



“5G for Drone-based Vertical Applications”

D6.6 – Final project report

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Approvals

	Name	Organization	Date
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V5	Resolved all comments and finalisation	Jussi Haapola (UO)	30.11.2022

Executive Summary

The aim of this Final project report, the 5G!Drones Deliverable 6.6, is to deliver the progress of 5G!Drones, as achieved during the months M37 – M42 of the project (June 1st, 2022 – November 30th, 2022). The deliverable describes the overall activities of the project between M37 and M42, 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 2022 and November 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 M37 to M42 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, D6.4, and D6.5, which covered the periods M1 – M12, M13 – M18, M19 – M24, and M25 – M36, respectively.

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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 OY	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
22	FLA	OU FLAPERON	Estonia

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 1 st , 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:

Q13: The period of the implementation of the action between June 1st, 2022 and August 31st, 2022 (M37 – M39).

Q14: The period of the implementation of the action between September 1st, 2022 and November 30th, 2022 (M40 – M42).

Reporting Period: Implementation of action from June 1st, 2022 to November 30th, 2022 (M37 – M42).

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 1st, 2022 to November 30th, 2022 of the 5G!Drones project, hereafter termed as Reporting Period. The previous Reporting Periods have been covered in the Deliverables D6.2, D6.3, D6.4, and D6.5 spanning the project timeframe from June 1st, 2019 to May 31st, 2020; June 1st, 2020 to November 30th, 2020; December 1st, 2020 to May 31st, 2021; and June 1st, 2021 to May 31st, 2022, respectively. This Deliverable D6.6 is a continuation of them and together provide a complete description of the state and advances of the project during its implementation. The Chapter 7 also recaptures the work done during the period from June 1st, 2019 to May 31st, 2022, 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, D6.4, and D6.5 is minimised.

1.1. Main achievements

The main achievements of the project for the Reporting Period are described as follows. There were two major project Milestones deadlines, MS5 and MS6. The MS5 topic was large-scale showcasing of the project. The achievement of MS5 was delayed from the original target of June 2022 to September 8th, 2022 due to cancellation of the originally planned showcasing event in Tallinn, Estonia. Therefore, new methods of completing MS5 had to be identified and realised. The last piece of MS5 attainment was reached on September 8th, at the showcasing event taking place in Municipality of Egaleo, Greece. The details regarding MS5 deadline deviation and alternate achievement has been reported in Section 4 of this Deliverable.

The Milestone MS6 considers the final outcomes of the project and it is directly related with submission of Deliverables D1.7 - Final report on UAV business and regulatory ecosystem and the role of 5G; D4.4 – Trial evaluation report; and D5.6 – Report on activities related to commercial exploitation and partnership development. All the three Deliverables have been completed and submitted at the end of November 2022.

In addition to the three MS6 related Deliverables, also the Deliverables D5.4 – Report on contribution to standardisation and international fora – 2nd Version; D5.5 – Final report on communication, showcasing, dissemination and exploitation; and D6.6 – Final project report (this Deliverable) have been completed and submitted at the end of November.

The technical work during the Reporting Period has focused on completing the Release 4 of the integration tests and on testing and conducting the final trials of the project's Use Cases. The selected Use Cases at each project facility, Athens 5GENESIS, EUR 5G-EVE, AU X-Networks, and UO 5GTN were successfully conducted and the results of the trials have been reported in Deliverable D4.4.

The WP1 work has focused on collection of potential content and down selection of the content for its only remaining Deliverable D1.7. The WP4 carried out final integration and testing through Releases, prepared and conducted trials, and documented the trials in D4.4. The communication aspects of WP5, 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 is also actively preparing after project exploitation. The Consortium's partners have been preparing business plans according to the specific methodology that was defined earlier, in order to report this activity and that have been fed into two deliverables D5.5 and D5.6 according to the nature of targeted outcome (commercial or not commercial).

With regards to project management, Milestones MS5 and MS6 have been reached. In order to do so, Amendment AMD-857031-33 was completed during Q13. The Technical Manager was changed from Ehsan Ebrahimi-Khaleghi to Farid Benbadis.

The Reporting Period included the submission of six project Deliverables:

- D1.7 – Final report on UAV business and regulatory ecosystem and the role of 5G (M42; R; PU; INF),
- D4.4 – Trial evaluation report (M42; R; PU; COS),
- D5.4 – Report on contribution to standardisation and international fora - 2nd Version (M42; R; PU; THA),
- D5.5 – Final report on communication, showcasing, dissemination and exploitation (M42; R; PU; ORA),
- D5.6 – Report on activities related to commercial exploitation and partnership development (M42; R; PU; OPL), and
- D6.6 – Final project report (M42; R; PU; UO)

1.1.1. Changes in the Consortium

The project had one Consortium initiated Amendment during the Reporting Period: Amendment AMD-33.

The Amendment AMD-857031-33 main changes are as follows.

- The Technical Coordinator has been changed from Ehsan Ebrahimi-Khaleghi to Farid Benbadis.
- Inclusion of OÜ Flaperon (FLA) as a full partner to the Consortium
- HEP contribution transfer from HEP to FLA: T4.1 FLA leads the integration testing for HEP's enablers and all up testing for HEP's led UC3 scenario. T4.2 FLA handles some technical preparations for the UC3 and UC4 trials HEP is involved in as well as attend the trials. T4.3 FLA assists in results evaluation for UC3 HEP's led scenario.
- Extension of Task 4.1 by one month. There were multiple integration issues not yet solved within Task 4.1. The task was scheduled to end in May 2022. As the leader of T4.1 Release 4 and on behalf of partners involved with release 4, HEP requested extending Task 4.1 by one month until the end of June 2022 (M37).
- Responsibility 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 requested transfer of a part of its budget and responsibilities to UO and UO was able to take up on those responsibilities.

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.

Table 1: Estimated Resource Use in PMs between M37 and M42

M37 - M42				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	-	-	-	40,17	1,47	2,42	44,06	17 %
			Total from GA	18,00	40,00	53,00	94,00	6,00	43,00	254,00	
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	QMRs	0,86	-	-	1,94	1,65	2,71	7,16	8 %
			Total from GA	10,00	10,00	24,00	13,00	10,00	20,00	87,00	
2.1	ERC	ERCOM ENGINEERING RESEAUX COMMUNICATIONS	QMRs	-	-	-	1,60	-	-	1,60	20 %
			Total from GA	-	-	6,00	2,00	-	-	8,00	
3	ALE	ALERION	QMRs	0,48	-	-	4,36	0,66	-	5,50	8 %
			Total from GA	10,00	-	20,00	31,00	4,00	-	65,00	
4	INV	INVOLI SA	QMRs	0,20	-	-	5,70	3,25	-	9,15	11 %
			Total from GA	12,00	22,00	8,00	30,00	15,00	-	87,00	
5	HEP	Hepta Group Airborne OÜ	QMRs	-	-	-	8,54	-	-	8,54	14 %
			Total from GA	5,00	7,00	13,00	38,00	-	-	63,00	
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	QMRs	1,01	-	-	13,69	1,32	0,66	16,68	18 %
			Total from GA	16,00	24,00	15,00	33,00	4,00	2,00	94,00	
7	AU	AALTO KORKEAKOULUSAATIO SR	QMRs	0,25	-	-	23,25	1,40	-	24,90	17 %
			Total from GA	10,00	45,00	45,00	35,00	14,00	-	149,00	
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	QMRs	0,40	-	-	4,00	1,70	-	6,10	20 %
			Total from GA	9,00	-	-	16,00	5,00	-	30,00	
9	AIR	AIRBUS DS SLC	QMRs	-	-	-	3,40	3,00	-	6,40	9 %
			Total from GA	13,00	12,00	-	26,00	21,08	-	72,08	
11	INF	INFOLYSIS P.C.	QMRs	1,98	-	-	4,04	3,31	-	9,33	19 %
			Total from GA	16,00	3,00	-	14,00	17,00	-	50,00	
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	QMRs	0,03	-	-	10,39	7,67	-	18,09	21 %
			Total from GA	11,00	20,00	18,00	26,00	11,00	-	86,00	

13	RXB	ROBOTS EXPERT FINLAND Ltd	QMRs	0,71	-	-	1,38	7,33	-	9,42	19 %
			Total from GA	5,00	3,00	2,50	12,00	27,50	-	50,00	
14	EUR	EURECOM	QMRs	-	-	-	5,19	2,35	-	7,54	8 %
			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	-	-	-	4,67	-	-	4,67	9 %
			Total from GA	7,00	16,00	11,00	16,00	-	-	50,00	
16	CAF	CAFA TECH OÜ	QMRs	0,05	-	-	3,50	2,80	-	6,35	8 %
			Total from GA	13,00	10,00	23,00	27,00	6,00	-	79,00	
17	FRQ	FREQUENTIS AG	QMRs	1,68	-	-	2,44	0,07	-	4,19	8 %
			Total from GA	13,00	12,00	7,00	14,00	4,00	-	50,00	
17.1	FSO	FREQUENTIS SOLUTIONS SRO	QMRs	-	-	-	5,54	-	-	5,54	23 %
			Total from GA	-	6,00	6,00	12,00	-	-	24,00	
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	QMRs	3,02	-	-	2,60	5,26	-	10,88	17 %
			Total from GA	16,00	-	25,00	12,00	12,00	-	65,00	
19	MOE	MUNICIPALITY OF EGALEO	QMRs	-	-	-	3,00	0,54	0,27	3,81	9 %
			Total from GA	9,00	4,00	6,00	18,00	4,00	2,00	43,00	
20	ORA	ORANGE SA	QMRs	-	-	-	2,50	1,00	-	3,50	18 %
			Total from GA	4,00	2,00	8,00	3,00	3,00	-	20,00	
21	UMS	UM AUTONOMOUS SYSTEMS LIMITED	QMRs	1,10	-	-	2,85	2,50	-	6,45	8 %
			Parner Total from GA	11,00	12,00	22,00	30,50	6,50	-	82,00	
22	FLA	OU FLAPERON	QMRs	-	-	-	9,45	-	-	9,45	79 %
			Parner Total from GA	-	-	-	12,00	-	-	12,00	
QMRs				11,77	-	-	164,20	47,28	6,06	229,31	14 %
Total effort from Description of Action				220,00	266,00	350,50	532,50	180,08	69,00	1 618,08	
Percentage used from total based on QMRs				5 %	0 %	0 %	31 %	26 %	9 %	14 %	
Definitions					Ended	Ended					
GA	Grant Agreement										
QMR	Quarterly Management Report										

The cumulative estimated resource use since the project start (M1 – M42) is presented in Overall, the project's estimated resource use in PMs is 1.662. The average estimated project resources used slightly exceed the total effort from the Description of Action by approximately 3%. There is variation as a number of partners have over-used the resources, while a few partners were 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 is 1.662. The average estimated project resources used slightly exceed the total effort from the Description of Action by approximately 3%. There is variation as a number of partners have over-used the resources, while a few partners were 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 M42

M1 - M42			Reported effort in PMs								Partner % from total PM declaration	Partner % from D6.8
Participant No.	Part. Short name	Participant organisation name		WP1	WP2	WP3	WP4	WP5	WP6	Total		
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	FS + QMRs	17,77	40,00	58,00	99,26	4,10	41,50	260,63	103 %	
			From FS	17,62	35,32	36,34	12,24	1,46	24,34	127,32	50 %	
			Partner Total from GA	18,00	40,00	53,00	94,00	6,00	43,00	254,00		80 %
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	FS + QMRs	8,96	9,05	27,60	12,06	10,00	19,97	87,64	101 %	
			From FS	6,30	7,60	22,10	6,20	6,00	11,90	60,10	69 %	
			Partner Total from GA	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	1,70	-	-	4,95	62 %	
			From FS	-	-	-	-	-	-	-	0 %	
			Partner Total from GA	-	-	6,00	2,00	-	-	8,00		6 %
3	ALE	ALERION	FS + QMRs	9,99	-	19,99	31,03	4,01	-	65,02	100 %	
			From FS	8,25	-	10,65	10,53	1,73	-	31,16	48 %	
			Partner Total from GA	10,00	-	20,00	31,00	4,00	-	65,00		52 %
4	INV	INVOLI SA	FS + QMRs	11,30	22,65	9,60	30,80	16,80	-	91,15	105 %	
			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	41,53	-	-	65,70	104 %	
			From FS	4,30	6,02	7,51	11,44	-	-	29,27	46 %	
			Partner Total from GA	5,00	7,00	13,00	38,00	-	-	63,00		57 %
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	FS + QMRs	17,17	25,21	15,70	39,91	4,89	2,11	104,99	112 %	
			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 KORKEAKOULUSAATIOS SR	FS + QMRs	9,42	39,49	44,13	48,43	7,76	-	149,23	100 %	
			From FS	9,17	28,96	33,54	10,79	5,35	-	87,81	59 %	
			Partner Total from GA	10,00	45,00	45,00	35,00	14,00	-	149,00		46 %
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	FS + QMRs	9,40	-	-	19,30	5,50	-	34,20	114 %	
			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	-	26,80	22,00	-	72,40	100 %	
			From FS	12,00	9,00	-	12,00	13,00	-	46,00	64 %	
			Partner Total from GA	13,00	12,00	-	26,00	21,08	-	72,08		95 %
11	INF	INFOLYSIS P.C.	FS + QMRs	17,16	3,25	-	13,83	17,81	-	52,05	104 %	
			From FS	12,10	2,57	-	3,01	9,61	-	27,29	55 %	
			Partner Total from GA	16,00	3,00	-	14,00	17,00	-	50,00		68 %

12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	FS + QMRs	10,20	19,44	14,72	23,16	12,40	-	79,92	93 %	
			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	4,67	3,89	1,21	7,84	28,16	-	45,77	92 %	
			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 %
				5,00	3,00	2,50	12,00	27,50	-	50,00		52 %
14	EUR	EURECOM	FS + QMRs	12,20	20,28	38,08	23,18	11,11	2,12	106,97	109 %	
			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	24,06	-	-	57,35	115 %	
			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	13,05	10,20	23,30	26,80	6,00	-	79,35	100 %	
			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	13,31	13,81	7,82	15,34	4,28	-	54,56	109 %	
			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	11,67	-	-	23,64	99 %	
			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	16,31	-	24,75	10,05	13,91	-	65,02	100 %	
			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	18,00	4,00	2,00	43,00	100 %	
			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	3,97	4,38	-	24,54	123 %	
			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	10,70	12,00	21,90	30,50	6,50	-	81,60	100 %	
			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 %
22	FLA	OU FLAPERON	FS + QMRs	-	-	-	12,10	-	-	12,10	101 %	
			From FS	-	-	-	-	-	-	-	0 %	
			Parner Total from GA									
				-	-	-	12,00	-	-	12,00		0 %
FS (Period 1) + QMRs				220,52	263,19	355,44	571,32	183,61	67,70	1 661,78	103 %	
Total used from Financial Statement (Period 1)				191,32	201,26	220,42	185,12	86,38	39,54	924,04		
Total effort from DoA				220,00	266,00	350,50	532,50	180,08	69,00	1 618,08		
Percentage used from total from FS (Period 1) + QMRs				100 %	99 %	101 %	107 %	102 %	98 %	103 %		
Percentage used from total from Financial Statement (P1)				87 %	76 %	63 %	35 %	48 %	57 %	57 %		59 %

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	Contr-actual delivery	Actual Delivery date
D1.7	Final report on UAV business and regulatory ecosystem and the role of 5G	1	INF	Report	Public	M42	28.11.2022
D4.4	Trial evaluation report	4	COS	Report	Public	M42	30.11.2022
D5.4	Report on contribution to standardisation and international fora - 2 nd Version	5	THA	Report	Public	M42	30.11.2022
D5.5	Final report on communication, showcasing, dissemination and exploitation	5	ORA	Report	Public	M42	30.11.2022
D5.6	Report on activities related to commercial exploitation and partnership development	5	OPL	Report	Public	M42	30.11.2022
D6.6	Final project report	6	UO	Report	Public	M42	30.11.2022

4. MILESTONES

There were two Milestones, MS5 and MS6 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
MS5	Large scale showcasing event successfully carried out.	See below	4,5	THA	M37 (June 2022)	08.09.2022
	Student showcasing in Aalto University	Pictures	4,5			27.05.2021
	4 th integration release completed	Testing	4			30.06.2022
	EuCNC 2022	Booth	4,5			08.-10.06.2022
	Showcasing in University of Oulu	Pictures, videos	4,5			26.8.2022
	Showcasing in Egaleo stadium	Pictures, videos	4,5			08.09.2022
MS6	Final outcomes	See below	1,4,5	THA	M42 (November 2022)	30.11.2022
	Final assessment of market and technological ecosystem and future perspectives.	D1.7 (INF)	1			28.11.2022
	Trial evaluation completed.	D4.4 (COS)	4			30.11.2022
	Exploitation and partnership plan for after the end of the project ready.	D5.6 (OPL)	5			30.11.2022

4.1. Justification for the delay for reaching MS5

MS5 Description in the DoA: Large scale showcasing event successfully carried out.

Due date: M36 (May 2022).

Achievement date: September 8th, 2022 (Date of the Egaleo showcasing, final piece of MS5).

Means of verification: According to the trial plan (D4.3), one or more large-scale showcasing events have been carried out. Videos, photos and press releases verify it.

4.1.1. Reason for not achieving MS5 by M36

5G!Drones initial plan was to make a demonstration of the 5G!Drones platform during a UAV platform in Tallin, Estonia, by the end of May 2022. CAF began preparations for showcasing trials in early January 2022. 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 Defence Forces. In February, it became clear that the Estonian 5G band auction would be postponed. The information as of April 7th, 2022 was 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 Defence 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 Defence Forces. Therefore, it was not possible to conduct 5G!Drones showcasing trials in Tallinn in May 2022, as originally planned.

Because of the cancellation of this event, INV, which was conducting a project with one of the Swiss MNOs on the deployment of the prototype of the UTM system for Switzerland, suggested to participate to this Swiss UAV event. INV's partner in this project was at that time enthusiast and willing to organise and participate to this 5G!Drones public event in Switzerland. Unfortunately, when things were to materialise and actions were to be carried out, we no longer obtained answers from these partners and we decided not to participate and to organise our own event.

However, organising a major event bringing people together takes time and the Covid period, end of 2021, did not allow us to have a clear view of spring 2022, whether it was going to be possible to organize an event before the month of May 2022. For this reason, we decided to target EuCNC 2022, few days the initial deadline, at the very beginning of June 2022 to show our platform to a large audience. However, some organisational and technical issues prevented us from achieving this goal and we had to revise our plans again. Thus, we organised two events open to the public during the summer of 2022 in order to demonstrate the results of the 5GDrones project.

4.1.2. MS5 Achievement

During 2021 we organised one and during 2022, we organised two public showcasing events at the partner sites of the project. These events are summarised in the following.

5G!Drones project partners demonstrated drones' control via 5G in Helsinki, at Aalto University
AU performed a small showcasing event on May 27th, 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. Deliverable D5.5 shows some pictures captured during the showcasing. By this event, the 5G!Drones project contributes to the society and the impact on the youth generation, which is a very valuable aspect. More information is available at <http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c>

Type of attendance: Mainly Aalto University graders students

Number of people attending the event: About 20

Photos and videos of the event:

<http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c>

Egaleo trials

The purpose of UC4Sc1 was to demonstrate how UAVs through 5G network capabilities can improve connectivity services in a highly crowded environment, e.g., during large events. To that end the capabilities of the scenario included autonomous flight planning and navigation (C2 over 5G), utilisation

of 5G User Equipment (UE) to extend the coverage and provide ad-hoc connectivity to people, as well as signal strength measurements across the flight.

The trials have proved that the performance characteristics of the existing 5G NR networks, both on latency and transfer rates, with careful planning even on the already deployed commercial 5G NSA networks, are adequate for the acceptable operation of 5G assisted UAV flights. The positive impact on the performance of the system was proven to autonomous drone system companies by the trials. The average latency between the drone and its control station is reduced when using the booster compared to the existing 5G network. But more than the average latency, the most interesting gain is avoiding peak latencies. A similar conclusion can be derived concerning the bandwidth. The bandwidth measurement was taken from an application point of view (from the drone to its control station) and the minimum, average and median values of the bandwidth were higher with the 5G booster, showing it to be more stable.

Type of attendance: Municipality of Egaleo officials, public

Number of people attending the event: A public audience of 70 external attendees approximately attended the showcasing event.

Photos, videos, and event links:

- <https://5gdrones.eu/5gdrones/5gdrones-showcasing-at-egaleo-stadium/> (website post)
- <https://www.youtube.com/watch?v=-LLJbj19Bx4> (5G!Drones Athens Showcasing event at Egaleo stadium, Greece)

Oulu trials

The Oulu showcasing event took place on August 26th, 2022 at the University of Oulu premises. The showcasing started with a 5G!Drones general presentation, focusing on the six use cases conducted in Oulu on the trials week. The methodology for conducting trials, starting from flight planning at the Web Portal 1 was described and demonstrated and the use cases were elaborated presenting the goals for the UAV operations and the KPIs collected. Out of the six use cases:

- UC1:SC2: 3D mapping and supporting visualization/analysis software for UTM,
- UC2:SC3: UAV and video analytics for police tasks, including counter-UAS activities,
- UC3:SC1: SubSc1: 5G QoS measurements,
- UC3:SC1: SubSc2: Long range power line inspection,
- UC3:SC1: SubSc3: Inspection and search & recovery operations in large body of water, and
- UC3:SC3: Location of UE in non-GPS environments,

the UC3:SC1:SubSc1 was demonstrated at the University of Oulu parking lot and the UC3:SC1:SubSc2 was demonstrated at the University of Oulu Botanical Garden area.

Type of attendance:

The showcasing event was an open event with participants ranging from representative of the city of Oulu to local stakeholders, and researchers.

Number of people attending the event: approximately 40

Photos and videos of the event:

[5G!Drones final trials and showcasing at the University of Oulu campus \(22-26 August 2022\)](https://www.youtube.com/watch?v=9sWQXDp3YEw&t=2s)
(<https://www.youtube.com/watch?v=9sWQXDp3YEw&t=2s>)

5. PROJECT BODIES AND MEETINGS

5.1. General Assembly / Plenary meeting

During the Reporting Period the 5G!Drones project held a hybrid Face-to-Face meeting on October 4th – 6th, 2022 where items for finalising project objectives and 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 (28/06, 13/09, 29/11) 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, the Facility Coordination Team (FCT) managed all the interactions with the facilities so as schedule the usage of the and the modules for the final trials and tests, as well as to organize frequent and timely communications between specific partners, towards the planning for the common component adoption, namely the middleware developed for extracting the data produced from the test cases.

5.4. External Advisory board

The External Advisory Board had no meetings during the reporting period as no date was found suitable during the time frame where the meeting would have been impactful. The External Advisory Board was invited to participate in the 5G!Drones webinar held on November 25th, 2022.

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
1. UAV Business case developments	RXB	Major drone services and developments related to 5G Drones activities.
2. Regulation of UAV flights	CAF	Updates of EU Regulation and further regulation developments
3. U-Space regulation and roll-out	FRQ	EU Regulation 2021/664, -665, -666 U-Space regulation updates and roll-out in EU.
4. Regulation of cellular UAV's and commercially available cellular UAVs	CAF	EU regulation to use 5G or other cellular devices onboard. Drones with cellular (incl. 5G) devices on board
5. 5G roll-out and developments of the 5G eco-system incl. 5G IoT	CAF	5G networks both 3.5GHz and 700MHz frequencies roll-out in EU and development of eco-system and functionalities (SA; MEC etc.)
6. Standardization of 5G (3GPP etc.) and specific fields (Slicing, MEC, UAVs)	OPL	3GPP technical studies and reports regarding 5G MEC, slicing and UAVs
7. UAVs Altitude and Location Reference problems	DRR	Altitude Reference problems and possible solutions
8. Interference problems	ORA	a) Between drones and base stations b) Between 5G and aviation radio altimeters

The IMT Team has prepared IMT Reports for the 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 November 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 30% female, 70% 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 14% to 20% female representation.

Table 6: Gender Balance of the 5G!Drones Project at M42

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																			219
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	Finland		1					1	10					3			4	11	0	15
2 (Tech. Coordinator)	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							1			1			2			0	4	0	4
	6 NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	Greece					2			6		1						0	9	0	9
	7 AU	AALTO KORKEAKOULUSÄÄTIO SR	Finland		1			1			7		1			4	3		4	13	0	17
	8 COS	COSMOTILE KINOTES 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						6	8	0	14
	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		1			1			10		1			1			2	12	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					4			2			2	1		2	8	0	10
	22 FLA	OU FLAPERON	Estonia							2									0	2	0	2
Percentage				0 %	100 %	0 %	20 %	80 %	0 %	19 %	81 %	0 %	14 %	86 %	0 %	62 %	38 %	0 %	30 %	70 %	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 – M42

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 (from D6.5)

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.

M37 – M42

The 5G!Drones software layer to execute UAV trial has been addressed in WP2. More precisely, WP2 has finalised the development of trial controller enablers used to run the UAV trials on the top of the target facilities. The final release of the trial controller software is reported in D2.5 while the data analysis and visualization software implementation is reported in D2.6.

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 work 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 (from D6.5)

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.

M37 – M42

The Web Portal 1 and Facility Web Portals were used during the ultimate tests in all test facilities. The solution is TRL3 level, what means experimental proof of concept. The solution for measurements and logs collection is accessible through REST APIs for real-time, online data collection. It has also the possibility for offline data import in case system is offline. Due to diversity of the used UAVs and 5G test networks, it was impossible to design and implement the universal tool for results analysis. The constraint was also that different partners used to work with different analysis tools and they were struggling with analysis process.

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 enablers despite coarse-grained. The later 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 (from D6.5)

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.

M37 – M42

The platform and UAV enablers have been addressed in WP3 from M3 to M36 and several Partners have collaborated to identify, design, and implement them. The final release of enablers has been achieved by M36 by the delivery of final UAV enablers. All these enablers have been at the core of the different tests and trials ran during this period, their description has been reported in deliverables D3.1, D3.2, D3.3, and 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 neighbour cells. The motivations of these tests were to achieve field measurements on interferences generated by cellular UAV on normal smartphones traffic in neighbour 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 (from D6.5)

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.

M37 – M42

During this Period the Consortium ran Trials based on the planning from D4.3 Trial Plan. The D4.4. Trial Evaluation Report gives an overview of the Trials as well as reporting qualitative and quantitative results of the individual Trials. The 5G/UAV KPIs already defined in D4.3. are also reported and evaluated as part of D4.4 which is released in M42.

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 (from D6.5)

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.

M37 – M42

Starting in June 2022, final trials were conducted at all four facilities with different scenarios. KPIs from the network and UAVs targeted by each scenario were collected and sent to the centralized 5G!Drones KPI management system (hosted at FRQ). Work to visualise these KPIs on the Kibana platform and verify them (i.e., that their values meet the target values and accuracy identified per use case) is ongoing during M42. The result of this work is presented in D4.4 for each use case.

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 (from D6.5)

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.

M37 – M42

Based on the work and findings from D2.3 and D2.6, which were already submitted in earlier periods, in this period the Consortium used the tools and mechanisms from WP2 for analysis and visualisation of the data collected during the WP4 Trials. Results and takeaways are reported in D4.4. Trial Evaluation Report. Deliverable D5.3. – Report on contribution to standardization and international fora aims at reporting standardisation activities and contributions at international fora achieved during the whole duration of the project.

Objective 8 “Dissemination, standardisation and exploitation of 5G!Drones”:
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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.
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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 (from D6.5)

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.

M37 – M42

During this Reporting Period, the partners have submitted several papers in journals and conferences, and some of them have been accepted. The project has also participated with a booth at EuCNC 2022 to demonstrate the platform to visitors. Also, during this period, the partners organised tests on the four facilities sites. During these events, many external people were invited and they could participate to demonstrations. Final results of the project have been shared with them, as well as in an open webinar on November 25th, 2022.

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 Q14 WP1 work has focused on final collection of content, editing, reviewing and finalizing its only remaining Deliverable D1.7.

Significant results

During Q14, deliverable D1.7. of task 1.1. has been worked out, reviewed and submitted.

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 Q13, the work of Task 1.1 was mainly related to collecting materials and writing text to the D1.7 document. Timeplan and ToC are final, table with all contact persons and optional contributions timing available. End of May D1.7 v0.3 released and contributions continued during Contribution Round #3. Mid of July D1.7 v0.4 released and contributions continue during Contribution Round #4. April, May, July and August telco meetings took place and D1.7 progress discussed. 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.

During Q14 the work of Task 1.1 was related to finalizing the D1.7 document. In September and October, evaluations of the content of D1.7 sub-chapters were carried out regularly and, if necessary, each partner was asked for additional contributions in different sub-chapters. The D1.7 finalization process was leaded by the INF team, supported by all partners with content contributions. In November, the D1.7 review process was carried out and submitted to the EC on 30.11.2022.

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. *UO* still contributed to D1.7 by providing input to sections 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, and to General 5G-UAV Market Recommendations and future Pathways.

2-*THA* participated to the edition of D1.7 During Q13 and Q14. Regarding the exploitation *THA* plans to make of the outputs of the project.

3-*ALE* had no activity on the Task during Q13. *ALE* made contributions to deliverable D1.7 including results on market research on situation awareness and its perspectives explored by *ALE*, as well as regulations aspects.

4-*INV* contributed during Q13 to the content of D1.7, by adding the first versions of chapters 4.3 “5G!Drones Business Model for 5G UAVs” and 4.4 “Overall 5G UAVs Market Perspectives and Recommendations”. In Q14 *INV* was providing input to chapter 4.2.1 related to UC1Sc1, correcting the chapter 4.4.1, according to partners’ comments and adding content to chapter 2.2.3.1.

5-*HEP* does not participate in this Task.

6-*NCSR*D has contributed to D1.7 in section 2 at the various market areas that drones are used, as well as in the Greek legislation section of UAV flights together with *COS* during Q13. During Q14, *NCSR*D contributed in D1.7 on the description of the Athens platform, the business opportunities and the lessons learned from the execution of the use-cases in Athens, listing also future research directives. Finally, *NCSR*D contributed in the last section of the deliverables, listing challenges and recommendations based on the experience from the Athens platform. *NCSR*D acted also as a

reviewer of the D1.7 final version.

7-AU has made several contributions to the deliverable D1.7. The different contributions are related to its use case scenario (UC3SC2), its 5G facility and its view as an academic institution. More precisely, AU has contributed to the sections 4.1.1, 4.1.2, 4.2.1 and 4.2.3.

8-COS provided content on Section 3.2.3 for D1.7 during Q13. Also, COS has orchestrated with INF the content proposition for section 4.2 of D1.7 to be produced by the use case leaders in accordance with the assessment results of T4.3. In Q14, COS has provided content in Sections 4.1.1 and 4.1.2.

9-AIR does not participate in this Task.

11-INF led D1.7 activities during Q13 and Q14. Timeplan and ToC are final, table with all contact persons and optional contributions timing available. End of May D1.7 v0.3 released, and contributions continued during Contribution Round #3. Mid of July D1.7 v0.4 released and contributions continue during Contribution Round #4. April, May, July and August telco meetings took place and D1.7 progress discussed. Contributions related to Sections 2 (Market), all Section 2 subsections and Section 4 (5G, UAVs and Use cases impact) have been made by INF. During Q14 a new working version of D1.7 (v0.5) edited and released mid of Sept. During October more contributions coordinated and made by INF and new working versions released (v0.6-v0.8). By mid Nov the final draft (v0.9) will be ready by INF and submitted for final review Linking T1.1 and T4.2 trial activities for defining and interpreting valid business trial results and business impact for further use in D1.7 was continuous during the reporting period. Communication of business and market aspects through 5G!Drones social media channels and website continued as per communication plan.

12-NOK analysed from UAV perspective both business and regulation impact for future wireless standards and business development point of view during Q14.

13-RXB contributed to the regulation chapter of D1.7 and reviewed the D1.7 documentation.

14-EUR had no activity on the Task during the reporting period.

15-DRR does not participate to this Task.

16-CAF collected and analysed materials related to USA regulation and EU radio communication regulation of UAV onboard communication devices during Q14. CAF acted as reviewer for D1.7.

17-FRQ as WP1 leader was responsible to lead the monthly WP1 telcos, for the creation and distribution of meeting minutes and the supervision of partners contributions. Content contributions to deliverable D1.7. were performed in sections 2.2., 2.4., 4.2. and 4.4.

18-OPL was tracking the recent 3GPP standardisation changes. Collecting and analysing the materials about drones' use cases in forestry, environment and water management, biodiversity monitoring, etc. Providing the comments and several contributions to D1.7 describing the above applications and open issues related to the support of communication services by the 5G System.

19-MOE does not participate in this Task.

20-ORA does not participate in this Task.

21-UMS participated in the development of the contributions for the D1.7. In section 2 some aspects of the market for public safety drones were outlined (sec.2.2.3.2) highlighting the recent accessibility of the drones due to the reduction of the costs and the added value provided in the sector. In addition, considering the use cases where it was involved, some insights were provided for the drones'

applications in the extension of the connectivity for enhancing the monitoring of crowded events (sec.2.2.3.4). In addition, section 4 was addressed to describe how was the business impact UMS, as UAV operator, received from the project in the use cases it was involved in (sec.4.2.2.2 for UC2 and 4.2.4.2 for UC4). Finally, some market perspectives, recommendations and future intentions were provided in sec. 4.4.1, 4.4.2 and 4.4.3.

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

The WP has ended.

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

The WP has ended.

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-M37) [DRR]
- T4.2: Preparation and execution of trials (M12-M42) [CAF]
- T4.3: Evaluation of trial results (M20-M42) [COS]

Description of work

T4.2 has focused on the conducting 5g!Drones project final trials in Finland, Greece and France August-September 2022. Final trials were successful and the planned scenarios were carried out. Results and data collected during the final trials was later analyzed in the T4.3 activity.

T4.3 has focused on the evaluation of the trials, that have all completed during the reporting period. Several discussions have taken place during this period regarding the KPIs and the definition and the validation of the test cases in their structure and templates.

Main Progress in the period:

A consolidated version of ToC for D4.4 including all the objectives for the trials and test case scenarios was achieved.

Significant results

A coordinated work among the partners has been done in order to collect all the information relevant for an effective evaluation of what happened during the trials use case scenarios. This work led to the finalisation of D4.4 “Trial Evaluation Report”.

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-M37) [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 the Q13 was to execute the integration testing of Release 4, Use Case Release as well as to cover all the remaining issues from previous releases, as it was the final release. All the results and final conclusions were captured in D4.4.

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 has been preparing 5GTN network, devices (like phones and modems), test software and 5G!Drones UO capability for the June technical tests and August trials. Extensive network coverage, signal strength and UL/DL throughput measurements have been done and Base station parameter and antenna direction modifications have been executed. UO has been working on SEP22 software installation, that includes installing Centos7 OS, Installing Kubernetes and Docker, Creating Huge Pages, Installing MULTUS SRIOV driver for CNI, creating Networks and Secrets, configuring .yaml files, and uploading the required images for SEP system. UO worked with the Keysight team to enable Samsung S21 phone #14 to work on the 5G-SA, activate the license, be used by Nemo Outdoor, and enable NATA solution for Nokia use-cases scenario. UO evaluated the option to send KPIs offline due to some limitations by the 5GTN Facility Adapter to send real-time KPIs to the KPIC monitoring component, which was later solved by discarding the implementation to send KPIs offline. UO improved the measurement collection and publishing from the 5GTN Adapter to sync faster the network measurements collected each second by Qosium Probes in the 5GTN Facility. UO implemented at the 5GTN Facility Adapter the additional functionality to send multiple 5GTN network KPIs measurements created for the use-cases scenarios trial of HEP/FLA and ALE partners. UO interacted with the Kaitotek team several times for Qosium collecting 5G radio signal-related metrics more accurately. UO investigated the network slicing operation in the Quectel modem and Samsung S21 phone to use the eMBB core network slice implementation. Before and during technical trials in Oulu, UO performed with INV end-to-end tests from Web Portals 1 & 2 to schedule and create a trial, network slice and measurement job of KPIs at the 5GTN Facility. UO performed pre-tests to measure the throughput rates of flying UE onboarding the Drone in the 5G-SA network to identify the best spots and altitudes for running the technical August's trials in Oulu. UO solved the issue about Trial Validator and Smartsis to create trials successfully. UO ran several smartphone tests to identify the low uplink throughput rate in the 5G-SA network with different base station configurations and antenna tilts. 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 improved the 5GTN facility adapter for radio-related data collection and publishing. UO carried out troubleshooting about the Kibana data index bug when sending data inside the list KPIs into the JSON data object. Currently, UO sends data inside the KPIs-UO list, and ELK/Kibana is receiving and storing the KPI data from the 5GTN facility. UO was helping UAV partners connecting the UE, especially, Quectel 5G modem to connect with the drone servers, i.e., Linux server using AT commands. Also, I was testing S-NSSAI based slicing using Quectel modem which was partially successful but not consistent. In addition to that, UO tested the APN based network slicing successfully in our 5GTN facility.

2-THA as technical coordinator, ensured that the tests run during summer were well conducted which has led to the achievement of MS5 during Q13. During Q14, THA participated to the validation of D4.4.

2.1-ERC has integrated the prototype for the radio source detection with a lab testing environment able to provide 3GPP radio signal. This environment is based on real radio signals coming from a test mobile handset. Software simulation capabilities is also deployed to evaluate the behaviour of the algorithms when radio conditions are degraded.

Deviation and proposed corrective action:

Testing has been done in lab only and in standalone mode as a simplification with relevant testing environment.

3-ALE had no activity on the task during Q13.

4-INV was participating to the work for Rel4 during Q13. In June INV had a number of meetings for testing the software before the final tests. The last bugs and issues were identified and corrected, in Web Portal 1 and Trial Controller.

5-HEP was leading Release 4 During Q13 and June of Q14. It did testing with KPIC, Trial Validator, Web Portal 1, SmartSis and how they interacted and prepared a dashboard in Kibana. HEP also did integration testing on site at Oulu.

6-NCSR D contributed and participated in Release 4 integration activities during Q13.

7-AU was hosting the majority of the software components developed in the project (including, webportal1, webportal2 AU, trial repository, trial enforcement, LCM, abstraction layer, ...). AU has there been the target of several requests to adjust the resources and the connectivity of the hosting environment. AU is continuously performing this task to ensure a good integration. During this reporting period, several trials have taken place, which made the role of AU very crucial as a facility hosting many modules using during the trials. Furthermore, AU is also maintaining the VPN connection from its site to EURECOM and the University of Oulu.

8-COS had no activity on the Task during Q13 and Q14.

9-AIR contribution to this task has been completed in the previous quarter to Q13.

11-INF completed its activities with a final overview on the 5G CPE integration and KPIs assessment (rel 4) for Athens upcoming final trials on early September during the last month of T4.1 (M37).

12-NOK has continued integrating edge processing environment and related SW integration to serve as a reference for trialling. Plenty of meetings and other cooperation activities with UO solving practical topics trial environment integration.

Deviation and proposed corrective action:

Building local processing environment following NOK reference was not successful due to incompatibility problems with configurations early product version and missing documentation. That led to use of alternative setup which was more suitable to installation available at UO during trial.

13-RXB had no activity on the Task during Q13.

14-EUR In Q13, EUR has updated the 5G facility with radio monitoring feature using O-RAN RIC model. This update has been made to support the final trials of September. Also, adjustment of the abstraction has been made to adapt to the LCM and KPI monitoring requirements. In Q14, EUR made major contribution to D4.4.

15-DRR did integration tests for Release 4. Updating of release documents. Review and update of ToC for D4.4. Scoping content for D4.4 (summary of Release 3 and 4), review of initial content for D4.4 (including test cases). Implementation of jurisdiction areas for Athens and Oulu trials. Regular DevOps activities. Software upgrades. Gitlab maintenance. DroneradarUTM FRQ integration – security keycloak.

16-CAF performed the integration and testing activities during Release 4. Performed functional tests and validation with CAF's own hardware and software components to verify compatibility with

5G!Drones facility partner networks.

17-FRQ participated in and provided support for Release 4 activities. Incorporated findings to improve components. U-space adapter and Trial Validator component support for test runs.

17.1-FSO participated in and provided support for Release 4 activities. Incorporated findings to improve components. U-space adapter and Trial Validator component support for test runs.

18-OPL preparations of the NWDAF component by OPL to its trials.

19-MOE had no activity on the task during Q13 & Q14.

20-ORA achieved functional tests of the Morinant enabler for evaluating network coverage in aerial situation over the target environment in Bretigny (> 1 km flight long with 5G connectivity and 4G as backup).

21-UMS contributed to the Release 4 testing definition, validation, and execution, providing inputs and evaluations when needed, consistently with the plan developed in the Annex I.

22-FLA Testing and configuring Qosium probes and scope to be ready to take measurements and push data to Oulu's server in the trial. FLA has implemented time synchronization solution for the on-board computers and laptops needed for delay measurements in the trials. Preparations and integration testing remotely. Integration testing at Oulu.

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:

The main focus of Task 4.2 during Q13 was to prepare for the 5G!Drones final tests in June and July and to conduct the final tests at Aalto and Oulu universities in August 2022.

In June, the following was carried out:

- technical tests at EURECOM and Aalto University to verify the compatibility of the drone's 5G modem and the local 5G SA network and edge servers' applications.
- At the University of Oulu, tests and tuning of the 5G SA base station were carried out, and the area where the final trials of the project would be carried out was mapped.

In July, tests of 5G modems and local 5G network connectivity were conducted by NCSR.D.

In August, the final trials were conducted as follows:

- Aalto University on August 15 and 18
- at the University of Oulu on August 20-26

The main focus of Task 4.2 during Q14 was to continue final tests in Athens (5Genesis platform) and at EURECOM (5G-EVE platform).

In September, the final trials were conducted as follows:

- at Municipality of Egaleo stadium (Stavros Mavrothalassitis) on September 5-8
- at EURECOM on September 16-17

Appropriate permits were requested for Final Trials. Minimal changes were made to the planned scenarios, taking into account the technical characteristics and limitations of 5G research networks and the restrictions arising from the regulation of drone flights. The planned scenarios were implemented on the dates planned for it.

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 has tested and verified the functionality of the 5GTN Components like 5GTN Adapter, Orchestrator, and VIM, and got them ready for trials and pre-trials during Q13. UO coordinated with each partner to collect the use-case-related network KPIs and run pre-tests of use cases to validate the required KPIs from the network, radio, and even UAV and thus be prepared to run the subsequent trials per test case suitably in the 5GTN facility. UO helped HEP/FLA to run pre-tests in June at the 5GTN facility. UO deployed Docker containers/services from CAF and ALE in the 5GTN facility as part of the preparatory activities for technical trials. UO helped CAF to run pre-tests a week before technical trials to prepare the services required and connectivity in the parking lot area. UO helped NOK to run pre-tests in June to prepare Nemo Outdoor, NATA solutions and permissions needed for the smartphone S21. UO participated in the preparatory meetings to report the facility's status and present a measurement system to collect 5G KPIs during the trials. UO schedule also includes the time each partner runs the trials considering the sequence of each partner's use-case scenario, one trial creation availability per partner, and KPIs collection during the trials. UO coordinated with each use-case leader to obtain a technical description of the KPIs, requirements, services and enablers that will run the following technical tests. UO has worked on preparing the 5GTN facility to support the requirements and enable the run of the enablers of each partner to execute their use case during the trials to prepare the 5GTN facility. Before August's trials, UO carried out more tests to measure, collect, and publish KPIs from the network and radio devices at the 5GTN facility. UO ran several tests to measure and identify the uplink and downlink throughput, signal strength, and interference using the SpeedTest app, Nemo Handy, and Qosium tool installed on 5G smartphones (e.g., One Plus 9 pro, Samsung S21 and Huawei 40 pro) connected to the 5G-SA network and also to check the best

connectivity spots at ground level to run the technical trials. UO provided full support to the partners during the trials, specifically to create trials at 5G!Drones platform collect the measurements from Qosium and sends network KPIs data to the KPIC monitoring component in Frequentis. UO presented the Qosium tool during the showcasing event and how it collects and publishes the measurements from the UE onboarding the UAV during the 5G!Drones trials.

During Q14, UO prepared conducted complementary tests to measure the 5GTN baseline KPIs during the flight mission and video streaming. UO repeated the previous test several times to obtain comparative measurements and consistent data of a well-configured scenario. UO committed the last version of the 5GTN facility adapter in the Gitlab code. UO added videos and screenshots about the partner's test cases, Qosium, the KPI system at the 5GTN facility, the Web Portal, and even logs collected by the Qosium tool for Hepta trials in the project repository. UO updated Web Portal 2 code for bugs related to updated KPI list for 5GTN facility and conducted end to end trials with INVOLI, and removed software integration bugs. UO measured average time required to create trials in 5GTN facility. UO Tested local installation of 5G!drones microservice (all software components) in 5GTN facility. UO continued cloud-network integrated resource orchestration for UAV Applications research by studying the problem of allocating computing and networking resources with the objective of maximizing the number of concurrent requests while minimizing the cost of allocated resources, given that end-users (UAVs) require computing resources to run their services with dynamic, stringent E2E latency and bandwidth requirements. UO also continued research on supporting deterministic network performance guarantee for UAV-based services by proposing a reinforcement learning-based synchronous flow routing and scheduling strategy to determine the optimal path selection and queue management scheme to ensure a deterministic bound for all the time-critical flows within UAV-based services.

2-*THA* participated to the discussion regarding the trials ran during the period and to the analysis of the outputs of these experiments during Q13 and Q14.

2.1-*ERC* no contribution during Q13 and Q14.

3-*ALE* has completed the preparation of its sub-scenario's trials. *ALE* has performed its trials on week 34 in Oulu. Trials were done during Q13, and complementary tests were conducted during Q14.

4-*INV* participated to the meetings about organising the final trials in UO and EUR during Q13. As the owner of the Web Portal for flight planning, *INV* was actively participating to all final trials' activities in AU, UO, Athens, and EUR. *INV* representative was supporting trials in Oulu on-site. *INV* has also recorded the video with instructions and example how to make the Operational Flight Plan in Web Portal 1, Web Portal 2 and validate it in Trial Validator. This video was shared with all project members. As the owner of UC1Sc1 *INV* travelled and participated to the final tests in EUR. *INV* was providing here its services, based on signals from G-1090 receiver and LEMAN tracker. During Q14, *INV* was supporting remotely the trials in Athens, regarding the Web Portal 1 trial. For tests in EUR, *INV* was on site to supervise and support the UC1Sc1 tests. It was involving the G-1090 installation for the trials, tests of Web Portal 1 and flight of CAF drone for UC1Sc1. *INV* reviewed the video prepared for UC1Sc1 and submitted the comments. Some additional tests of Web Portal 1 were performed.

5-*HEP* was preparing for and requesting flight permits for the trial in Oulu during Q13. It constructed a mock-up power line used in the trial in Oulu, did preparatory flight tests for the trial in Oulu, did administrative preparations for participating in the trial in Oulu, and took part in the said trial. For the trial in Athens, *HEP* acquired flight permits, integrated and tested UMS payload for the drone, and did various administrative preparations. During Q14 *HEP* did some further administrative preparations for the trial in Athens and participated in the Athens trial by providing a drone for the trials and providing assistance at the trial site.

6-NCSRDC coordinated the preparation activities for the Athens final trials and showcasing event during Q13. More specifically, biweekly telcos were organised with all the involved partners and specific 5G equipment was shipped to NCSRDC in order to test its compatibility to NCSRDC and COS 5G equipment. During Q14, NCSRDC, as UC4Sc1 leader organized all the technical aspects of the final trials at Municipality of Egaleo stadium (Stavros Mavrothalassitis) on September 5-7. This included network continuum establishment and configuration between Egaleo stadium, where experiments were executed, and NCSRDC premises, where 5Genesis services and internet access was provided. Also, NCSRDC supported the integration of all devices, equipment and deployed services both in the local edge and the remote sites, as needed for the end-to-end successful execution of partners' trials. NCSRDC, as one of the project facilities offered the 5G experimentation testbed for automated measurements over the open5Genesis platform (NCSRDC core location).

7-AU conducted its final trials during Q13. To this end, Aalto University has heavily worked on the preparation of these events. These include checking the network connectivity around the campus, reserving the parking spots to fly the drones, preparing the logistic materials (tables, cables for providing electricity, ...). The pre-trial phase took place in June. During this phase AU has assisted CAF to connect their Quectel Modem to the 5G network of the University, which did not work by that time. AU has then investigated the issue and worked on several 5G modems to test their connectivity with the network of the University. After a deep work, AU has successfully connected several modems, including the Quectel of CAF. During the trial dates (15th and 18th of August) AU has shown to CAF the procedure to connect their modem and instantiating their containers in the edge server of the University. CAF was able to perform its trial. In addition, AU has also performed its trial related to collecting UAV-based IoT data collection. The final trial was qualified successful thanks to the good preparation performed by AU.

8-COS has supported the preparation of the Athens Trial 5G infrastructure by planning and providing 5G network coverage in the Egaleo stadium during Q13. A mobile unit (5G NSA gNB and eNB) and the relevant transport network have been configured to provide 5G coverage over the commercial COSMOTE network to support the Athens demo zone experiment with Drones C2 over 5G. During Q14, COS has installed the mmWave backhaul network to support the trials over the commercial network, and has brought the mobile unit as resident in the area and operating according to the planning agreed for the 5G!Drones trial.

9-AIR has contributed to last trial execution on 5G-EVE platform 2022 on week 37. The 5G native mission critical application provided by Airbus has been trialled in association with INV for web portal 1, EUR as infrastructure provider and web portal 2, and CAF for drone operation. The trial was successfully held.

11-INF continued during Q13 and Q14 with the planning and execution of final trials in Athens in September 2022. Participation to biweekly dedicated telcos for Athens trials. Arrangements, setup and provision of 5G CPE box equipment to be used onboard UAVs and execution of related tests and more specifically to be used as a coverage extension module on a moving node (e.g. drone). Pretrial tests performed with NCSRDC during July and August. Maintaining with rest Greek partners the continuous operation of 5GENESIS Athens platform and Open5GENESIS even after the end of 5GENESIS project. Related updates have been also made. During the first week of September INF participated in the Athens trials and showcasing event in all days. Briefing and debriefing sessions took place and recorded KPIs were analysed for T4.3 input. Overall, all final trials' results in all 4 5G!Drones locations were analysed from a business perspective, communicating the trial results through social media, website, YouTube, linking T4.2 activities to T1.1, T4.3 and T5.1.

12-NOK conducted tests using UO drone with Nokia measurement devices as cargo was prepared for trialling. Measurement solution included modem, radio I/F measurement solution and QoE solution. Planned Trial flights were executed successfully on week 34 using UO test facility at university campus in Oulu. Simulation on 5G-parameters in GCS software based on trial results.

Chipset and modem related simulations and laboratory tests for radio emission verification during Q14.

13-RXB participated on preparations and trials in Greece and preparations for Oulu trials.

14-EUR In Q13, EUR run several tests have been conducted to test the new version of the AIR MCS application in order to prepare for the trials. EUR has hosted CAF team in June to retest the UC1Sc1 components. One full day was dedicated to preparing the facility and one day to test the CAF components. In Q14, EUR worked closely with AIR to analyse the results of MCS trials on the facility.

15-DRR Implementation of jurisdiction areas for Athens and Oulu trials. Regular DevOps activities. Software upgrades. Gitlab maintenance. Droneradar UTM FRQ integration - security keycloak. Remote support for trials in Athens and EUR.

16-CAF as Task 4.2 leader organised and led preparatory meetings and activities and trials. In June, the following trials carried out: technical tests at EUR and AU to verify the compatibility of the drone's 5G modem and the local 5G SA network and applications. Corresponding radio permits for drone flights in Finland were applied for. In July, tests of 5G modems and local 5G network connectivity were conducted by NCSRD using CAFA PX4 cellular drone onboard Quectel 5G modem. In August, the final trials were conducted as follows: At the Aalto University on August 15 and 18; At the University of Oulu on August 22-26 by CAF. CAF conducted trials and drone flights and all software integrations for scenarios UC1SC1 UTM flights; UC1Sc3 Logistics flights; UC2Sc3 Police and UC3Sc1:SSC1 5G QoS measurements. During Q14 CAF conducted trials and drone flights and software integrations for scenario UC4Sc1 Connectivity in Athens at 5GENESIS platform on September 5-6 and UC1Sc1 UTM for drones on September 16-17 at EUR platform.

17-FRQ Remote and investigation support of trial preparations, tests and integration during pre-trials and trials itself during Q13. During Q13 and Q14 FRQ did preparation and pretests for Trials. Investigation of issues and configuration updates. Actual Trial run support including analysis and KPI collection.

17.1-FSO Remote and investigation support of trial preparations, tests and integration during pre-trials and trials itself during Q13. During Q13 and Q14 FSO did preparation and pretests for Trials. Investigation of issues and configuration updates. Actual Trial run support including analysis and KPI collection.

18-OPL Preparations to participation in trials. The on-site participation was finally cancelled due to the internal decision.

19-MOE contributed to the preparation of the Egaleo final trails and showcasing event during Q13. During Q14 MOE contributed to the execution Athens trials, which took place 5 – 8 September 2022 in Egaleo stadium as well as in Egaleo Entrepreneurship Hub, by providing all the necessary infrastructure and facilities.

20-ORA did live tests of network coverage in aerial situation over the Orange commercial network during Demo Day in June, and post flight analysis. It provided input for sections 2.5 and 2.6 in D4.4.

21-UMS carried out intensive activities, through its tech team, to support the preparation and execution of UC4Sc1 trial in Egaleo stadium. Most of the efforts have been addressed to experiment and demonstrate the safety of 5G autonomous flight even in densely populated area. With its platform UMS allowed to arrange the autonomous flight and collected a great number of data to be analysed.

22-FLA has done technical modifications to the drone in preparation for the trials. Reconfiguring and testing laser scanning software. Bug fixing camera streaming software. Administrative preparations

for the trial and taking part of the Oulu trials. FLA has contributed by preparing the drone for Athens trials and admin prep for Athens trials. FLA has participated in Athens trials in support of HEP & UMS by providing technical assistance on the site and providing a professional drone pilot, transporting dangerous goods to the trial site (batteries, parachute pyrotechnic charges).

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 main activity during Q13 has been the population of the test cases templates per use case scenario to ensure the appropriate collection, correlation and postprocessing of the log data that will support the systemic analysis of the results of the final trials to be used in the context of the use cases assessment. The assessment framework and methodology have been finalised and documented, and the first draft of D4.4 has been published. During Q14, special focus has been put to collect documented material for the test cases performed during the trials and describe the associated results in a harmonised and condensed manner. To ensure consistency, alignment with the set objectives, target KPIs, and reduce result duplications, an assessment board was setup, providing guidance and recommendations to produce D4.4 and evaluating the end key messages.

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 platform members team worked internally to add 5GTN platform contributions D4.4 deliverable during Q13. UO interacted with partners to validate contributions about UTM, GCS, and UAV in the second section of D4.4. UO added the contributions related to the Oulu platform and thus the 5GTN facility for 5G!Drones project in the shared version of D4.4 deliverable available in MS Teams (WP4/T4.3/D4.4). During Q14, UO performed a KPI data treatment, formatting, and analysis from the

Qosium Storage database for contributions on D4.4 and provided the KPI data from the Qosium tool to the partners and also collected the separated KPI data files from August's trials. UO continued working on presentation of the KPI data analysis and statistical results together as part of the D4.4. During the October face-to-face meeting, UO suggested ways to depict and analyse the KPI data in the Kibana dashboard for the D4.4 document. Also, UO provided help to solve partners' questions about the network facility infrastructure and the results obtained during August's trials. UO coordinated with COS as T4.3 leader and CAF as the owner of UC2:SC3 to add the assessment and results of the 5GTN baseline KPIs measurement as a special test case in the UC2:SC3 section of D4.4. UO provided the contributions about the 5GTN baseline KPIs measurements test case in sections 2, 3, 4, and 6 of the D4.4 document. UO made revisions and comments on the partners' contributions along the D4.4 document as part of the assessment board team from the University of Oulu. UO reviewed the whole D4.4 document considering the action points defined in the weekly assessment board meetings and an overall D4.4 review.

2-*THA* had no activity on the Task during Q13. As Technical Leader, *THA* is participating in the WP4 Assessment Board during period Q14 and helps in validating the trials results and finalizing deliverable D4.4.

2.1-*ERC* did an analysis of first results produced through lab experiments during Q13. *ERC* also defined new tests to be done to get more data. During Q14 *ERC* has run additional tests with new simulated radio conditions and has performed the analysis of the associated algorithm's performances.

Deviation during Q13: Analysis of lab results only.

3-*ALE* has provided early contribution to D4.4 during Q13. *ALE* has adapted its test-cases and KPIs collection to on-site situation in Oulu's trials. During Q14, *ALE* has processed the data collected during trials. Results have been contributed to D4.4.

4-*INV* was providing the inputs for D4.4 related to UC1Sc1 and parameters which are going to be collected. *INV* provided the description of the cellular network parameters, which can be extracted from LEMAN remote ID tracker for 4G network. In Q14, *INV* as the UC1Sc1 owner was actively contributing to D4.4 document and as the Web Portal 1 owner, to its tests analysis in all facilities. Chapters ownership: 2.3.1, 4.1 and 6.1. and help to other partners, who tested Web Portal in facilities other than EUR. *INV* created diagrams and figures used in D4.4.

5-*HEP* During Q13 *HEP* contributed to D4.4 and further developed its test-cases for the trial in Oulu. During Q14 *HEP* further contributed to D4.4, processed and evaluated data collected during the trial.

6-*NCSR*D contributed by developing an appropriate script for extracting the collected data to suitable form for visualization by all the platforms during the final execution of the trials during Q13. Appropriate contributions are prepared for D4.4, beyond the initial contributions provided so far. Within the Q14 period, *NCSR*D as a major contributor of D4.4 provided content and coordinated the writing for UC4Sc1 section of the deliverable, regarding the execution of trials, and relative results, that took place in Egaleo Municipality stadium. *NCSR*D took over further adaptation of scripts, developed during Q13, and provided the service, based on these scripts, for trials' data upload in the KPI component. Additionally in cooperation with other partners performed the development of dashboards in Kibana containing meaningful visualization and graphs for measurements recorded in the KPI component, depicting the quality of the 5G network. For the activities mentioned above *NCSR*D organised and participated in several on line meetings both providing support and guidance and also collaborating with deliverable editors for producing homogenised content.

7-*AU*: The contribution of *AU* during Q13 covers two parts. First, in order to perform trial evaluation, *AU* has applied the evaluation methodology discussed in T4.3 on the trials performed at the University. Thanks to the monitoring tools and the specified methodology, several KPIs have been collected and

stored in the ELK stack, which has been customized to visualise the KPIs captured from the use case scenario of AU. The evaluation of the results will be reflected in the deliverable D4.4. On the other hand, AU has also provided initial contributions to the deliverable D4.4. These contributions have been detailed in Q14. More precisely, AU contributed to different sections including 2.1, 2.2.4, 2.4.2, 4.9 and 6.9.

8-COS is the Task 4.3 leader and has orchestrated all the activities for the alignment of the trial assessment actions for all user stories. COS has provided the used templates and methodologies. COS is also the D4.4 main editor and has worked with the provision of the 1st draft. COS has provided content for Section 3.2 documenting the evaluation methodology and quantitative indicators. COS being the responsible partner for Test Case #5 of UC4Sc1 has provided content and results for the relevant Sections (4 and 6) of D4.4 and has worked for the preparation of the associated diagrams in a separate dashboard at the project's Kibana as well as the correlation of results with Test Case #6. Especially in Q14 significant effort has been put for the quality assurance and final editorial contributions for the whole D4.4 document.

9-AIR has established a complete test plan and conceived a specific microservice for assessing the KPI that has been measured during 2022, week 37 trial on 5G-EVE infrastructure. Then, AIR provided a complete analysis of test results from the KPI captured during the trial session and delivered synoptic views and detailed information as well as their conclusions and lessons learnt from whole project experimentations in D4.4.

11-INF provided input on KPIs, methodology and evaluation of results concerning latest working versions of D4.4 during Q13 and Q14. It made contributions on the definition of the trials' execution, vertical KPIs and evaluation methodology, with focus on 5GENESIS Athens platform and Athens final trials in September. INF had 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 No activities during Q13. Project management tasks about how 5G!Drones output and trialling experiences could be utilised in Nokia upcoming projects. Helping with postprocessing and end-report activities. Coordinated assembling of assessment board to support D4.4 review.

13-RXB provided contribution to KPI related clarifications and discussions during Q13. It provided and documented capability to visualise geo-based KPIs within Kibana. RXB participated to review Trial results in Q14 and identifying relevant trial results for 5GBook.

14-EUR did several tests on collecting the radio KPI were done using the new RIC O-RAN based solution during Q13 and Q14. Also, in Q14 EUR has made several contributions to D4.4, where a major one has been made to include and describe results on UC1Sc1.

15-DRR reviewed and updated ToC for D4.4, scoping content for D4.4 (summary of Release 3 and 4), review of initial content for D4.4 (including test cases). Preparation of content (Section 2) for D4.4 (integration status update, summary of releases 3 and 4). Updating the content and review the D4.4. Updating business outcomes. Review of finalised D4.4.

16-CAF provided input on scenarios and UAV operators' KPIs, methodology and evaluation of results concerning latest working versions of D4.4. Contributions on the definition of the trials' execution, vertical KPIs and evaluation methodology. During Q14, CAF has processed the results and data collected during trials. Results have been contributed to D4.4. CAF actively participated in the finalization of the D4.4 document, including also 2021-2022 Trials review chapter and conducted D4.4 review.

17-FRQ provided contribution to KPI related clarifications and discussions during Q13. It provided and documented capability to visualise geo-based KPIs within Kibana. During Q14 FRQ supported various partners in organising and visualising their trial results with Kibana reports. Contribution to D4.4.

17.1-FSO provided contribution to KPI related clarifications and discussions during Q13. It provided and documented capability to visualise geo-based KPIs within Kibana. During Q14 FSO supported various partners in organising and visualising their trial results with Kibana reports. Contribution to D4.4.

18-OPL contributed to the post-trial discussions of the results and prepared the harmonised design of high-level trials architecture diagrams for the trials description and results presentation.

19-MOE contributed in the preparation of the physical site of the trials in week 5-9 September 2022, in municipal stadium “Stavros Mavrothalassitis” and municipal hub, during the Q13. On Q14 MOE contributed to the execution of the trials (5 to 8 September 2022) as well as to the evaluation of the trials results.

20-ORA contributed to D4.4 on QoS measurement in large scale environments by updating section 2.3 and adding trial description and result assessments in sections 4.6 and 6.6. ORA has completed their section inputs in a finalised version of D4.4 in Q14.

21-UMS participated to the task providing some test cases for the scenario where it is involved. UMS supported the following work of definition of the D4.4 technical contents, especially in relation to functional tests, use cases, KPIs and TOCs in sec 2, 4 and 6.

22-FLA Contributing to D4.4 (D5.5, D5.6) and evaluating and interpreting trial results.

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:

Lots of activities have been carried out during Q13 and Q14 completing the work undertaken in 5G!Drones WP5, and concluded with the release of 3 deliverables D5.4, D5.5 and D5.6. All the communication channels were kept updated with latest news and activities: Website, Social media channels, Newsletters (Issue 12 to 14 were released). 5G!Drones partners actively contributed to the different SDOs they were involved in as in the previous periods (3GPP, ACJA, ASTM, EUROCAE, IETF, ITU-T). Also, all the exploitation activities led during the project are now reported in D5.5 (for non-commercial activities) and D5.6 (for commercial activities) as well as future strategies to exploit the technology developed within the framework of the project. Multiple showcasing and dissemination activities were performed by the consortium. In particular, 5G!Drones consortium presented a booth at EuCNC 2022. All the 5G infrastructures hosted the last and more advanced trials and disseminated the project results. In particular, lots of short and impactful video were edited. They are all available inter alia on the project youtube channel. Finally, project members contributed to diverse conferences and publication relatively to 5G!Drones project. All of these dissemination activities are reported in D5.6.

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

Not applicable

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:

During Q13 and Q14 all communication channels were kept updated with latest 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. Newsletter issues No. 12 and 13 were released in June and September, and the final issue No.14 is under editing (to be released end Nov). Special WP5 telcos attended for addressing 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 (especially EuCNC in June with communication material, videos, leaflets, posters and stickers, final trials with videos, Athens showcasing event with communication material and videos). Communication material and actions related to final trials had been prepared used (mainly at final trials and Athens showcasing event in September). Intense communication of all final trials through all channels and in 5G-PPP WGs/6G-IA. Preparation, communication and support to T5.3 for preparing and executing the final 5G!Drones webinar end of November.

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

1-UO did work on a major revision for "Performance Enhancement of C-V2X Mode 4 Utilizing Multiple Candidate Single-subframe Resources" paper submitted to IEEE transaction on ITS during Q13. UO

participated EuCNC 2022 organisation and to 5G-I SB teleconference. During Q14 UO participated in 5G-I SB physical meeting in Athens, Greece and to 5G-I SB teleconference. UO also acted as an internal reviewer for D5.5.

2-THA actively participated to the organization of the EuCNC 2022 booth that took place in June. Leaflets, stickers and posters were used as communication supports. During Q14, THA also supported the preparation of the 5G!Drones Webinar in November.

3-ALE has shot videos and photos during Oulu's trials. Resulting materials will be used for communication on social media. During Q14, these materials have been used for communications on social media (LinkedIn).

4-INV internally prepared during Q13 an updated one-page slide about 5G!Drones project, which can add to any INV presentation for our customers. In this slide INV presents its role and contribution to the project, focused on UC1Sc1. Following the 5G!Drones tests and trials in different locations, INV has been sharing the news about them to its followers and preparing its own communication for the trials in EUR. During Q14 INV was reviewing and making the comments about videos produced after the final tests. INV prepared the LinkedIn post sharing the video from EUR tests. INV contributed to D5.5 document, describing the 5G!Drones Web Portal as the one of the project's outputs.

5-HEP does not partake in WP5.

6-NCSR D has prepared the activities needed for recordings during the final trial in Athens in order to provide to INF appropriate communication material during Q13. Moreover, 5G!Drones project has been also properly communicated during the Summer School of NCSR D to University students. During Q14 NCSR D contributed also in the creation of the communication material related to the final trials in Athens testbed and more specifically NCSR D participated in the interviews that were recorded for debriefing the trials and explaining the added-value, as well as NCSR D prepared and presented during the showcasing event to the participants the project overall, as well as the main points and benefits of the presented trial. All the recorded videos are available at the YouTube channel of the project.

7-AU has captured different screen recordings and videos during the trials performed at Aalto University that it shared with CAF. CAF later edited them and shared them with the rest of the consortium, and later via the social media of the project. AU has also been providing the camera-ready versions of the different accepted papers (related to the activity of the project and authored by AU) to INF, which communicates them via the social media of the project. In addition, AU edited a video demonstrating its follow-me edge platform for VNF migration. The prepared video has been communicated to INF that disseminated it via the social media of the project.

8-COS has supported the 5G!Drones communication activities in EuCNC 2022 especially related to booth activities. Also, COS has contributed to the preparation of the Athens demo zone communication activities and the involvement of COS communication team. Especially in Q14, COS had significant presence in the Athens final event, by providing communication material and liaising activities with the internal COS departments that were necessary to ensure the success of the demo. COS has also supported the final delivery of D5.5 and D5.6.

9-AIR has presented Mission Critical application leveraging drones to firefighters end users in specific National firefighters congress during Q13. AIR has produced communication around UC2SC1 wildfire scenario trial achieved in EUR premises in September 2022, and in particular an appealing video publicly available inter alia on project youtube channel:

<https://www.youtube.com/watch?v=8NvExnbb33M>

11-INF does coordination of overall Task 5.1 activities and participates in the dedicated WP5 telcos and actions. During Q13 and Q14, INF has been maintaining the project website and News section (updates, content creation, news, posts, uploads). Running all social media accounts (Twitter, LinkedIn, Facebook, Instagram, YouTube) - updates, posts, videos, reply to comments etc., and also maintaining in Teams the communication activities repository. INF edited and released newsletter issues No. 12 and 13. It has been preparing and editing newsletter issue No. 14 (Sept-Nov). INF provides monthly statistical dashboards released internally to the consortium (M36, M37, M38, M39, M40, M41) and special ones under preparation for D5.5. INF was supporting 5G!Drones booth presence in EuCNC as well as the Athens final trials and showcasing event with provision of communication material such as leaflets, stickers and posters as well as videos. Arrangements were made with T4.2 partners for videos to be recorded during trials for YouTube channel. It made contributions to all D5.5 working versions (all the contributions and update on the section of communication activities and channels for the period M25-M40), preparation of statistics and actions to follow, and contributions to D5.6 working versions with INF updated exploitation plan. INF has made communication of all 5G!Drones final trials, final 5G!Drones webinar, 5G-PPP/6G-IA events, publications and activities and tag of 5G-PPP in all our communication activities. It has been monitoring all running WP1, WP4, and WP5 tasks for reporting and communicating activities and results.

12-NOK had no activity on the Task during the Reporting Period.

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

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

15-DRR does not partake in WP5.

16-CAF prepared photo and video materials of the results of the AU and UO trials which materials and news texts used in the social media channels of the 5G!Drones project. During the Athens and EUR final trials during Q14, the CAF team made photo, audio and video recordings, which were used to create final videos of AU, UO, Athens and EUR trials. In addition, drawings were made for each scenario, which were included in the final trials videos. The videos were made available to all partners and published on the partners' websites and on the Youtube channel and website of the 5G!Drones project.

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

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

20-ORA did consolidation of the table of contents of D5.5, and regular presentation of this plan to the involved partners via the WP5 bi-weekly meetings. Then, as D5.5 editor, initialisation of the content to the first sections (including the communication and the result sections) and collection of contribution from the involved partners. ORA made sure that a working document for D5.5 draft content is always updated on the 5G!Drones/WP5/D5.5 Teams shared folder. During Q14, ORA was D5.5 editor, which is a joint deliverable between T5.1 and T5.3, since it seeks to report the activities related to communication, showcasing, dissemination and exploitation for the last period of the project. In this context, ORA consistently interacted with T5.1 leader to: i) gather all relevant communication material to build the communication section of D5.5 and ii) agree on an editorial tone for the communications aspects of D5.5.

21-UMS kept on being active in social media and spread communications about the project actions through its website and blog promoting the project during Q13. UMS had no activity on the Task during Q14.

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:

Task activities during this last period were twofold: the completion of the standardization activities report D5.4 and the report of the exploitation activities distributed between D5.5 (non-commercial project outcomes) and D5.6 (for commercial project outcomes). On the standardization chapter, 5G!Drones partners actively contributed to ACJA WT2 and WT4 maintaining previous effort, and also participated to 3GPP, EUROCAE, ASTM, IETF and ITU-T. Considering exploitation, the strategy defined during the first half of the project and written down in D5.2 has been applied to provide detailed plans for benefiting from the efforts invested in the project from an individual and from a global perspective.

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

1-*UO* provided inputs to D5.4 and D5.5.

2-*THA* is responsible for deliverable D5.4. In this context, *THA* defined a ToC in accordance with WP5 partners, and started collecting and consolidating contributions to standardization related to the project. During Q13, *THA* also contributed to three technical specification documents for 3GPP Release 18. During period Q14, *THA* continued the work on D5.4. This includes the collection of all partners contributions, editorial work, ensuring coherence within the document, and with other deliverables. The reviewing process of the document began in early November, and is on track to be submitted in time, at the end of M42.

3-*ALE* has carried on national standardisation monitoring activities during Q13 and Q14. *ALE* has contributed to deliverables on standardisation and on exploitable outcomes D5.4, D5.5 and D5.6, including an analysis on the possible commercial exploitation.

4-*INV* continued engagement to ACJA WP2 work and meetings during Q13. The activity is focused on document called "Reference Method for Measuring and Characterizing the Cellular RF Environment". *Manu Lubrano* is still co-leading ASTM WK69690, currently in ballot. *INV* continues its collaboration within SUSI initiative. *INV* added its contribution to D5.4 for following organisations, where it is an active member: ACJA, GUTMA and ASTM. In Q14 *INV* participated to ACJA WP2 meetings and reviewed and commented about the document "Network Data Service Definition", which is the v2 and evolution of the "Network Coverage Service Definition". Work for ASTM and SUSI was also continued. *INV* prepared the description and content about LEMAN Remote ID tracker in D5.6.

5-*HEP* does not partake in WP5.

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

7-*AU* has been looking for opportunities to disseminate the results of the project under IEEE standard association. In addition, *AU* has been appointed by the PMT as a reviewer of D5.4 and performed this

task.

8-COS has supported the exploitation methodology initiatives of the project and the generation of the D5.5 and D5.6 drafts during the Reporting Period. COS has also revised its individual exploitation plans.

9-AIR has described exploitation plan for the asset deployed in 5G!Drones and entitled “5G Mission Critical application integrating Drone as a Service”. AIR has made available a prototype of the application to SDIS56 (French firefighters at the East of France) for collecting feedback during Q13. AIR has contributed to 5GPPP WG Pre-standardization RAN plenary debrief sessions. AIR has completed exploitation canvas for their exploitable outcome to feed D5.6.

11-INF is not partaking in Task 5.2.

12-NOK has been providing standardisation progress results to project use and delivering project output to standardisation delegates to be handled in relevant standardisation bodies during Q13. Practical international standardisation works e.g. via ACJA WT4, where work-group documents have been reviewed and commented. Similarly, 3GPP Rel-15 LTE features defined for LTE use have been analysed and mapped them to coming 5G 3GPP releases. During Q14, Design-verification topics. Regulatory certification tests for 5G UAV's. Follow-up and Analysing needs for standardization and regulation. Researched UAV business side impact to coming Rel-18 and Rel-19 3GPP standards. Researched UX aspects of tooling for network planning when UAV flight corridors are factors. Collaboration and follow-up with Nokia 3GPP delegates and ACJA on 5G!Drones results.

13-RXB participated in ASTM standardisation work and participated in several EUROCAE standardisation working groups, such as for WG-105 SG-4 and UAS 2520 MOC. RXB evaluated if there are opportunities for MS5 in the standardisation network and updated 5GBook according to the latest development in standardisation (ASTM and EUROCAE). Q14 RXB did further research to identify relevant standardizations and actions done by the consortium for standardization to include insight into 5GBook.

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

15-DRR does not partake in WP5.

16-CAF had no activity on the Task during Q13. During Q14, ECC Decision 22-07 and related reports has been analysed by CAF. ECC Decision 22-07 stipulates 5G 700MHz frequency restrictions for drone take-off and landing up to 30m above the ground. CAF has forwarded the inputs from the drone company's point of view, based on the trials conducted during the 5G!Drones project, to the Estonian National Communications Agency, which started the development of the corresponding regulation in Estonia.

17-FRQ does not partake in Task 5.2.

18-OPL had leadership of D5.6 preparation and was editing the sections allocated to OPL. The D5.6 workshop session during the plenary meeting in Athens has been animated to discuss and arrange the finalisation of the deliverable. The consolidated final version of D5.6 has been delivered within the scheduled deadline. It was participating in the ITU-T session in July and November with contributions. Contribution to D5.4 (section about ITU) has been delivered.

19-MOE does not partake in Task 5.2.

20-ORA completed several sections of D5.4 during Q13, on 3GPP SA1, GSMA, ACJA, and IETF DRIP. During Q14 Orange completed D5.4 on section ECC/CEPT.

21-UMS contributed to the development of the contents related to the possibilities of commercial exploitations of the outcomes of the projects in the D5.6, especially in section 3.10, 3.11, 3.12, 3.13. Even if the TRL of its outcomes in the project were not so mature, a good overview of the commercial perspectives has been provided.

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 Q13, multiple showcasing and dissemination activities were performed by the consortium. UO, THA, INV, and EUR participated in the EuCNC 2022 event and disseminated 5G!Drones in the booth. During the EuCNC event, the consortium demonstrated web portals and presented video demos at the booth. Two showcasing events were held during the reporting period, one in Oulu and the other in Municipality of Egaleo. AU published three scientific papers, one in IEEE IOT Journal and two in IEEE GLOBECOM 2022. COS contributed to the white paper for 5GPPP Test, Measurement and KPIs Validation Working Group. INF disseminated 5G!Drones in 5G-PPP and 6G-IA channels, RXB presented 5G!Drones in Interpol Expert Summit, EUR participated in IEEE ICC 2022 (South Korea) and presented two papers acknowledging the project, OPL presented the paper “Application of mobile networks (5G and beyond) in precision agriculture” at AIAI 2022/5G-PINE conference. OPL prepared also a journal paper “Mobile networks’ support for large-scale UAV services” for MDPI Energies and EUR has been accepted Demo in ACM Mobihoc 2022.

During Q14, 5G Book and six publications have been published and disseminated on social media. Greek partners, NCSR D, MoE, COS and INF arranged a public showcasing event, where COS 5G van was open to the public. Video has been prepared for the showcasing event and shared via social media. Airbus promoted 5G!Drones outcomes and impacts in annual Airbus DS SLC tech days on November 11th and 12th in France. 25th of November public webinar was arranged where the consortium presented the project and lessons learned. AU, OU, FRQ, NCSR, EUR, THA, and CAF were presenting.

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

1-*UO* was a 5G!Drones booth presenter at the EuCNC 2022 conference in conjunction with EUR, THA, and COS. UO paid for the booth. UO organised, advertised, and held a local showcasing event of the 5G!Drones project on August 26th, 2022 using the UO 5GTN. CAF, HEP, FLA, INV, ALE, and NOK participated in the successful showcasing event with approximately 40 external participants. During Q14, UO used its dissemination channels to advertise trials and showcasing videos. UO also acted as an internal reviewer for D5.5. UO actively promoted and participated as a presenter in the 5G!Drones public webinar on November 25th, 2022.

2-*THA* actively participated to EuCNC in June in Grenoble, France. Two persons from THA were present on the booth to present the 5G!Drones project, Web Portal and a video demo. THA also participated to the organisation of the booth. During Q14, THA plans to participate to the 5G!Drones Webinar, organized with the objective to disseminate the project findings and takeaways.

3-*ALE* has taken part in showcasing activity during Oulu's trials. During Q14, ALE uploaded videos from trials on social media.

4-*INV* supported EuCNC 2022 event remotely. INV prepared the document describing all functions of Web Portal for Operational Flight Planning, that the persons on place can demonstrate the tool to the visitors. The document was also used for events in Oulu and Athens. During the public event in Oulu, INV was present on place and demonstrating Web Portal to the visitors and answering questions related to the process of Operational Flight Planning and obtaining the flight permit. In Q14 INV collected and shared with others the materials from tests in Athens and EUR, which were used in the dissemination and final reporting. As agreed during the last F2F meeting, INV asked all partners the feedback about major project learnings and takeaways, and based on the responses, the 5G book chapter "Highlight of key takeaways and learnings" were prepared and submitted to RXB. This material is also valuable for the final workshop planned in the end of November and for D1.7.

5-*HEP* does not partake in WP5.

6-*NCSR D* took immediate actions together with MoE, COS and INF in order to organise in parallel to the final trials in Athens, a showcasing event, inviting audience to showcase the 5G!Drones results and use-cases. With regard to Q14, NCSR D as Use Case leader of Athens platform, coordinated also together with the rest Greek partners, namely MoE, COS, INF, the preparation of the Athens showcasing event. During the event, NCSR D participated as main presenter of the 5G!Drones project, highlighting the main objectives of the project as well as the advances of the showcasing trial. NCSR D, narrated also to the public all the details of the showcasing field trial, during the execution of it, answering also to any question raised by the participants. So, NCSR D lead the activities both at the briefing and the field/demo session of the showcasing event. All the relevant material has been also reported in D5.5. The respective showcasing event video is also available at the Youtube Channel of the project (available [here](#)). Moreover, NCSR D supported the preparation and participated as a presenter (overview of the 5GENESIS infrastructure) in the final webinar planned in the end of November. Moreover, NCSR D contributed to D5.5 and D5.6 and acted as an internal reviewer for the latter.

7-AU as an academic institution is continuing the dissemination of the activity of the project in the form of scientific publications. During Q13 AU got three accepted papers (one journal and two conference papers) related and acknowledging 5G!Drones. The journal paper has been accepted for publication in the IEEE IOT Journal and is related to the use of mobile network for detecting GPS spoofing for drones. As for the two papers, they have been accepted for publication in the IEEE GLOBECOM 2022 and related to the use of cellular network to enhance the communication of drones. AU has also worked on preparing the camera-ready version of the papers during Q14 (revision and addressing the reviewers' comments). The three papers have been communicated via the social media of the project.

8-COS has contributed on behalf of 5G!Drones on the white paper prepared by 5G-PPP Test, Measurement and KPIs Validation Working Group on Beyond 5G KPIs and target values, published in https://5g-ppp.eu/wp-content/uploads/2022/06/white_paper_b5g-6g-kpis-camera-ready.pdf. COS has also contributed together with INF, MOE and NCSRD to the organisation of the showcasing event planning the availability of the COSMOTE VAN for public events.

9-AIR has continued supporting the effort for MS5 completion that shall be achieved with a combination of commercial showcasing events with large scale audience and with technological and detailed demonstrations encompassing all the innovation work carried out in 5G!Drones for specialised attendance. AIR has promoted 5G!Drones outcomes and impact in annual Airbus DS SLC Tech days on November 11th and 12th in Elancourt, France. This event allowed to demonstrate 5G!Drones technology to technical audience as well as end users.

11-INF during Q13 and Q14, maintained in Teams the dissemination activities repository and excel tracking file. It has been updating 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), and monitoring and participating to SME WG activities and meetings (May, July, Sept). INF reported to 5G!Drones consortium on SME WG participation and latest activities. It has been disseminating 5G!Drones activities through 5G-PPP and 6G-IA channels, and supporting with communication material the 5G!Drones booth at EuCNC. INF maintains up to date the dissemination content to be reported by dissemination leader in D5.5. Supported the preparation and execution of the showcasing event at Egaleo stadium during Athens trials in September as well as the final 5G!Drones webinar end of November.

12-NOK participated to local showcasing event during August trialling at UO campus. NOK use case was presented and demonstrated during the trial. NOK did not have activity on the Task during Q14.

13-RXB was participating in Interpol Expert Summit, where RXB was presenting 5G!Drones project and how 5G and Drones can be used for defence purposes. During the Q13, RXB worked for Aalto showcasing event, which needed to cancel due to the network compatibility issues with the 5G modem used in the drone. RXB also prepared and helped COS for Athens showcasing event. Major work due to the Q13 was planning the large-scale showcasing in the 5GWorld event. 5GWorld Event work continued until First month of Q14. In Q14 RXB worked further for 5GBook by providing content, curating the content written by other consortium members and coordinating. RXB prepared and coordinated the Final webinar for the 25th of November and evaluated possibilities to disseminate in more events.

14-EUR has had a strong presence in EuCNC 2022, where two persons were present in the booth to show EUR/AIR demo on MCS. EUR team has attended the three days of the conferences presenting the 5G!Drones to the booth visitors. EUR has contributed to the D5.4. EUR has participated to IEEE ICC 2022 in South Korea presenting two papers acknowledging the project. EUR has accepted Demo in ACM Mobihoc 2022. EUR has released a dataset on containers' performances using its 5G facility

and acknowledging the project (more information is available in Data Management Plan update). During Q14, EURECOM has three publications accepted related to 5G!Drones activities. Two in IEEE Globecom 2022, and one in IEEE Internet of Things Magazine describing the improvement made during 5G!Drones on the facility. Also, in Q14, EUR contributed with many sections to D5.4.

15-DRR does not partake WP5.

16-CAF contributed to the implementation of the Oulu local showcasing event in August 2022 and prepared photo and video material that could be used for the showcasing and dissemination activities of the project. During Q14, CAF presented the results of the 5G!Drones project on its website. CAF helped prepare and participated as a speaker in the Final Webinar presenting the results of the 5G!Drones project in November 2022.

17-FRQ had no activity on the Task during Q13. FRQ contributed to various chapters of D5.5, D5.6 during Q14.

18-OPL was preparing the conference paper “Application of mobile networks (5G and beyond) in precision agriculture” and its presentation at the AIAI 2022/5G-PINE conference. Participation in the conference. Preparation of the journal paper “Mobile networks’ support for large-scale UAV services” for MDPI Energies. Delivery of the contribution to D5.5 during Q14.

19-MOE started planning with NCSR, COS, and INF the showcasing event for the UC4Sc1 trial which will be done in Egaleo, Greece, in September 2022, during Q13. For Q14 MoE, with NCSR, COS and INF, organised and executed the showcasing event, inviting audience to showcase the 5G!Drones results and use-cases in Egaleo municipal stadium.

20-ORA does not partake in Task 5.3.

21-UMS had no activity on the Task during Q13, but in Q14 participated in the showcasing event for the UC4Sc1 trial which was held in Egaleo, Greece, during September, actively contributing to the dissemination of relevant news through its web page and social channels.

8.5.1. Exhaustive list of dissemination and exploitation activities performed between M25 and M40

This subsection describes the dissemination and exploitation actions carried out between June 2021 and September 2022. Social media dashboards are only available up until the end of September 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 WP5 Deliverables, and also shown below. In the following, an overview of the various social media channels is shown during the period from June 2021 to September 2022 (reporting also October and November 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, 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/bc7f0976-e928-4f37-b5e5-f1c553e30cf9>.



5G!DRONES Website

June 2021 - September 2022 Analytics

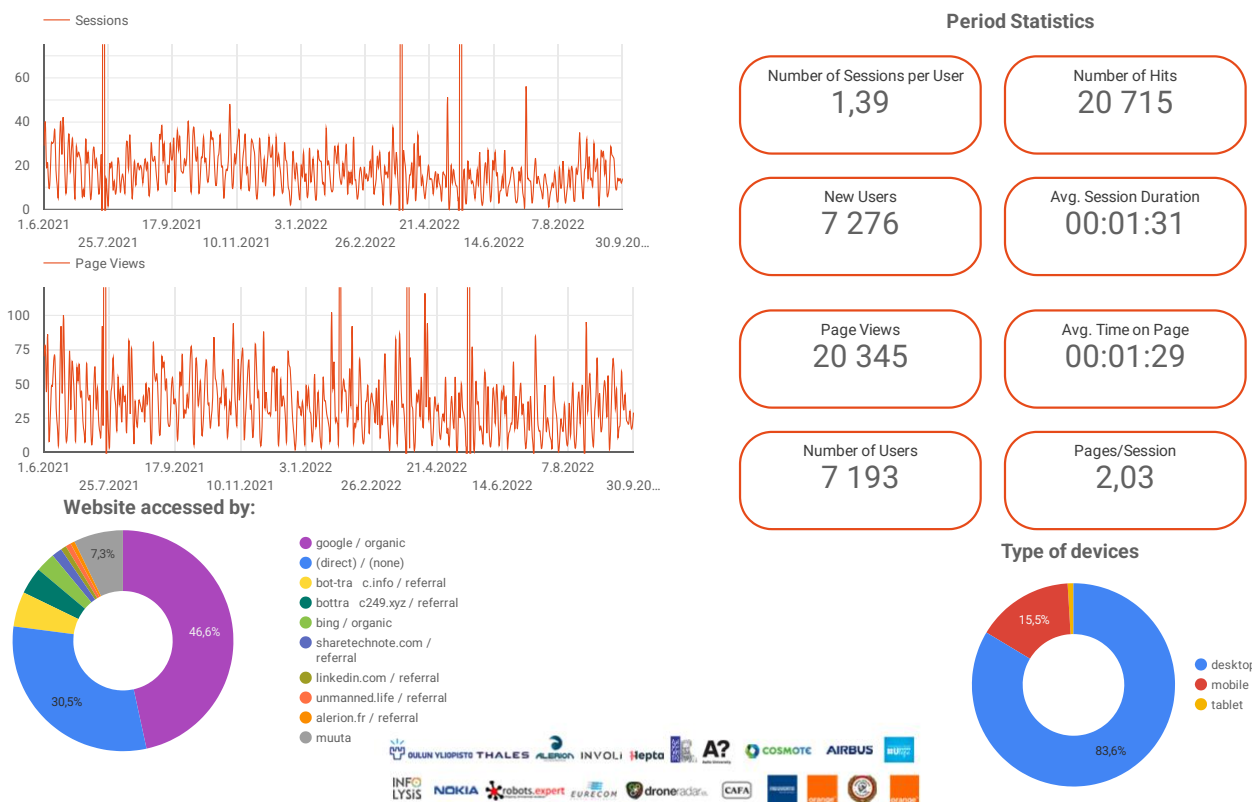


Figure 1: 5G!Drones Website Statistics/Dashboards, June 2021 – September 2022.

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

Instagram: 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/0f0fe7da-3e33-4baf-a927-4e164e7fd1cf>.

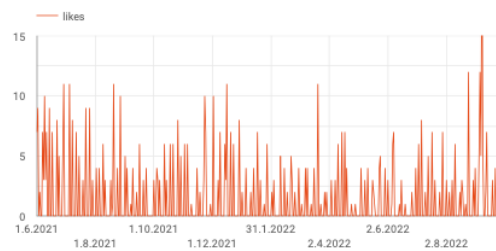


5G!DRONES Twitter Dashboard

June 2021 - September 2022 Statistics



Number of Likes per Total Tweets/Date



Top Rated Tweets

	Tweet text	Date	likes	impressions	engagements
1.	#LearnAbout5G...	21.3.2022 klo 9...			
2.	#LearnAbout5G...	29.6.2021 klo 9...			
3.	#LearnAbout5G...	5.7.2021 klo 9.0...			
4.	The last 5GENE...	16.12.2021 klo ...			
5.	#LearnAbout5G...	2.12.2021 klo 9...			
6.	#LearnAbout5G...	27.8.2021 klo 7...			
7.	#LearnAbout5G...	9.6.2021 klo 8.1...			
8.	#LearnAbout5G...	23.11.2021 klo ...			
9.	#LearnAbout5G...	2.6.2021 klo 9.4...			

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Period Statistics

Number of Tweets 166	Number of Retweets 136
Total Impressions 29 750	Total Engagements 1 756
Mentions 67	Total Likes 702
User Profile Clicks 97	Average Engagement Rate 0,06

Total Statistics

Following 262	Followers 809
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5G!DRONES Twitter Dashboard

June 2021 - September 2022 Statistics

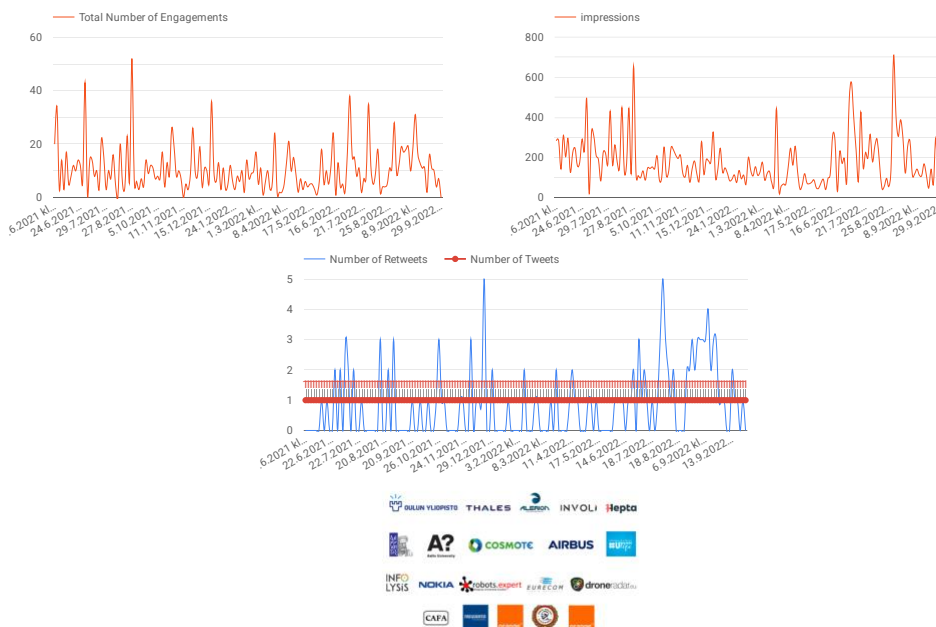


Figure 2: 5G!Drones Twitter Statistics/Dashboards, June 2021 – September 2022.

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/0795f948-d161-4e85-8cfa-1a8199c3a365>.

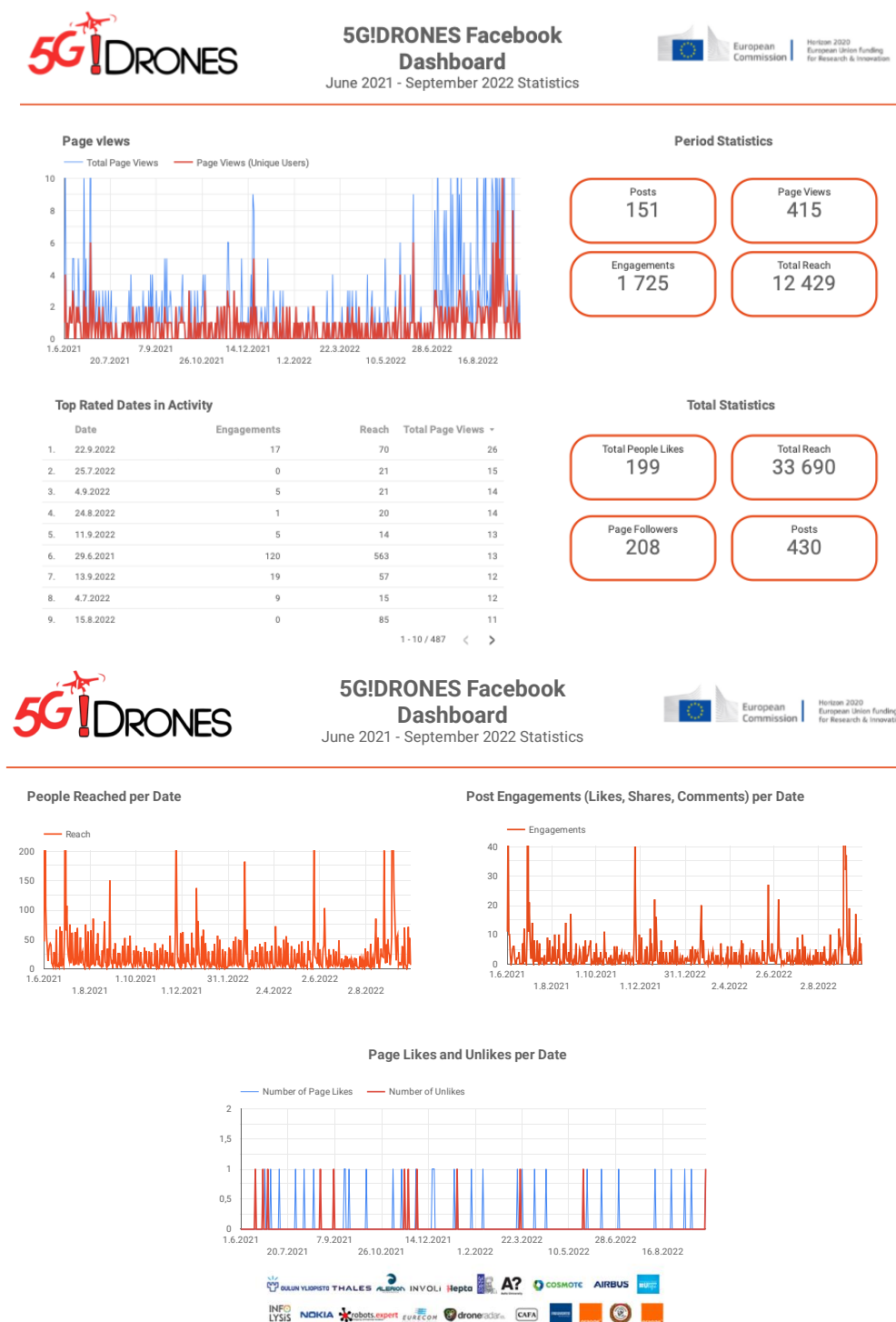


Figure 3: 5G!Drones Facebook Statistics/Dashboards, June 2021 – September 2022.

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/27b7a6ed-4a3d-4238-8db0-0bffe14c607d>.

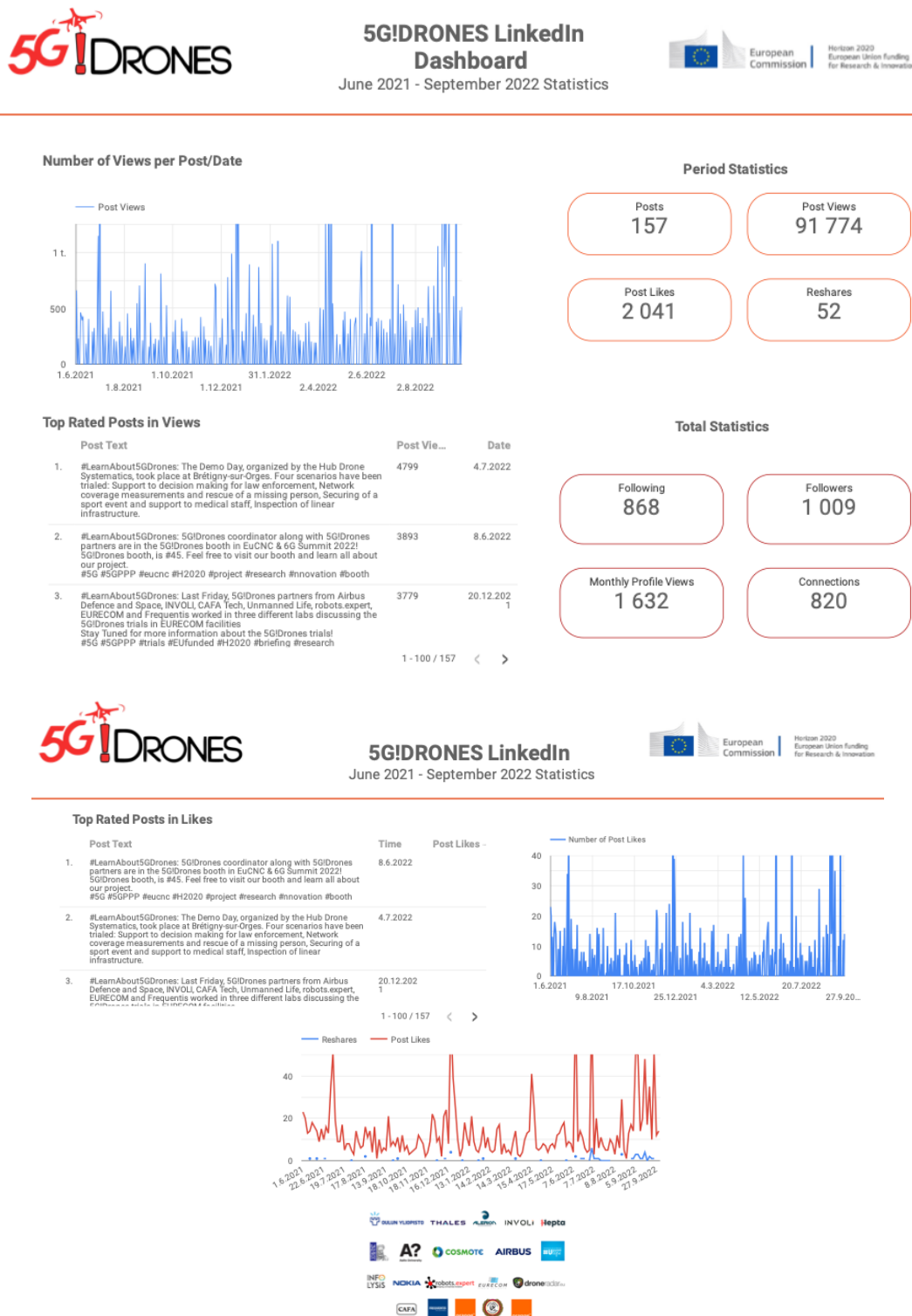


Figure 4: 5G!Drones LinkedIn Statistics/Dashboards, June 2021 – September 2022.

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/1c774c3e-5d05-45c5-820d-65eb1e0a594b>.



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

The project also published newsletters. During the Reporting Period (M37 – M42), three 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 (M37 – M42) 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
June 2022 – November 2022				
42	Nokia	1 co-organised session	7 th PrintoCent Industry Seminar	<p>Session 4B: Discovering extreme antennas (L10) Title: Printed Electronics Ecosystem for Future Wireless Networks, by Ilkka Käsälä / Nokia Seminar</p> <p>Title: 7th PrintoCent Industry Seminar</p> <p>Link: PrintoCent - Piloting and manufacturing printed intelligence</p> <p>PRINSE'22 in June 8–9, 2022, Oulu, Finland</p>
43	Orange	Demo Session	Hub Drones Systematic	<p>The Demo Day, organized by the Hub Drone Systematics, took place at Brétigny-sur-Orge. Four scenarios have been trialed: Support to decision making for law enforcement, Network coverage measurements and rescue of a missing person, Securing of a sport event and support to medical staff, Inspection of linear infrastructure. Orange took part in the second scenario where the Morinant enabler from 5G!Drones, a platform for data collection, has been presented. This platform aims to combine UE performance KPIs (e.g. RSRP, attached cell, etc.) and network KPIs (e.g. overall number of connected UEs, traffic load, etc.) and to visualize them in real-time. It consists of an Android app installed on a smartphone embedded on a drone, and a web interface. The trials were followed by a sharing session which have highlighted the need to better evaluate aerial connectivity and propose models for pre-flight coverage estimation, to minimize risks and predict QoS along the drone trajectory.</p> <p>This Demo Day was a great success, with more than a hundred guests from industry, civil aviation, academy and public institutions. The press was invited too and has been very impressed by the quality and wide variety of addressed topics.</p>

44	Orange Poland	Conference Paper Presentation	AIAI 2022/5G-PINE, 17 June 2022	Lechosław Tomaszewski and Robert Kołakowski, Orange Poland and 5G!Drones partner, presented the paper “Application of Mobile Networks (5G and Beyond) in Precision Agriculture” on 17 th of June at AIAI 2022/5G-PINE, session 14. More information available at https://ifipaiai.org/2022/program/ and at https://link.springer.com/chapter/10.1007/978-3-031-08341-9_7 .
45	robots.expert	Presentation	the Interpol Drone Expert summit in Oslo 24 June 2022	5G!Drones partner Gokul Srinivasan (robots.expert) took place and presented 5G!Drones and its upcoming trials during the Interpol Drone Expert summit in Oslo. You may learn more about the event here: https://www.interpol.int/News-and-Events/News/2022/INTERPOL-convenes-global-summit-on-the-use-of-drones
46	Harilaos Koumaras/ NCSR Demokritos	Presentation	57 th Summer School, NCSR campus, 11-15 July 2022, Aghia Paraskevi, Greece	Dr. Harilaos Koumaras (NCSR), 5G!Drones partner, participated at the NCSR 57 th Summer School on 12 th July 2022, discussing and presenting the findings and the lessons learnt from 5G!Drones project.
47	Harilaos Koumaras/ NCSR Demokritos	Presentation	12 th Infocom Mobile Connected “Smartverse: Pushing the boundaries of connectivity”, 12 July 2022 (online), Greece	Dr. Harilaos Koumaras (NCSR), 5G!Drones partner, participated at 12 th Infocom Mobile Connected “Smartverse: Pushing the boundaries of connectivity”, 12 th July 2022, discussing the 5G openness aspects and programmability findings of the 5G!Drones project.
48	EURECOM	Conference Paper	LCN 2022, 47 th Annual IEEE Conference on Local Computer Networks, Edmonton, Canada, 26-28 September 2022	Mohamed Mekki, Nassima Toumi, Adlen Ksentini, Benchmarking on Microservices Configurations and the Impact on the Performance in Cloud Native Environments, LCN 2022, 47 th Annual IEEE Conference on Local Computer Networks, Edmonton, Canada, 26-28 September 2022 Data set also available at https://zenodo.org/record/6907619#.YuqHaBxBxD-DOI: 10.5281/zenodo.6907619
49	5G!Drones Partners	Trials	Aalto University	On Thursday 18 August 2022, 5G!Drones project partners conducted final trials at Aalto University in the following scenarios: UC1Sc1 UTM, UC1Sc3 Logistics, UC3Sc2 IoT sensing. Involved partners: Aalto University, CAFA Tech, Involi, Frequentis, DroneRadar, RobotsExpert.

50	5G!Drones Partners	Trials	Oulu University	5G!Drones project performed the final trials of Oulu platform and showcased its findings at the University of Oulu campus (22-26 August 2022). Use cases tested: UC1Sc1, UC1Sc2, UC2Sc2, UC3SC1 UC3Sc3. Involved partners: University of Oulu, CAFA Tech, Alerion, Hepta and FLA. More information coming soon.
51	Y. Dang, C. Benzaid, B. Yang, T. Taleb, and Y. Shen	Journal Paper	IEEE IoT journal	Y. Dang, C. Benzaid, B. Yang, T. Taleb, and Y. Shen, "Deep Ensemble Learning based GPS Spoofing Detection for Cellular-Connected UAVs," in IEEE IoT (to appear)
52	H. Hellaoui, B. Yang, T. Taleb, and J. Manner	Conference Paper	IEEE Globecom'22	H. Hellaoui, B. Yang, T. Taleb, and J. Manner, "Ahead-Me Coverage (AMC): On Maintaining Enhanced Mobile Network Coverage for UAVs," in Proc. of IEEE Globecom'22, Rio De Janeiro, Brazil, Dec. 2022.
53	H. Hellaoui, B. Yang, T. Taleb, and J. Manner	Conference Paper	IEEE Globecom'22	H. Hellaoui, B. Yang, T. Taleb, and J. Manner, "Seamless Replacement of UAV-BSs Providing Connectivity to the IoT," in Proc. of IEEE Globecom'22, Rio De Janeiro, Brazil, Dec. 2022.
54	EURECOM	Conference Paper	Globecom 2022	Availability and latency aware deployment of Cloud native edge slices
55	EURECOM	Conference Paper	IEEE Globecom'22	On using deep reinforcement learning to reduce uplink latency for URLLC services
56	EURECOM	Demo	ACM MobiHoc 2022	
57	RXB, UO, FRQ, NCSRD, EUR, AU, THA, CAF	Webinar	5G!Drones online open webinar, November 25 th , 2022	5G!Drones project held an open invitation webinar about the project's main results and key takeaways.

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:

This Reporting Period was the last period of the project and all main activities aimed at enabling and steering the project towards its conclusion. The major checkpoints were achievement of project Milestones MS5 and MS6. There was one amendment, AMD-857031-33, which collection was already initiated in the previous reporting period. The amendment itself was prepared and submitted during this Reporting Period. One non-mitigable risk realised during the period, UMS UC2Sc2 withdrawal from trials and the deviation is reported in Annex I of this document. The project had its first physical face-to-face meeting in October, which was organised as a hybrid event at the Municipality of Egaleo, Greece to facilitate finalisation of project activities.

Significant results

The significant results of the period are MS5 and MS6 completion and submitting the final deliverables of the project. These activities finalise the 5G!Drones project. Activities towards Period 2 reporting have started.

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

The Amendment AMD-857031-33 has been completed and accepted by the Commission updating the DoA. UMS UC2Sc2 deviation has been documented, along with the reasons for the deviation and impact to UMS and to the project itself. The Milestone MS5 was completed behind schedule and its reasons and alternative accomplishment have been reported in Section 4.1.

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

All critical objectives have been reached and the reasons for delays have been reported.

8.6.2. Task 6.1 Administrative, financial and contractual management (M1-M42) [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 prepared, negotiated, compiled, and submitted the Amendment AMD-857031-33, which was accepted by the Commission. During Q14, UO coordinated, prepared, and edited D6.6 deliverable and provided initial instructions for the preparation of Period 2 reports. UO also prepared the agenda and led the hybrid face-to-face meeting at Municipality of Egaleo, Greece in October.

Deviation and corrective action:

The Amendment addresses deviations to DoA.

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 supported UMS in addressing its deviation to DoA on dropping its participation to UC2Sc2. UO participated in the discussions to successfully complete MS5. UO coordinated, prepared, and edited D6.6 deliverable and provided initial instructions for the preparation of Period 2 reports that contain risk and quality management related topics.

Deviation and proposed corrective action:

UMS experienced a realised risk in not being able to participate in UC2Sc2. Detailed deviation to DoA will be reported in Period 2 report. It is also included as Annex I (Section 10) of this deliverable.

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 Q13 and Q14. 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 also involved on the achievement of MS5 through its participation to the organisation of the large-scale events.

8.6.5. Task 6.4 5G facility relationship management (M1-M42) [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:

The task activities during Q13 were focused on the homogenisation of the data visualisation from the different platforms in order to be the same depiction and comparison of the data possible. Towards this the necessary interoperability middleware was provided by NCSRD in order to facilitate the data extraction by each platform and intro to the relevant data visualisation module.

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 conducted many coordination activities in coordination of the interactions between UO and AU facilities for successful trials. UO had no activity on the Task during Q14.

2-THA had no activity on the Task during Q13 and Q14.

6-NCSRD developed and provided a middleware that facilitates the data extraction and import from the different platforms to the 5G!Drones database and visualisation module. Additionally within Q14 NCSR D provided support to partners so as to upload the data and create common visualisation dashboards that allow the KPI comparison among the execution of the various use-cases across the 5G platforms and testbeds.

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

19-MOE: During Q13 and Q14, MOE contributed to the 5G licensing in Athen's platform and provision of frequencies for test use, which allowed the execution of the trials in Egaleo municipal stadium "Stavros Mavrothalasitis" at 5 to 9 September 2022.

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

During the Reported Period (M37 – M42), 5G!Drones has continued to follow-up activities at 5G-PPP Programme level and contribute upon specific needs/demands. 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, is hereafter reminded (see Table 8) Notwithstanding 5G PPP SB & TB it shows appointed 5G!Drones representatives as per WG of interest.

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

5G-PPP SB	5G-PPP	Jussi Haapola	jussi.haapola@oulu.fi
5G-PPP TB	5G-PPP	Pascal Bisson	pascal.bisson@thalesgroup.com
SME WG / NetworkEurope		Vaios KOUMARAS	vkoumaras@infolysis.gr
SEC WG	5G-IA	Pascal Bisson Tanel Järvet	tanel.jarvet@cafatech.com pascal.bisson@thalesgroup.com (co-chair of 5G IA SEC WG)
ARCH WG	5G-PPP	Pascal Bisson Farid Benbadis	Pascal.bisson@thalesgroup.com farid.benbadis@thalesgroup.com
Pre-standards WG	5G-IA	Serge Delmas	serge.delmas@airbus.com
SOFT NET	5G-PPP	Gregor Mogeritsch	Gregor.MOGERITSCH@frequentis.com
NET WMG & QOS			WG stopped
Spectrum	5G-IA		NA
Vision & societal Challenges	5G-IA	Farid Benbadis Pascal Bisson	Farid.benbadis@thalesgroup.com pascal.bisson@thalesgroup.com
Trials WG	5G-IA	Gokul Srinivasan (discontinued 10/2022)	gokul.srinivasan@robots.expert
5G-CAM	5G-PPP	Tanel Järvet	tanel.jarvet@cafatech.com
IMT 2020 Evaluation Group		Fotis Lazarakis	flaz@iit.demokritos.gr
Test, measurement & KPIs validation	5G-PPP	Ilkka Käsälä (discontinued 1/2022) Gokul Srinivasan (discontinued 10/2022)	Ilkka.kansala@nokia.com KPI Champion: gokul.srinivasan@robots.expert

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

9.1. 5G-PPP Steering Board

Activity name	5G-PPP SB
Main interface	Jussi Haapola (UO)
Activities	The overall management of the 5G-PPP and cross-project co-operation
5G!Drones contributions	- UO participated in 5G-I SB telco on July 20 th , 2022.

	<ul style="list-style-type: none"> - UO participated in 5G-I SB physical meeting in Athens, Greece on October 5th, 2022. - UO participated in 5G-I SB telco on November 23rd, 2022 - UO has been disseminating 5G-PPP announcements to the project and encouraged participation throughout the reporting period.
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9.2. 5G-PPP Technology Board

Activity name	5G-PPP TB
Main interface	Farid Benbadis (TM) & Pascal Bisson (TMD) (THA)
Activities	Overlooking the aspects related to the technology work of the projects and respective implementation of the initiative.
5G!Drones contributions	<ul style="list-style-type: none"> • THA did follow 5G PPP TB activities through meeting organized (02/06,16/06,08/09,22/09,27/10,17/11). Apart from virtual meetings attended • THA did also join the physical meeting organized on October 6th in Athens. • THA did continuously work on the demands issued by 5G-TB in order to have them shared at project level and get handled when of concerns. As for activities conducted, they have been directly linked those 5G TB demands ranging from Whitepapers, to reference figures going through heritage figure and key achievements reporting.

9.3. SME WG

Activity name	SME WG/NetworldEurope (former NetWorld2020)
Main interface	Vaios Koumaras (INF)
Activities	The SME Working Group represents the NetWorld2020/NetworldEurope SME community, and provides the networking place for the NetWorld2020 SME community related to EC and 5G-PPP research projects and activities.
5G!Drones contributions	<ul style="list-style-type: none"> - No core dissemination activities or events during this period. - A remote GA meeting took place at the end of September which was attended by INF representing 5G!Drones. - Upcoming actions and interactions with 6G-IA and SNS upcoming calls were discussed and suggestions were made. - INF participated with contributions for the upcoming SMEs brochure and "Find your SME" webpage content update.

9.4. 5G-PPP cooperation on 5G security

Activity name	5G-PPP SEC
Main interface	Tanel Järvet (CAF), Pascal Bisson (THA) as co-chair of 5G IA SEC WG
Activities	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)
5G!Drones contributions	<ul style="list-style-type: none"> • Participation to 5G IA SEC WG meetings held on June (27/06) and September (20/09). • Work on specific needs/demands issued by 5G IA SEC WG (e.g., review of short whitepapers drafted, contribution of research topics for SRIA (Security Chapter) update since in the context of 6G SNS.

9.5. 5G Architecture WG

Activity name	5G-PPP Architecture WG
Main interface	WG monitored by THA Acting Farid Benbadis (TM) with support from Pascal Bisson (TMD)
Activities	Follow up evolvement of overall 5G architecture and contribute
5G!Drones contributions	<ul style="list-style-type: none"> • Monitoring of activities performed by WG. • 5GDrones deliverable on final Architecture shared with the Group. • 5GENESIS & 5GEVE point of contact within 5GDrones did also follow & contribute since also concerned by activities led by the Arch WG.

9.6. Pre-Standardization WG

Activity name	Pre-standards WG
Main interface	Serge Delmas (AIR)
Activities	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)
5G!Drones contributions	During this period 5G!Drones project has contributed to 2022 Q2 and Q3 SDO Impact report. As they include some members from 3GPP RAN#2, 5G!Drones representatives have also participated to 3GPP RAN plenary debrief sessions organised in this working group.

9.7. Software Networks WG

Activity name	Software Networks WG
Main interface	Gregor Mogeritsch (FRQ)
Activities	As defined by Software Networks WG chairs
5G!Drones contributions	FRQ did not perform any activity during the reporting period.

9.8. Vision and societal challenges WG

Activity name	Vision & societal Challenges WG
Main interface	Acting TM/TMD (Farid Benbadis / Pascal Bisson) (THA)
WG activities	As defined by Vision and Societal challenges WG chairs
5G!Drones contributions	Most of the work performed was devoted to monitor activities of the WG and contribute to further develop the Vision (towards 5G & Beyond also 6G) and to further/better stress some of the Societal Challenges for which 5G!Drones had things to say based on what was done/learned.

9.9. Trials WG

Activity name	Trials Working Group
Main interface	Gokul Srinivasan (RXB)
Group activities	As defined by Trials WG chairs
5G!Drones contributions	There was no activity on this WG during the Reporting Period.

9.10. 5G-CAM WG (previously Automotive WG)

Activity name	5G-CAM WG
Main interface	Tanel Järvelä (CAF)
Activities	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 5G-CAM 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).
5G!Drones contributions	CAF has participated in 5G-CAM bi-weekly meetings and provided inputs to the discussions regarding the use of cellular drones that are controlled over mobile communications. Especially during cross-border flights, where the long waiting time for roaming to start can endanger cellular drone control.

9.11. IMT 2020 Evaluation WG

Activity name	IMT 2020 Evaluation WG
Main interface	Fotis Lazarakis (NCSR)
Activities	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.
5G!Drones contributions	No activity during the reporting period.

9.12. Test, measurement & KPIs validation

Activity name	5G PPP Test, Measurement and KPIs Validation Working Group
Main interface	Gokul Srinivasan (RXB) (RXB discontinued from 10/2022) and Ilkka Käsälä (NOK) (NOK discontinued from 1/2022)
Activities	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.
5G!Drones contributions	No activity during the reporting period.

10. ANNEX I – UMS WITHDRAWAL OF UC2SC2

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10.1. PREFACE

On 13th July 2022 UMS officially declared to be not in the position of carrying out the UC2Sc2 trial at EURECOM's 5G-EVE trial facility. This document is intended to provide the proper justifications highlighting UMS full commitment to the project, the efforts put to achieve the forecasted objectives and the good faith characterising our choices.

10.2. UMS ROLE IN THE PROJECT

The following tables help to show the overall effort of UMS in each WP and in each deliverable of the project explaining the role covered:

Work Package	Effort (PM)	UML Role
WP1	11	UMS used its business and technological expertise to define the target use-cases. It worked in collaboration with the project partners to identify the requirements of application performance and define the vertical service level KPIs.
WP2	12	UMS provided the necessary software layer that will enable the execution and control of trials on top of the ICT-17 5G facilities. UMS will also assist in developing the tools and APIs which will generate automatic tests for the use cases.
WP3	22	UMS assisted the 5G facilities in understanding the mechanisms identified in T1.3 which were necessary for the support of the use cases defined in T1.2.
WP4	30.5	UMS is leading WP4. UMS provided the software integration of the 5G!Drones trial controller and 5G!Drones enablers along with deploying the 5G!Drones software components on top of the selected facilities. UMS also designed the functional tests for the validation of the 5G!Drones architecture and integrated and tested the UAV hardware with respect to the ICT-17 facilities.
WP5	6.5	UMS will communicate the outcome of the project via public outreach activities (its own social media channels, 5G!Drones website, conferences, exhibitions, etc.). It will also disseminate the results to its industrial partners while showcasing the capabilities of 5G-enabled drones at global events.

WP	Del.	Name	UML Role	Status
WP 1	D1.1	Use case specifications and requirements	Leader	Done
	D1.2	Initial description of the 5G trial facilities	None	Done
	D1.3	5G!Drones system architecture initial design	Contributor	Done
	D1.4	Report on UAV business and regulatory ecosystem and the role of 5G	Contributor	Done
	D1.5	Description of the 5G trial facilities and use case mapping	Contributor	Done
	D1.6	5G!Drones system architecture refined design	Contributor	Done
	D1.7	Final report on UAV business and regulatory ecosystem and the role of 5G	Contributor	Done

WP 2	D2.1	Initial definition of the trial controller architecture, mechanisms, and APIs	Contributor	Done
	D2.2	Initial implementation of the trial controller	Contributor	Done
	D2.3	Report on algorithms, mechanisms and tools for data analysis and visualisation	Contributor	Done
	D2.4	Definition of the trial controller architecture, mechanisms, and APIs	Contributor	Done
	D2.5	Trial controller software final release	Reviewer	Done
WP 3	D3.1	Report on infrastructure level enablers for 5G!Drones	Contributor	Done
	D3.2	Report on vertical service-level enablers for 5G!Drones	Contributor	Done
	D3.3	5G!Drones Enablers Software Suite	Contributor	Done
	D3.4	UAV use case service components	Contributor	Done with delay
WP 4	D4.1	Integration plan	Contributor	Done
	D4.2	Integration status and updated integration plan	Contributor	Done
	D4.3	Trial plan	Contributor	Done
	D4.4	Trial evaluation report	Contributor	Done
WP 5	D5.1	Communication, showcasing, dissemination and exploitation plan and standardization roadmap	Contributor	Done
	D5.2	Report on communication, showcasing, dissemination and exploitation achievements and plan for the second term of the project	Contributor	Done
	D5.5	Final report on communication, showcasing, dissemination and exploitation	Contributor	Done
	D5.6	Report on activities related to commercial exploitation and partnership development	Contributor	Done
	D6.2	Annual report, year 1	Contributor	Done
	D6.3	Mid-term review report	Contributor	Done
	D6.4	Annual report, year 2	Contributor	Done
	D6.5	Annual report, year 3	Contributor	Done
	D6.6	Final project report	Contributor	Done

10.3. UC2SC2 DELIVERY OBJECTIVES

In the document D1.1 consortium agreed that the purpose of Use Case 2 Scenario 2 was to **demonstrate how UAVs can help first response teams during disaster situations** such as fires, earthquakes, flooding, etc. through 5G network capabilities. This scenario was mainly focused on **real-time video streaming between the UAV and UAS application on the edge**. The scenario was intended to provide a benchmark insight on both the network and UAV KPIs for disaster recovery situations via a scalable and extendible architecture for both autonomous UAV swarm control and communications.

10.4. MAIN REASONS FOR UNMANNED LIFE WITHDRAWAL

The main reason for UMS withdrawal from the UC2Sc2 is **technical**: UMS systems could not work effectively in EUR facility due to inefficient integration of the functional components.

10.4.1. PREAMBLE TO THE EXPLANATION

From its entry into the project, UMS developed the activities related to the UC2Sc2 in accordance with what has been reported in the document D4.3, Chapter 3.9 (Schedule for preparations, technical tests, execution, and conclusions), page 86, table 22, as shown in yellow below:

Date	Topic	Description	Responsible
D-60	Deciding when to conduct a physical trial	The decision is made for each scenario separately.	Participating partners
D-50	5G Network parameters	Frequencies for 5G and IoT, then partners can adapt relevant 5G modem.	Facility owner
D-35	Deciding when to conduct remote tests	Parameters for CAFA Tech, then CAFA Tech can choose relevant IoT sensors.	Participating partners
D-30	5G Network coverage and DL/UL in main Testing area and in Reserve area	To choose locations for trials (Main testing area and Reserve area).	Facility owner
D-30	Notification about Specific category flight	Notification to the local CAA to conduct Specific category flights.	Drone operator
D-30	Apply for permission to add 5G UE onboard a drone	Permission from Finnish Traficom (Finnish Radio Communication)	Drone operator

		Authority) to add 5G UE onboard a drone.	
D-28 until D-7	Technical tests	Technical tests and final preparations. 5G network coverage measurements in Main area and in Reserved area.	Participating partners
D-5	Rehearsals	Rehearsals will be conducted remotely. Rehearsals include all steps of field tests.	Participating partners

In addition to this UMS made all the possible efforts to respect the Grant Agreement and the D1.5 document (Description of the 5G trial facilities and use-case mapping) approved on 22nd May 2020, before the entry of UMS into the project (29th April 2021), aware of the fact that, as WP4 leader, it could count also on the support of the facility owner, the Task Leaders and of the PMT both to monitor and to efficiently implement the project activities.

10.4.2. JUSTIFICATIONS FOR RISK MANAGEMENT

In the following section justifications for the following fact:

“UMS has apparently not addressed the risk on time and in the way to take some contingencies, trying something else or opting for another facility”

are provided trying to give context to the description.

UMS conducted remote feasibility tests for UC2Sc2 via the simulation platform on the 5G-EVE architecture in June 2021, according to some previous commitments of EUR. UL-ACE was hosted at EUR premises while other modules were running at the UMS lab in Belgium.

UL-ACEs were connected to 5G-enabled smartphones provided by EUR. Vehicle to Vehicle (V2V) communication over EUR's MEC infrastructure and the communication to our central control platform when running it on our server in Belgium were tested successfully.

However, during the preparation for these tests, UMS identified certain unique preferences for deploying all our modules on EUR's MEC infrastructure. As UMS recent deployments on other MEC infrastructures in 5G!Drones and other commercial solutions used a different setup, UMS observed that the modules were not directly deployable in their current format and that certain adaptations were necessary to accommodate this.

On the 24th of September 2021 UMS internally identified the integration issues generating the withdrawal; during the monthly PMT meeting of 11th October 2021, issues to use EUR MEC infrastructure were traced on the meeting minutes. The risk of having a diverse integration architecture across the different use cases in the project was early identified and captured in the consortium risk register also putting some notes in red nearby; on the purpose Nemish Mehta (UMS) asked DRR, T4.1 leader, some elements to address the question properly.

After discussions with EUR, the reason for this was found to be a difference in the deployment mechanism on the 5G-EVE infrastructure.

On November 2021 EUR openly declared to UMS their availability to provide a Virtual Machine to solve the problems but with no GPU support, which was required by UMS because of the video analysis useful to the video streaming. In this period the risk was inserted by UMS as moderate in the Risk Identification and management table.

As a Robotics company, UMS uses Robot Operating System (ROS) and DDS framework for building its applications. We required to EUR all the agents to be in the same network and this is the reason for us to make use of an internal-tunnel in all external deployments.

5G-EVE does not give privileged rights (admin) for any vertical user, including our application to access tun/tap interface. This turned out to be a bottleneck as UMS was unable to deploy its application without getting access to the MEC infrastructure during deployment.

Due to security reasons on EUR side, it was not possible to use a VPN or access our application via SSH. All the access to 5G EVE ICT infrastructure have to pass through a Web portal 1. UMS system required necessarily a VPN access to manage a remote device connected to the mobile network. This kind of VPN access could not be granted. So it was not possible to proceed with the physical trial.

On December 2021 new physical trials have been executed in EUR facilities, where UMS tried some new configurations (also on EUR infrastructure side) but with no positive results. The communication issues within the UMS application and the drone were persisting because the 2 agents are not on the same cluster.

EUR's availability to provide a virtual machine to solve the integration issues has also been registered, as we can read in the following PMT meeting minutes of the 28th of January 2022. However, the issues could not be solved without the use of a VPN, which EUR never accepted to use; in this sense, the last refusal from EUR was given by email on 10th May 2022 to Nacho Conde Sanchez. In that circumstance, Adlen Ksentini encouraged UMS **to check with other facilities**.

Meanwhile, UMS left the status of the risk in the Risk Identification and management table as moderate since we were involved in another important trial (UC4Sc1, Athens) where it was possible to cover most of the results expected in the Eurecom trial. So, after some internal discussions, we agreed to drop the trial.

To summarize all the efforts carried out by UMS to achieve the objective of the UC2Sc2 we listed some relevant R&D activities we have developed to adapt the core application to the EUR infrastructure:

- 6th July 2021: Integrate Zenoh, a wrapper as a bridge between DDS and a router. The option was discarded due to the non-maturity of the technology.
- 11th March 2022: Exploration of FastDDS with DDS router and discovery server. Same success as Zenoh.
- 5th May 2022: We propose a tunnel solution (wireguard) or configure routing between devices and app.
- 5th - 9th May 2022: Test and deploy our tunnel solution (wireguard) into the public cloud (AWS or Azure) and in the private cloud.

10.5. IMPACT OF THE WITHDRAWAL

10.5.1. IMPACT ON OTHER PARTNERS

The sources used for this analysis have been the following official documents:

D1.1 Use case requirements (page 71);

D4.3 Trial Plan (page 93);

Grant Agreement in its latest version.

Among the above-mentioned documents, on page 94 of the D4.3 we can find the following list with all the involved providers of the UC2Sc2 trial:

Trial Components:

1. UAV Components: 2 × DJI M600 Pro, Video Streaming Camera, Wi-Fi Access Point, 5G Smartphones (with USB tethering). Providers: HEP, UMS, EUR
2. UAV Operator Components: UL-ACE, UL-CCP, UL-VA. Providers: UMS
3. UTM Components: Support for dFPL (drone Flight Plan), Situational awareness (airspace perspective) service to submit dFPL. Provider, U-space telemetry endpoint. Providers: FRQ, DRR
4. 5G Components: 5G Network, MEC Infrastructure. Provider: EUR
5. Other Components: 3020 LifeX Solution. Provider: FRQ

Since HEP and DRR were only involved as providers in the trial (for a drone and UTM components), we came to the point that our withdrawal could impact only the following partner: **FRQ**

In fact, in the D4.3 we can read that:

"In the context of UC2Sc2, Frequentis will be performing a standalone proof-of-concept activity to validate their technology".

However, UMS collaborated with FRQ in the recent Athens UC4Sc1 trial, where we allowed them to validate externally hosted services such as UTM, so we are sure that even this potential impact can be overlooked.

10.5.2. IMPACT ON THE DELIVERY OF THE RESULTS OF EURECOM TRIAL

Considering what we have recalled as trial delivery objectives in the first section of this document, UMS withdrawal from the UC2Sc2 will have negligible impact on the forecasted results, above all thanks to our efforts in mitigating this event and to our commitment towards the further trial where UMS has been involved in Athens, the UC4Sc1 (Connectivity extension and offloading during crowded events).

The purpose of our activity in UC4Sc1 was to demonstrate how UAVs through 5G network capabilities can improve connectivity services in a highly crowded environment, e.g. during large events. The solution capabilities included autonomous flight planning and navigation, live-video streaming, utilising 5G User Equipment (UE) to provide ad-hoc connectivity to people, and analysis of the accumulated data to provide real-time AI-augmented insights to assist in decision-making. Many of these capabilities are common to the two use cases we were in charge.

After the Athens trial **we can confirm that the following applications**, as forecasted in the Trial Plan (D4.3) on table 14, page 77, **have been deployed successfully**:

- C2 application/Unmanned Life Central Command Platform (UL-CCP) software;
- Unmanned Life Video analytics (UL-VA).

In addition to this we have demonstrated successfully that 5G network can:

- enhance our UAVs capabilities in people detection in crowded events (like the ones during disaster recovery);
- Improve autonomous flight planning and navigation;
- Allow effective live-video streaming and the possibility of analysing the accumulated data to support a fast decision-making process.

The last points will be widely justified in the KPIs document D4.4 which is going to be developed.