"5G for Drone-based Vertical Applications"

D5.5 – Final report on communication, showcasing, dissemination and exploitation

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Approvals

	Name	Organization	Date
Coordinator	Jussi Haapola	UO	30.11.2022
Technical Committee	Farid Benbadis and Pascal Bisson (TM deputy)	THA	30.11.2022
Management Committee	Project Management Team and	FRQ, AU, THA, UMS, AIR, UO	28.11.2022

Document History

Version	Contribution	Authors	Date
V0.1	**Template and first Table of Contents**	**ORA**	**30.03.2022**
V0.2	**Updated document according to initial partner feedback (e.g., for section 5, added updated individual exploitation plans)**	**All D5.5 partners**	**30.05.2022**
V0.3-0.10	**Updated document according to further partner feedback (e.g., for section 4, added lists of publications)**	**All D5.5 partners**	**30.07.2022**
V0.11-0.19	**Updated section 1 (Introduction), section 3 (Showcasing) and section 5 (Initial lists of non-commercial outcomes, patents)**	**All D5.5 partners**	**15.10.2022**
V0.20-0.21	**Updated section 2 (all section updated with latest statistical data), section 5 (added non commercial outcome**	**All D5.5 partners**	**20.11.2022**

	information) and general additions		
V1.0	**Resolving internal review comments**	**ORA**	**28.11.2022**

Executive Summary

Deliverable D5.5 (D5.5) documents the finalized 5G!Drones communication, showcasing, dissemination as well as the project's outcomes of non-commercial nature. For these subjects, D5.5 aims at completing and taking over previous deliverable D5.2 [1], which mainly covered the project's second term and subsequent plans, and which was published at month M21. All the described activities are a part of WP5 "Dissemination, standardisation and exploitation" and corresponding WP5 project tasks. Although the general intention with this deliverable is to report and detail the aforementioned topics for the second part of the project lifecycle, some subsections take a step back and consider in their entirety the relevant project outcome.

All performed communication activities and interactions are described in detail and are evaluated against the goals that were set by the 5G!Drones communication, showcasing, dissemination, exploitation plan and standardization roadmap (D5.1), delivered at M6. Statistics, results and impacts are analysed and are compared to the projections in terms of goals and plans for the activities initially set into D5.2.

WP5, D5.2 and D5.5 all contribute towards the high-level project Objective 8 (O8): "Dissemination, standardisation and exploitation of 5G!Drones". For attainment O8, following specific objectives have been pursued within WP5, D5.2, D5.5 as well as among the entire project activities:

- 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 standardisation 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. and
- Produce and manage intellectual property and perform activities towards commercialisation.

With respect to communication, showcasing and dissemination objectives, this deliverable performs an in-depth description of the relevant achievements. All time-relevant publications that were recorded and communicated through the project's Webpage are reported into Section 2. Moreover, this second period being strongly focused on trialing and then showcasing the results of 5G!Drones, pre-trials, trials and showcasing events are summarized and illustrated in Section 3. Subsequent descriptions refer, when applicable, to the video footage that was published on the project YouTube channel during this last reporting period. In addition, section 4 notably reports papers that were published in journals and in conferences. It summarizes workshops that were organized and presentations that were given during various conferences and panel discussions. More generally, the project Website has been constantly updated, and 5G!Drones has been active in all popular social media networks, Twitter, LinkedIn, Facebook, Instagram and YouTube, as analysed in the document.

Considering the exploitation activity, this deliverable mainly focused on describing the project outcomes of non-commercial nature, as well as providing an update of all 5G!Drones partners' individual exploitation plans, which finalizes the descriptions previously done in D5.2. Likewise, a general overview of the Intellectual Property of the project is given. As such, it completes deliverable D5.6 [3], which provides an in-depth description and analysis of the commercial exploitable outcomes and patents of the projects.

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List of Abbreviations

5G	5th Generation Cellular Technology
5G (6G) IA	5G (6G) Infrastructure Association
5G NSA	5G Non-Standalone
5G-PPP	The 5G Infrastructure Public Private Partnership
5G SA	5G Standalone
6G SNS	6G Smart Networks and Services
5GTNF	5G Test Network Finland
ANSP	Air Navigation Service Provider
API	Application Programming Interface
ATC	Air Traffic Controller
B2B	Business to business
BVLoS	Beyond Visual Line of Sight
C2	Command and Control
C3	Command, Control and Communications
CARS	Common Altitude Reference System
CSP	Communications Service Provider
DGAC	Direction Générale de l'Aviation Civile (French civil aviation authority)
DL	Deep Learning
Dx.y	Deliverable y of WP x
GNSS	Global Navigation Satellite System
GOF	Gulf Of Finland
ICT	Information and Communication Technology
IoT	Internet of Things
INPI	Institut national de la propriété industrielle (French National Institute for Industrial Intellectual Property)

IPR	Intellectual Property Rights
KPI	Key Performance Indicator
MCS	Mission Critical Services
MEC	Multi-access Edge Computing
MNO	Mobile Network Operator
NFV	Network Function Virtualisation
NLP	Natural Language Processing
NWDAF	Network Data Analytics Function
OAI	Open Air Interface
PMR	Private Mobile Radio
PPDR	Public Protection and Disaster Relief
SDN	Software-Defined Networking
SDO	Standards Developing Organization
TRL	Technology Readiness Level
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UE	User Equipment
URL	Uniform Resource Locator
USSP	U-Space Service Providers
UTM	UAS Traffic Management
VR	Virtual Reality
WP	Work Package

1 Introduction

1.1. Objectives of the document

The scope of D5.5 is to present the final status regarding 5G!Drones communication, showcasing and dissemination activities, as well as the project's outcomes of non-commercial nature. For these topics, it completes and takes over previous deliverable D5.2 [1], which mainly covered the project's second term and subsequent plans. All the described activities are a part of WP5 "Dissemination, standardisation and exploitation" and corresponding WP5 project tasks. Although the general intention with this deliverable is to report and detail the aforementioned topics for the second part of the project lifecycle, some subsections take a step back and consider in their entirety the relevant project outcomes. That is notably the case of communication activities, for which it is felt that, in addition to the detailed report of the events during the second part of the project lifetime, any interested stakeholder may require a complementary overview about the communication activities that have taken place in the context of the project for its whole duration.

1.2. Structure of the document

The document is structured into six main sections as follows:

- An introduction to the deliverable is given to the reader in **Section 1**. It includes a description of the purpose of the deliverable, as well as an outline of the structure of the document, the target audience and the considered activity phases.
- **Section 2** presents an overview of the performed communication activities of 5G!Drones. Analysis is made on the communication channels used, with emphasis on Website and social media channels, targeted audience, content used, strategy applied, and control/monitoring tools used. A report on the overall communication activities during the whole[1] project duration ends this section.
- **Section 3** summarises and illustrates the pre-trials, trials and showcasing activities held during Months 22 to 42 of 5G!Drones.
- **Section 4** covers all dissemination activities that include the publication of journal articles, conference papers, book chapters, white papers, presentations and other forms of communications.
- **Section 5** provides a summary of the project outcomes of non-commercial nature, followed by a final description of the 5G!Drones partners' individual exploitation plans, which at the end of the project updates and finalizes the descriptions previously done in D5.2. This section ends with a general overview of the Intellectual Property of the project, which for the interested reader is meant to be completed by a more in-depth commercial analysis in deliverable D5.6 [3].
- Finally, **Section 6** gives the concluding remarks of the deliverable.

1.3. Target audience and activity phases

5G!Drones communication, dissemination, showcasing, exploitation plans and standardization strategies are executed by all the partners and differ in regard to the nature of the partner as well as the means, content and target audience. The industrial partners have approached industry sectors and their distributors as well as client networks, academic and research partners - relevant research institutes and universities, and cross-sectoral collaboration was performed as well. Furthermore, an additional number of activities have been targeting organizations, communities, industry, academia and research institutions, as well as the general public.

Overall, the target audience of D5.5 is the following:

[1] More precisely, this subsection spans months 1 to 40. In effect, two months before the delivery deadline of the current document were used for the document elaboration, editing and finalization.

- The broadest possible technical and non-technical audience. This category covers the potential end users of 5G network and drones' products and services as well as the general public who is interested in these technological fields and advancements.
- All 5G!Drones partners, collaborators and stakeholders. This document addresses the entire 5G!Drones Consortium and serves as an end-project documentation of the performed actions on communication and dissemination activities, including trials, showcasing undertakings, publication of various types and partner specific exploitation of noncommercial nature.

Additional details on the targeted audience are given at the corresponding sections of each chapter.

2 Communication Activities – Second Period (M25-M42)

2.1 Communication channels and activities

The 5G!Drones communication channels were established and were fully functional during the first month of the project. The project has already elaborated on the creation and use of an effective communication action plan that is directed at particular market targets and stakeholders, since the first period of its duration (M1-M6). In this context, since June 2019, several communication channels have been set up, regularly updated, and extensively used up until this point in order to optimize the influence of the project's actions, results, and accomplishments. More details on the communication channels have been provided in the D5.1 [4], where the 5G!Drones communication channels were introduced and the communication plan to be followed throughout the project lifetime was presented. In this section an update is provided for all 5G!Drones communication channels, showcasing how they have been utilized throughout the reported period (M25-M42) and what type of content and activities have been communicated and by which channel during the last 20 months of the project (period: June 2021-November 2022).

2.1.1 Website

The 5G!Drones official Website (**https://5gdrones.eu/**) is the pipeline and the core digital means of communication and also one of the principal publicity tools of the project. It was created and launched before the kick-off meeting of the project. It is public and has been live since May 2019. The visitors can find information about each and every aspect of the project such as its nature, the use cases, the objectives, the consortium, the dissemination activities and how to communicate with us.

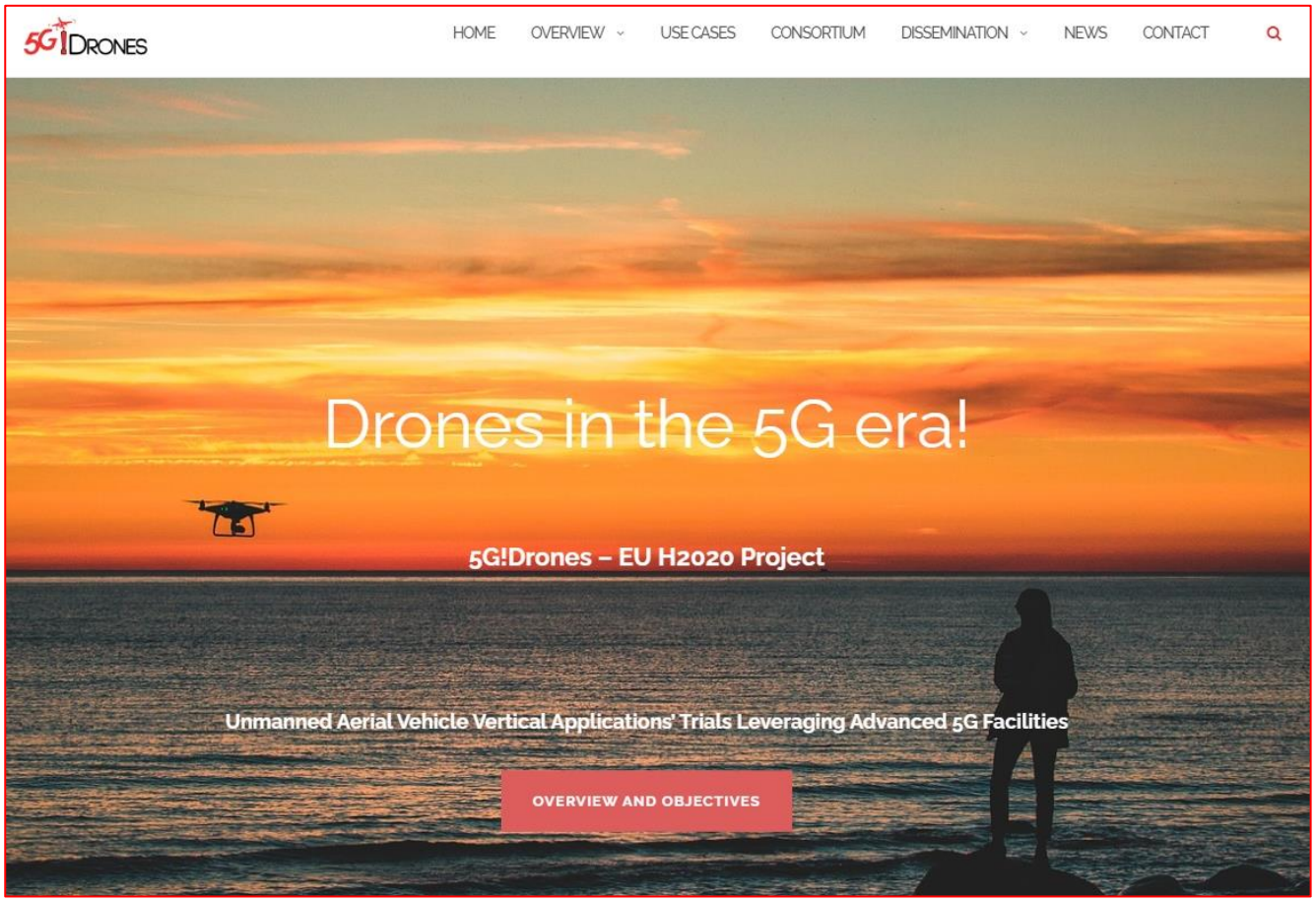
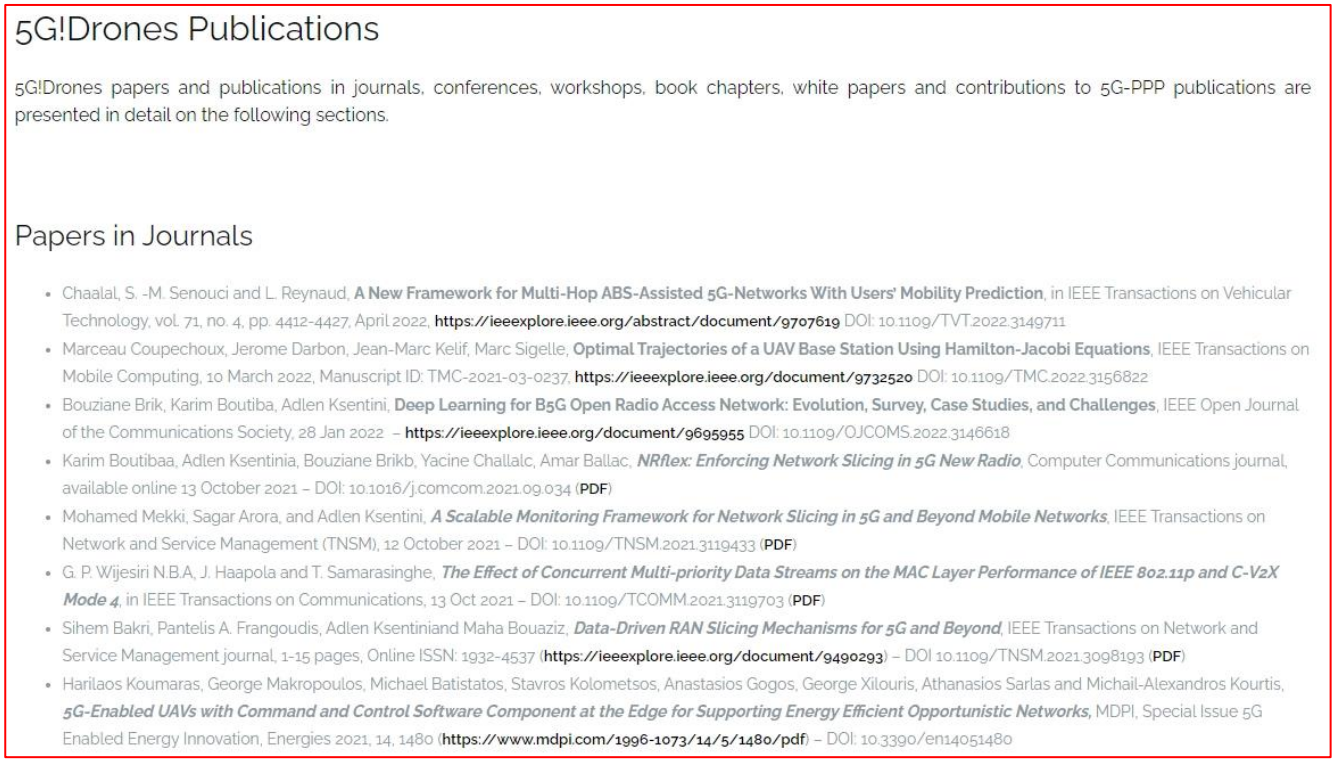


Figure 1 - 5G!Drones Website

Through the 42 months of its operation, the 5G!Drones Website is constantly updated on a weekly basis with project news and activities providing direct access to vital information to its audience. Weekly updates on project news and activities are posted to the 5G!Drones Website, giving users easy access to essential information. In order to better present within D5.5 the activities that have been communicated through the Website, each Webpage that has been updated through the period June 2019 - November 2022 is briefly presented below (per Webpage).

- **Publications Webpage (https://5gdrones.eu/research-papers/):** The 5G!Drones publications page is constantly updated with 5G!Drones publications such as papers in journals, in conferences, in workshops, book chapters, white papers and contributions to other 5G-PPP publications. Additionally, every publication has a specific Uniform Resource Locator (URL) where the reader can access the desired content as well as the publication's Digital Object Identifier (DOI), if available. During this last period of the project (and up to the moment this deliverable was under editing): **27 publications** have been recorded and communicated through this Webpage. Members of the consortium published **9 papers in journals**, **11 conference papers**, **5 5G-PPP white papers** with 5G!Drones contributions. For each publication type, a separate section is provided on the Webpage.



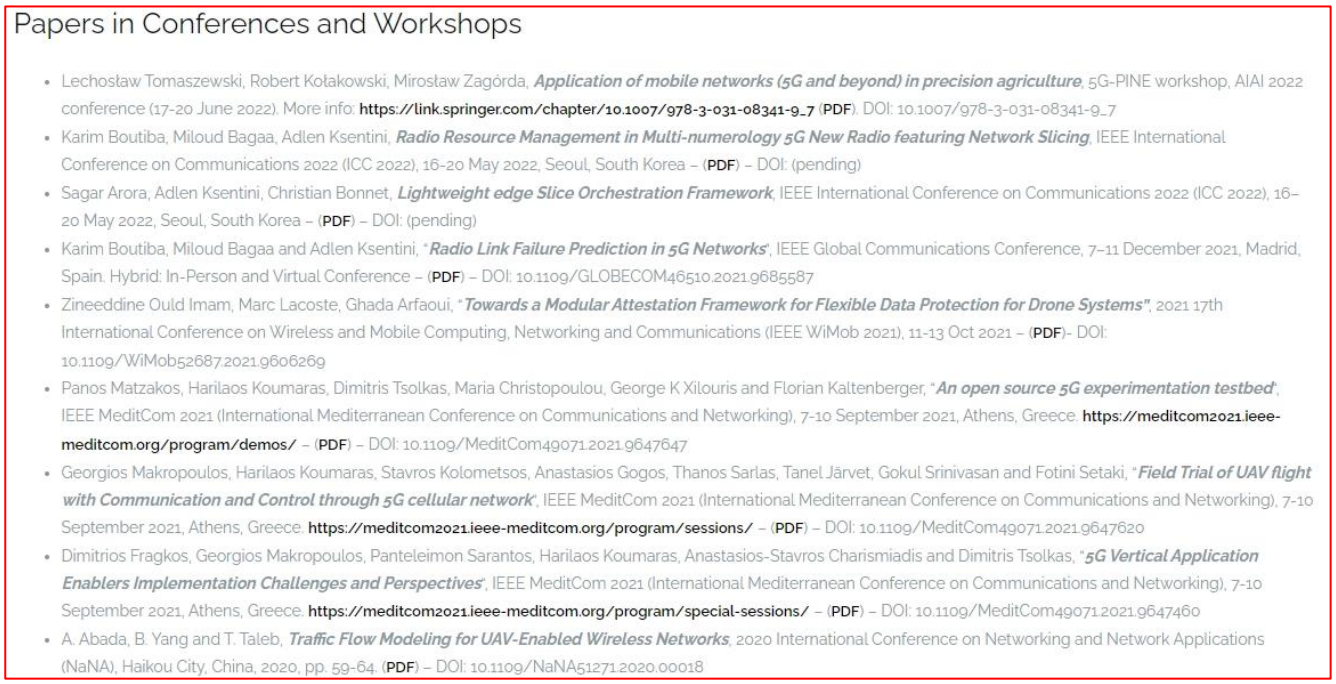
5G!Drones Publications

5G!Drones papers and publications in journals, conferences, workshops, book chapters, white papers and contributions to 5G-PPP publications are presented in detail on the following sections.

Papers in Journals

- Chaalal, S. -M. Senouci and L. Reynaud, **A New Framework for Multi-Hop ABS-Assisted 5G-Networks With Users' Mobility Prediction**, in IEEE Transactions on Vehicular Technology, vol. 71, no. 4, pp. 4412-4427, April 2022, https://ieeexplore.ieee.org/abstract/document/9707619 DOI: 10.1109/TVT.2022.3149711
- Marceau Coupechoux, Jerome Darbon, Jean-Marc Kelif, Marc Sigelle, **Optimal Trajectories of a UAV Base Station Using Hamilton-Jacobi Equations**, IEEE Transactions on Mobile Computing, 10 March 2022, Manuscript ID: TMC-2021-03-0237, https://ieeexplore.ieee.org/document/9732520 DOI: 10.1109/TMC.2022.3156822
- Bouziane Brik, Karim Boutiba, Adlen Ksentini, **Deep Learning for B5G Open Radio Access Network: Evolution, Survey, Case Studies, and Challenges**, IEEE Open Journal of the Communications Society, 28 Jan 2022 – https://ieeexplore.ieee.org/document/9695955 DOI: 10.1109/OJCOMS.2022.3146618
- Karim Boutibaa, Adlen Ksentinia, Bouziane Brikb, Yacine Challalc, Amar Ballac, ***NRflex: Enforcing Network Slicing in 5G New Radio***, Computer Communications journal, available online 13 October 2021 – DOI: 10.1016/j.comcom.2021.09.034 (PDF)
- Mohamed Mekki, Sagar Arora, and Adlen Ksentini, ***A Scalable Monitoring Framework for Network Slicing in 5G and Beyond Mobile Networks***, IEEE Transactions on Network and Service Management (TNSM), 12 October 2021 – DOI: 10.1109/TNSM.2021.3119433 (PDF)
- G. P. Wijesiri N.B.A, J. Haapola and T. Samarasinghe, ***The Effect of Concurrent Multi-priority Data Streams on the MAC Layer Performance of IEEE 802.11p and C-V2X Mode 4***, in IEEE Transactions on Communications, 13 Oct 2021 – DOI: 10.1109/TCOMM.2021.3119703 (PDF)
- Sihem Bakri, Pantelis A. Frangoudis, Adlen Ksentiniand Maha Bouaziz, ***Data-Driven RAN Slicing Mechanisms for 5G and Beyond***, IEEE Transactions on Network and Service Management journal, 1-15 pages, Online ISSN: 1932-4537 (https://ieeexplore.ieee.org/document/9490293) – DOI 10.1109/TNSM.2021.3098193 (PDF)
- 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: 10.3390/en14051480

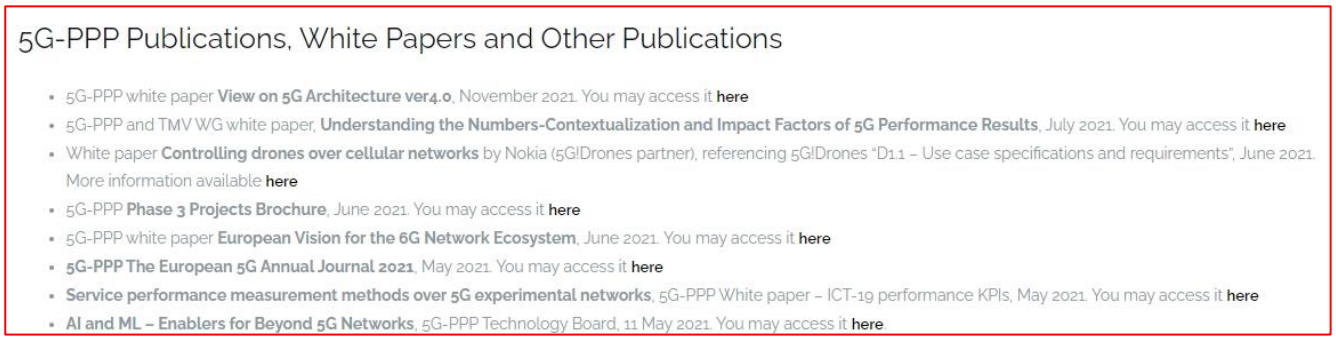
Figure 2 - 5G!Drones journal papers



Papers in Conferences and Workshops

- Lechosław Tomaszewski, Robert Kołakowski, Mirosław Zagórda, ***Application of mobile networks (5G and beyond) in precision agriculture***, 5G-PINE workshop, AIAI 2022 conference (17-20 June 2022). More info: **https://link.springer.com/chapter/10.1007/978-3-031-08341-9_7** (PDF). DOI: 10.1007/978-3-031-08341-9_7
- Karim Boutiba, Miloud Bagaa, Adlen Ksentini, ***Radio Resource Management in Multi-numerology 5G New Radio featuring Network Slicing***, IEEE International Conference on Communications 2022 (ICC 2022), 16-20 May 2022, Seoul, South Korea – (PDF) – DOI: (pending)
- Sagar Arora, Adlen Ksentini, Christian Bonnet, ***Lightweight edge Slice Orchestration Framework***, IEEE International Conference on Communications 2022 (ICC 2022), 16–20 May 2022, Seoul, South Korea – (PDF) – DOI: (pending)
- Karim Boutiba, Miloud Bagaa and Adlen Ksentini, "***Radio Link Failure Prediction in 5G Networks***", IEEE Global Communications Conference, 7–11 December 2021, Madrid, Spain. Hybrid: In-Person and Virtual Conference – (PDF) – DOI: 10.1109/GLOBECOM46510.2021.9685587
- Zineeddine Ould Imam, Marc Lacoste, Ghada Arfaoui, "***Towards a Modular Attestation Framework for Flexible Data Protection for Drone Systems***", 2021 17th International Conference on Wireless and Mobile Computing, Networking and Communications (IEEE WiMob 2021), 11-13 Oct 2021 – (PDF)- DOI: 10.1109/WiMob52687.2021.9606269
- Panos Matzakos, Harilaos Koumaras, Dimitris Tsolkas, Maria Christopoulou, George K Xilouris and Florian Kaltenberger, "***An open source 5G experimentation testbed***", IEEE MeditCom 2021 (International Mediterranean Conference on Communications and Networking), 7-10 September 2021, Athens, Greece. **https://meditcom2021.ieee-meditcom.org/program/demos/** – (PDF) – DOI: 10.1109/MeditCom49071.2021.9647647
- Georgios Makropoulos, Harilaos Koumaras, Stavros Kolometsos, Anastasios Gogos, Thanos Sarlas, Tanel Järvet, Gokul Srinivasan and Fotini Setaki, "***Field Trial of UAV flight with Communication and Control through 5G cellular network***", IEEE MeditCom 2021 (International Mediterranean Conference on Communications and Networking), 7-10 September 2021, Athens, Greece. **https://meditcom2021.ieee-meditcom.org/program/sessions/** – (PDF) – DOI: 10.1109/MeditCom49071.2021.9647620
- Dimitrios Fragkos, Georgios Makropoulos, Panteleimon Sarantos, Harilaos Koumaras, Anastasios-Stavros Charismiadis and Dimitris Tsolkas, "***5G Vertical Application Enablers Implementation Challenges and Perspectives***", IEEE MeditCom 2021 (International Mediterranean Conference on Communications and Networking), 7-10 September 2021, Athens, Greece. **https://meditcom2021.ieee-meditcom.org/program/special-sessions/** – (PDF) – DOI: 10.1109/MeditCom49071.2021.9647460
- A. Abada, B. Yang and T. Taleb, ***Traffic Flow Modeling for UAV-Enabled Wireless Networks***, 2020 International Conference on Networking and Network Applications (NaNA), Haikou City, China, 2020, pp. 59-64. (PDF) – DOI: 10.1109/NaNA51271.2020.00018

Figure 3 - 5G!Drones conference and workshop papers



5G-PPP Publications, White Papers and Other Publications

- 5G-PPP white paper **View on 5G Architecture ver4.0**, November 2021. You may access it **here**
- 5G-PPP and TMV WG white paper, **Understanding the Numbers-Contextualization and Impact Factors of 5G Performance Results**, July 2021. You may access it **here**
- White paper **Controlling drones over cellular networks** by Nokia (5G!Drones partner), referencing 5G!Drones "D1.1 – Use case specifications and requirements", June 2021. More information available **here**
- 5G-PPP **Phase 3 Projects Brochure**, June 2021. You may access it **here**
- 5G-PPP white paper **European Vision for the 6G Network Ecosystem**, June 2021. You may access it **here**
- **5G-PPP The European 5G Annual Journal 2021**, May 2021. You may access it **here**
- **Service performance measurement methods over 5G experimental networks**, 5G-PPP White paper – ICT-19 performance KPIs, May 2021. You may access it **here**
- **AI and ML – Enablers for Beyond 5G Networks**, 5G-PPP Technology Board, 11 May 2021. You may access it **here**

Figure 4 - 5G-PPP White Paper publications

Figure 2 and Figure 3 depict indicative publications in journals, conferences and workshops, while Figure 4 delineates all the 5G PPP related publications. More details on publication and 5G!Drones dissemination are provided in Section 4.1.

- **Workshops, presentation and trials Webpage (https://5gdrones.eu/workshops/).** Any stakeholder can easily access activities from seminars, presentations, conferences, panel discussions, and trials that are related with 5G!Drones. During the reporting period 5G!Drones partners have made 17 Presentations, organized/co-organized 1 workshop and performed 10 pretrials/trials.

Workshops-Special Sessions

5G!Drones has organized or co-organized with other projects the following workshops.

	EVENT	WORKSHOP-SPECIAL SESSION DETAILS
1	IEEE WCNC2020	Aerial Communications in 5G and Beyond Networks (AERCOMM) workshop, co-organized by 5G!Drones and EU-Korea PriMO-5G project, colocated with IEEE Wireless Communications and Networking Conference, 25-28 May 2020 (Virtual Conference), Beyond Connectivity: What Comes After 5G
2	Online workshop	"5G Experimentation Facilities and Vertical Trials: Current Status and Future Perspectives" online workshop on 14 Oct 2020. This online workshop is organised by the Institute of Informatics & Telecommunications of NCSR Demokritos (Athens, Greece), EU projects 5GENESIS and 5G!Drones and with the support of the 5G-PPP partnership.
3	Seminar Session at PRINSE'22	Session 4B: Discovering extreme antennas (L10) Title: Printed Electronics Ecosystem for Future Wireless Networks, by Ilkka Känsälä / Nokia, in the Seminar "7th PrintoCent Industry Seminar" **PrintoCent – Piloting and manufacturing printed intelligence**. PRINSE'22 in June 8–9, 2022, Oulu, Finland

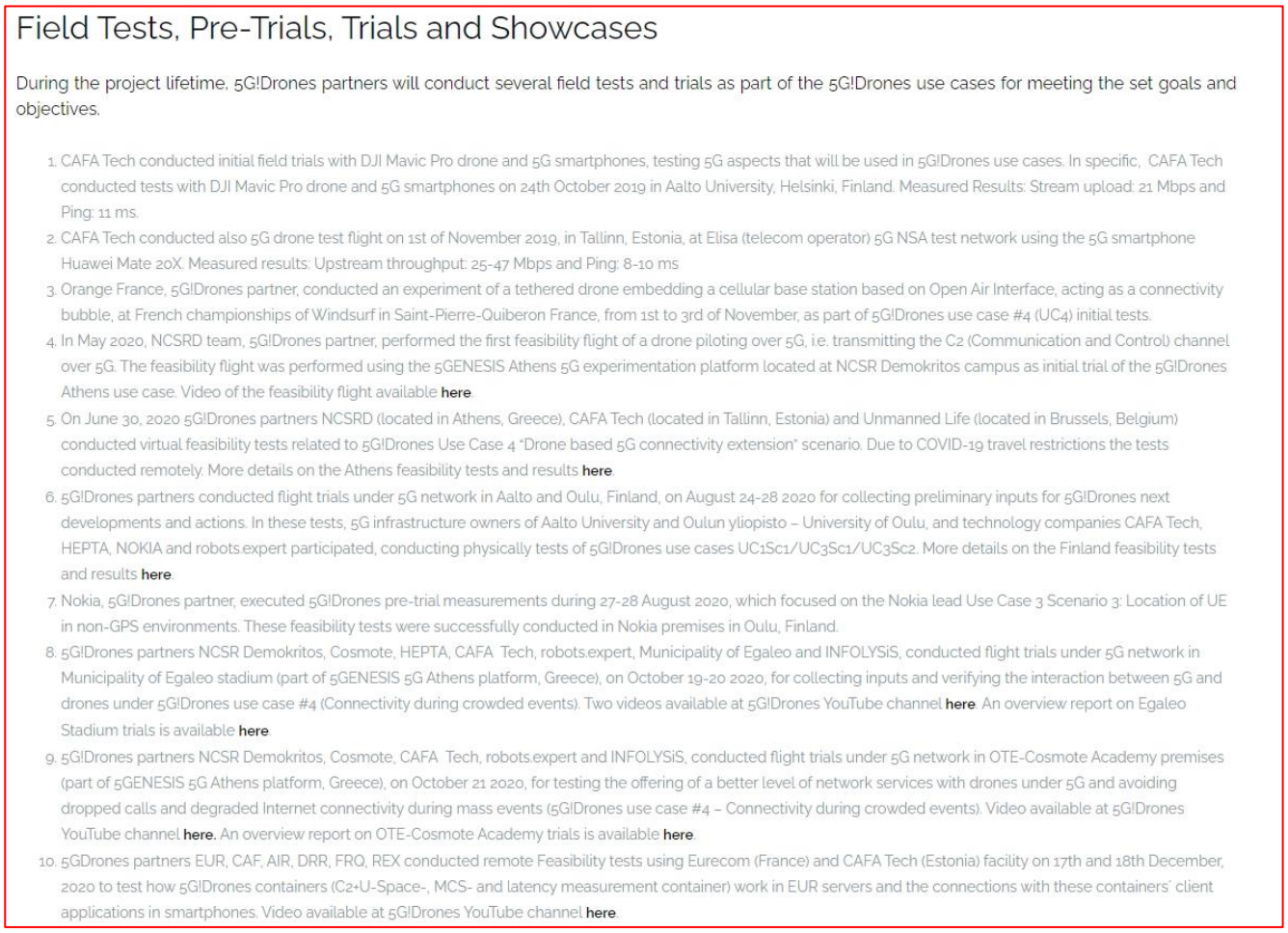
Figure 5 - 5G!Drones workshops and special sessions

Presentations, Webinars, Booths, Poster sessions and Panel Discussions

5G!Drones partners have participated in various events in order to promote 5G!Drones activities and achievements through presentations. The table below summarizes all presentations made by 5G!Drones partners in conferences, workshops, special sessions and info/business days.

	EVENT	EVENT DETAILS	PRESENTATION TITLE
1	EuCNC 2019	EMPOWER workshop "Empowering Transatlantic Platforms for Advance Wireless Research", 18 June 2019, Valencia, Spain	5G!Drones vertical use cases and requirements
2	EuCNC 2019	5G PPP ICT-19 session "Launching of Advanced 5G validation trials across multiple vertical industries and the next steps", 21 June 2019, Valencia, Spain	5G!Drones technical overview
3	Salon du Bourget, Paris Air Lab	Company presentation of INVOLI partner by Mélanie Guittet and its involvement into the 5G!Drones European project in Salon du Bourget, Paris Air Lab, 21 June 2019	INVOLI and 5G!Drones
4	5GEVE Meeting, Pisa	Adlen Ksentini (Eurocom) presented 5G!Drones to 5GEVE ICT-17 partners duting theri GA meeting in Pisa, Italy, Sept 2019	5G!Drones Overview
5	Digital Transport Days, Helsinki	Dr. Jussi Haapola (University of Oulu), 5G!DRONES project coordinator, presented 5G!DRONES project and the opportunities 5G can bring to UAV transport sector (October 9th, 2019).	What can 5G bring to Drones?
6	ITS World Congress 2019, Singapore	Tero Vuorenmaa (Robots Expert) presented Urban Air Mobility requirements and 5G!Drones project in ITS World Congress in Singapore on 24 October 2019	5G!Drones
7	5GTNF Results and Demo Seminar, Helsinki, Finland	Prof. Ari Pouttu (University of Oulu) presented the 5G!Drones at the poster session of 5GTNF Results and Demo Seminar in Helsinki, Finland, on 1st of November 2019.	5G!Drones Poster session
8	FRUCT2019 conference Helsinki, Finland	Tero Vuorenmaa (Robots Expert) presented "Is UAM ready for business?" focused on challenges of the Urban Air Mobility and 5G!Drones as a use case of activity towards 5G connected drones, on 8 November 2019 in the FRUCT2019 conference Helsinki, Finland	5G!Drones as a use case of activity towards 5G connected drones
9	10th FOKUS FUSECO 2019 Forum – Berlin, Germany	Dr. Lechosław Tomaszewski (Orange Poland) and Tanel Järvet (CAFA Tech) presented "5G!Drones trials – how to match UAV business cases, drone capabilities and 5G test facilities" on 8 November 2019 in the 10th FOKUS FUSECO 2019 Forum – Berlin, Germany	5G!Drones trials – how to match UAV business cases, drone capabilities and 5G test facilities

Figure 6 - 5G!Drones presentations



Field Tests, Pre-Trials, Trials and Showcases

During the project lifetime, 5G!Drones partners will conduct several field tests and trials as part of the 5G!Drones use cases for meeting the set goals and objectives.

1. CAFA Tech conducted initial field trials with DJI Mavic Pro drone and 5G smartphones, testing 5G aspects that will be used in 5G!Drones use cases. In specific, CAFA Tech conducted tests with DJI Mavic Pro drone and 5G smartphones on 24th October 2019 in Aalto University, Helsinki, Finland. Measured Results: Stream upload: 21 Mbps and Ping: 11 ms.
2. CAFA Tech conducted also 5G drone test flight on 1st of November 2019, in Tallinn, Estonia, at Elisa (telecom operator) 5G NSA test network using the 5G smartphone Huawei Mate 20X. Measured results: Upstream throughput: 25-47 Mbps and Ping: 8-10 ms
3. Orange France, 5G!Drones partner, conducted an experiment of a tethered drone embedding a cellular base station based on Open Air Interface, acting as a connectivity bubble, at French championships of Windsurf in Saint-Pierre-Quiberon France, from 1st to 3rd of November, as part of 5G!Drones use case #4 (UC4) initial tests.
4. In May 2020, NCSRD team, 5G!Drones partner, performed the first feasibility flight of a drone piloting over 5G, i.e. transmitting the C2 (Communication and Control) channel over 5G. The feasibility flight was performed using the 5GENESIS Athens 5G experimentation platform located at NCSR Demokritos campus as initial trial of the 5G!Drones Athens use case. Video of the feasibility flight available here.
5. On June 30, 2020 5G!Drones partners NCSRD (located in Athens, Greece), CAFA Tech (located in Tallinn, Estonia) and Unmanned Life (located in Brussels, Belgium) conducted virtual feasibility tests related to 5G!Drones Use Case 4 "Drone based 5G connectivity extension" scenario. Due to COVID-19 travel restrictions the tests conducted remotely. More details on the Athens feasibility tests and results here.
6. 5G!Drones partners conducted flight trials under 5G network in Aalto and Oulu, Finland, on August 24-28 2020 for collecting preliminary inputs for 5G!Drones next developments and actions. In these tests, 5G infrastructure owners of Aalto University and Oulun yliopisto – University of Oulu, and technology companies CAFA Tech, HEPTA, NOKIA and robots.expert participated, conducting physically tests of 5G!Drones use cases UC1Sc1/UC3Sc1/UC3Sc2. More details on the Finland feasibility tests and results here.
7. Nokia, 5G!Drones partner, executed 5G!Drones pre-trial measurements during 27-28 August 2020, which focused on the Nokia lead Use Case 3 Scenario 3: Location of UE in non-GPS environments. These feasibility tests were successfully conducted in Nokia premises in Oulu, Finland.
8. 5G!Drones partners NCSR Demokritos, Cosmote, HEPTA, CAFA Tech, robots.expert, Municipality of Egaleo and INFOLYSiS, conducted flight trials under 5G network in Municipality of Egaleo stadium (part of 5GENESIS 5G Athens platform, Greece), on October 19-20 2020, for collecting inputs and verifying the interaction between 5G and drones under 5G!Drones use case #4 (Connectivity during crowded events). Two videos available at 5G!Drones YouTube channel here. An overview report on Egaleo Stadium trials is available here.
9. 5G!Drones partners NCSR Demokritos, Cosmote, CAFA Tech, robots.expert and INFOLYSiS, conducted flight trials under 5G network in OTE-Cosmote Academy premises (part of 5GENESIS 5G Athens platform, Greece), on October 21 2020, for testing the offering of a better level of network services with drones under 5G and avoiding dropped calls and degraded Internet connectivity during mass events (5G!Drones use case #4 – Connectivity during crowded events). Video available at 5G!Drones YouTube channel here. An overview report on OTE-Cosmote Academy trials is available here.
10. 5GDrones partners EUR, CAF, AIR, DRR, FRQ, REX 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 at 5G!Drones YouTube channel here.

Figure 7 - 5G!Drones trials

- **Articles Webpage (https://5gdrones.eu/published-articles/):** In the Articles Webpage **26 online articles** and interviews are listed; 4 of them belong to the latest period.

23. "NCSR Demokritos pioneering activities in 5G research and 5G-PPP projects", interview by Dr. Harilaos Koumaras in Startupper magazine (in GreeK) – (pdf)
24. "Showcasing 5G!Drones – Espoo International School First Graders Visit to Aalto", http://mosaic-lab.org/events.aspx?id=c4c30c79-7b70-42c7-9097-bf1711879d2c
25. "How the drones of the future will be?", https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html
26. "How can drones play an essential role for smart cities safety?", 5G!Drones testing session at EURECOM campus, https://eurecom-blog.medium.com/how-can-drones-play-an-essential-role-for-smart-cities-safety-a9e869901d82

Figure 8 - 5G!Drones articles

- **Deliverables Webpage (https://5gdrones.eu/deliverables/).** Deliverables are a highly efficient method of evaluating and monitoring a project's objectives and results, documenting them in a report and making it public so as everyone can be informed. In this Webpage, 5G!Drones Website visitor may access and read all released public deliverables and be informed about the upcoming ones. Until the moment D5.5 was under editing, **35 deliverables** have been published online or were about to in M42. Of course, deliverables are usually subject to some delay before publishing them on the Website.

5G!Drones Deliverables are listed below. All public (PU) deliverables are available for downloading.

Del.#	Name	WP#	Lead Participant	Type	Dissemination Level	Delivery Date	Download
D1.1	Use case specifications and requirements	1	UML	R	PU	M06	PDF
D1.2	Initial description of the 5G trial facilities	1	UO	R	PU	M06	PDF
D1.3	5G!Drones system architecture initial design	1	ORA	R	PU	M08	PDF
D1.4	Report on UAV business and regulatory ecosystem and the role of 5G	1	CAF	R	PU	M12	PDF
D1.5	Description of the 5G trial facilities and use case mapping	1	UO	R	PU	M12	PDF
D1.6	5G!Drones system architecture refined design	1	DEM	R	PU	M24	PDF
D1.7	Final report on UAV business and regulatory ecosystem and the role of 5G	1	INF	R	PU	M42	
D2.1	Initial definition of the trial controller architecture, mechanisms, and APIs	2	AU	R	PU	M12	PDF
D2.2	Initial implementation of the trial controller	2	INV	O	Software, CO	M23	
D2.3	Report on algorithms, mechanisms and tools for data analysis and visualisation	2	FRQ	R	PU	M24	PDF
D2.4	Definition of the trial controller architecture, mechanisms, and APIs	2	EUR	R	PU	M24	PDF
D2.5	Trial controller software final release	2	DEM	O	Software, CO	M33	
D2.6	Data analysis and visualisation software implementation	2	NOK	O	Software, CO	M33	
D3.1	Report on infrastructure-level enablers for 5G!Drones	3	OPL	R	PU	M18	PDF
D3.2	Report on vertical service-level enablers for 5G!Drones	3	EUR	R	PU	M26	PDF
D3.3	5G!Drones Enablers Software Suite	3	UO	O	Software, CO	M35	
D3.4	UAV use case service components	3	ALE	O	Software, CO	M36	
D4.1	Integration plan	4	DRR	R	PU	M7	PDF

Figure 9 - 5G!Drones deliverables

D4.2	Integration status and updated integration plan	4	DRR	R	PU	M26	PDF
D4.3	Trial plan	4	CAF	R	PU	M26	PDF
D4.4	Trial evaluation report	4	COS	R	PU	M42	
D5.1	Communication, showcasing, dissemination and exploitation plan and standardization roadmap	5	INF	R	PU	M6	PDF
D5.2	Report on communication, showcasing, dissemination and exploitation achievements and plan for the second term of the project	5	RXB	R	PU	M23	PDF
D5.3	Report on contribution to standardisation and international fora– 1st Version	5	AIR	R	PU	M18	PDF
D5.4	Report on contribution to standardisation and international fora– 2nd Version	5	THA	R	PU	M42	
D5.5	Final report on communication, showcasing, dissemination and exploitation	5	ORA	R	PU	M42	
D5.6	Report on activities related to commercial exploitation and partnership development	5	OPL	R	PU	M42	
D6.1	Data Management Plan and quality and risk management plan	6	OU	ORDP	PU	M4	PDF
D6.2	Annual report, year 1	6	OU	R	PU	M12	PDF
D6.3	Mid-term review report	6	OU	R	PU	M18	PDF
D6.4	Annual report, year 2	6	OU	R	PU	M24	PDF
D6.5	Annual report, year 3	6	OU	R	PU	M36	
D6.6	Final project report	6	OU	R	PU	M42	
D6.7	Information on cumulative expenditure incurred – M18	6	OU	R	CO	M18	
D6.8	Information on cumulative expenditure incurred – M30	6	OU	R	CO	M30	

Figure 10 - 5G!Drones deliverables 2

- **Events Webpage (https://5gdrones.eu/past-events/).** In this Webpage every event in which 5G!Drones participates is recorded. In the final project period up to November 2022, partners have participated in **at least 23 events**.

All events such as conferences, workshops, special sessions, invited talks and presentations in which 5G!DRONES participated are summarized in this page.

- Interpol Drone Expert Summit, 20-22/06/2022 Oslo, Norway
- AIAI 2022/5G-PINE, 17-20 June 2022, Crete, Greece
- 7th PrintoCent Industry Seminar – PRINSE'22, 8–9 June 2022, Oulu, Finland
- EUCNC 2022 | 6G Summit, 7-10 June 2022, Grenoble, France & Online
- ITS European Congress 2022, 30 May – 1 June 2022
- IEEE International Conference on Communications 2022 (ICC 2022), 16-20 May 2022, Seoul, South Korea
- Amsterdam Drone Week ADW, 29-31 March 2022
- IEEE Global Communications Conference, 7–11 December 2021, Madrid, Spain
- 5G Techritory – Europe's Leading 5G Ecosystem Forum, November 22-25, 2021
- Smart City Expo World Congress, 16-18 November 2021, Barcelona, Spain
- Dubai Airshow, 14-18 November 2021
- AirTec, 26-28 October 2021, Munich, Germany
- 17th International Conference on Wireless and Mobile Computing, Networking and Communications (IEEE WiMob 2021), 11-13 Oct 2021
- 26th Finnish National Conference on Telemedicine and eHealth, "eHealth in a Lifecycle", 7-8 October 2021, Oulu, Finland
- IEEE International Mediterranean Conference on Communications and Networking (MeditCom 2021), 7–10 September 2021, Athens, Greece
- IoT Week, 31 August – 3 September 2021, Dublin, Ireland
- 2021 Joint EuCNC & 6G Summit, 8-11 June 2021, Porto, Portugal
- Finnish UAV Ecosystem (FUAVE) Stakeholder event (15 April 2021)
- Athens Science Festival, online 27-29 March 2021 (Athens, Greece)

Figure 11 - 5G!Drones events

- **News Webpage (https://5gdrones.eu/news/).** The News Webpage is the most regularly updated page of the Website. It informs the visitor on a weekly basis about new events, project activities, partners actions, flagship events and the 5G-PPP dissemination and communication actions along with URLs to related material, videos and files. During the period M25-M42 5G!Drones has communicated **more than 70 News posts** through the News Webpage (Figure 12). and **more than 200 News** posts since the beginning of the project.

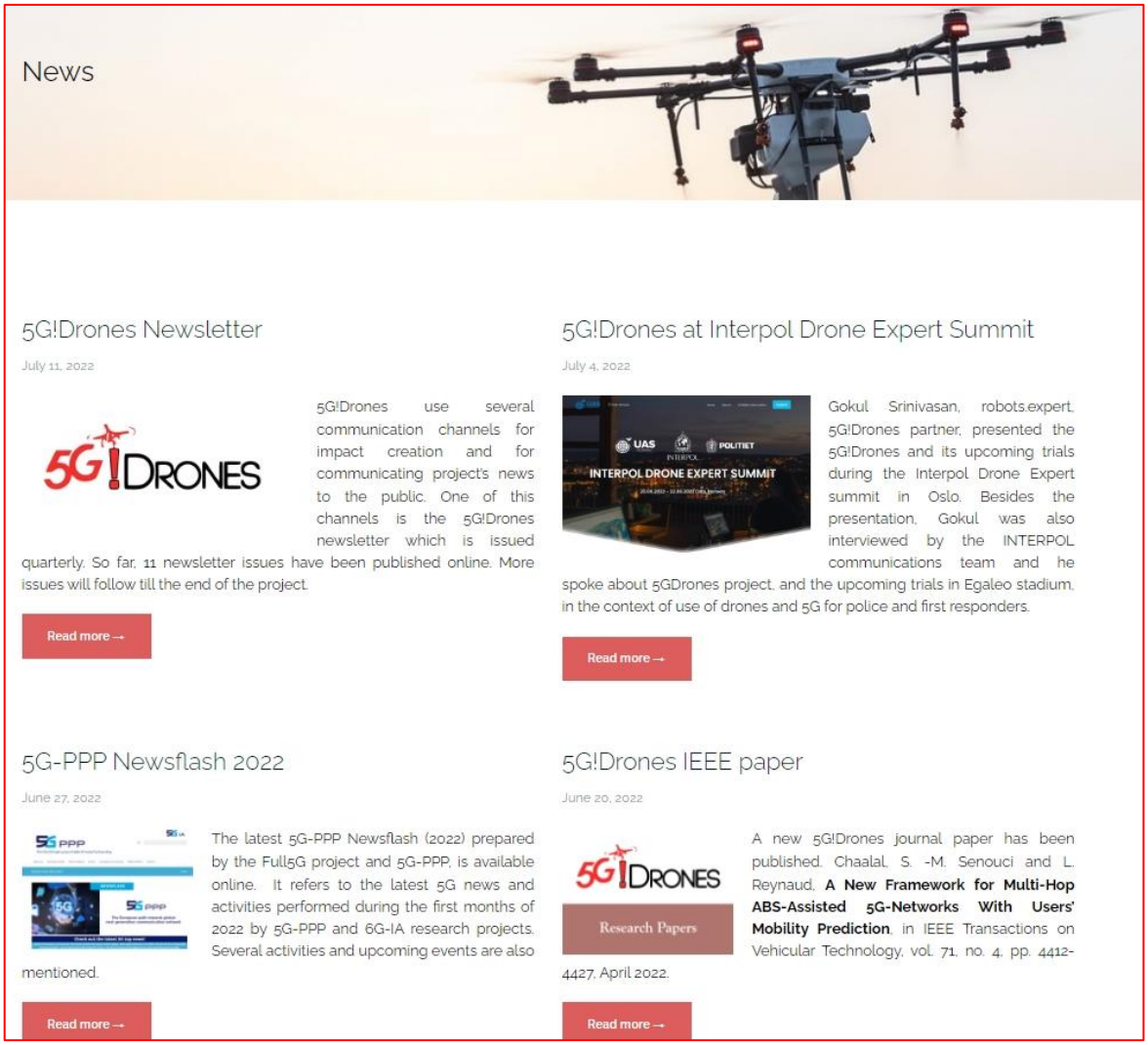


Figure 12 - 5G!Drones news Webpage

In conclusion, as it is evident from the descriptions and illustrations of the aforementioned sections, 5G! Drones Website is a condensed, thorough, and constantly updated communication channel that offers all relevant information and materials on project activities. Keep in mind a more detailed Website description about all the technical aspects and the sections of the Website has been provided through D5.1 [4].

2.1.2 5G!Drones social media channels

5G!Drones is actively present in all impactful and famous social media channels. More specifically, the following 5G!Drones social media accounts are available and have been actively used since the first day of the project (May 2019): Twitter, LinkedIn, Facebook, Instagram and YouTube and their access links are the following (Table 1).

Facebook	www.facebook.com/5gdrones
Twitter	https://twitter.com/5gdrones
LinkedIn	https://www.linkedin.com/in/5gdrones/
Instagram	https://www.instagram.com/5gdrones_project/
YouTube	https://www.youtube.com/channel/UChPj4gQ5P5go7Fer6NJxGOQ

Table 1 - 5G!Drones social media channels

5G!Drones Social media posts are concentrated on sharing information about the project and the dissemination efforts that the Consortium members are engaged in. Briefly the following news and type of activities are communicated through the 5G!Drones social media channels:

- News and updates on the 5G!Drones activities and progression of project's tasks and deliverables
- Papers and presentations originating from workshops, conferences, journals etc.
- White papers and technical reports
- Project showcases/demonstrations
- Publications in articles, online sources, newspapers/newsletter
- Upcoming events prompting stakeholders for papers (CfP) and events participation (registration)
- Videos and photos from activities (conferences, presentations, trials) related to the project
- 5G!Drones Partners related activities and achievements
- Newsletter issues
- General articles about 5G and Drones topics (addressing a wide non-technical audience)
- 5G-PPP activities (events, newsletters, newsflashes, publications, white papers and articles)
- 5G-PPP, NetWorld2020/NetworldEurope and 5G-IA Working Groups activities, 6G-IA and 6G SNS activities
- Related activities of other 5G-PPP and 5G related research projects

In parallel to the main social media channels, 5G!Drones is also available in 5G!Drones YouTube channel. A communication tool focused exclusively on videos from 5G!Drones events, presentations, workshops, conferences and trials. More details are provided in the next sections where the activity of all 5G!Drones social media channels are reported for the period June 2021-September 2022.

2.1.2.1 Facebook account

The 5G!Drones Facebook account is used to intensively communicate project activities to a wide nontechnical audience (Figure 13). In the Facebook page any interested visitor may access the latest posts of the project activities (technical and non-technical), 5G!Drones project information/identity, as well as several article posts based on the two fundamental pillars of the project: the 5G and the UAVs topics. Also, there are frequent references through posts to 5G-PPP association that supports all 5G-related Information and Communication Technology (ICT) projects with several activities.

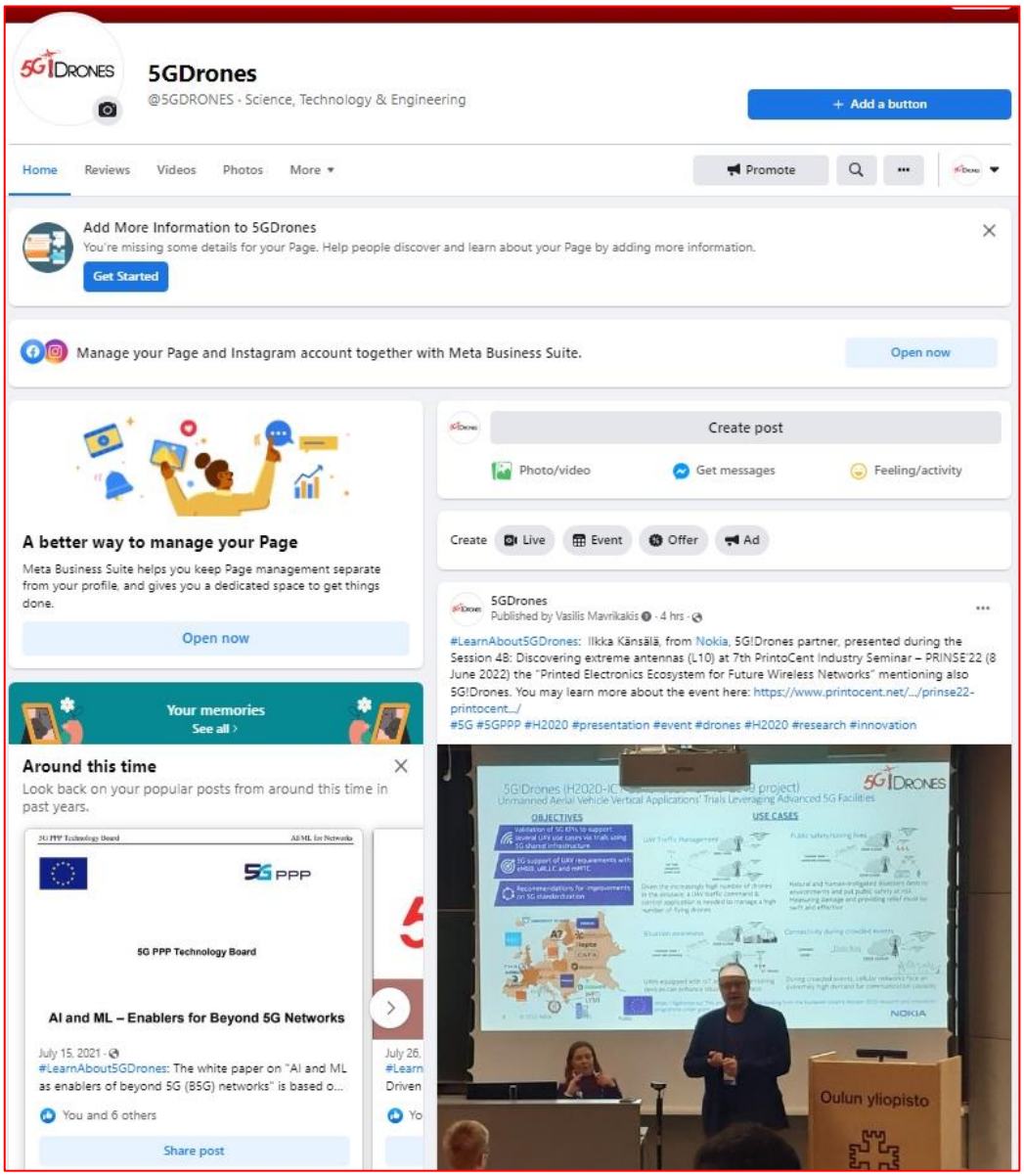


Figure 13 - 5G!Drones Facebook page

Facebook Activity (during the reporting period)	
June 2021-September 2022	
Period Posts	151
Period Reach	12,429
Page Views	415
Engagements	1,725

Table 2 - Facebook activity (M25-M40)

2.1.2.2 Twitter account

The project's news overview site is the 5G!Drones Twitter account, which uses a clear and straightforward format to inform its followers of all 5G!Drones activities, both technical and non-technical (Figure 14).

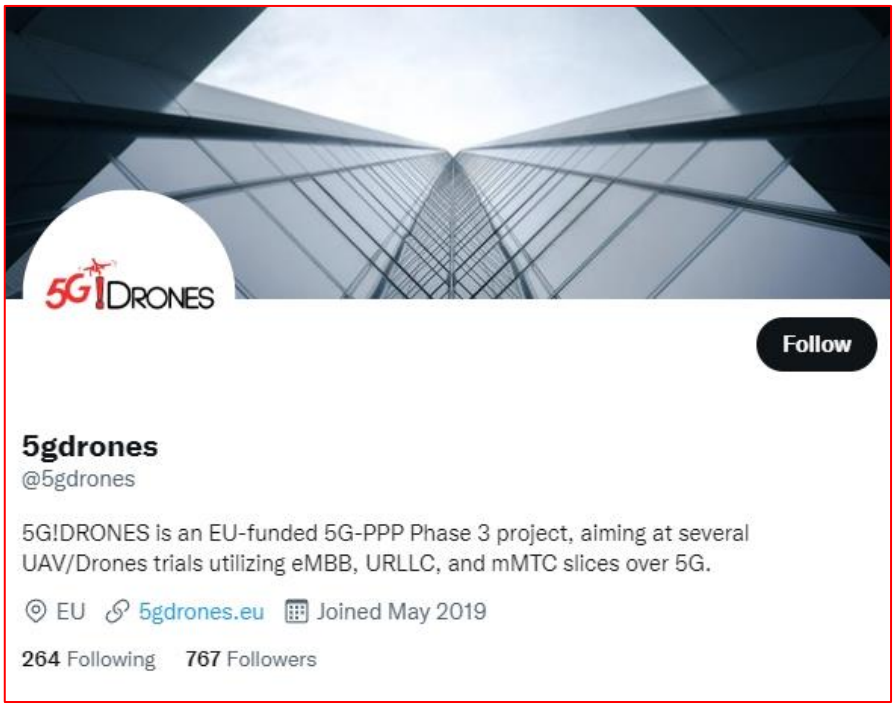


Figure 14 - 5G!Drones Twitter account

Twitter Activity	
June 2021-September 2022	
Period Tweets	166
Period Likes	702
Impressions	29,750

Table 3 - Twitter activity (M25-M40)

2.1.2.3 LinkedIn account

The LinkedIn account allows the user to present material in a more academic and business manner for addressing a more technical audience. 5G!Drones LinkedIn channel (Figure 15) showcases all the activities of the project and information about its results. Since a more technical and academic audience is targeted, LinkedIn is occasionally used for sharing content that is more technical and academic.

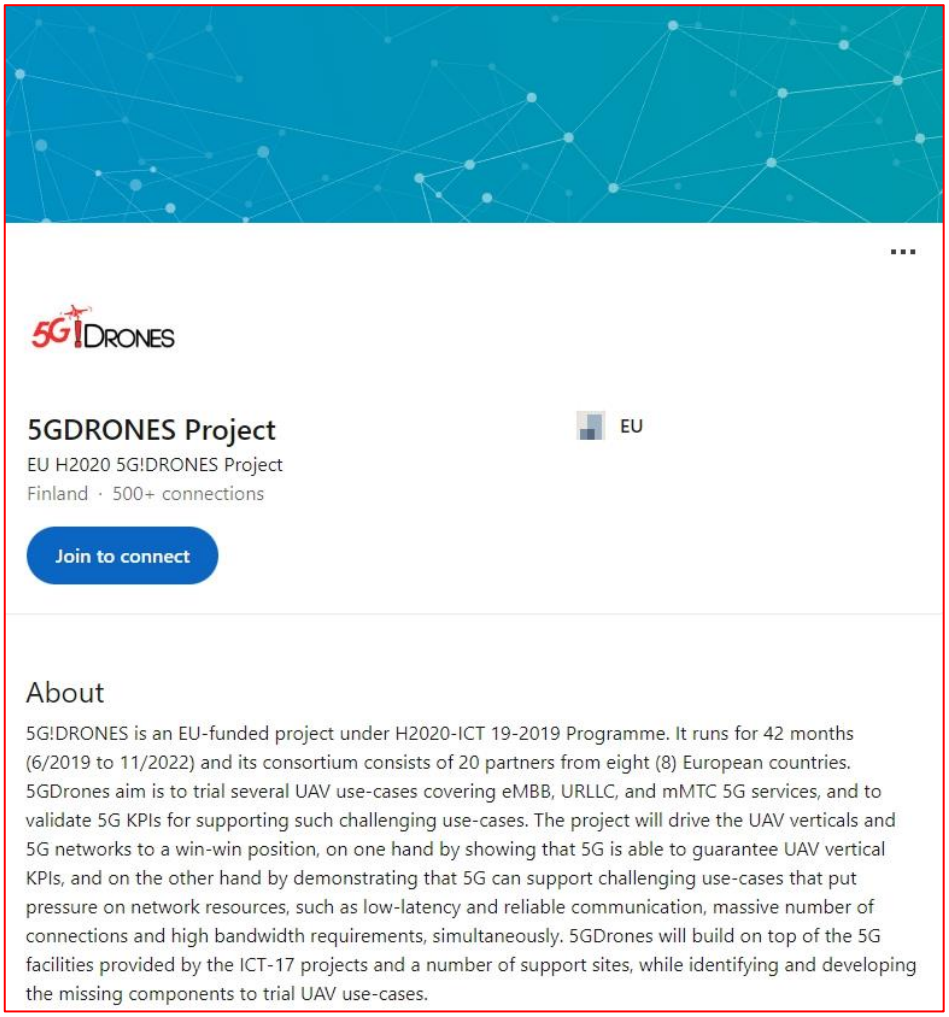


Figure 15 - 5G!Drones LinkedIn account

LinkedIn Activity (during the reporting period)	
June 2021-September 2022	
Period Posts	157
Period Likes	2,041
Period Reshares	52
Post Views	91,774

Table 4 - LinkedIn activity (M25-M40)

2.1.2.4 Instagram account

The 5G!Drones Instagram account is also used to communicate material from events and activities related to the project but using a more visual approach. Considering the nature and the audience of the Instagram platform, 5G!Drones team communicates mainly visual content and especially images through the 5G!Drones Instagram channel. Images from events, presentations and trials along with a short text outline any posted activity. Furthermore, in the bio of the profile, any interested visitor can find the 5G!Drones Website address where he can be redirected for more details (this URL is temporarily updated with links that need to address specific post activities such URL of an event or a video that was posted on that period).

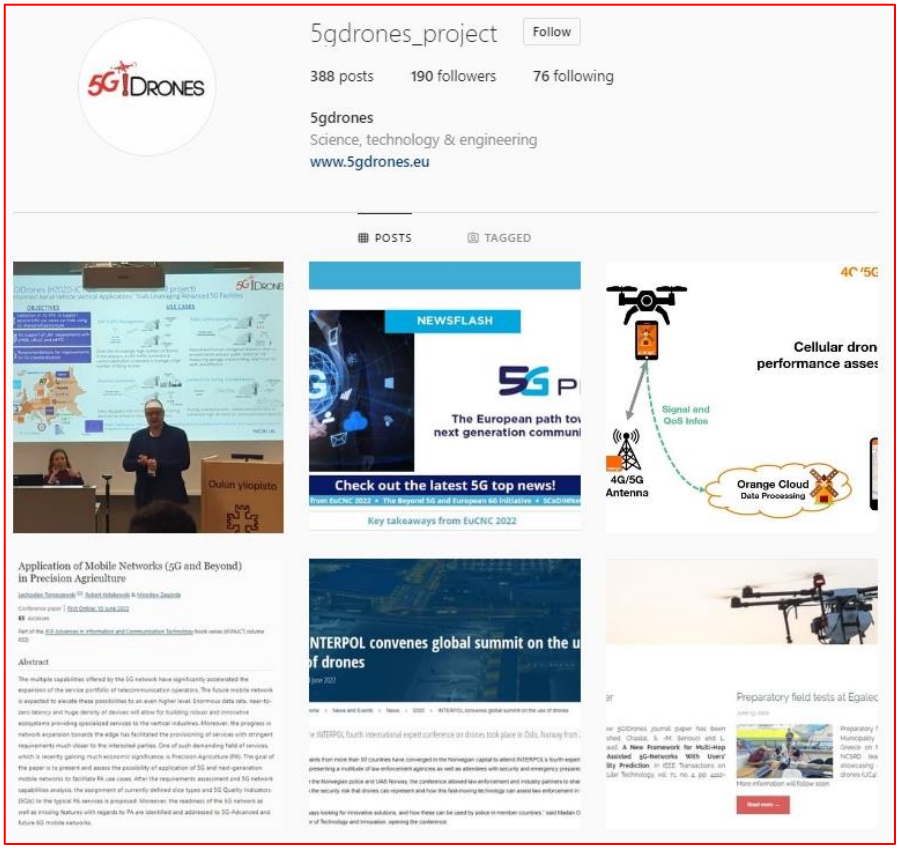


Figure 16 - 5G!Drones Instagram account

Instagram Activity (during the reporting period)	
June 2021-September 2022	
Period Posts	148
Period Likes	720

Impressions	5,942
Reach	5,332

Table 5 – Instagram activity (M25-M40)

2.1.2.5 YouTube account

A video-based communication channel is YouTube. As a result, movies on the 5G!Drones YouTube channel are utilized to share project activities, experiments, and outcomes (Figure 17). In the 5G!Drones YouTube channel there are available videos from project's presentations, trials and conferences.

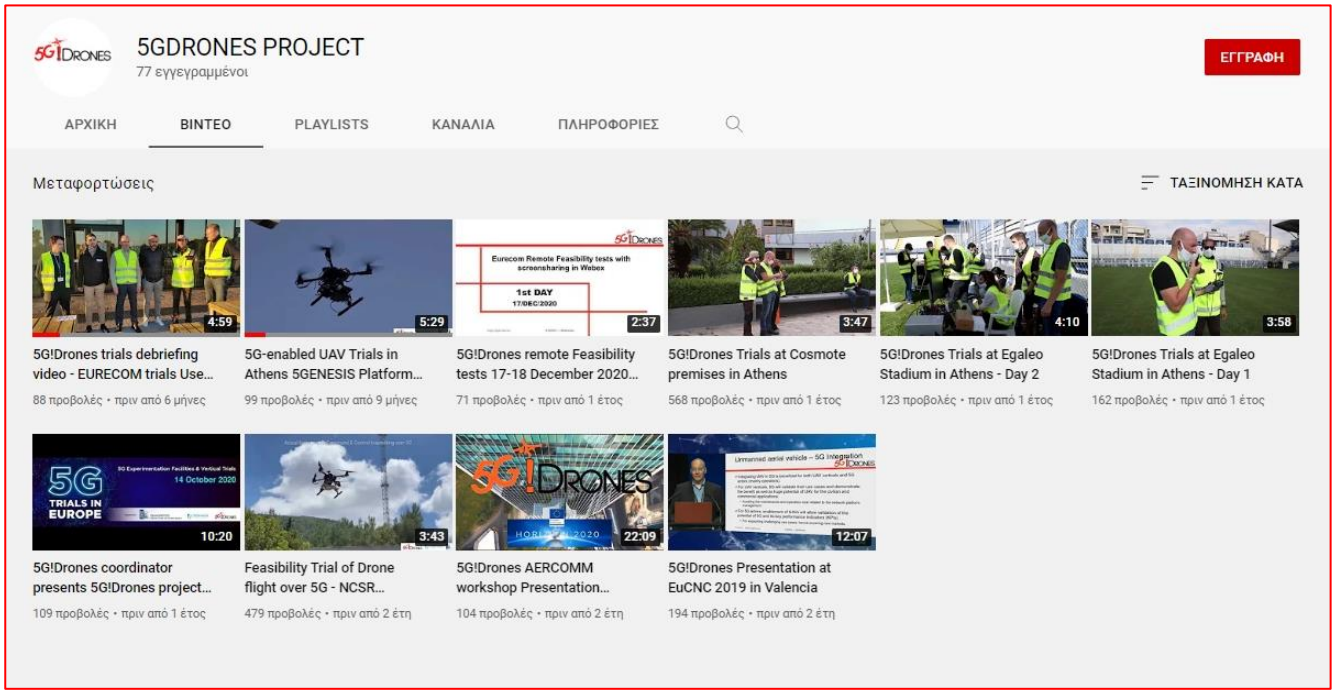


Figure 17 - 5G!Drones YouTube channel

YouTube Activity (during the reporting period)	
June 2021-September 2022	
Total Subscribers	87
Period Videos	>8 (more to be added during M41-42)
Period Views	696
Period Likes	51

Table 6 - 5G!Drones YouTube activity

2.1.3 Newsletter

The 5G!Drones newsletter is being issued on a quarterly basis (every three months). Each quarter's newsletter clearly and thoroughly covers events and activities of the recorded time period. A specific template is used making the 5G!Drones newsletter easily recognisable and each text paragraph is followed by a URL and a small picture in order to show off better the equivalent activity. Each newsletter issue, upon release in public, is communicated through 5G!Drones social media channels and it is also available for downloading (pdf format) through the 5G!Drones Website, on the Newsletters Webpage in the following link: **https://5gdrones.eu/newsletter**.

Newsletter Issues		
Issue #	Period	Link
1	June-August 2019	https://5gdrones.eu/wp-content/uploads/2019/09/5GDrones-Newsletter-Issue-1.pdf
2	September-November 2019	https://5gdrones.eu/wp-content/uploads/2019/12/5GDrones-Newsletter-Issue-2.pdf
3	December 2019-February 2020	https://5gdrones.eu/wp-content/uploads/2020/03/5GDrones-Newsletter-Issue-3-v1.0.pdf
4	March-May 2020	https://5gdrones.eu/wp-content/uploads/2020/06/5GDrones-Newsletter-Issue-4-v1.0.pdf
5	June-August 2020	https://5gdrones.eu/wp-content/uploads/2020/09/5GDrones-Newsletter-Issue-5-v1.0.pdf
6	September-November 2020	https://5gdrones.eu/wp-content/uploads/2020/12/5GDrones-Newsletter-Issue-6-v1.0.pdf
7	December 2020-February 2021	https://5gdrones.eu/wp-content/uploads/2021/03/5GDrones-Newsletter-Issue-7-v1.0.pdf
8	March-May 2021	https://5gdrones.eu/wp-content/uploads/2021/06/5GDrones-Newsletter-Issue-8-v1.0.pdf
9	June-August 2021	https://5gdrones.eu/wp-content/uploads/2021/09/5GDrones-Newsletter-Issue-9-v1.0.pdf

10	September-November 2021	https://5gdrones.eu/wp-content/uploads/2021/12/5GDrones-Newsletter-Issue-10-v1.0.pdf
11	December 2021-February 2022	https://5gdrones.eu/wp-content/uploads/2022/03/5GDrones-Newsletter-Issue-11-v1.0.pdf
12	March-May 2022	https://5gdrones.eu/wp-content/uploads/2022/06/5GDrones-Newsletter-Issue-12.pdf
9	June-August 2021	https://5gdrones.eu/wp-content/uploads/2021/09/5GDrones-Newsletter-Issue-9-v1.0.pdf
10	September-November 2021	https://5gdrones.eu/wp-content/uploads/2021/12/5GDrones-Newsletter-Issue-10-v1.0.pdf
11	December 2021-February 2022	https://5gdrones.eu/wp-content/uploads/2022/03/5GDrones-Newsletter-Issue-11-v1.0.pdf
12	March-May 2022	https://5gdrones.eu/wp-content/uploads/2022/06/5GDrones-Newsletter-Issue-12.pdf
13	June-August 2022	https://5gdrones.eu/wp-content/uploads/2022/09/5GDrones-Newsletter-Issue-13.pdf
14	September-November 2022	This issue will be found on the 5G!Drones Website along the other newsletters at the end of the project.

Table 7 - 5G!Drones newsletter issues

During the reporting period, 7 newsletter issues have been published. The latest one will be the issue No 14 referring to the quarter September 2022-November 2022 (Table 7). At the time that this deliverable was under editing, the initial draft version of newsletter issue 14 has been created and its editing process also initiated.

Each issue follows a special internal editing procedure before going public. Every new issue is initially made available internally as a draft and distributed to the consortium partners via the specific WP5 mailing list for internal evaluation (comments, additions, editing). When the evaluation process is over, the INF groups the issues (if any) and proceeds in fixing them. Finally, the newsletter is available through the Website's Newsletter page (which can be downloaded via a dedicated link), as well as through the 5G!Drones social media platforms.

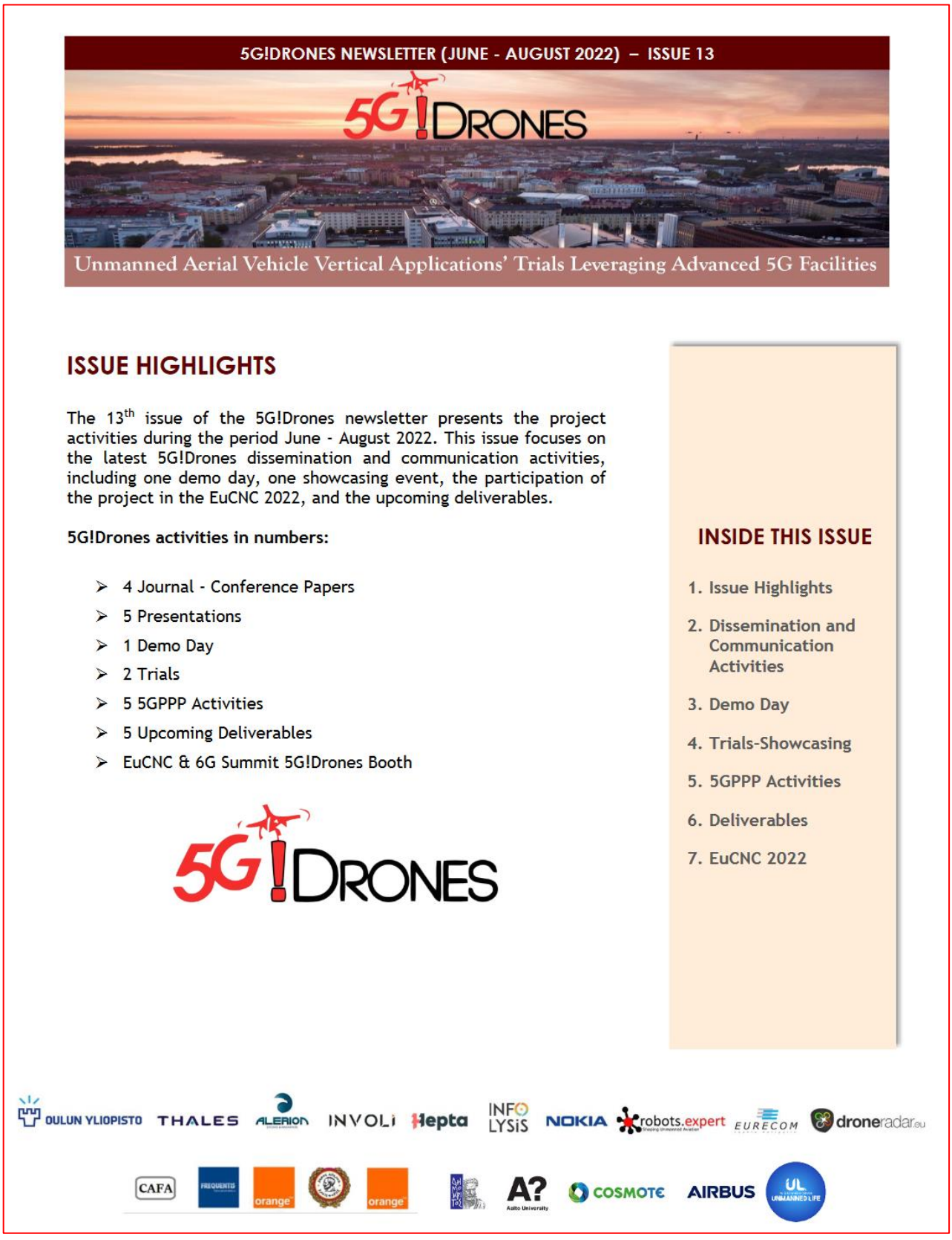


Figure 18 - 5G!Drones newsletter issue 13 cover page

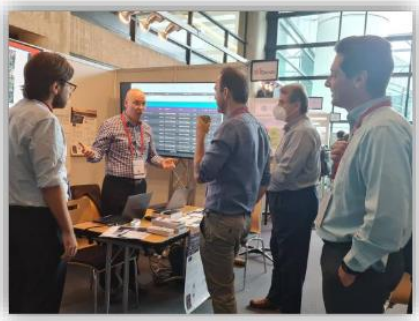
EUCNC & 6G SUMMIT 2022

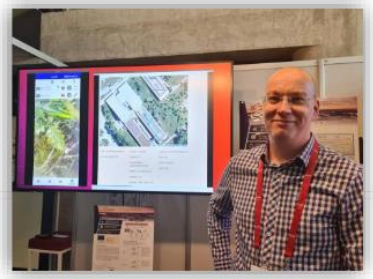
5G!Drones project participated in the EuCNC & 6G Summit 2022 with a booth. This year's EuCNC event took place on the 7th - 10th June 2022, in Grenoble, France. The conference, sponsored by the IEEE Communications Society and the European Association for Signal Processing, focuses on all aspects of telecommunications ranging from 5G deployment and mobile IoT to 6G exploration and future communications systems and networks, including experimentation and testbeds, and applications and services.

The conference was intended to be held for in-person attendance, with remote attendance in a Hybrid mode. 5GDrones had the chance to be promoted in a diverse audience, by sharing details about its nature and the trials that have been conducted in its context until now. Visitors had also the chance to be handed with materials such as stickers, leaflets, and posters, while also to watch videos related to the project.

For more details: https://www.eucnc.eu/

The 5G!Drones project was present with its own booth at the Booth #45.






Communication Channels

https://5gdrones.eu/

e-mail: info@5gdrones.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857031

Call: H2020-ICT-2018-2
Topic: ICT-19-2019
Type of action: R&I
Duration: 42 Months
Start date: 1/6/2019

Figure 19 - 5G!Drones newsletter issue 13 - last page

2.1.4 Leaflet

To enhance its communicative impact, 5G!Drones developed a three-fold leaflet. Leaflet versions are continuously updated and utilized to communicate the project at various events and activities where audience members are present in both printed and digital format. The 5G!Drones leaflet briefly describes details of the project such as objectives, architecture, use cases and the consortium members. The latest leaflet version is also available for downloading through 5G!Drones Communication and Dissemination Webpage here: https://5gdrones.eu/wp-content/uploads/2022/05/200114-Leaftlets-DL6-v0.4.pdf

Figure 20 - 5G!Drones leaflet front

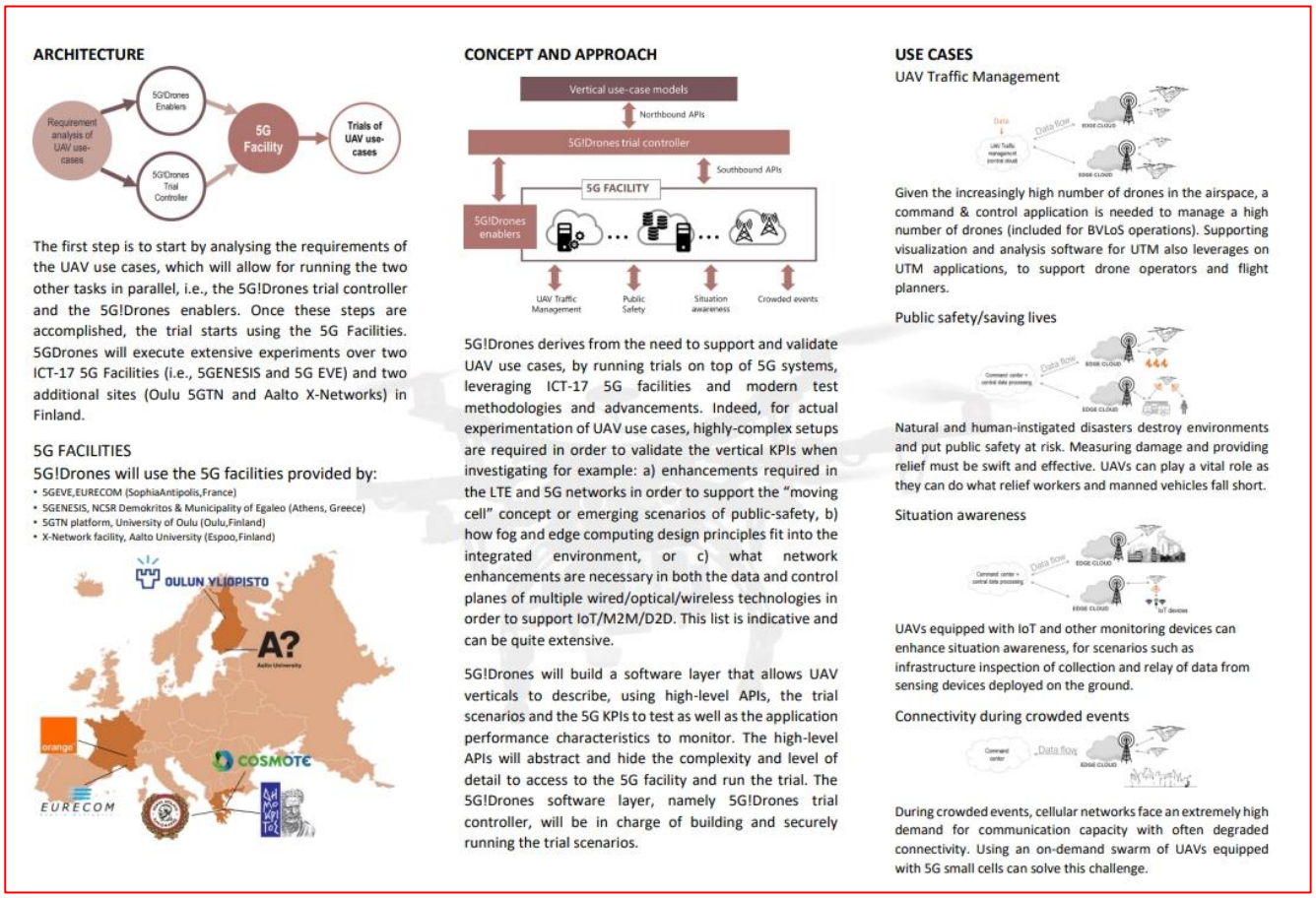


Figure 21 - 5G!Drones leaflet back

2.1.5 Poster

To support the project's communication strategy, a pertinent 5G!Drones poster has also been produced. Similar functions are served by the poster and the leaflet. In other words, the primary purpose of the poster is to showcase the project at conferences, meetings, presentations, and booths at other events. Additionally, it can be applied to online functions and digital events. Additionally, the most recent poster (A1 size) is available here on the Communication and Dissemination Webpage: **here**

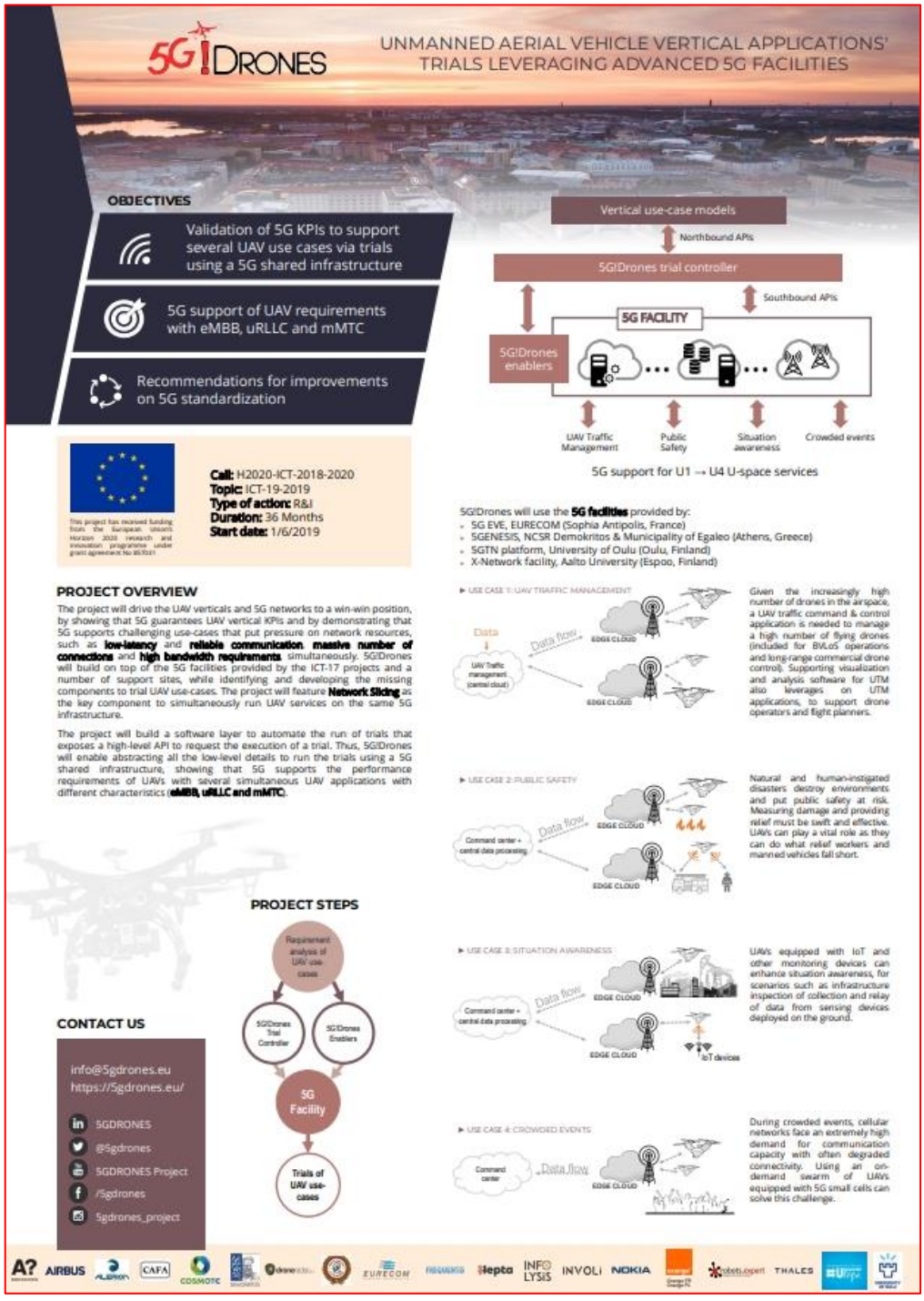


Figure 22 - 5G!Drones poster

2.1.6 Press releases

Press releases are created and shared via our partners to various media and press contacts (European and international). Press releases are also issued by partners (mainly online) and hosted on a dedicated page of the 5G!Drones Website here: **https://5gdrones.eu/press-releases/**. Press releases are mainly intended to increase visibility and public awareness. During the reporting period 1, press releases have been reported.

2.1.7 Articles

5G!Drones articles are being published in several media such as journals, newspapers, Websites, newsletters, etc., throughout the project lifetime. The three released articles of the reporting period can be found in the following table:

Articles		
Author	Title	Link
1. NSCR Demokritos	What will the drones of the future be like?	https://www.news247.gr/technologia/pos-tha-einai-ta-drones-toy-mellontos.9272133.html
2. Eurecom	How can drones play an essential role for smart cities' safety?	https://eurecom-blog.medium.com/how-can-drones-play-an-essential-role-for-smart-cities-safety-a9e869901d82
3. Unmanned Systems	Successful completion of 5G!Drones Trials in Athens	https://unmanned.life/successful-completion-of-5gdrone-trials-in-athens/

Table 8 - 5G!Drones articles

2.1.8 Other communication channels

The 5G!Drones project has enabled some additional means in order to effectively promote and disseminate the project such as:

- Online articles
- Published articles in magazines/newspapers
- Interviews, as well as videos, which may be conducted by the partners, events in which the partners participated or demonstrations
- Use of EU and 5G-PPP channels (e.g. Websites, newsletters, newsflashes) for communicating 5G!Drones and stepping on findings
- 6G – IA and 6G SNS news
- Printed material (Leaflets)
- Stickers

The project has been effectively promoted and communicated thanks to the efforts of the partners, who have been engaged in a variety of activities. **The following table lists all of the period's communication-related activities, for the June 2021-September 2022 (M25-M40)**.

Mean	Channel - Section	URL	Activity M25-M40
Website	News	https://5gdrones.eu/news/	70
	Publications	https://5gdrones.eu/research-papers/	22

	Workshops/ Presentations	https://5gdrones.eu/workshops/	1/17
	Trials	https://5gdrones.eu/workshops/	10
	White Papers	https://5gdrones.eu/research-papers/	2
	Press Releases	https://5gdrones.eu/press-releases/	1
	Events	https://5gdrones.eu/past-events/	21
	Website Visitors		7,193
	Website page views		20,345
Social Media	Facebook	www.facebook.com/5gdrones	151 posts
	LinkedIn	https://www.linkedin.com/in/5gdrones/	181 posts
	Twitter	https://twitter.com/5gdrones	166 tweets
	Instagram	https://www.instagram.com/5gdrones_project/	148 posts
	YouTube	https://www.youtube.com/ channel/UChPj4gQ5P5go7Fer6NJxGOQ	8
	Total Followers		715
	Total Posts		646
Leaflets		https://5gdrones.eu/publications-and-dissemination/	2 leaflet versions
Posters		https://5gdrones.eu/publications-and-dissemination/	1 poster version
Newsletters		https://5gdrones.eu/newsletter/	
Printed Material	Printed Leaflets		750
	Stickers		400

Table 9 - Communication activities summary (M25-M42)

2.2 Control-monitoring mechanisms and statistical dashboards - second period (M22-M42)

2.2.1 Control and monitoring mechanisms for communication material

The 5G!Drones partners have put in place control and monitoring systems since the project's launch in order to continuously review and assess the communication and dissemination efforts. These mechanisms can monitor and verify the communication processes. Also, these control and monitoring mechanisms are incredibly beneficial for the project because they serve as a means of cooperation as well as giving us essential information about the project's digital existence. All of them were extensively used throughout the project lifetime.

- **Microsoft Teams Online Repository and Collaboration Tool**

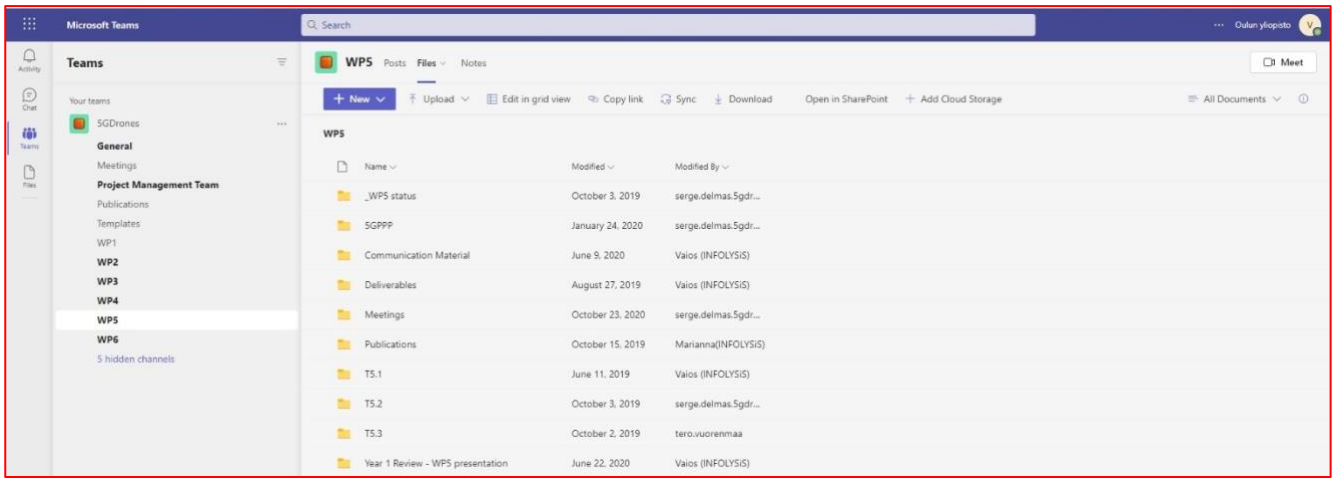


Figure 23 - 5G!Drones MS - Teams interface

- **Activities' documentation in dedicated WP7 Excel file for communication purposes**

As we have already discussed on previous deliverables, INFOLYSiS team (T5.1 leader) has established an additional mechanism to document communication and dissemination activities that they have performed and are available for communication. This mechanism relies on the existence of an online Excel file on MS Teams entitled "WP5 activities" This file is located in the T5.1 folder inside WP5 section and only registered users (i.e., partners) may access and modify it, as outlined in Figure 24.

There is a specific procedure concerning the Excel file that is followed by all partners. In detail, every partner is responsible for updating the Excel file with the information that it wants to be communicated by INF through the project's communication channels. The Excel file has specific details that must be filled in by the interested partner such as: *Item No - Authors/Partners - Activity Title - Target (Event, Location, Date) – Description*. Information that must be filled-in in the Excel file is of vital importance. It first gives us a general understanding of the situation and the activity carried out by a partner. Second, it improves communication by enhancing the available communication materials. To put it in another way, this documentation technique assists in organizing and prioritizing each activity and selecting the most appropriate content for each communication channel.

In total, **56 activities** have been documented by partners in this file during M25-M40, and **162 activities** for the whole project duration.

Item #	Authors/Partners	Activity Title	Target (Event, Location, Date)	Description
42	Nokia	1 co-organised session	7th PrintoCent Industry Seminar	Electronics Ecosystem for Future Wireless Networks, by Ilkka Känsälä / Nokia Seminar Title: 7th PrintoCent Industry Seminar Link: PrintoCent - Piloting and manufacturing printed intelligence PRINSE'22 in June 8–9, 2022, Oulu, Finland
43	Orange	Demo Session	Hub Drones Systematic	The Demo Day, organized by the Hub Drone Systematics, took place at Brétigny-sur-Orges. Four scenarios have been trialed: Support to decision making for law enforcement, Network coverage measurements and rescue of a missing person, Securing of a sport event and support to medical staff, Inspection of linear infrastructure. Orange took part in the second scenario where the Morinant enabler from 5G!Drones, a platform for data collection, has been presented. This platform aims to combine UE performance KPIs (e.g. RSRP, attached cell, etc.) and network KPIs (e.g. overall number of connected UEs, traffic load, etc.) and to visualize them in real-time. It consists of an Android app installed on a smartphone embedded on a drone, and a web interface. The trials were followed by a sharing session which have highlighted the need to better evaluate aerial connectivity and propose models for pre-flight coverage estimation, to minimize risks and predict QoS along the drone trajectory. This Demo Day was a great success, with more than a hundred guests from industry, civil aviation, academy and public institutions. The press was invited too and has been very impressed by the quality and wide variety of addressed topics.
44	Orange Poland	Conference Paper Presentation	AIAI 2022/5G-PINE, 17 June 2022	Tomaszewski Lechosław, Orange Poland and 5G!Drones partner, presented the paper "Application of Mobile Networks (5G and Beyond) in Precision Agriculture" on 17th of June at AIAI 2022/5G-PINE, session 14. More information available at https://ifipaiai.org/2022/program/ and at https://link.springer.com/chapter/10.1007/978-3-031-08341-9_7.

Figure 24 - 5G!Drones Excel file on MS Teams

Additionally to the Excel file, every partner was responsible for uploading any related material such as photos, presentations, webinars, camera ready papers, etc. from the event one participated to, in WP5 corresponding event folders by creating a dedicated subfolder. All these event sub-folders are created inside the "Activities Material" folder.

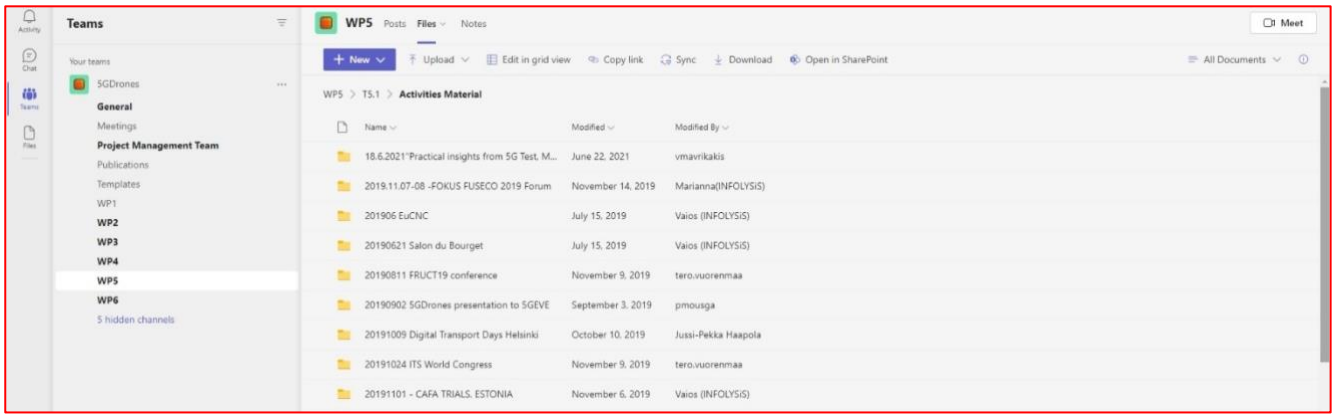


Figure 25 – WP5 communication activities - events folder

2.2.2 Website and social media statistical dashboards for M25-M40

At this point, before we start analyzing the material derived from the dashboards, it is very helpful to analyze some terms for the better understanding of the reader. Table 10 summarizes the basic terms of social media and Website activity.

Term[2][3][4]	Meaning
Engagement	Is a measure of how people are interacting with your social media accounts and content.
Impressions	Are the number of times your content is displayed, no matter if it was clicked or not.
Page View	A page view is reported when a user on your Website has viewed a page.
Reach	Is the total number of people who see your content.
Sessions	A group of interactions that take place on your Website within a given time frame
User	An individual who interacts with your Website or app.
Views	Number of views your content gets on social media channels.

Table 10 - Website and social media terms

2.2.2.1 Website performance, statistics and dashboard (M25-M40)

The 5G!Drones Website is the basic means of the digital presence of the project. It can be seen as a news portal, where any interested visitor can learn the latest news about project-oriented activities, but also as an online portal where everyone can navigate through different project material such as publications and activities and redirect to different project links such as the library and the marketplace. That is why, it is of utmost importance to track, monitor and evaluate the Website's activity. For this purpose, Google Analytics and Google Data Studio are utilized to depict the Website's activity in the most comprehensive and understandable way.

[2] https://sproutsocial.com/insights/reach-vs-impressions/
[3] https://buffer.com/library/social-media-metrics/#conversion-metrics-actions-sales-and-results
[4] https://www.lovesdata.com/blog/google-analytics-glossary

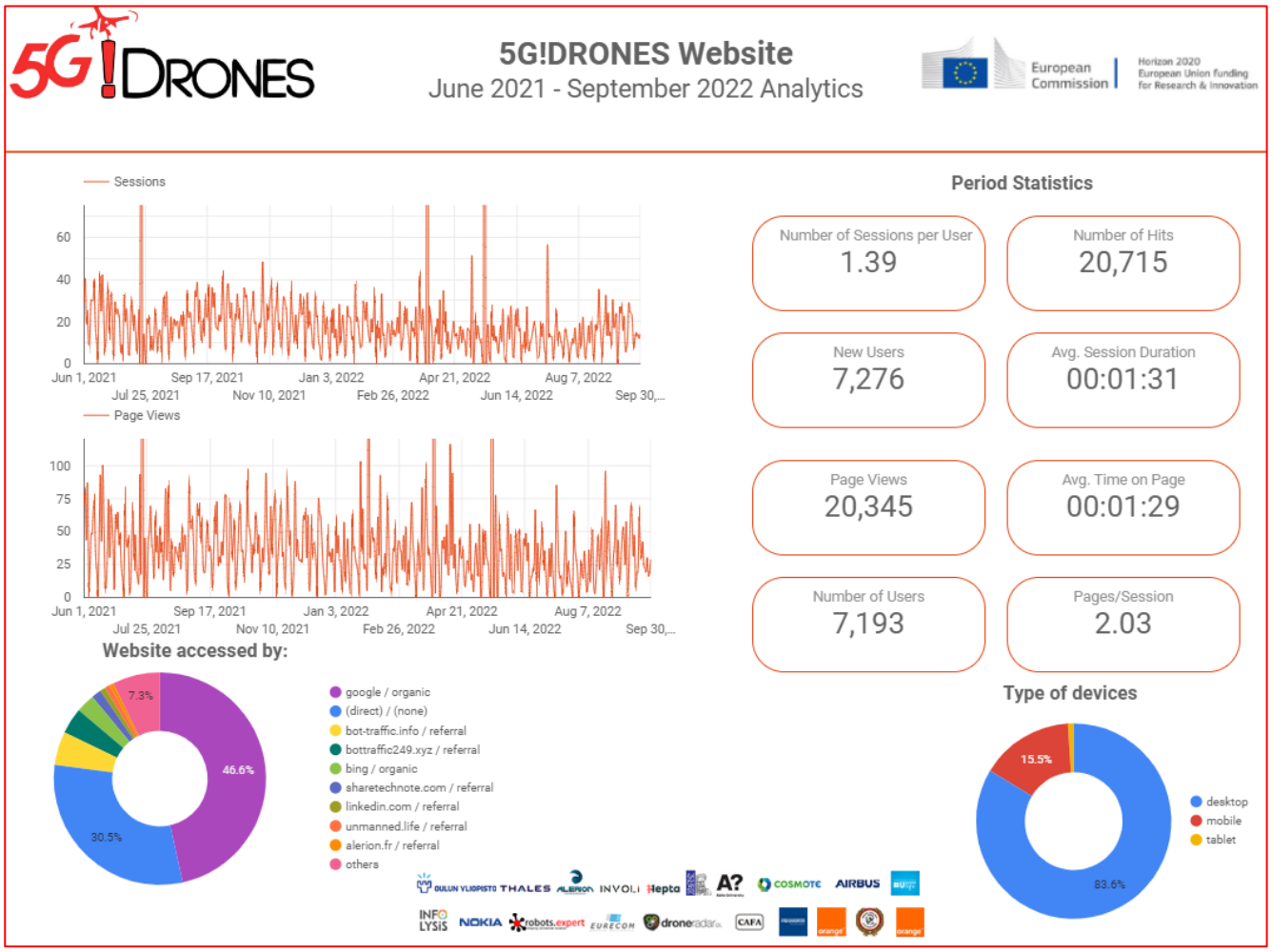


Figure 26 - 5G!Drones Website dashboard

Figure 26 describes the activity of 5G!Drones Website during the third period of the project (June 2021-September 2022). Previous periods have been analyzed thoroughly in previous deliverables (D5.1 [4] & D5.2 [1]) So, at this dashboard we can see three different sections which inform stakeholders about different insights.

On the top left part of the dashboard there are two infographics showing the sessions and the page views activities per specific dates. On the right section of the dashboard, we provide information about specific metrics of the recorded period. For instance, the 5G!Drones Website on this specific period has acquired **7276 new visitors**, has achieved a total number of **20345 page views** and the **average session duration was 1 minute and 31 seconds**.

Finally, the Website dashboard includes two pie charts sharing more details. The one pie chart indicates the path that each visitor of the Website has followed. More specifically, the most popular choice with 46.6% is Google search engine machine, while the second most choice (30.5%) was the direct visit to the Website. At this point we should not forget to mention the power of social media channels as referrals. The second pie chart gives insights about the device that each visitor used. The **desktop – laptop devices were by far the most popular choice with 83.6%**, right after is the mobile devices (15,5%) while a minor percentage used tablet devices.

2.2.2.2 Social media, statistics and dashboards

Besides Website, statistical dashboards have been prepared for each social media separately. Each dashboard is divided into different sections. There is an infographic part which depicts information about post views and a dropdown list where the visitor can browse in different posts of the recorded period. On the right side of each dashboard, we have included period and total statistics. The dashboards are being issued on a monthly basis or per request for special occasions and periods like this deliverable. Social media dashboards are accompanied with dedicated charts with the total followers and posts flow.

- **5G!Drones LinkedIn account**

5G!Drones statistics for months M25-M42 are being presented in Figure 27 and Figure 28. In the first figure, any interested stakeholder can see the period statistics along with the total ones. For this recorded period, **157 posts** have been made, acquiring **2041 likes** and **91774 post views**. Also, any interested viewer can browse through the drop-down list to see all the post details of the reported period, while at the same time he can see through the three different infographics related to post views per date, number of post likes and post likes in comparison with the reshares. Finally, there is an additional drop-down list showing the most popular posts. The LinkedIn dashboards are available online **here**.

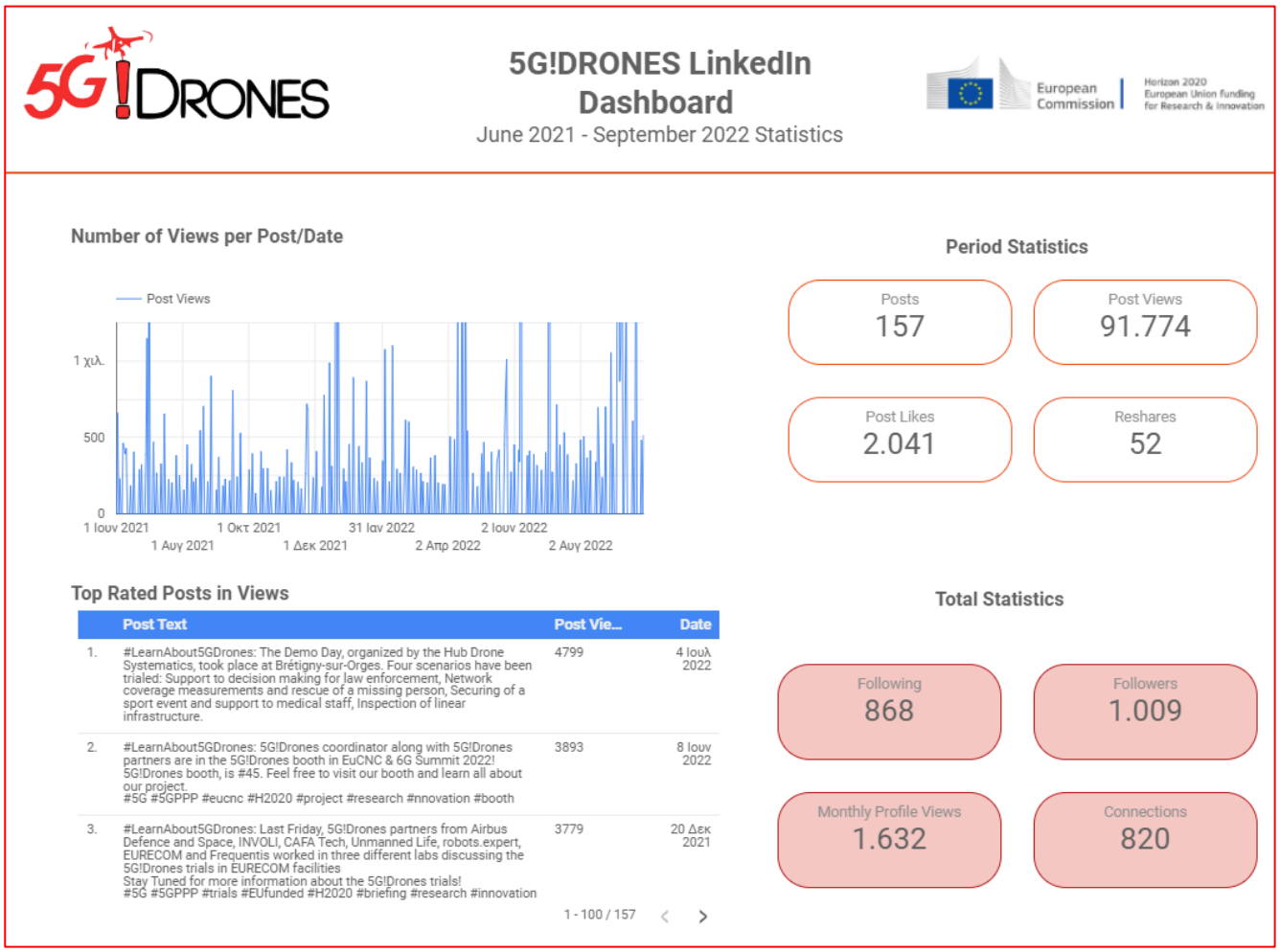


Figure 27 - LinkedIn dashboard (1)

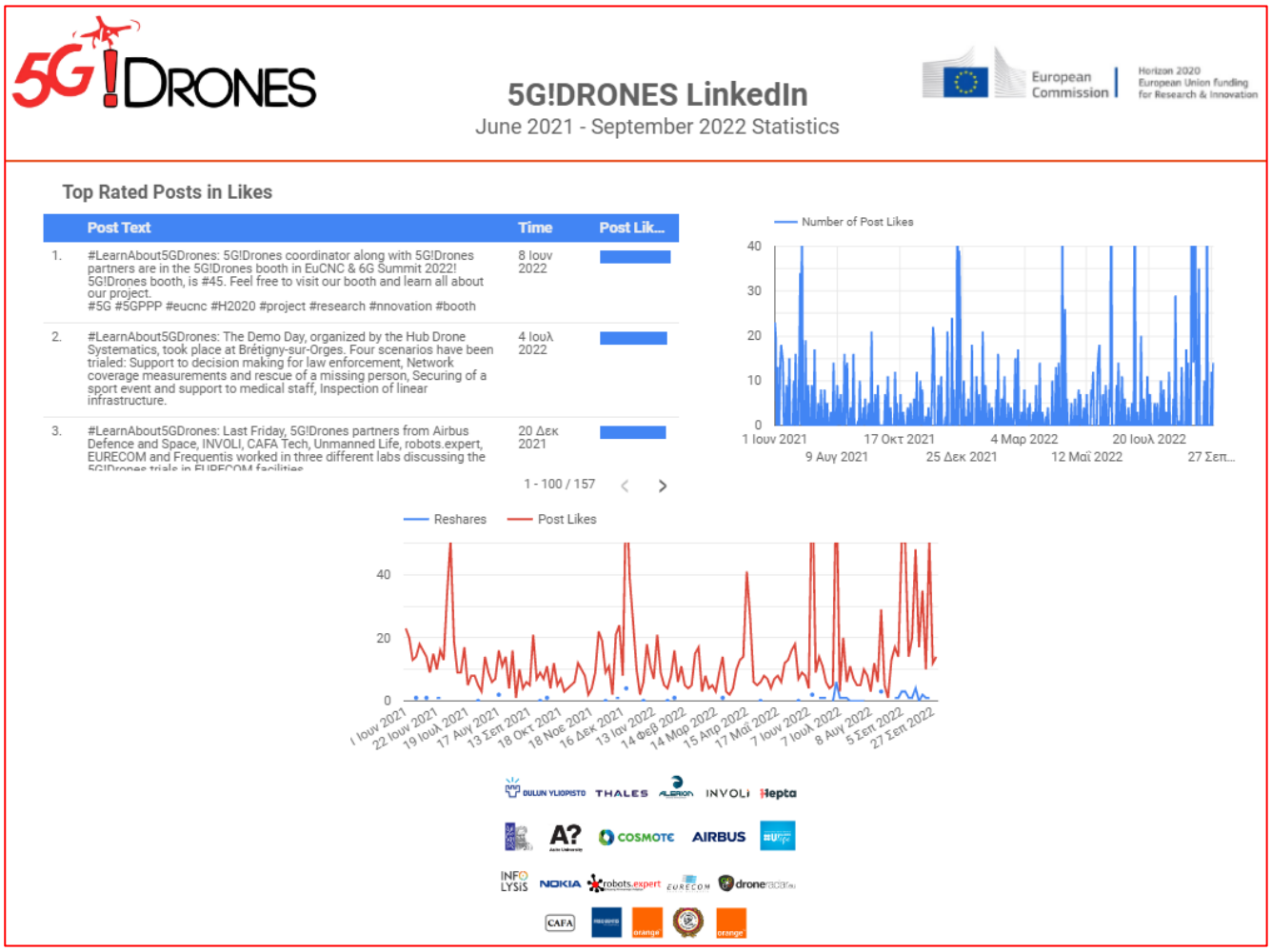


Figure 28 - LinkedIn dashboard (2)

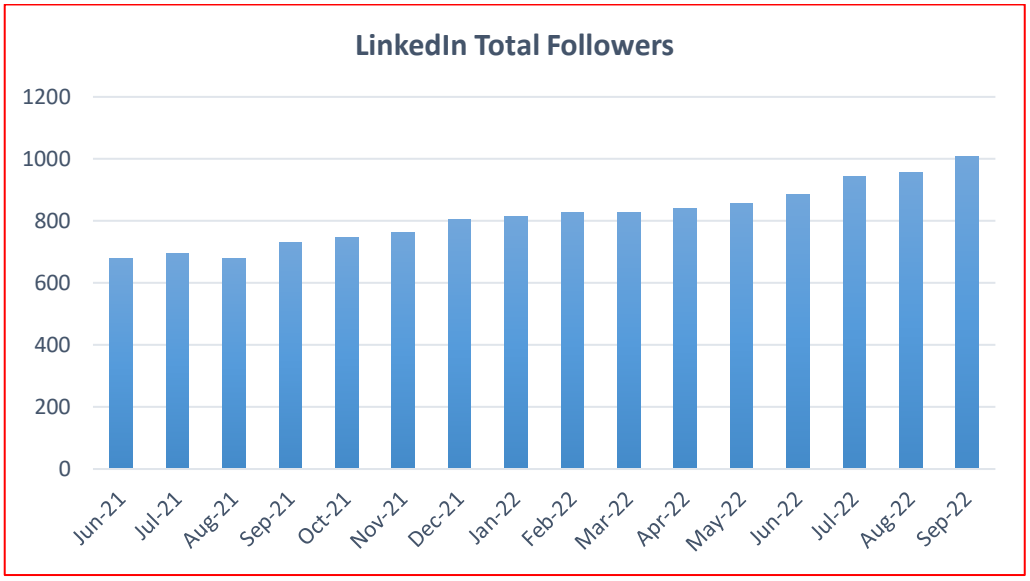


Figure 29 - 5G!Drones LinkedIn total followers chart

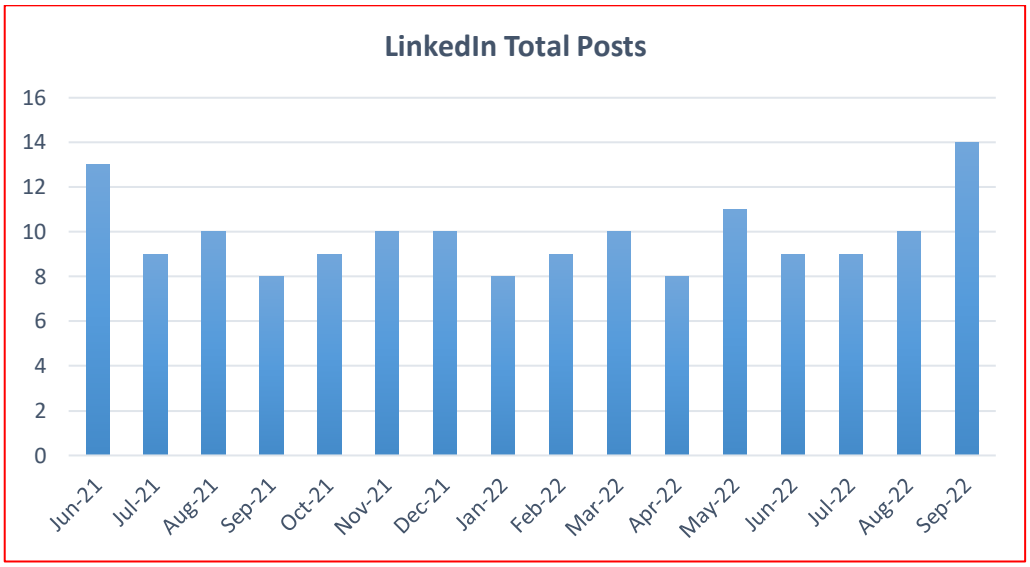


Figure 30 - 5G!Drones LinkedIn total posts

Figure 29 and Figure 30 show the total number of followers and posts (per month), for the June 2021-September 2022 period. Concerning the followers graph, we can see a continuous growth apart from specific periods. This condition indicates that there is a continued increase in the 5G!Drones community. On the other hand, the total posts figure displays several fluctuations. This is because of the different periods and the availability of activities to be posted on the social media channels. However, as an average we can state that **9 posts per month** are being posted.

- **5G!Drones Twitter account**

In the following figures (Figure 31 & Figure 32) the dashboards of the Twitter channel are being presented. As we have described earlier, they are based on the same template and they follow the same rationale of analysis and quantitative reporting.

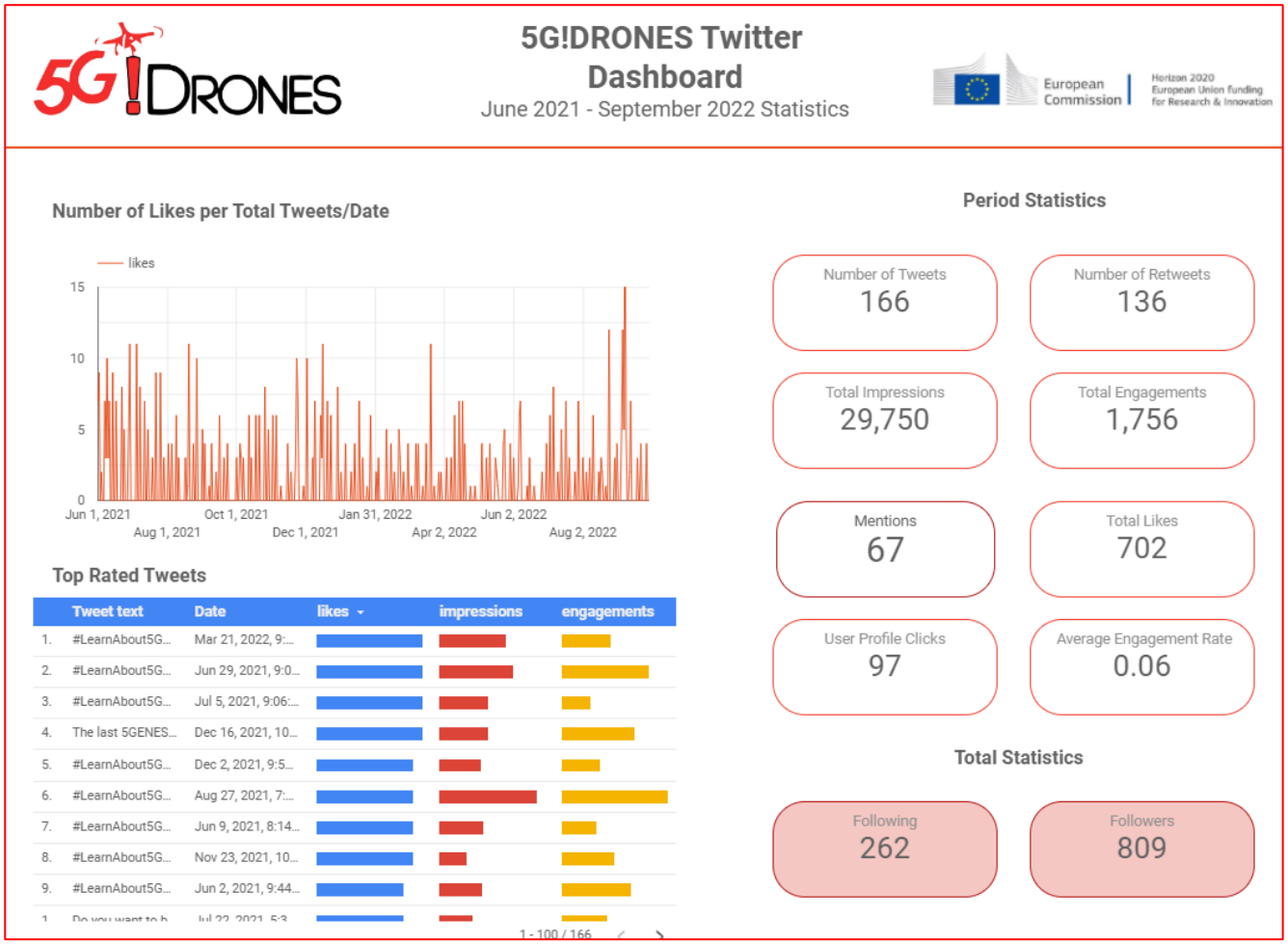


Figure 31 - Twitter dashboard (1)

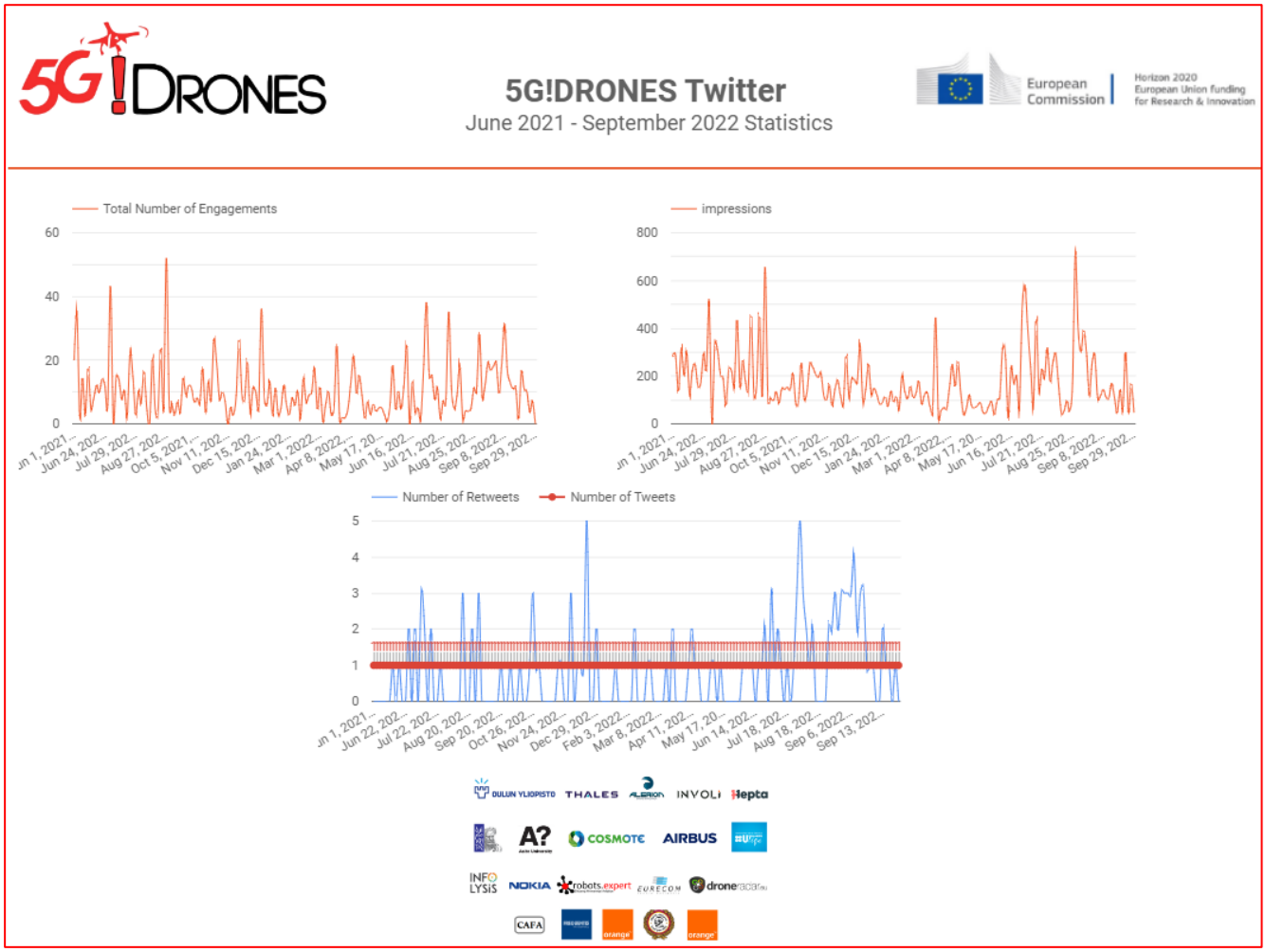


Figure 32 - Twitter dashboard (2)

So, for the reporting period (M25-M40) the 5G!Drones Twitter channel was extremely active with **166 tweets**, acquiring **702 likes** and a total number of **136 retweets**. Furthermore, we have managed to get **29750 total impressions** and **1756 engagements**.

The 5G!Drones Twitter dashboards for M25-M40 are available **here**.

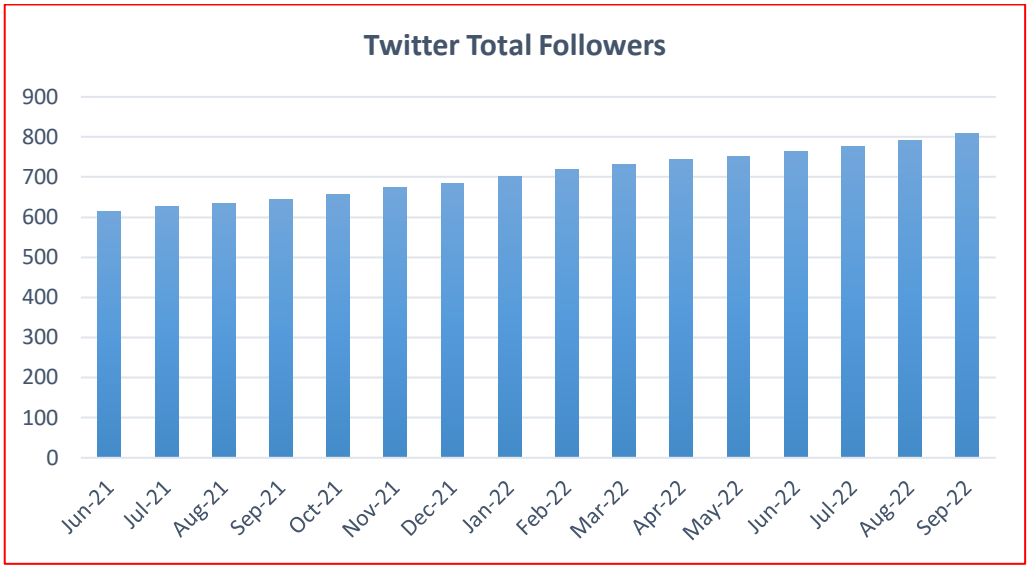


Figure 33 - 5G!Drones Twitter total followers chart

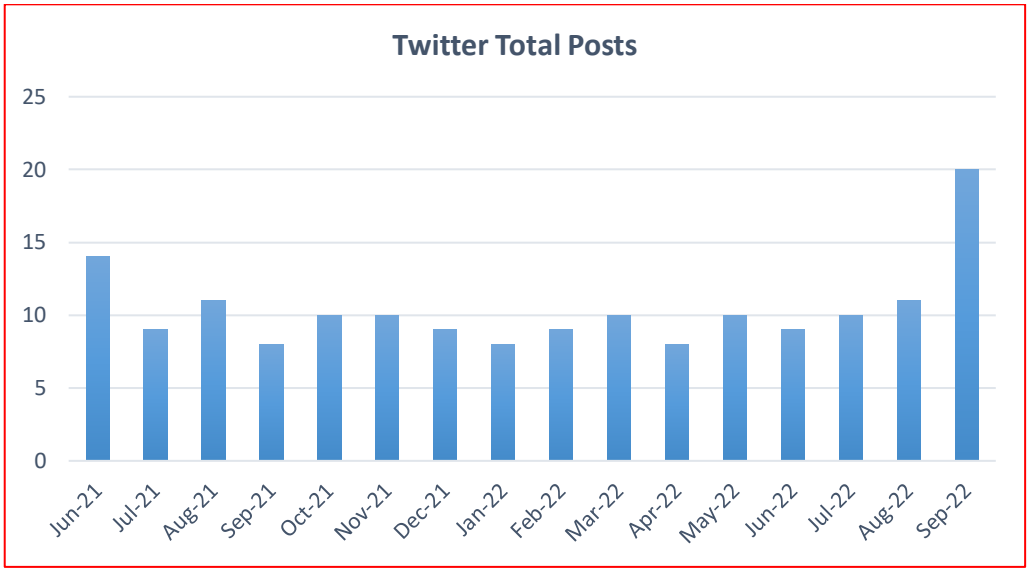


Figure 34 - 5G!Drones total posts

As we can see from the chart, the Twitter account is on the same page with the LinkedIn one. There is a continuous increase in the number of followers (Figure 33). The total posts chart indicates that there are some bigger fluctuations in the posting activity, something that is completely reasonable due to Twitter's nature, as it works better as the news platform of the project.

- **5G!Drones Facebook account**

Figure 35 and Figure 36 present all the Facebook activity of the 5G!Drones period. As it can be seen during this specific period, **151 posts** have been made with 415 page views and a total **reach of 12429**. Also, the Facebook posts reached a total number of **1725 engagements**.

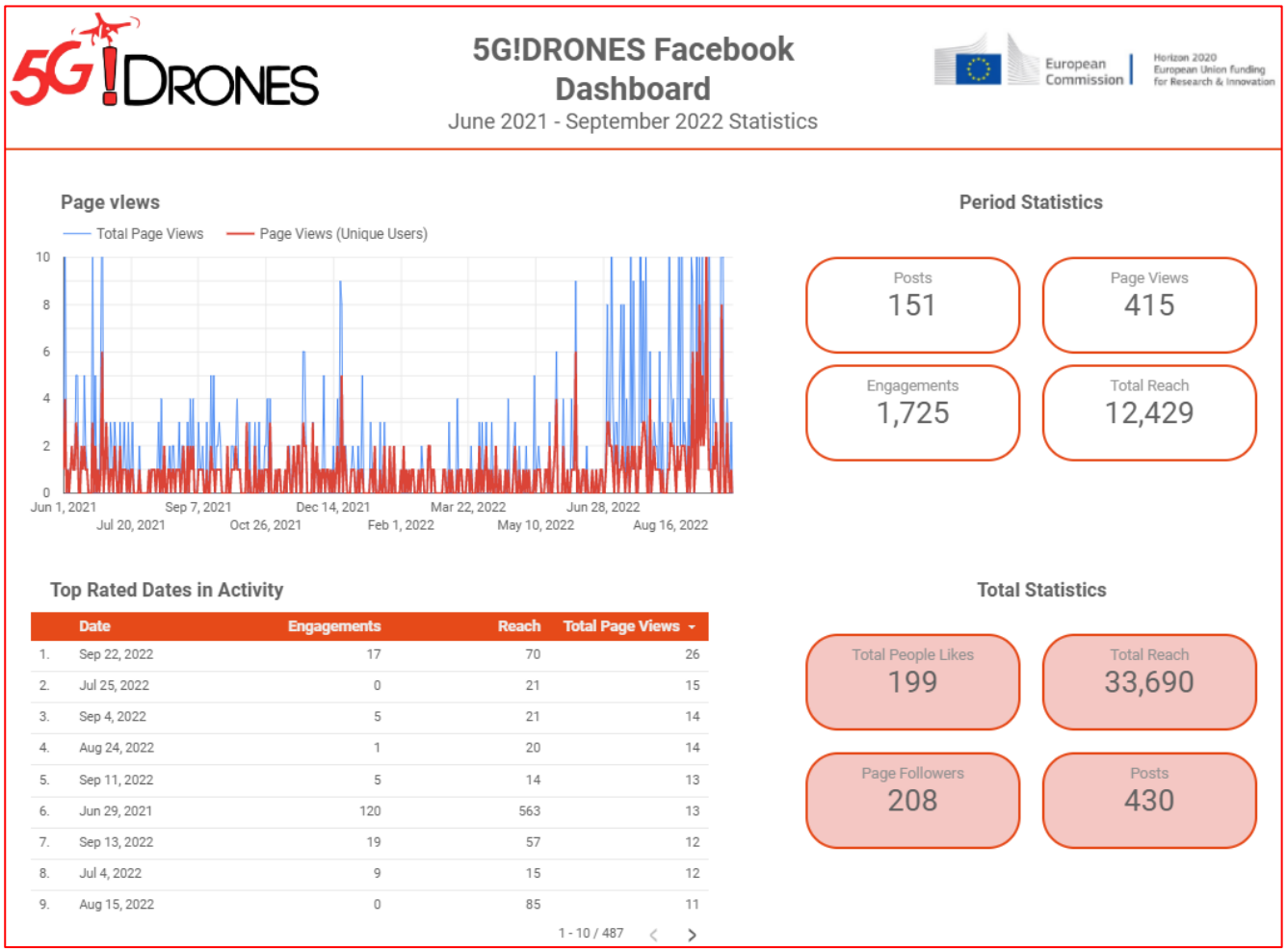


Figure 35 - Facebook dashboard (1)

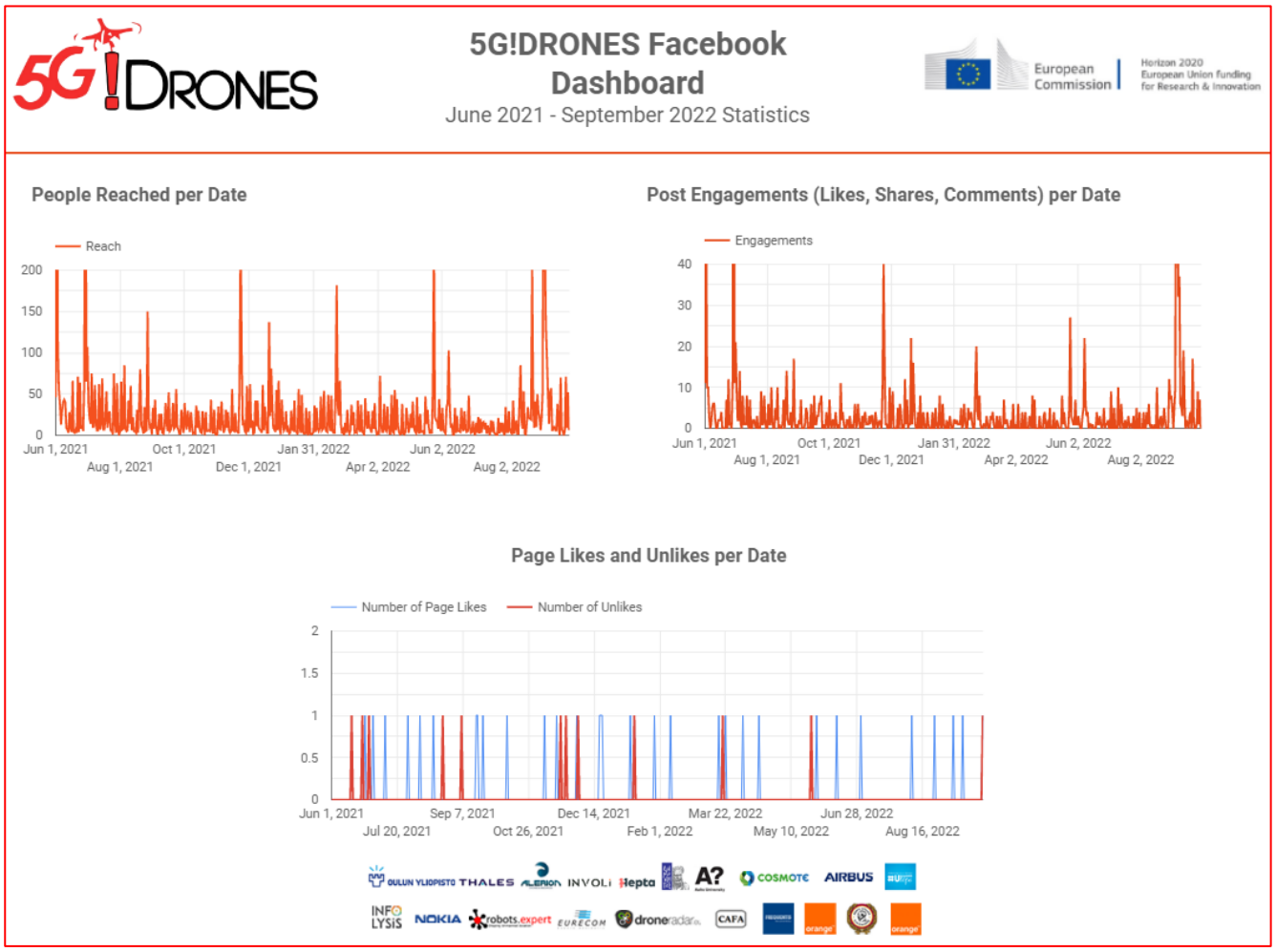


Figure 36 - Facebook dashboard (2)

The Facebook dashboards are available online **here**.

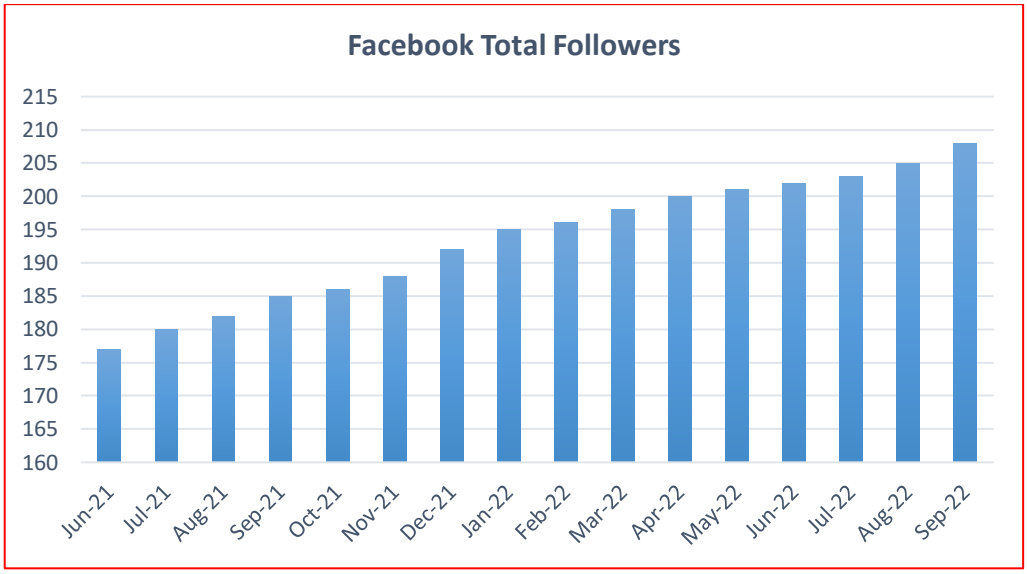


Figure 37 - 5G!Drones Facebook total followers chart

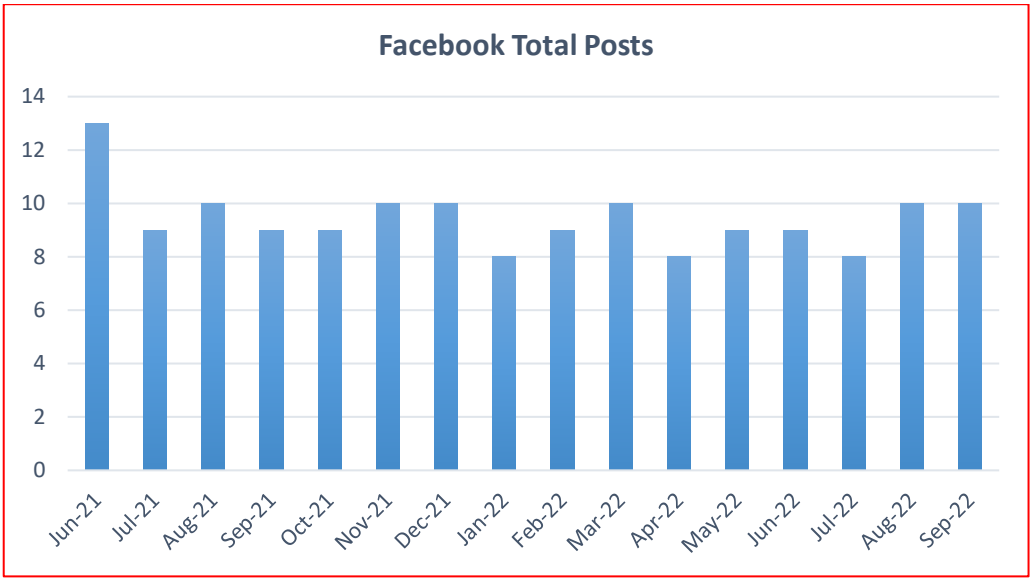


Figure 38 - 5G!Drones Facebook total posts chart

In Figure 37, we can see that there is a continuous increase in the number of followers, showing that 5G!Drones has a strong audience beyond the academic and the scientific communities, in Facebook. On the number of posts, we still see this fluctuation which exists in all social media channels due to the availability of material and activities as we have already explained. The number of average 9 posts per month remains also valid for Facebook.

- **5G!Drones Instagram account**

Finally, the Instagram account is presented with Figure 39. For this reported period, the 5G!Drones Instagram account has acquired **720 likes** in **148 posts** with **5942 impressions** and **5332 reach**. The 5G!Drones Instagram account can be accessed online **here**.

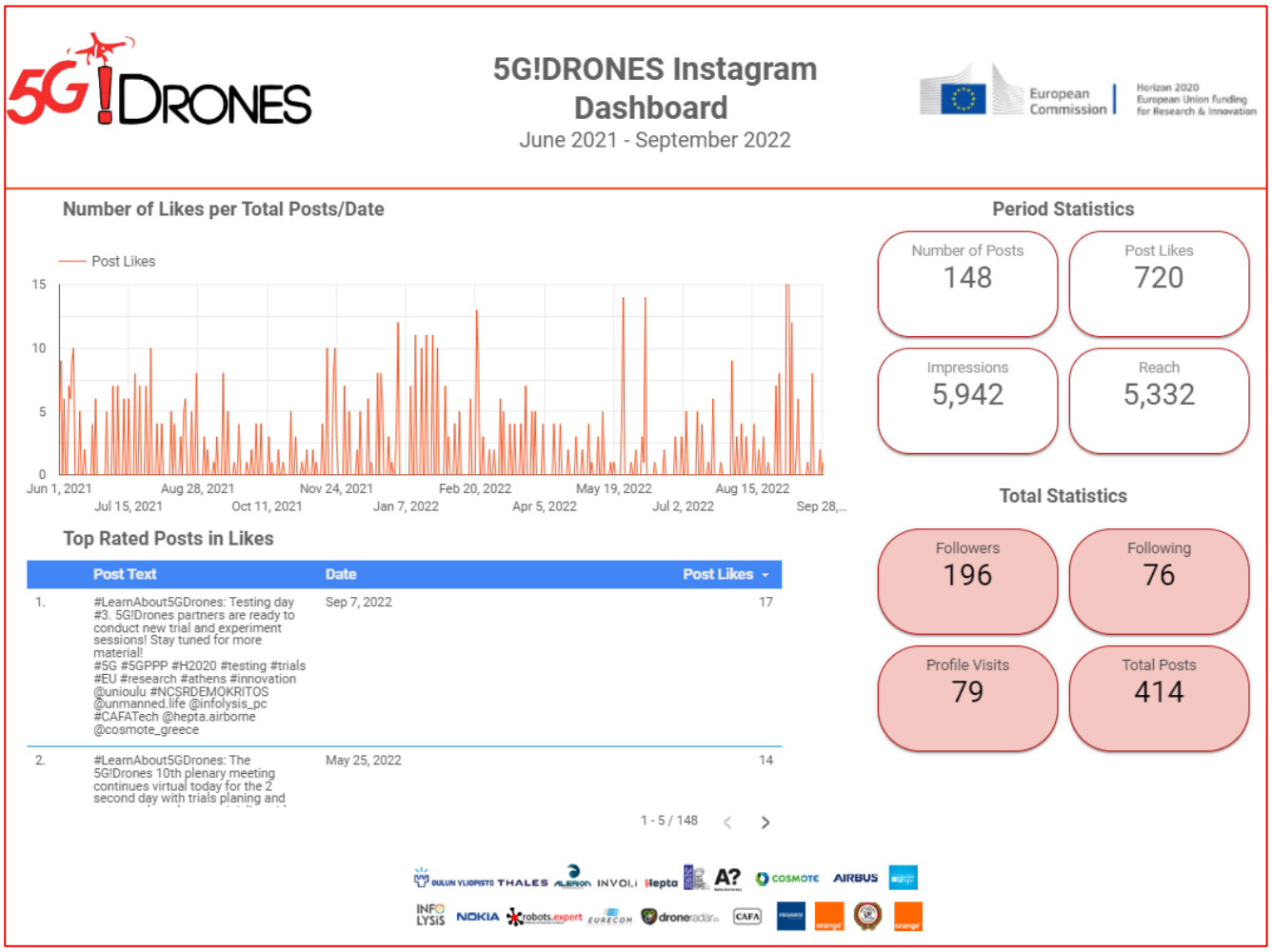


Figure 39 - Instagram dashboard

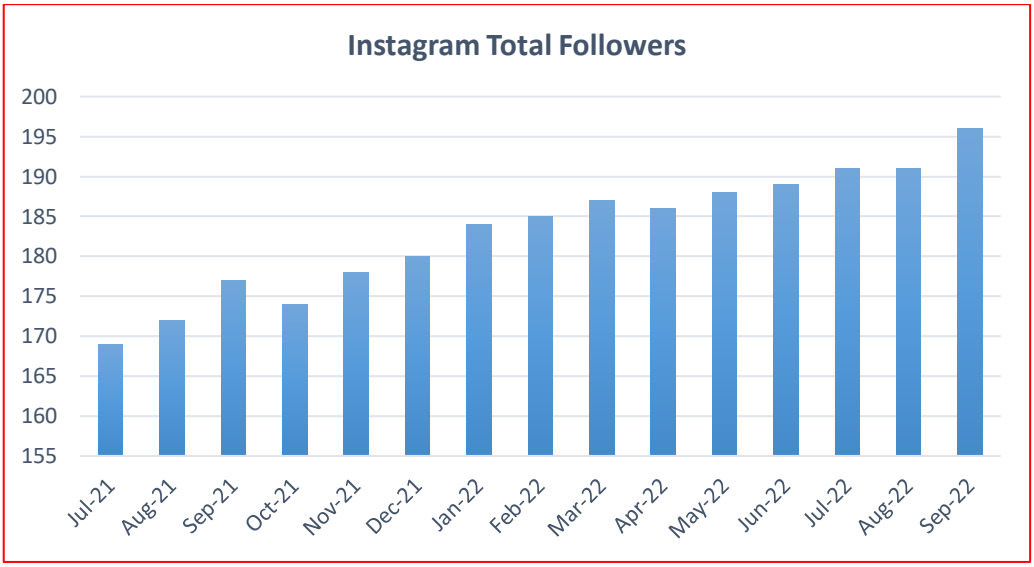


Figure 40 - 5G!Drones Instagram total followers chart

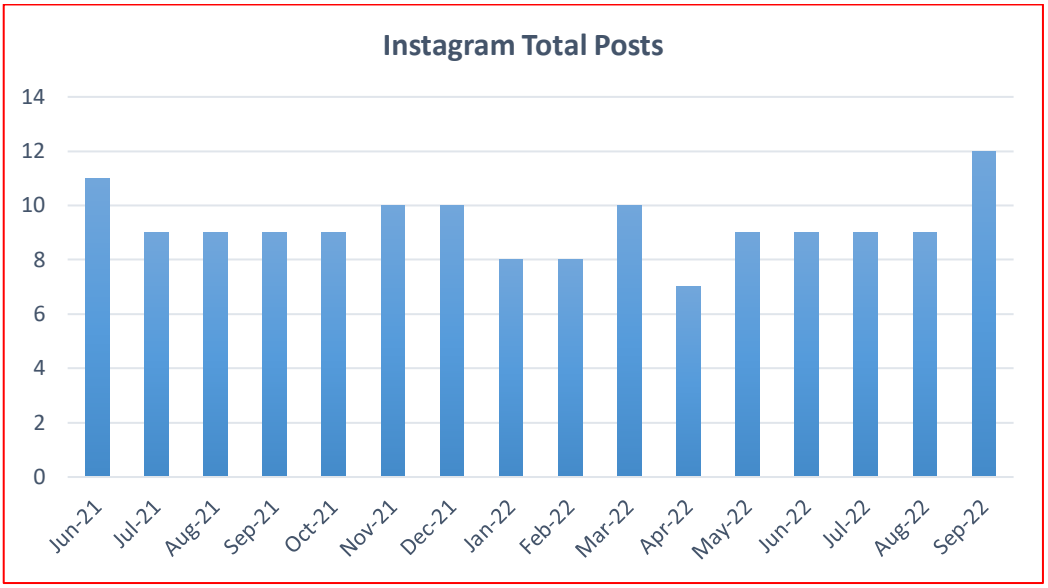


Figure 41 - 5G!Drones Instagram total posts chart

The Instagram account of the project continues to attract a growing audience, especially without the relevant technological background due to the channel's nature. Furthermore, the total posts graph (as seen in Figure 41) shows a number of approximately 8-10 posts made on a monthly basis.

2.3 Overall communication activities (M1-M40)

2.3.1 Website and social media statistical dashboards for M1-M40

Since this deliverable is the final one concerning communication activities reporting, it is worth mentioning also the full period performance of the Website and social media channels performance throughout the full project lifetime M1-M40 (up to the moment this deliverable was under final editing).

- **Website total statistical dashboard M1-M40**

Figure 42 briefly presents the total statistics from the Website activity during the 40-month period of the project. As it can be clearly seen, the 5G!Drones Website has attracted **56357 hits**, with **16743 unique users** and **55759 page views**. Furthermore, most of the visitors used Google search engine machine to visit our Website. The second most popular choice was the direct visit to the Website. Specific referrals such the project's social media channels along with the MS Teams platforms were used by the visitors. Finally, most of the partners used either a desktop or a laptop device to visit 5G!Drones Website.

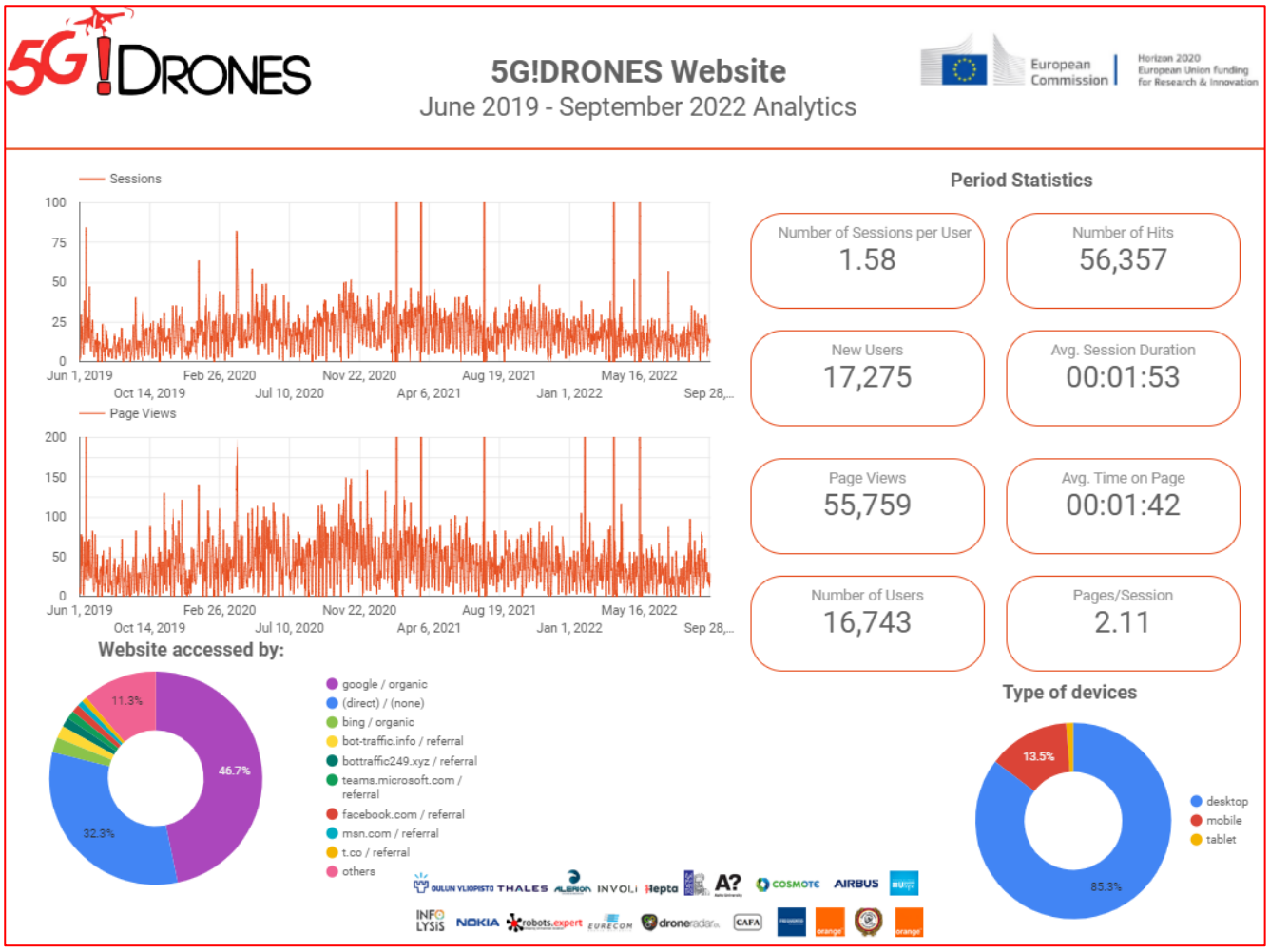


Figure 42 - Website total statistical dashboard

You may find the M1-M40 statistical dashboard **here**.

- **LinkedIn total statistical dashboard M1-M40**

Figure 43 summarizes the LinkedIn activities for the previous months. In total, 5G!Drones LinkedIn account has acquired **1009 followers** and **820 connections** in **434 total posts**. We also had a total number of 202,294 post views and 4,720 likes.

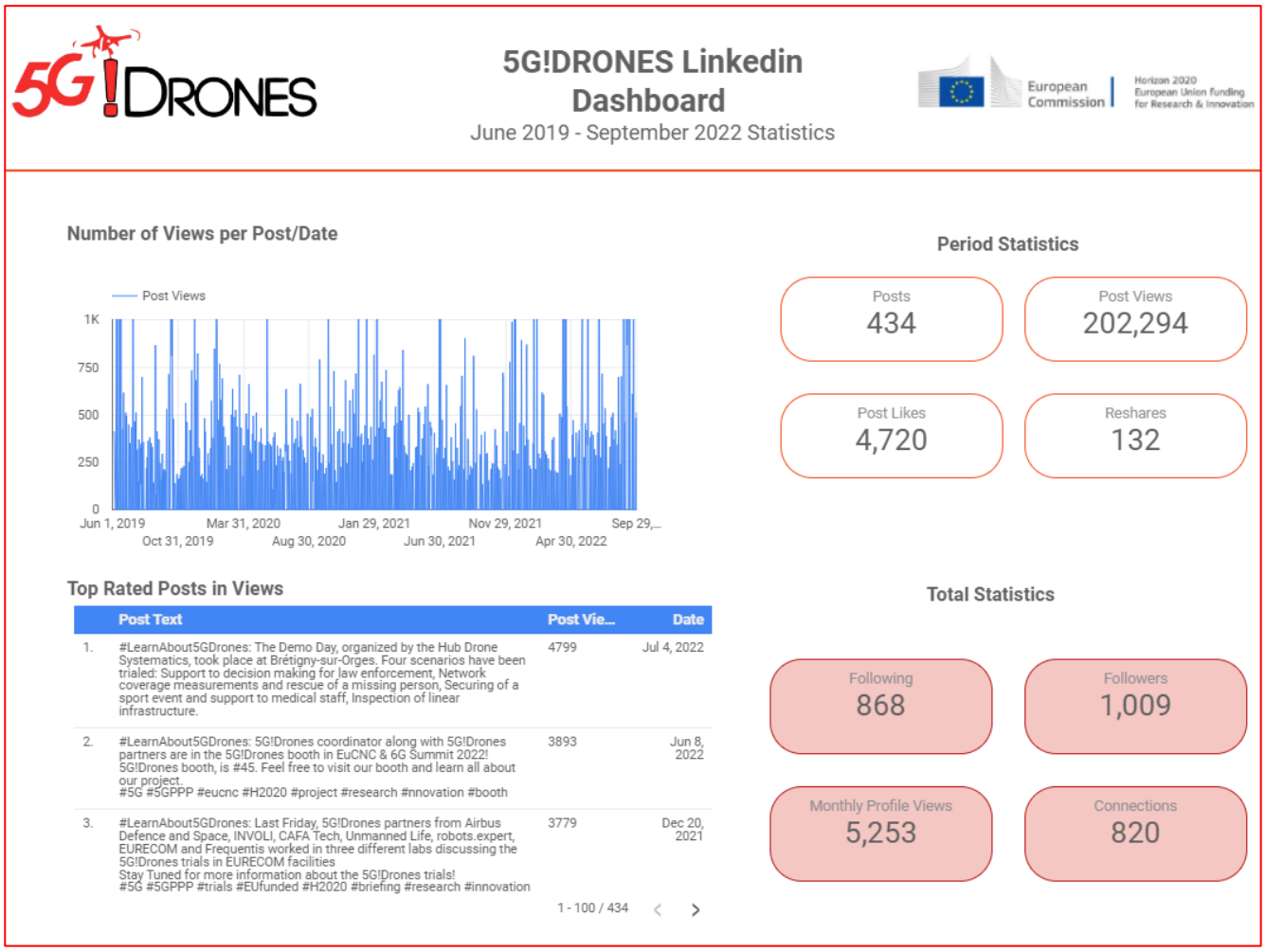


Figure 43 - LinkedIn total statistical dashboard

The M1-M40 LinkedIn statistical dashboard is available **here**.

- **Twitter total statistical dashboard**

Concerning the Twitter account, we can see with Figure 44 that we have recorded **468 total tweets**, acquiring a total number of **2844 likes** with **203114 total impressions**. Also, we have **809 followers** and a total number of **7352 engagements**.

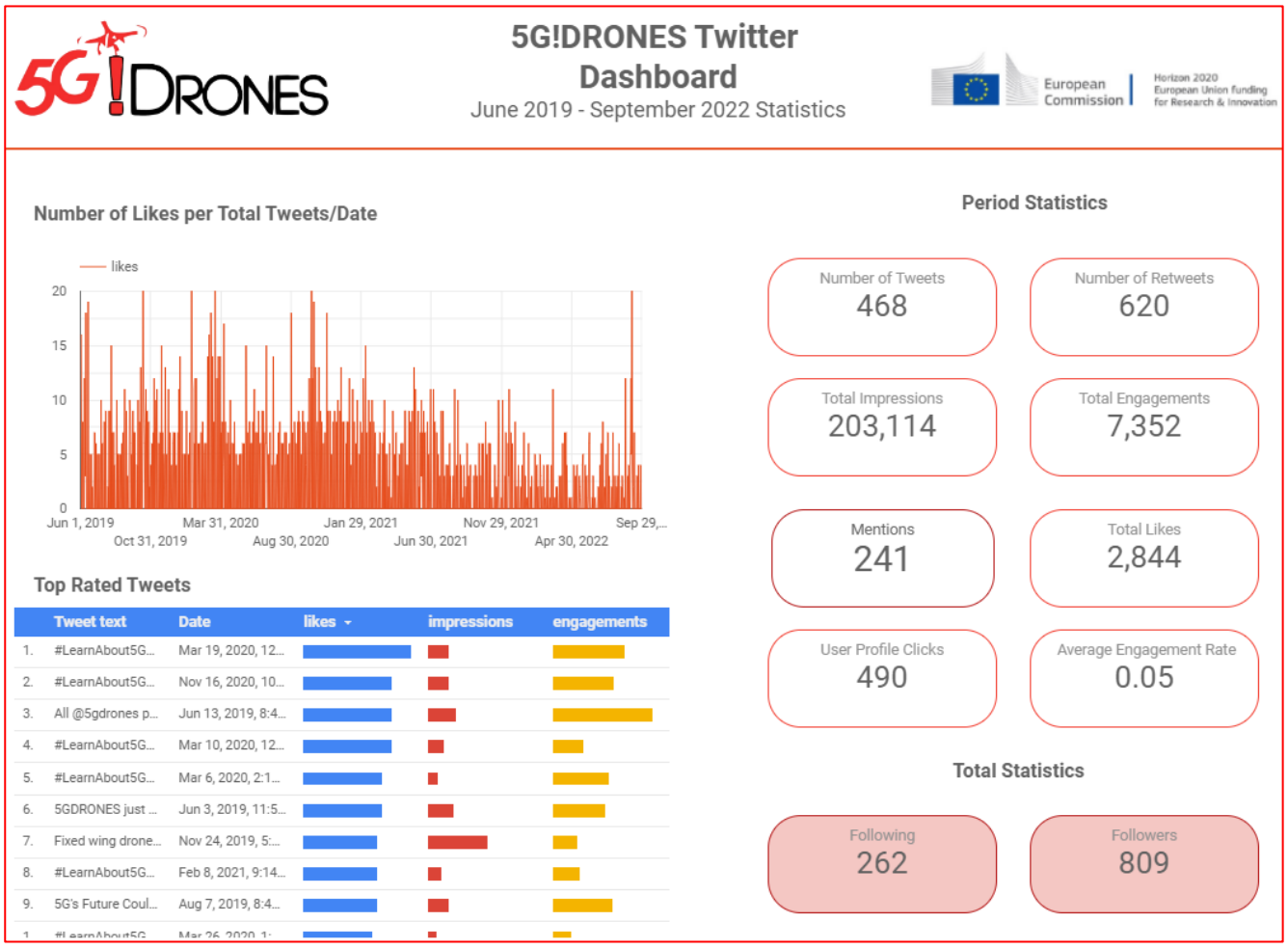
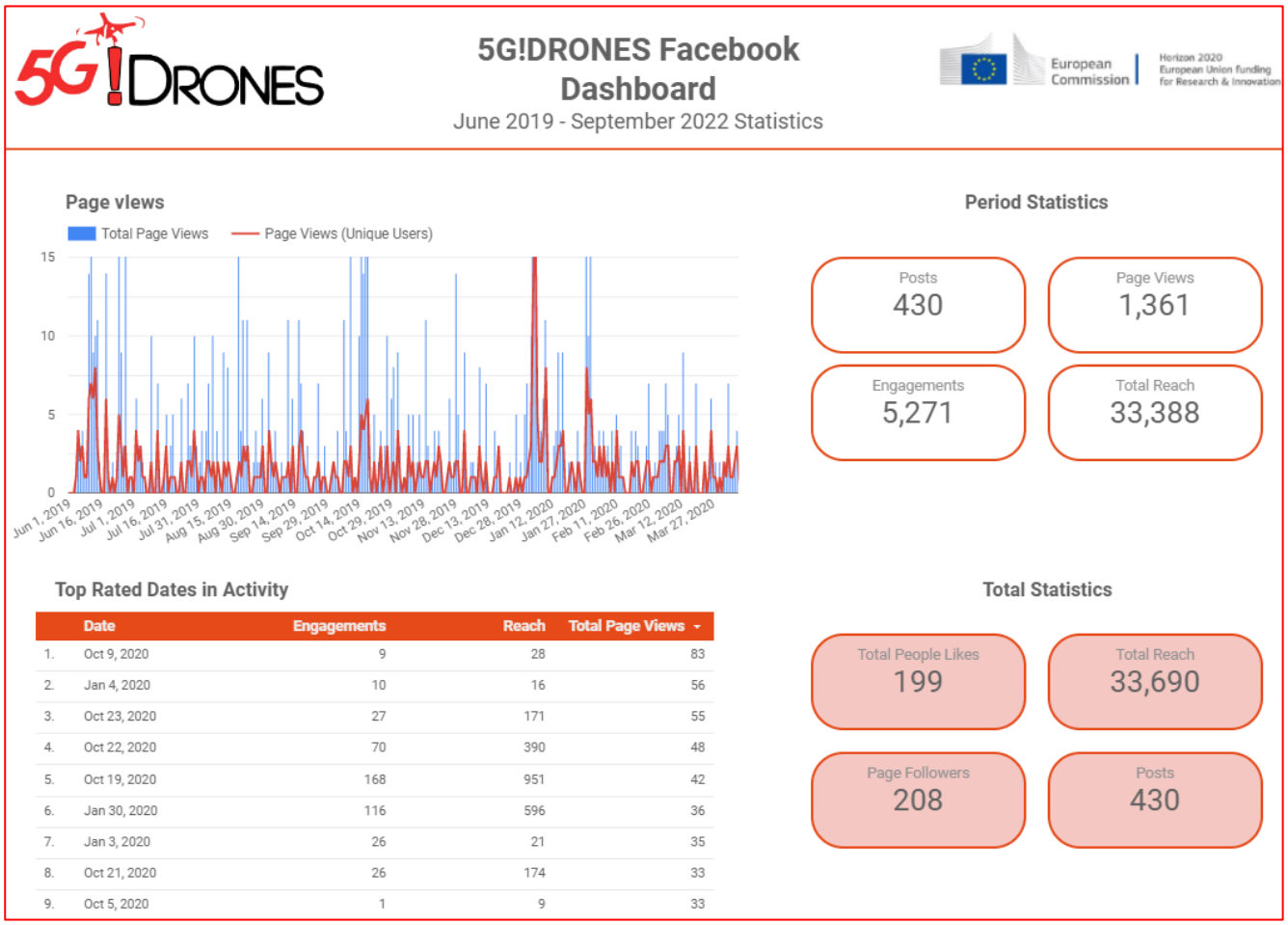


Figure 44 - Twitter total statistical dashboard

The Twitter dashboard for the M1-M40 period is available **here**.

- **Facebook total statistical dashboard**

The total statistics of 5G!Drones Facebook account are being depicted in Figure 45. In total, **430 posts** have been made with **33388 total reach** and **5271 engagements**. The Facebook page has **199 total page likes** and **1361 page views**.



	Date	Engagements	Reach	Total Page Views
1.	Oct 9, 2020	9	28	83
2.	Jan 4, 2020	10	16	56
3.	Oct 23, 2020	27	171	55
4.	Oct 22, 2020	70	390	48
5.	Oct 19, 2020	168	951	42
6.	Jan 30, 2020	116	596	36
7.	Jan 3, 2020	26	21	35
8.	Oct 21, 2020	26	174	33
9.	Oct 5, 2020	1	9	33

Figure 45 - Facebook total statistical dashboard

The Facebook Dashboard for the M1-M40 period is available **here**.

- **Instagram total statistical dashboard**

Figure 46 showcases the total statistics of the 5G!Drones Instagram account. In total, **414 posts** have been made, acquiring **3084 post likes** and **23043 impressions**. Concerning the followers, our Instagram channel has acquired **196 followers**.

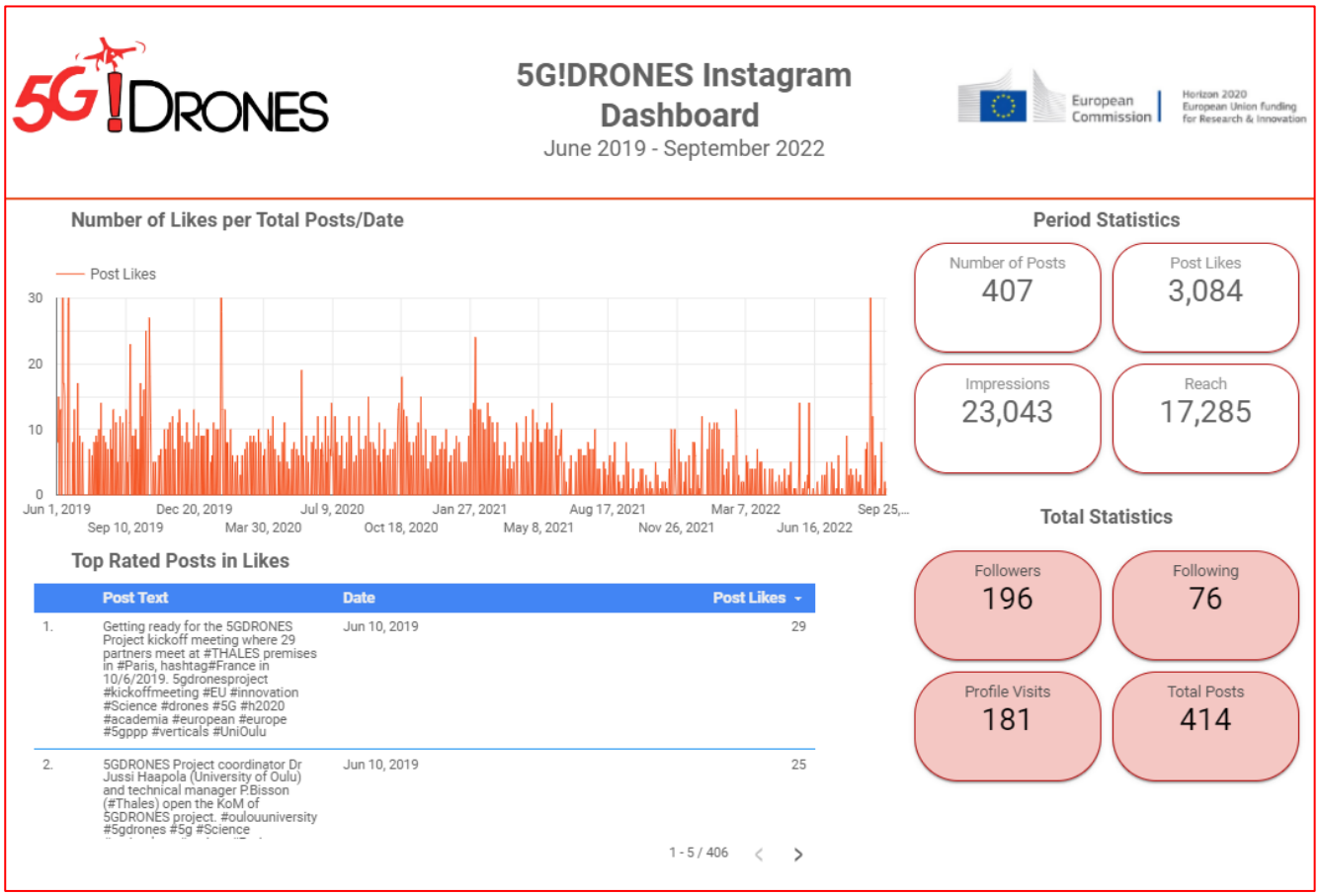


Figure 46 - Instagram total statistical dashboard

Instagram dashboard for the M1-M40 period is available **here**.

In the following table (Table 11) any interested stakeholder may have an overview about the communication activities that have taken place in the context of the project for its whole duration. This table shares insights about the Website and social media activity along with figures of parallel communication activities.

Mean	Channel - Section	URL	Activity M1-M40
Website	News	https://5gdrones.eu/news/	>200
	Publications	https://5gdrones.eu/research-papers/	45
	Workshops/ Presentations	https://5gdrones.eu/workshops/	3/58

	Pretrials/Trials/Demos	https://5gdrones.eu/workshops/	23
	White Papers	https://5gdrones.eu/research-papers/	14
	Press Releases	https://5gdrones.eu/press-releases/	6
	Events	https://5gdrones.eu/past-events/	67
	Website Visitors		16,743
	Website page views		55,719
Social Media	Facebook	www.facebook.com/5gdrones	430 posts
	LinkedIn	https://www.linkedin.com/in/5gdrones/	434 posts
	Twitter	https://twitter.com/5gdrones	468 tweets
	Instagram	https://www.instagram.com/5gdrones_project/	414 posts
	YouTube	https://www.youtube.com/channel/UChPj4gQ5P5go7Fer6NJxGOQ	16 videos 2633 views
	Total Followers		2222
	Total Posts		1746
Leaflets		https://5gdrones.eu/publications-and-dissemination/	2 leaflet versions
Posters		https://5gdrones.eu/publications-and-dissemination/	1 poster version
Newsletters		https://5gdrones.eu/newsletter/	14
Printed Material	Printed Leaflets		1250 Pieces
	Stickers		800 pieces

Table 11 - 5G!Drones Activities (M1-M42)

3 5G!Drones showcasing

This section aims at summarising and illustrating all pre-trials, trials and showcasing activities that were held during Months 22 to 42 of 5G!Drones.

3.1 Trials

The field tests and trials are crucial for the project success, since these serve as validation of the proposed highly innovative communication technology approaches enabling a successfully operated advanced air mobility, and thirteen pre-trials and trials were performed during the second period of the project:

- **Athens remote-emulated tests (23 April), Athens remote pre-trials, Greece, 23 April 2021**

  Athens remote-emulated tests on 5GENESIS Athens 5G experimental platform at NCSRD campus. Focus paid on measurements, connectivity, KPIs and Athens UC4 details. Involved partners: NCSRD, COS, UMS, INF.

- **Eurecom remote tests and pre-trials, France, 17 June 2021**

  Eurecom remote tests and pretrials on 17 June 2021, for testing 5G!Drones Integration Release1 components and UC1Sc1 and UC2Sc1, UC2SC2 scenarios and collecting feedback for physical tests in Sep-Oct 2021. Involved partners: EUR, CAF, INV, DRR, UMS, AIR.

- **5G!Drones Athens trials on 5GENESIS Athens platform, Greece, 28 June-2 July 2021**

  Joint trials of 5GENESIS and 5G!Drones projects 5G!Drones UC4 (Connectivity during crowded events) was tested on the 5GENESIS Athens 5G experimental platform at COSMOTE Academy premises in Athens (28 June-2 July 2021). Involved partners: NCSRD, COS. The link to the footage of the trial is available **on the project Youtube channel**.

- **Technical tests 1st round at Aalto University, Finland, 19-20 August 2021**

  Involved 5G!Drones partners validated use cases with 5G flights including scenarios where the remote pilot (not the PIC) takes over the control and pilots the aircraft with a tethered joystick. The pilot used the video stream from the aircraft's onboard camera, streamed over 5G network. The team also validated Command and Control (C2) link over 5G, and Unmanned Aerial System Traffic Management (UTM) over 5G.

- **Technical tests 1st round at Oulu, Finland, 24-26 August 2021**

  Integration Rel.1 tests in Oulu (Web Portal1 and UO Web Portal 2 components). Setting up and testing 5G network coverage and Edge server solutions in Botanical Garden area. 4 operators connecting to the network and sharing the 5G network and the airspace, video streaming over 5G for near real-time search, UTM over 5G, C2 link over 5G, and several other system critical functionalities were tested. Participants: UO, NOK, CAF, HEP, ALE. Remotely: DRR, INV, FRQ.

- **Technical tests 1st round at Eurecom, France, 16-18 December 2021**

  Those trials were held in Eurecom premises, Campus SophiaTech, Sophia Antipolis, France. We tested both UC1Sc1, UC2Sc1, and a simulation of UC2Sc2, validating both C2 link connectivity and UTM over 5G SA, and AIR Mission Critical Services (MCS) application. The tests were run using CAF drones and two Huawei P40 phones to run the MCS application. All tests were successful. Participants: EUR, CAF, INV, AIR, RBX, FRQ. Debriefing interviews are available **on the project YouTube channel**.

- **Pre-trials (setup and tests) at Municipality of Egaleo Stadium, Greece, 27 May 2022**

NCSRD performed preparatory field setups and tests at Municipality of Egaleo stadium (Greece) on Friday 27 May 2022, towards the final showcasing 5G trial with UAVs (UC4) held 5-7 September 2022.

- **Technical tests 2nd round at University of Oulu, Finland, June 2022**

  In order to ensure success at the final trials, a technical test session took place on 2nd and 3rd June 2022 on the University of Oulu premises. HEP as the scenario leader of UC3SC1-SS2, FLA and the facility owner UO attended this session to test out the Key Performance Indicator (KPI) collection techniques and to rehearse the full flow for the trial on site. These tests revealed the issue of not being able to collect KPIs with multiple Qosium scopes simultaneously. This issue was subsequently solved prior to the actual trials.

- **Technical tests 2nd round at Aalto University, Finland, June 2022**

  In order to ensure efficient preparation of the final trials, a technical test session took place on 13th June 2022. This technical test session has seen the physical presence of AU (facility owner) and CAF (UC1SC3 owner) and aimed to test the connection between the Quectel modem of CAF (used on the CAFA drone) with the 5G network of AU. Indeed, the 5G network of AU has been upgraded to the 5G Standalone (5G SA) mode and undergone several changes, which motivated this physical technical session. The identified issues have been followed up by AU and CAF in order to ensure better preparation for the final trials.

- **Technical tests 2nd round at University of Oulu, Finland, 16 August 2022**

  In order to carry out efficient final trials, CAF visited UO to test the connection between the Quectel modem of CAF (used on the CAFA drone) with the 5GTN network of UO. In addition, tests on getting desired Qosium data were conducted. The identified issues have been followed up by UO and CAF to ensure better preparation for the final trials.

- **Trials at Aalto University, Finland, 15-18 August 2022**

  The final trials of the project in the AU trial site took place on the 15th and the 18th of August 2022. The two use scenarios planned for the AU trial site have been demonstrated. This event has seen the physical presence of AU (facility owner and UC3SC2 owner), CAF (UC1SC3 owner) in addition to the remote participation of INV, FRQ and DRR (for UTM and trial preparation using the webportal and the trial validator tools). A video disseminating the event has been prepared by CAF, which is available **on the project Youtube channel**.

- **Trials at University of Oulu, Finland, 22-26 August 2022**

  The final trials took place at the UO 5GTN coverage area. CAF conducted three use cases (UC1SC2, UC2SC3, UC3SC1-SS1), HEP/FLA conducted UC3SC1-SS2, ALE conducted UC3SC1-SS3, UO conducted UC1SC2, NOK conducted a Use Case on 5GTN SA beam mapping, but had to delay UC3SC3 to a later date due to technical obstacles in needed User Equipment (UE) being able to run Nemo Outdoor and NATA. INV provided support during the trials on-site as well. A video disseminating the event has been prepared by CAF on the video footage taken by partners, which is available **on the project Youtube channel**.

- **Trials at Municipality of Egaleo Stadium (Athens), Greece, 5-7 September 2022**

  The final trials of the project in Athens platform coordinated by NCSRD and took place on 5th – 7th September 2022. The trials technically supported by the following partners NCSRD, COS, INF, MoE, HEP, DRR, FRQ, UML and CAF realising the use case related to coverage extension of the 5G network utilizing a WiFi-6 hotspot 5G modem which was lifted-off by an automatically flying drone. The event was successful and the successful completion of the trials gave the green light to proceed to the showcasing event on 8th September. It is worth mentioning that the trials were supported by a 5G Van provided by COS in order to offer a pure quality 5G network for the needs

of the trials. Footage of the trial is available **on the project YouTube channel**, which also features **debriefing interviews** in which lead partners provided insights and recommendations.

- **Trials at Eurecom, France, 16-17 September 2022**

  5G!Drones project final trials in France were executed at EURECOM premises, on 16th and 17th September 2022. 5G fully automated drone flight controlled by a C2 container located on Eurecom's MEC server and UC2Sc1 were tested. Participating partners were EUR, CAF, INV, AIR, FRQ and UO. A video footage summarizing the event is available **on the project YouTube channel**.

Figure 47 - Trial at Egaleo Stadium (Athens), September 2022

3.2 Showcasing

- **AU, international school of Espoo, 27 May 2021**

  AU performed a small showcasing event on 27th May 2021. The showcasing was for the benefit of first graders students from the international school of Espoo, Finland. AU presented its current work

related to cellular drones and Virtual Reality (VR) as part of 5G!Drones activities and also presented a demo of streaming a 360 video from flying drones. Figure 48 shows some pictures captured during the showcasing. By this event, the 5G!Drones project contributes to the society and the impact on the youth generation, which is a very valuable aspect. More info on this event may be found **here**.

Figure 48: Pictures from the showcasing organized by AU

- **UO, Oulu Campus area and Botanical Garden, 26 August 2021**

  UO in collaboration with CAF, INV, HEP, FLA, and ALE held a 5G!Drones showcasing event on August 26th at the University of Oulu Campus area and Botanical Garden. The showcasing activity attained attendance of approximately 40 project external participants, including a representative of the city of Oulu. The showcasing event presented the project goals and the means to achieve them, demonstrated the developed components of the 5G!Drones architecture in preparing, commissioning, executing, and KPI collection of a trial.

Figure 49 - Pictures from the showcasing organized by UO

- **ORA, 5G!Drones demo at Demo Day Drones, Bretigny-sur-Orge, 23 June 2022**

  ORA presented the Morinant enabler tool developed in the context of 5G!Drones during the Demo Day, organized by the Hub Drone Systematics. 5G!Drones was also presented at the beginning of the event with details on its use cases and technologies. This Demo Day was a great success, with more than a hundred guests from industry, civil aviation, academy and public institutions. The press was invited too and has been very impressed by the quality and wide variety of addressed topics More information on the presented 5G!Drones results may be found **on the project Website**.

Figure 50 - Pictures from the 2022 Demo Day Drone event

- **Athens showcasing event, 8 September 2022**

  NCSRD as coordinator of Athens testbed organised with the support of MoE and the rest partners that participated in Athens trials (i.e., COS, INF, MoE, HEP, DRR, FRQ, RXB, UML and CAF) a public showcasing event of the extended connectivity use-case, inviting the public to participate. The event was tremendously successful attracting approx. 70 participants, among which the mayor of the city and others distinguished guests. The showcasing event included two parts, initially a briefing session explaining the 5G!Drones project and the use-case that will be presented to the public and then the field trials, where the participants asked to be moved to the field of the stadium to watch the demo. It is important to mention that all the necessary security measures had been taken, following also the guidelines of Drones Expert and the participants found really interesting the showcasing part of the event. In addition, the following picture and **a video footage hosted on the 5G!Drones YouTube channel** can help delineate the activities taken in Athens showcasing event.

Figure 51 - Pictures from the Athens showcasing event in September 2022

4 5G!Drones dissemination

This section covers all dissemination activities that include the publication of journal articles, conference papers, book chapters, white papers, presentations and other forms of communications.

4.1 Publications

A variety of relevant publications was elaborated by the project team during the second period of the project runtime (M22-M42). These have found place at high-level journals, conferences and workshops, the 5G-PPP network, as well as academic thesis works, and are as follows:

4.1.1 Papers in Journals

The following articles were published in broadly acknowledged leading journals, as follows:

- **AU, IEEE Transactions on Wireless Communications, April 2021**

  B. Yang, T. Taleb, Y. Shen, X. Jiang and W. Yang, published "Performance, Fairness, and Tradeoff in UAV Swarm Underlaid mmWave Cellular Networks with Directional Antennas" in IEEE Transactions on Wireless Communications, DOI: 10.1109/TWC.2020.3041800, **link to the paper**, **open-access link**.

- **AU, IEEE Network Magazine, April 2021**

  B. Yang, T. Taleb, Y. Fan and S. Shen, published "Mode Selection and Cooperative Jamming for Covert Communication in D2D Underlaid UAV Networks" in IEEE Network Magazine, DOI: 10.1109/MNET.011.2000100, **link to the paper**, **open-access link**.

- **AU, Journal of Networking and Network Applications, 2021**

  A. Abada, B. Yang and T. Taleb, published "Generalized Traffic Flow Model for Multi-Services Oriented UAV System", in Journal of Networking and Network Applications, DOI: **10.33969/J-NaNA.2021.010101**, **open-access link**.

- **EUR, IEEE Transactions on Network and Service Management journal, 19 July 2021**

  S. Bakri, P. A. Frangoudis, A. Ksentiniand and M. Bouaziz (EUR), published "Data-Driven RAN Slicing Mechanisms for 5G and Beyond", IEEE Transactions on Network and Service Management journal, pp. 1-15, Online ISSN: 1932-4537, DOI: 10.1109/TNSM.2021.3098193, **link to the paper**, **open-access link**.

- **AU, IEEE Network Magazine, July 2021**

  T. Taleb, A. Ksentini, H. Hellaoui, and O. Bekkouche, published "On Supporting UAV based Services in 5G and Beyond Mobile Systems", in IEEE Network Magazine, DOI: 10.1109/MNET.021.2000358, **link to the paper**, **open-access link**.

- **EUR, IEEE Transactions on Network and Service Management journal, October 2021**

  M. Mekki, S. Arora, and A. Ksentini (EUR), published "A Scalable Monitoring Framework for Network Slicing in 5G and Beyond Mobile Networks", in IEEE Transactions on Network and Service Management (TNSM), DOI: 10.1109/TNSM.2021.3119433, **open-access link**.

- **UO, IEEE Transactions on Communications, 22 October 2021**

  G. P. Wijesiri N.B.A, J. Haapola (UO) and T. Samarasinghe, published "The Effect of Concurrent Multi-priority Data Streams on the MAC Layer Performance of IEEE 802.11p and C-V2X Mode 4", in IEEE Transactions on Communications, DOI: 10.1109/TCOMM.2021.3119703, **open-access link**.

- **AU, IEEE Network Magazine, December 2021**

  O. Bekkouche, F. Z. Yousaf, X. Li, and T. Taleb, published "Management and Orchestration of Mobile Network Services over Federated Mobile Infrastructures", in IEEE Network Magazine, DOI: 10.1109/MNET.101.2000522, **link to the paper**, **open-access link**.

- **EUR, Computer Communications journal, January 2022**

  K. Boutiba, A. Ksentini (EUR), B. Brik, Y. Challal and Amar Balla, published "NRflex: Enforcing Network Slicing in 5G New Radio", in Computer Communication journal. DOI: 10.1016/j.comcom.2021.09.034, **open-access link**.

- **EUR, IEEE Open Journal of the Communications, 28 January 2022**

  B. Brik, K. Boutiba and A. Ksentini (EUR), published "Deep Learning for B5G Open Radio Access Network: Evolution, Survey, Case Studies, and Challenges", in IEEE Open Journal of the Communications Society, **open-access link**.

- **ORA, IEEE Transactions on Mobile Computing, 10 March 2022**

  M. Coupechoux, J. Darbon, J.-M. Kelif (ORA) and M. Sigelle, published "Optimal Trajectories of a UAV Base Station Using Hamilton-Jacobi Equations", in IEEE Transactions on Mobile Computing, **link to the paper**.

- **ORA, IEEE Transactions on Vehicular Technology, April 2022**

  E. Chaalal, S. -M. Senouci and L. Reynaud (ORA), published "A New Framework for Multi-Hop ABS-Assisted 5G-Networks With Users' Mobility Prediction", IEEE Transactions on Vehicular Technology, vol. 71, no. 4, pp. 4412-4427, DOI: 10.1109/TVT.2022.3149711, **link to the paper**.

- **OPL and DRR, MDPI Energies, 7 July 2022**

  L. Tomaszewski (OPL), R. Kołakowski (OPL), P. Dybiec (DRR) and S. Kukliński (OPL), published "Mobile Networks' Support for Large-Scale UAV Services", in Energies 2022, DOI: 10.3390/en15144974, **open-access link**.

- **AU, IEEE Internet of Things Journal, 01 August 2022**

  Y. Dang, C. Benzaid, B. Yang, T. Taleb, and Y. Shen, published "Deep Ensemble Learning based GPS Spoofing Detection for Cellular-Connected UAVs", in IEEE Internet of Things Journal, DOI: 10.1109/JIOT.2022.3195320, **open-access link**.

4.1.2 Papers in Conferences and Workshops

The following papers were published and/or presented at workshops and conferences for the reported period, as follows:

- **AU, IEEE ICC 2021 conference, 14-23 June 2021**

  Y. Bin, T. Taleb, and G. Chen, presented "On Sum Rate Maximization Study for Cellular-Connected UAV Swarm Communications", in IEEE ICC 2021 conference, DOI: 10.1109/ICC42927.2021.9500245, **link to the paper**, **open-access link**.

- **OPL, IFIP AIAI 2021 conference, 25-27 June 2021**

  L. Tomaszewski, I. P. Chochliouros, R. Kołakowski, S. Kukliński (OPL) and M.-A. Kourtis, presented "High Mobility 5G Services for Vertical Industries – Network Operator's View", in 5G-PINE 2021 workshop, IFIP AIAI 2021 conference, DOI: 10.1007/978-3-030-79157-5_7, **link to the paper**.

- **NCSRD, IEEE MeditCom, 7-10 September 2021**

  D. Fragkos, G. Makropoulos, P. Sarantos, H. Koumaras (NCSRD); A.-S. Charismiadis and D. Tsolkas, presented "5G Vertical Application Enablers: Implementation Challenges and Perspectives", in IEEE 2021 International Mediterranean Conference on Communications and Networking, **open-access link**.

- **NCSRD, CAF, RXB and COS, IEEE MeditCom, 7-10 September 2021**

  G. Makropoulos, H. Koumaras, S. Kolometsos, A. Gogos, T. Sarlas (NCSRD), T. Järvet (CAF), G. Srinivasan (RXB) and F. Setaki (COS), presented "Field Trial of UAV flight with Communication and Control through 5G cellular network", in IEEE 2021 International Mediterranean Conference on Communications and Networking, **open-access link**.

- **EUR and NCSRD, IEEE MeditCom, 7-10 September 2021**

  P. Matzakos (EUR), H. Koumaras (NCSRD), D. Tsolkas, M. Christopoulou, G. K Xilouris (NCSRD) and F. Kaltenberger (EUR), presented "An open source 5G experimentation testbed", in IEEE 2021 International Mediterranean Conference on Communications and Networking, **open-access link**.

- **ORA, IEEE WiMob 2021, 11-13 October 2021**

  Z. O. Imam, M. Lacoste and G. Arfaoui, presented "Towards a Modular Attestation Framework for Flexible Data Protection for Drone Systems", in the 17th International Conference on Wireless and Mobile Computing, Networking and Communications, **link to the paper**, **open-access link**.

- **AU, NaNA 2021 conference, November 2021**

  Y. Dang, C. Benzaid, B. Yang and T. Taleb, presented "Deep Learning for GPS Spoofing Detection in Cellular-Enabled UAV Systems" in NaNA 2021 conference, DOI: 10.1109/NaNA53684.2021.00093, **link to the paper**, **open-access link**.

- **EUR, IEEE Globecom 2021, 7–11 December 2021**

  K. Boutiba, M. Bagaa and Adlen Ksentini (EUR), presented "Radio Link Failure Prediction in 5G Networks", in GLOBECOM'21, Madrid, Spain, **open-access link**.

- **AU, IEEE Globecom 2021, December 2021**

  H. Hellaoui, B. Yang, and T. Taleb, presented "Towards using Deep Reinforcement Learning for Connection Steering in Cellular UAVs", in IEEE Globecom 2021 conference, DOI: 10.1109/GLOBECOM46510.2021.9685265, **link to the paper**, **open-access link**.

- **AU, IEEE Globecom 2021, December 2021**

  O.Bekkouche, S. Kianpisheh and T. Taleb, presented "Toward Proactive Service Relocation for UAVs in MEC", in IEEE Globecom 2021 conference, DOI: 10.1109/GLOBECOM46510.2021.9685066, **link to the paper**.

- **EUR, IEEE ICC 2022, 16-20 May 2022**

  K. Boutiba, M. Bagaa and A. Ksentini (EUR), presented "Radio Resource Management in Multi-numerology 5G New Radio featuring Network Slicing", in IEEE International Conference on Communications 2022 in Seoul, South Korea, **open-access link**.

- **EUR, IEEE ICC 2022, 16-20 May 2022**

  S. Arora, A. Ksentini and C. Bonnet (EUR), presented "Lightweight edge Slice Orchestration Framework", in IEEE International Conference on Communications 2022 in Seoul, South Korea, **open-access link**.

- **OPL, AIAI 2022 conference, 17-20 June 2022**

L. Tomaszewski, R. Kołakowski (OPL) and M. Zagórda, presented “Application of mobile networks (5G and beyond) in precision agriculture”, in 5G-PINE workshop, AIAI 2022 conference, in Heraklion, Greece, **open-access link**.

- **EUR, IEEE LCN 2022, 26-28 September 2022**

  M.Mekki, N. Toumi and A. Ksentini (EUR), presented “Benchmarking on Microservices Configurations and the Impact on the Performance in Cloud Native Environments”, in 47th Annual IEEE Conference on Local Computer Networks, Edmonton, Canada, **open-access link**, **link to dataset**.

- **EUR, ACM Mobihoc 2022, Demo, 17-20 October, 2022.**

  K. Boutiba, M. Bagaa and A. Ksentini (EUR), presented “Demo: On enabling 5G Dynamic TDD by leveraging Deep Reinforcement Learning and O-RAN“, in MobiHoc ’22, Seoul, Republic of Korea, **open-access link**.

- **EUR, IEEE Globecom 2022, 4-8 December 2022**

  K. Boutiba, M. Bagaa and A. Ksentini (EUR), will present “On using Deep Reinforcement Learning to reduce Uplink Latency for uRLLC services”, in IEEE Global Communications Conference, Rio de Janeiro, Brazil, **open-access link**.

- **EUR, IEEE Globecom 2022, 4-8 December 2022**

  S. Arora, A. Ksentini and C. Bonnet (EUR), will present “Availability and Latency Aware Deployment of Cloud Native edge Slices”, in IEEE Global Communications Conference, Rio de Janeiro, Brazil, **link to the paper**.

- **AU, IEEE Globecom 2022 conference, 4-8 December 2022**

  H. Hellaoui, B. Yang, T. Taleb and J. Manner, will present “Ahead-Me Coverage (AMC): On Maintaining Enhanced Mobile Network Coverage for UAVs” in IEEE Globecom 2022 conference, **link to early access**.

- **AU, IEEE Globecom 2022 conference, 4-8 December 2022**

  H. Hellaoui, B. Yang, T. Taleb and J. Manner, will present “Seamless Replacement of UAV-BSs Providing Connectivity to the IoT”, in IEEE Globecom 2022 conference, **link to early access**.

4.1.3 Book chapters

- **Book Chapter "5G and Unmanned Aerial Vehicles (UAVs) Use Cases: Analysis of the Ecosystem, Architecture, and Applications", May 2021**

  G. Makropoulos, H. Koumaras (NCSRD), F. Setaki, K. Filis (COS), T. Lutz (FRQ), P. Montowtt (INV), L. Tomaszewski (OPL), P. Dybiec (DRR) and T. Järvet (CAF) contributed to this chapter which was published in the Handbook of Research on 5G Networks and Advancements in Computing, Electronics, and Electrical Engineering, edited by A. O. Nwajana and I. K. Ihianle, IGI Global, 2021, pp. 36-69, DOI: 10.4018/978-1-7998-6992-4, **Link to the book**.

4.1.4 5G PPP publications

- **5G PPP White Paper, May 2021**

  G. Srinivasan (RXB) participated to the elaboration of "Service performance measurement methods over 5G experimental networks White paper – ICT-19 performance KPIs". This White Paper may be accessed **here**.

- **5G PPP White Paper, May 2021**

  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. This White Paper may be accessed **here**.

- **5G PPP 5G Annual Journal, May 2021**

  The sixth issue of the European 5G Annual Journal was released at the end of May 2021, this issue may be accessed **here**.

- **NCSRD, 5G PPP White Paper, June 2021**

  H. Koumaras (NCSRD) participated to the 5G-PPP White Paper entitled "European Vision for the 6G Network Ecosystem", June 2021. This White Paper may be accessed **here**.

- **5G PPP Phase 3 Publication Brochure, June 2021**

  This brochure may be accessed **here**.

- **RXB and NOK, White Paper, August 2021**

  G. Srinivasan (RXB) and I. Kansala (NOK) participated in the 5G PPP white paper entitled: "Understanding the Numbers – Contextualization and Impact Factors of 5G Performance Results". This White Paper may be accessed **here**.

- **5G PPP White Paper, November 2021**

  5G PPP Architecture Working Group published "View on 5G Architecture" #4. This White Paper may be accessed **here**.

- **COS, June 2022**

  COS, leading Task 4.3 on Evaluation of Project results, has contributed the relevant work on the standard network KPIs definition in the White Paper "Beyond 5G/6G KPIs and Target Values" of the 5G PPP Test, Measurement and KPIs Validation (TMV) Working Group that was published June 2022. This White Paper may be accessed **here**.

4.1.5 Other White Papers

- **NOK, White Paper, June 2021**

  A White paper entitled "Controlling drones over cellular networks" has been released by NOK, referencing 5G!Drones "D1.1 – Use case specifications and requirements" [5], June 2021. This White Paper may be accessed **here**.

4.1.6 Thesis publications

- **NOK, Master Thesis, June 2022**

  H. Mir (UO) completed his Master thesis “Machine Learning-Based Motion Type Classification From 5G Data”.

4.2 Workshops and presentations

Another part of the dissemination activities has taken place in the framework of thematic workshops, presentations and demonstration activities, as described in the following subsection. For the considered period, a list of the attended workshops and the presentations made in various events is given.

4.2.1 Workshops

- **NOK, Seminar Session at PRINSE’22, June 2022**

  I. Känsälä (NOK) participated to the Seminar “7th PrintoCent Industry Seminar” and presented “Printed Electronics Ecosystem for Future Wireless Networks” to the seminar session 4B: Discovering extreme antennas (L10). More information on this event may be found **here**.

- **5G!Drones Webinar, 25 November 2022**

  5G!Drones partners organised the final online webinar of 5G!Drones project! In this webinar, a 5G!Drones project overview, its final results and the lessons learned were presented.

4.2.2 Presentations, Poster sessions, Committees, Webinars, and Panel Discussions

During the considered period, the following presentations in different relevant forms were performed at online meetings, poster sessions and conventions.

- **EUR, video “Eurecom: OpenAirInterface – 5G software alliance for democratizing wireless innovation”, April 2021**

  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 A. Ksentini and F. Kaltenberge from EUR. This video footage may be accessed **here**.

- **UO, FUAVE stakeholder online event, 16 April 2021**

  J. Haapola (UO) provided a presentation of the current state and the next steps of 5G!Drones project, entitled “Towards UAV trials - Architectural advancements and takeaways from feasibility tests” at the Finnish UAV Ecosystem (FUAVE) Stakeholder event. The presentation may be retrieved **here**.

- **RXB, Presentation at the 5G PPP TB Workshop, 21 May 2021**

  RXB presented the 5G!Drones project at the 5G PPP TB Workshop held May the 21st 2021, and focused on the lessons learned from the 5G!Drones Athens trials over the 5GENESIS 5G Athens experimental platform in October 2020.

- **AU, international school of Espoo, 27 May 2021**

AU has performed a small showcasing event on 27th May 2021. The showcasing was for the benefit of first graders students from the international school of Espoo, Finland. AU presented its current work related to cellular drones and VR as part of 5G!Drones activities and also presented a demo of streaming a 360 video from flying drones. A link to the event may be found **here**.

- **Virtual Booth during the EuCNC & 6G Summit, 8-11 June 2021**

  From 8-11 June 2021, the 5G!Drones project participated in the virtual Joint EuCNC & 6G Summit, which brought together cutting edge research and world renown industries and businesses to present and discuss the latest results focusing on all aspects of telecommunications ranging from 5G deployment and mobile IoT to 6G exploration and future communications systems and networks, including experimentation and testbeds, applications, and services.

  The project team gave a project overview and presented the 5G!Drones consortium. In addition, the 5G!Drones newsletter Issue 7 was uploaded to the virtual booth and disseminated to the visitors. It presented the project activities during the period December 2020 - February 2021 and focused on the dissemination and communication activities, the trials performed, the deliverables that have been published, as well as the general assembly meeting's details. Furthermore, all social media channels of the project and the project Website were linked to the virtual booth so every visitor could click on the respective channels for further information, increasing the visibility of the project scope, goals, and findings.

  Figure 52 - Virtual booth of the 5G!Drones project at the Joint EuCNC & 6G Summit 2021

  Additionally, a **project promo video** was linked to the virtual booth of 5G!Drones, summarising the main objectives of the project.

- **NOK, Presentation at 5G-PPP TMV event, 18 June 2021**

  I. Kansala (NOK) and O. Grøndalen participated and presented in 5G-PPP TMV event: "Practical insights from 5G Test, Measurement and KPI Validation with vertical applications". The presentation title is: "Coverage aspects in 5G experimentation results". The link to the presentation may be found **here**.

- **NOK, Presentation at the 26th Finnish National Conference on Telemedicine and eHealth, "eHealth in a Lifecycle", 7-8 October 2021**

  NOK presented the role of telcos and latest technologies in eHealth. The presentation entitled "Telco shaking hands with eHealth" also featured 5G!Drones. More information on this event may be found **here**.

- **RXB, Presentation at Dubai Airshow, 14-18 Nov 2021**

  G. Srinivasan (RXB) presented 5G attributes in the context of UAVs in a panel discussion of the Dubai Airshow. More information on this event may be found **here**.

- **RXB, Presentation / Panel discussion at 5G Techritory, 22-25 November 2021**

  G. Srinivasan (RXB) presented 5G!Drones at 5G Techritory - Europe's Leading 5G Ecosystem Forum. More information on this event may be found **here**.

- **CAF, Presentation / Booth at the Smart City Expo World Congress, 16-18 November 2021**

  CAF participated to the Estonian Joint Stand at the Smart City Expo World Congress in Barcelona. More than 400 companies were represented at the fair, introducing innovative solutions to create a better urban life for people and enable more efficient and inclusive urban services. CAF presented its Worker robot and 5G cellular drone and introduced 5G!Drones project and initial results. More information on this congress may be found **here**.

- **CAF, Panel discussion at the Smart City Expo World Congress, 16-18 November 2021**

  T. Järvet (CAF) participated in a panel discussion, Moderated by the TalTech – Tallinn University of Technology Smart City Centre of Excellence and featuring CAF, Fyma and Envelope, during the Smart City Expo World Congress where aspects and results of the 5G!Drones project and its use cases were also discussed and presented. More information on this congress may be found **here**.

- **NCSRD, Presentation / Panel discussion at IEEE GLOBECOM, 8 December 2021**

  H. Koumaras (NCSRD) participated to the Industry Panel "5G and beyond – The Perspective of European Research Projects" during IEEE GLOBECOM 2021, discussing and presenting the "Findings and lessons learnt from the 5G trials of 5G!Drones project". You may find more information on the event **here**.

- **RXB, Panel discussion at Amsterdam Drone Week, 29-31 March 2022**

  G. Srinivasan (RXB) participated to the panel discussion at the mainstage on the topic "Autonomous Drone Networks". 5G!Drones project was represented sharing insights about the role of network related to autonomy, Beyond Visual Line of Sight (BVLoS) & certification standards. More information on the event may be found **here**.

- **RXB, Presentation at Amsterdam Drone Week, 29-31 March 2022**

  G. Srinivasan (RXB) made a 30 minutes presentation on "BVLOS missions & lessons learned". Insights and activities from 5G!Drones project were communicated. More information on the event may be found **here**.

- **RXB, Presentation at the Interpol Drone Expert summit, 20-22 June 2022**

  G. Srinivasan (RXB) presented the 5G!Drones and its upcoming trials during the Interpol Drone Expert summit held in Oslo, Norway.

- **NCSRD, Presentation at the NCSRD 57th Summer School, 12 July 2022**

  H. Koumaras (NCSRD) participated to the NCSRD 57th Summer School on 12th July 2022, discussing and presenting the findings and the lessons learnt from 5G!Drones project.

- **NCSRD, Panel discussion at the 12th Infocom Mobile Connected "Smartverse: Pushing the boundaries of connectivity", online, 12 July 2022**

  H. Koumaras (NCSRD) participated to the 12th Infocom Mobile Connected "Smartverse: Pushing the boundaries of connectivity", discussing the 5G openness aspects and programmability findings of the 5G!Drones project.

- **ORA, Panel discussion at the Hub Drone Systematics, 23 September 2022**

  F. Parzysz (ORA) presented main objectives of the trial controller developed within 5G !Drones during a panel discussion on the benefits of 5G for the drone ecosystems. The audience was composed of drone manufacturers, operators and software service providers, but also industrial end-users and members of the Direction Générale de l'Aviation Civile (DGAC) and Eurocontrol. More information on the event may be found **here**.

4.3 Deliverables

The planned deliverables provision has been performed according to the updated project plan and in accordance with the high-quality management and assessment criteria, set by the project consortium member organisations and external advisors. The following table provides an overview of the publicly accessible deliverables, already submitted and uploaded to the Website during the second period of the project, available for download to the Website visitors.

Table 12: List of Reported Deliverables

Del#	Name	WP#	Lead	Type	Diss. Level	Delivery date	Link
D1.6	5G!Drones system architecture refined design	1	NCSRD	Report	Public	M24	URL
D1.7	Final report on UAV business and regulatory ecosystem and the role of 5G	1	INF	Report	Public	M42	N/A[5]
D2.2	Initial implementation of the trial controller	2	INV	Other	Confidential	M23	N/A[6]
D2.3	Report on algorithms, mechanisms and tools for data analysis and visualisation	2	FRQ	Report	Public	M24	URL
D2.4	Definition of the trial controller architecture, mechanisms, and APIs	2	EUR	Report	Public	M24	URL
D2.5	Trial controller software final release	2	NCSRD	Other	Confidential	M33	N/A[6]
D2.6	Data analysis and visualisation software implementation	2	NOK	Other	Confidential	M33	N/A[6]
D3.2	Report on vertical service-level enablers for 5G!Drones	3	EUR	Report	Public	M26	URL
D3.3	5G!Drones Enablers Software Suite	3	UO	Other	Confidential	M35	N/A[6]
D3.4	UAV use case service components	3	ALE	Other	Confidential	M36	N/A[6]
D4.2	Integration status and updated integration plan	4	DRR	Report	Public	M26	URL

[5] This deliverable is not yet available at the time of publishing this document. It will be found on the 5G!Drones Website along the other public deliverables at the end of the project.
[6] No public link is available since this deliverable dissemination level is confidential (CO).

Del#	Name	WP#	Lead	Type	Diss. Level	Delivery date	Link
D4.3	Trial plan	4	CAF	Report	Public	M26	URL
D4.4	Trial evaluation report	4	COS	Report	Public	M42	N/A[5]
D5.2	Report on communication, showcasing, dissemination and exploitation achievements and plan for the second term of the project	5	RXB	Report	Public	M23	URL
D5.3	Report on contribution to standardisation and international fora– 1st Version	5	AIR	Report	Public	M18	URL
D5.4	Report on contribution to standardisation and international fora– 2nd Version	5	THA	Report	Public	M42	N/A[5]
D5.5	Final report on communication, showcasing, dissemination and exploitation	5	ORA	Report	Public	M42	N/A[5]
D5.6	Report on activities related to commercial exploitation and partnership development	5	OPL	Report	Public	M42	N/A[5]
D6.4	Annual report, year 2	6	UO	Report	Public	M24	URL
D6.5	Annual report, year 3	6	UO	Report	Public	M36	N/A[5]
D6.8	Information on cumulative expenditure incurred, M30	6	UO	Report	Confidential	M30	N/A[6]

4.4 Updates to the dissemination plan for M22 – M42

The objective of this subsection is to review the dissemination plan for Months 22 to 42 initially published in previous deliverable D5.2 [1], to provide a synthetic analysis of the accuracy (and when applicable, where and why deviations need to be reported) for this plan, at the time of finalising the 5G!Drones project activities. As a reminder, this initial plan was structured along targets in terms of showcasing and dissemination. Therefore, in the rest of this subsection, those targets are compared with the actual showcasing and dissemination activities that were conducted during the reported period.

4.4.1 Showcasing

Regarding showcasing, the dissemination plan mainly expressed qualitative targets, by highlighting that "*the already performed and planned project achievements and showcasing activities are based on cutting-edge technologies and systemic solutions, enabling completely new approaches to be implemented in the real world and by this improve the daily life of EU citizens*." The overall goal of the showcasing activities was to "*perfectly reflect these results among the public audience, as it has been the case until now and it should be intensified in future*". The three showcasing events reported in subsection 3.2 contribute to that objective, both in terms of intended audience and showcased features:

- In terms of public, the three referenced showcasing events, respectively at the international school of Espoo, Finland (May 2021), the Oulu Campus area and Botanical Garden (August 2021) and finally in Athens (September) indeed attracted a diverse and general audience, with respectively younger students, 40 project external participants (including a representative of the city of Oulu), and 70 participants (including the mayor of the city of Athens, among other specific guests).
- In terms of features, the three showcasing events presented the project goals and the means to achieve them. Through those events, and in particular during the 2022 event held in Athens, with the finalized developed components of the projects, the consortium managed to "demonstrate the developed components of the 5G!Drones architecture in preparing, commissioning, executing, and KPI collection of a trial", as was stated in the showcasing targets set in D5.2 [1].

4.4.2 Workshops and presentations

The consortium members participated in workshops in order to disseminate the 5G!Drones project outcomes, including the recommendations of the use of 5G for drone connectivity.

- Besides participating in the 7th Seminar PrintoCent Industry Seminar (PRINSE'22), at the time of finalizing this deliverable, the project members organised in November 2022 a Webinar addressing many of the 5G!Drones project results, such as a presentation of the main Use Cases, architectural elements, a summary of the four trial Facilities, a presentation on the trial outcomes, the project results and the lessons learned.

4.4.3 Journals, conferences and other publications

For publications, the general plan for D5.2 was to target the appropriate audience and readership: major journals and magazines on communications/networking as well as high-impact communications-related and vertical-oriented publications and conferences.

- The number of journal publications as well as the targeted journals (which includes the IEEE Transactions series, as well as the IEEE Network Magazine, the IEEE Open Journal of the Communications, …) are in line with the ambitious plan outlined in D5.2.
- Likewise, the conference outcomes are well within the ambitioned plan, with a majority of papers presented in high-impact conferences, such as the IEEE International Conference on Communications (ICC), the IEEE Conference on Local Computer Networks (LCN), and the IEEE Global Communications Conference (Globecom).
- In addition, the consortium took part in complementary dissemination activities, notably via its strong participation to the elaboration of many 5G-PPP publications.

With these dissemination actions, it is believed the project reached its target to efficiently publicise and circulate its activity outcomes as well its main takeaways, including the market opportunities of the drone sector in telecommunications, especially in 5G. These results are therefore in line with the outlined dissemination plan published in D5.2.

5 5G!Drones Project exploitation results

As previously mentioned in previous deliverable D5.2 [1], 5G!Drones project's mission is to demonstrate the remarkable potentials that 5G technology can bring to the UAV transformed vertical industries and sets to validate capabilities that deeply disrupt the existing state-of-the-art. Naturally, the exploitable opportunities that arise from the project's results are diverse in nature and span in various categories – including drones, remote control and traffic management systems, full-fledged integrated trial 5G environments, and packaged use case solutions. As these results are generated by many partners of versatile interests and strategic (profitable or non-profitable) goals, it is important to devise an all-encompassing exploitation strategy that shall capture and classify all possible prospects and partners' interests.

This section will first outline the updated list of 5G!Drones exploitable outcomes, focusing on all non-commercial results of the project. Then, a final revision of all partners' individual exploitation plans is given. Finally, the generated Intellectual Property (under the form of patents) is delineated in subsection 5.3. It is to be noted that the reading of this deliverable, which focuses on non-commercial results, complements deliverable D5.6 [3], which intends to give a more in-depth analysis of all commercial outcomes, including the patents generated during the 5G!Drones project.

5.1 Update on 5G!Drones exploitable outcomes

The table below is derived from the list of exploitable outcomes initially identified in deliverable D5.2 [1]. This table presents the exploitable outcomes from 5G!Drones identified so far, project result category, end customer and involved collaborating partner for each of them. A thorough review of 5G!Drones activities showed no deviation with respect to this initial list: this list of outcomes is therefore unchanged and confirmed at the time of writing this final deliverable. On this basis, an analysis of the commercial applicability of all mentioned outcomes, involving the identification of a Technology Readiness Level (TRL) for each outcome, was conducted in the context of the elaboration of deliverable D5.6 [3], in which commercial results of this table are meant to be analysed.

In this context, the rest of this subsection will describe the remaining outcomes from Table 13 which were identified as non-commercial. These results may be non-commercial by nature (e.g., scientific research or standardization publications, prototypes, demonstrators, non-commercial datasets, …) or their TRL may be too low to allow short-term commercialization perspectives. The rest of this section will therefore detail outcomes 2, 4-12, 14-19, 21-23, 30-31 and 33-36 from Table 13. For the commercial results and associated TRL and marketability analysis, refer to deliverable D5.6 [3].

Table 13 - 5G!Drones exploitable outcomes with non-commercial results highlighted in green

#	Outcome	Project Result Category	Exploitable Type	End Customer	Involved Partners
1	5G!Drones USPACE Adaptor	Prototype	Product Development	Integrator	FRQ, DRR, CAF
2	Drones Platform for Experiments	Prototype	Product Development	Vertical Industry	ALL WP2 and WP3 partners
3	Mission Critical Services platform integrating Drone-as-a-Service on 5G network	Prototype	Product Development	Public Safety Authorities - Firefighters, Emergency services, Police	AIR, CAF

#	Outcome	Project Result Category	Exploitable Type	End Customer	Involved Partners
4	Computer Vision cloud native application for 5G MEC	Prototype	Product Development	Construction companies	CAF
5	C2 container-based cloud native application for 5G MEC	Prototype	Product Development	Drone companies	CAF
9	Transportable 5GTN system	Demonstrator	Research Achievements	Academia	UO
10	Transportable 5GTN system	Validation Activities	Research Achievements	Vertical Industry	UO
11	Academic results, data sets	Publications	Research Achievements	Academia	UO, NOK, OPL, AU, THA, EUR
12	Contributions to ETSI SmartBAN	Publications	Standardisation	Technology Vendor	UO
13	Networked Remote ID Tracker	Demonstrator	Start-ups	Vertical Industry	INV
14	Trial Validator	Demonstrator	Product Development	Software Developer	RXB, FRQ
15	KPI Component	Demonstrator	Product Development	Technology Vendor	FRQ
16	A general data collector	Other	Product Development	Software Developer	NOK
17	Drones extending 5G Connectivity	Demonstrator	Product Development	Telecom Operator	NCSRD, COS, MOE
18	Business KPIs and metrics	Other	Business Development	Vertical Industry	INF, T2.4 and T4.2 partners
19	New Business models	Other	Business Development	Vertical Industry	INF and T1.1 partners
20	Post-storm analysis of power lines	Prototype	Product development	Vertical Industry	HEP
21	Academic results	publications	research Achievements	academia	AU
22	X-network ecosystem	demonstrator	product Development	telecom Operator	AU
23	UAV-based IoT data collection	prototype	product Development	vertical Industry	AU
24	5G Hydradrone platform for inspection operations	Demonstrator	Product Development	Vertical Industry	ALE

#	Outcome	Project Result Category	Exploitable Type	End Customer	Involved Partners
25	UMS' software platform's capabilities in: - a. Autonomous drone swarm management - b. People detection through video analysis - c. Enabling use cases like on-demand connectivity by providing network connectivity through drones	Demonstrator	Business Development	Vertical Industry	UMS
29	UMS simulation testbed	Prototype	Research Achievements	Vertical Industry	UMS
30	Academic results, data sets	publications	research Achievements	academia	THA
31	New network anomaly detection mechanisms	Demonstrator	Product Development	Integrator	THA
32	Mission Critical Services	Prototype	Product Development	Public Safety Authorities - Firefighters, Emergency services, Police	THA
33	Analysis of 5G architecture and mechanisms compliance with requirements and needs of the entire UAV ecosystem recognized during the 5G!Drones project	Publications	Standardisation	Telecom Operator, Vertical Industry, SDO	OPL
34	C2 over 5G on-board component	Prototype	Research Achievements	Research Center	NCSRD
35	Academic results	Publications	Research Achievements	academia	EUR
36	5GEVE Sophia Antipolis ecosystem	demonstrator	Open source	Telecom Operator	EUR
37	Localization of a drone, mission planning and drone operations	10 patents	Product Development	Drone companies /Telecom Operator	ORA, NOK

The following paragraphs provide a concise summary of all non-commercial outcomes listed in Table 13, sorted by category.

5.1.1 Publications

Outcomes 11-12, 21, 30, 33 and 35 can all be categorized as publications. They however differ as follows:

- Among those, outcomes 11, 21, 30 (as far as the academic results are concerned) and 35 are academic results, mainly spanning scientific articles published in various conference proceedings and journals. The articles published within the timeline covered by this deliverable are described in section 4.1, while the list of previous publications may be consulted in deliverable D5.2 [1]. Note that concerning outcome 30, only scientific papers have been published and no dataset related to 5G!Drones activities has been produced. The only dataset that has been generated was related to synthetic users mobility.
- In contrast, the work that led to outcomes 12 and 33 was conducted in liaison with standards developing organizations (SDO). More information on the interactions with ETSI, 3GPP and other SDOs can be found in deliverable D5.4 [2].

5.1.2 Prototypes, demonstrators and validation activities

The following paragraph gives a brief description of outcomes 2, 4-5, 9-10, 14-15, 17, 22-23, 31, 34, 36. Moreover, each summary is followed by a concise explanation of the reasons why no associated commercial plans were identified, and when applicable, of the alternative means to disseminate or share the outcome beyond the 5G!Drones project environment.

- In the context of **outcome 2**, NOK designed a Lifecycle Manager, i.e., a sub-module responsible for managing the lifecycle of the trial and handling a stream of information between sources. Lifecycle Manager contains two main parts to care trials, Schedule and Executor. Like outcome 16, this Lifecycle Manager will not be commercialized and instead has been offered **publicly as open-source software**.

  The Web Portal for experimenter is also falling into outcome 2 classification. Already in the initial design phase, it has been noticed that it will be difficult to build the interface for experimenter, which will cover all end-to-end Operational Flight Planning aspects. The reasons for that are that experimenter is not an expert in the 5G parameters configuration and these details should be transparent or invisible for him. The other difficulty was the existence of 4 different infrastructure suppliers, each with different connectivity and configuration requirements. Hence, the functions for end-to-end Operational Flight Planning in 5G!Drones were split into Web Portal 1 and Facility Web Portal. Web Portal 1 is a place where UAV vertical is defining his requirements and equipment, including the basic connectivity needs, which impacts the 5G. Facility Web Portal is accessible from Web Portal 1, but the configuration here requires the knowledge of specificity for each facility setup and is supposed to be done by facility operator.

  The Technology Readiness Level (TRL) of Web Portal 1 and Facility Web Portals can be defined as TRL 4 (technology validated in lab). As it is still far from the prototype, which can be demonstrated in the real operational environment, none of the partners decided to progress further and commercialize it. The source code for Web Portal 1 front-end, APIs for communication with repository storing the data and repository itself, will be accessible publicly by the end of the project.
- **Outcomes 4** and **5** refer to the developments performed by CAF during the project, which finally led to the following developments: CAFA VideoLyzer 4K video analytics system; Ground Control Station and UTM system integration plugin GIP; 3D Analyzer; CAFA cellular drone and finally CAFA Field C2 system. Note that these outcomes are detailed in deliverable D3.4 [8]. CAF has developed and tested the aforementioned technologies, which are necessary for the

development of the future CAFA own drone logistics system. As the regulation of drone flights and the use of radio equipment on board and automatic BVLOS low-level flights in urban conditions and EASA guidelines and regulations are evolving and under development, it is currently not possible to outline the commercialization plan of the aforementioned technologies and these outcomes were assessed non-commercial in the scope of the 5G!Drones project.

- **Outcomes 9** and**10** relate to a transportable 5GTN system to be completed by UO, which encompasses 5G core, MEC, and gNB for testing and showcasing beyond the current coverage area of the network. The individual components have been developed as research outputs, but the system integration in an operational vehicle is still on the roadmap, targeting completion by the end of 2023.
- **Outcomes 14** and **15** respectively refer to the results around the trial validator and KPI component developments. Those results were associated with TRL 4 (i.e., small scale / laboratory prototypes) with no identified commercial targets. More information on these components can be notably found in [7], in sections 4.2.3.2 and 3.1.9.
- **Outcome 17** is a demonstrator prototype showcasing drones to extend 5G connectivity. Due to its purpose for demonstration in a prominently academic context and its relatively low TRL, there is no plan to commercialize it as it is.
- A summary of the X-network ecosystem and facility enablers (**outcome 22**) can be found in [7], in section 5.1.2. In this context, AU prototyped a UAV-based Internet of Things (IoT) data collection service (**outcome 23**), aiming to validate this ecosystem. This development was therefore not targeting commercial exploitation.
- **Outcome 31** is about the Network anomaly detection mechanism, which has been demonstrated in Thales premises and a scientific journal paper has been **published in Computer Networks Journal**. This anomaly detection mechanism is related to the dataset used and should be adapted to the new data. Thus, there is no plan to commercialize it as it is.
- **Outcome 34** is a development aiming to investigate the use of Command & Control (C2) over 5G. Much like other outcomes 9-10 and 23, this component was prototyped targeting research achievement and not commercial exploitation.
- Finally, **outcome 36** relates to the ecosystem around the 5GEVE Facility in Sophia Antipolis, for which a brief summary can be found in [7], in section 5.1.3. Like outcome 22 for X-Network, this ecosystem is supported by a platform aiming at test demonstrations, which is composed of open-source components, such as OAI, Kubernetes, Openshift, Grafana and Kibana. The platform has been built in the context of 5GEVE and maintained by EUR using their own resources. In the context of 5G!Drones, components were developed on top of the facility to run the trial, such as Abstraction layer, Facility translator, Webportal and various MEC enablers. In general, the associated TRLs are low, with no commercialization visibility.

5.1.3 Other results

The following outcomes 16, 18 and 19 from Table 13 are described as follows:

Outcome 16, the generalized data collector (NOK) was a Python software application to enhance CPU and Memory data collection from any computer system running linux. A data pipeline would then be processed and stored as interval-based data connected via nodes. This could then enable (a) analysis and data use for Machine Learning and (b) continual data for enabling services for different 5G system, IoT and UAV control or payload devices. It was concluded that the resulting software was not a significant enough sellable item to justify commercializing it.

In the context of 5G!Drones, studies and results regarding market analysis, business impact of technical KPIs and business modelling are described in deliverable D1.7 [6] and more precisely:

- **Outcome 18** relates to the project outcomes regarding business impact of KPIs and metrics. These results have been described in sections 4.1 and 4.2 of D1.7.
- Likewise, **outcome 19**, regarding new business models opportunities, is described in D1.7. First, section 2 provides a detailed analysis of the current UAV market and drones applicability which leads to the creation of new business opportunities, processes and potentially to new business models in the evolving UAV business environment. Secondly, section 4 provides recommendations and suggestions as lessons learned from the 5G!Drones trials, by all involved partners and from their business perspectives, towards new future pathways and technological/business opportunities. It is worth mentioning that a lean canvas methodology was described in D5.2, which allows completing this description of outcome 19.

5.2 Update on individual exploitation plans

- In the following table, each 5G!Drones project partner gave a final updated version of its exploitation plan at M42.

Table 14: 5G!Drones partners individual exploitation plan updates

Partner	Exploitation plan
AIR	Exploitation plans for AIR have evolved during the whole duration of the project as new skills have been acquired and further technical and financial studies have been achieved within the project. 5G!Drones outcomes has allowed Airbus DS SLC to demonstrate that 5G techniques based on native cloud technologies and network slicing technology will further enable Public Safety users with rich and reliable multimedia services and applications, as part of the Private Mobile Radio (PMR) industry evolution to 5G Broadband. Airbus DS SLC has developed concrete innovative 5G use cases focused on firefighters' needs but that could apply to other mission critical and business critical end users. Main derived products will consist of a critical collaboration platform integrating Drones As A Service and powered by 5G capacities. 5GDRONES project also confirmed the readiness of Airbus secured communications products to support this technology ensuring performances in accordance with public safety requirements. The project outputs will nurture Airbus DS SLC products and solutions roadmap to build a competitive portfolio and to maintain its leadership in the PMR/Public Protection and Disaster Relief (PPDR) industries
ALE	Alerion develops smart custom drones for specific applications. Alerion is involved in different projects in which it creates solutions for infrastructure inspection, environmental surveillance, and broadcasting events. With the upcoming era of 5G, Alerion is willing to use the results of this project to upgrade its offer and explore new possibilities and markets. Using 5G capabilities to enhance Alerion drones – Especially, we would like to equip our Hydradrones to explore a new usage of our technology. Our trial will explore the advantages of 5G, especially for inspection and search & recovery operations in large bodies of water tasks and will help us to understand how this technology will improve the performance of our Hydradrones for inspection's tasks. Thus, the possibilities offered by 5G are a great opportunity for Alerion to develop its business.
AU	AU will exploit the main findings and outputs arising from 5G!Drones to strengthen its research and technical expertise in different fields related to UAVs and 5G. As an

Partner	Exploitation plan
	academic institution, AU is aiming to enrich its teaching activities at different levels. Incorporating different technological aspects of the project in the teaching content will allow exposing students to real-world technologies. The project results will be also exploited as a catalyser for further research projects in relevant scientific and technological areas. Moreover, AU will leverage the research findings from 5G!Drones to continuously evolve its network facility. In addition to ICT-17 facilities, 5G!Drones will make use of the X-Network trial site of AU. The testbed is part of the Finnish national project 5GTNF (5G Test Network Finland), which is an evolving ecosystem supporting 5G and beyond technology research and validation. The site is being refined to cover drone use cases.
CAF	CAFA Tech will use the technologies (CAFA VideoLyzer 4K video analytics system; C2 Ground Control Station and UTM system integration plugin GIP) developed during the project for its own automated CAFA Dock360 drone logistics system. As the regulation of drone flights and the use of radio equipment on board and automatic BVLOS low-level flights in urban conditions and EASA guidelines and regulations are evolving and under development, it is currently not possible to outline the commercialization plan of the aforementioned technologies and these outcomes were assessed non-commercial in the scope of the 5G!Drones project.
COS	COSMOTE, being the largest telecommunications provider in the Greek market positions technology superiority as a strategic pillar, aiming at creating new prospects for Greece's digital development. COSMOTE has set 5G among its top priorities starting with an initial investment of 123 million € for spectrum licensing only, and seeks to invest in premium 5G services to support innovative use cases and applications. It is evident that the utilization of drones provides significant operational gains and revolutionizes businesses in many markets, and joined with the capabilities unleased through 5G can unravel corporate investments boosting the actual 5G adoption and therefore increasing revenues for the operators. Through 5G!DRONES COSMOTE had originally set the following four explicit exploitation goals, documented in D5.2, that have been re-prioritised as following: 1. As a first priority, COSMOTE is interested in reducing OPEX by the utilization of UAVs in its mobile network and internal operational procedures, **especially by applying "Situation Awareness" (Use Case 3)** to assist the conventional tower inspection for faults detection and correction. This inspection at the time being involves tower climbing, which requires specialized skills, and is effort and cost demanding. UAVs could very well be used instead, capturing and transmitting in real-time pictures and video to COSMOTE's operation and maintenance centers at the same time faster and more efficiently, producing reliable data allowing instant analysis. Moreover, UAVs could also be actuators, e.g. utilized for melting ice from MW antennas by throwing water carried in buckets, or for bringing spares from the earth up to the antenna via an elastic tube. In another account, UAVs can support radio planning e.g. used to determine the ideal location and height for new antenna locations substituting expensive on-site visits. Towards the appropriate incorporation of the Situation Awareness use case, COSMOTE has already taken actions investing on its own UAVs fleet (including smaller drones and hexacopters) and has trained employees to obtain professional UAV piloting licenses. 2. Secondly, COSMOTE sees the potential to expand its B2B (business-to-business) products portfolio with services targeting vertical industry needs. All

Partner	Exploitation plan
	the 5G!DRONES use cases are therefore relevant in this respect and especially their **application in Logistics and Agriculture business** which are of high potential for the Greek market. COSMOTE has a strong business segment on ICT having specialized sales teams building integrated solutions for the business market with special focus in niche IoT solutions and Fleet Management. Actively exploiting all the emerging trends in these domains, and therefore inevitably UAVs, is of key interest for these teams. 3. Apart from the revenue generation opportunities seen in the Business to business (B2B) segment, COSMOTE seeks to maintain its status as an innovation pioneer in the Greek market, and its strong social responsibility profile by actively contributing to solutions to public safety and protection. The application of Use Case 2, "**Disaster recovery and emergency communications**" is of great value. The project proves that UAVs can support first responders and telecommunications services in case of a disaster including earthquakes, wildfires, floods, etc. The utilization of UAVs for COVID-related activities (transportation of health packages, thermometry etc.), as well as in various situations where immediate human interaction is impossible (fire and sea) comes to point out that involving UAV technology is pivotal for effective and innovative solutions in emergencies. As a next step, COSMOTE plans to investigate the use of drones for early fire recognition, which is a top- threat for our country. Finally yet importantly, supporting COSMOTE's core business which promises premium connectivity in all circumstances and for all, the Use Case 4, "**Connectivity Extension during Crowded Events**" has been put in the spotlight: UAVs equipped with 5G base stations are expected to provide additional on-demand capacity in cases of crowded events (festivals, large stadiums, demonstrations, traffic jams, etc.). This use case was expected to advance the end-user premium experience (ex. 8K video quality streaming), and result in high data usage and increased consumption of the network services offerings. Nonetheless, through the extensive experimentation as part of 5G!DRONES, it became clear that the solution is still under a lower TRL than necessary for a wider adoption in an enterprise environment. Limitations on the power supply mandating tethered solutions, necessary to power both the UAV and the 5G gNB and considering current 5G Non-Standalone (5G NSA) network deployments, the need to onboard also an eNB, and therefore the cumulative weight that the UAVs can carry, as well as the necessary cabling to ensure backhaul connectivity become prohibiting factors for short-term adoption. Nonetheless, with the optimizations expected with the SA deployment, that COSMOTE is planning commercially for 2024-2028, as well as, the advent of advanced radio and transport technology such as wireless optical front-haul and backhaul, the use case remains extremely relevant for the mid-term with further evaluation necessary once the more advanced technology becomes available.
DRR	Droneradar exploitation plan for 5G!Drones is focused on finding ways of 5G network usage in U-space, performing a comprehensive technical analysis with the intention of spotting the Mobile Network Operators (MNO) towards active members of U-space ecosystem. During the course of the project we've identified, thoroughly analyzed and tested few areas of business and technological synergies: 5G communication as a bearer for C2, telemetry and reliable communication between UAS operators and Air Traffic Controllers (ATC), beamforming for adjusting coverage to UAS needs, slicing for assurance of appropriate Quality of Service and separation, edge computing for hosting supplementary services like CARS (Common Altitude Reference Systems). This sets up

Partner	Exploitation plan
	initial challenges to be addressed and opens up plenty of areas for discussions with commercial mobile operators, who want to support UAS in their 5G capable networks. The integration of Droneradar products in 5G!Drones trials will help to standardize methods of communication between UTM/CIS systems and Supplementary U-Space Service Providers (USSP). Droneradar will also focus on freedom which gives NFV concept for U-space stakeholders. Droneradar is eager to share manned and unmanned experiences focused on connection to the Air Navigation Service Provider (ANSP)/CIS between the Consortium members. During the project we achieved to demonstrate the interconnection between different UTM/CIS systems (Droneradar's and Frequentis') as well as to integrate them with project's Trial Controller platform. Other objectives include generating awareness for the current Droneradar UAS product portfolio among the stakeholders, creating an efficient business model, and establishing a product roadmap based on the trials output. Additionally, Droneradar showcased to utilize outcomes of 5G!Drones project to another SESARJU projects, like ICARUS in which usage of EDGE computing become absolutely critical in the development and implementation of CARS. The thoughts and ideas of 5G!Drones project will be validated prior commercialisation with customers and organisation we cooperate with (ANSP, CAA, Commercial and GA pilots), with the high-level purpose of reducing and predicting risks associated with UAS missions. Droneradar will expand its products portfolio with services targeting vertical industry needs, exploring new business model potentials. All the project use cases are considered relevant to this, through their application in Command, Control and Communications (C3) links, that are very important to the European U-space market.
EUR	EUR exploits the work within 5G!Drones via its academic activities, strengthening its scientific and technical expertise in cutting edge research areas in which it is already very active, such as software- defined communication systems, cloud computing and NFV, mobile communication systems, network slicing and softwarisation, and edge computing, but also extending its know-how with respect to the UAV vertical industry. EURECOM's participation in 5G!Drones will allow it to channel this knowledge to its M.Sc. and Ph.D. programs, preparing its students and interns for work in advanced science and technology sectors and giving them the opportunity to carry out timely research. Two PhD and five M. Sc have been enrolled to work on 5G!Drones topics. EURECOM also exploits the selection of the Sophia Antipolis site of the ICT-17 5G-EVE facility for 5G!Drones trials, enhancing the functionality of the facility to meet the needs of the UAV industry, and ensuring the utility of the platform well-beyond the end of the 5G-EVE project. EURECOM has developed several components such as Abstraction Layer and WebPortal 2 to leverage the 5G-EVE facility to support 5G!Drones trials. Finally, EURECOM has published several papers in conferences and journals to disseminate the project findings.
FLA	Flaperon will use the 5G!Drones project to help develop its payload system to enable the capability to conduct post-storm analysis flights day-and-night. Also, because of the project, FLA will have better real time control of the payload and the drone. Furthermore, 5G connectivity allows for using the drones in a much wider area when compared to classical point-to-point datalinks with decreased technical and operational complexity.
FRQ	Frequentis will use the 5G!Drones project to expand its portfolio with respect to Flight Information Management Systems for UAVs.

Partner	Exploitation plan
	The integration of Frequentis products in 5G!Drones trials will help to build a better marketing visibility and gain deeper insights by sharing experiences and valuable know-how between the Consortium members. Other objectives include generating awareness for the current Frequentis UAV product portfolio among the stakeholders, creating an efficient business model, and establishing a product roadmap based on the trials output. As innovation leader, FRQ is actively researching the potential of 5G networks to improve its portfolio. Additionally, Frequentis attempts to showcase solution integrations based on agreed standards and regulations.
HEP	Hepta Airborne will use the 5G!Drones project to help develop the necessary interfaces to its data analysing services to facilitate decreasing the time needed from the start of capturing the data till receiving the analysed results. 5G connectivity allows the drones to upload the captured data in real time via our API and analyse it while the drone is still in the air. This will enable better accuracy with more automation in the post-storm inspection domain and greatly decrease the time needed for the inspection in scheduled inspection domain. Our trial helped us understand how 5G can change power line inspection as a service and lay the foundation for more efficient solutions.
INF	INFOLYSIS is an innovative SME company, established in Athens, Greece, specialising on the design and development of chatbots, either as custom-made standalone applications or as subscribed-based services (Chatbot as a Service) via the privately owned chatbot platform, operating in also 5G and IoT enabled environments. Chatbots are applications that simulate human conversation, based primarily on conversational flows and occasionally enriched with Deep Learning (DL)/(Natural Language Processing) NLP technologies for more sophisticated automation of use-cases. INFOLYSIS, in parallel to its commercial activities, is committed to driving research results forward by experimenting with novel technologies and infrastructures, such as 5G, Software-Defined Networking (SDN)/Network Function Virtualisation (NFV) at the network edge and container-based virtualization in IoT areas (mainly of IoT interoperability) in order to advance the chatbot capabilities and expand its applicability in novel ICT use-cases such as 5G and IoT enabled environments, smart home solutions and smart cities. INFOLYSIS will further exploit 5G!Drones results by increasing INFOLYSIS's presence and penetration in the respective areas of IoT and 5G research and will facilitate the processes to make the project achieve maximum visibility and to maximise its impact within the business and scientific communities, as well as within the chatbot apps commercial market, even after the project's end, so as to guarantee a fast adoption of the project outputs and easier commercialization of its chatbot based services. INFOLYSIS participation to the 5G!Drones project, will further: • Enrich the know-how and the research expertise of the company in 5G technologies under drone environments • Foster INFOLYSIS IoT and 5G R&D activities coupled with chatbot technologies and UAVs • Create new chatbot based products and services targeting new markets and sectors (even within the UAV market/areas) • Exploit 5G!Drones results within related scientific and industry communities as well as in the evolving chatbot apps markets

Partner	Exploitation plan
	• Use expertise gained in the research activities of ongoing 5G related projects in which INFOLYSIS participates In specific, INFOLYSIS exploitation plan for 5G!Drones (especially after its end and when all trials results will be available) is focused on a comprehensive business model/market analysis with the intention of spotting the markets towards which 5G!Drones is targeted, their segmentation, existing competitor positioning, and all relevant emerging trends and key players. Parallel to this, the theoretical description and assessment of the market and financial feasibility of possible business models and alternative solutions (originating for the examined 5G!Drones use cases) that could be used to provide the project solution and services to the established stakeholders will be evaluated and potentially utilized from a business perspective. According to INFOLYSIS' marketing plan/strategy, the shipping industry is especially interested in the 5G expansion, with a focus on area surveillance by drones, IoT on vessels, and vast IoT opportunities over 5G with the help of various applications such as chatbots (which is the core commercial activity of INFOLYSIS). As a result of its involvement in 5G!Drones and the industry and market analysis conducted, INFOLYSIS will gain valuable 5G know-how and a major competitive advantage in the upcoming 5G market. The project's results will profit and grow INF products and services (such as the INFOLYSIS chatbot apps and platform), resulting in a competitive and innovative portfolio of 5G, IoT and chatbot apps.
INV	INVOLI works hard to permit unparalleled flight awareness for our clients with a never-seen-before safety regarding potential collisions in the sky. INVOLI's products or services are not closely related to single supporting data transport technology, as it's possible to use Ethernet, Wi-Fi or cellular networks as a medium for interconnection between the network of INVOLI's receivers and central server. At the end of the project, INVOLI's exploitation plan is to profit from advantages of the 5G technology in our products, under the condition that the coverage and services are widely accessible in the area where we use our products and there are suitable 5G devices at affordable cost. Our participation to the 5G!Drones project helped us to follow up closely the advancements of the 5G technology and its advantages from the vertical's perspective. We are also better informed about the role of standardization organizations like 3GPP - how they work and how to use their documentation. We will investigate the new 5G capabilities for our business model for manned and unmanned traffic tracking, allowing fusion of both traffic types together to avoid in the future the inflexible segregation of the airspace for advantage of the coexistence of both traffic types in the same airspace volume. Project's tests also allowed to understand the dependencies between INVOLI products and ICT-17 5G test networks - how the current telecom infrastructure which INVOLI uses could be extended towards 5G (many partners with whom INVOLI works in the telecom industry have already pledged to extend their network to 5G). The project outcome supports the update of our business model, with the introduction of 5G and the new technological advances offered by it. 5G will finally permit sending live streams of data to the drone regarding the whole air traffic around, thus requiring a large amount of data sent with the lowest latency possible. Project outputs also nurture INVOLI products and their credibility and viability on the long-term. Our transponder's receiver equipment tracking the aerial traffic and sending the data back to the central place for processing will be updated with 5G compatible modem when possible. We are also looking forward to updating to 5G the Remote ID

Partner	Exploitation plan
	tracker attachable to the drone. Such equipment is required by the European legislation, which was delayed due to many reasons, but entering soon into the force.
MOE	MOE will try to exploit the capabilities that will be made available after the end of this project in order to drive development of community impacting applications and services. This will be working closely with the local community and companies. MOE will further exploit the 5G!Drones project in order to develop novel services for the citizens of the city of Egaleo, mainly focusing to the social role of the municipality. In this case, drones will be used for medicine and other services delivery to socially vulnerable groups that would benefit from the seamless door-to-door delivery via a drone. This can be in the frame of municipal social services that the corresponding local authority can provide to its citizens. This service will be also extended to cover the needs of citizens belonging to vulnerable groups of people concerning COVID-19, where such groups need to be isolated from interactions with other people, in order to exchange goods and medicine. Furthermore, within the 5G!Drones project, we will explore whether the municipal drone fleet can be subcontracted to various SMEs, or companies in order to fulfil product/services delivery across the municipality. This paradigm can not only benefit the local community in a direct manner, but also create an additional incentive for business opportunities across multiple layers of the ecosystem.
NCSRD	Participation in 5G!Drones is seen by DEMOKRITOS as a direct step toward establishing a strong research and scientific position in the field of future network architectures and management systems. Based on the experience gained by 5G!Drones trials, NCSR Demokritos has gained experience and expertise in novel 5G network infrastructures and related technologies (slicing, software networks, monitoring, and orchestration) leading to the development of an automated experimentation framework for KPI assessment on top of 5G infrastructures. Such experimentation tools that developed by NCSRD within 5G!Drones are planned to be further exploited as services offered by NCSR Demokritos to external SMEs in the framework of the digital innovation hub Ahedd (**https://ahedd.demokritos.gr/**) that operates within NCSR Demokritos premises. Furthermore, DEMOKRITOS is home to the "Lefkipos" Technical Park, which houses many private companies and startups in the fields of IT and telecommunications, where the results of the Athens platform trials will be promoted, looking for possible synergies and joint ventures.
NOK	The NOK exploitation plans for 5G!Drones include: • Promote vertical business opportunities like UAV on top of 5G to public and private sector customers. For example, help communications service providers (CSP) to utilize 5G possibilities and reduce their OPEX by using UAV in 5G Base Station (BTS) radiofrequency performance planning validation or telecommunication equipment inspection. • Promotion of the project by target workshops at key conferences. • Promotion of 5G!Drones project partner's AU and UO open 5G Test Network Partner facility ecosystem for the rapid business development (**https://5gtn.fi/**). Exploitation after the project includes: • The 5G!Drones project results will actively be used for creating internal 5G features and contributing those to different standards and patents. • Further development of Nokia Drones like enabling VR usage for managing Nokia Drone.

Partner	Exploitation plan
OPL	The value of the 5G!Drones project's innovation comes from pioneering the implementation of the entire UAV vertical ecosystem's model with multilateral business and operational interactions, in which the network operator will be involved. Based on the experiences of the project, building within the Orange Polska organization the awareness of the forthcoming complex ecosystem is in progress through the sessions of internal sharing of information about the projects' outcomes. The general business ecosystem has been identified, including the needs of particular actors. Hence, the business development units in Orange Polska may start their efforts to establish business relations with the identified actors of the drone ecosystem in Poland. Also, yet during the 5G!Drones project, Orange Polska became involved as an associated partner of the Gulf Of Finland (GOF) 2.0 project consortium, implemented partly by partners participating in the 5G! Drones project. Thus, the initial involvement of Orange Polska to the business use of drone services, started within the 5G!Drones project, is further developed to build a market offer tailored precisely to the needs of this vertical sector. From the technology point of view, the involvement in the project, the own research on specific topics within the project and shared achievements of other partners, especially in the domain of UAV enablers, allowed to do the reality check, i.e. to determine the technological maturity of solutions both on the side of the drone and communication domains (e.g., readiness of comprehensive solutions for BVLoS flights, maturity of the network slicing support by the current 3GPP standardization and available solutions is much less than promised and required, unavailability of the Network Data Analytics Function (NWDAF)-like solutions to support the TS 22.125 requirements related to real-time interactions between the 5G Control Plane and the drones ecosystem, etc.). During the project, some issues were identified that go beyond the scope of the project, but are important from the point of view of the completeness of technological support for drone services by telecommunications networks, hence they yet have to be researched and trialed: validation of E2E service continuity during handovers, cross-border operations, availability of services outside the country of registration in accordance with the rules of "Single European Sky" and free movement of goods and services within the EU (including of roaming-capable inter-PLMN portability of individual communication services using specific User Plane Functions architectures and MEC), 3D network coverage prediction for pre-flight trajectory feasibility check, etc. The vision of the further trials' directions may be followed in the future to build the complete vision for the network operator. Orange Polska will carefully investigate the trial findings to build the foundation for the future conscious decisions on 5G technology development and roll-out strategy in the Orange Polska network, related to the support of services for drones. In addition, opportunities will be sought to supplement the current knowledge by exploring the "greenfields" mentioned above. Special focus will be devoted to the aspect of network capabilities exposure to the vertical ecosystem through the North-Bound Interface, as well as the integration of the 5G network framework with MEC framework.
ORA	Orange expects to extend its existing business dedicated to terrestrial UE to UAV market as soon as the European regulations rules are stabilized. Orange proactively keeps on investigating at UAV 5G connectivity as a must have requirement for vertical markets (such as smart industry, smart cities…), as well as a new vertical itself for specific UAV applications. In addition, Orange aims to contribute to define secure conditions for

Partner	Exploitation plan
	BVLoS flights and autonomous UAV in respect with regulation rules regarding the use of cellular frequencies in aerial situation. Typically, it is about to assess the quality of service in the context of long-distance missions and/or high throughput requirements. It is also about the coexistence between aerial coverage and terrestrial coverage. On one hand, Orange is eager to share results of tests about the impact of interferences, caused by cellular UAV on normal smartphones on ground located in adjacent cells in order to demonstrate that the introduction of cellular UAV won't jeopardize existing MNO traffic. On the other hand, Orange has defined an enabler to measure connectivity in aerial situation demonstrated in 5G!Drones in order to contribute to set up an aerial coverage map in collaboration with UAV operators and to leverage standardized 5G mechanisms, such as NWDAF, to take advantage of network KPIs regarding such coverage map, as the next steps. Thirdly, Orange has also special interest on Use Case 4 "Connectivity Extension during Crowded Events" as long as commercial solutions with real capacity will appear on the market. In this case, it could be extended to disaster recovery. Then, Orange is ready to discuss with partners for defining a commercial framework for using the patents on cellular-based UAV localisation in situations when Global Navigation Satellite System (GNSS) cannot apply. Finally, Orange will pursue works at standardisation, especially CEPT ECC for taking care of interferences with adjacent bands owned by other domains (e.g., weather forecast, space-based observation, military), as well as discussions with local regulator (typically, ANFR in France). Orange is also considering capitalizing on 5G!Drones outcomes within the national and local drone ecosystems, in particular through the Hub Drone Systematics in Paris.
RXB	Robots Expert exploitation plan is mainly to lead activities related Dissemination & communication as part of T5.3. This includes a series of presentations, podcasts, and other public facing events to promote the activities and results of the project trials and activities. Robots Expert will also lead the activities related to the development and demonstration of Trial Validator, and coordinate with FRQ to ensure that the development, deployment, integration and testing of the said component adheres to the proposed release plan. Furthermore, Robots Expert will also participate in a variety of standardisation activities, notably, leading the efforts towards ACJA MOPS & KPI definitions to contribute to the first release of ACJA's WT3 activities. Besides ACJA, RXB will also participate and contribute majorly towards 5G-PPP activities in terms of white paper, research articles, and standardisation activities. Also, RXB's standardisation activities extends to ASTM, Eurocae, EASA U-space expert group, and other notable international standardization bodies. (AMC activities)
THA	The initial work and results of the project made it possible to set up demonstrators showing the capacities of 5G networks in the fields of civil security, disaster assistance and, of course, the piloting and management of drone fleets. Thus, since the start of the project, we have been able to show the value of slicing for the separation of resources and to set up solutions that can be deployed at the edge of the network. The results of the project are also being studied for use in ECO, the drone fleet management solution made by Thales.
UMS	UMS' exploitation plans for 5G!Drones include:

Partner	Exploitation plan
	• Demonstrate the capability of autonomous drones' swarms controlled by the perfect synergy of our software platform in conjunction with 5G to aid first response agencies during emergency scenarios and to support telcos in providing last-mile connectivity required in specific areas. • Use trial results to validate our technology, implement any useful improvement to widen its effective application and its need to enable drone-based Smart Cities use cases. • Establish the company as a key member within the U-Space community through its active collaboration with other UAV partners within the consortium. • To utilize and further develop the UMS simulation testbed to conduct testing and integration activities which do not require physical drone flights.
UO	The UO exploitation plans for 5G!Drones include: • Showcasing 5G!Drones verticals and results at key events. As the Coordinator of the project UO gives presentations in several events promoted by the European Commission. • Promotion of the project by target workshops at key conferences. • Promotion of 5G!Drones use of ICT-17 test facilities and the UO open 5G Test Network Partner facility ecosystem and beyond, aimed at rapid business development, www.5gtn.fi. • Promotion of the project results via the Finnish 6G Flagship Programme, https://www.6gflagship.com/. • Participation as a key member in urban air mobility Oulu strategic initiative, https://uam-oulu.com/ Exploitation after the project includes: • The 5G!Drones project results will actively be shared within the industrial consortium partners beyond H2020 realm. • The UO support facility will remain available as a significant part of the 5GTN (5G Test Network) for increasing visibility and market uptake of the project outcomes. The 5GTN will also evolve towards 6th Generation facility via the National Flagship program 6Genesis related activities. • As a result of the 5G!Drones activity, UO has in its roadmap to have a transportable 5GTN system encompassing 5G core, MEC, and gNB for testing and showcasing beyond the current coverage area of the network. UO plans to introduce its assets to operational network at the university and also for educational purposes especially in ICT related but also in multi-disciplinary fashion between all faculties in UO.

5.3 IPR and patents achievements

Ten patents have been produced, in connection with 5G!Drones.

The first four patents, prepared and registered at French INPI by ORA, all contribute to addressing the general problem of allowing to determine the exact position of a drone, without GNSS support. Two patents, FR2006741 and FR2009246, allow determining the altitude of a drone. Two others, FR2004322 and FR1907193, allow determining the coordinates of a receiver, on the ground or on the sea. In brief, using patent FR2006741 (or patent FR2009246) together with patent FR2004322 (or with patent FR1907193) allows determining the location of a drone.

Those four patents can be individually summarized as follows:

1. Patent FR2006741 (INPI): “Procédé de détermination d’une altitude d’un équipement utilisateur, dispositif, station de base, système et programme d’ordinateur correspondants”. This patent describes a method for determining the height or altitude of a user equipment, in particular a drone. The method involves the powers received by the user equipment from a unique site of a terrestrial wireless network.
2. Patent FR2009246 (INPI): “Procédé de détermination d’une altitude d’un équipement utilisateur, dispositif, équipement utilisateur, station de base, système et programme d’ordinateur correspondants”. This second patent describes a method for determining the height or altitude of a user equipment, in particular a drone. The method involves the powers received by the user equipment from 2 sites of a terrestrial wireless network.
3. Patent FR2004322 (INPI): “Procédé de géolocalisation d’un équipement utilisateur, dispositif, équipement utilisateur, station de base, système et programme d’ordinateur correspondants”. This third patent describes a method for determining the location of a user equipment (or a ship) on the sea, which receives signals powers from 2 base stations of a terrestrial wireless network. Used together with patent FR2006741 or with patent FR2009246, it allows determining the location of a drone.
4. Patent FR1907193 (INPI): “Procédé et dispositif de localisation d’un terminal connecté à un réseau”. This last patent describes a method for determining the ground location of a user equipment, in particular a drone. The method involves the powers received by the user equipment from 2 base stations of a terrestrial wireless network. Used together with patent FR2006741 or with patent FR2009246, it allows determining the location of a drone.

In addition, six patent filings have been produced by NOK in connection with 5G!Drones. At the time of this report the NOK patent applications had not proceeded to the point their contents can be reported in the public domain.

Finally, note that this brief IPR and patents achievements overview is further completed in deliverable D5.6 [3] by a more in-depth analysis regarding the perspectives of commercial exploitation and subsequent commercialization plans.

6 CONCLUSION

This document materialized the final status of the 5G!Drones project regarding communication, showcasing and dissemination activities, as well as a part of the project's exploitation outcomes, mainly of non-commercial nature. Regarding these topics, D5.5 detailed the related activities compared to the initial plans made in the scope of WP5 ("Dissemination, standardisation and exploitation") and more particularly in previous deliverables D5.1 [4] and D5.2 [1], which respectively covered, for these activities, the initial roadmap and the revised plan after the project's M1-M21 reporting period.

In continuation to the ambitious approach set by D5.2, this document has methodically highlighted the various project outcomes regarding the communication, showcasing and dissemination activities, as well as all exploitation production of non-commercial nature, during the last phase of the project and until the project achievement at M42. All the results of the project serve the purpose of going beyond initial expectations and objectives set in the project previous roadmap, thereby achieving an outstanding catalogue of cutting-edge innovative systemic approach elements in the 5G-driven Vertical Take-off and Landing UAVs operations context. Moreover, despite the external constraints set by the environment of the project, including the challenging COVID-19 pandemic, the project managed to achieve its goals regarding these activities.

ANNEX 1 - 5G!DRONES Statistical Dashboards (M25-M40)

Below are provided the access links/URLs to the monthly statistical dashboards as issued at the end of each month of the period June 2021-September 2022.

Website statistical dashboards

June 2021
https://datastudio.google.com/reporting/93bb0e88-0c7b-4908-a86d-ba0a2471f1d7
July 2021
https://datastudio.google.com/reporting/bd929437-584e-415e-b641-07f4a4ac02b2/page/HfAs
August 2021
https://datastudio.google.com/reporting/1a917308-4f00-4346-b379-c03712a64282/page/HfAs
September 2021
https://datastudio.google.com/reporting/88a70b1c-4008-4c6a-a2a0-1a0eb1fc4a68/page/HfAs
October 2021
https://datastudio.google.com/reporting/0358ff0c-88c1-431d-936f-d4ba58404614/page/HfAs
November 2021
https://datastudio.google.com/reporting/36f5fa37-f55b-435d-bfc6-5b9fa8755da8/page/HfAs
December 2021
https://datastudio.google.com/reporting/8573a03e-9e55-4e7a-bd68-cf5c15225e8b/page/HfAs
January 2022
https://datastudio.google.com/reporting/98d8332b-4c5b-4dca-939d-7644473e62d9
February 2022
https://datastudio.google.com/reporting/35b13199-0019-48a8-afd0-4a281e1eefa1/page/HfAs
March 2022
https://datastudio.google.com/reporting/9cb77b98-7fd6-46f0-964b-43db538b4f2b/page/HfAs
April 2022
https://datastudio.google.com/reporting/77b47cc8-8ae5-4e98-a7c7-e1cae18a8304
May 2022
https://datastudio.google.com/reporting/651cc0da-462b-4dde-851b-8b591a8cabac/page/HfAs
June 2022
https://datastudio.google.com/reporting/d4123b70-e357-485c-a0ce-3dd89999205d/page/HfAs
July 2022
https://datastudio.google.com/reporting/7ac16a2b-39f9-4763-ab15-ee88a7d1ba54/page/HfAs
August 2022
https://datastudio.google.com/reporting/4993606a-dbef-460d-bd17-0a8b16237bfa/page/HfAs
September 2022
https://datastudio.google.com/reporting/72292d33-2043-4731-ba0d-0574e1c3dff3/page/HfAs

LinkedIn statistical dashboards

June 2021
https://datastudio.google.com/reporting/c0e27c43-b358-40b7-a1e2-5d0ece7cb1e9/page/IMxr
July 2021
https://datastudio.google.com/reporting/4e0f3a1f-8868-488b-a776-812a4530b50f/page/IMxr
August 2021
https://datastudio.google.com/reporting/40927051-d2f0-4984-a683-ff43a6144482/page/IMxr
September 2021
https://datastudio.google.com/reporting/0eeb6578-1307-4533-ae19-43ec264b88fb/page/IMxr
October 2021

https://datastudio.google.com/reporting/b44b0f13-552e-4c5b-ae8f-76cde8be2531/page/lMxr
November 2021
https://datastudio.google.com/reporting/db04162e-2491-4b8f-96ae-1414d675821b/page/lMxr
December 2021
https://datastudio.google.com/reporting/55e88b93-e4fd-4134-8665-0c567ee94eb6/page/lMxr
January 2022
https://datastudio.google.com/reporting/93609b85-22cb-4905-a8dd-4ad8ecedb957/page/lMxr
February 2022
https://datastudio.google.com/reporting/b42099da-aacc-4274-944f-2c8f75e848ef/page/lMxr
March 2022
https://datastudio.google.com/reporting/94b9b813-03d7-49c3-b26a-b6e759aca946/page/lMxr
April 2022
https://datastudio.google.com/reporting/0264d41c-2978-459f-9665-7e4d69517acf/page/lMxr
May 2022
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