); Fotini Setaki (COSMOTE Mobile Telecommunications S.A. Greece, Greece) <a href="https://meditcom2021.ieee-meditcom.org/program/sessions/">https://meditcom2021.ieee-meditcom.org/program/sessions/</a>
15	Panos Matzakos (EURECOM, France); Harilaos Koumaras (NCSR Demokritos, Greece); Dimitris Tsolkas (Fogus Innovations and Services, Greece); Maria Christopoulou and George K Xilouris	An open source 5G experimentation testbed Conference paper	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	An open source 5G experimentation testbed  Panos Matzakos (EURECOM, France); Harilaos Koumaras (NCSR Demokritos, Greece); Dimitris Tsolkas (Fogus Innovations and Services, Greece); Maria Christopoulou and George K Xilouris (NCSR Demokritos, Greece); Florian Kaltenberger (Eurecom, France) <a href="https://meditcom2021.ieee-meditcom.org/program/demos/">https://meditcom2021.ieee-meditcom.org/program/demos/</a>

	(NCSR Demokritos, Greece); Florian Kaltenberger (Eurecom, France)			
16	Dimitrios Fragkos/ NCSR	Paper Presentation	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	5G!Drones partner Dimitrios Fragkos (NCSR "DEMOKRITOS") presented the conference paper entitled "5G Vertical Application Enablers Implementation Challenges and Perspectives " on the context of IEEE MeditCom 2021 which took place in #Athens on 7-10 September 2021.
17	George Makropoulos/NCSR	Paper Presentation	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	5G!Drones partner George Makropoulos (NCSR "DEMOKRITOS") presented the conference paper entitled "Field Trial of UAV flight with Communication and Control through 5G cellular network on the context of IEEE MeditCom 2021 which took place in #Athens on 7-10 September 2021.
18	Panos Matzakos /EURECOM	Paper Presentation	IEEE International Mediterranean Conference on Communications and Networking 7–10 September 2021 // Hybrid: In-Person and Virtual Conference	5G!Drones partner Panos Matzakos (EURECOM), presented the conference paper entitled "An open source 5G experimentation testbed" on the context of IEEE MeditCom 2021 which took place in #Athens on 7-10 September 2021.
19	NCSR/Co smote	Video	5G-enabled UAV Trials in Athens 5GENESIS Platform with COSMOTE commercial-grade equipment (7/2021)	5G!Drones partners NCSR and COSMOTE conducted UAV trials in the COSMOTE academy premises in Athens. The trials took place on the context of Use Case 4. You may watch the video here: <a href="https://www.youtube.com/watch?v=7Dj3ehOxQog">https://www.youtube.com/watch?v=7Dj3ehOxQog</a>

20	Srinivasan Gokul (RXB) - presentation	Presentation	Presentation of 5G!Drones at 5G Techritory - Europe's Leading 5G Ecosystem Forum, November 22-25, 2022	Presentation at 5G Techritory - Europe's Leading 5G Ecosystem Forum, November 22-25, 2021
21	Srinivasan Gokul (RXB)	Panel Discussion	Dubai Airshow , 14-18 Nov 2021	#LearnAbout5GDrones: 5G!Drones partner Gokul Srinivasan (robots.expert) will present the 5G attributes in the context of UAVs in a #panel discussion of the Dubai Airshow. You may find more information about the event and the registration form here: <a href="https://www.dubaiairshow.aero/#5G">#5G</a> #5GPPP #EUfunded #H2020 #research #innovation #airshow #event #UAVS #drones
22	NOKIA	Presentation	26th Finnish National Conference on Telemedicine and eHealth, "eHealth in a Lifecycle" 7th – 8th October 2021	The NOKIA team, 5G!Drones partner, presented during the 26th Finnish National Conference on Telemedicine and eHealth the role of telcos and latest technologies in eHealth. The presentation entitled "Telco shaking hands with eHealth" featured also 5G!Drones and it was made by Liinamaa Olli, Hannula Juha and Jyrkkä Johannes
23	G. P. Wijesiri N.B.A (University of Moratuwa, Sri Lanka and University of Ruhuna, Sri Lanka), J. Haapola (University of Oulu, Finland), T. Samarasinghe (University of Moratuwa, Sri Lanka and University of	Journal paper	IEEE Transactions on Communications	G. P. Wijesiri N.B.A, J. Haapola and T. Samarasinghe, "The Effect of Concurrent Multi-priority Data Streams on the MAC Layer Performance of IEEE 802.11p and C-V2X Mode 4," in IEEE Transactions on Communications, doi: 10.1109/TCOMM.2021.3119703. Parallel publishing repository: <a href="http://jultika.oulu.fi/Record/nbnfi-fe2021102252047">http://jultika.oulu.fi/Record/nbnfi-fe2021102252047</a>

	Melbourne, Australia)			
24	Mohamed Mekki, Sagar Arora, and Adlen Ksentini	Journal Paper	IEEE Transactions on Network and Service Management (TNSM), 12 October 202	A Scalable Monitoring Framework for Network Slicing in 5G and Beyond Mobile Networks, IEEE Transactions on Network and Service Management (TNSM), 12 October 202 (PDF) - DOI: 10.1109/TNSM.2021.3119433
24	Karim Boutibaa, Adlen Ksentini, Bouziane Brikb, Yacine Challal, Amar Ballac	Journal Paper	Computer Communications journal	"NRflex: Enforcing Network Slicing in 5G New Radio" DOI: <a href="https://doi.org/10.1016/j.comcom.2021.09.034">https://doi.org/10.1016/j.comcom.2021.09.034</a>
25	Karim Boutiba, Miloud Bagaa and Adlen Ksentini	Conference Paper accepted	IEEE Global Communications Conference 7–11 December 2021, Madrid, Spain. Hybrid: In-Person and Virtual Conference	"Radio Link Failure Prediction in 5G Networks", IEEE Global Communications Conference 7–11 December 2021, Madrid, Spain. Hybrid: In-Person and Virtual Conference
26	5GPPP	White Paper	5G PPP Architecture Working Group, "View on 5G Architecture" #4	<a href="https://5g-ppp.eu/5g-ppp-architecture-working-group-view-on-5g-architecture-4/">https://5g-ppp.eu/5g-ppp-architecture-working-group-view-on-5g-architecture-4/</a>

27	CAF	Booth	Smart City Expo World Congress	<p>CAFA Tech, 5G!Drones partner, is participating in the Estonian Joint Stand at the Smart City Expo World Congress in Barcelona, which takes place November 16th -18th . More than 400 companies are represented at the fair, introducing innovative solutions to create a better urban life for people and enable more efficient and inclusive urban services. CAFA tech presents the CAFA Worker robot and the 5G cellular drone at the fair and introducing 5G!Drones project and initial results. More information available here:</p> <p><a href="https://www.smartcityexpo.com/agenda/?type=scewc-digital">https://www.smartcityexpo.com/agenda/?type=scewc-digital</a></p>
28	CAFA Tech	Presentation	Smart City Expo World Congress	<p>Tanel Järvet (CAFA) participated in a panel discussion, Moderated by the TalTech – Tallinn University of Technology Smart City Centre of Excellence and featuring CAFA Tech, Fyma and Envelope, during the Smart City Expo World Congress where aspects and results of the 5G!Drones project and its use cases were also discussed and presented.</p> <p><a href="https://www.smartcityexpo.com/agenda/?type=scewc-digital">https://www.smartcityexpo.com/agenda/?type=scewc-digital</a></p>
29	Cafa Tech	Panel Discussion	Smart City Expo World Congress	<p>Tanel Järvet (CAFA) participated in a panel discussion, Moderated by the TalTech – Tallinn University of Technology Smart City Centre of Excellence and featuring CAFA Tech, Fyma and Envelope, during the Smart City Expo World Congress where aspects and results of the 5G!Drones project and its use cases were also discussed and presented.</p>
30	Srinivasan Gokul (RXB)	Panel Discussion	5G Techritory 22 - 24 November 2021	<p>Presentation at 5G Techritory - Europe's Leading 5G Ecosystem Forum, November 22-25, 2021</p> <p><a href="https://live.5gtechritory.com/agenda">https://live.5gtechritory.com/agenda</a></p>
31	Harilaos Koumaras/ NCSR	Presentation - Panel Discussion	IEEE GLOBECOM 2021 - 8 December 2021	<p>#LearnAbout5GDrones: Dr. Haris Koumaras (NCSR "DEMOKRITOS"), 5G!Drones partner, participated at Industry Panel "5G and beyond – The Perspective of European Research Projects" of IEEE GLOBECOM 2021 on 8th December 2021, discussing and presenting the "Findings and lessons learnt from the 5G trials of 5G!Drones project". You may find more information here:</p>



				<a href="https://globecom2021.ieee-globecom.org/">https://globecom2021.ieee-globecom.org/</a>
32	EURECOM	Online Article	eurecom-blog.medium.com /	<a href="https://eurecom-blog.medium.com/how-can-drones-play-an-essential-role-for-smart-cities-safety-a9e869901d82">https://eurecom-blog.medium.com/how-can-drones-play-an-essential-role-for-smart-cities-safety-a9e869901d82</a>
33	Trials	Trials	Eurecom	Trials at Eurecom premises, Campus SophiaTech, Sophia Antipolis, France (16-18 December 2021)
34	Zineeddine Ould Imam, Marc Lacoste, Ghada Arfaoui	Conference Paper	"Towards a Modular Attestation Framework for Flexible Data Protection for Drone Systems", 2021 17th International Conference on Wireless and Mobile Computing, Networking and Communications (IEEE WiMob 2021)	<a href="https://ieeexplore.ieee.org/document/9606269/authors#authors">https://ieeexplore.ieee.org/document/9606269/authors#authors</a>
35	Bouziane Brik, Karim Boutiba, Adlen Ksentini	Journal Paper	Deep Learning for B5G Open Radio Access Network: Evolution, Survey, Case Studies, and Challenges, IEEE Open Journal of the Communications Society, 28 Jan 2022.	#LearnAbout5GDrones: 5G!Drones partners from EURECOM has released a journal paper entitled "Deep Learning for B5G Open Radio Access Network: Evolution, Survey, Case Studies, and Challenges" in the context of IEEE Xplore Journal of the Communications Society. You may learn more here: <a href="https://ieeexplore.ieee.org/document/9695955">https://ieeexplore.ieee.org/document/9695955</a>
36	Karim Boutiba, Miloud Bagaa, Adlen Ksentini	Conference paper	Radio Resource Management in Multi-numerology 5G New Radio featuring Network Slicing, IEEE International Conference on	<a href="https://5gdrones.eu/wp-content/uploads/2022/02/ICC2022_radio-source-management-network-slicing.pdf">https://5gdrones.eu/wp-content/uploads/2022/02/ICC2022_radio-source-management-network-slicing.pdf</a>

			Communications 2022 (ICC 2022), 16–20 May 2022, Seoul, South Korea	
36	Sagar Arora, Adlen Ksentini, Christian Bonnet,	Conference paper	Lightweight edge Slice Orchestration Framework, IEEE International Conference on Communications 2022 (ICC 2022), 16–20 May 2022, Seoul, South Korea.	<a href="https://5gdrones.eu/wp-content/uploads/2022/02/icc2022_Lightweight-edge-Slice-Orchestration-Framework.pdf">https://5gdrones.eu/wp-content/uploads/2022/02/icc2022_Lightweight-edge-Slice-Orchestration-Framework.pdf</a>
37	robots.expert	Panel Discussion	Amsterdam Drone Week 29 - 31 March 2022	Gokul Srinivasan, robots.expert and 5G!Drones partner, participated at panel discussion at the mainstage on the topic “Autonomous Drone Networks” on the 31st of March 2022 during the Amsterdam Drone Week. 5G!Drones project was represented sharing insights about the role of network related to autonomy, BVLOS & certification standards. <a href="https://www.amsterdamdroneweek.com/">https://www.amsterdamdroneweek.com/</a>
38	RXB	Presentation	Amsterdam Drone Week 29 - 31 March 2022	Gokul Srinivasan, robots.expert and 5G!Drones partner, made a 30 minutes presentation on “BVLOS missions & lessons learned” during the Amsterdam Drone Week. Insights and activities from 5G!Drones project were communicated.
39	OPL	Conference Paper	AIAI 2022 conference (17-20 June 2022)	The 5G!Drones conference paper entitled "Application of mobile networks (5G and beyond) in precision agriculture" has been accepted in the 5G-PINE workshop, in the context of AIAI 2022 conference (17-20 June 2022). You may learn more about the event here: <a href="https://www.5g-essence-h2020.eu/Contact/5GPine.aspx">https://www.5g-essence-h2020.eu/Contact/5GPine.aspx</a>
40	Orange	Journal paper	IEEE Transactions on Mobile Computing	The 5G!Drones journal paper entitled "A New Framework for Multi-Hop ABS-Assisted 5G-Networks With Users' Mobility Prediction" has been accepted in IEEE Transactions on Vehicular Technology magazine. You may learn more information here: <a href="https://ieeexplore.ieee.org/abstract/document/9707619">https://ieeexplore.ieee.org/abstract/document/9707619</a>

41	Orange	Journal paper	IEEE Transactions on Mobile Computing	Optimal Trajectories of a UAV Base Station Using Hamilton-Jacobi Equations <a href="https://ieeexplore.ieee.org/document/9732520">https://ieeexplore.ieee.org/document/9732520</a>
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## 8.6. WP6 Project Management

### 8.6.1. Progress towards objectives and details for each Task

#### WP Objectives

This work package is responsible for coordinating the overall project aiming towards achieving effective operation of the project as well as timely delivery of quality results. The management structure and tools described within will be instrumental to the achievement of the following objectives:

- Implement management procedures, produce reports, carry out project meetings, conflict resolution mechanisms, knowledge management, and others.
- To steer the project to ensure the success of the UAV use case trials within the ICT-17 and other facilities.
- To liaise with the EC and share with the EU the status of project progress.
- To establish appropriate quality management procedures within the project.
- Planning, monitoring, and controlling project progress and outputs as well as anticipating and taking corrective actions.
- Administer the project funds in the interest of the success of the project, in accordance with the consortium, and according to individual partner performance.
- Management of the relationship with the ICT-17 5G facilities.
- Management of the relationship at 5G-PPP Programme level.

#### WP Tasks and interrelations:

- T6.1: Administrative, financial and contractual management (M1-M42)
- T6.2: Risk and quality management (M1-M42)
- T6.3: Technical coordination and innovation management (M1-M42)
- T6.4: 5G facility relationship management (M1-M42)

#### Main Progress in the period:

The main activity during Q9 was the preparation of Period 1 reports, administrative and Technical. In addition input collection for Amendment AMD-857031-24 begun that has been described in Section 1.1.1. The project also held a virtual Face-to-Face meeting on June 1<sup>st</sup> to 2<sup>nd</sup> 2021. During Q10 the main milestone was the Period 1 review and analysis of its results. The project showed very good progress even though Deliverable D2.3 needed to be revised based on reviewer comments. The remaining review recommendations for the project are being addressed. The project Technical Manager changed from Farid Benbadis to Ehsan Ebrahimi-Khaleghi in September 2021. Farid Benbadis maintained WP3 leadership. The Amendment AMD-857031-24 was also completed including significant changes in Partners' Person Month efforts due to resource shifts and PM cost re-evaluations. The need for a new Amendment, AMD-857031-27, was also identified during the period due to a number of partners' cost category shifts being large enough to warrant an Amendment. Preparations for the Amendment AMD-857031-27 were initiated. The project held a virtual Face-to-Face meeting on November 22<sup>nd</sup> - 23<sup>rd</sup>, where the status of the project was presented over the General Assembly and project-related decisions were made. The Deliverable D6.8 – Information on

cumulative expenditures incurred, M30. Was submitted. During Q11 the Amendment AMD-857031-27 was initiated and completed. The project held a virtual Face-to-Face meeting on February 21<sup>st</sup> to 22<sup>nd</sup>, 2022. The Tallinn May 2022 large-scale showcasing event was cancelled. Alternative means for reaching Milestone MS5 were initiated. During Q12 abolishment of the need of NDA for the External Advisory Board was decided by the General Assembly. Change of the Technical Manager from Ehsan Ebrahimi-Khaleghi to Farid Benbadis. The Consortium voted for adding a new partner to the Consortium because of HEP split into two companies. Preparation of Amendment AMD-857031-33 started. The project held a virtual virtual Face-to-Face meeting from May 24<sup>th</sup> to 25<sup>th</sup>.

#### **Significant results**

Period 1 reports were delivered on time and Period 1 review was completed successfully. Milestone MS3 was achieved by the submission of D3.2, D4.2, and D4.3. Amendment AMD-857031-24 was completed during Q10. The TM was changed from Farid Benbadis to Ehsan Ebrahimi-Khaleghi. Submission of D6.8 – Information on cumulative expenditures incurred, M30 was completed on time. WP2 has been concluded successfully with the submission of Deliverables D2.5 and D2.6 at the end of Q11. WP3 has been concluded successfully with the submission of D3.4 at the end of Q12, which also achieves the Milestone MS4 of the project.

#### **Deviations from Annex I and impact on other tasks, available resources and planning**

Amendment AMD-857031-24 was accepted by the Commission in early September 2021. Amendment AMD-57031-27 was accepted by the Commission in early February 2021. The Tallinn May 2022 large-scale showcasing event has been cancelled at the end of February. During the Reporting Period the Technical Manager person has changed from Farid Benbadis to Ehsan Khalegi to Hicham Khalife, back to Farid Benbadis. Pascal Bisson has maintained the deputy TM position. The Technical Manager organisation remains the same. Some Consortium members have experienced internal changes that require a new Amendment to resolve. The Amendment AMD-857031-33 has been opened on the Commission portal and waiting for OÜ Flaperon validation by the Commission services.

#### **Reasoning for failing to achieve critical objectives and/or not being on schedule**

The changes in the Amendments mitigate the challenges to achieve critical objectives and are described in Section 1.1.1. CAF began preparations for showcasing trials in early January 2022. The plan was to conduct 5G!Drones tests in Tallinn in May 2022. The basis was the possibility to use the 5G commercial network or the 5G base station of the Estonian Defense Forces. In February, it became clear that the Estonian 5G band auction would be postponed. The latest information as of April 7, 2022 is as follows: The Estonian Communications Board plans to invite telecom companies to auction 5G frequency licenses at the end of April-May.

The availability of the commercial 5G network can be expected at the earliest from August 2022. Alternatively, the Estonian Defense Forces were contacted, from whom information was received in mid-February 2022 that they did not have the permission of the Communications Board to set up their 5G base station and use it in the planned location on the territory of the Estonian Academy of Internal Affairs. However, drone flights cannot be carried out in the territory of the Defense Forces.

Therefore, it is not possible to conduct 5G!Drones showcasing trials in Tallinn in May 2022, as originally planned. Task T5.3 has started pursuing alternatives. INV has proposed conducting the large-scale showcasing in Switzerland using Swisscom commercial 5G and discussions are ongoing. During Q12 it has become apparent the Switzerland showcasing will be delayed, if possible at all. The most likely large-scale showcasing will take place in AU premises in conjunction with the August Trials.

### **8.6.2. Task 6.1 Administrative, financial and contractual management (M1-M36) [UO]**

#### **Task Objectives:**

This Task is related with the overall project management from an organisational, administrative, and financial point of view. This Task is in the hands of the Project Coordinator. It covers the following activities:

- Ensuring knowledge sharing and communication within the consortium: the project management must receive from each consortium member periodic reports to present accurately and briefly the work performed during the period, problems encountered, expected impact, and resources consumed.
- Administration and contract management: the UO will ensure this activity. It will deal with the proper management of the Contract, the proper management of the decision process within the Consortium, and the liaison with the EC Office.
- Financial management: It will monitor that the project budget and resources are distributed in a timely manner, including the preparation of cost statements and of the supporting justification by the project partners and ensure that these are produced at dates according to the contract, and context meeting the EU financial procedures and guidelines.

#### **Task Activities during the period:**

Only the Coordinator – UO is partaking this Task.

**1-UO** did creation, preparation, revision, submission, and resubmission of Period 1 report. It was cross-checking partner inputs to Period 1 Commission portal and addressing discrepancies. UO collected input, prepared, and submitted of project Amendment AMD-857031-24. It carried out preparation for Period 1 review from administrative and financial perspective. During Q10 the main milestone for the Q10 was the Period 1 review and analysis of its results. The project held a virtual Face-to-Face meeting on November 22nd - 23rd, where the status of the project was presented over the General Assembly and project-related decisions were made. Interim Payment was received from the Commission and UO financial administration has been carrying out calculations for its division. During Q11 UO distributed interim payments to Partners. It initiated, collected inputs, edited, and submitted and revised Amendment AMD-857031-27 that was approved by the Commission. The project held a virtual Face-to-Face meeting in February, 2022. UO drafted the agenda, organised the meeting, and recorded the minutes of the meeting. During Q12 UO organised a General Assembly vote to abolish the need of NDA for the External Advisory Board. THA had a change of the Technical Manager from Ehsan Ebrahimi-Khaleghi to Farid Benbadis. UO organised a Consortium vote for adding a new partner, OÜ Flaperon to the Consortium due to HEP internal split of enterprise activities. As a result, UO prepared Amendment AMD-857031-33. UO hosted the May 24-25 virtual Face-to-Face meeting. Milestone MS4 was completed at the submission of Deliverable D3.4, which also concluded WP3.

Deviation and corrective action:

New Amendments were needed to be requested due to reasons described in Section 1.1.1 of this Deliverable.

### **8.6.3. Task 6.2 Risk and quality management (M1-M42) [UO]**

#### **Task Objectives:**

This Task focuses on establishing risk and quality management procedures, monitoring and identification potential problems, and developing plans to mitigate the impact of such events, should one arise. Managing technical risks or quality deviations handled closely with the technical coordinator THA. The Task covers the following activities:

- Quality management: It will define quality assessment guidelines and monitor their implementation in the project on the different deliverables (e.g. reports, code, etc.).



- Risk management: It will define risk assessment guidelines, identify potential risks, and minimize their impact on the project implementation.

#### **Task Activities during the period:**

Only the Coordinator – UO is partaking this Task. The quality and risk management are, on the other hand, closely tied with project technical management. As a consequence, there is significant collaboration with the Technical Manager – THA on the topic.

**1-UO** completed revision of the project Data Management Plan. It reviewed and commented project's critical risks for implementation on the Period 1 report on the Commission portal. UO requested partners to report and identified partners' deviations to description of action, and collected justifications to the deviations. These are reported in Period 1 report Part B. UO initiated project Amendment AMD-857031-24 based on the deviations found during reporting to mitigate project's risks. It collected responses to 1st year review comments and included the in in Period 1 report Part B.

During Q10 the project showed very good progress even though Deliverable D2.3 needed to be revised based on reviewer comments. Some of other deliverables that were accepted figure qualities were improved and the references were corrected with working links. Those deliverables were then made available on the project public website. The remaining review recommendations for the project are being addressed. The Amendment AMD-857031-24 was also completed including significant changes in Partners' Person Month efforts due to resource shifts and PM cost re-evaluations. The need for a new Amendment, AMD-857031-27, was also identified during Q10 due to a number of partners' cost category shifts being large enough to warrant an Amendment. Preparations for the Amendment AMD-857031-27 were initiated.

During Q11 UO has monitored the project's risk management procedures. Existing risks have been followed up and mitigation actions have been reviewed by the PMT. A significant open risk remains reaching Milestone MS5 and the venue and time for a large-scale showcasing event are under investigation. During Q12 There have been no new risks identified. The currently known risks are under mitigation actions and are being regularly monitored. UO has repeatedly reminded the Consortium members to keep the Commission grant management system continuous reporting up to date with their activities. The deliverables submitted during the period have followed the project's quality assurance plan.

Deviation and proposed corrective action:

The project's large-scale showcasing event in Tallinn on May 2022 has been cancelled during Q11. The Estonian defense forces cyber-security department cannot provide 5G outside their premises and drone flights cannot be conducted within their premises. Task T5.3 has started pursuing alternatives. INV has proposed conducting the large-scale showcasing in Switzerland using Swisscom commercial 5G and discussions are ongoing. Also, exploiting EuCNC 2022 virtual booth and an online showcasing event during the exhibition is under consideration. A large-scale showcasing in conjunction with the AU August trials are also an option.

### **8.6.4. Task 6.3 Technical coordination and innovation management (M1-M42) [THA]**

#### **Task Objectives:**

This Task will be led by THA as Technical Manager of 5G!Drones in coordination with the Project Coordinator. This Task will ensure that all technical outcomes comply with the project work plan, and results fulfil the technical requirements set by the consortium for effective progresses toward the achievement of the project goals. It covers the following activities:

- Project planning and control: assessment of project progress and subsequent recommendations for work packages implementation.
- prepare proposals for the Project Management Team (PMT) on technical concepts, principles and architectural view.

- control the accomplishment of technical objectives and implementation of decisions and monitor WPs and overall project progress.
- approve deliverables for submission to the PMT and to ensure technical consistency within the project,
- verify milestones.
- manage communication with external liaison and External Advisory Board,
- control exploitation activities,
- identify potential major technical problems and propose solutions and actions to the PMT,
- coordinate the final report and technical audit, and
- contribute to the 5G-PPP program activities like the Technology Board and coordination with other 5G-PPP projects. Also organize and monitor project's representation at 5G PPP or IA WG of interest.

#### **Task Activities during the period:**

Only the Technical Manager – THA is partaking this Task.

**2-THA** as technical coordinator of the project has continued the monitoring and assessment of the overall progress of the project during Q9. THA has also continued the monitoring and assessment of the progress at Programme level; by monitoring activities performed by each of the 5G!Drones appointed representatives to WG of interest till direct contribution through participation to 5G TB working on the actions requested. THA was in charge of regular reporting at different PMT meetings, where it interacts with PMT members, by providing necessary guidance and support in view of topics of concerns. THA was also in charge of the overall check and consistency of the work performed, including the revision of the deliverables before submission. THA has also be in charge of coordinating the technical aspects of the Period 1 review, including the preparation of the different demonstrations. During Q10 THA, as technical coordinator of the project, has continued the monitoring and assessment of the overall progress of the project. THA has also continued the monitoring and assessment of the progress at the Programme level; by monitoring activities performed by each of the 5GDrones appointed representatives to WG of interest until direct contribution through participation to 5G TB working on the actions requested. THA was in charge of regular reporting at different PMT meetings, where it interacts with PMT members, by providing necessary guidance and support in view of technical topics of concerns. Moreover, THA was also in charge of the overall check and consistency of the work performed, including the revision of the deliverables requested by the commission. In addition, THA followed partners contributions to 5G-PPP. Therefore, THA has also been in charge of coordinating the technical aspects of the second year's activities, including the preparation of the different demonstrations. Moreover, THA planned different repetition sessions to prepare the Period 1 review and even to overcome technical issues regarding the demonstrations. After the Period 1 review THA organised a dedicated session to address the comments of the reviewers, the action plan has been defined to address review comments and within involved WPs answers will be prepared. The role of Technical Manager so far ensured by Farid Benbadis (THA) was handed over to Ehsan Ebrahimi Khaleghi (THA) to become effective by mid of September 2021. THA followed precisely release 2 activities and ensures that 5G!Drones upcoming trials are well aligned with the technical architecture of the project and use-cases. CAF with the coordination of THA led the work of the Innovation Management Team and led the preparation of the IMT Report for the project General Meeting in November 2021. THA, as technical coordinator of the project continued the monitoring and assessment of the overall progress of the project between Q11 and Q12. THA also continued the monitoring and assessment of the progress at Programme level; by monitoring activities performed by each of the 5G!Drones appointed representatives to WG of interest till direct contribution through participation to 5G TB working on the actions requested.

#### **Deviation:**

During Q9 CAF led the work of the Innovation Management Team and led the preparation of the IMT Report for the project General Meeting in June 2021. The IMT consists partners: CAF, DRR, FRQ,

ORA, OPL, RXB) prepared a regular report for the 5G!Drones plenaries. The report covers innovation and developments in the following eight areas: 1. UAV Business case developments; 2. Regulation of UAV flights; 3. U-Space regulation and roll-out; 4. Regulation of cellular UAVs and commercially available cellular UAVs; 5. 5G roll-out and developments of the 5G eco-system incl. 5G IoT; 6. Standardization of 5G (3GPP etc.) and specific fields (Slicing, MEC, UAVs); 7. UAVs Altitude and Location Reference problems; and 8. Interference problems.

#### 8.6.5. Task 6.4 5G facility relationship management (M1-M36) [NCSRD]

##### Task Objectives:

This Task is dedicated for coordination of 5G facilities of the project. The Task contains frequent and timely communications between the facility owners, planning for common component adoption, such as UTM deployment, managing agreements, and managing permissions for the execution of trials. The Task covers the activities:

- Management of the communication between facility owners
- Manage agreements between facility owners
- Manage permissions for the execution of trials

##### Task Activities during the period:

During Q9 NCSRD coordinated the Task activities in order the complementarity of the ICT-17 platforms with the 5G!Drones project to be properly reported in the integration activities and especially in D4.2. Special coordination effort was put on the QoE of the experimenter following the experiment initiation in Web Portal 1 and Web Portal 2. During Q10 the Task closely monitored the integration workshop progress in order to be reassured a smooth integration of the 5G!Drones trials controller on top of the 5G infrastructures in order to reassure a common experimentation experience. Moreover, the ICT-17 platforms, considered specific extensions in their architectures in order to properly integrate with the UAS domain. During Q11 effort was consumed on agreeing on a common visualisation tool for the needs of the 5G!Drones trials among the platforms that participate in the project. During the final phase of the project (Q12) special attention has been paid to the proper relationship of the various 5G facilities that are participating in the project in order to reassure the proper representation of the experiment results in a coherent and comparable manner. Towards this the involved 5G facility owners have performed the necessary updates to the trial enforcement abstraction layer in terms of the Trial-ID definition, as well as the Kibana data entry and visual representation of the results.

The breakdown of the contribution, results, deviation and proposed corrective action of each partner in this Task are as follows. Only facilities and the TM are partaking this Task.

*1-UO* followed up the 5GENESIS and 5GEVE activities with regards to trial activities during Q9. During Q10 UO participated and contributed to the integration workshop to maintain a well-understood connection to the 5G facilities of the project. Understanding and aligning the KPIs and the use-cases between the facilities is an ongoing task. During Q11 UO has contributed to the cross-facility KPI collection and monitoring work. During Q12 UO has coordinated with AU, EUR, and the NCSRD platform teams to update the trial enforcement, abstraction layer, and facility adapters to enable Trial-ID as a parameter in the body request to create measurement jobs and provide it into the KPI data streaming sent to KPIC.

*2-THA* had no activity on the Task during Q9, Q11, and Q12. During Q10 THA did follow the work and contributed to the discussion and exchange with the objective to ease the work and make it coherent and consistent with the overall objectives of the project. Moreover, THA has been in charge of monitoring the progress achieved at the project level for exploiting 5G; on the other hand, THA as the

TM of the project highlighted that the features of the 5G ecosystem should be visible and reflected in the UAV industry and project contributions (or upcoming trials).

**6-NCSR**D performed a complementarity analysis of the Open5GENESIS platform with the 5G!Drones trial controller during Q9. Moreover, analysis on the experimenter steps was performed between Web Portal 1 and Web Portal 2. Preparation for the Period 1 review were also made, as well as contributions in the PPR#2. During Q10 NCSR D contributed in the 5G-PPP cartography, emphasising on the capabilities and the support of 5G!Drones platforms to the respective KPIs and use-cases. Moreover, NCSR D as task leader monitored the progress of the integration workshops of the release 2, that will reassure a common experimentation experience across the 5G!Drones platforms. During Q11 NCSR D coordinated the efforts for importing properly the data files from the various platforms to the elastic database and then Kibana to properly visualise in a common and comparable way the stored data from the experiments. By this the comparison of the various results is feasible, even if the platforms that supported the experiments are different. During Q12 NCSR D has actively contributed in the updates to the trial enforcement abstraction layer in terms of the Trial-ID definition, as well as the Kibana data entry and visual representation of the results.

**14-EUR** conducted several meetings with 5GEVE Sophia-Antipolis IT manager in order to prepare the pre-trials of June 2021. EUR had no activity on the Task between Q10 and Q12.

**19-MOE** has addressed the 5G licensing in Athen's platform and provision of frequencies for test use, which will allow the execution of the trials in Egaleo stadium "Stavros Mavrothalasitis" in 5 to 9 September 2022.

## 9. 5G-PPP CROSS-PROJECT CO-OPERATION

During the Reported Period (M19 – M24), 5G!Drones has been also deeply involved at 5G-PPP Programme level. First through representation of Project Manager and Technical Manager at respectively 5G-PPP Steering Board and Technology Board and second, through participation to 5G-PPP & IA WGs of interest for the project. 5G!Drones representation at 5G-PPP Programme level, which is shown in Table 8 depicts the level of involvement together with names of appointed representatives.

**Table 8: 5G!Drones project 5G PPP & IA representatives**

5G-PPP SB	5G-PPP	Jussi Haapola	<a href="mailto:jussi.haapola@oulu.fi">jussi.haapola@oulu.fi</a>
5G-PPP TB	5G-PPP	Pascal Bisson	<a href="mailto:pascal.bisson@thalesgroup.com">pascal.bisson@thalesgroup.com</a>
SME WG / NetworkEurope		Vaios KOUMARAS	<a href="mailto:vkoumaras@infolysis.gr">vkoumaras@infolysis.gr</a>
SEC WG	5G-IA	Tanel Järvet	<a href="mailto:tanel.jarvet@cafatech.com">tanel.jarvet@cafatech.com</a>
ARCH WG	5G-PPP	Pascal Bisson Farid Benbadis	<a href="mailto:pascal.bisson@thalesgroup.com">pascal.bisson@thalesgroup.com</a> <a href="mailto:farid.benbadis@thalesgroup.com">farid.benbadis@thalesgroup.com</a>
Pre-standards WG	5G-IA	Serge Delmas	<a href="mailto:serge.delmas@airbus.com">serge.delmas@airbus.com</a>
SOFT NET	5G-PPP	Gregor Mogeritsch	<a href="mailto:Gregor.MOGERITSCH@frequentis.com">Gregor.MOGERITSCH@frequentis.com</a>
NET WMG & QOS			WG stopped
Spectrum	5G-IA		NA
Vision & societal Challenges	5G-IA	Farid Benbadis Pascal Bisson	<a href="mailto:Farid.benbadis@thalesgroup.com">Farid.benbadis@thalesgroup.com</a> <a href="mailto:pascal.bisson@thalesgroup.com">pascal.bisson@thalesgroup.com</a>
Trials WG	5G-IA	Gokul Srinivasan	<a href="mailto:gokul.srinivasan@robots.expert">gokul.srinivasan@robots.expert</a>
5G Automotive	5G-PPP	Tanel Järvet	<a href="mailto:tanel.jarvet@cafatech.com">tanel.jarvet@cafatech.com</a>
IMT 2020 Evaluation Group		Fotis Lazarakis	<a href="mailto:flaz@iit.demokritos.gr">flaz@iit.demokritos.gr</a>
Test, measurement & KPIs validation	5G-PPP	Ilkka Käsälä Gokul Srinivasan	<a href="mailto:Ilkka.kansala@nokia.com">Ilkka.kansala@nokia.com</a> KPI Champion: <a href="mailto:gokul.srinivasan@robots.expert">gokul.srinivasan@robots.expert</a>

In what follows we detail the activities which have been performed.

### 9.1. 5G-PPP Steering Board

<b>Activity name</b>	5G-PPP SB
<b>Main interface</b>	Jussi Haapola (UO)
<b>Activities</b>	The overall management of the 5G-PPP and cross-project co-operation
<b>5G!Drones contributions</b>	During Q9 UO participated in June 6 <sup>th</sup> , 2021 SB full day telco. It forwarded Women in Hexa-X/6G information and participation information to 5G!Drones and kept the project informed about 5G-PPP and complementary grant project events. UO also participated to July 20 <sup>th</sup> , 2021 SB telco. During Q10 UO participated to the SB telco on September 27 <sup>th</sup> , 2021 and to the SB telco on November 29 <sup>th</sup> , 2021. UO has shared the 5G-PPP repository costs on behalf of 5G!Drones during the support action stop gap period. UO disseminated 5G!Drones complementary grant project's activities and events to the Consortium and has been coordinating potential collaboration activities with other complementary grant projects. During



	Q11 UO attended SB long telco on January 24 <sup>th</sup> , 2022. It conducted liaison of activities between the Consortium and the activities advertised in SB communications. During Q12 UO attended the full-day SB telco on May 9 <sup>th</sup> , 2022. UO has acted as the intermediary between the Consortium and SB by letting the Consortium know about 5G-PPP related events and items as well as informing the SB about 5G!Drones participation in events.
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## 9.2. 5G-PPP Technology Board

<b>Activity name</b>	5G-PPP TB
<b>Main interface</b>	<b>Farid Benbadis (TM)</b> & Pascal Bisson (TMD) (THA)
<b>Activities</b>	Overlooking the aspects related to the technology work of the projects and respective implementation of the initiative.
<b>5G!Drones contributions</b>	The WG participant failed to report activities even though multiple requests were made.

## 9.3. SME WG

<b>Activity name</b>	SME WG/NetworldEurope (former NetWorld2020)
<b>Main interface</b>	Vaios Koumaras (INF)
<b>Activities</b>	The SME Working Group represents the NetWorld2020 SME community, and provides the networking place for the NetWorld2020 SME community related to EC and 5G-PPP research projects and activities.
<b>5G!Drones contributions</b>	INF has been monitoring SME WG activities during Q9: Contributing to the update of Find your SME web page (released end of August 2021), updating related section to SMEs brochure (released end of August 2021), and reporting to 5G!Drones consortium on SME WG participation and latest activities. During Q10 INF attended, as 5G!Drones representative, the NetworldEurope SME Working Group and the SME WG-European Digital SME Alliance workshop on 5G, Edge Computing and IoT topics on 16 September 2021. SME WG general assembly meeting took place online on Monday 15 November 2021. Attended by INF on behalf of 5G!Drones. It was also highlighted that there will be no new update of the SME web page or brochure before at least mid-2022, when the new CSA supporting 5G-PPP and NetworldEurope shall be launched. During Q11 no main activities during the reporting period. Only email communication for future events. Period of transition from 5G-PPP to 6G-IA SNS. During Q12 the virtual GA of SME WG took place on Monday 23 May 2022. Next actions and interaction with 6G-IA and SNS calls were discussed. Future events, conferences, workshops will be planned and INF will participate in the upcoming SMEs brochure and "Find your SME" webpage content update actions.

## 9.4. 5G-PPP cooperation on 5G security

<b>Activity name</b>	5G-PPP SEC
<b>Main interface</b>	<b>Tanel Järvet (CAF)</b> , Pascal Bisson (THA) as co-chair of 5G IA SEC WG
<b>Activities</b>	Join activities of 5G IA SEC WG and report on specific security challenges tackled within 5G!Drones. Also liaise with other project interested or interesting (e.g. ICT-17 but also ICT-19 projects which have joined). Contribution on behalf of

	5G!Drones to all activities performed by 5G IA SEC WG during the period including: contribution on behalf of 5G!Drones to short whitepapers in scope as well as the ones from 5G TB. contribution to Security workshops proposed for EuCNC of which one was accepted)
<b>5G!Drones contributions</b>	There were no meetings or activities of the Security WG during this Reporting Period.

### 9.5. 5G Architecture WG

<b>Activity name</b>	5G-PPP Architecture WG
<b>Main interface</b>	WG monitored by THA <b>Acting Farid Benbadis (TM)</b> with support from Pascal Bisson (TMD)
<b>Activities</b>	Follow up evolvement of overall 5G architecture and contribute
<b>5G!Drones contributions</b>	The WG participant failed to report activities even though multiple requests were made.

### 9.6. Pre-Standardization WG

<b>Activity name</b>	Pre-standards WG
<b>Main interface</b>	Serge Delmas (AIR)
<b>Activities</b>	Identify standardization and regulatory bodies to align with e.g. ETSI, 3GPP, IEEE and other relevant standards bodies, & ITU-R (incl. WPs) and WRC (including e.g. ECC PT1). Develop a roadmap of relevant standardization and regulatory topics for 5G: Evaluate existing roadmaps at international level; Propose own roadmap for 5G being aligned at international level. Influencing pre-standardization on 5G and related R&D: Potentially propose where topics should be standardized; Influence timing on R&D work programs (e.g. EC WPs)
<b>5G!Drones contributions</b>	<p>During the period 5GDRONES has actively contributed to the following items:</p> <ul style="list-style-type: none"> <li>• B5G/6G Standardization Roadmap creation: the main purpose of this activity was to provide a “tool” in order to help projects to make impact, e.g., suggesting what kind of research output should be produced in a given moment in time, in order to be ready when SDO may use such results. 5G!Drones took part in the work around this topic and especially to the: <ul style="list-style-type: none"> <li>○ Elaboration of the 6G vision,</li> <li>○ Coordination activities with other WGs in order to avoid conflicts,</li> <li>○ Input from 5G!Drones companies on their B5G/6G vision and roadmap, and</li> <li>○ B5G/6G Roadmap report (v2).</li> </ul> </li> <li>• SDO impact survey: 5G!Drones contributed to the survey by providing the most notable achieved impacts of the project on the relevant 5G standards and helping at identifying areas of improvement to maximise technology transfer “from research to standards” for future research frameworks.</li> <li>• Webinar participation: <ul style="list-style-type: none"> <li>○ “3GPP Release 18: Opportunities for Industry Verticals” Webinar. During this workshop the industry vertical viewpoints and technical requirements were presented and an interactive session was done between verticals and 3GPP TSG chairs.</li> </ul> </li> </ul>

### 9.7. Software Networks WG

<b>Activity name</b>	Software Networks WG
<b>Main interface</b>	Gregor Mogeritsch (FRQ)
<b>Activities</b>	As defined by Architecture WG chairs
<b>5G!Drones contributions</b>	Between Q9 and Q12 FRQ was attending and actively participating in the WG meetings.

### 9.8. Vision and societal challenges WG

<b>Activity name</b>	Vision & societal Challenges WG
<b>Main interface</b>	Acting TM/TMD (Farid Benbadis / Pascal Bisson) (THA)
<b>WG activities</b>	As defined by Architecture WG chairs
<b>5GDrones contributions</b>	The WG participant failed to report activities even though multiple requests were made.

### 9.9. Trials WG

<b>Activity name</b>	Trials Working Group
<b>Main interface</b>	Gokul Srinivasan (RXB)
<b>Group activities</b>	As defined by Architecture WG chairs
<b>5GDrones contributions</b>	The WG participant failed to report activities even though multiple requests were made.

### 9.10. 5G Automotive WG / 5G-CAM WG

<b>Activity name</b>	Automotive WG
<b>Main interface</b>	Tanel Järvet (CAF)
<b>Activities</b>	Activities defined by chairs but in the meantime no more limited to only Automotive, hence also 5G!Drones joined (since extended scope of interest for the project). Tasks of Automotive WG: to contribute to designing, developing, testing, validating, and promoting the potential of 5G-based vehicular communications (so-called V2X communications) for CAM (Connected and Automated Mobility). It is worth noting that the term V2X refers to communication between a vehicle and anything else, yielding terms such as V2V (vehicle-to-vehicle), V2N (vehicle-to-network), V2I (network-to-infrastructure), or V2P (vehicle-to-pedestrian). Similar architectural points are relevant also vehicles on the ground and in the air (drones).
<b>5GDrones contributions</b>	During Q9 and Q10 a representative of the CAF actively participated in the meetings and discussions of the WG, being the only representative of the drone

	sector in that WG. During this period, WG was renamed 5G-CAM WG. During Q11 and Q12 CAF representative regularly attended 5G CAM WG meetings.
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### 9.11. IMT 2020 Evaluation WG

<b>Activity name</b>	IMT 2020 Evaluation WG
<b>Main interface</b>	Fotis Lazarakis (NCSR)
<b>Activities</b>	IMT-2020 5G IA Evaluation Group is an independent Evaluation Group that officially initiated their work in January 2018. The scope of the Group is the evaluation of candidate Radio Interface Technologies (RITs) submitted by standardization organizations.
<b>5G!Drones contributions</b>	The WG didn't perform any activity during the reporting period.

### 9.12. Test, measurement & KPIs validation

<b>Activity name</b>	5G PPP Test, Measurement and KPIs Validation Working Group
<b>Main interface</b>	Gokul Srinivasan (RXB) and Ilkka Käsälä (NOK) (NOK discontinued from 1/2022)
<b>Activities</b>	The purpose of the Group is to bring together the projects that have common interest in topics related to the development of T&M and validation methods, test cases, procedures.
<b>5G!Drones contributions</b>	The WG participant failed to report activities even though multiple requests were made.

## References