

**Unmanned Aerial Vehicle Vertical Applications' Trials Leveraging Advanced 5G Facilities**

# 5G!Drones Overview

**Infocom 2019**

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

2.12.2019



# 5G!Drones general



- ✈️ 5G Unmanned aerial vehicles (UAVs) have initiated a wide range of civilian and commercial applications.
  - Traffic control, cargo delivery, precise agriculture, video streaming, rescue and search, and data collection for Internet of Things (IoT).
- ✈️ 5G Regulatory changes, technological advancements, and the reduced cost of sensory components and onboard control units have made UAVs more accessible for consumer and civilian applications.
- ✈️ 5G To enable the wide adoption of UAVs, it is vital to build on reliable wireless networks that support
  - ultra-reliable and low latency remote command and control of UAVs to guarantee their safe operations, and
  - high-capacity data transmissions for bandwidth-demanding applications.

# Unmanned aerial vehicle – 5G Integration

The logo for 5G! DRONES is located in the top right corner. It features the text "5G! DRONES" in a bold, sans-serif font. The "5G" is in red, and the "!" is a large, stylized red exclamation mark. The word "DRONES" is in black.

- ✈️ Integrating UAV in 5G is beneficial for both UAV verticals and 5G actors (mainly operators).
- ✈️ For UAV verticals, 5G will validate their use cases and demonstrate the benefit as well as huge potential of UAV for the civilian and commercial applications.
  - Avoiding the maintenance and operation cost related to the network platform management.
- ✈️ For 5G actors, enablement of UAVs will allow validation of the potential of 5G and its key performance indicators (KPIs).
  - For supporting challenging use cases, hence covering new markets.

# 5G!Drones main targets



- ✶<sup>5G</sup> The project aims to trial several UAV use cases that cover eMBB, uRLLC, and mMTC 5G services.
  - Validate 5G KPIs which apply to support such challenging use cases.
- ✶<sup>5G</sup> The project will build on top of the 5G facilities provided by the ICT-17 projects.
  - Identifying and developing the missing components to trial UAV use cases.
- ✶<sup>5G</sup> The project will feature Network Slicing (NS) as the key component to simultaneously run the three types of UAV services on the same 5G infrastructure.
  - Including the RAN, back/fronthaul, Core.
  - Demonstrating that each UAV application runs independently and does not affect the performance of other UAV applications, while covering different 5G services.



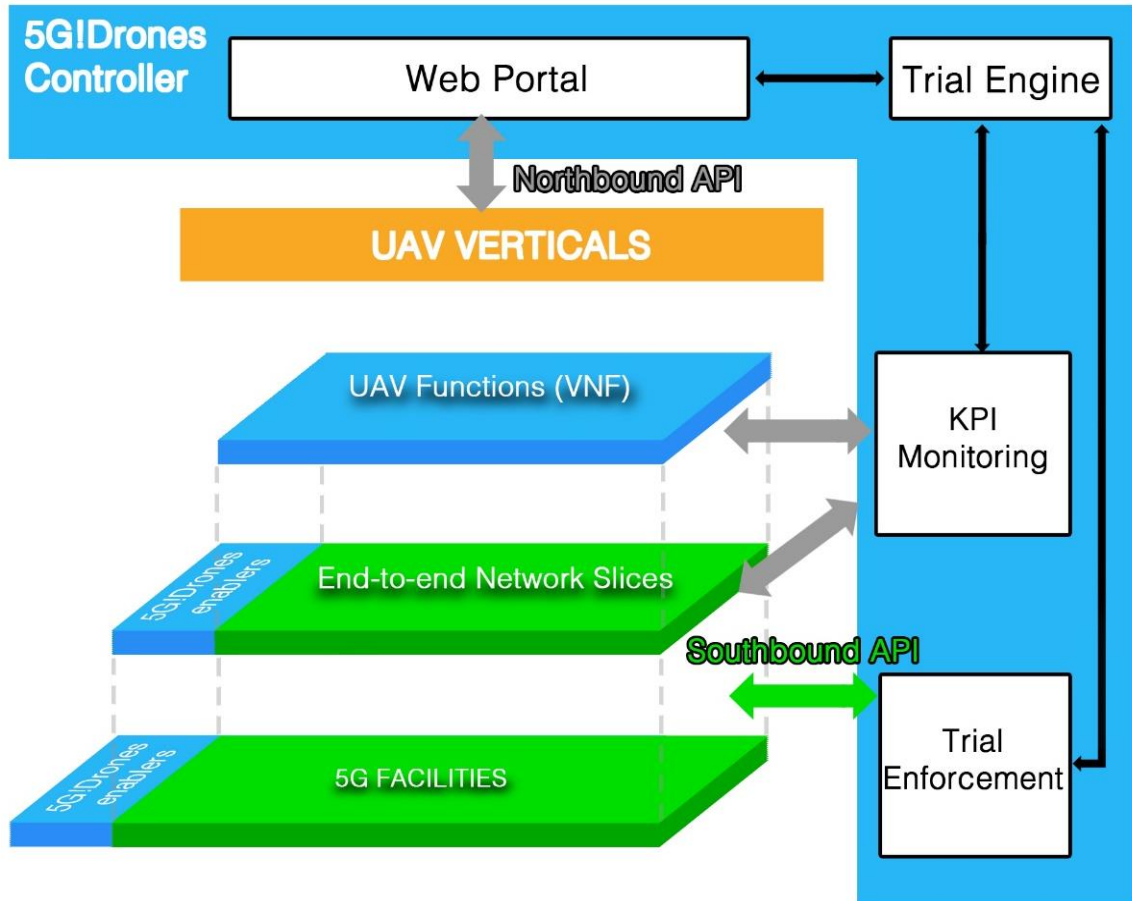
# 5G!Drones specific challenges



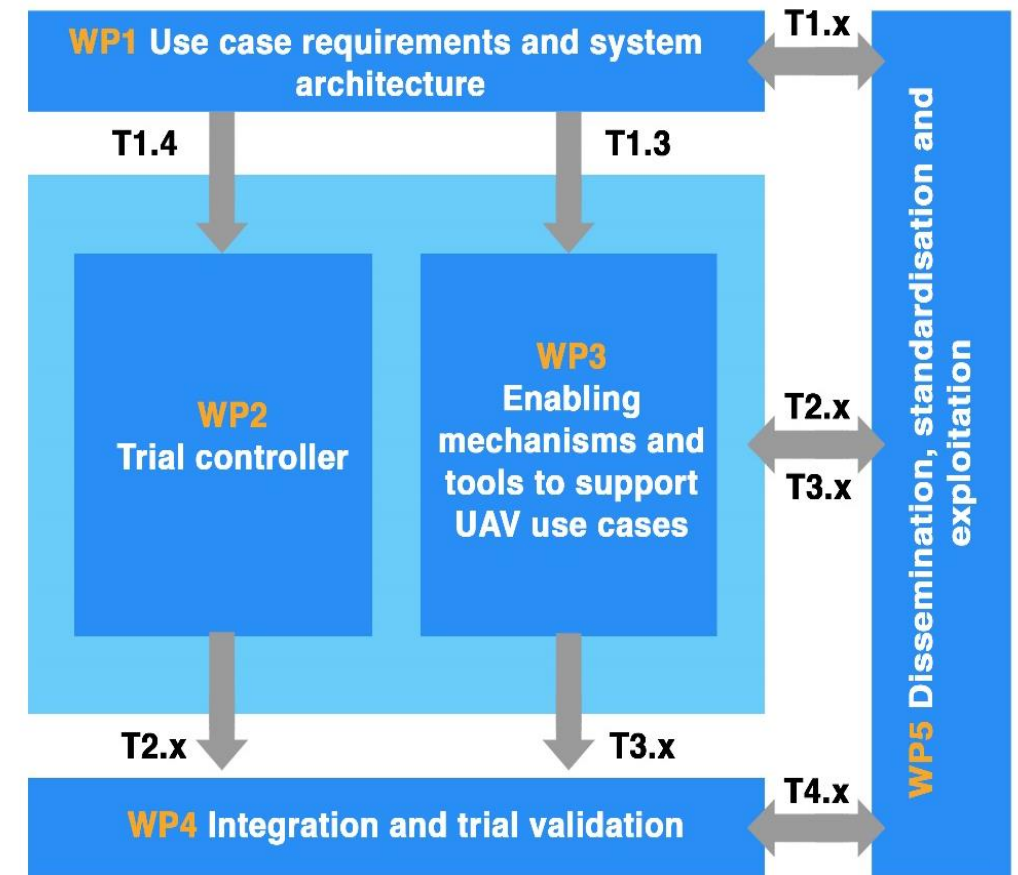
<sup>5G</sup> The project addresses the following specific challenges:

- What are the **missing components** of current ICT-17 facilities to enable the trials of UAV use cases and to validate their KPIs?
- What current 5G components **need to be improved** to support UAV use cases?
- How to allow the UAV verticals to run the tests?
- How to **abstract** the low-level ICT-17 facility-exposed **API** to run the trials?
- How to **test** UAV service **performance** using the ICT-17 facilities?
- How to **build and secure a network slice** (i.e., types of Virtual Network Functions – VNFs, amount of RAN resources, and RAN split) the way needed to run UAV trials?
- How to allow UAV verticals to monitor and manage Network Slices running UAV applications?
- What are the 5G KPIs that should be met to validate the performance of UAV applications?
- What are the 5G components that need to be improved to guarantee UAV performance?

# Division of work



**WP6 Project Management**



# 5G!Drones objectives



<b>Objective 1</b>	<b>Analysis of the performance requirements of UAV verticals' applications and business models in 5G.</b>
<b>Description</b>	A deep analysis of the UAV use case requirements in terms of the needed network functionalities and the required application performance to validate. Business models will be also derived.
<b>R&amp;D Topics</b>	<ul style="list-style-type: none"><li>• Definition of the required 5G network functionalities to run the UAV use cases.</li><li>• Definition of the KPIs of the UAV applications involved in 5G!Drones use cases.</li></ul>
<b>Verification</b>	<ul style="list-style-type: none"><li>• Report on techno-economic study.</li><li>• Report on the UAV use case requirements.</li></ul>

<b>Objective 2</b>	<b>Design and implementation of the 5G!Drones software layer (or system) to execute UAV trials</b>
<b>Description</b>	Design and implement the 5G!Drones trial system, which will be in charge of running the UAV trials using the ICT-17 facility components and 5G!Drones enablers developed during the project. The envisioned 5G!Drones system abstracts the low-level details on the usage of 5G facilities resources, by providing a high-level API to describe, run and obtain results on the specific KPIs.
<b>R&amp;D Topics</b>	Experimental validation of 5G!Drones components and integrated platform.
<b>Verification</b>	Develop and demonstrate the 5G!Drones system via trials

# 5G!Drones objectives (cont.)



<b>Objective 3</b>	<b>Design a high-level scenario descriptor language to run and analyse the results of the UAV trials</b>
<b>Description</b>	Design a high-level (or Northbound) API to allow a UAV vertical to configure a trial and run the test.
<b>R&amp;D Topics</b>	<ul style="list-style-type: none"><li>• Devise a northbound API to describe the trial and configure the UAV use case (e.g., type of 5G service it requires), using a high-level language, such as a JSON-based API.</li><li>• Devise a graphical user interface (GUI) to display results and KPIs.</li><li>• Provide data analytics tools to analyse the results.</li><li>• Devise a management interface to allow a vertical to have access to the Network Slice(s) running its services, for high-level configuration and management.</li></ul>
<b>Verification</b>	Demonstrate the Northbound API



# 5G!Drones objectives (cont.)



<b>Objective 4</b>	<b>Design and implementation of 5G!Drones enablers for UAV trials and operations.</b>
<b>Description</b>	5G!Drones will use the 5G facilities provided by i) 5G EVE, ii) 5GENESIS, in addition to iii) the 5GTN platform available at the University of Oulu, Finland and iv) the X-Network facility available at the Aalto University, Finland. Based on the analysis of the target UAV use cases, 5G features of these platforms will be used, and, when deemed appropriate, additional software will be developed by the project, and additional UAV-relevant hardware will be acquired. These new components represent the 5G!Drones enablers. Particularly, 5G!Drones will focus on improving Network Slicing functionalities, as UAVs require at least two running network slices; one for command and control (type uRLLC) and one for the data plane (type eMBB or mMTC). The security of each of these network slices will be also investigated and duly addressed.
<b>R&amp;D Topics</b>	<ul style="list-style-type: none"><li>• Improve Network Slicing to run parallel UAV applications representing the 5G services, namely eMBB, uRLLC, and mMTC, and offer appropriate level of security to generate trust and confidence.</li><li>• Investigate and cover security requirements of each of the network slices considered starting first with the two running network slices (i.e. command &amp; control and data plane).</li><li>• Optimise Network Slicing management procedures to efficiently share the resources among the slices dedicated to UAV.</li><li>• Support orchestration of end-to-end services across federated domains.</li><li>• Update UAV hardware if deemed appropriate, e.g. integrate 5G modems and other peripheral devices such as cameras.</li><li>• Update the 5G Facility and 5G!Drones platform in terms of software components and hardware.</li><li>• Definition and design of the required APIs on network and open access services side, as well as of the related GUI.</li></ul>
<b>Verification</b>	<ul style="list-style-type: none"><li>• Run several secured Network Slices in parallels to demonstrate UAV use cases (UCs) and scenarios.</li><li>• Develop and demonstrate the digital twin environment.</li></ul>

# 5G!Drones objectives (cont.)



<b>Objective 5</b>	<b>Validate 5G KPIs that demonstrate execution of UAV use cases</b>
<b>Description</b>	According to the envisioned UAV use cases and scenarios, several 5G KPIs need to be demonstrated and tested to validate UAV application requirements. As per the ambitious requirements of 5G, the most critical ones are: End-to-end latency of < 1ms, (URLLC use cases), 1000 times higher mobile data volume per geographical area, (eMBB use cases), and 10 to 100 times more connected devices (mMTC use cases).
<b>R&amp;D Topics</b>	Performance evaluation of the different 5G!Drones use cases focusing on 5G KPIs.
<b>Verification</b>	Evaluate 5G KPIs during the trials and obtain results closer to the ambitious values of 5G KPIs.
<b>Objective 6</b>	<b>Validate UAV KPIs using 5G</b>
<b>Description</b>	Many UAV applications, and particularly Unmanned Aerial Systems (UAS) traffic management (UTM), require very challenging KPIs such as low latency, security, coverage, high data rates, all of which are hard to attain in current networks. One advantage of 5G is its ability to ensure the aforementioned KPIs. Therefore, 5G!Drones will focus on validating the UAV use case application KPIs, carefully taking care of the UTM use case, as it is the main enabler of all other envisioned UAV use cases.
<b>R&amp;D Topics</b>	Advancements on challenging KPIs of concerns for UAV. Performance evaluation of the different 5G!Drones use cases focusing on the UAV KPIs, particularly the UTM KPIs.
<b>Verification</b>	Evaluate the 5G UAV KPIs during the trials.

# 5G!Drones objectives (cont.)



<b>Objective 7</b>	<b>Advanced data analytics tools to visualise and deeply analyse the trial results, and provide feedback to the 5G and UAV ecosystem</b>
<b>Description</b>	By using data analytics tools, each use case scenario will be carefully studied in terms of performance, aiming at drawing conclusions and recommendations to the 5G and UAV ecosystems. The feedback can be used as input to standardisation bodies, such as 3GPP or ETSI MEC, in order to optimise or update 5G standards for UAV.
<b>R&amp;D Topics</b>	Provide advanced data analytics tool and Machine Learning (ML) algorithms to analyse the trial results.
<b>Verification</b>	Demonstrate the tools.

# 5G!Drones objectives (cont.)



Objective 8	Dissemination, standardisation and exploitation of 5G!Drones
Description	Dissemination, standardisation and exploitation of all concepts and technologies developed in the 5G!Drones project. A special focus is given to showcasing components of the project in UAV- and 5G-related events.
R&D Topics	<ul style="list-style-type: none"><li>• Outreach communication to all stakeholders including the general public.</li><li>• Dissemination to relevant industrial and academic communities.</li><li>• Dissemination of results at 5G PPP Programme level and beyond.</li><li>• Showcasing of 5G!Drones components in events relevant to vertical industry (UAV) and 5G community.</li><li>• Contributions to standardisation bodies.</li><li>• Cross-fertilization with and contributions to relevant working groups from 5G-PPP or 5G-IA (e.g. Security WG).</li><li>• Contributions to top tier conferences and journals.</li><li>• Generation of IPR.</li></ul>
Verification	<ul style="list-style-type: none"><li>• Participation to events organised by the UAV industry as well as the 5G community.</li><li>• Level of involvement at 5G PPP Programme level (e.g. working groups joined with contributions).</li><li>• Organisation of workshop(s) dedicated to UAV.</li><li>• Patents filed.</li><li>• Scientific publications and standards contributions made.</li></ul>

# The Consortium



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



# Thank you



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