UNICO I+D Project
6G-INTEGRATION-4

# E08-6G-INTEGRATION-4

# P2 Activity plan for the project


## Abstract

This document presents the initial activity plan for the first year of the 6G-INTEGRATION-4 platform topics. It defines the main requirements that the system must meet to achieve the operating scenarios. The document identifies the work packages necessary to fulfill the scope of the project. This deliverable focuses on defining the scenarios and requirements of the 6G-INTEGRATION-4 system.



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# Disclaimer

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# List of Acronyms

AI: Artificial Intelligence

B5G: Beyond 5G

DT: Digital Twin

GHG: Green Houses Gases

HAPS: High Altitude Platform System

IoT: Internet of Things

LTA – Lighter Than Air

LSTM: Long Short Term Memory

ML: Machine Learning

# Resumen Ejecutivo

Este documento proporciona la especificación de los temas a trabajar durante el primer año del proyecto 6G-INTEGRATION-4, Caracterizado por el uso de una plataforma HAPS para demostrar el concepto de un Hybrid Autonomous Aircraft basado en el concepto de Lighter-Than-Air aircraft. Definiendo la ingeniería del sistema completo del circuito cerrado de energía para abordar la generación, elevación, almacenamiento y propulsión. Así como, la simulación de gemelos digitales del sistema y parámetros de trabajo.

El documento describe los paquetes de trabajo necesarios para abordar el proyecto, así como los análisis realizados para describirlos, y todos aquellos estudios previos realizados para su consecución.

Los principales resultados descritos en este entregable son:

- la descripción de los paquetes de trabajo para definir escenarios de operación, diseño de plataforma y estrategia de navegación;
- evaluación de riesgos;
- plan de comunicación;
- acuerdo de propiedad intelectual

En línea con los estudios realizados en el presente documento, se ha llevado a cabo investigación relacionada con la industria de los sistemas de plataformas de alta altitud. El resto del documento está redactado en inglés, de cara a maximizar el impacto del trabajo realizado en este proyecto.

# Executive Summary

This document provides the specification of the issues to be worked on during the first year of the 6G-INTEGRATION-4 project, characterized by the use of a HAPS platform to demonstrate the concept of a Hybrid Autonomous Aircraft based on the Lighter-Than- Air aircraft. Defining the engineering of the complete closed loop energy system to address generation, elevation, storage and propulsion. As well as the simulation of digital twins of the system and work parameters.

The document describes the work packages necessary to tackle the project, as well as the analysis carried out to describe them, and all those previous studies carried out to achieve them.

The main results described in this deliverable are:

- the description of the work packages to define operating scenarios, platform design and navigation strategy;
- risk assessment;
- communication plan;
- intellectual property rights (IPR) agreement

In line with the studies carried out in this document, research related to the industry of high-altitude platform systems has been carried out. The rest of the document is written in English, in order to maximize the impact of the work carried out in this project.

# 1. Introduction

The main objective of the 6G-INTEGRATION-4 (6G-INT-4) project is to demonstrate to TRL4, the technological concept of developing a hybrid autonomous aircraft based on the concept of a lighter-than-air aircraft using hydrogen as a buoyancy system and as powertrain fuel by combining instantaneous solar production with fuel cell power generation, battery and ultracapacitor support, and intelligent energy and hydrogen management.

In the context of current pressure on the transport sector, and the aeronautical sector in particular, hydrogen decarbonisation of large commercial and regional aircraft will take time to arrive. The challenges are enormous, the energy calculations lead to cryogenic liquid hydrogen and, even when this is at low pressure, the tank requires a considerable design, a considerable volume, and there is the boil-off, if the evaporation has to be managed. This opens the possibility of medium-term actions in which the intensive use of hydrogen is viable when it comes to reducing the impact of air transport on CO2 emissions and starting the hydrogen value chain with a use that is appropriate to the demands of the transportation market.

The 6G-INTEGRATION-4 project not only aims to reduce emissions from Air transport, but also to promote a new type of transport that influences the format of freight transport, monopolising the share of other means of transport in which decarbonization be slower and therefore costs apart from generating lateral market options for the use of the platform such as:

- Efficient and non-polluting point-to-point air transport systems for large-volume goods and parts.
- Efficient and non-polluting transport system for gases such as Hydrogen, Natural Gas, Biogas...
- Support system and support to areas affected by natural disasters Transportation of large volumes point to point.

Pseudo-satellite system (HAPS), which makes it possible to improve current terrestrial observation, surveillance, communications services, etc., while allowing progress towards the objectives of reducing emissions and climate neutrality. Adaptation of the project to the selected technological challenges.

Decarbonization is a major challenge for aviation. The aviation sector emits about 0.8 Giga tons per year of carbon dioxide (CO2) (2020 estimate). This represents 2.5 to 3% of the total CO2 emission generated by humans. In a context of global pressure, on the reduction of emissions, and with the continuity of the emission reduction strategy of the sector; based on technological, operational and infrastructure developments would generate a decrease in emissions by 2050, compared to the case of doing nothing, but it would not be enough to prevent the sector's contribution to 2050 from becoming, according to forecasts, a percentage of between 5 to 7% of the global generated. There is debate about whether these percentages should also be affected by a multiplying factor, for example 1.9, because this CO2 is generated at altitude, having a more adverse effect on the Stratosphere by staying longer in suspension.

Introducing the improvements, noted above, and assuming industry growth of 3 to 4 percent per year (p.a.) and improved efficiency of 2 percent per year, emissions would more than double by 2050 (0.8 to 1.6 Gt /anus). In the same time period, the Air Transport Action Group (A.T.A.G.), made up of a wide range of relevant industry representatives, committed to reducing CO2 emissions by 50% (compared to 2005) and the European Union (EU) established with the Green Pact an objective to become a neutral carbon which, taking into account the importance of the industrial sector and the use of air transport in Europe, definitively marks the future of the sector. For this reason, the objective of the sector is framed

in becoming a Zero Net Emissions sector by 2050, well understood, that is to say that: Aircraft that continue to fly and generate CO2 will be compensated by aircraft that will not generate CO2, the net balance being ZERO. This nuance is important, because the idea of the EU is carbon neutral, which implies Scopes 1 and 2 of emissions, which are more controllable. While Net Zero also involves Scope 3 emissions, much more difficult to calculate.

On the other hand, and beyond CO2, an impact of aircraft on the climate is also defined through the emissions of nitrogen oxides (NOx), soot and water vapour. The latter that create condensation trails and cirrus clouds. It is for this reason that the "total" contribution to global warming is considered greater than just CO2 emissions, although there is really little scientific certainty regarding all these last emissions.

The renewed interest in airships comes at a time when the energy footprint of all modes of transportation is being scrutinised in the knowledge that we cannot continue to exclusively use petroleum-based fuels to power our planes, ships, and land media. These concerns have prompted new research on biofuels for jets and fuel-efficient jet engines. We have also begun to understand that not all flights must be carried out at eight tenths of the speed of sound. During the COVID-19 pandemic, air transport was one of the most used means, but due to the cost per Kg and the volume of cargo transported They were not as efficient as needed, maritime transport suffered significant delays and conditions due to its times and the necessary infrastructure, evidencing in both cases that intermediate transport systems, neither as fast as the plane nor as heavy as the ships, have their space in the world of the future, evidencing that for certain tasks hybrid transport systems will obtain their space in the sector. In this sense, the 6G-INTEGRATION-4 consortium proposes to investigate and develop a series of innovations to face this situation in the future

Among the main objectives set by the EC, we can highlight the desire to improve the services demanded by future air transport concepts from a perspective that is more respectful of the environment. These objectives can be achieved by developing new forms of freight traffic flows. In this sense, the 6G-INTEGRATION-4 project represents a step forward in the development of the hybrid transport of the future.

Our objective is to develop an economically viable aircraft power system concept with a zero environmental footprint based on Hydrogen and with 6G-INTEGRATION-4 as a launch system and promoter not only of the technology but also of new business lines with the use of Hydrogen as fuel.

In a collaborative scheme with all participants, the conceptual idea is to develop a new energy system that will allow rigid aircraft of the future to use hybrid engines with partly solar and hydrogen fueled engines in case of covering the entire surface. of the Aircraft with solar panels and thus powering the engines. This project is a pioneering demonstration in which a system based on hydrogen and solar energy can be converted into an efficient transport system.

Main novelties:

- *Development of an innovative aircraft based on the concept of a hybrid aircraft with a lighter-than-air buoyancy system based on H2.*
- *Development of a navigation and control system for a hydrogen-based aircraft*
- *Development of composite materials and 3D printing of structures based on lightweight fibres capable of functioning as solar panels*
- *Control unit and power consumption.*
- *Integration of 5G&more comms systems as a payload*

- *Development of comms systems with sense and avoid, air traffic integration and satcom.*
- *Development of 5G POD to accommodate the necessary systems and antennas.*
- *Design of the control loop and control rules and algorithms to allow total autonomy*

Recent developments in lightweight materials and renewable energy technologies have sparked renewed interest in an age-old concept. Airships have been flying since 1852. Since their creation, they have been used for tourism, civil and military transportation, and more recently, advertising. However, the potential of these lighter-than-air vehicles has yet to be fully realised.

With recent advances in ultra-lightweight fabrics, composites, and thin-film solar cells, there is undoubtedly a revival of interest in this development environment, as evidenced by recent industrial developments in heavy-duty transportation projects (SkyCat, Aeroscraft), and High Altitude Long Duration Surveillance Platforms and Applications (HAA HALE-D). They are easy to operate, they can fly safely at very low altitudes (up to a few meters), and they can hover for a long time over a particular area, while they can fly at a few tens of kilometers per hour, even consuming little power. The following table displays a list of some aircraft manufacturers and products.

Most of the airships featured are non-rigid airships or airships from the Lighter Than Air family of aircraft. Airships have no structure of any kind inside the envelope, just helium and air. All but one of the airship models seen today are not rigid and use helium for lift. The helium has a lifting capacity of 1.02 kg/m3. This may seem quite small, but interesting aircraft envelopes.

Using the advanced technology available today in materials and computer-aided design, the modern aircraft looks like a distant relative to those of just 50 years ago. The shell materials, which when inflated have an aerodynamic shape and contain helium to lift them, are made of high-strength, low-weight synthetic materials that are impervious to degradation by ultraviolet light.

At 6G-INTEGRATION-4 we are taking several steps forward in the design of this type of system, initially by integrating semi-rigid structures that allow greater consistency and, above all, aerodynamic control in flight.

But this is thanks to the use of Hydrogen instead of Helium, this allows us to triple the lifting capacity. This type of Aircraft obtains its lift aerostatically, according to the ancient principle of Archimedes, a law of physics that establishes that the upward buoyant force exerted on a body submerged in a fluid is equal to the weight of the fluid that the body displaces. In other words, a submerged object is propelled by a force equal to the weight of the fluid it actually displaces. Just as ships float on water, these aircraft float in the air lifted by the lighter gas inside the vehicle compared to the heavier air outside. Unlike heavier-than-air vehicles such as airplanes and helicopters, balloons or aircraft do not burn fuel for ascent, they only need energy for propulsion.

The lift depends on the volume. 1m$^3$ of helium lifts 1 kg and 1 m$^3$ of Hydrogen lifts 3Kg. In other words: enough gas volume to lift itself and the payload. To lift one (1) ton, a system of this type needs around 1,500 m$^3$ in the case of Helium and 500 m$^3$ in the case of Hydrogen. This allows us to develop semi-rigid systems without losing load capacity and gaining aerodynamic lift and control which means greater stability at higher wind speeds.

Hydrogen is lighter, cheaper, and more readily available than helium. Hydrogen can even be produced on the platform and can also be used for propulsion as 6G-INTEGRATION-4 proposes. Modern airships are filled with helium, but modern sports balloons are filled with hydrogen, even if they are carrying passengers. Historically, hydrogen in relation to aircraft is associated with images of the burning Hindenburg. However, today it is possible to reliably handle hydrogen with a pressure of 700 bar,

something already recognized by the European Aviation and Safety Agency (EASA) in its support for other developments in hydrogen as an aviation fuel.

In this way, 6G-INTEGRATION-4 also meets the objective of developing the complete hydrogen cycle on an aerial platform.

An unmanned system does not imply direct human risk in the operation, at the working altitude due to the pressure and amount of oxygen the deflagration implies a minimum risk, so the risks derive from operations close to land or other systems and in case of In an emergency, the payload can be equipped with redundant security systems that allow its recovery.

These factors invite the use of hydrogen as an alternative to helium in this case and will reduce the cost of the energy cycle of the system's operation.

This cycle is made up of the following phases:

1. *Generation: From photovoltaic cells as part of the structural fairing of the platform. Due to its size in square meters of potential solar exposure and its position at altitude, the generation possibilities are high in quantity. The absence of spending on sustainment implies an energy remnant*
2. *Storage: Storage systems make it possible to store the remaining energy and essentially deliver it based on the needs of the platform. This system is made up of hybrid chemical storage (batteries and ultracapacitors) and gas (hydrogen fuel cells and sustaining gas).*
3. *Co-generation: Part of the gas cycle, the platform and the system, when using hydrogen as a storage cell, the remainder can be used to supplement possible sustaining gas leaks.*
4. *Energy distribution and management: Energy management and control system, control and power electronics processor that, through real-time control algorithms, establishes the management parameters of the different parts of the process, doing it in the most efficient way, controlling the generation, storage and the need for the operation at all times.*
5. *Primary use (propulsion): Management of the energy needs of the system, the main load to support is that of the propulsion based on turbines type electric PODs.*
6. *Secondary use (auxiliary systems):*
    a. *Avionics systems, communications, payload etc…*
7. *Tertiary use. gas cycle:*

Management of gas cycle loads from accumulation in cells to the collection and generation system, through the use of composition, volume, temperature and pressure measurement sensors. This system will allow the absence of gas losses and the permanence in flight looking for situations of balance between production and energy expenditure, allowing the existence of a storable remnant in chemical, cell or gas format.

It is important to understand that the pressure inside the structure can be kept very low, around 1/15 psi: equal to that of a 4-5 cm (11/2 in) high column of water depending on the altitude of flight and because of this the chances of escape are very slow in an emergency, taking hours or even days to affect the performance of the aircraft.

Apart from solutions such as interior balloons (Hydrogen balloons at higher pressure) they can increase the efficiency of the system in its scaling process to higher loads and dimensions, reducing the cost of Hydrogen if that were the objective case.

The figure to the right illustrates how the balloon system of an airship accommodates changing volume. As the aircraft rises, the hydrogen expands. It contracts when the aircraft descends.

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To maintain constant pressure within the enclosure, a balloon (or, in some aircraft, multiple balloons) is installed. They are simply bags containing air, which inflate or deflate to maintain a constant pressure inside the structure. This allows the hydrogen to expand and contract. When the balloon is completely empty, the aircraft is said to be at its "pressure height". The initial balloon size design will determine the maximum altitude change capability of an individual aircraft.

In addition to the lift provided by the hydrogen 6G-INTEGRATION-4 uses the aerodynamic shape of the envelope as it moves through the air, much like a biplane aircraft does.

Once in the air, it can function much like helicopters, remaining almost geostationary for long periods of time. Helicopters must use almost 100% of their power to fly, but 6G-INTEGRATION-4 reduces power, fuel consumption, noise and vibration. In fact, there is no more comfortable airborne platform for extended 24/7/365 missions.

6G-INTEGRATION-4 unifies the latest advances in lightweight aeronautical materials, structures and Hydrogen management systems, control and power electronics, new satellite navigation systems and state-of-the-art photovoltaic panels to create a new concept of rigid hybrid aircraft. hybrid electric propulsion for the transport of goods, surveillance, disaster support... and a long list of pioneering and completely neutral uses and applications.

High energy efficiency systems for aircraft propulsion management will prevail in the future due to the need to reduce the carbon footprint of air transport and 6G-INTEGRATION-4 seeks to develop a maximum efficiency system based on the use of hydrogen.

These systems seek in hybrid propulsion a medium-term solution that allows the reduction of said footprint and in hydrogen systems the long-term solution.

In fixed or rotary wing aircraft, the need for a large amount of thrust power for lift makes it difficult to integrate these technologies in a short period of time.

6G-INTEGRATION-4 presents an opportunity for the short-term integration of the technologies that facilitate the development of sustainable propulsion systems capable of eliminating the carbon footprint in air transport, since it is the case of a type of aircraft that allows the complete development of the hydrogen cycle within a system of generation, storage and use of energy, as well as the use of gas in the support phase. However, this type of aircraft is very sensitive to air currents. In fixed-wing aircraft, the power generation system will be based on fabrics that, having solar energy capture properties, will give the aerodynamic shape and contribute to reducing the weight of the aircraft. In rotary-wing aircraft, the need for a large amount of thrust power for lift makes it difficult to integrate these technologies in a short time. The solution, therefore, will involve an aerodynamic structure that allows it to be controlled in a greater number of flight conditions and makes use of technologies that minimize weight and integrate in-flight power generation.

Since 6G-INTEGRATION-4 does not use energy for support, it avoids these problems when developing solutions that can be transferred to other aircraft in the future, also serving as a platform for testing and verifying new technologies in a simple way and with controlled risks.

It should be noted that the approach of the 6G-INTEGRATION-4 project, and its consortium, is very interesting, because a "Spanish Supplier of Original Hydrogen-based Flight Equipment" would naturally be generated, based on inventive and protected technologies. This is probably one of the great advantages of the new hydrogen economy, the opportunity it will give consortia of SMEs, such as 6G-INTEGRATION-4, to enter sectors that until now have been highly protected, such as aircraft. It is already seen how, in other European countries and the US, Start-ups, such as Hybrid Air Vehicles, have ambitious roadmaps and even threaten to compete or at least be one more player in the aircraft sector.

6G-INTEGRATION-4 is a platform that will apply modern technology advances to an unmanned solar hydrogen hybrid system. Although the concept of hybrid systems is not new and we can consider that as a type of aircraft it is a proven system, the completely new design adapting the latest computer analysis technologies, the use of solar energy combined with hydrogen and accumulation, the safe use of hydrogen as a fuel as well as an energy reservoir and the autonomous predictive navigation system are concepts of new development that move the project to a level of concept development that requires a process of technological demonstration and validation that allows the scalable development of both the product and the technologies it implements.

This TRL2 starting level of the 6G-INTEGRATION-4 concept is due to the fact that, although the viability of the concept is known, both the new designs and the technologies to be implemented in some cases do not exceed this level of development. It is true that, unlike other actions, its risk is considerably reduced due to the already mentioned robustness of the concept itself. In this way, the consortium aims to develop the project up to a TRL4-5 level that allows demonstrating both the different technologies that are developed within it and the final product that is obtained by integrating all of them.

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# 2. Description of activities

## 2.1. Workplan

The work plan is developed in 3 work packages, each one with objectives and tasks whose explanation we develop in this section.

**Work Packages:**

| WP# | Work Packages |
|---|---|
| A5 | Energy management system |
| A6 | Comms integration |
| A7 | 5G pod 3D design |
| A8 | Autopilot and control |
| A9 | 5G POD material selection study for airborne operations |

TABLE 2-1 WORK PACKAGES

The project is divided into 5 main work packages that define the development phases of the project from concept to the development of the final demonstrator.

The firsts two work packages tries to define, starting from the initial concept, the key design parameters of the final product and of each of its systems, using advanced design and calculation tools to be able to predefine its scope in its scaling, precisely defining a final parameterizable and scalable concept that allows reliable data to be obtained from a demonstrator for subsequent scaling once this package is advanced, this package allows us to start the numerical iterations in the next phase of structure and systems design, from the analysis of operation to the numerical simulation of the structure and systems sizing, which will allow us to specify in the next phase the design detail as well as the manufacturing and assembly processes applicable to the development.

| A5 | Energy management system |
|---|---|
| Obj | Integration of 5G&more comms systems as a payload to the energy loop generating the energy need typology of the payload including ECS and control systems |
| | **Tasks Descriptions** |
| | 5G Tx/RX simulated integration as an energy payload request to the main energy system,I/O needs and CONOPS of the payload energy requirements. integration of the environmental conditions to sustain the 5G system payload on board of the HAPS |

TABLE 2-2 A5 ENERGY MANAGEMENT SYSTEM

| A6 | Comms integration |
|---|---|
| Obj | HAPS (high Altitude pseudo satellite) comms system. Sense and avoid, air traffic integration and satcom.AIr traffic integration and satcom redundancy communication system to allow swarm autonomous working. This development will also study the integration of other tasks performed by the consortium to create comms redundancy and use the 5G/6G network as an active comms path |
| | **Tasks Descriptions** |
| | definition of required systems for HAPS air traffic integration. Basic systems to allow unmanned operations of a LAT (lighter than air) unmanned system into the non segregated air space. Study of how to integrate the 5G into the navigation system to operate among different systems as a swarm of vehicles using the 5G&6G connectivity |

TABLE 2-3 A6 COMMS INTEGRATION

| A7 | 5G pod 3D design |
|---|---|
| Obj | HAPS (high Altittude pseudo satellite) 5G POD POD to accomodate the necessary systems and antennas to create a 5G network from high alttitude (60.000ft). this POD will allocate the developments of the antennas and terminals from other tasks adapted to unmanned air vehicles condition. |
| | **Tasks Descriptions** |
| | POD 3D models with integrated life support systems for 5G&6G equipment. ECS simulation and integration of major components. POD final design to integrate the Tx/Rx equipment to be integrated in a unmanned HAPS |

TABLE 2-4 A7 5G POD 3D DESIGN

| A8 | Autopilot and control |
|---|---|
| Obj | design of the control loop and control rules and algorithms to allow total autonomy of the system taking in account flight control and air traffic integration |
| | **Tasks Descriptions** |

| | |
|---|---|
| | first level of control equations to be integrated on simulated autopilot to control HAPS flight performances. first level of control equations to be integrated on simulated autopilot to control HAPS flight performances |

TABLE 2-5 A8 AUTOPILOT AND CONTROL

| | |
|---|---|
| **A9** | **5G POD material selection study for airborne operations** |
| **Obj** | 5G POD material selection study for airborne operations |
| | **Tasks Descriptions** |
| | Analysis of selected materials for POD dome manufacturing based on 5G&6G material permeability data gathering |

TABLE 2-6 A9 5G POD MATERIAL SELECTION STUDY FOR AIRBORNE OPERATIONS

## 2.2. Schedule / Planning

The schedule is developed for years 2023 and 2024. The following chart describes task description with start and finish months (duration is expressed in months). Main milestones are also declared in the chart.

| | | 2023 | | | | | | | | | | 2024 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **6G INTEGRATION-4** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| **P2** | **WP2 - Energy Efficent HAP design for B5G integration** | | | | E8 | | | | | | | | | | | | | | | | | | |
| **A5** | Energy management system | | | | E9 | | | E11 | | | | | | | | | | | | | | | |
| **A6** | Comms integration | | | | | | | | | | E12 | | | | | | | | | | | | E13 |
| **A7** | 5G pod 3D design | | | | | | | E10 | | | E14 | | | | | | | | | | | | E15 |
| **A8** | Autopilot and control | | | | E16 | | | | | | | | | | | | | | | | | | E17 |
| **A9** | HAPS (high Altittude pseudo satellite) 5G POD material selection study for airborne operations | | | | | | | | | | | | | | | | | | | | | | E18 |

TABLE 2-7 WORK PACKAGE SCHEDULE

# 3. Deliverables

The following table describes deliverables in the project, work package frame and dates.

| Del Num | Title | Description | Type | Contents | WP | Date |
|---|---|---|---|---|---|---|
| E8 | P2 Activity plan for the project | Specification of the topics to work on during the first year | Doc | Consortium agreement signed, plan for research during the first year | P2 | 30/6/2023 |
| E9 | 5G energy feed design to support 25/7 operational system. Requirements and I/O | 5G Tx/RX simulated integration as energy payload request to the main energy system,I/O needs and CONOPS of the payload energy requirements | Doc | 5G Tx/RX simulated integration as energy payload request to the main energy system,I/O needs and CONOPS of the payload energy requirements | P2 | 30/6/2023 |

| | | | | | | |
|---|---|---|---|---|---|---|
| E10 | Environmental control system energy load definition to 5g payload | integration of the environmental conditions to substain the 5G system payload on boardof the HAPS | Doc | integration of the environmental conditions to substain the 5G system payload on boardof the HAPS | P2 | 30/9/2023 |
| E11 | Simulation of 5G system energy loads as part of energy system | simulation validation of 5G energy load into the system | Design | simulation validation of 5G energy load into the system | P2 | 30/9/2023 |
| E12 | Definition of basic navigation and comms systems for HAPS operation | definition of required systems for HAPS air traffic integration. Basic systems to allow unmanned operations of a LAT (lighter than air) unmanned system into the non segregated air space | Doct | definition of required systems for HAPS air traffic integration. Basic systems to allow unmanned operations of a LAT (lighter than air) unmanned system into the non segregated air space | P2 | 31/12/2023 |
| E13 | Integration of 5G&6G comms into the navigation comms | Study of how to integrate the 5G into the navigation system to operate among different systems as a swarm of vehicles using the 5G&6G connectivity | Doc | Study of how to integrate the 5G into the navigation system to operate among different systems as a swarm of vehicles using the 5G&6G connectivity | P2 | 31/12/2024 |
| E14 | Preliminary 5G comms POD design | POD 3D models with integrated life support systems for 5G&6G equipment. ECS simulation and integration of major components | Design | POD 3D models with integrated life support systems for 5G&6G equipment. ECS simulation and integration of major components | P2 | 31/12/2023 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| E15 | Critical 5G comms POD design | POD final design to integrate the Tx/Rx equipment to be integrated in a unmanned HAPS | Design | POD final design to integrate the Tx/Rx equipment to be integrated in a unmanned HAPS | P2 | 31/12/2024 |
| E16 | Main flight control equations | first level of control equations to be integrated on simulated autopilot to control HAPS flight performances | SW | first level of control equations to be integrated on simulated autopilot to control HAPS flight performances | P2 | 30/6/2023 |
| E17 | Control algorithms software model | control algorithms to be validated by simulation on the final HAPS design | SW | control algorithms to be validated by simulation on the final HAPS design | P2 | 31/12/2024 |
| E18 | 5G POD material selection study for airborne operations | Analysis of selected materials for POD dome manufacturing based on 5G&6G material permeability data gathering | Report | Analysis of selected materials for POD dome manufacturing based on 5G&6G material permeability data gathering | P2 | 31/12/2024 |

TABLE 2-8 WORK PACKAGES DELIVERABLES

## 3.1. Risk assessment

The following table describes main risks identified, with evaluation in this stage and mitigation action declared.

| Identified risk | Type of risk (technical, legal or economic) | Risk impact | probability of occurrence | Mitigation actions |
|---|---|---|---|---|
| Weight balance of the system suitable for the prototype | Technical | High | Medium | Study of different UAV architecture scenarios, analyzing their risks and opportunities for the positioning of the different equipment in different maneuvering scenarios. |
| Management and safety of H2 for the aircraft | Technical | High | Medium | Evaluation of risks derived from the storage and handling of H2, definition of mitigating actions and their implementation in the design of the aircraft. Risks derived from handling on the ground as well as from its use in flight are taken into account. |
| The payload capacity depends to a large extent on achieving an ultra-efficient structure | Technical | Medium | Medium | Optimization of all structural elements<br>Use of additive manufacturing to optimize weight and lightweight materials: polyurethanes, carbon fiber,... |
| The aeronautical regulations for embarking hydrogen propulsion solutions are not fully developed | Legal | Medium | High | The participation of CTA (EUROCAE WG-80 /SAE AE-7A), which are the international groups that are working on the development of the regulations, will help to specify requirements, based on the current status of these definitions, and their future forecast. |
| Lack of sufficient data to train the supervised machine learning predictive model supervised machine learning | Technical | Low | Low | The strategy is to work with 4 control techniques, one of them a classic PI that also already provides proper functioning of the system. The use of AI is disruptive, but its results may vary, since there are other alternative control techniques |

TABLE 2-9 RISK ASSESTMENT

## 3.2. Communication Plan

The application was born in 2023 with a low TRL of 2, with a consortium that has all the main capabilities. It was born in the aeronautical sector, therefore, it is not credible to think of immediate commercialization. In the 6G-INTEGRATION-4, it develops up to a TRL4 level and through a campaign of Diffusion and involvement of the partners it finds a target client, let's take for example the case of the state for a first development of surveillance, previously analyzed. Obtaining a target customer accelerates development, probably already with that target customer for the flight tests that will have to be done.

Given that this is an Exploitation Plan for an idea to TRL2, the confirmation of concepts and technology maturation, during the project, will make it possible to provide cost figures and market potential, as well as the organizational structure of the consortium that would be formed for the commercialization of solutions in various sectors.

The Exploitation Plan concept exposed here has a fundamental component, which is finding the target client/application, for which an adequate dissemination plan will be necessary. This Dissemination plan has been drawn up by the consortium in a preliminary way and is presented here. The details of it will be worked on during the first activity, to have it fully diagrammed at the end of it, however, and given the nature of the exploitation plan viewed, the main objective from the first tasks, as already indicated

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in Activity 1 will be government and private entities of the logistics sector, these are defined as Tier 1 stakeholders, the most important from the point of view of exploitation.

Additionally, the consortium has defined other sectors in which 6G-INTEGRATION-4 can be a viable solution as LEVEL 1. All of them will be listed and a specific action plan will be defined, as indicated in lists 1 to 26 of potential actions, depending on the progress of the project.

ALL LEVEL 1 => They are potential clients, or with a high direct influence in the financing of 6G-INTEGRATION-4 and therefore are a focus of special interest.

Depending on the influence on potential exploitation, 3 additional levels are defined. LEVEL 2 with the scientific and technical community for the influence on a wide range of technological audience such as future professionals. The next one is LEVEL 3, where those in charge of carrying out environmental policy are, whether in partner countries of the EU, or main ones such as the US, Canada. All of these countries already have hydrogen organizations and they generally help determine policies related to the technology. Finally, at LEVEL 4 the general public will receive special attention through measures 1 to 26 that are listed, and will be defined in detail, in this preliminary dissemination plan.

## 3.3. Intellectual Property Rights

The intellectual property rights over the results of this project will be managed in accordance with the collaboration agreement signed by EDAIR for the collaboration in 5TONIC with the contracting entity UC3M, as well as the other collaborating entities participating in 6G-INTEGRATION-4, which have also signed said agreement. Seen *Annex - Declaration of accession for collaborators in 5TONIC.*

# 4. Summary and Conclusions

This deliverable describes the activity plan for the first year. The specifications of the topics to work in the 6G-INTEGRATION-4 project, declare the work packages necessary to address the project, as well as the initial schedule. A risk assessment, and a communication plan, as well as the intellectual property agreement with 5TONIC have also been included.

# 5. References

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# 6. Annex - Declaration of accession for collaborators in 5TONIC

# DECLARATION OF ACCESSION FOR COLLABORATORS IN 5TONIC

**Edair Technologies** (hereinafter EDT) an entity organized and existing under the laws of Spain, represented for this purpose by Eduardo Cano, with legal registration number B-90364068 and with its principal place of business at Sevilla (Spain).

**5TONIC LAB** (hereinafter 5TONIC) represented for this purpose by Mr. Carlos Jesús Bernardos, Professor of University Carlos III Madrid and Vicechairman of 5TONIC, with its principal place of business at Leganes Madrid (Spain).

All parties mutually recognize the legal and functional capacities necessary to sign this document, and declare that,

**I.-** The founding charter of 5TONIC, carried out in the Agreement signed on October 6th, 2015, in its clause 6, "Organization and structure", defines the figure of Collaborator.

**II.**- EDT hereby declares its interest in becoming a Collaborator of 5TONIC (hereinafter called "Collaborator").

**III.-** The 5TONIC Steering Board is in charge of deciding the conditions for each type of collaborator and whether the involved collaboration fees will be paid in cash, in kind or a combination.

**IV.-** The 5TONIC Steering Board approved this specific collaboration,

The conditions of the collaboration will be as follows:

## 1.- DESCRIPTION OF THE COLLABORATION

The collaboration is related to the participation of EDT in different projects that also involve several 5TONIC members and collaborators.

- Proyecto UNICO-6G 6G-INTEGRATION-3

**T**he activities to be covered are those specified in the projects' descriptions.

The collaboration agreement also contemplates the realization of other activities related to other projects that 5TONIC may support.

## 2.- COLLABORATION DURATION

This collaboration has a planned duration from *1st January 2023* to *31st December 2024*, coming into force once the document has been signed.

At the end of this period, the Collaborator will no longer be a collaborator of 5TONIC, unless the period is extended or a new declaration of accession including other activities is signed.

## 3.- CHARGES (IF APPLICABLE)

The Collaborator will participate to 5TONIC activities with in-kind contributions to 5TONIC activities.

## 4.- PARTIES INVOLVED IN THIS COLLABORATION

The specific members of 5TONIC (and other parties if applicable), involved in this collaboration are the following ones:

- EDT
- Telefonica I+D
- Capgemini Engineering
- ATOS
- Universidad Carlos III de Madrid

If it is necessary for the parties involved in this collaboration, they could sign a private agreement and/or agreements or private documents to lay out the specific conditions to carry out this collaboration. The private agreement may not oppose or contradict the provisions of this declaration, nor the Charter of 5TONIC.

## 5.- OWNERSHIP OF THE RESULTS

Each party retains exclusively all intellectual property rights, whether owned or licensed, in any pre-existing software, patents, ideas, methods documents, copy, data, text, trademarks, brands, logos, information, specifications, drawings, or any other IPR material, held by them prior to the signature of this document (hereinafter called “Pre-existing Material”).

The parties agree that when any Pre-existing Material is provided by a party, as part of the activities of this collaboration any adaptation, improvement, enhancement, modification or derivative work affecting this Pre-existing material that may be eventually developed by the parties (jointly or solely) under this Agreement, shall exclusively belong to the owner of such Pre-existing material.

The parties may establish system for the ownership of the intellectual property rights resulting from the collaboration, when considered necessary, in a private agreement signed among them.

The management of the protection and exploitation of the research results will be performed by each party, or involved parties, which must inform all other parties of its actions. The costs and profits will be distributed in proportion to the contributions of the parties or the agreement reached.

## 6- GENERAL TERMS AND CONDITIONS

The Collaborator does not have the right to appoint a representative on the Steering Board of 5TONIC.

The terms and conditions incorporated in the founding charter of 5TONIC (Agreement dated October 6th, 2015) will be applicable to this Collaboration, a copy of which is attached hereto as exhibit A.

In the event of a conflict between the provisions of this Declaration and the Agreement dated October 6th, 2015, mentioned above, the provisions of this Declaration will take precedence.

This Declaration shall not be deemed to create any rights in Collaborators, or to create any obligations, except as expressly set out therein.

Two original of this Accession Document has been signed by the authorized representatives on November 28th, 2022.

| COLLABORATOR | 5TONIC LAB |
| --- | --- |
| Authorized signature:<br>Eduardo Cano<br>CEO Edairtec | Authorized signature:<br>Mr. Carlos Jesús Bernardos Cano<br><br>Vicechairman 5TONIC |