"5G for Drone-based Vertical Applications"

D6.4 – Annual report, year 2

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Approvals

	Name	Organization	Date
Coordinator	Jussi Haapola	UO	31.05.2021
Technical Committee	Farid Benbadis	THA	25.05.2021
Management Committee	Project Management Team and NCSRD	FRQ, AU, THA, UMS, AIR, UO, NCSRD	25.05.2021

Document History

Version	Contribution	Authors	Date
V1	**Document creation**	**Jussi Haapola (UO)**	**06.05.2021**
V2	**Integration of Quarterly Management Reports QMR#7 and QMR#8, overall introduction, resourcing, gender balance, etc.**	**Jussi Haapola (UO), All Beneficiaries**	**21.05.2021**
V3	**Revision based on PMT and TM review**	**Harilaos Koumaras (NCSRD), Hamed Hellaoui (AU), Farid Benbadis (THA), Jussi Haapola (UO)**	**26.05.2021**
V4	**Finalisation of the Deliverable**	**Jussi Haapola (UO)**	**31.05.2021**

Executive Summary

The aim of this Annual report, year 2, the 5G!Drones Deliverable 6.4, is to deliver the progress of 5G!Drones, as achieved during the months M19 – M24 of the project (December 1st, 2020 – May 31st, 2021). The deliverable describes the overall activities of the project between M19 and M24 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. It is noteworthy that there are no specific Milestones for the project during this period.

The report addresses the main achievements of the project between December 2020 and May 2021 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, while communication, showcasing, dissemination, and exploitation achievements of the Period 1 (M1-M24) of the project and plan for the second term of the project are reported in detail in Deliverable D5.2. 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 M19 to M24 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 and D6.3, which covered the periods M1 – M12 and M13 – M18, 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
10	UMS	UNMANNED SYSTEMS LIMITED	United Kingdom
11	INF	INFOLYSIS P.C.	Greece
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	Finland
13	RXB	ROBOTS EXPERT FINLAND Ltd	Finland
14	EUR	EURECOM	France
15	DRR	DRONERADAR Sp z o.o.	Poland
16	CAF	CAFA TECH OÜ	Estonia
17	FRQ	FREQUENTIS AG	Austria
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	Poland
19	MOE	MUNICIPALITY OF EGALEO	Greece
20	ORA	ORANGE SA	France

List of Abbreviations and Definitions

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

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

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

Definitions:

Quarter #7: The period of the implementation of the action between December 1st, 2020 and February 28th, 2021 (M19 – M21).

Quarter #8: The period of the implementation of the action between March 1st, 2021 and May 31st, 2021 (M22 – M24).

Reporting Period: Implementation of action from December 1st, 2020 to May 31st, 2021 (M19 – M24).

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

1.1. Main achievements

The main achievements of the project for the Reporting Period are described as follows:

A remote feasibility test was conducted in EUR's facilities in December 2020, where communications between several modules hosted on the Multi-access Edge Computing (MEC) server in EUR were tested with remote flights conducted in Tallinn.

The project had a virtual Face-to-Face meeting at the beginning of February 2021, where a number of items important for project outputs, such as open-source software, licensing, open data sets, and showcasing events were discussed. Project internally, various integration aspects were identified and action plans were started. A document has also been created to map out the trial activities in 2021 and work has also been initiated to align on the various Key Performance Indicator (KPI) measurement tools and methodologies currently used in the different trial facilities.

The project finalised the revision of the overall system architecture. Several changes related to the initial architecture have been performed and documented in Deliverable D1.6, which submission at the end of May also marks the ending of WP1 Task 1.4. WP2 has focused on the implementation work during the Reporting Period. The work covers the four tasks: Web Portals for Task 2.1, Life-Cycle Manager (LCM) and Trial Validator for Task 2.2, Trial Enforcement for Task 2.3, and U-Space adapter and KPI component for Task 2.4. This Reporting Period has also seen more synergy between the four tasks to efficiently develop and integrate the different modules, e.g., integration of Web Portal1 with the repositories, initial integration of LCM with the repositories, as well as the trial validator with the repositories. The implementation work has been recorded in WP2 releasing three Deliverables: D2.2, D2.3, and D2.4 at the end part of the Reporting Period.

WP3 also focused on development of the trial enablers. Slicing work is advancing with testing of slice management at various facilities and finalization of end-to-end network slicing at the 5GEVE facility. MEC work has progressed well with all facilities having finalised a solution and now moving to hosting the required Use Case applications on them. The Task 3.3 efforts were mainly focused on the alignment of the interfaces and implementations provided by the facility owners and on the development of the facilities' parsers. Special care was also taken to explain the different interfaces and mechanisms exposed by the Abstraction Layer to the Trial Controller. A lot of work has been put on UAV enablers development and the work is advancing well. Task 3.4 maintains a list all the UAV enablers, their current status and the expected release dates.

WP4 has focused on setting out the integration plan for the WP2 modules and WP3 enablers. A further focus has been on getting visibility of the low-level interactions between the various entities involved in the Use Case scenarios (Experimenter, Trial Controller, 5G Facility, UTM provider, UAV Operator). Work has also been done to align on the various KPI measurement tools and methodologies currently

used in the different trial facilities. Significant work has been done on preparing the Deliverables D4.2 and D4.3 that are due in July, 2021.

In addition to the above, testing was conducted by UMS in collaboration with NCSRD, COS and other relevant partners on the simulation testbed that was created by UMS within T3.4. The WP5 has kept is course despite the Covid-19 pandemic situation with high level of activity. The Deliverable D5.2 was finalised and published in time. Significant steps towards the broad range dissemination were undertaken, since in June 2021 the project will be presented at EuCNC 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. There were articles published at major journals, disseminating and communicating the project activities' progress were performed, and established standardisation activities were progressing. An exploitation strategy was set and the Beneficiaries identified a list of exploitable outcomes from their research work.

The Reporting Period included the submission of six project Deliverables:

- D1.6 – 5G!Drones system architecture refined design (M24; R; PU; NSCRD),
- D2.2 – Initial implementation of the trial controller (M23; O; CO; INV),
- D2.3 – Report on algorithms, mechanisms and tools for data analysis and visualisation (M24; R; PU; FRQ),
- D2.4 – Definition of the trial controller architecture, mechanisms, and APIs (M24; R; PU; EUR),
- D5.2 – Report on communication, showcasing, dissemination and exploitation achievements and plan for the second term of the project (M23; R; PU; RXB), and
- D6.4 – Annual report, year 2 (M24; R; PU; UO).

1.1.1. Changes in the Consortium

The project had one Amendment during the Reporting Period: Amendment 4 was Commission initiated to change the list of complementary grants to 5G!Drones.

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 are 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. Significant effort has been expended despite the pandemic and the activity in the technical WPs well advancing.

Table 1: Estimated Resource Use in PMs between M19 and M24

Reporting Period M19 - M24			Reported effort in PMs						
Participant No.	Part. Short name	Participant organisation name	WP1	WP2	WP3	WP4	WP5	WP6	**Total**
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	0,12	9,36	11,49	3,45	0,27	5,87	30,56
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	1,11	1,27	3,79	2,03	1,45	2,85	12,50
3	ALE	ALERION	0,46		4,12	8,08	0,82		13,48
4	INV	INVOLI SA	1,00	5,25	1,20	4,00	1,95		13,40
5	HEP	Hepta Group Airborne OÜ	-	3,52	4,61	3,75			11,88
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	3,59	6,00	1,14	4,77	0,26	0,20	15,96
7	AU	AALTO KORKEAKOULUSAATIO SR	1,00	8,91	7,27	6,14	4,17		27,49
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	0,20			2,00	2,00		4,20
9	AIR	AIRBUS DS SLC	2,00	2,60		4,40	3,00		12,00
10	UMS	UNMANNED SYSTEMS LIMITED	1,20	2,60	6,40	6,50	0,60		17,30
11	INF	INFOLYSIS P.C.	1,58	0,66		1,16	2,63		6,03
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	2,60	5,20	1,30	2,00	0,60		11,70
13	RXB	ROBOTS EXPERT FINLAND Ltd	0,15	0,65	0,01	0,84	2,95		4,60
14	EUR	EURECOM	0,20	1,90	9,00	4,59	0,79	0,41	16,89
15	DRR	DRONERADAR Sp z o.o.	0,09	2,94	1,46	4,63			9,12
16	CAF	CAFA TECH OÜ	0,80	2,80	3,39	5,20	0,10		12,29
17	FRQ	FREQUENTIS AG	0,53	3,56	1,14	3,22	0,82		9,27
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	4,17		1,82	0,80	1,00		7,79
19	MOE	MUNICIPALITY OF EGALEO	3,50	0,64	0,96	2,40	0,48	0,24	8,22
20	ORA	ORANGE SA	-	-	0,60	0,45	0,90		1,95
		Total	24,30	57,86	59,70	70,41	24,79	9,57	246,63
	No contractual effort in respective WP								

The cumulative estimated resource use since the project start (M1 – M24) is presented in Table 2.

Table 2: Estimated Cumulative Resource Use in PMs between M1 and M24

Reporting Period M1 - M24			Reported effort in PMs								
Participant No.	Part. Short name	Participant organisation name	WP1	WP2	WP3	WP4	WP5	WP6	**Total M1 - M24**	Partner Total	Parnter % from total
1 (Admin. Coordinator)	UO	OULUN YLIOPISTO	11,10	22,25	22,89	7,71	0,95	15,33	80,23	125	64 %
2 (Tech. Coordinator)	THA	THALES SIX GTS FRANCE SAS	6,40	6,85	21,85	6,51	4,90	12,55	59,06	95	62 %
3	ALE	ALERION	7,55	-	11,32	10,15	1,72	-	30,74	55	56 %
4	INV	INVOLI SA	10,90	17,45	5,85	9,30	9,25	-	52,75	69	76 %
5	HEP	Hepta Group Airborne OÜ	4,30	6,02	7,51	11,44	-	-	29,27	60	49 %
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	10,56	14,97	5,36	10,35	1,14	0,38	42,76	84	51 %
7	AU	AALTO KORKEAKOULUSAATIO SR	9,16	30,60	33,38	11,48	5,41	-	90,03	98	92 %
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	8,90	-	-	10,50	3,30	-	22,70	30	76 %
9	AIR	AIRBUS DS SLC	13,00	9,50	-	11,80	12,10	-	46,40	72,08	64 %
10	UMS	UNMANNED SYSTEMS LIMITED	8,80	9,60	12,30	15,40	1,35	-	47,45	82	58 %
11	INF	INFOLYSIS P.C.	11,30	2,27	-	2,92	9,14	-	25,63	43	60 %
12	NOK	NOKIA SOLUTIONS AND NETWORKS OY	11,88	13,37	9,69	7,61	2,00	-	44,55	86	52 %
13	RXB	ROBOTS EXPERT FINLAND Ltd	3,48	3,50	0,77	4,68	9,29	-	21,72	50	43 %
14	EUR	EURECOM	11,46	18,29	26,57	7,09	5,05	2,05	70,51	98	72 %
15	DRR	DRONERADAR Sp z o.o.	4,05	10,05	5,26	14,18	-	-	33,54	50	67 %
16	CAF	CAFA TECH OÜ	13,00	6,50	12,29	15,20	2,80	-	49,79	79	63 %
17	FRQ	FREQUENTIS AG	9,09	10,52	8,41	11,69	3,27	-	42,98	72	60 %
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	9,94	-	8,24	3,28	4,34	-	25,80	60	43 %
19	MOE	MUNICIPALITY OF EGALEO	9,00	3,52	4,84	8,64	2,46	1,14	29,60	40	74 %
20	ORA	ORANGE SA	5,20	2,20	3,00	0,75	2,40	-	13,55	20	68 %
		Total used M1 - M18	**179,07**	**187,46**	**199,53**	**180,68**	**80,87**	**31,45**	**859,06**		
		Total effort from DoA	208	246	303	408	161,08	42	1368,08		
		Percentage used from total	86 %	76 %	66 %	44 %	50 %	75 %	63 %		

Overall, the project's estimated resource use in PMs follows well the stage and the timeline of the project. There appears to be a mismatch between the AU estimated resources in terms of estimated incurred costs and estimated cumulative resource use. The estimate on incurred costs shows AU is in line with the general project resource use and AU is currently investigating its PM reporting logic.

3. DELIVERABLES

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

Table 3: Deliverables due during the reporting period

Del. #	Name of Deliverable	WP #	Lead Beneficiary	Type	Dissemination level	Contractual delivery	Actual Delivery date
D2.2	Initial implementation of the trial controller	2	INV	Other	Confidential	M23	30.04.2021
D5.2	Report on communication, showcasing, dissemination and exploitation achievements and plan for the second term of the project	5	RXB	Report	Public	M23	30.04.2021
D1.6	5G!Drones system architecture refined design	1	NCSRD	Report	Public	M24	28.05.2021
D2.3	Report on algorithms, mechanisms and tools for data analysis and visualisation	2	FRQ	Report	Public	M24	28.05.2021
D2.4	Definition of the trial controller architecture, mechanisms, and APIs	2	EUR	Report	Public	M24	28.05.2021
D6.4	Annual report, year 2	6	UO	Report	Public	M24	31.05.2021

4. MILESTONES

There were no Milestones due during the Reporting Period. Important actions were performed in all technical Work Packages as reaching Milestone MS3 is expected to be completed at M26.

5. PROJECT BODIES AND MEETINGS

5.1. General Assembly / Plenary meeting

During the Reporting Period the 5G!Drones project held one virtual Face-to-Face meeting at 3rd – 4th of February 2021 where General Assembly points were discussed and decided. Other General Assembly subjects were conducted through remote voting and consensus and preparations have been made for the next virtual Face-to-Face meeting to be held on June 1st – 2nd, 2021.

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 (29/01, 01/03, 26/03, 23/04, 28/05) over the Reporting Period where the progress towards the objectives was reviewed to further drive the project according to the work plan defined. For each of these meetings minutes were produced and uploaded on the project's workspace. It has become customary that all partners of the project may partake and contribute to PMT activities, but it is the core PMT, which drives the activities leading to General Assembly matters.

5.3. Facility Coordination Team

The ICT-17 facilities have continued to monitor the progress of their platforms, both at infrastructure level (e.g. SA deployments), as well as at regulatory level for the provision of frequencies licenses that will allow the execution of the 5G!Drones trials. Similarly, activities have been taken under consideration in the non-ICT-17 platforms. The recent Drones regulation released by EASA is monitored in order to identify potential conflicts with the planned trials.

The FCT has monitored the integration activities of the abstraction layer in WP3 and the integration activities of the various components in WP4 in order to be reassured that the 5G Facilities are conforming with the project experimentation objectives and plans. More specifically, for the ICT-17 facilities that participate in the project as a whole, supporting the experimentation with the tools and components that have been built in their own framework, it was discussed the mapping of the different functionalities between the 5G!Drones components and the ICT-17 components. From this mapping, it was identified that the U-Space components, e.g. UTMs, Web Portal1 etc. are the vertical specific components that are needed to be integrated in all the platforms, independently if they are ICT-17 or not. For the rest experimentation tools and components a complimentary approach has been considered, focusing mainly on the case of 5GENESIS, which will integrate and complement the Open5GENESIS experimentation framework with the 5GDrones U-Space components only. These activities will be properly reflected in WP4 deliverables.

5.4. External Advisory board

A second EAB meeting was held on May 27th. During this meeting, the project presented activities that have been achieved since the first meeting and the main progress that have been reached. Some of the directions of at least the future Deliverable D1.7 will be revised based on the discussions with the EAB members. Overall, the interplay between regulations, UAV ecosystem, and telecommunications operators was a topic of discussion that will influence the project's exploitation targets.

In order for the project to sign an NDA between the members of the EAB and the project partners, and in order to facilitate the process, the legal administration of the University of Oulu proposed a power of

attorney by the members of the Consortium so that it can sign the NDAs on behalf of the Consortium's members. Discussions between the legal services of the various partners took place in order to obtain a satisfactory document for all.

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
- Priit Rifk, Director 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.

IMT has submitted an IMT Report to PMT on a monthly basis and has also made presentations at virtual Face-to-Face meetings. The IMT Team consists of members from CAF, RXB, DRR, ORA, FRQ, and OPL and responsibilities described in Table 4.

Table 4: IMT topics in 2020

Topic	Responsible	Description
1. UAV Business case developments	RXB	Major drone services and developments related to 5G!Drones activities.
2. Regulation of UAV flights	CAF, ALE	Updates of EU Regulation (from January 01, 2021) and further regulation developments.
3. U-Space regulation and roll-out	FRQ	U-Space regulation updates and roll-out in EU.
4. Regulation of cellular UAV´s and interference mitigation	CAF, ORA	EU regulation to use 5G or other cellular devices onboard.
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.)	OPL	3GPP technical studies and reports regarding UAVs.

7. UAV-s with in-built cellular communication devices	CAF	Drones with cellular (incl. 5G) devices on board.
8. D2D (Drone2Drone) communication systems	DRR	Developments on the field of C-V2X, V2X, ITS etc.

6. GENDER BALANCE

The Table 5 describes the gender balance of the project in May 2021. The gender balance has not changed significantly from the previous Reporting Period to this one. The table describes not only the personnel who directly used the resources of the project but also the staff directly supporting 5G!Drones activities. As can be seen from the table the overall gender balance is 31% female, 69% male, and 0% other genders working for the project. The WP leader positions are dominated by male representation, whereas the support personnel are dominated by female representation. Overall, other project roles vary having 13% to 20% female representation.

Table 5: Gender Balance of the 5G!Drones Project at M24

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																			229
1 (Admin. Coordin	UO	OULUN YLIOPISTO	Finland		1					1	13					3			4	14	0	18
2 (Tech. Coordinat	THA	THALES SIX GTS FRANCE SAS	France		1					3	8			1		4			7	10	0	17
3	ALE	ALERION	France					1			1			1					0	3	0	3
4	INV	INVOLI SA	Switzerland				1	1		1	6			1		3	1		5	9	0	14
5	HEP	Hepta Group Airborne OÜ	Estonia								6			4		4	1		4	11	0	15
6	NCSRD	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	Greece					2			6			1					0	9	0	9
7	AU	AALTO KORKEAKOULUSAATIO SR	Finland		1			1			7			1		4	3		4	13	0	17
8	COS	COSMOTE KINITES TILEPIKOINONIES AE	Greece				1			3	6								4	6	0	10
9	AIR	AIRBUS DS SLC	France		1					2	7					5	2		7	10	0	17
10	UMS	UNMANNED SYSTEMS LIMITED	United Kingdom		1						5			1		1			1	7	0	8
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		2			1		2	7		1			1			4	10	0	14
18	OPL	ORANGE POLSKA SPOLKA AKCYJNA	Poland							1	5			1		2			3	6	0	9
19	MOE	MUNICIPALITY OF EGALEO	Greece							3	5			1		4	2		7	8	0	15
20	ORA	ORANGE SA	France					1		1	3								1	4	0	5
			Percentage	0 %	100 %	0 %	20 %	80 %	0 %	20 %	80 %	0 %	13 %	88 %	0 %	66 %	34 %	0 %	31 %	69 %	0 %	

7. PROGRESS OF TECHNICAL WORK AND ACHIEVEMENTS

This section reports on major work performed and achievements obtained for each of the 5G!Drones project objectives during the Reporting Period (M13 – M18). In order to provide context, the progress towards project objectives is recapped from Deliverables D6.2 and D6.3 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

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.

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 trail 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.
- **Infrastucture 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

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.
- **Infrastucture 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.

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

M1 – M12 (from D6.2)

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

M13 – M18 (from D6.3)

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

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

M19 – M24

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.

Objective 4 "Design and implementation of 5G!Drones enablers for UAV trials and operations": 5G!Drones will use the 5G facilities provided by i) EURECOM (5G EVE–Sophia Antipolis, France), ii) NCSR Demokritos and the Municipality of Egaleo (5GENESIS, Athens, Greece), in addition to iii) the 5GTN platform available at the University of Oulu, Finland and iv) the X-Network facility available at the Aalto University, Finland. Based on the

analysis of the target UAV use cases, 5G features of these platforms will be used, and, when deemed appropriate, additional software will be developed by the project, and additional UAV-relevant hardware will be acquired. These new components represent the 5G!Drones enablers. Particularly, 5G!Drones will focus on improving Network Slicing functionalities, as UAVs require at least two running network slices; one for command and control (type uRLLC) and one for the data plane (type eMBB or mMTC). The security of each of these network slices will be also investigated and duly addressed. Moreover, a UAV traffic management service based on virtual reality allowing control and/or supervision of multiple UAVs operating in the same area will be studied.

M1 – M12 (from D6.2)

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

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.

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

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

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

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

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).

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

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.

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

M1 – M12 (from D6.2)

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

M13 – M18 (from D6.3)

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

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

M19 – M24

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.

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:

- Work on Deliverable D1.7 in task 1.1.
- Work on and submission of deliverable D1.6 in task 1.4.
- Creation of a presentation summarizing the refined architecture.

Significant results

WP1 made presentation summarizing the refined architecture. The Deliverable D1.6 is was submitted by end of May 2021.

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

There has been no deviation from the expected contributions in WP1.

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 the Reporting Period the main focus of task 1.1 was the preparation for deliverable D1.7 - collection of information for D1.7 is performed in dedicated folders of the project repository. A draft of D1.7 is planned to be ready in M38, submission of D1.7 in M42. Information from Pre-Trials and Trials from WP4 (especially regulatory aspects and radio frequency topics from France, Finland, and Greece) shall also be collected as input for D1.7.

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.

2-THA made contributions with the results documented in the content collection for deliverable D1.7. THA also had internal discussions with another entity regarding the regulatory ecosystem and its integration in the project.

3-ALE made contributions with the results documented in the content collection for deliverable D1.7.

4-INV: For defining the Operational Flights Plans and adding UAV to the local repositories in Web Portal 1 INV had to read and adopt to the European Implementing Regulation. In their design, INV is following the EU regulation documents 947 and 945 with their annexes. In December INV was participating in the Amsterdam Drone Week through virtual platform. During Quarter #8 INV has been observing the news and legislation, which can impact the company and 5G!Drones project activities. Document "Draft U-Space Regulation" (+ annexes) was used to design Web Portal Operational Flight Planning requirements. INV also participated to Polish webinar about SORA risk analysis, organised by PAŻP (Polish Air Navigation Services Agency). Recently, INV has received information about modification of the forbidden fly zones in France, in the location of our UC1Sc1 test in EURECOM (see deviations below).

Deviation and proposed corrective action:
New fly restriction zone defined for the main area of tests in EUR. ALE is checking for solutions – what will be required to get the permission to fly.

5-HEP does not participate in this Task.

6-NCSRD has contributed in the definition of the use-cases and the identification of the added-value of 5G on the use-cases, by proposing specific KPIs that could be considered and assessed during the

execution of the trials, such as energy efficiency, piloting agility, autonomous capabilities. Etc. Regulatory aspects have been also contributed by NCSRD in relevance to the Athens trials, considering the radio/frequency licenses and the flight zones. 3GPP architectural consideration in Rel. 17 and SA6, as well as vertical enablers are also considered. This material will be reported in D1.7. NCSRD, together with the Athens scenario partners, have defined two pre-trials, one based on the UMS emulated/simulated drone platform, which has been successfully integrated in Athens 5G platform, allowing to proceed with the experimentation despite the Covid-19 restrictions, and a second one pre-trial that will take place physically at the end of June in Athens 5G platform, utilising the NOKIA MEC solution that has been recently enabled and properly configured in Athens platform. The trials focus on assessing the business importance of the edge computing in the responsiveness KPI of the Drones use-cases. This material will also be reported in D1.7

7-AU is following business and regulatory aspects related to the scenario led by AU (UAV-based IoT data collection). The inputs will be reflected in the deliverable D1.7.

8-COS had no significant effort/contribution during Quarter #7. During Quarter #8 COS has contributed to the specification of the simulation use case as a measure for the execution of remote tests during the Covid-19 restrictions. Final specification on the use case to be executed at the OTE Academy site was prepared with the support of the other Athens scenario partners. This is work to be reported in D1.7.

9-AIR does not participate in this Task.

10-UMS has made contributions with the results documented in the content collection for deliverable D1.7. It collaborated with NCSRD to define pre-trials based on the simulation testbed created by UMS within T3.4 to ensure continued experimentation even during the Covid-19 travel restrictions. Work on this especially around KPIs will be reported in D1.7.

11-INF has conducted internal processes for continuous D1.7 actions planning. There has been creation and continued use of repository locations/files in Teams for D1.7 in advance accumulation of material, resources and references for D1.7. INF has also made initial contributions in the analysis, market and business of the UAV cases and contributed material in the appropriate repositories/files. It has been linking Task 2.4 and WP4 activities for defining valid business KPIs, metrics, and impact for further use in D1.7. INF has made communication of business and market aspects of the project and D1.4 through 5G!Drones social media channels and website. INF has been linking Task 1.1 and Task 4.2 trial activities for defining valid business KPIs, metrics and business impact for further use in D1.7.

12-NOK has discussed with Finnish Aviation Authorities related to EU and Finland regulation requirements. This information collection is an ongoing action and these will be updated with be reported to D1.7. NOK had internal conference with other entities regarding the regulatory and business ecosystem and its impact to the project.

13-RXB has made contributions with the results documented in the content collection for deliverable D1.7. Also, RXB contributed to conversations related to Operational Flight Plan, U-space and UAV business use cases. RXB is leading one working group within the U-space Expert Group appointed officially by EASA and the work done by RXB within the U-space Expert group will contribute directly to the regulatory framework related to UAVs in the EU and also for the project. Furthermore, RXB has been appointed as the KPI champion representing 5G!Drones project in the 5G-PPP and has been collaborating with NOK to lead and contribute towards UAV & Business KPIs.

14-EUR made contributions with the results documented in deliverable D1.7. EUR has also investigated how MEC services can be useful for UAV, and particularly how the RNIS MEC services can be used. This study allowed to define the MEC RNIS enabler developed on T3.4.

15-DRR does not participate to this Task.

16-CAF made contributions with the results documented in the content collection for deliverable D1.7. CAF is leading IMT team and collected information about six main topics for deliverable D1.7: UAV flights regulation; UTM regulation; Radio communication regulation to add a 5G communication device onboard a drone; 5G rollout in EU; Cellular drones business use cases; Cellular drones manufacturing.

17-FRQ led monthly WP1 telcos, supervised progress, and contributed to content collection for deliverable D1.7.

18-OPL made contributions with the results documented in the content collection for deliverable D1.7. Analysis of current development of the 3GPP documents (technical reports and standards) that deal with support of UAV services (generic mechanisms and UAV-specific) - results to be used within the T1.4, WP3, WP4 and WP5.

19-MOE does not participate in this Task.

20-ORA does not participate in this Task.

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]

Task Objectives:
This Task will provide the overall system architecture design (i) to support the selected use cases over a federated, multi-domain 5G infrastructure and (ii) to execute large-scale UAV trials. It will identify and design at a high level the architectural components to provide the necessary infrastructure support for the selected use cases (5G!Drones enablers), which will be elaborated in WP3. Furthermore, it will define the underlying 5G architecture on top of which the vertical services will be deployed. This includes all the necessary 5G system components, as well as the specific 5G!Drones enablers. At the same time, it will provide a high-level design of the management plane for the execution of the trials, which will be the basis for the detailed design and implementation of the 5G!Drones trial controller (WP2). T1.4 will deliver an initial architecture design (**D1.3**) at the end of M08, marking partially **MS2** (due M12) of the project. An updated version of the architecture (**D1.6**) will be delivered at M24 based on feedback from implementation and integration activities of WP2-WP4.

Task Activities during the period:

The main focus of Task 1.4 is the creation of Deliverable D1.6. Several changes related to the initial architecture have been performed and documented in D1.6. The Deliverable has been submitted at the end of May 2021.

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 contributions have focused on Deliverable D1.6. It has provided inputs on the overall methodology, repositories, facility enablers, 5GTN evolution analysis, and UAV enablers. UO did not declare any personnel effort on the WP1 during Quarter #7.

2-THA participated to the edition of D1.6, especially by describing how use cases could benefit from cybersecurity enablers (typically IAM & PEP for all Drone C2 communications involved). THA has also worked with AIR and ORA in their security enablers. THA has worked on the integration of its trajectory computation system and its integration in the architecture, especially with MEC RNIS service. That will allow the real-time refinement of drones' trajectory according to network (among others) conditions. THA continued its work on cybersecurity enablers (typically IAM & PEP for all Drone C2 communications involved).

3-ALE made contributions with respect to D1.6 regarding the section Updates in 5G UAV Enablers. ALE has contributed to this deliverable by providing the information regarding the update on the status of the UAV enablers with respect to the status provided during M8 (D1.3). UAV Enabler list has evolved and new enablers have been added to it during last year. Updates in the status as well as the expected release date were provided to the document. Contributions to chapter 4.2.2.9.

4-INV followed up and added its inputs to the discussion carried out in the project about high level design and management plane functions. Particularly, INV gave its inputs and comments to D1.6 document: the High Level Design schema and parts regarding the interworking of Web Portal 1 with other components (chapters 3.2. and 4.1.1). INV was contributing to D1.6 through participation in the discussions and modifications of the Flight Planning and Flight Execution message flows, which will be added to D1.6 document. INV also proposed to limit the Security Enablers list in the D1.6 to "high priority".

5-HEP does not partake the Task 1.4.

6-NCSRD coordinated the activities towards a refined and final overall architecture of the project, focusing on the 3GPP compliance, as well as the depiction of the vertical enablers. It prepared a draft version of the D1.6 during Quarter #7 and released it for comments. During Quarter #8 NCSRD distributed the final draft of D1.6, which includes the refined and final overall architecture of the project, focusing on the 3GPP compliance, as well as the depiction of the vertical enablers per platform in a coherent and comprehensive way. The Deliverable went through its internal review process and the final version of it was prepared by NCSRD and released for submission at the EC portal.

7-AU has contributed to the deliverable D1.6 by providing updated information on its facility enablers. AU has also provided inputs on high-level gap analysis related to its trial site. Furthermore, AU has also provided inputs related to its Web Portal and the repositories module in addition to UAV service enablers of the scenario it is leading. All these inputs have been reflected in the appropriate chapter of D1.6 (2.1.2, 2.1.5, 4.1.2, 4.3.5).

8-COS made no significant effort/contribution during Quarter #7. It contributed to the final revision of Deliverable D1.6, with significant editorial changes in all sections.

9-AIR has enhanced the internal architecture of the sub-systems they provide ensuring their resilience from a sharp breakdown into more micro-services. (D1.6. chapter 4.2.2.1) AIR has added in the architecture a new server allowing to convey augmented reality information on MCDATA channel. The global architecture of Mission Critical Platform for 5G UAV use cases is now fully specified and will be demonstrated in Public Safety scenario.

10-UMS made contributions with the results documented in deliverable D1.6. (chapters 4.1. and 4.10). UMS has contributed to D1.6 by providing the database architecture for UAV repository development. UMS has further provided content on the implementation of the UAV repository developed with support from INV and AU.

11-INF has been commenting and reviewing on D1.6 structure and content. It contributed to D1.6 introduction, target audience, and 5G!Drones ecosystem sections and it has been monitoring and analysing Task 1.4 activities for communicating the results through social media and website, and linking them to Task 1.1 (business impact) .

12-NOK contributed to D1.6 for chapters 1.22 LCM, 1.34 5G!Drones Refined Architecture, 1.44 LCM, 1.48 Data Collector, 1.65 NOK. NOK has also designed architecture details with DRR, INV, NCSRD, UO, AU, AIR, CAF, and FRQ. NOK contributed with the results documented in deliverable D1.6 chapters 3.1.4, 4.1, 4.2.5 and 5.3.8. It made a full review of the Deliverable with feedback.

13-RXB contributed to deliverable D1.6 for chapters 3.1, 4.1, and 4.2.

14-EUR has worked on updating the UAS and 5G integration. In addition, EUR contributed to the deliverable D1.6 by providing details on the Trial Engine details: including the Web Portal2. EUR provided updates on the Facility components regarding 5G SA support, network slicing, and MEC enablers. In summary, EUR has provided contributions to sections: 2.2.6, 3.5.2.2, 3.5.3, 3.6.1 and 4.2.1.

15-DRR made no contribution during Quarter #7. During Quarter #8 it reviewed the trial preparation flow prepared by NOK to be included in D1.6. It made an analysis of general architecture diagram for D1.6 (1.03) and integration diagram. DRR reviewed FRQ contribution regarding U-space adapter. It conducted review of D1.6 and updated the integration architecture diagram (chapter 4).

16-CAF provided texts for D1.6 Chapters 3 and 4 about Dashboard and Security requirements. CAF collected materials for D1.7 Regulation and drone businesses field.

17-FRQ led monthly WP1 telcos, supervised progress, and contributed to Deliverable D1.6. (chapter 3.1 and chapter 4.1). FRQ was one of the internal reviewers of D1.6 and provided comments and feedback to the authors of the deliverable.

18-OPL made contributions to the Deliverable D1.6 (chapter 2.5) and remarks to the text.

19-MOE has conducted an analysis together with NCSRD and COS on the architecture of 5GENESIS facility and Use Case (UC4Sc1). MOE has contributed on the analysis and the business of the UAV cases planned to taken place in Athens platform and has also commented on D1.6 structure and contents.

20 – ORA made a short outline of the 2 UAV service enablers under development by Orange in D1.6. It provided comprehensive feedback to the D1.6 editor regarding D1.6.

8.2. WP2 Trial controller

8.2.1. Progress towards objectives and details for each Task

WP2 Objectives
This WP will work towards the following high-level project objectives:

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

WP Tasks and interrelations:

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

Main Progress in the period:
During Quarter #7, the WP2 has focused on the implementation work. This work covers the four tasks: web portals for Task 2.1, LCM and trial validator for Task 2.2, trial enforcement for Task 2.3, U-space adapter and KPI component for Task 2.4. This period has also seen more synergy between the four tasks to efficiently develop and integrate the different modules, e.g., integration of Web Portal1 with the repositories, initial integration of LCM with the repositories, as well as the trial validator with the repositories. The work of the WP is on track.
The WP has focused during Quarter #8 on the due deliverables. Three deliverables have been released, in time, during this period, covering the four tasks of the WP. Furthermore, WP2 has also focused on updating the different modules of the trial controller, which are already developed, based on the feedbacks from the integration activities.

Significant results
Various modules have been released:

- Web Portals: first version of Web Portal1 was released in December 2020 (the facility web portals have been released during the previous period).
- LCM: first version was released in the end of January 2021.
- Trial enforcement: initial version was released in December 2020.
- U-space adapter: a version is available since December 2020.
- KPI component: a version is available since December 2020.
- Repositories module: is being updated upon continuously.
- D2.2 Initial implementation of the trial controller (M23; O; CO; INV).
- D2.3 Report on algorithms, mechanisms and tools for data analysis and visualisation (M24; R; PU; FRQ).
- D2.4 Definition of the trial controller architecture, mechanisms, and APIs (M24; R; PU; EUR).

Deviations from Annex I and impact on other Tasks, available resources and planning
There has been no deviation from planned activity.

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

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

Task Activities during the period:

During Quarter #7, the Task started work related to the D2.2 delivery: "Initial Implementation of Trial Controller". All the partners in charge were contacted and asked to prepare their contribution. UO was working on their Web Portal 2 implementation, following the design proposed by EUR. INV started work with Web Portal 1 implementation. The mock-up design was presented in early December, and in next months the user interface was built and presented to other partners. INV was also working with THA on defining the conditions for introduction of IAM (Identity and Authentication Module) to enable safe login and use of the portal. It was also agreed with RXB and FRQ that Trial Validator user interface will be embedded in the Web Portal 1 interface. In the scope of Operational Flight Planning using the Web Portal 1 interface, several interested partners (RXB, UMS, CAF, DRR) were discussing the process flow and parameters necessary for planning the mission. Based on this, The Task 2.1 has created the draft with the list of parameters which are mandatory or optional for submitting the mission to UTM for approval.

During Quarter #8 period the Task was finalising the work on Deliverable D2.2. Numerous partners were participating in this activity. The draft report was reviewed by CAF and UO and next sent to the review by PMT. The Deliverable was submitted on time, the 30th April 2021. INV and THA were working on integration of Web Portal 1 with Identity and Access Management (IAM). The IAM was deployed by THA on the AU hosted server to assure the management of the users, their secure access to the web portal and secure communication between different Trial Controller nodes, which doesn't need to be in the same place. Additionally, the mail server had to be deployed to communicate with the end users. CAF was working with Dashboard part. INV and AU were also working on the integration of the Web Portal UAV definition and Operational Flight Planning with the repositories. The Task also worked with the facility owners to make the redirection from Web Portal 1 to Web Portal 2. Finally, The Task discussed the possible solutions to give the user a real time view to the ongoing mission in the Dashboard window.

A power outage in AU infrastructure revealed the problem of recovery after such event – all services were down and inaccessible: Web Portal 1, mail server, IAM, repositories. This is one of the lessons learned, that we need to take care about recovery after such event.

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 maintains and further plans the schedule for WP2 related modules that are to be developed by University of Oulu. The plan is followed-up on weekly basis to have a clear perspective of the schedule. UO has studied the Web Portal 2, REST API developed by EUR for their facility, to develop Web Portal 2 for University of Oulu. UO has developed its Web Portal 2 using Flask Python. Before that it built and integrated EURECOM's Web Portal 2 on 5GTN with a static IP address, to communicate and test the flow of information between Web Portal 2 (Flask REST API), light weight LCM (Swagger implementation) and Abstraction layer. UO tested integration of Web Portal 2 directly with OSM MANO server, which eventually failed because OSM accepts YAML format, however EUR's Web Portal 2 generates JSON. This required access to Aalto University's hosted Trial Registry and UO has requested access to it. UO further had a meeting with EUR to develop an understanding on generating NST using Flask REST API. UO has started full stack development of Web Portal 2 finishing the first release of Web Portal 2, but immediately started modification. UO has had internal meetings for the development of NST which would be suitable for 5GTN's OSM Server. For Web Portal 2 second release, UO developed the frontend according to the newly finalized NST. UO has also done backend programming of the URLLC, eMBB, and mMTC parameters (radio buttons) on the user interface which will be used in the form by the user in slice selection (currently modifying for release 2).

During Quarter #8 UO has carried out definition of KPIs to monitor and measure using Qosium Tool. It has reviewed the deliverable D2.2 as internal reviewer. It made the first release of Web Portal 2 UO, to generate network slice template (NST) acceptable by current 5GTN system. UO carried out integration and testing of Web Portal 2 output (NST), with Trial Repository, LCM and Trial Enforcement components. It included "Trial ID" parameter in Web Portal 2 UO URL (Slice Info page), which will accept trial ID value originating from Web Portal 1. UO has been developing Web Portal 2 UO release 2 which will include "KPI list" supporting 5GTN facility.

2-THA participated to the technical discussions regarding the initial implementation of the security aspects of the trial controller. THA is also working with INV on Web Portal 1 for the integration with IAM enabler on AU's X-Network facility (with help of AU's IT staff).

3-ALE does not partake the WP2.

4-INV led the work related to D2.2 "Initial implementation of the Trial Engine" – it is in touch with partners to track the work progress and make the initial review of the delivered content. In Quarter #7 INV started preparations for delivering the first version of Web Portal 1 module with special emphasis for Operational Flight Planning and UAV definition. INV was discussing in multiple sessions with DRR and FRQ, what are the mandatory and optional fields for creating the Operational Flight Plan, which can be treated and approved by U-Space. In the framework of Web Portal 1, INV was also collaborating with THA to setup the Identity and Authentication Module for the users of the portal.

During Quarter #8, INV was coordinating the work on delivery of D2.2 report about initial implementation of Trial Controller software. The document was reviewed internally by OU and CAF, next sent to review by PMT. Finally, it was submitted to EC portal in due time (30th Apr 2021). INV continued the development of the Web Portal 1 Release 1 and collaboration with other key partners: THA for Identity and Access Management and AU for repositories. INV introduced https protocol instead of http to exchange the data between different nodes. This work is described further in T4.1.

5-HEP does not partake in the Task 2.1.

6-NCSRD has contributed in the design of the trial engine in a complimentary way with the 5GENESIS platform, considering the ICT-17 platform constraints. Special attention has been put on the U-Space integration with the 5G facility, considering also the integration of Web Portal1 with the portal of the 5G facility. During the Reporting Period, NCSRD contributed in D2.2 and D2.4 deliverables by

describing the trial enforcement component, which is the main part of the trial architecture management plane, participating in the interconnection with the upper layer and the support of APIs for vertical experimentation.

7-AU has worked on updating its web portal, mainly in terms of interconnection with the repositories module. Furthermore, AU has been collaborating with INV to integrate Web Portal1 with the repository module, where dedicated meetings have been organised. AU has also coordinated with THA to provide a virtual machine to install IAM module for Web Portal1. In addition, AU has coordinated with INV, editor of D2.2, on the structure of section 4 which is dedicated to report the developed enablers (this deliverable covers across T2.1, T2.2, and T2.3). AU has also provided its inputs to this deliverable and edited the sections related to the modules Web Portal2-AU and repositories. In addition, as WP leader, AU has organized bi-weekly meetings to discuss and monitor the progress of the activity of T2.1. AU has also worked on collecting information on the enablers of T2.1 as well as reporting the progress status of the task to the PMT.

AU has updated it Web Portal to enable accepting http redirection. This enabled the integration of Web Portal of AU and Web Portal1. AU has also participated to the definition of the operational flight plan. The latter was led by UAV partners, including INV, DRR, FRQ and UMS. Once defined, AU implemented the specified functionalities in the repositories' module. For D2.2, AU supervised the process and coordinated with the editor, INV. AU also reviewed the deliverable. In addition, AU has organized bi-weekly meetings to discuss and monitor the progress of the activities of T2.1. AU has also worked on collecting information on the enablers of T2.1 as well as reporting the progress status of the task to the PMT.

8-COS does not partake in WP2.

9-AIR has completed development of APIs building added value applications on top of the mission critical collaboration platform providing an universal connector accepting most common real time video protocols including RTSP and RTMP commonly used within drones' embedded software. AIR has been developing new lightweight APIs based on WebSockets technology allowing any connected component to register as a Mission Critical Services client. The API will soon be available for any consortium partner or any third party intending to enrol drone embedded components.

10-UMS participated in discussions with several partners on the process flow of the drone operational flight plan and defining the mission plan which led to the decision that the mission plan consisting of waypoints for drone navigation will be created offline by the UAV operators. UMS also provided input to D2.2 on the development and implementation of UAV repositories. Within this task, UMS collaborated with INV and AU to define and finalise the Information Elements (IEs) for UAV repositories.

11-INF does not partake in Task 2.1.

12-NOK has contributed via trial sequency diagrams to API definitions and workshop with RXB of KPI definitions. NOK did collaborate with INV, AU, and many other partners to synchronise trial planning, but particularly execution phase status and message flow.

13-RXB has contributed to Trial KPI definitions, measurement methods and tools and contributed to D2.2. As the leader for Trial Validator, RXB supported and facilitated multilateral conversations, development and testing of Trial Validator related KPIs. RXB actively contributed to several sections of D2.2 and coordinated with INV and FRQ for multilateral calls to act as subject matter expert on several topics.

14-EUR participated in the refinement of the interface between Web Portal1 and Web Portal2. EUR has provided to INV a model of a software-oriented deliverable to define the structure of D2.2. EUR has contributed to D2.2 regarding the 5GEVE Web Portal2 release, which is available in the project Gitlab. A description of the software has been provided. A demo (video) is available in project's Teams (WP4) repossitory showing the integration between a dummy Web Portal1 and EUR's Web Portal 2.

15-DRR had discussions with INV related to specifications and requirements for drone flight plan interface to be implemented in Web Portal and interfaces with other components. It had further discussions with INV regarding the detailed drone flight plan flow/data scope to be implemented in Web Portal. DRR is preparing input for detailed flight plan Portal implementation. It made a review of D2.2, structure and update proposals to the scope and ToC. It prepared the D2.2 Chapter 5 contribution describing testing approach (general, unit, integration and acceptance tests). Review and update of D2.2 - addition of section with release information (ch 5.1).

16-CAF has contributed with Dashboard architecture and participated in discussions with other project partners to refine functions and workflows between Dashboard, Web Portal1 and Web Portal2. Contributions to the D2.2 regarding Dashboard part. CAF continued work with Dashboard. The main function of the Dashboard is to provide a visual overview of the planning and execution of the trial and its results. Dashboard is accessible via Web Portal 1 and it uses multiple screens at the same time. First version of Dashboard with 4 screens was presented to the consortium partners.

17-FRQ prepared and reiterated specification of detailed Trial Validator requirements and aligned according APIs with partners. Also, KPI related sequence diagrams and API discussions were supported.

18-OPL does not partake in WP2.

19-MOE does not partake in Task 2.1.

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

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

Task Objectives:
Requests for the execution of trial scenarios that are received over the northbound API of the trial controller need to be translated to an actual UAV service deployment on top of one or more trial sites, and the appropriate functionality should be in place to manage the execution of the trial. This is the purpose of T2.2. The trial execution engine needs to interface with the different facilities that will be used in the project using APIs exposed by the facilities, as well as the interfaces of the enablers that will be designed and implemented in WP3. Regarding the latter, particularly important is the work in T3.3, which provides an infrastructure abstraction offering the trial controller a unified view of the resources and the capabilities available across facilities. The execution engine is responsible for extracting the requirements of each UAV trial in terms of 5G (and other) features and (i) establishing end-to-end network slices with the required performance, security and isolation characteristics using the APIs provided by the slicing enablers (see T3.1), (ii) if necessary, onboarding and instantiating application components at edge data centers by interfacing with Mobile Edge Application Orchestrators (see T3.2), (iii) configuring and launching UAV-service and connectivity-related components onboard the UAVs. The trial scenario execution engine thus manages the full "lifecycle" of a trial, from deployment to termination and result collection

Task Activities during the period:
During Quarter #7, the task activities focused on the Web Portal 2 (or Trial Translator), the LCM, and the Trial Validator. The Web Portal2 task was almost finished. Three facilities already have their Web

Portal 2 ready, except UO. The Web Portal2 developed by EUR is available in the project Gitlab. The LCM team led by Nokia finalised the architecture of LCM, and released the first version implementation of LCM. The Trial Validator team led by RXB has also achieved good advances.

During Quarter #8, the Task updated and finalised the architecture and components of the trial engine. All Web Portal2's have been released. A second version of the LCM has been released and the first version of the Trial Validator. Meanwhile, the deliverable D2.4 has been finalised.

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 built and integrated EUR's Web Portal 2 on 5GTN with a static IP address, to communicate and test the flow of information between Web Portal2 (Flask REST API), light weight LCM (Swagger implementation) and Abstraction layer. UO also coordinated on meetings with LCM and Abstraction Layer testing, and networking issues and troubleshooting. UO tested integration of LCM and Abstraction layer developed by Nokia, using POSTMAN API, and documented the tests for the project. UO had a case specific meeting with Nokia on LCM integration with Web Portal2 which would be used by UO's facility. UO received access of Trial Registry from AU to test integration between LCM and Abstraction Layer. UO has defined a KPI List (KPI, traffic type, measurement points, time interval) for Web Portal implementation. It has also reviewed the deliverable D2.2 as internal reviewer.

2-THA has participated to the different meetings and discussions where flight planning and execution of the drones by using its trajectory computation mechanism have been discussed. THA has also participated to the edition to D2.4. It participated to the design of the LCM.

3-ALE does not partake in WP2.

4-INV participated in a number of the sessions dedicated to messages flow definition for flight planning and execution for Trial Controller and reviewing them after modifications. INV participated to the meetings, where it discussed the interfaces and exchange of the data between UAS and Trial Controller. INV was particularly involved and active in the definition of the role of the Web Portal1 as the interface between experimenter and the rest of the system. INV was also trying to find the best solution for presentation of the on-going mission status in Web Portal1. INV contributed to D2.4 document, describing components and functions of Web Portal1, and Web Portal1 centric workflows between Web Portal and User (authentication), Trial Repository (plan creation and status updates), Trial Validator, Web Portal2 (5G network config) and LCM (mission execution).

5-HEP is not partaking Task 2.2.

6-NCSRD has contributed together with NOK in the definition of the LCM module and its interaction with the trial execution engine. Analysis of flow diagrams and interactions of the different modules have been also part of this work. Compliance with 5GENESIS platform operations have been considered. Effort also has been devoted in the integration of the LCM with the Trial Enforcement module. During the Reporting Period, NCSRD has contributed in D2.2 and D2.4, and in parallel has performed two actions: I) participated in the design of the trial controller and especially the LCM in order to reassure smooth integration with the trial enforcement component. II)reviewed the functionality of the trial controller in order to perform a gap analysis with the respective Open5GENESIS framework, in order to identify the missing components that are needed to be integrated for the proper support and execution of the experimentation lifecycle. The integration of the U-SPACE components (I.e. UTM provided by DRR, FRQ, flight controller provided by UMS) and especially Web Portal1 provided by INV has been identified as the main missing components in the 5GENESIS platform and its integration will be performed as part of WP4 activities.

7-AU has been evaluating the development of a version of LCM where more automation can be included (the LCM can take autonomous decisions). This also serves for a research purpose and paves the way towards autonomous management of trials. AU has already made an initial implementation of this version. Furthermore, being the developer and the owner of the "repositories" module, AU has been involved in different discussions with other module owners where communication with the repositories module is required, including NOK for the LCM module, and RXB/FRQ for the trial validator. AU has also initiated a discussed with EUR, editor of D2.4, on including a section to report on research aspects related to supporting mechanisms and algorithms. As WP leader, AU has also reported at the PMT level on the importance of emphasizing with research aspects as the project belongs to a RIA call. In addition, AU has organised bi-weekly meetings to discuss and monitor the progress of the activity of Task 2.2. AU has also worked on collecting information on the enablers of Task 2.2 as well as reporting the progress status of the task to the PMT. For D2.4, AU emphasised with the importance of including research related topics in this deliverable. To this end, AU proposed and edited a section related to autonomous management of trials, based on a policy-model and reinforcement learning algorithms. AU is implementing some of these functionalities. In addition, AU also reviewed the deliverable D2.4 entirely.

8-COS does not partake WP2.

9-AIR does not partake Task 2.2.

10-UMS had no planned involvement in this Reporting Period outside of expected participation in the task.

11-INF does not partake Task 2.2.

12-NOK designed (together with partners), implemented, and delivered to project GitLab the LCM (Life-Cycle Manager) component. NOK did contribute to LCM part of D2.2 and D2.4.

13-RXB led the efforts towards Trial validator, and supported FRQ in the development, testing, and releases. Also, RXB participated in multiple calls with partners from INV, NOK, FRQ, and others to add value to conversations regarding LCM, Trial Engine and other components of the trial engine. RXB actively contributed to D2.2 & D2.4 and coordinated with several partners to clarify and answer questions related to various matters related to RXB's expertise.

14-EUR is coordinating the task activities making sure that everything is advancing well. EUR, as editor of D2.4 has shared a ToC and assigned a leader for each section. Besides, a time-line has been proposed. Both the ToC and time-line have obtained the agreement of the involved partners. EUR has updated the code of Web Portal2, which has been integrated with the trial repository developed and hosted by AU. A demo video is available in project's Teams WP4 repository showing the integration between Web Portal1, Web Portal2 (EUR), and trial repository (AU). As the editor of the deliverable D2.4, EUR contributed heavily to the deliverable text and review.

15-DRR had discussions and designing related to integration approach and functionalities / development states of LCM/Trial Enforcement. It updated review of trial validator sequence flows diagrams and architecture requirements / functionalities. It did technical consultation of architecture requirements in the aspect of aviation regulations. DRR had discussions with THA, ORA, and OPL regarding architectural leadership and testing platform - THA would take a lead on architecture, no dedicated testbed is planned (11.0); Workshop with THA and ORA regarding security enablers (PKI, IAM, PEP) - update to implementation diagrams. DRR made a review and adjustments to D2.4 contribution (U-space adapter module of DRR). It drafted content for chapter related to Testing (proposed documenting of Robot Framework and other tools/processes used for internal unit/integration tests of partners during the development of Trial Controller's modules). Preparation of

the content for ch. 2.2.2-2.2.4 of D2.4. DRR made a feasibility study for the possibility of implementing Common Altitude Reference System on EDGE.

16-CAF has contributed to LCM team activities with UAV operator inputs - how LCM should support drone flights, how LCM should be align with changes made by drone pilot during the trial etc. Also CAF team contributed to the discussions about LCM architecture. CAF started work with mapping Web Portal1 and Web Portal2 functions and technical requirements for Dashboard.

17-FRQ created a detailed Trial Validator software architecture and it was agreed with partners. Initial development phases were started and release 1 was delivered with a 2-week delay. Detailed scope and implementation of the Trial Validator was agreed and planned in accordance to general execution engine planning. FRQ U-Space adapter implementation was continued, as well as according documentation improved. Based on feedback from integrations sessions bugfixes and improvements were planned. During Quarter #8 Trial Validator software implementation was continued. Trial Validator release 2 was delivered as planned. Further discussion and agreements for release 3 were done. Release 3 is expected for end of May. Based on feedback from integrations sessions bugfixes and improvements are planned. D2.2 contributions were provided for assigned chapters.

18-OPL does not partake WP2

19-MOE does not partake Task 2.2.

20-ORA does not partake Task 2.2.

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

Task Objectives:

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

Task Activities during the period:

A first prototype has been demonstrated and successfully integrated with the facilities Abstraction Layer from WP3. The development has been continued in order to design and add additional features. Unit tests have also been created for the module as well as some preliminary integration tests. Various meetings with all the partners have been scheduled in order to discuss, design, and develop the interfaces towards the UAV operators. Development is still under-way, with the close participation of modules from tasks of other WP2 Tasks. During the Reporting Period NCSRD has coordinated the task activities towards providing release 1 of trial enforcement component that has been used to be

integrated with the LCM and the rest components of the trial controller, as well as with the abstraction layer. D2.2 and D2.4 have been prepared and submitted in time.

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 designing diagrams and flows of deployments over KPI and the related components. It has also been researching 3GPP Technical Specifications to get Performance Measurements from the 5G Network. UO has been testing components and modules related to KPIs in the project like KPI Monitoring Component and Lifecycle Manager of Trial Controller and Abstraction Layer. UO started working with Qosium, in specific with QMCP Listener and Qosium Scope to capture both uni- and bi-directional KPIs in real time over the desired components of the Use Cases. UO has made a measurement plan definition using Qosium among mobile phones on UAV and 5G network components. It has carried out identification and tests for creating measurement job request from LCM to the Abstraction Layer and also from LCM to Trial Enforcement and then to Abstraction Layer. It has sent the observations to NOK about the mechanism of LCM to create the Measurement Job directly or by means of Trial Enforcement at Abstraction Layer. UO has reviewed the deliverable D2.2 as internal reviewer.

2-THA has participated to the different technical meetings related to the trial architecture management and has participated to the edition of D2.3 by providing inputs related to data analysis methods that will be implemented in the trial controller. THA is also working on providing an API to its trajectory computation enabler that is planned to be integrated with the trial controller. THA has actively participated to the edition of D2.3 by providing inputs related to data analysis methods.

3-ALE does not partake WP2.

4-INV: Part of work for Security Work Group can be attributed to this task, particularly the definition of the security requirements regarding communication between Trial Engine components and facility, using the abstraction layer. Interworking of Web Portal1 and Web Portal2 is an important part of the trial architecture management. INV agreed to use http redirection method. Work with all four facilities is on-going to allow the experimenter to configure the 5G network in each facility and create NST, which will be stored in repository and used in due time to configure the facility setup for the test.

5-HEP has contributed to the discussions and work for clarifying the UAV operator interfaces led by UMS. It has contributed by doing an internal review of D2.4.

6-NCSRD is leading this activity. A first prototype has been demonstrated, clarifying also the requirements needed for the interacting this layer with the upper layers in order to be reassured the automatic execution of the experiment. During the Reporting Period NCSRD has led the activities of developing the trial enforcement component, providing its first release that is used for the integration with the other trial controller components, as well as with the abstraction layer. Contributions to D2.2 and D2.4 have been made with respect to the above points.

7-AU AU has been following the discussion on “interfaces with UAV operators” that has been led by NCSRD and UMS. AU has attended and contributed to the discussion during two dedicated meetings (from February 17th to April 8th 2021). In addition, AU has organised bi-weekly meetings to discuss and monitor the progress of the activity of Task 2.3. AU has also worked on collecting information on the enablers of Task 2.3 as well as reporting the progress status of the task to the PMT.

8-COS does not partake in WP2.

9-AIR does not partake in Task 2.3.

10-UMS is leading the activity of developing UAV Operator Interfaces with support from NCSRD. Following on the description of the UAV Operator Interfaces provided within Section 2.5.2 of D2.1, UMS organised discussions with other UAV partners and NCSRD to agree on the development of these interfaces. Based on these discussions, a consensus was reached where there will be only one UAV Operator Interface that will provide information on the trial status/progress/results to the end user/experimenter. UMS also participated in initial technical discussions on the implementation of this interface. UMS lead the discussions on the design and development of UAV Operator Interfaces and the process flow of operational flight plan with other UAV partners and relevant parties. The outcome of this work lead to the agreement that the UTM's GUI would be embedded on the web portal for the experimenter to visualize the trial status/progress and that a secondary visualization interface (optional) could be provided by the UAV operator to be embedded in the web portal. This interface would be based on each UAV operator's GCS and could contain more detailed information about the trial.

11-INF does not partake in Task 2.3.

12-NOK did participate to design workshops for API and functionality definitions. NOK has studied and updated trial sequency charts with DRR, INV, NCSRD, CAF, UO, AU, EUR, and many other partners to keep system design on sync. This common output is visible in D2.2 and particularly in D2.4.

13-RXB does not partake Task 2.3 but it has contributed actively to D2.3 and coordinated with FRQ for contributions in D2.2 and D2.4.

14-EUR EUR is preparing a new version of the Abstraction layer using Kong. The API has been tested locally. EUR participates to the update of the Abstraction layer to allow the Trial Enforcement to deploy a Network Slice on top of 5GEVE.

15-DRR made a review, discussion, and analysis of 5GENESIS approaches and proposed tools to be used for integration and automated testing in Trial Enforcement module (Robot Framework, OpenTap). It had discussion with NCSRD/HEP/INV and other partners on mission planning vs operation planning: how to prepare and download missions to UAVs and manage this from the Trial Controller (17.02) and internal follow-up; Discussions and alignment on potential functionalities of UAV<-> Trial Enforcement i/f (would trial enforcement being able to upload flight waypoints to UAV). Procedural and technical support for the discussion with NCSRD/HEP/INV and other partners on mission planning vs operation planning. DRR held Trial enforcement on-line workshop (18.03) with NCSRD, INV, UMS, NOK, UO, and AU regarding the integration of UAV subsystems for mission status presentation and flight plan preparation.

16-CAF has contributed to the UAV operators interfaces part and discussions. The main focus was to point out main parameters which should be sent to the Trial Validator. It made contributions to D2.4 for Dashboard part.

17-FRQ During Quarter #7, no tasks or contributions were done during this period for T2.3. During Quarter #8, FRQ made contributions to D2.4 for KPI component, U-Space, as well as Trial Validator.

18-OPL does not partake WP2.

19-MOE contributed in the flow diagram of the execution engine with the trial enforcement of the UC4Sc1 and in the relation to the various enablers with the trial controller architecture regarding the UC4Sc1. MOE participated in trial architecture management plane discussions and preparations for meetings.

20-ORA does not partake Task 2.3.

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

Task Objectives:

The goal of this Task is to provide sophisticated mechanisms for the management and analysis of the data that will be generated during the trials. These mechanisms will be applied in WP4. This Task will face important challenges. First, very large volumes of experimental data will be generated during the trials; these data pertain to both the UAV-service level (e.g., video traces, sensor readings, etc.) and the 5G facility level (e.g., packet-level measurements, signal coverage reports, latency measurements, etc.). Second, these data are often unstructured, have multiple dimensions, and involve multiple KPIs to measure. The expected challenges pertain particularly to the management, analysis, and the visualization of the experimental data and call for (i) big data management techniques, (ii) the application of data analytics and/or machine learning techniques for the analysis of trial results, (iii) development of visualization tools which will be used both at trial execution time and for the post-trial evaluation of the results.

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

Task Activities during the period:

Clarifications regarding the detailed workflows and sequences regarding KPI collection for the Trials took place. Individual partners were working on their data collection and analysis topics and research activities. Also, further activities on software development and integration of data collection components were undertaken during this period. The main focus of Task 2.4 within this period was on the delivery of D2.3. The involved partners were first starting on drafting a structure for the Deliverable, which resulted in a table of content. This was the baseline to distribute the work and allow all partners to make useful contributions within their specific area of expertise. Contributions started to flow in which allowed contributors to review, align and polish the content of the deliverable. D2.3 is finalised and submitted with the end of the period.

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 worked on VR visualisation. It added a way to modify flight path in VR and use it for visualising position analysis module. UO implemented and tested multi-robot location visualisation in VR and implemented a new way to visualise spatially collected number layers. UO added a way to modify flight path in VR and use it for visualising position analysis module; now ready for trials. It also made contribution in section 3.1 of D2.3 by describing the main functionalities, a brief detail of measurement results, and use of Qosium tool in the 5G!Drones system.

2-THA leads the data analysis team and worked on the integration of its AI error detection mechanism in order to be integrated to the ELK stack. THA is also working on another AI and ML mechanism that will be used to compute UAVs trajectory in order to be integrated to both UGC and UAVs.

3-ALE does not partake WP2.

4-INV was participating in the discussion regarding the experiment execution messages flow for KPIs collection. It also made the review and gave its feedback and comments about pre-test results and report from EUR tests. INV contributed to chapter 3.2 “Data Types” in D2.3, describing the UAV related data, notably the data, which is supplied by our K-1090 receiver.

5-HEP has trained ML models for analysing photos planned to be captured in Hepta’s led trial scenario. HEP has done work on labelling data and training ML models for image processing and had promising results. The models will be used in UC3Sc1 Sub-Scenario 2 for object and fault detection. HEP has also prepared and provided input for D2.3.

6-NCSRD has contributed in the design and development of client probes at 5G UEs that will be able to capture 5G data and visualise them in order to be used as part of the use-case experimentation. NCSRD together with COS have contributed during the Reporting Period in D2.3 with a mobile app that gathers and visualises the 5G related KPIs, such as throughput and latency. A first version was released during the Reporting Period, which will be used in the Athens trials of this year. Further discussions have been made concerning the KPIs related to MEC, and the latency related KPI, considering the deployment location of the related application or service.

7-AU has been evaluating the implementation of a data collection module that can empower the LCM version it is envisaging (to enable autonomous decision based on the collected data). An initial implementation has been performed. AU has also been implementing machine learning algorithms that develop models to optimise the network. The considered data is generation from simulation, where earlier realistic models have been developed. Furthermore, AU has also pushed towards including research works related to data analysis and machine learning the deliverable D2.3, and raised this point at the PMT level. In addition, AU has organised bi-weekly meetings to discuss and monitor the progress of the activity of T2.4. AU has also worked on collecting information on the enablers of T2.4 as well as reporting the progress status of the task to the PMT.
During Quarter #8 AU has worked on the implementation of machine learning algorithms. The contributions of the implemented algorithms have been reflected in D2.3 and D2.4. For D2.3, AU emphasised with the importance of including research related topics in the deliverable. To this end, AU proposed and edited a section related to enhancing C2 communication using deep learning. AU did also emphasise with section related to simulated data.

8-COS does not partake WP2.

9-AIR does not partake Task 2.4.

10-UMS had no planned involvement in this period outside of expected participation in this task during Quarter #7. During Quarter #8 UMS contributed to D2.3 by introducing the simulation testbed that has designed and developed in the context of the project.

11-INF made contributions to data analytics task force for potential business exploitation of specific business metrics and impact that have been pointed out. It worked on specifying data metrics with business impact to be analysed and visualized. It contributed to D2.3 ToC and to Data Analysis Business Aspects and Impact section. INF monitored and analysed T2.4 activities from a business perspective, communicating the results through social media and website, linking T2.4 activities to T1.1 and T5.1. During the Quarter #8 INF made contributions for potential business exploitation of

specific business metrics and impact. Specifying data metrics with business impact to be analysed and visualised. INF made contributions to D2.3 in sections 1.3, 2.1, 2.3 and 4.6.2.

12-NOK has studied different KPIs definitions. NOK has research ways to collect data of Trial Controller behavior. NOK implemented to LCM (Life-cycle Manager) a heartbeat functionality as an enabler to collect data trial controller state and as an example, NOK has implemented the heartbeat functionality to fetch KPI samples with timestamps for enable easy KPI data visualisation. NOK did contribute to D2.3 chapter 2.4 Requirements and design phase, 2.3 Data analysis using KIBANA and in full document reviewer.

13-RXB initiated the conversation about verifying that KPIs are being collected prior to the start of the trials and facilitated multiple discussions with relevant partners. RXB contributed to D2.3 and coordinated with partners for topics related to simulation, U-space adapter and lead the work for Trial Validator with support from FRQ.

14-EUR has updated the measurement API of the Abstraction Layer to interface with the monitoring visualisation tool built in this task. EUR is updating the Trial Adapter of 5GEVE to allow the integration with the monitoring module.

15-DRR did KPI module analyses. It held a discussion on KPI gathering module and had review meetings with FRQ - creation of UTM interconnection (exchange of ad hoc NFZ). DRR had internal discussion on KPIs - which and how business KPIs related to UAV/U-space should be measured (methods) and what tools need to be used/implemented to support data collections for such KPI. It had a discussion among other partners (FRQ) regarding content and scope of D2.3, suggested improvements on data collection/adaptation. It also held a discussion on KPI implementation and the need and role of KPI adaptation module (fetching measurements and adjusting to KPIC format) - how to implement? Business KPI preparation for 5G!Drones.

16-CAF has contributed to discussions and preparatory actions with KPIs measurement methodologies and results which had collected during feasibility tests in 2020. Also, CAF has contributed to the D2.3 regarding KPIs and measurements methodologies subchapters. CAF team also did internal review for D2.3.

17-FRQ continued implementation of KPI component. Integration support for partners was offered to allow usage of KPIC for partners to enable centralised KPI storage and analysis during and after trials. D2.3 Deliverable was prepared and ToC prepared by collecting input from all contributing partners. Deliverable D2.3 was finalised. Contributions, input, and feedback from partners to it were coordinated and organised. FRQ input was added to assigned chapters.

18-OPL does not partake WP2.

19-MOE does not partake Task 2.4.

20-ORA does not partake Task 2.4.

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

8.3.1. Progress towards objectives and details for each Task

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

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

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

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

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

Main Progress in the period:
Regarding slicing activities, during this Reporting Period, WP3 has worked on the preparation of instantiable 5G Core for slicing and cloud-native 5G Core and the validation of Open5GS 5GC/free5GC with UERANSIM, and slicing capabilities of OSM. WP3 has also worked on software-defined security mechanisms in E2E slice orchestration, slice access control, mechanisms for inter- and intra-slice scheduling at the RAN level, and dynamic management of 5G numerology to enforce network slices. The WP has also spent some time on testing the UE-based slice attachment functionality and the support of dedicated user plane Network Functions (NFs) with shared control plane NFs. The WP has also initiated during this Reporting Period the development of the NWDAF enabler, preparation of UE-related analytics collection application for NWDAF and 3D coverage maps for test sites (initially for Sophia 5G-EVE site).

On MEC side, three main activities are still running in the task: MEC Slicing (OPL would provide a contribution), MEC Security (THA would provide a contribution) and MEC Mobility (AU would provide a demo). Two enablers based on MEC have been proposed by EUR. One on enabling LoRa as a Slice using MEC and another one on using MEC RNIS to support UAV operations.

The WP3 has also worked 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 OU abstracted a subset of interfaces. The Abstraction Layer has been deployed in AU premises and has been integrated with EUR facility.

On the UAV side, The WP has been active on the development of enablers. Many of the 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). A summary of the enabler's status will be presented during the next F2F Meeting.

Significant results
During this Reporting Period, the WP3 has released several Abstraction Layer components on the project's GitLab repository and the WP has made good progress on UAV enablers design and implementation. Moreover, significant work has been done on End-to-End (E2E) slicing and MEC service migration. The WP3 has also achived the following items:

- Preparation of instantiable 5G Core for slicing and cloud-native 5G Core.
- Design and preparation of UE-related analytics collection application for NWDAF.

Also, the following set of UAV enablers is ready to be tested and integrated:

- AU data Collection Module,,
- AU IoT HAT,
- AU IoT HAT driver,
- AU Virtual flight controller,
- Hepta's Data Cloud,
- Hepta's GCS,
- Hepta's drone with tether,
- Payload - Lidar for 3D mapping,
- Interface with AP,
- Sensor data streaming,
- Data processing,
- INVOLI Central Server,
- K-1090 receiver,
- Nokia Drone,
- UWB based drone positioning system,
- 5G Modem,
- 5G smartphone & camera holder, and
- DJI Matrice 600 payload adapter.

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

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

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

In particular, it will develop components for end-to-end secure slice deployment and orchestration, with the support for managing slice components across administrative domains. This is necessary for the cases where the functionality of an end-to-end slice spans across facilities (e.g., one facility is providing RAN and MEC functionality, while UAV control functions are split between the trial site and the vertical's premises; UAVs are restricted to a single facility due to regulatory requirements, while core network components and other functions of the UAV slice are executed as virtual instances at another trial site/facility). Activities in this Task will be in close synergy with T3.3, where the necessary infrastructure abstractions will be developed to facilitate federation and multi-domain operation
The selected 5G!Drones use cases have as a typical feature the *coexistence of multiple network slices* with different performance requirements for the provision of a *single drone service*. For example, for

a public safety scenario, apart from operation of UTM modules, which require a uRLLC slice to meet the strict timing and reliability requirements for safe and secure flight operations, video has to be streamed from the drones necessitating the deployment of an eMBB slice to support it. Taking into consideration that

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

raises significant concerns regarding *scalable slice management*.

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

Task Activities during the period:

During the Quarter #7, the development of specific 5G!Drones test platforms as well as enablers (NWDAF, UAV Attestation, RAN slicing in NR) was continued. During the Quarter #8, the works on 5G Core Network solutions testing, slicing ability, instantiation in cloud-native environments as well as slice management and orchestration solutions, including slice security, were continued. Additionally, works on the enabling mechanisms of NWDAF and 3D coverage modelling around test sites were initiated.

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 maintains and further plans the schedule for WP3 related modules that are to be developed by it. It conducts plan follow-up on a weekly basis. UO has participated in work for several documents and deliverable updates. It also contributed to facility enabler document updating. UO has been further studying of 5G slicing and EDGE/MEC architecture. UO worked on facility implementation of network system enabling slicing using OSM as an Orchestrator and Openstack as Virtual Infrastructure Manager. The activity involved vEPC as a core and BTS (Nokia Pico-cell) to create a Network Slice which is a part of integration planning whose target is to have virtual 5G core and gNB to create a standalone 5G Network Slicing system. Additionally, UO defined a Network Slice Template compatible with OSM for Web Portal 2. UO has been working on Openstack (Microstack) set up and configuration as well as to make it compatible with 5GTN. Then, UO made the 4G core available on Openstack environment as well as connected with the Nokia Pico BTS. After that, UO moved to 5G Core implementation where it checked and compared the different options available and selected the ones to go ahead with.
UO has run a series of planning workshops for Slice creation in University of Oulu / 5GTN. It verified some additional slicing capabilities of OSM, including the automation of allocating floating IPs to network slice instances in Openstack. UO also made an instantiable 5G Core for slicing. UO has configured both Open5GS 5GC (Open-Source 5G Core) and free5GC (another open-source 5G Core) on the physical server aiming to connect the gNB with the core. It set up and successfully tested two different testbeds for 5G Network: 1. Open5GS 5GC + UERANSIM (Simulated UE and RAN), and 2.

free5GC + UERANSIM. UO further configured and successfully run the first setup on OpenStack environment as well. UO has maintaining and revised University of Oulu WP3 implementation plan, schedule, and resources for Tasks 3.1, 3.2 and 3.3.

2-THA has worked on providing its slicing and MEC platform based on 5G-Empower and srs-LTE to UO. In addition to that, THA as part of the security task force, is working on software-defined security mechanisms in E2E slice orchestration. It has thus participated to the edition of D1.6. THA is working on software-defined security mechanisms in E2E slice orchestration and is working on using IAM and PEP for slice access control. On the other hand, THA is working on mechanisms for inter and intra slice scheduling at the RAN level.

3-ALE does not partake in Task 3.1.

4-INV does not partake in Task 3.1.

5-HEP does not partake in Task 3.1.

6-NCSRD continued the development of the KATANA slice manager, adding additional features and functionalities that enhance the provision of the slice over the latest version of OpenStack. More specifically:

1. New Monitoring Module (Grafana, Prometheus server & Prometheus node exporter)
    - Integrate ODL Prometheus exporter to collect traffic metrics per flow,
    - Per slice Network Service Status monitoring,
    - Per slice VM monitoring,
    - Katana Home Dashboard on Grafana,
    - Create a Grafana Dashboard for every new slice.
2. Support OSM8 and OpenStack Stein as MANO components.

During the reporting period NCSRD performed significant activities for testing the extension of the slice manager between the two locations of the Athens testbed, namely the NCSRD campus and the COSMOTE campus. The extension of the slicing at both sites in planned to be tested during the June trials.

7-AU has worked on the deployment and integration of its cloud-native solution for network slicing. This includes the deployment of a production grade Kubernetes cluster composed of three physical servers, configuration of the physical network connecting the servers to RAN, and the deployment network slices management function on top of the new cluster. AU has deployed the core network on the previously deployed cloud-native platform and tested the API exposed by the Network Slices Management Function (NSFM) responsible for the management of network slices. AU is also testing the UE-based slice attachment functionality and the support of dedicated data plane NFs with shared control plane NFs.

8-COS does not partake WP3.

9-AIR does not partake WP3.

10-UMS had no planned involvement in this Reporting Period outside of expected participation in this task.

11-INF does not partake WP3.

12-NOK does not partake Task 3.1.

13-RXB does not partake Task 3.1.

14-EUR is working on the 5G NR slicing where a paper has been submitted, including the contribution and the results obtained through simulations. The paper details the proposed network slicing framework that relies on O-RAN and aims to enable 5G NR Slicing. In parallel, EUR has finalised the end-to-end network slicing on top of the 5GEVE facility, migrated to a full cloud-native system. It should be noted that the current version supports only 4G RAN slices, but it allows slicing MEC and cloud-native resources. EUR is testing the Network Slicing feature provided by OAI 5G CN. EUR is working on a dynamic management of 5G numerology to enforce network slices. A publication is under preparation on this topic.

15-DRR made an analysis and assignment of UTM enablers delivery plans to D3.3 plan tables. Together with FRQ, DRR is working on 5G - U-space glossary standardization. During Quarter #8 DRR had no planned activity on the Task.

16-CAF has contributed with discussions and inputs for designing security enablers and conducted research about possible solutions for slicing. CAF designed and prepared UE related analytics collection application for NWDAF.

17-FRQ had no planned involvement in this Reporting Period outside of expected participation in this task.

18-OPL is the Task leader, preparing the status presentations. It conducted studies on possible generic enabler (NWDAF functionality) and has had discussions with WP3 leader on further directions. OPL initiated preparation of the NWDAF implementation as a new 5G!Drones enabler, starting of preparation of 3D coverage maps for test sites (initially for Sophia 5GEVE site) – collection of necessary information for calculation model (radio and antenna system parameters, antennae location, flight zones definitions).

19-MOE does not partake in Task 3.1.

20-ORA did not previously partake in Task 3.1. During Quarter #7 it has made a definition a new security enabler: remote UAV Attestation for data integrity. During Quarter # 8, regarding security, ORA explored the design of a modular drone attestation mechanism to guarantee data integrity in a drone system, with a planned implementation based on Trusted Execution Environments (TEE). A first application focuses on No-Fly Zone (NFZ) validation, with evaluation of security, data protection, and performance.

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

Task Objectives:

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

Building on existing MEC components provided by the partners, T3.2 will create the necessary support for the inclusion of MEC application instances and related network and compute resources into an

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

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

Task Activities during the period:

All the activities identified in T3.2 are closed, except MEC security and MEC mobility management are running. Thales and ORA are active on the MEC security part. AU is preparing a demonstration showing the MEC mobility management. EUR has identified two MEC enablers that have been included in T3.4. Regarding the closed activities, all details have been included in D3.1. Three activities are still running in the task: MEC Slicing (OPL would provide a contribution), MEC Security (THA would provide a contribution), and MEC Mobility (AU would provide a demo). Two enablers based on MEC has been proposed by EUR. One on enabling LORA as a Slice using MEC and another one on using MEC RNIS to support UAV operations.

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 finalised installation of ETSI based Nokia vMEC19 platform and traffic from BTS (Nokia Pico eNB) to EPC routed through vMEC19. At the moment, open source NextEPC is used as an EPC for a basic setup testing. Using 5GTN EPC as a core in testing is under investigation, while this would need new configuration to all BTSs in 5GTN. Basic test application is installed in vMEC19 environment and connectivity from BTS to application with S1-LBO functionality has been established. UO tested the vMEC slicing capabilities. It was concluded only to use one vMEC for all the slices. UO created VNFDs, NSDS, and NST in OSM for deploying VMs as part of slices in Openstack for installing MEC applications.

2-THA is working with EUR to get remote access to their RNIS API of the MEC platform in order to use it in its trajectory computation enabler developed in the scope of task 3.4. Also, as part of the security task force, THA is working on the security mechanisms in MEC with focus on MEC infrastructure security, data plane security. THA has collaborated with EUR to integrate this latter's RNIS API of the MEC platform in order to use it in its trajectory computation enabler developed in the scope of task 3.4. A joint paper has been submitted to an IEEE conference. THA continues its work on the security mechanisms in MEC with focus on MEC infrastructure security, data plane security.

3-ALE does not partake in Task 3.2.

4-INV does not partake in Task 3.2.

5-HEP does not partake in Task 3.2.

6-NCSRD together with COS have contributed in the configuration of a MEC/LBO deployment at NOKIA 5G Airscale, utilizing ATHONET core network. The MEC deployment will be used for supporting trials at the 5GENESIS platform. NCSRD together with COS during the Reporting Period has focused their efforts in the proper configuration and functionality of the MEC provision at the COS campus, reassuring the proper interconnection of the two sites and operating the 5G network under a common PLMN and core network located at NCSRD. The initial measurements reported an increased latency, which led to many internal technical meetings and hands-on trials in order to resolve the issue. A misconfiguration in the gNodeBs was spotted and the problem has been resolved during the reporting period and therefore the platform is ready to be used for the trials.

7-AU is carrying out a research activity regarding smart relocation of MEC applications. The solution leverages Machine Learning (ML) techniques to minimise the number of failed relocations. In parallel, AU continued working on the preparation of the service mobility PoC, where a web portal that allows the visualisation of the relocation process has been developed. AU prepared the first version of the PoC demo regarding service mobility for UAVs in MEC. Also, a paper addressing optimised service mobility for UAVs has was to IEEE GLOBECOM 2021.

8-COS does not partake WP3.

9-AIR does not partake WP3.

10-UMS had no planned involvement in this Reporting Period outside of expected participation in this task.

11-INF does not partake WP3.

12-NOK team has researched the coming NOK MEC functionality. NOK has supported OU research with their vMEC19 implementation. NOK has kept workshops with UO to align integration efforts related to existing and new SEP21 integration.

13-RXB does not partake in Task 3.2.

14-EUR is the leader of the Task. It ensures that the activities are well advanced and reported by partners. In addition, EUR is working with THA to provide them remote access to the RNIS API of the MEC platform. EUR developed two MEC enablers: LORA MEC and UAV radio failure prediction using MEC RNIS. Both versions v0 are ready and validated on top of 5GEVE facility.

15-DRR had no planned involvement in this Reporting Period outside of expected participation in this task.

16-CAF has contributed with developments of CAF MEC applications: map application and video analyzer. Also CAF conducted research about Dashboard functions regarding MEC. During Quarter #8 CAF did not contribute to the Task.

17-FRQ did not actively contribute to this task in this Reporting Period.

18-OPL conducted further studies on integration of MEC with slicing-enabled 5G. It had direct arrangements with T3.2 leader and has advanced work on MEC slicing.

19-MOE does not partake in Task 3.2.

20-ORA does not partake in Task 3.2.

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

Task Objectives:

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

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

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

Task Activities during the period:

During this period the task efforts were mainly focused on the alignment of the interfaces and implementations provided by the facility owners (mainly AU and EUR). Special care was also taken to explain the different interfaces and mechanisms exposed by the abstraction layer to the trial controller and examples of implementations that support interfaces for network slices management and KPIs collection have been released and tested with the Trial Enforcement module. The technical presentations during the bi-weekly meetings were dedicated to shaping the contribution of each partner to this task. However, we identified that not all the partners are able to contribute to this task and the matter was reported to the PMT. During Quarter #8, the Task efforts were mainly focused on the development of the facilities' parsers. EUR finished abstracting the interfaces required for the management of network slices and KPIs monitoring. For the time being, AU and UO abstracted only a subset of interfaces. NCSRD did not decide yet whether to provide a parser or not.

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 UO has worked on the Abstraction Layer. It has initialised the development of Facility Parser to manage the life cycle of a network slice i.e. create, update, terminate, and delete a slice, etc. This task activity also includes collaborations for KPI measurements. UO tested deployments of Abstraction Layer container to validate the functionality of API gateway and Measurement Job function on it. It did a basic implementation and deployment of Qosium as measurement system, which consist of Qosium Probes agents, Qosium Scope controller, and Qosium Store database. UO did code releases of KPI Measurement REST API from 5GTN-Qosium measurements as part of the

Measurement Job function of Abstraction Layer is in the project GitLab **https://gitlab.5gdrones.droneradar.eu/5GDrones-UO-team/KPIMeas/-/tree/dbcon**. The Qosium Storage deployment consisted of the installation, configurations, and tests of Nginx server, REST interface, and PostgreSQL database to store average statistics results obtained by Qosium Probes. Proper configuration and packet filtering to capture specific traffic using Qosium Scope in scenarios where there are several instances running in the OpenStack Server and it is required to measure one specific traffic of specific Network Slice Instance, for example, the throughput and latency of video streaming of an eMBB Network Slice. UO did installation and configuration of the Protocol Time Precision (PTP) daemon as part of Linux-based machines involved in the latency-related measurement to get accurate clock synchronization for delay measurements. It ran tests of Qosium measurement scenarios including measurement points like the OpenStack server, the instances like the EPC of OpenStack Server, Qosium Storage machine, and more machines based on Linux Ubuntu. UO made implementations of PostgreSQL database views to get specific measurements (e.g., throughput and latency) for the time interval of one second during the measurements and establishment of remote connection among the REST API of KPI Measurement (from Abstraction Layer) to Qosium Storage database (from 5GTN facility). Consumption of each database view of Qosium Storage at 5GTN by the REST API of KPI Measurement was tested as well as a measurement job implementation to associate each measurement result collected to one specific Network Slice Id. UO further did Qosium measurements activities including measurement points like NGINX Edge Server and MEC Server of 5GTN. UO started radio quality measurements tests using Nemo tool tests of a mobile device on the Nokia Pico base station and evaluation of centralized integration of radio-related measurements performed by the Nemo tool as well as computing resources measurements from OpenStack toward the Trial Controller system. UO has been developing the 5GTN parser, 3 interfaces (get slices, get a slice, and delete a slice) are abstracted. It is currently working on other two interfaces (create a slice, and feasibility check).

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

6-NCSRD has contributed in the discussions of the 5G!Drones Abstraction Layer in order to consider possible integration with the 5GENESIS platform through the Open API of the specific facility with special focus on the U-Space integration. NCSRD has also assisted with the integration of abstraction layer with the Trial Controller developed in WP2. NCSRD has contributed with the proper interfacing of the trial enforcement with the abstraction layer in order to support proper orchestration with the LCM and the trial controller. During the Reporting Period the first interfacing has been performed.

7-AU defined the abstracted interfaces for KPIs collection and the corresponding mechanisms based on measurement jobs, in addition to leading and coordinating the activities of this task. Also, AU added support for the KPIs collection interfaces to the previously released version of the Abstraction Layer. Part of the effort was also dedicated to organising ad-hoc meetings and clarifying the interworking of the Abstraction Layer with the trial controller. AU deployed the API gateway part of the Abstraction Layer on its premises and configured a domain name for it (**http://abstraction-layer.mosaic.org**). The deployed API gateway was tested and integrated with EUR's facility. Also, AU continued working on the development of its Facility Parser.

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

10-UMS had no planned involvement in this Reporting Period outside of expected participation in this task.

11-INF does not partake in WP3.

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

14-EUR works on updating of the Abstraction Layer translator of the 5GEVE to align it with Kong implementation. EUR will support the two Abstraction Layer approaches of 5G!Drones. EUR finalised the Trial Adapter of 5GEVE and successfully integrated it with Abstraction Layer gateway. A demo video is available in project WP4 repository showing the integration of the 5GEVE Trial Adapter with Abstraction layer gateway hosted in AU.

15-DRR prepared a presentation about U-space interaction with Abstraction Layer T3.3 (KPI & performance monitoring) and technical input to the U-space interaction with abstraction layer. It had no contributions on this Task during Quarter #8.

16-CAF has contributed to the facilities discussions with UAV operator and experimenter´s expectations and needs. It had no contributions on this Task during Quarter #8.

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

18-OPL does not partake in Task 3.3.

19-MOE: For the support of Athens trials, MOE with NCSRD and COS provided at the Egaleo stadium “Stavros Mavrothalassitis” the portable edge computing solution. Furthermore, MOE with NCSRD together with COS works on realising an LBO ETSI MEC solution. Part of this work will be used in Egaleo 5G trials.

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

Deviation and Corrective action:
The Person Months have been shifted into Task 3.1 on a new security enabler.

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

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

Task Activities during the period:

ALE has organised Technical presentations in order to show the progress regarding the UAV enablers development. Some partners were able to present their work and presentations from other partners were scheduled and will be held during this year. ALE has also participated in refining the existing UAV enabler list in order to ease the integration task T4.1 expected for M26. As task leader, ALE has followed the evolution regarding the implementation of the UAV service enablers. By regularly contacting each of the concerned partners, ALE was able to keep an updated list regrouping all the enablers, their current status and the expected release dates. This information has been transmitted to WP4 in order to keep updated T4.1 about the release dates for each UAV service enabler. Besides, ALE has organised future technical presentations in the context of T3.4**.**

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 completed the first version of position data collection, including use of high precision GNSS and IMU system. It has continued improvements to large cable drone to be able to operate automatically. It also continued processing high precision reference point cloud for UO botanical garden to be used as baseline for drone laser scan testing on the area. UO created a test plan for making testing on the site (botanical garden). During Quarter #8 UO continued and improved position data collection, including use of high precision GNSS and IMU system. It also made improvements to large cable drone to be able to operate automatically; preliminary outdoor tests. UO continued processing High precision reference point cloud for UO botanical garden to be used as baseline for drone laser scan testing on the area; first trials with cable drone.

2-THA is developing a trajectory computation enabler to be embedded in UAVs. This enabler will get information from MEC services and will be integrated with trial controller. The enabler will get information from MEC services and will be integrated with Trial Controller. It will use AI and ML techniques.

3-ALE as leader of this Task, one of the functions of ALE is to monitor and to keep an eye on the development and implementation of the UAV service enablers by each of the concerned partners. In this way, ALE has periodically contacted the involved partners in order to have an update regarding the status of each of the partner's service enablers. This activity allowed ALE to keep track and to guarantee the progress of this task. Besides, and in order to allow partners to share their work regarding the implementation of UAV service enablers, ALE has coordinated several technical presentations within the WP3 calls. Results of this management task were presented during the last F2F meeting. ALE has focused on the implementation of its own enablers (Alerion GCS, Data processing, Sensor Streaming and the Hydradrone), defined for its use case: UC3Sc1 Sub-Scenario 3. All of these ALE enablers are expected to be released for soon and tested during the expected trials at UO. ALE is currently working on its UAV enablers which are expected to be released for the first and second integration release this year, specially its Hydradrone which will be ready to test by the end of May. Tests are expected to be done during June.

4-INV gave the update about status of INV's components, which can be utilised in 5G!Drones project. As a part of the task, INV was also working on definition of security requirements as part of Security Work Group related to UAV software, services and hardware. INV participated to all WP3 calls, read the documents or presentations, commented and gave the feedback for other T3.x streams. INV works on addition of broadcasting feature to its LEMAN tracker device, which it would like to use for UC1Sc1. The new option should be finalised before the trials in EUR scheduled for September 2021.

5-HEP: In Quarter #7 HEP has done planning work to clean up its enablers list and also done development work on them. Bench testing of the tether system for Hepta's heavy lift drone and testing for RF interference has been done. HEP has also done tests with different mapping lidars to arrive to the best platform and done work to integrate this lidar into out use case. HEP has also done work on UI-s for the GCS enabler. During Quarter #8, HEP has finalised Lidar setup with companion PC for UC3Sc1 Sub-Scenario 2 and has also been working on the point cloud streaming setup to enable dynamic data compression depending on the measured link speeds. HEP has also developed APIs for authentication and sending images to its data cloud platform uBird. HEP is expecting to prepare contributions for D3.2, continue with the development of UAV Operator VNF and finalise the testing and characterization of tethered heavy lift drone platform within the reporting period.

Deviation and proposed corrective action:

UAV operator VNF development is behind schedule, but Data cloud development is ahead of schedule. HEP will put heavy focus of UAV operator VNF development from 17.05.2021 with the goal of releasing the 1st release mid-June 2021.

6-NCSRD does not partake in Task 3.4. Although NCSRD does not participate to this task, it has contributed during the reporting period in the editing of the D3.2, on the sections that refer to the service enablers of the Athens use case.

7-AU worked on the development of the platform that will allow the end-users to request IoT services as per UC3Sc2. The platform allows the users to visualise the available UAVs and select them for providing IoT services. During Quarter #8, AU finalised the development of the IoT-as-a-Service (IoTaaS) platform that will allow the end-users to request IoT services as per UC3Sc2.

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

10-UMS was working on the development of its four enablers during Quarter #7. UMS made major progress on the first release of its enablers with multiple features and functionalities being implemented. The aim of this development cycle is to have our first release by March 2021. Additionally, UMS made progress on the development of the hybrid simulation testbed that can assist in remotely testing, and integrating with APIs as well as measure pre-defined KPIs over 5G networks. During Quarter #8, UMS continued the development of its enablers. The first internal release of all the enablers with certain features (as specified in the release planning) was done by end of March. UMS also worked on the design and development of the simulation testbed.

11-INF does not partake WP3.

12-NOK has researched 5G modem integration and functionality in the drone. NOK has researched to attach different measurement devices via adapters to NOK drones. NOK continues to development enablers. Delivered a VR equipment (Oculus Quest) to CAF for enabler research.

13-RXB Contributed to U-space adapter and trial validator requirements, service definitions, and enablers list in coordination with FRQ. During Quarter #8, RXB coordinated with FRQ & INV in design, development and synchronisation of U-space adapter and Trial Validator services. It provided key requirements for U-space regulations and operational plan requirements. Also, there was coordination with NOK related to KPI requirements.

14-EUR is working on two MEC enablers for UAV scenarios. The first is double connectivity support LORA with MEC application deployment and 5G for multi-RAT drones. The status is ready and tested. The second is MEC RNIS usage for UAV. The status is v0; displays the information on a web browser (ready and tested). During Quarter #8, EUR provided those two enablers using MEC. EUR is the editor of D3.2. A first ToC and timeline has been provided.

15-DRR conducted a review of U-space adapter enablers functionality with FRQ and followed up on planning of adapters' functionality developments in DRR UTM. Work on FRQ-DRR U-space adapter specification for dynamic airspace reconfiguration using UVR. FRQ had internal meetings with the technical teams. A demo was performed between PansaUTM and SmartSIS for dynamic U-space reconfiguration. Coordinating and reporting the progress on developing UTM related connectors and data schemas: for dFPL, airspace zone configuration, telemetry. DRR also did preparation of U-space adapter standardisation schema in the area of Operational Flight Plan. During Quarter #8, DRR had a meeting with FRQ dedicated to designing and synchronisation of U-space services/enablers designing and development - flight plan data exchange and structure, exchange information on

defined geozones, communication protocol between UAS operators and ATCs. U-space adapter development for Flight plans and mission prioritisation.

16-CAF team developed UGCS based platform (CUP) cloud native application and Latency measurement Docker container for EUR remote feasibility tests in December 2020. Also CAF continued developments for CAFA Field system for drone photos geotagging to 2D map and video analyzer software. During Quarter #8 CAF continued to develop the CAFA drone, which supports the transmission of commands directly to the on-board controller over a 5G network. A real-time near-teleoperation system was also developed to be able to control the drone in precision operations as well, such as the delivery of a package in a box in the UC1Sc3 Logistics scenario.

17-FRQ participated in discussions to conclude KPI related topics. KPI Component as centralised collection and storage mechanism was provided for Facility. Final concepts and setup were agreed between partners. Additional investigation and clarification will be done in upcoming periods. FRQ also analysed the "latency script" as optional integration possibility for KPIC. FRQ initiated and continued internal analysis of UTM network coverage service for UAV scenarios to enhance U-space integration.

18-OPL is not partaking the Task 3.4.

19-MOE participated in the preparation of a simulation testbed for trials at 5GENESIS platform.

20-ORA studied on the enabler adapting the position and trajectory of a drone so to improve performance and quality of service, that have been submitted to a journal. This work in ongoing.

8.4. WP4 Integration and trial validation

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

WP4 Objectives

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

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

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

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

WP Tasks and interrelations:

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

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

Main Progress in the period:
Within the reporting period, Task 4.1 focused on setting out the integration plan for the WP2 modules and WP3 enablers. In relation to this, a release plan excel was created that mapped all the developments across WP2 and WP3 to the scenarios they were going to be used along with the timeline for their development. Responsibilities were assigned for content provision within D4.2 as well as a timeline for delivering the deliverable. Task 4.1 further focused on getting visibility of the low-level interactions between the various entities involved in the use case scenarios (Experimenter, Trial Controller, 5G Facility, UTM provider, UAV Operator). Regarding dedicated meetings were organised with scenario leaders, trial facilities, and other contributing partners which led to the creation of the deployment architecture. T4.1 beneficiary also engaged in discussions with WP2 modules to gain greater clarity on their functions and interactions. Work on D4.2 has been progressing well.

Within T4.2, a remote feasibility test was conducted in EUR's facilities in December where communications between several modules hosted on the MEC server in EUR were tested with remote flights conducted in Tallinn. A draft document was also created to map out the trial activities in 2021. The ToC for D4.3 was also drafted along with assigning of responsibilities and a timeline for the delivery. The focus of T4.2 was to set out and detail the plans for trial activities in 2021-2022. In this regard, dates of Trials Phase – have been finalised. A decision was made to conduct trials remotely in NCSRD and EUR in June or July in 2021 while physical trials are planned to take place in UO and AU. Within T4.2, work has also been initiated to align on the various KPI measurement tools and methodologies currently used in the different trial facilities. Work on the above points is to be reported in D4.3. In addition, testing was conducted by UMS in collaboration with NCSRD and other relevant partners on the simulation testbed that was created by UMS within T3.4.

Significant results
Within T4.1, a decision was also taken on the total number of releases and the partners responsible for leading the releases. A release plan excel was created to track development and integration of WP2 and WP3 modules and enablers. D4.2 chapter responsibilities were assigned to partners. Within T4.1, deployment architectures of multiple use case scenarios have been created which are to be documented within D4.2. Partners have provided initial contributions to relevant sections within D4.2.

In T4.2, remote feasibility tests were conducted in EUR. ToC, chapter responsibilities and timeline for delivery were agreed for D4.3. In T4.2, trial plans for Trials – Phase I which is related Integration Release 1 have been finalised and documented in D4.3. The work done with regards to the KPI measurement tools and methodologies is also documented in D4.3. Finally, a successful testing of the simulation testbed was conducted by UMS, NCSRD and relevant partners. The results of these tests will also be a part of D4.3.

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

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

Task Objectives:

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

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

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

Task Activities during the period:

The main focus during Quarter #7 was to align on the complete lists of enablers grouped by specific use cases and gather the delivery plans of all enablers from all contributing partners with the goal of creating the overall delivery plan and finally to align with proposed release plan (4 major releases). This was achieved and all the relevant information was captured. During that period Task 4.1 also started to scope the details of each releases. In parallel further development of D4.2 was performed: assignment of agreed structure to particular partners as well as agreed document structure and content.

The main focus during the Quarter #8 was to develop D4.2 in parts describing: updated release planning, testing and integration approach. As a result, first versions of sections 2.1, 2.2 and 2.3 of D4.2 were prepared and discussed. Additionally, more detailed release planning and scoping was done (Chapter 3), especially for Release 1: scope of the release, deliverables, integration tests were defined. Also release tests schedules were carefully aligned with schedules of pre-trials and trials planned in D4.3 to allow performing on-site, end-to-end tests together.

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 carries out continuous work to maintain and further develop the Integration and release plan for UO modules developed under Work Packages 2 and 3. UO has participated in and contributed to several tasks in WP4 common 5G!Drones release planning. UO integration and release plan is now connected to common 5G!Drones release plan. UO made contributions to 5G!Drones integration architecture work and it created Integration Test Step Template for the project. UO participated in work for several document and deliverable updates. During Quarter #8, UO made a deployment of the first version of the Qosium system (Qosium Probes, Qosium Scope, and Qosium Storage) as a component of the 5GTN facility for 5G!Drones Project. It also made planning of software integration for specific KPI list coming from the Web Portal, and it goes through Trial Repository, LCM, Trial

Enforcement, until it arrives at the Abstraction Layer (Measurement Job Controller) which forward the measurement results from the 5G facility database toward the KPI Monitoring component located at Trial Controller. UO has been planning and maintaining University of Oulu integration and test plan, schedule and resources. It participated in several document creation and review activities. UO has been an active participant in 5G!Drones project integration plan creation; it created the proposal for Integration Test Specification that is included in D4.2.

2-THA contributed and participated actively in WP4 meetings, releases, integrations, and ongoing discussions. WP3 enablers such as security, end-to-end slicing and trajectory calculation of UAVs have been proposed and discussed in detail with scenario leaders and WP4 partners for upcoming trials in 2021. THA was working actively on different features of security enabler for different releases and use-case scenarios. In addition to the technical contributions on security and anomaly detection mechanism, THA started a theoretical study on scheduling algorithms for slicing (inter-slice and intra-slice). The final goal of this ongoing study is to improve the existing resource allocation algorithms for the RAN side. THA contributed and participated actively in WP4 technical meeting and discussions where enablers concerning E2E slicing and trajectory calculation based on MEC services have been addressed. THA has also discussed with scenario leaders and other partners the integration concerns for the upcoming trials of 2021.

3-ALE contributed to this task by assuring the maintenance of the UAV enabler list. Some time has been dedicated to keep this list as updated as possible since from now on, maintenance of 5G enablers (both UAV and facility enablers) will be kept in release plan, task 4.1. Besides, ALE has contributed to this task by providing useful information regarding the status of its own enablers and especially, by providing the estimated release dates of them. ALE also worked in the definition of its own use case architecture for integration purposes. During Quarter #8, ALE has contributed to this task by providing inputs to D4.2. Concretely, information regarding the functionalities which are going to be released on each Release Cycle was provided. Besides, ALE has also provided information regarding UAV enablers interfaces. Internal discussions were held within ALE team in order to add/remove/update these interfaces in order to have a clear idea hoy our components are going to be integrated during the releases.

4-INV has been updating the requirements for Traceability Matrix for Web Portal1 and Facility Web Portal. In December, INV worked on the first prototype of Web Portal1 and in January INV provided the first release. INV updated the release plan for Web Portal development. INV has been collecting inputs and preparing the content for Rel. 3 description in D4.2. During Quarter #8, INV continued its work related to integration and testing of Web Portal1 with IAM from THA and repositories (managed by AU). This required coordination and information exchange between partners to remove inconsistencies, bugs and development of further functionalities defined in the Web Portal1 requirements. INV is able to save and modify UAV and Operational Flight Plan, add new users and assign them the roles, redirect the experimenter to relevant Web Portal2, depending on selected 5G facility.

5-HEP contributed to the release planning and to D4.2 release 4 part. Also, refined integration plans for UC3Sc1 Sub-Scenario 2. HEP has provided inputs for D4.2, done testing with Dockerising it's software components and tested them on UO server. HEP is also cooperating with UMS to integrate their enabler software with our drones and has done enabler integration testing by testing the streaming of images to Hepta's data cloud from the drone over 4G connection.

6-NCSRD has been contributing in the activities led by DRR in the definition of the integration plan of all the enablers and components needed for the execution of the Athens trials. Moreover, the interactions between the different components are specified, creating an overview of the whole system, both from the experimenter perspective, but as well as from the Trial Controller operation. This content will be included in D4.2. During the Quarter #8 NCSRD has closely collaborated with

DRR in the preparation of the overall architectural figure that depicts the integration components of the project, where the mapping with the respective functional components of the 5GENESIS platform has been performed. This activity has been performed as part of D4.2, where NCSRD together with the rest 5GENESIS platform related partners i.e. COS and MOE will report on the components, such as the U-Space, the will be integrated in the Athens platform in order to support the experimentation.

7-AU is continuing the integration of its developed modules. For the "repositories" module, AU has been coordinating with different module owners where connection to the repositories module is required (including INV for Web Portal1, NOK for LCM, RXB for Trial Validator, and FRQ for U-Space adapter). AU has coordinated with INV and THA to host Web Portal1 and IAM module. During Quarter #8 AU has worked on the integration of the repository module with Web Portal1. The two modules are respectively developed by AU and INV. To this end, AU has performed several meetings with INV and changed the repository module accordingly. AU also coordinated with EUR to integrate the Web Portal of the latter with the repository module. In addition, AU worked on the integration of its Web Portal with Web Portal1. To this end, AU implemented functionalities to enable http redirection to its Web Portal. AU has also assisted EUR in integrating its facility adapter with the gateway of the Abstraction Layer. The latter is hosted at AU trial site. Moreover, AU worked on ensuring tunneling connection to the facility Adapter of EUR. Furthermore, AU has been coordinating FRQ and RXB integrating the trial validator with repository module.

8-COS has supported T4.1 activity on initial and amended integration plan approach and has completed the contribution expected in this task as part of the previous reporting period. Even though COS plans to follow the activity as necessary, no significant effort shall be reported for this task.

9-AIR led and contributed to the final design of the trial relative to use scenario UC2Sc1 detailing the enablers from WP2 and WP3, their interactions, their deployments, and the detailed architecture of the facility before upcoming trials. AIR has prepared new application containers for next trial session planned in June.

10-UMS has been, as leader of WP4, responsible for organising and leading WP4 bi-weekly meetings. UMS has provided inputs on the release plan excel both in its capacity as the owner of UC2Sc2 and as a participant in UC4Sc1. UMS has also integrated with the FRQ UTM platform as part of efforts for the simulation testbed testing. Within Quarter #7, UMS has also integrated preliminary versions of their enablers with the NCSRD edge infrastructure. UMS also provided feedback on the D4.2. During Quarter #8 UMS engaged in discussions with DRR and relevant 5G facility partners to define and finalise the deployment architecture, role of each partner during the trials, and integration plan. A final description of these aspects will be provided within D4.2. UMS also expended efforts in providing required contribution regarding its enablers in D4.2.

11-INF made initial comments on D4.2 and internal activities for contributions to D4.2 in sections 1.1, 1.2, 1.3, 1.4 and in 3.2.3 and 3.2.4 (with focus on Athens UC4) from non-technical business and communication perspective. It has been monitoring and analysing T4.1 activities from a business perspective, communicating the results through social media and website, linking T4.1 activities to T4.2, T1.1 and T5.1 for evaluating business impact.

12-NOK contributed to the release planning. NOK has delivered to the release plan information of NOK enablers and updated LCM's RTM list. It has contributed to D4.2 to chapter 2 Testing approach and participated to workshops with partners.

13-RXB contributed to Traceability Matrix (RTM), sequence diagram, and release planning. RXB also contributed to validating the requirements and interfaces for Trial Validator. RXB contributed to Task 4.1 activities by having multilateral coordination calls with several partners in preparation for the deliverables.

14-EUR has tested several interfaces in order to verify the compliance with the 5GEVE cloud native platform during the pre-trial tests in December. EUR has contributed to D4.2 providing details on the 5GEVE facility API and KPI measurement components. EUR is working with AIR to integrate and test a new version of the MCS application to be used during the trial. EUR has successfully integrated the EUR's Web Portal2 with Trial Repository (Hosted in AU) and it has successfully integrated the EUR's Trial Adapter with the Abstraction Layer gateway (Hosted in AU).

15-DRR is the Task leader. It updated the release plan sheet (alignment with enablers list of T3.4). It updated D4.2 - drafting chapters related to delivery and release plan: scope of release planning, structure of delivery related chapters; selection and assignment discussion on release owners. There was technical continuation of work related to the definition of plans and prioritisation. DRR did preparation of Release plan update summary mail with next steps to be taken and preparation of Integration Validation Release plan (scope, goals, outcomes, tasks) and appropriate mailing. There was also preparation of summary for virtual F2F meeting (T4.1 update and plans, D4.2 status, release planning status) and preparation of presentation. As an activity related to the standardisation DRR is working on JARUS WG-5 document: WHITE PAPER: USE OF MOBILE NETWORKS TO SUPPORT UAS OPERATIONS. Familiarisation with overall solution architecture. It maintains tasks related to Gitlab and has done preparation for integration activities. DRR has ownership and maintains process of project's inventory (enablers list, release plan, pre-trial list, etc) - discussion with UMS, AU, THA, and CAF. DRR did preparation of architecture function roles and responsibilities - response to project's risk registry item related to lack of integration strategy.

DRR has done internal brainstorming and planning - proposal of the release documentation (Interfaces' inventory, guidelines for deployment). It has prepared tools for managing integration architecture (inventory sheets, diagrams); Gathering updates to use case specific deployment architectures - meeting with HEP and UO on US3Sc1 Sub-Scenario 2. DRR did preparation and scheduling coordination of integration alignment meetings with facility representatives and use case owners/contributors - dedicated meetings for each use case. It prepared minutes, conclusions, deployment architecture diagrams and component integration sheets preparation, and updates, planning further steps - defining questions/issues to be addressed/resolved. DRR did technical analysis for connection with facilities and a feasibility study for SW deployment on EDGE. It made analysis of testing automation frameworks - review of Robot framework.

16-CAF has contributed to the Integration Release 1 planning table: organised enablers list and divided it between scenarios. CAF participated in integrations work with CAFA CUP and FRQ, DRR UTM systems. CAF planned and prepared integration actions for Dashboard. CAF has provided contributions to Integration Release 1 D4.2 document and separate drawings describing the Integration Release 1 architecture for each facility. CAF also started integrating Dashboard and Web Portal1.

17-FRQ worked with various partners on integrating the UTM system via the U-space adapter. Integration session and discussions were supported to allow UTM integration based on currents industry standards and recommendations. Main focus on integrations currently lies with Telemetry and UVR data. Operations Plan integration has begun and start to show first positive results, it will be continued in the next period as well as other U-Space integrations. FRQ supported RXB in providing and aligning a release plan for the Trial Validator.

18-OPL made preparation for contribution to D4.2. It contributed to D4.2 (chapters 1 and 2, and review of the rest of the document).

19-MOE has participated to the bi-weekly telcos dedicated to the Athens trial site. It made contributions to the definition of the components for the feasibility trial and has supported the planned

activities for the (June and October 2021) for the Egaelo demonstration in stadium "*Stavros Mavrothalasitis*".

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

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 in December 2020 was on preparing and conducting remote feasibility tests using the EURECOM facility. These tests were performed as planned and gathered a lot of useful information. The summaries are described in the EUR remote feasibility tests in December 2020 Report. From January, the preparation and preparatory activities of the 2021 trials plan began. The D4.3 trials plan has been created, to which many partners have contributed in January-February 2021. CAF led the preparation of the D4.3 Trials plan document. The D4.3 document has been contributed by all partners and a comprehensive document has been completed addressing all relevant factors affecting the conduct of the Trials, i.e. regulatory, security, and safety aspects. The grand plan is to conduct Trials in a total of four phases, respectively, after each Integration release in 2021-2022 and trials will be conducted at all four facilities. D4.3 will contain a detailed description of Measurement methodologies. A comprehensive overview of the Feasibility tests conducted in 2020 is also included. In June 2021, it is planned to introduce the latest changes and start the D4.3 internal review process.

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

1-UO participated to 5G!Drones integration and trial/pre-trial planning activities. It has coordinated with 5GTN dedicated Use Case owners on facility developments and readiness towards pre-trials. UO provided a full functional test description using Qosium and Nemo tools. It made a presentation of Qosium tool via emails and meetings to WP4 partners. UO provided a description of the Trial Site Measurements to be performed as part of 5GTN. It provided a description of the KPIs, tools, dates, and procedures to be performed in the trial execution at 5GTN and collection of trial results in the D4.3. UO made a description of the Qosium metrics, trials evaluations objectives, measurement methodology in section 3.4 of the D4.3. UO has contributed in the first trials planning.

2-THA has contributed in Task 4.2 in order to enrich the ongoing discussions for planning the pre-trials and trials, which will take place in 2021. Enablers, such as security and trajectory calculation for UAVs (based on the network quality – RSSI) were planned for integration. THA prepared the ground for defining the essential links between WP3 enablers and WP4 activities in order to be coherent with the general architecture of the 5G!Drones project and use case scenarios. Furthermore, THA has participated in discussions for the integration, preparation, execution and validation of trials and collecting the related KPIs (business and technical). Different trials considered towards the final use-cases. On the other hand, THA and UO have started the initial discussions on the end-to-end slicing. THA is currently evaluating the potential of using this enabler with UO's existing platform. THA is working on an ongoing study on the scheduling algorithms. THA has participated to planning of the trials, which will take place in 2021. Enablers such as security and trajectory calculation for UAVs (based on the network quality – RSSI) were planned for integration. THA has also participated to technical meetings regarding development and testing platform.

3-ALE has made contributions regarding the New EU Regulation framework. Since the 31st of December 2020, a new EU regulation framework is replacing each EU state's existing laws with respect to drone's operations. Thus, there are some things that must be taken into account with respect to the operation as well as the administrative procedures. ALE has contributed to this task by providing an overview of this new regulation and explaining the particular case in France during the transition period defined by the EASA. These contributions were provided to the upcoming D4.3 deliverable, section 2.4. ALE has also started to contribute to D4.3 regarding the trial plans by providing the architecture, the enablers and how them are going to interact with the UO infrastructure in the trial's phase. ALE has worked extensively on this task by providing contributions to D4.3: 1-technical specification of its scenario and how the scenario is going to be trialled at UO; 2- information regarding the regulation UAV flights in EU. Besides, ALE has also worked in preparing schedule and the technical aspects of the trial section which will take place at the beginning of July.

4-INV participated in the preparations to pre-trial in EUR and giving feedback to the report produced after the pre-trial in EUR. INV worked together with CAF on preparation to the next phase of tests in May-July 2021. As the UC1Sc1 owner, INV contributed to D4.3, the chapter 4.1.3 describing the experiment overall architecture and planned tests for UTM Command and Control Application. INV also contributed to chapter 3.4 developed by COS by adding our points to the list of evaluation objectives for the 2nd year trials.

5-HEP Followed the lessons learned from Oct 2020 feasibility tests in Athens and searched for ways to optimise air transport costs of Hepta's drone needed for trials in Greece and France. This involves arranging a new transport crate, redesigning the battery configuration of Hepta's heavy lift drone in tethered mode and facilitation of disassembly for transport. HEP also did internal planning for UC3Sc1 Sub-Scenario 2. HEP has applied for permits for the trial in Oulu, flight tested WP3 enablers in

preparation for the trial of UC3Sc1 Sub-Scenario 2 and contributed to D4.3. HEP has also done design work in preparation for a mock-up test track for UC3Sc1 Sub-Scenario 2 and is planning to start constructing the mock-up track elements within the reporting period.

6-NCSRD has contributed in the definition of the pre-trials and trials according to the plan that has been provided by CAF. For the forthcoming period, the definition of a trial in June 2021 in 5GENESIS platform utilising the Open-5GENESIS platform enhanced with on-board UAV monitoring component (COSMO-tool) is foreseen and a trial in October 2021 at Egaleo stadium supported by CAF and HEP drones is also planned. During Quarter #8, NCSRD has contributed in D4.3 by describing two pre-trials that will take place in Athens platform (both of them at COSMOTE premises), as well as one trial that will take place in October at Egaleo stadium "*Stavros Mavrothalasitis*".

7-AU did not perform real field trials during Quarter #7 that coincided with a holiday period and difficult weather conditions. However, AU has been closely following the feasibility test conducted at EUR trial site. In parallel, an initial planning for the next trials at AU has been established internally. During Quarter #8, AU was preparing for the feasibility test at Aalto University's trial site planned for June 2021. To this end, AU has been mapping the campus to look for a suitable area with good coverage to perform the trails. AU has been coordinating with CAF on this matter, as the latter will run their use case scenario at AU trial site. Furthermore, AU was also coordinating internally (with the site manager of the university) to ensure the availability of the network during the trial period (as the facility is shared with other teams of the university).

8-COS has prepared the harmonised template to document the trials' measuring methodology and tools in the form of a live excel document, that has already been populated with the data from the 1st year feasibility tests across all testbeds. COS has also prepared as part of this task the Openstack environment to support the simulation execution environment. COS has also initiated the adaptation of the COSMOtool mobile app, to automate the metrics collection process. During Quarter #8 COS continued the integration activities for the execution of the trials at the OTE Academy using the MEC/LBO installation including the execution of a first feasibility trial at the OTE Academy site using the simulation environment. Also, COS orchestrated the data gathering and provided the initial content for Section 3.4 of D4.2.

9-AIR led and contributed to UC2Sc1 trials plan. This plan will be a part of D4.3. To be noted that this plan may dynamically evolve with regards to Covid-19 restrictions. AIR contributed to D4.3 and coordinated contributions to sections relative to UC2Sc1 trials ensuring partners' alignment. AIR has conceived and released a new version of the media streaming library that should cope with the instability of the Open Air Interface used in 5GEVE platform and that was observed during feasibility tests.

10-UMS has been, as leader of WP4, responsible for organising and leading WP4 bi-weekly meetings. Additionally, within Quarter #7 UMS shipped their simulation testbed to NCSRD and conducted a preliminary test to validate functionality of all system components along with network connectivity and communication. UMS has conducted simulation trials for UC4Sc1 based on the simulation testbed that has been developed with support from NCSRD and COS. A detailed report on the results of the simulation trials and next steps will be provided in D4.3.

11-INF has done internal processes for monitoring and analysing performed trials activities as communication and business liaison of WP4. INF has done Pre-Trials reporting and communication material preparation. It has reviewed D4.3 ToC, initial structure and drafts. Discussions and action for involved partners to link technical KPIs and metrics to business KPIs and impact. INF has been analysing T4.2 activities from a business perspective, communicating the results through social media and website, linking T4.2 activities to T4.1, T1.1 and T5.1.

12-NOK Created a "Pretrials plan UC3Sc3 Location of UE in non-GPS environments" document with partners. NOK has also analysed internally T4.2 activities from a business and dissemination perspective. Contribution to D4.3 via Nokia plans for Trials in UO chapter 2.2 and Nokia led scenario chapter 4.3.6. NOK has kept several internal planning sessions and tested different UE suitability to NOK use case. Participated to several project integration workshops.

13-RXB reviewed ToC for D4.3, and actively contributed to technical discussions related to KPIs and worked closely with NOK, NCSRD, COS, and other partners involved in the topic discussion. RXB was also actively involved in planning and coordination activities related T4.2. During Quarter #8 RXB actively contributed to D4.3 and activities related to trial preparation.

14-EUR dedicated two weeks in December for the first pre-trial tests on the 5GEVE facility. Four preparation meetings have been dedicated to the preparation of the pre-trial and two days involving different persons (3) to run the tests. EUR has deployed both CAF and AIR applications on the clusters. EUR provided two phones for AIR MCS tests. EUR provided a secure way to allow CAF to access remotely to their run application. The solution was developed specifically for the pre-trials. EUR has provided a how-to document to allow partners to deploy a cloud-native application. EUR is working with ALE to check the UAV authorisations with the local regulator in order to run trial on EUR premises. EUR has contributed to D4.3 regarding updated information on the 5GEVE facility.

Deviation and corrective action:
Due to Covid-19 the Pre-Trial tests were conducted remotely.

15-DRR provided assistance to feasibility tests by coordination of preparatory activities to feasibility tests at EUR. It contributed to online feasibility tests and initial review. Implementation of technical requirements for EUR tests was done, including FRQ connector adoption and DRR UTM reconfiguration. DRR did a review, update, and alignment of DRR's U-Space adapters delivery and release planning with Pre-Trial planning. It did feasibility testing using UMS simulation solution discussion with partners (RXB, UMS, CAF, NCSRD). DRR did standardisation activities related to the U-Space adapter (flight planning and airspace definitions). It is working on tasks with FRQ team. DRR did preparation of the contributions (Chapter 2.3) to the D4.3: description of integration releases and their relation to on-site pre-trials, trials and showcasing.

16-CAF team main focus in December 2020 was on preparing and conducting remote feasibility tests using the EUR facility. These tests were performed as planned and conducted smoothly. The conclusions are described in the EUR remote feasibility tests in December 2020 Report. From January, the preparation and preparatory activities of the 2021 trials plan began. The D4.3 trials plan has been created by CAF who is leader of D4.3, to which many partners have contributed in January-February 2021. CAF has contributed a lot of texts to the D4.3 and organised trials planning activities of all partners. CAF added updated scenario descriptions and architectural drawings to document D4.3, for the scenarios led by the CAF. Summaries of 2020 Feasibility tests were also included in the upcoming D4.3. In addition, the CAF began applying for permits to conduct physical tests in June-July 2021 at AU and UO locations.

17-FRQ contributed to T4.2. by analysing and reviewing architecture and sequence diagrams to prepare and align the trial runs, especially with focus on KPI management, Trial LCM and Trial Validator. FRQ provided UTM related content for D4.3 Trials plan document, with focus on chapter 3.6. Additionally, FRQ supported the overall trial and feasibility planning activities and coordination.

18-OPL did no specific activity for the Task during the Reporting Period apart from preparation of contributions to D4.3.

Deviation and corrective action:
In OPL travelling abroad is still banned due to the coronavirus situation. More active participation to trials will be possible once the ban is recalled.

19-MOE provided assistance to feasibility tests and preparatory activities to feasibility tests (June and October 2021) in Egaleo stadium "*Stavros Mavrothalasitis*" supported by NCSRD, COS, CAF and HEP. MOE is also contributed to UC4Sc1 trials plan. This plan is part of D4.3. Contributing in D4.3 ToC, initial structure and drafts. MOE has contributed in the definition of the trials according to the plan that has been provided by CAF.

20-ORA made a report of the technical tests of Interference measurements carried out by Orange France in December 2020. It has made preparation of coverage tests measurements (tools, methods, planning).

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:
WP5 has kept its course in spite of Covid-19 situation and all its related activities were maintained:

- All communication channels were kept updated with news and activities.
- Website and social media channels kept posting news and dissemination activities on a weekly basis.
- Statistical dashboards were issued and circulated on a monthly basis.
- Partners have still been focused on producing relevant IPRs.
- 5G!Drones project partners have followed up contributing to SDO and contributed to 5G-PPP Pre standardization WG.
- 5G!Drones partners have set up an exploitation strategy and identified a list of exploitable outcomes from their research work.
- 5G!Drones project participated to events, publications, articles, etc.

Significant results
D5.2 was finalised and published in time. Significant steps towards the broad range dissemination were undertaken, since in June 2021 the project will be presented at EUCNC2021 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. Articles at major journals, disseminating and communicating the project activities' progress were performed.

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

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

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

Task Activities during the period:
During the reporting per period all communication channels were kept updated with news and activities. Website and social media channels kept posting news and dissemination activities on a weekly basis (a min average of 2 posts per week). Statistical dashboards were issued and circulated on a monthly basis. Newsletter issue #7 was released and the issue No 8 is under editing (to be released early June). D5.2 was finalised and submitted with communication details and update of communication plan for period M1-M21. Special statistical dashboards were developed for the reporting period M1-M21 (included in D5.2) and more are under preparation (M19-M23 and M1-M24). 5G-PPP activities, events, newsletters, and newsflashes were communicated internally to the Consortium and over 5G!Drones communication channels.

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

1-UO has prepared and submitted a journal paper for publication in IEEE transactions on Communications, which is under major revision. It has maintained the project's online repository. UO has also contributed to Deliverable D5.2 on communication, dissemination, and exploitation topics. UO has contributed to D5.2 by acting as a project internal reviewer.

2-THA had internal discussions regarding THA activities in the scope of 5G!Drones. Also, presentation of the project to THA entities in order to integrate them as third-party partners. THA has organised an internal technical meeting where outputs of 5G!Drones project have been presented. THA and EUR have collaborated on a trajectory computation system. The results of this collaboration have been submitted to an IEEE conference to be presented.

3-ALE did not contribute to this Task during the Reporting Period.

4-INV was active on social media and posting the updates about 5G!Drones project. INV was following social media and social media strategy and steps. INV has presented the 5G!Drones project activities to Belgian partners, with which it cooperates on another projects.

5-HEP does not partake in WP5.

6-NCSRD (Dr. Harilaos Koumaras) has communicated during the reporting period the project activities by presenting in the following events:

- Invited speaker at **Drones 3S Project Conference on the results of UAV Trials on top of 5G Athens Experimental Network**, Virtual Event, January 2021 (**Youtube Video**)
- H. Koumaras: Invited speaker at Winter School on 5G and IoT with title IoT in 5G: The use-case of 5G-enabled UAVs as IoT nodes.
- Invited speaker at 5G-PPP Technical Board eWorkshop with title «5G-enabled UAVs supporting advanced multimedia services", Virtual Event, December 2020
- Invited speaker a Xchanging Ideas – Global 5G Evolution with title «Field Trials of 5G-enabled UAVs on Private Infrastructures», Virtual Event, December 2020 (**Video**)

During the reporting period, Dr. Harilaos Koumaras from NCSR "Demokritos, 5G!Drones partner, provided an interview at Startupper Magazine (in Greek) providing insights about NCSR "Demokritos" pioneering activities in 5G research and EU 5G-PPP projects. Special mention is made to 5G!Drones project and its 5G activities. 5G!Drones was present at the Athens Science Festival 2021 with a demo video of the Use Case 4 Athens trials (video produced and edited by CAFA Tech, NCSRD and INFOLYSIS partners). More info at https://www.athens-science-festival.gr/.

7-AU has provided its inputs related to the exploitation plans. AU has also elaborated and provided the list of its exploitable outcomes. AU has contributed to the deliverable D5.2. With regards to section 4, AU provided its inputs related to its exploitation plan and its exploitable outcomes. With regards to section 3, AU updated the list of publications made by AU and communicated them to INF.

8-COS had no contribution in this Reporting Period for the Task.

9-AIR has supervised this task as WP leader. AIR has contributed to article for sixth edition of 5G-PPP annual European journal. AIR has presented 5G!Drones outcomes to Belgium operator Proximus for future exploitation possibilities.

10-UMS had no contribution in this Reporting Period for the Task.

11-INF did coordination of T5.1 activities and participation WP5 actions. It is maintaining the project website and News section (updates, content creation, news, posts, uploads) and running all social media accounts (Twitter, LinkedIn, Facebook, Instagram, YouTube) - updates, posts, videos, reply to comments. INF did development of monthly statistical dashboards for monitoring the performance of web site and social media (Dec, Jan, Feb). It is maintaining in Teams the communication activities repository. INF edited and released the newsletter issue 6 (Sept-Nov) at the middle of December and Issue 7 (Dec-Feb) released in middle of March. INF is preparing and editing newsletter Issue 8 (Mar-May) (to be released middle of June). INF did special statistical dashboards preparation for including them in D5.2 (June 2019 – February 2021 period) and also development of monthly statistical dashboards for monitoring the performance of web site and social media (March, April, May). There are more statistical dashboards under development (M1-M24 and M19-M23) for additional reporting. It made contributions to D5.2 (communication chapter 2, M1-M23 communication activities and update on communication plan) and review of it. Communication of 5GPPP newsletters, newsflashes, publications and activities and tag of 5G-PPP in all our communication activities. INF is monitoring all

running WP1, WP2, WP4 and WP5 tasks for reporting and communicating activities and results. INF prepared digital communication material for the 5G!Drones EuCNC2021 virtual booth.

12-NOK had internal discussions regarding NOK activities in the scope of 5G!Drones and preparing materials to present 5G!Drones to the customers as a reference point to understand UAV/UAS potential to their future businesses from 5G and applications point of view. NOK also had an internal workshop related UAV. Internal planning was done for a PR like a blog or video.

13-RXB has been actively involved in the project developments communication on EU-level, with relevant academic and commercial stakeholders from both the advanced communications and UAV verticals domains. RXB has led the successful elaboration and finalisation of D5.2. RXB has also contributed to the high-level context communication of the project advancements and milestones, incl. showcases, at various events and interdisciplinary thematic committees, e.g. at EASA (EU), VDI UAS working group (Germany) and others. The whitepaper "AI and ML – Enablers for Beyond 5G Networks" was published in the context of 5G-PPP with a significant contribution from RXB.

14-EUR had no contribution for this Task during Quarter #7. During Quarter #8 EUR contributed to the deliverable D5.2. For section 4, EUR provided its inputs related to its exploitation plan and its exploitable outcomes. For section 3, EUR updated its list of publications.

15-DRR does not partake in WP5.

16-CAF contributed by communication work after remote feasibility tests in EUR in December 2020. The CAF team prepared a summary video covering important aspects of the December 2020 EUR tests. The video has been published on Youtube and on the 5G! Drones project website. During quarter #8 CAF continued the communication activities related to 5G!Drones' activities on the CAF website, which consisted of updating the content of the website.

17-FRQ contributed by publishing social media posts on the various social media channels. Besides, FRQ reviewed book chapter: 5G and Unmanned Aerial Vehicle (UAV) Use Cases and reviewed the 6th issue of newsletter. Newsletter was posted on social media account. FRQ reviewed the Deliverable D5.2 and the 7th newsletter.

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

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

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:
5G!Drones project partners have followed up contributing to SDOs in which they had already been

active in previous periods, in particular 3GPP (RAN2, RAN3, SA2, SA6), IEEE on 5G and UAS, ASTM, participated also to ACJA WT1, WT2 and WT3, and had a specific contribution to ANFR interference tests reports. 5G!Drones partners are also contributing to 5G-PPP Pre-standardization WG. 5G!Drones partners have produced a significant effort on the exploitation chapter during this reporting period. They have defined a complete methodology for their exploitation strategy (explained in D5.2) based on a mix of well proven methodology (including Value Proposition Canvas methodology and Lean Canvas methodology) and they have identified exploitable outcomes for which it can be applied, including 37 assets among prototypes, demonstrators, publications, patents, etc. Moreover, Each partner has released an update of its exploitation plan after two years of collaboration in the framework of 5G!Drones projects (Updated plans are available in D5.2).

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

1-UO had no reported effort on this task between December 2020 and February 2021. During Quarter #8 UO provided inputs to D5.2 by defining a number of exploitable outcomes and updating its exploitation plan.

2-THA continues to follow closerly the evolution of standards and pursues the monitoring of standardisation activities at RAN2 and RAN3 working group.

3-ALE has participated in discussions regarding the IPR development. Internal discussions about this topic were also carried out by ALE's team. Internal discussions regarding the exploitation of results were also held. ALE has contributed to this task by providing the information regarding the Standardisation. Besides, ALE has provided the dissemination and exploitation plan for the second term of the project.

4-INV is participating to ACJA activities in WT2, where recently the document "ACJA Interface for Data Exchange between MNOs and the UTM Ecosystem: NetworkCoverage Service Definition v1.00" was published. INV was participating in creation and review/commenting of this document. INV is co-leading the ASTM standards working committee on the topic of SSDPs (supplemental service data providers) – meetings are held once per week, with additional work spent on preparing the meetings and the strategy by the 2 co-leads. INV is also participating in bi-weekly ACJA meetings of WT2. In the last months has been participating to the T5.2 meetings on standardisation activities and prepared the update of report on INV effort and plans for the next year.

5-HEP does not partake in WP5.

6-NCSRD does not partake in Task 5.2.

7-AU has been checking for suitable groups related to UAVs within IEEE Standards Association to contribute its ongoing work on 5G and UAVs.

8-COS has prepared the proposition for the Exploitation Methodology at the project level and has supported the relevant Task activities for the execution of the methodology through the identification and classification of the relevant project results. COS has also updated the individual exploitation plan to be included in D5.2. COS has prepared the contribution for Exploitation Section in D5.2.

9-AIR is the Task leader. AIR has contributed to 5G-PPP Pre Standardization Work Group for ToR and Work Plan Update, as well as B5G/6G Roadmap current action. AIR has also led with COS the setup of a framework in order to identify and rationalize exploitation activities within 5G!Drones. AIR has contributed to 3GPP discussions around UAS in 3GPP SA6 – contributing to architecture for UAS application layer - and CT1 – following discussion on identification. AIR has facilitated and contributed

to collection of exploitable outcomes as well as implementation of exploitation plan for global project as well as individual exploitations plan for each partner as part of D5.2.

10-UMS provided its input to the Exploitation methodology created by COS. Members of the UMS team aligned internally to understand IP related aspects of simulation testbed that was developed within T3.4. The result of this work was documented within D5.2. UMS also provided an update on its exploitation plans which was also documented within D5.2.

11-INF is not partaking in Task 5.2.

12-NOK has contributed with RXB to 5G-PPP Test, Measurement, and KPIs Validation Working Group White Paper "Understanding the Numbers – Contextualization and Impact Factors of 5G Performance Results" to chapter "Coverage aspects". NOK organised a 5G!Drones internal presentation "NOK presentation - 3GPP Rel-17 work on 5GC support of UAS - High level architecture and use cases" by Bell-Labs standardization experts. It participated to 5G PPP TMV meetings and contributed with RXB to two coming white papers.

13-RXB has considered the opportunity for a standardisation of the systemic approach pursued at 5G!Drones. The idea is still do be advised with more partners and the EC. It would enable the 5G!Drones approach to reach a wide range of awareness and involvement of relevant experts and stakeholders, for its further development and market deployment. The RXB team has discussed on the utilisation opportunities for the project know-how and which target groups - industrial and R&D partners, as well as strategically relevant investors in the EU - should be considered. First discussions with such potential partners have been led, at a later stage a broader circle of project members will be involved in the process.

14-EUR is following the MEC standard to find opportunities to contribute its ongoing work on MEC LORA support for 5G!Drones. EUR did not contribute to this Task during Quarter #8.

15-DRR does not partake in WP5.

16-CAF has participated in the European Conference of Postal and Telecommunications Administrations – CEPT Electronic Communications Committee – ECC WG FM 59 meeting and organised an exchange of information with the Estonian Communications Board. This working group is working on how to standardise the use of radio communication equipment, including 5G equipment, by ECCs on board UAVs. During Quarter #8 CAF applied to join the CEPT ECC PT1 working group. ECC PT1 drafts CEPT Reports in response to EC Mandates. These CEPT Reports are the basis either for the update or the development of EC framework. PT1 is currently working on CEPT ECC Report No. 309 "Analysis of the usage of aerial UE for communication in current MFCN harmonised bands", and will develop a position on it by 2022. This report addresses one of the cornerstones of the field of cellular drones (including 5G drones) - the interference from cellular devices onboard a drone to control a drone or used for communication for payload sensor(s).

17-FRQ does not partake in Task 5.2.

18-OPL had no activities on the Task during the Quarter #7. During Quarter #8 it participated in the internal Orange Group 3GPP standardisation workforce discussions and lobbying for the vision of requirements and solutions built within the 5G!Drones project. It provided contribution to D5.2.

19-MOE does not partake in Task 5.2.

20-ORA has on-going activities in standardisation (CEPT, 3GPP, ACJA) and meeting with ANFR to report on interference test results impacts for MNO and regulators. It has submitted a new patent.

ORA made contribution to first draft of TS 23.256 v0.1.0 from 3GPP SA2 Release 17 ("Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2"). It also made contributions to ACJA WT2 and 4, and GSMA DIG. ORA further contributed to IPR plan related to geolocation of drone without using GPS.

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:

The work on Task 5.3 were predominantly focused on preparing the Deliverable D5.2, besides of the constant dissemination activities. Since the project concept covers both the UAV verticals operations and the enabling advanced communication technologies, the integration of both is being disseminated as a high priority topic on the practical, R&D and policy making level. During the observed period the elaboration of D5.2 was in focus for the project team. Large amount of highly quality inputs, e.g. events, publications, conferences, media articles etc., was listed and integrated into the deliverable structure, in order to optimally present the advancements in dissemination and communication. A crucial step was the setting of the future goals in the thematic area for the rest period of the project runtime, including scheduling and organising the project representation at high-level conventions and transdisciplinary media formats. Significant element of the activities in the context of D5.2 were the considerations regarding the market utilization of project outcomes in an optimal manner, serving the societal, economic and environmental sustainability in cities, by introducing advanced communication technological systemic solutions, enabling the sustainable operation of UAV verticals for transportation and mobility purposes.

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

1-UO had no reported effort on this task between December 2020 and February 2021. During Quarter #8 UO gave a 5G!Drones presentation in Finnish UAV Ecosystem stakeholder event. It also initiated the activity to organise a virtual booth in EuCNC 2021. It also participated and contributed to the selection of material to be included in the booth.

2-THA has presented internally the first outputs of the project to other BLs that may be interested. THA has also organised internal meeting where some outputs of the project have been demonstrated.

3-ALE has had discussions regarding the dissemination strategies and activities were held internally. ALE had no contributions on the Task during Quarter #8.

4-INV participated to preparing content to D5.2 document. It updated INV dissemination plan in D5.2 document.

5-HEP does not partake in WP5.

6-NCSRD During the reporting period, NCSRD has lead the preparation of:

- A conference paper to be submitted at EUCNC 2021.
- A book chapter to submitted at Handbook of Research on 5G Networks and Advancements in Computing, Electronics, and Electrical Engineering.

NCSRD published the journal article “5G-Enabled UAVs with Command and Control Software Component at the Edge for Supporting Energy Efficient Opportunistic Networks”, MDPI, Special Issue 5G Enabled Energy Innovation, Energies 2021, 14, 1480. Dr. H. Koumaras is co-chairing the demo session of IEEE Meditcom 2021. NCSRD monitors also the 5G-PPP IMT-2020 activities.

7-AU has worked on the dissemination activities of the project in the form of scientific contributions related to 5G!Drones. During the month of December, AU has presented its accepted paper to GLOBECOM2020. This publication has received the “best paper” award. AU has also published another paper acking 5G!Drones in the conference NaNA 2020. This paper has also received the best paper award. Furthermore, AU has worked on four publications related to 5G!Drones activities. These publications are currently under submission. AU has prepared and edited some papers linked to the activities of 5G!Drones. The papers have been submitted to GLOBECOM2021. In addition, during this period, AU has also edited and submitted a paper (related to the use of mobile networks to support UAV applications) to a magazine, that is currently subject to major revision. Furthermore, AU has also submitted another paper (related to enhancing UAV communication in cellular networks) to an international journal.

8-COS In the reporting period COS has prepared and presented the “5GDrones Athens Trials Scope, Architecture & Challenges” in the Drones 3S Pro conference (in Greece), see **https://www.youtube.com/watch?v=S82hNTULUzA&t=4024s**. Also COS has been a supporting editor to 'Field Trial of UAV Flight with Communication and Control Through 5G Cellular Network' for 2021 EuCNC and has provided a Section contribution as part of IGI Global book chapter preparation"5G and Unmanned Aerial Vehicle (UAV) Use Cases: Analysis of the Ecosystem, Architecture and Applications," for the upcoming book, "5G Networks and Advancements in Computing, Electronics, and Electrical Engineering." During Quarter #8 COS has contributed to the final adaptation and submission of the IGI Global book chapter preparation "5G and Unmanned Aerial Vehicle (UAV) Use Cases: Analysis of the Ecosystem, Architecture and Applications," for the upcoming book, "5G Networks and Advancements in Computing, Electronics, and Electrical Engineering."

9-AIR has supervised this task as WP leader. AIR has contributed to discussions within ACJA and especially recent discussion issued from Ericsson Rel-18 proposal. AIR has contributed to D5.2. for some inputs and corrections relative to dissemination sections.

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

11-INF Maintains in Teams the dissemination activities repository and excel tracking file. It is updating and communicating dissemination activities via website and social media channels. Monitoring SME WG activities: i) 5G-PPP 5G!Drones leaflet for future phase 3 projects publication was re-updated and submitted to 5G-PPP bscw repository, ii) contributing to the new SME planning for Horizon Europe and SNS association structure (position paper), iii) reporting to 5G!Drones consortium on SME WG participation. INF made contributions to D5.2 concerning the grouping and listing of dissemination activities (period M1-M21). It contributed to EuCNC 5G!Drones virtual booth with preparation and provision of digital communication material (photos, leaflet, poster, videos etc.). INF is Monitoring SME WG activities: Contributing to the new SME planning for Horizon Europe and SNS association structure (position paper), **Find your SME** web page was updated, reporting to 5G!Drones consortium on SME WG participation.

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

13-RXB leads the efforts towards Task 5.3. RXB has led the preparation of D5.2. Besides of this, RXB has covered through participating at several key conventions the wide dissemination of the project developments, under all by starting a strategic cooperation with CIVATAglobal. RXB coordinated the activities of the interdisciplinary project team towards the successful elaboration of D5.2 and published the document in time. RXB has participated in a leading role at the preparation of the project representation at several significant events, as for example EUCNC2021 and Amsterdam Drone Week 2021 / Commercial UAV Expo 2021.

14-EUR led the revision of the paper which has been finally accepted in IEEE Vehicular Magazine on the integration of UAS and 5G. EUR has a paper accepted in IEEE ICC 2021 acknowledging 5G!Drones on network function placement in a Cloud-Native environment. EUR has submitted a paper to Elsevier's Computer Communication journal and its activity on 5G NR Network slicing.

15-DRR does not partake WP5.

16-CAF has carried out Dissemination activities primarily through the CAF website and professional meetings with the Estonian Air Traffic Service and other stakeholders. CAF prepared showcasing plan for Tallinn showcasing event in May 2022 and added it to the D4.3.

17-FRQ had no contributions in this Task during Quarter #7. During Quarter #8 FRQ prepared and actively contributed to the first concept for CUAV Expo Europe 2021. Together with RXB and UO, FRQ prepared the digital communication material and design of virtual booth for EUCNC & 6GSummit.

18-OPL prepared contribution to the IGI Global book chapter "5G and Unmanned Aerial Vehicle (UAV) Use Cases: Analysis of the Ecosystem, Architecture and Applications" for the upcoming book "5G Networks and Advancements in Computing, Electronics, and Electrical Engineering". It made contributions to D5.2. OPL prepared the IAIA2021/5G-PINE conference paper "High mobility 5G services for vertical industries - network operator's view" acknowledging the 5G!Drones project.

19-MOE has been updating and communicating dissemination activities via website (**www.aigaleo.gr**) and social media channels of MOE regarding the forthcoming feasibility tests in Egaleo stadium "*Stavros Mavrothalasitis*" in June 2021.

20-ORA does not partake in Task 5.3.

8.5.1. Exhaustive list of dissemination and exploitation activities performed between M19 and M24

This subsection describes the dissemination and exploitation actions carried out during the Reporting Period. Social media dashboards are only available up until the end of May 2021 at the submission of this deliverable. An exhaustive description of communication, showcasing, dissemination, and exploitation achievements and plan for the second term of the project has been conducted in D5.2, submitted at M23.

8.5.1.1. Social Media

The 5G!Drones project tracks its social media impact on a monthly basis. The project social media links have been defined in Deliverable D5.1 and D5.2. In the following, an overview of the various social media channels is shown during the period from December 2020 to April 2021 (reporting also May is not feasible as its statistics will be available only after the submission of this Deliverable). The overviews are in a form of dashboard reports. They are live data updated regularly. The Website, Twitter, Facebook, LinkedIn, and Instagram use statistics are illustrated in Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5, respectively.

The 5G!Drones project has established its official website available at **www.5gdrones.eu,** 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/ee0a74b2-e31b-4085-ae6f-d2b095dbe3d5**.

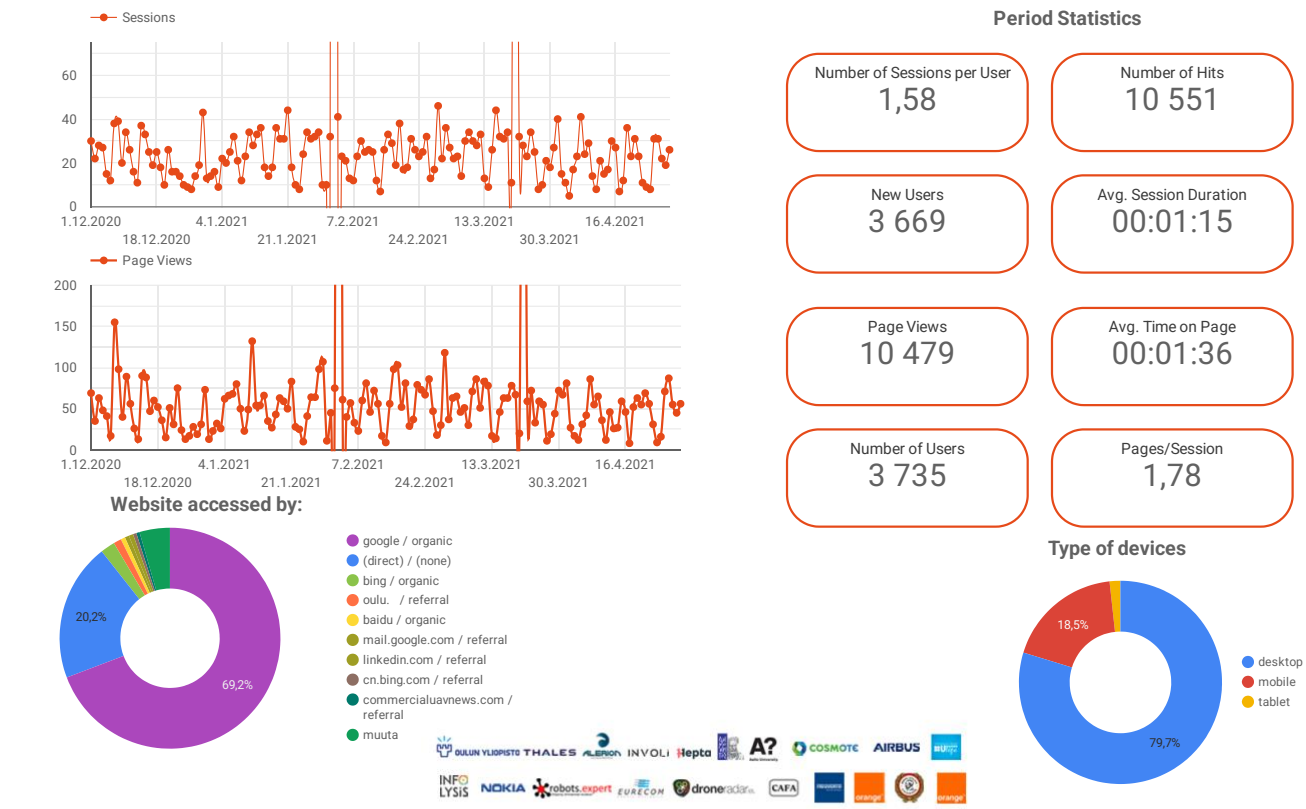

Figure 1: 5G!Drones Website Statistics/Dashboards, December 2020 – April 2021.

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/hPj4qQ5P5go7Fer6NJxGOQ

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/6fca8fb9-d81d-4b3b-b7a8-09086463a001.

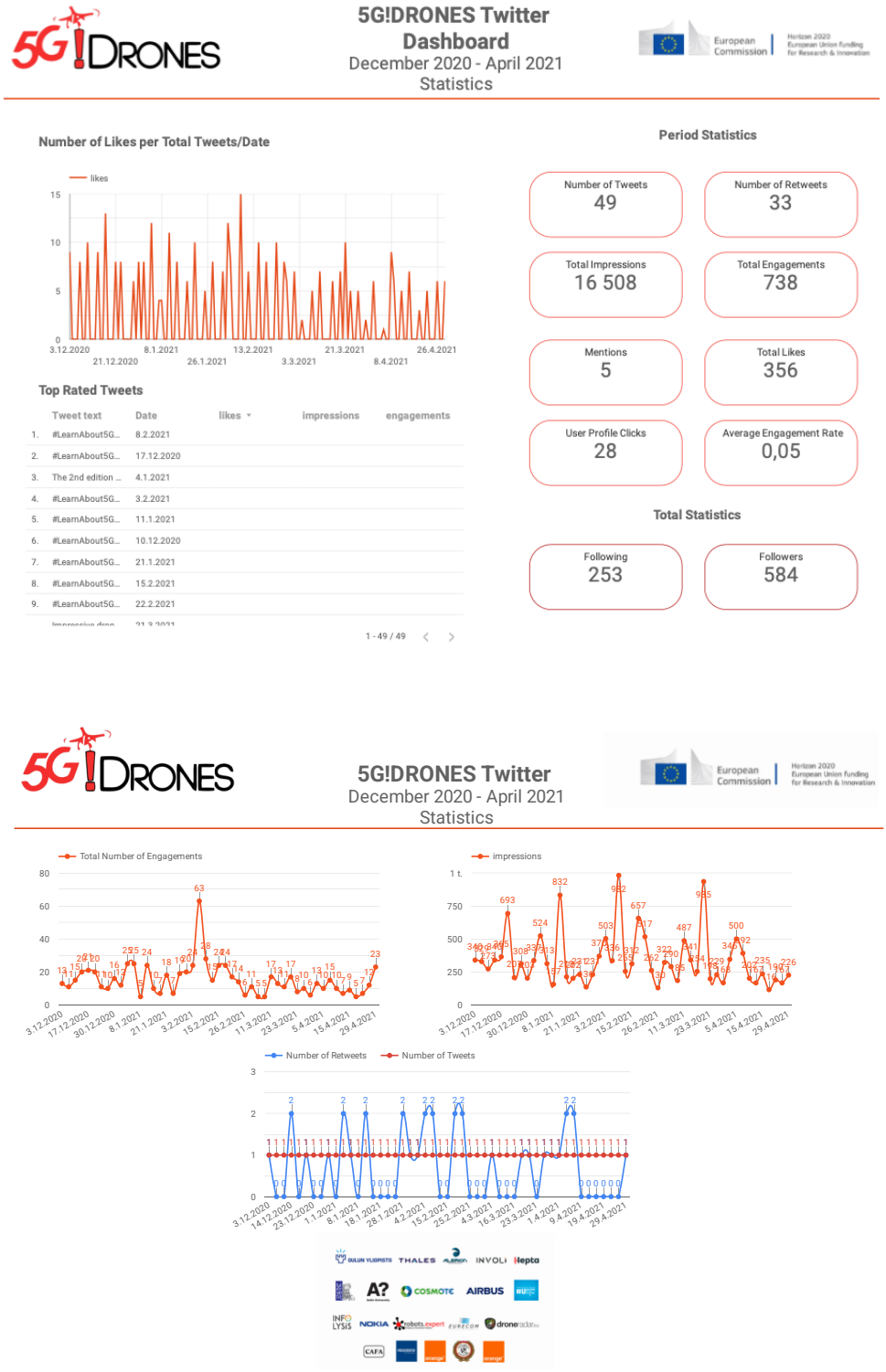

Figure 2: 5G!Drones Twitter Statistics/Dashboards, December 2020 – April 2021.

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/dedb2437-d56c-4359-8fad-06e02938c95c.

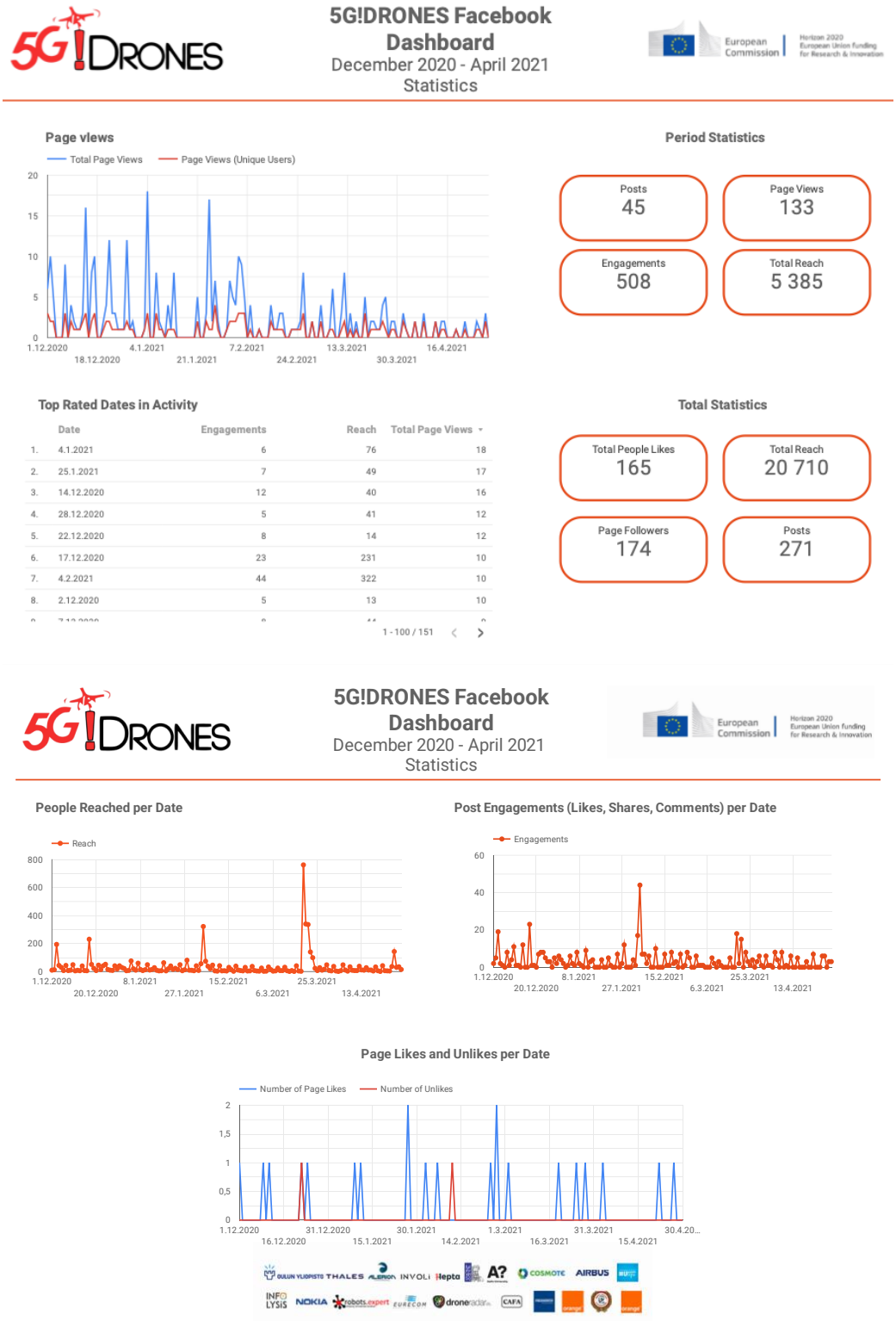

Figure 3: 5G!Drones Facebook Statistics/Dashboards, December 2020 – April 2021.

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/513fd689-4e4b-4d76-be69-e80ec4885ade.

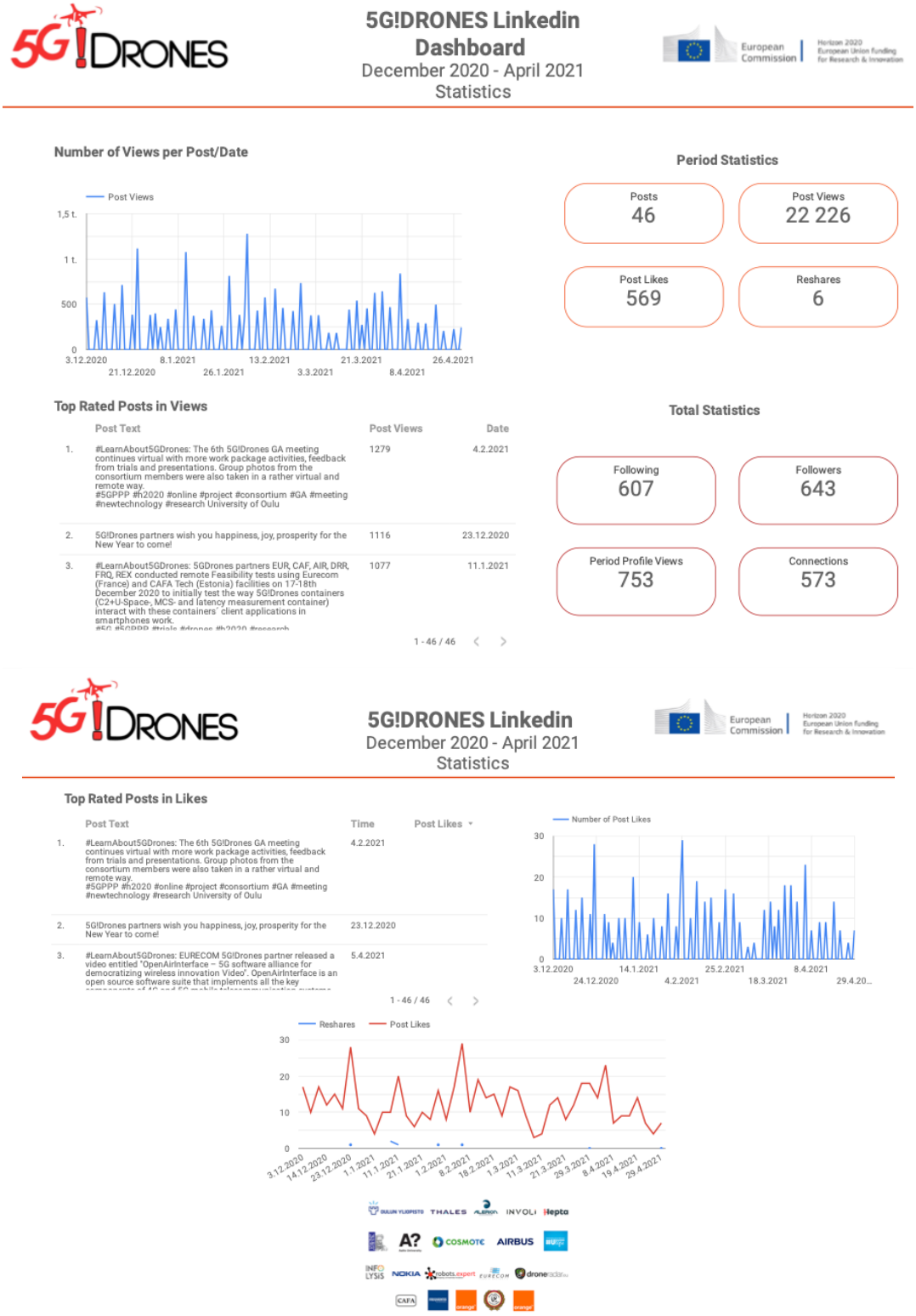

Figure 4: 5G!Drones Linkedin Statistics/Dashboards, December 2020 – April 2021.

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/8bb8b52b-533e-429d-807d-69fb5b97bb5c.

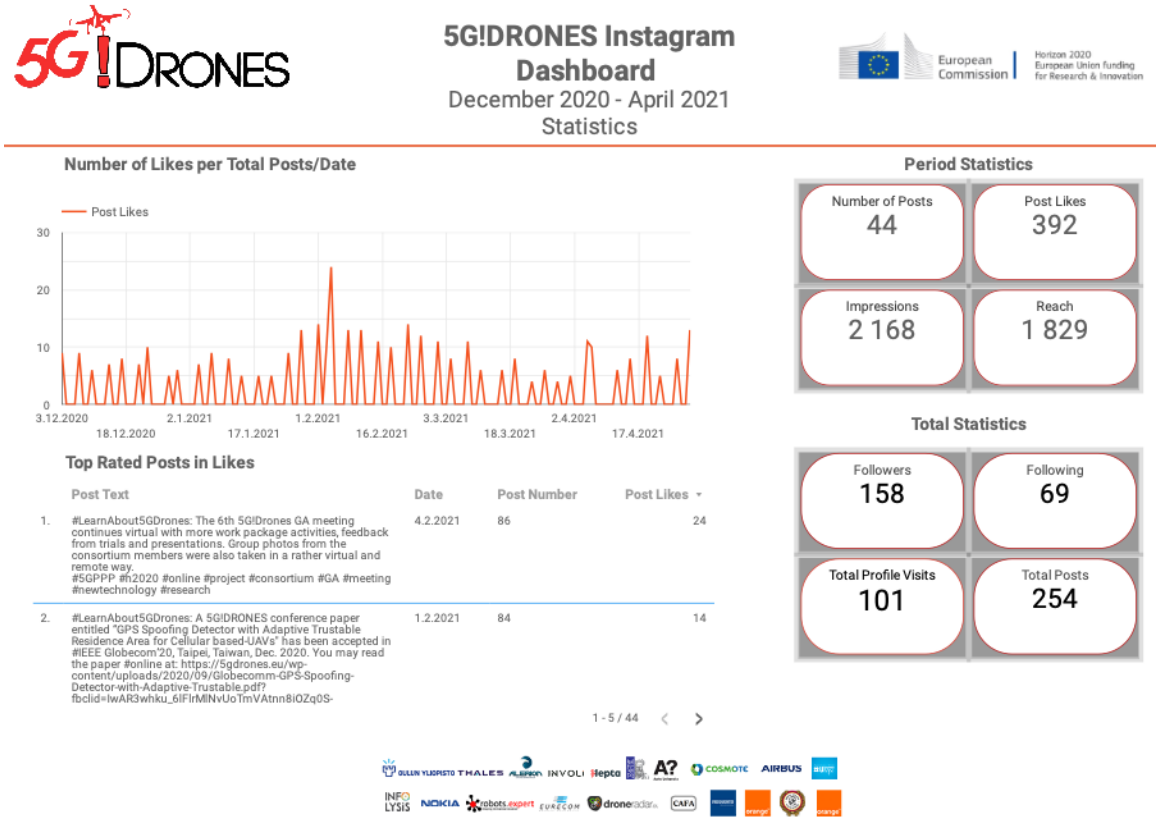

Figure 5: 5G!Drones Instagram Statistics/Dashboards, December 2020 – April 2021.

The project also published newsletters. During the Reporting Period (M19 – M24), two 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 (M19 – M24) are listed in more detail in Table 6. 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. It needs to be noted the Table 6 does not list some of the planned activities as the Covid-19 pandemic has caused events to be cancelled, postponed, changed as virtual events, or changed form in such a fashion that dissemination and exploitation is not feasible.

Table 6: 5G!Drones table of dissemination and exploitation activities

#	Authors / Partners	Activity	Target (Event, Location, Date)	Description
47	Dr. Harilaos Koumaras/ NCSRD	Online event for 5G presentation	"Xchanging Ideas - Global 5G Evolution " 8th December 2020	Harilaos Koumaras from NCSRD, 5G!Drones partner and 5GENESIS project coordinator participates and presents in the online event "Xchanging Ideas - Global 5G Evolution " on 8th of December 2020, presenting the trial field results of 5G-enabled UAVs that performed in the framework of 5GDRONES Project on top of 5GENESIS Project experimental 5G infrastructure, where NCSR "DEMOKRITOS" participates. The event will be broadcasted through YouTube channel of Xchanging Ideas.
48	Dr. Harilaos Koumaras/ NCSRD	5G-PPP Technology Board e-Workshop presentation	"Field Trials of UAVs on top of 5GENESIS platform: Advances and Lessons Learned" at the 5G-PPP Technology Board e-Workshop	#LearnAbout5GDrones Dr. Harilaos Koumaras (NCSRD), 5G!Drones partner, presented online the presentation "Field Trials of UAVs on top of 5GENESIS platform: Advances and Lessons Learned" at the 5G-PPP Technology Board e-Workshop, session " Working on Verticals", on 10 December 2020
49	Dr. Harilaos Koumaras/ NCSRD	Online Presentation 14 December 2020	"5G and Internet of Things Thessaloniki Week 2020"	Dr. Harilaos Koumaras (NCSRD), 5G!Drones partner, presented today at the "5G and Internet of Things Thessaloniki Week 2020" how 5G-enabled UAVs can support the IoT vertical industry, based on the work that is performed in 5G!Drones and 5GENESIS 5G-PPP projects. More information available at: **https://www.ihu.gr/ucips/post-3399**
50	robots.expert/ Gokul Srinivasan	InterDrone online event 15-17 December 2020	InterDrone online event : What do we need for successful Implementation of UTM Technologies	#LearnAbout5GDrones: robots.expert, 5G!Drones partner participated in the InterDrone online event, 16 December 2020. The panel discussed about “What do we need for successful Implementation of UTM Technologies” where insights about the 5G!Drones were also shared. More information here: **https://interdrone.com/**

51	robots.expert/ Gokul Srinivasan	Unmanned Cargo Aircraft conference "Drone Deliveries: Who pays the bills"	Unmanned Cargo Aircraft conference 9th Edition 8 Dec. 2020	#LearnAbout5GDrones: Gokul Srinivasan from robots.expert, 5G!Drones partner participated in Unmanned Cargo Aircraft conference presenting "Drone Deliveries: Who pays the bills". In this session he also shared some useful insights of 5G!Drones project. You may watch the session online here: **https://www.youtube.com/watch?v=MhU1D0r6Coc&feature=youtu.be**
52	robots.expert/ Gokul Srinivasan	Online Article based on Interdrone Online Event	InterDrone Online 2020: 'It is hard to promote the drone industry while drones are still not visible' at unmannedairspace.info	#LearnAbout5GDrones: An online article based on InterDrone Online 2020 conference was published by unmmanned airspace. Gokul Srinivasan from robots.expert, took part in the conference that brought in the light the interoperability capabilities of UAVs and the potential that can give to the society. Learn more by clicking on the following link: **https://www.unmannedairspace.info/uncategorized/interdrone-online-2020-it-is-hard-to-promote-the-drone-industry-while-drones-are-still-not-visible-north-central-texas-aviation-department/**
53	EUR, CAF, AIR, DRR, FRQ, RXB	Remote Feasibility Tests	Remote Feasibility Tests (France) on 17-18 Dec 2020	5GDrones partners EUR, CAF, AIR, DRR, FRQ, RXB conducted remote Feasibility tests using Eurecom (France) and CAFA Tech (Estonia) facilities on 17-18th December 2020 to initially test how 5G!Drones containers (C2+U-Space-, MCS- and latency measurement container) the connections with these containers´ client applications in smartphones work in Eurecom servers.
54	Article	Online Article at Commercial UAV News	"Top 10 Commercial Drone Insights and Updates from 2020" by Commercial UAV News online	"Top 10 Commercial Drone Insights and Updates from 2020" by Commercial UAV News online at **https://www.commercialuavnews.com/energy/top-10-commercial-drone-insights-from-2020?utm_source=Commercial%20UAV%20News&utm_medium=social&utm_campaign=5_minute**
55	Dr. Harilaos Koumaras/ NCSRD	Presentation: Trials , Challenges	Drones 3S Project	https://dronespro.gr/drones-3s-project-2021/programma/

		& Next Steps		
56	Fofy Setaki / COSMOTE	Presentation: Goals, Trials & Greek Participation in 5G!Drones	Drones 3S Project	https://dronespro.gr/drones-3s-project-2021/programma/
57	Article	xtypos.gr	article	"Drones over Egaleo city" by xtypos.gr (in Greek) available online **https://www.xtypos.gr/%CE%B4%CE%AE%CE%BC%CE%BF%CE%B9-%CE%B1%CF%84%CF%84%CE%B9%CE%BA%CE%AE%CF%82/%CE%B4%CE%AE%CE%BC%CE%BF%CF%82-%CE%B1%CE%B9%CE%B3%CE%AC%CE%BB%CE%B5%CF%89/drones-%CE%BC%CE%B5-5g-%CF%80%CE%AD%CF%84%CE%B1%CE%BE%CE%B1%CE%BD-%CF%80%CE%AC%CE%BD%CF%89-%CE%B1%CF%80%CF%8C-%CF%84%CE%BF-%CE%B1%CE%B9%CE%B3%CE%AC%CE%BB%CE%B5%CF%89/**
58	Article	kedke.gr	article	5G and Drones trials at Egaleo stadium by kedke.gr online at **https://kedke.gr/technikes-dokimes-5g-me-drones-sto-dimotiko-gipedo-aigaleo/**
59	ACJA, GSMA & GUTMA	White Paper	Interface for Data Exchange between MNOs and the UTM Ecosystem NetworkCoverage Service Definition White paper	#LearnAbout5GDrones: 5G!Drones insights are shared by the Interface for Data Exchange between MNOs and the UTM Ecosystem in the NetworkCoverage Service Definition. More information available here: **https://www.gsma.com/iot/wp-content/uploads/2021/02/ACJA-NetworkCoverage-Service-Definition-v1.00.pdf**

60	EUR, CAF, AIR, DRR, FRQ, RXB	Trials Video	Video: Trials 17 & 18 December	5GDrones partners EUR, CAF, AIR, DRR, FRQ, RXB conducted remote Feasibility tests using Eurecom (France) and CAFA Tech (Estonia) facility on 17th and 18th December, 2020 to test how 5G!Drones containers (C2+U-Space-, MCS- and latency measurement container) work in EUR servers and the connections with these containers´ client applications in smartphones.Video available here: **https://youtu.be/DUxaUAABuVk**
61	Gokul Srinivasan/ robots.experts	Online Article	Online Article unmannedairspace.info “The idea that 5G can enable BVLOS missions is something of a myth”	Gokul Srinivasan from robots.experts, 5G!Drones partner, shared some details about the interiperability between BVLOS and UTM devices with 5G network, in the online article “The idea that 5G can enable BVLOS missions is something of a myth” by unmannedairspaceinfo. You may access the article here: **https://www.unmannedairspace.info/news-first/the-idea-that-5g-can-enable-bvlos-missions-is-something-of-a-myth-gokul-srinivasan/**
62	Harilaos Koumaras, George Makropoulos, Michael Batistatos, Stavros Kolometsos, Anastasios Gogos, George Xilouris, Athanasios Sarlas and Michail-Alexandros Kourtis	Journal Paper	5G-Enabled UAVs with Command and Control Software Component at the Edge for Supporting Energy Efficient Opportunistic Networks, MDPI, Special Issue 5G Enabled Energy Innovation, Energies 2021, 14, 1480	Harilaos Koumaras, George Makropoulos, Michael Batistatos, Stavros Kolometsos, Anastasios Gogos, George Xilouris, Athanasios Sarlas and Michail-Alexandros Kourtis, 5G-Enabled UAVs with Command and Control Software Component at the Edge for Supporting Energy Efficient Opportunistic Networks, MDPI, Special Issue 5G Enabled Energy Innovation, Energies 2021, 14, 1480 (**https://www.mdpi.com/1996-1073/14/5/1480/pdf**) - DOI: **https://doi.org/10.3390/en14051480**
63	Harilaos Koumaras/ NCSRD	Article-Interview in Startupper Magazine (in Greek)	Article Title: NCSR "Demokritos" is pioneering in 5G research and 5G-PPP projects	Dr. Harilaos Koumaras from NCSR "Demokritos, 5G!Drones partner, provided an interview at Startupper Magazine (in Greek) providing insights about NCSR "Demokritos" pioneering activities in 5G research and EU 5G-PPP projects. Special mention is made to 5G!Drones project and its 5G activities.

64	A. Abada, B. Yang and T. Taleb/Aalto	Conference Paper "Traffic Flow Modeling for UAV-Enabled Wireless Networks "	2020 International Conference on Networking and Network Applications (NaNA), Haikou City, China, 2020	A. Abada, B. Yang and T. Taleb from Aaalto University released a research paper in the context of 2020 International Conference on Networking and Network Applications (NaNA), Haikou City, China, 2020 entitled: "Traffic Flow Modeling for UAV-Enabled Wireless Networks ". you may access and read the paper her: **https://5gdrones.eu/wp-content/uploads/2021/03/Traffic-Flow-Modeling-for-UAV-Enabled-Wireless-Networks.pdf**
65	Presentation-Demo video	Demo Video: 5G!Drones UC4 Athens Trials	Athens Science Festival 2021, online event, 27-29 March Athens, Greece	5G!Drones was present at the Athens Science Festival 2021 with a demo video of the Use Case 4 Athens trials (video produced and edited by CAFA Tech, NCSRD and INFOLYSIS partners). More info at **https://www.athens-science-festival.gr/**
66	Eurecom	Video	Eurecom: OpenAirInterface – 5G software alliance for democratizing wireless innovation Video	Eurecom: OpenAirInterface – 5G software alliance for democratizing wireless innovation Video Initiated by EURECOM, OpenAirInterface is an open source software suite that implements all the key components of 4G and 5G mobile telecommunication systems. This video also features aspects of 5G!Drones project utilising OpenAirInterface as presented by EURECOM 5G!Drones partners Adlen Ksentini, Florian Kaltenberge. You may access the video at **https://youtu.be/3QiujoBk8z4**
67	5G!Drones	5GPPP White Paper	AI and ML – Enablers for Beyond 5G Networks	The white paper on "AI and ML as enablers of beyond 5G (B5G) networks" is based on contributions from almost 20 5G PPP projects, including 5G!Drones coordinated through the 5G PPP Technology Board, that research, implement and validate 5G and B5G network systems. The paper introduces the main relevant mechanisms in Artificial Intelligence (AI) and Machine Learning (ML), currently investigated and exploited for enhancing 5G and B5G networks. You may access it at the 5G-PPP website: **https://5g-ppp.eu/wp-content/uploads/2021/05/AI-MLforNetworks-v1-0.pdf**

68	5G!Drones	Virtual Booth	EUCNC & 6G Summit	5G!Drones will be present at EuCNC 2021 through its virtual booth No 4! You may visit us online during 8-11 June. More information available here **https://www.eucnc.eu/exhibitions-and-demos/** Stay tuned!
69	Jussi Haapola (UO)	Towards UAV trials - Architectural advancements and takeaways from feasibility tests	FUAVE stakeholder online event	Jussi Haapola provided a presentation of the current state and the next steps of 5G!Drones project at the Finnish UAV Ecosystem (FUAVE) Stakeholder event. **https://www.fuave.fi/wp-content/uploads/5GDrones-towards-UAV-trials.pdf**
70	robots.expert	Presentation "5G!Drones Athens trials over the 5GENESIS 5G Athens experimental platform in October 2020"	5G-PPP TB WORKSHOP	robots.expert, 5G!Drones partner, presented 5G!Drones Project at the 5G-PPP TB Workshop (21 May 2021) and focused on the lessons learned from the 5G!Drones Athens trials over the 5GENESIS 5G Athens experimental platform in October 2020.
71	"Georgios Makropoulos, NCSR “Demokritos”, Greece Harilaos Koumaras, NCSR “Demokritos”, Greece Fotini Setaki, Cosmote S.A., Greece Konstantinos Filis, Cosmote S.A., Greece Thomas Lutz, Frequentis, Austria	Book Chapter "5G and Unmanned Aerial Vehicles (UAVs) Use Cases: Analysis of the Ecosystem, Architecture, and Applications"	Handbook of Research on 5G Networks and Advancements in Computing, Electronics, and Electrical Engineering, edited by Augustine O. Nwajana and Isibor Kennedy Ihianle, IGI Global, 2021, pp. 36-69. **http://doi:10.4018/978-1-7998-6992-4**	In the past few years, UAVs have evolved considerably towards real-world applications, going beyond entertaining activities. The unique features that UAVs can provide, such as flexible and easy deployment, high mobility, and mostly autonomous operation, tend to be appealing solutions in a wide variety of applications. With the number of UAVs expected to increase significantly in the forthcoming years, it is deemed mandatory to integrate innovative features of communication technologies in order to tackle several limitations and challenges that exist to date. To this end, the amalgamation of UAVs and 5G cellular networks is an auspicious solution in order to realise the full potential that the UAVs can provide as well as to effectively open up new fields of applications. The unique features that 5G cellular networks offer are utilised for supporting and providing reliable and secure UAV command and control. This

	Pawel Montowtt, Involi, Switzerland Lechoslaw Tomaszewski, Orange Polska S.A., Poland Piotr Dybiec, DroneRadar, Poland Tanel Järvet, CafaTech, Estonia"			chapter provides an overview of the 5G technology to support communication services for the UAV ecosystem.
72	Gokul Srinivasan	"Service performance measurement methods over 5G experimental networks White paper – ICT-19 performance KPIs"	5GPPP White Paper	https://5g-ppp.eu/wp-content/uploads/2021/05/Service-performance-measurement-methods-over-5G-experimental-networks_08052021-Final.pdf

8.6. WP6 Project Management

8.6.1. Progress towards objectives and details for each Task

WP Objectives

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

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

- Management of the relationship with the ICT-17 5G facilities.
- Management of the relationship at 5G-PPP Programme level.

WP Tasks and interrelations:

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

Main Progress in the period:

The period between December 2020 and February 2021 has been intensive with development and implementation aspects of the project. The project had a virtual Face-to-Face meeting at the beginning of February 2021, where a number of items important for project outputs, such as open source software, licensing, open data sets, and showcasing events were discussed. Project internally, various integration aspects were identified and action plans were started. The reporting period saw identification and mitigation plans for a number of risks related to Covid-19 restrictions in access to infrastructures and physical collaboration events.

The end of the previous period provided an opportunity to compare project's estimated resources used with the estimation of financial expenditures. The comparison showed that overall, the project's expenditures reflect well the declared personnel effort as well as the amount of resources used in comparison to the stage of the project and timeline.

The main achievements of the Quarter #8 focus on maintaining the project timeline, including the timely releases of project deliverables from WP1, WP2, WP5, WP6. The next WP3 and WP4 deliverables are also going to be released soon after this Reporting Period and hence, monitoring and maintaining the timeline for those has been a matter at hand. The ongoing Covid-19 pandemic has led to the identification of risks that could materialise if left unattended and risk management has been a topic of regular activity. The project Data Management Plan has also been updated with a clearer perspective on the types and purposes of data that is going to be collected during the trials.

Significant results

Initiation of actions towards common approach for addressing:

- Open source software,
- Licensing, and
- Open data sets.

Covid-19 induced risk mitigation plans were updated and caveats in integration plan have been both identified and actions have been started to close those gaps. During the reporting period there was one Commission initiated Amendment for the project concerning complementary grants. In 5G-PPP forum the Full 5G coordination and support action will end before the end of 5G!Drones project and mitigation plans for maintaining the 5G PPP services were addressed.

- Delivery of project deliverables on time.
- Updating the Data Management Plan of the project

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

During the period the Technical Manager person has changed from Pascal Bisson to Farid Benbadis, who has previously been the deputy TM. Pascal Bisson has assumed the deputy TM position. The Technical Manager organisation remains the same.

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

Task Objectives:

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

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

Task Activities during the period:
Only the Coordinator – UO is partaking this Task.

1-UO carried out an analysis based on the information provided in D6.3 and D6.7 on the declared use of project resources and financial expenditure estimates. Overall, the project is in line with its state, timeline, use of personnel resources, and financial expenditure estimates. UO has requested a justification from individual partners with moderate deviation from the project average resource use and made sure any such deviations are according to the partners' plan. UO has also been managing confidentiality agreements between the project and external parties. UO has also informed the Consortium about significant events or webinars related to 5G!Drones activities that either require 5G!Drones participation or contribution. UO presented to the consortium what is required for updating the project Data Management Plan during the General Assembly of the virtual Face-to-Face meeting. UO has been collecting and compiling the updates for the project Data Management Plan. UO has hosted and acted as the secretary on project management-related topics and it has orchestrated upcoming meetings schedules and agendas. Finally, UO has collected and compiled the Deliverable 6.4 based on Project Beneficiary inputs.

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 has monitored the project's deliverable developments and advised to follow project's quality insurance guidelines. During the reporting period a number of project implementation related risks along with their likelihood and severity have been identified and analysed. They have been discussed during the General Assembly and project management team meetings. Monitoring and mitigation actions have been derived. UO has led the work. UO has coordinated the Data Management Plan update and has provided updates to it regarding UO and 5GTN related matters. UO has acted as a project internal reviewer for D2.2 and D5.2.

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. This ensures deliverables are delivered on time and milestones are met. THA has also continued the monitoring and assessment of the progress at Programme level; by monitoring activities performed by each of the 5GDrones appointed representatives to WG of interest till direct contribution through participation to 5G TB working on the actions requested. THA was in charge of regular reporting at different PMT meetings, where it interacts with PMT members, by providing necessary guidance and support in view of topics of concerns. THA was also in charge of the overall check and consistency of the work performed, including the revision of the deliverables before submission.

Role of Technical Manager so far ensured by Pascal Bisson (THA) was handed over to Farid Benbadis (THA) to become effective by end of April. Pascal will stay in support of Farid but more in role of TM Deputy to support and advise. This change was mainly due to new role and responsibilities endorsed

by Pascal had within ThereSIS Lab of Thales SIX GTS that make it no more compatible with him keeping TM active role. So why this charge was transferred to Farid, this change was well prepared, discussed with Project coordinator also at PMT and GA, and organised to ensure a smooth transition.

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

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

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

Task Activities during the period:
During the reporting period, the ICT-17 facilities have continued to monitor the progress of their platforms, both at infrastructure level (e.g. SA deployments), as well as at regulatory level for the provision of frequencies licenses that will allow the execution of the 5GDrones trials. Similar, activities have been taken under consideration in the non-ICT-17 platforms. Moreover, the recent Drones regulation released by EASA is monitored in order to identify potential conflicts with the planned trials. During Quarter #8 the task monitored the integration activities of the abstraction layer in WP3 and the integration activities of the various components in WP4 in order to be reassured that the 5G Facilities are conforming with the project experimentation objectives and plans. More specifically, for the ICT-17 facilities that participate in the project as a whole, supporting the experimentation with the tools and components that have been built in their own framework, it was discussed the mapping of the different functionalities between the 5G!Drones components and the ICT-17 components. From this mapping, it was identified that the U-SPACE components, e.g. UTMs, Web Portal1 etc. are the vertical specific components that are needed to be integrated in all the platforms, independently if they are ICT-17 or not. For the rest experimentation tools and components a complimentary approach has been considered, focusing mainly on the case of 5GENESIS, which will integrate and complement the Open5GENESIS experimentation framework with the 5GDrones U-SPACE components only. These activities will be properly reflected in WP4 deliverables.

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 has had no reported activity on this task between December 2020 and February 2021. During Quarter #8 UO has been following ICT-17 facilities activities and participated in their dissemination events.

2-THA has been in charge of monitoring the progress achieved as well as update of individual vs. collective workplans and of the investigation of major components or features of concerns for 5G!Drones as well as their delivery mode and attached APIs when it applies. Thales did follow the work and contributed to the discussion and exchange with objective to ease the work and make it coherent and consistent to overall objectives.

6-NCSRD has closely monitored the activities of 5GENESIS towards the release of Open5GENESIS rel. B, considering its integration with the U-Space. Further activities have considered the 5G licensing in Athens Platform and the provision of frequencies for academic use, which will allow the execution of the trials within 2021. NCSRD has, during the Reporting Period, monitored the progress of the

integration activities across the 5G facilities. Considering the different level of maturity of ICT-17 facility, the respective relationship management among them followed the recommendation that has been made, from the beginning of the project, that the ICT-17 facilities that participate in the project together with their own experimentation and automation layer will complement their infrastructure with drone specific components (ie the U-Space) in order to reassure compliance with the 5G!Drones scenarios and use-cases.

14-EUR is monitoring the 5GEVE SA development, which has been strongly impacted by the Covid-19, but also by the decision of the French government to sell all the 5G <6Ghz band for commercial use. 5GEVE SA can exploit only 20Mhz of bandwidth, which may strongly impact the envisioned UC. A solution is to use > 6Ghz, but due to the Covid-19 the development of OAI millimetre waves is slowed down. EUR has provided a contribution to the deliverable D2.5 of 5GEVE, detailing the 5G!Drones use-cases to be run in 5GEVE Sophia Antipolis and the components of 5GEVE that will be used.

19-MOE has considered the 5G licensing in Athens platform and provision of frequencies for test use, which will allow the execution of the trials in Egaleo stadium "*Stavros Mavrothalasitis*" in 2021.

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

During the Reported Period (M19 – M24), 5G!Drones has been also deeply involved at 5G-PPP Programme level. First through representation of Project Manager and Technical Manager at respectively 5G-PPP Steering Board and Technology Board and second, through participation to 5G-PPP & IA WGs of interest for the project. 5G!Drones representation at 5G-PPP Programme level, which is shown in Table 7 depicts the level of involvement together with names of appointed representatives.

Table 7: 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 / NetworldEurope		Vaios KOUMARAS	vkoumaras@infolysis.gr
SEC WG	5G-IA	Tanel Järvet	tanel.jarvet@cafatech.com
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	gokul.srinivasan@robots.expert
5G Automotive	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 Känsälä Gokul Srinivasan	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	- Participation in the full day virtual 5G-PPP SB conference on February 8th. - Addressing 5G PPP support action Full 5G stop gap on behalf of 5G!Drones. - Dissemination of 5G PPP webinars and events to the project consortium. - UO participated in the April 7th conference call. - UO notified the consortium about the upcoming 5G-PPP support action GAP and it is taking care of the expenses related to having 5G-PPP basic

	services running during the support action gap on behalf of the 5G!Drones project.

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	- Active participation in the regular 5G-PPP TB meetings organised during the reported period including the e-TB workshop held in May. - Regular reporting to 5G TB on 5G!Drones achievements/results. - Monitoring as well as internal assessment of 5G!Drones participation to the various WGs of interest (both 5G-PPP & 5G IA). - Contribution on behalf of the project to a number of Whitepapers established by 5G-PPP TB among which the **Edge Computing for 5G Networks** Whitepaper as well **AI and ML – Enablers for Beyond 5G Networks** Whitepaper. - Contributions to a number of actions to best support project participation to EuCNC 2021 Event (including contribution to workshop proposals).

9.3. SME WG

Activity name	SME WG/NetworldEurope (former NetWorld2020)
Main interface	Vaios Koumaras (INF)
Activities	The SME Working Group represents the NetWorld2020 SME community, and provides the networking place for the NetWorld2020 SME community related to EC and 5G-PPP research projects and activities.
5G!Drones contributions	- One SME WG meeting/telco was organized was attended during the reporting period - 5G-PPP 5G!Drones leaflet for future phase 3 projects publication was re-updated and submitted to 5G-PPP BSCW repository. - Contributing to the new SME planning for Horizon Europe and SNS association structure (SME WG SNS position paper), - Contributing to the release of an updated SME brochure - Attending the SME WG meeting on 1st of March 2021 (virtual meeting) - The latest news from 5G-PPP new projects (with focus on ICT-41 and ICT-52) were presented by Jacques and asking for existing SME members to acknowledge their participation in any of them - Contributing to the new SME planning for Horizon Europe and SNS association structure (SME WG SNS position paper), - Contributing to the release of an updated SME brochure and Find Your SME web page - Networld2020 (the association in which the SME WG belongs) is rebranded to NetworldEurope, in order to reflect the changed priorities of the current European policies (and the Horizon Europe program). Website **https://www.networldeurope.eu/** and all mailing lists have been changed

	to the <name>@networldeurope.eu, while a new logo was also released All members approved.

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	Attending the Security WG meeting on 26th April (virtual meeting) Preparations have begun to compile a Short Whitepaper 5G! Drones project on the security aspects of the tests. The Short Whitepaper can be completed after the 2021 trials.

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	Contributions from 5GDrones to meeting as well as to the following sections of the architecture white paper in object during the reported period • 2 Requirements and Challenges • 3 Overall Architecture • 4 Logical/Functional Architecture • 6 Software Network Technologies

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	2021 ToR and Work Plan update. • Comments accepted on the draft 2021ToR (v0.1) and 2021WP (v0.1).

	• Final versions were uploaded beginning of March on the BSCW and sent to 5G-IA Board. Webinar and Success Story Input Discussion. • A spreadsheet has been created to track interest in contributing to webinars co-hosted with 3GPP MRPs or as stand-alone events, and/or podcasts. A short guide is here: **https://bscw.5g-ppp.eu/sec/bscw.cgi/398773**. • Both webinars and podcasts can be clustered with other projects, e.g. by technology or vertical. • Success stories are a means for showing impacts. A template has been created and is uploaded here: **https://bscw.5g-ppp.eu/sec/bscw.cgi/398741**. B5G/6G Standardisation Roadmap creation: • the main purpose of the activity should be to provide a "tool" helping projects to make impact, e.g. suggesting what kind of research output should be produced in a given moment in time, in order to be ready when SDO may absorb such results. • output of the activity should also be used to help for the pre-structuring model being prepared in other WGs. • The activity status has been summarized: 11 responses to the questionnaire have been received. • The preparation of "The Roadmap" technical report has started. The ToC has been discussed and approved.

9.7. Software Networks WG

Activity name	Software Networks WG
Main interface	Gregor Mogeritsch (FRQ)
Activities	As defined by Architecture WG chairs
5G!Drones contributions	Attending and actively participating in the WG meetings

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 Architecture WG chairs
5GDrones contributions	TM did continue to follow up and contribute to activities.

9.9. Trials WG

Activity name	Trials Working Group
Main interface	Gokul Srinivasan (RXB)

Group activities	As defined by Architecture WG chairs
5GDrones contributions	RXB with NOK. • White paper 1: Service performance measurement methods over 5G experimental networks. • White paper II: “Test, Measurement, and KPIs Validation Working Group”; White Paper; Understanding the Numbers; Contextualization and Impact Factors of 5G Performance Results. • RXB & NOK participated in 5G-PPP TMV working group calls and contributed to White paper II: “Test, Measurement, and KPIs Validation Working Group”; White Paper; Understanding the Numbers; Contextualization and Impact Factors of 5G Performance Results.

9.10. 5G Automotive WG

Activity name	Automotive WG
Main interface	Tanel Järvet (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 Automotive WG: to contribute to designing, developing, testing, validating, and promoting the potential of 5G-based vehicular communications (so-called V2X communications) for CAM (Connected and Automated Mobility). It is worth noting that the term V2X refers to communication between a vehicle and anything else, yielding terms such as V2V (vehicle-to-vehicle), V2N (vehicle-to-network), V2I (network-to-infrastructure), or V2P (vehicle-to-pedestrian). Similar architectural points are relevant also vehicles on the ground and in the air (drones).
5GDrones contributions	Attending and actively participating the Automotive WG biweekly meetings (virtual meetings) From June 2021 the WG name will be changed to Smart and Connected Mobility WG.

9.11. IMT 2020 Evaluation WG

Activity name	IMT 2020 Evaluation WG
Main interface	Fotis Lazarakis (NCSRD)
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	After the submission of the Final Report, the Group interacts with ITU-R for various clarifications. Some complementary actions were requested, but not from the IMT-2020 working group. The process has been progressed and not further actions are pending. The group has not initiated other activities 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) and Ilkka Känsälä (NOK)
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	RXB & NOK participated in 5G-PPP TMV working group calls and contributed to two White papers: 1. "Service performance measurement methods over 5G experimental networks"; 2. “Test, Measurement, and KPIs Validation Working Group”; Understanding the Numbers; Contextualization and Impact Factors of 5G Performance Results (Coming paper) .

References

5G-PPP whitepaper “AI and ML – Enablers for Beyond 5G Networks”: **AI-MLforNetworks-v1-0.pdf (5g-ppp.eu)**