WHITE PAPER R&D

FOR UNMANNED AVIATION IN SPAIN

AESA AGENCIA ESTATAL DE SEGURIDAD AÉREA

Center of Excellence for UAS
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The Agency's objective is to promote the robust and safe growth of unmanned aviation in Spain, and for this it is key to identify the critical pillars of research, development, and innovation that allow Spain to be a leading country in this field.

The collaboration between the Universities, companies, and other organizations, allows us to have a privileged vision of the situation and of the way that opens towards the future

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ÍNDEX

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INTRODUCTION

Predicting the future has always been a utopian aspiration of humanity, and although at the dawn of the 1980s the possibility of developing unmanned aircraft systems for civil and military use began to be considered, no one could foresee in those years the exponential growth experienced by the applications of "UAS".

Today, joining the efforts of the aviation sector and the new technology sector, both characterized by their ability to undertake disruptive projects, we may be on the verge of a new revolution that will significantly change the transport of people and goods and possibly our style of life.

For years the subways in many cities around the world have been fully autonomous, the automobile industry is betting on the autonomous car, and the UAS industry is following the same trend, taking advantage of and sharing technologies with the rest of the economic sectors.

The Spanish Aviation Safety and Security Agency is responsible for ensuring air transport safety and, in the field of UAS, guaranteeing that the development and implementation of UAS is carried out in a totally safe framework.

The drone/UAS sector shows a potential for growth and development that can be an important economic driver for the Spanish economy and industry.

The Administration is focusing on this sector and associated technologies due to its potential development and integration with other means of transport. Proof of this is the proposed investment in grants for R&D initiatives reflected, for example, in the Strategic Project for Aerospace Recovery and Transformation (PERTE by its acronym in Spanish) or also in the Aeronautical Technology Program (PTA by its acronym in Spanish), some of which are described in this document.

The White Paper prepared in September 2020 aimed to foresee what the research, development, and innovation challenges should be, identifying the critical programs or projects that must be supported for the development of the UAS sector in order to facilitate Spain's transit towards the leadership of one of the sectors with the most future. R+D is vital for the growth of unmanned aviation in Spain and the robust and safe development of UAS applications in Spain.

In the review we are now presenting, the R&D priorities have been updated in the nine identified areas, and a new one has been added. The last one is related to sustainability. The challenges that air transport has in its objective of being a "less polluting" means are partly supported by the use of UAS in many activities as an alternative. However, the potential of UAS as a new environmental management tool is analyzed in this White Paper.

The Spanish Aviation Safety and Security Agency will continue working on analyzing R&D in Spain, and the Center of Excellence will carry out new reviews to identify progress in this field, including new programs and projects to support.

EXECUTIVE SUMMARY

Unmanned aviation, commonly known as drones and technically by its acronym in English UAS (Unmanned Aircraft System), is a sector in continuous development and with new impacts. In this new edition, the field of sustainability has been included due to its great interaction with the world of drones. In total, ten topics are analyzed, in which the objectives for the 2022-2026 period are established. Furthermore, the research needs, development, and innovation (R&D) related to unmanned aviation in Spain are identified.

The objective of the White Paper is to establish the key priorities regarding R&D that should be considered as a guideline for the sector and the Administration to achieve Spain's leadership in the field of unmanned aviation, one of the sectors with the most future in the current technological landscape and with the greatest challenges.

SCOPE 1: Socioeconomic, Strategy, and National Interests

The special socioeconomic, educational, geographic, and climatic conditions of our country place us in a privileged position to promote research and the industry of technologies associated with drone/UAS operations and obtain leadership in certain strategic areas of the sector, such as training in long-distance operations, drone/UAS applications in maritime and natural environments, certification of new traffic management systems, highly autonomous systems, etc.

The priorities related to R&D identified for this area are:

- Availability and effective and efficient management to allow the use of airspaces that enable the testing of technologies related to drone/UAS operations and their traffic management. Some of these spaces must facilitate the transition from terrestrial to maritime environments.

- Defend and consolidate the technological heritage generated in Spain by facilitating and helping to obtain and maintain patents.

- Development of new traffic management technologies that allow long-distance operations and help us become one of the first countries to authorize this type of operations on a recurring basis

SCOPE 2: Value Chain and Business Development

Spain is currently the fourth country in Europe in the number of UAS manufacturers, but despite this, they have difficulties competing with the large world manufacturers. The new European regulation, based on risk management, allows the operation of UAS safely. This new scenario and the advantages presented using UAS in terms of effectiveness, efficiency, and sustainability, favors the application of this technology to more and more processes and in different types of users. This growing interest and technological advances will contribute to creating new services that we are convinced will attract new users.

The priorities related to R&D identified for this area are:

- Support from public administrations (local, regional, and state) in developing new applications with high added value through instruments such as Innovative Public Procurement and the Association for Innovation.

- Encourage and promote the development of applications in the field of intelligent infrastructure inspection and monitoring, emergency management, observation and surveillance, traffic management, advanced mapping, or smart tourism.

- Promote the transfer of knowledge among all agents in the value chain.

SCOPE 3: Human Factors and Social Acceptance

The rapid development of drones/UAS has to be accompanied by continuous analysis of the effect on the operating environment and their acceptance by society, as reported by Europe, which carried out a macro-survey on how society would accept drones in different fields.

The priorities related to R&D identified for this area are:

- Research lines that improve the interaction of drones/UAS with the human being, human factors, and that increase the acceptance of these systems in society by analyzing factors such as privacy, noise, inconvenience, etc

SCOPE 4: Regulation and Certification

The challenge is to implement adequate regulation that meets the expectations of the unmanned aircraft sector through the areas that the future European regulation leaves in the hands of the Member States and to promote lines of action that favor the development of a certified category. Finding a balance between security and the promotion of innovation is the challenge that lies ahead, and in this sense, the "sandbox" environment facilitates that balance.

The priorities related to R&D identified for this area are:

- Development of digital systems with simple interfaces for implementing the UTM/U-Space system in all its phases.
- Identify the adoption of ETSOs for the certification of critical equipment: autopilot, detect and avoid, motor controllers, etc.
- Allocation of own frequencies in the field of drones/UAS.
- Creation of interoperable database systems.
- Development of applications for smartphones and other official devices that allow greater agility and simplicity of procedures.
- Development of specific protocols for emergency operations.
- Study systems that allow physical inspections to be carried out remotely by the authority.
- Promote and propose specific category requirements for a high-risk level, especially those related to technical aspects.
- Development of certification bases and standards for terrestrial and satellite systems, as well as certification bases for aerial platforms.

SCOPE 5: Safety

The objective is to ensure that Safety in the field of activities carried out with drones/UAS reaches a level comparable to that of manned aviation.

The priorities related to R&D identified for this area are:

- Definition of technical and operational requirements in U-Space volumes through collision risk simulations in accordance with the provisions of the State Operational Safety Program.
- Development of use cases for integration in Safety Management Systems (SMS) in those types of operation that require them.

SCOPE 6: Security and Cybersecurity

The objective should be to promote the development of an integrated concept of security in drone/UAS operations that mitigates the risks in the face of possible threats.

The priorities related to R&D identified for this area are:

- Detection, monitoring, and mitigation of threats related to drones/UAS.
- Support the research and deployment of drone/UAS detection systems as protection in critical infrastructures.
- Promote the inclusion of safety measures throughout the life cycle that cover not only the period of operation but also manufacturing (systems and components), maintenance, supply, storage, and transportation of spare parts and the end of the product's life.

SCOPE 7: Traffic Management

Facilitate the management of unmanned operations in all types of airspace. Automation of the provision of traffic management services: UTM and U-Space

The priorities related to R&D identified for this area are:

- Definition, development (technical and regulatory), and implementation of the Spanish system for unmanned aircraft electronic remote identification and tracking.
- Introduction of electronic remote identification technologies and tracking of UAS to other traditional users of the airspace, in particular at low altitudes (ultralight aircraft, general aviation, aerostats, parachutists, ...).
- Integration of non-aeronautical data sources in the current geo-awareness systems in the common digital map (ENAIRE/Drones).
- Development and operational implementation of U-Space in accordance with its European regulations.

SCOPE 8: Technology and Technological Change

Development of new disruptive technologies that place the Spanish drone/UAS sector at the international forefront and allow the creation of an ecosystem that favors technology transfer.

The priorities related to R&D identified for this area are:

- Navigation systems with high accuracy in urban environments and operation in infrastructures or strategic areas and generation of technologies to increase operational Safety ("Detect & Avoid", impact absorption capacity, etc.).
- Development of technologies to increase operational safety (collision detection and avoidance, impact absorption capacity, etc.).
- Aerial robotics and an increased capacity for aircraft autonomy decision-making, with the ability to react to the environment and land safely in different conditions, including automatic battery recharging or replacement.
- Technologies that allow robust and safe flying in confined spaces.
- Systems that facilitate the homologation of hardware and software systems (HW and SW) for medium and high-risk operations (levels M and H of the SORA).
- Robust communications for Beyond Visual Line of Sight (BVLOS) operations.
- Advanced ground interfaces and satellite and communications support for low latency and high bandwidth.

SCOPE 9: Mobility, Transport, and Integration with Infrastructures, "Smart-Cities"

We are at the dawn of a completely new industry: Urban Air Mobility (UAM), including new technologies (propulsion, structures, avionics / autonomous systems) and infrastructures, and involving business models that will radically rethink urban and aerospace space.

Safely and environmentally friendly, vertiports will be all around us in our homes and workplaces, on the rooftops of buildings, and on the roofs of delivery vans and fire trucks. The UAM will change not only the way we travel but also the way we live.

The priorities related to R&D identified for this area are:

- Define, together with the European institutions, what regulation would be necessary based on the risk, focused on Safety, training, certifications, and standards.
- ATM + UTM integrated, as digitized and automated services, within an ecosystem to maximize flexibility and efficiency in an environment driven by satellite CNS, performance-based operations, and personalized services.
- Modelling and simulation, using urban flow data, to understand how to add mobility solutions to existing and future city networks.
- Establish and validate digital protocols for exchanging information that allows communication and coordination among all the agents involved (land and air segment).

SCOPE 10: Sustainability

Drones/UAS are currently an alternative to less sustainable procedures and have great potential as new environmental management tools. Drones can decisively contribute to improving the global sustainability of the planet.

The priorities related to R&D identified for this area are:

- Study the acoustics of drones/UAS and promote technologies aimed at reducing the acoustic footprint of drones/UAS intended for inhabited environments.
- Analyze the sustainability chain in all areas related to drones/UAS, including the complete life cycle of drones/UAS under circular economy criteria and environmental needs in the management of U-Space.
- Promote electrification, miniaturization, and automation in drone/UAS platforms dedicated to working in the natural environment, including autonomous systems, and with multiple swarm UAS.
- Develop drone/UAS platforms and transversal technologies useful as advanced environmental management tools that improve efficiency or are applied to new areas of specialization.

SCOPE 1: Socioeconomic, Strategy, and National Interests

Analysis of socioeconomic aspects that influence the development of the unmanned aviation industry in Spain. In this environment, strategic lines are outlined to be followed in accordance with various national interests.

THE CURRENT SITUATION

- Spain, with more than 47.3 million inhabitants and 500,000 km2 of territory, is the 14th largest economy in the world by volume of gross domestic product (GDP), with a per capita income of €23,690 per inhabitant per year.
- In Europe, it is the second country in extension and the fifth with more population. However, the average population density is one of the lowest, with 94 inhabitants per square km, and it has large depopulated areas of the territory (with less than 30 inhabitants per square km).
- Our country's special socioeconomic, educational, geographic and climatic conditions place us in a privileged position to promote research and the industry of technologies associated with the operation of drones/UAS and obtain leadership in certain strategic areas of the sector.
  - AESA has registered more than 50,000 drone/UAS operators and more than 68,000 pilots.
  - According to analysts, the drone/UAS operation market is still fragmented, volatile, and immature but has strong growth.
  - Integrating operations with other activities or sectors (e.g. agriculture, environment, infrastructure or mining) is perceived as an opportunity for companies in the sector.
  - The current market for professional and civil drones/UAS is worth billions of dollars, according to 2020 data, in Europe alone and more than 15 billion dollars worldwide[1].
- The need to advance in the implementation of the regulation, with agile and highly digital processes, at the same pace as the technologies to allow its development, is detected as a concern.

[1] Levitate Capital, **"The Future of the Drone Economy"**

- The general perception of the Spanish population in relation to drone/UAS applications within the economic and social activity is in favour, according to all the opinions collected.
- Incipient outstanding developments have already been promoted within the industry in terms of civil and military applications.
- The need to generate innovative solutions in terms of operational Safety to move towards flight scenarios in shared airspace between manned and unmanned aviation is detected.
- To increase integration, and the appeal of drones/UAS, in society, it would be important to facilitate as much as possible the recreational use of drones/UAS in organized and safe environments. On the other hand, to facilitate technological development and the sector itself, a greater proportionality of the current regulation is advocated.
- The Aerospace PERTE and the Aeronautical Technology Program are the means through which R&D programs may obtain the appropriate funds.

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
• To be a reference country in Europe in air regulation that makes security requirements compatible with the growth of business cases with a disruptive approach. • Maintain leadership in the administrative management of authorizations for drone/UAS operations. • To lead the R&D initiatives and the trials of drones/UAS operational cases in Europe. • Lead advanced drone/UAS training in Europe, including real operating scenarios. • Promote the generation of highly specialized comprehensive solutions (drones/UAS plus associated technological environment). • Establishment of a national drone/UAS technology engineering research and development initiative open to international collaboration. • Establishment of a network of associated centers with multidisciplinary capacity that transversally assists public and private environments in business guidance and entrepreneurship in the drone/UAS sector. • Promote a national public forum from the Administration that encourages the financing and consolidation of drone/UAS technological solutions.	• Make proposals for the implementation of air regulation for drone/UAS operations that are in advance in terms of security and business development (such as long-distance flights or specialized operations with small highly autonomous systems). Advance in the digitization and automation of the administration in relation to processing permits and authorizations. • Availability and effective and efficient management to allow the use of airspaces that allow the testing of technologies related to the operation of drones/UAS and their traffic management, including access to the maritime environment. • Promote the dissemination of advantages and benefits in the use of drones/UAS for society through pilot projects and successful experiences. • Promote the provision of air spaces that allow the development of drone/UAS technologies for transport in areas of difficult access and maritime operations, firefighting, infrastructure, security, mining, environmental management, and precision agriculture, especially in operations long distance, improving the efficiency in the processes. • Defend and consolidate the drone/UAS technological heritage generated in Spain, creating a specific structure to obtain and maintain patents with public support.

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
- Gain awareness as a country of reference in long-distance operations with drones/UAS for rescue and maritime surveillance, maintenance of energy infrastructures, firefighting, and support for the aeronautical sector. - Promote an organized recreational use of drones as a seed of growth for an area of great future demand for qualified professionals.	- Bet with specific lines of R&D and funds, the development and implementation of new traffic management technologies that allow long-distance operations and place us as one of the first countries to authorize this type of operations on a recurring basis. - Promote the consolidation and growth of the number of SMEs specialized in drones/UAS and associated transversal technologies. - Promote the need for and importance of establishing a multidisciplinary national initiative in relation to drones/UAS, its effective integration, and consolidation in the market and increase the international positioning of these activities.

SCOPE 2: Value Chain and Business Development

Creation of a solid and structured value chain that allows the growth of the sector around drone/UAS applications with high-added value.

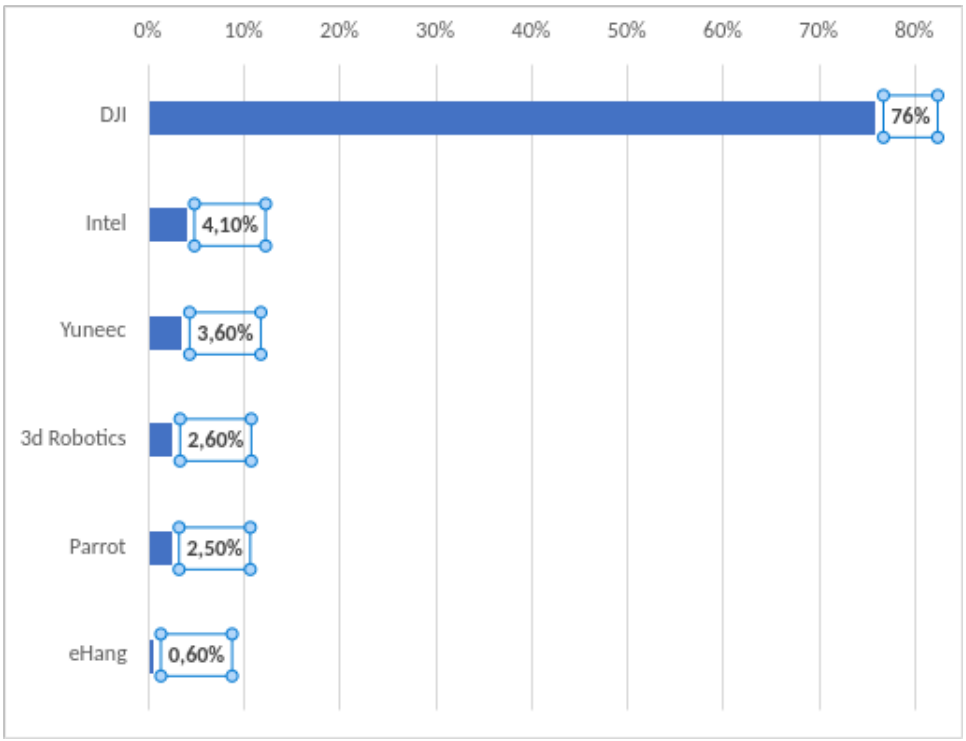
INTERNATIONAL SCENARIO

- An evolving regulatory framework must adapt to the needs of a sector with strong economic potential. Accordingly, Europe is making a big effort to standardize and establish acceptable means of compliance that help the development of the sector.
- The European Commission is committed to promoting the drone/UAS sector by encouraging innovation within the framework of the European SESAR program (Single European Sky ATM Research) and Horizon Europe.
- The growing market for drones/UAS increases interest in anti-drone measures.
- During the Covid-19 pandemic, a decline in the growth of the drone/UAS market has been noted.
- The European Commission estimates that in 2050 there will be 7 million drones in the EU for leisure use and 400,000 for commercial and government use. The "accurate agriculture", the specialized solutions for the primary sector, the quick transport of parcels and critical goods such as medicines, the inspections of large infrastructures, the observation, and surveillance, the high-accuracy mapping, the management of emergencies, the management of environmental issues, etc. These are some of the sectors in which drones can allow the development of high-added value and economic impact.
- China and the United States are positioned as the markets with the highest growth both in the number of operators and drones in use, as well as manufacturers that dominate the market, both leisure and professional.

NATIONAL SCENARIO

- The regulation for EASA operations (Delegated Regulation (EU) 2019/945 and Execution Regulation (EU) 2019/947) has established an operating system based on risks; this allows greater flexibility and usability of the airspace.
- The Spanish Royal Decree 1036/2017 applies to police activities, customs, rescue, firefighting, etc., that fall outside the European standard.

- Work is underway to update the national regulations for applying the risk-based system in all types of operations.
- Spain has more than 20 registered drone/UAS manufacturers, which places us in the 4th position in Europe, but with difficulties competing in price with the big world manufacturers.
- Strong fragmentation of the operator sector: 85% of the operators are micro-SMEs with very limited access to the high-added-value market.
- Increase in the number of local and regional administrations committed to developing drones/UAS by supporting projects such as Innovative Public Procurement, R&D centers, testing centers... that help create drones/UAS with high added value.
- Deficit of specific, structured, and consistent long-term financing that encourages innovation in the development of value-added applications



Global market share of consumer and commercial drone manufacturers in March 2021, based on sales volume (Statista Data)

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
Promote market studies regarding drone/UAS applications, defining the business models and the elements of the value chain: provision of service to the end customer, analysis and processing of information, operation, control, and flight monitoring, services of aeronautics information for drones/UAS, manufacture of platforms and sensors, training schools, etc. Analyse and define the business cases of reference according to their economic viability, determining the business requirements for the different operational scenarios. Promote the brainstorming and the protection of patents and intellectual property. Accelerate the development of a stable regulatory framework and standards that, without compromising security, consider business requirements as a key aspect. Continue to encourage the Public Administrations to be the driving force in developing drone/UAS applications with high added value through financial instruments. Availability of public funds that stimulate and accompany private investment in developing advanced drone/UAS applications.	Support from public administrations (local, regional and national) to the development of new applications with high added value through the use of instruments such as Innovative Public Procurement and the Association for Innovation, in accordance with Law 9/2017, of 8 November, Public Sector Contracts. Foster and support the development of pilot projects that allow the integration of advanced sensors in drones/UAS, data processing, artificial intelligence techniques, etc., necessary to bring the field of drones/UAS closer to those requesting high value-added services.

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
Promote exhibitions, forums, seminars, etc., to connect end users who demand value-added services with operators and other agents. Conduct public events to attract investment for all agents in the value chain. Public venture capital fund to help brainstorm, generate patents and release them in favour of the competitiveness of small industries.	Encourage and promote private investment for developing applications in the field of inspection and intelligent monitoring of infrastructures, emergency management, observation and surveillance, traffic management, advanced mapping, intelligent tourism, and security. Develop business collaboration hubs/ecosystems for knowledge sharing.

SCOPE 3: Human Factors and Social Acceptance

Increase the knowledge of human factors in unmanned aviation and the human-machine interface with a global-scale approach and, on the other hand, foster the understanding of drones/UAS integration in everyday life, promoting their integration as an element that will give a boost to the economy.

THE CURRENT SITUATION

- There is not enough information or data to support studies on the interaction of humans and drones.
- There are no regulations or standards related to human factors for unmanned aviation at the national level.
- The volume of operations with drones/UAS is insufficient, at the moment, to be perceived by society as a threat.
- There is little specific environmental regulation regarding drones/UAS, emissions, radioelectric contamination, manufacturing, and recycling.
- The first European studies about social acceptance, in particular the part of Urban Air Mobility, have shown a positive response from the public since it is understood that the advantages outweigh the disadvantages
- There is a general perception of technological substitution in the workplace

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
▰ Deepen understanding of the role of the human being in the interaction with drones/UAS, especially with autonomous drones/UAS or swarms. ▰ Develop aspects that favour human interaction - drones/UAS. ▰ Promote, advertise and authorize services of high interest with drones so that the public's initial perception will be mostly positive. ▰ Implement European and national regulations on environmental protection and protection of personal data. ▰ Keep the social environment mostly in favour of the development of the sector.	▰ Work on research areas that improve certain aspects of human factors to adapt to the peculiarities of drones/UAS, either due to the lack of sensory stimuli and other factors because they are drones/UAS or due to the implications of autonomous systems management. ▰ Propose projects that take into account social and environmental factors: ▪ Systems that allow surveillance and monitoring of image capture devices. ▪ Recycling of drone/UAS parts and components. ▪ Noise and emission studies for different types of drones/UAS. ▪ Analysis of the evolution of the spectrum of jobs that arises with the integration of drones/UAS in society on a large scale. ▪ Promotion of uses and applications that increase social acceptance: applications that help to improve the environment and/or facilitate quality of life (logistics, security, and emergencies...), social entertainment applications (drone shows, audiovisuals...).

SCOPE 4: Regulation and Certification

Propose and implement a convenient regulation that meets the expectations of the unmanned aircraft sector through the areas that European regulation leaves in the hands of the Member States and leads the promotion of the development of the specific and certified categories.

THE CURRENT SITUATION

- It is necessary to harmonize, at the European level, the geographical areas where the different types of drones/UAS can be flown and under what conditions they should be updated to the current and future situation of drones/UAS.
- It is necessary to develop certain standards and low-level requirements for providing U-Space services.
- There are no standards for the different systems and equipment related to drones/UAS, such as "Detect & Avoid" systems.
- There are not enough technical standards for designing and manufacturing drones/UAS dedicated to operations in the 'specific' category of future community regulations.
- Drone/UAS maintenance organizations dedicated to operations in the 'specific' category of the future community regulations do not have requirements.
- There is currently no complete harmonization in the definition of pilot competency requirements for operations in the 'specific' category of future community regulations, although EU Regulation 2019/947 has defined a syllabus in this regard.
- There are no technical standards for the design and verification of simulators aimed at training and maintaining the aptitude of the pilot who performs his duties in the 'specific' category of future community regulations.
- The development of anti-drone systems does not have a clear and official defined line.
- There are no protocols for the transfer of control & command between remote control units on the ground.
- Experience and development of standards and low-level requirements are necessary to be able to effectively implement U-Space models.

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
▰ Continue active participation in the drafting of European and international regulations. ▰ Implementation of those regulatory aspects that remain in the domain of the Member States. ▰ Contribute to developing certification bases that respond to current and future needs. ▰ Implementation of regulatory aspects related to design and production organizations. ▰ Contribute to the development of standards for facilities and systems on land.	▰ Development of specific category requirements, especially those related to technical aspects for a high-risk level (SAIL IV to VI), which allow applications such as the distribution of goods in urban environments. ▰ Contribute to developing digital systems with simple interfaces for implementing the UTM/U-Space system in all its phases. ▰ Establishment of interoperable database systems that allow more efficient coordination with all the stakeholders: air navigation service providers, airport managers, intelligence and law enforcement agencies, etc. The one-stop scheme will be promoted. ▰ Development of specific protocols for emergency operations. ▰ Analysis of systems that allow physical inspections by the authority remotely. ▰ Allocation of own frequencies in the field of drones/UAS. ▰ Development of effective systems for reducing impact energy at very low altitudes or intrinsically harmless drones for operations in urban environments. ▰ Promote trials and tests that allow the development of the regulatory framework, certification basis, ETSOs, and standards for drones/UAS, including subsystems, such as detection and avoidance systems, and other external systems, such as specific simulators. ▰ Development of research for a certified category in all types of operation, mainly the transport of people without a pilot on board (Type # 2). ▰ Support the development of requirements for C2Link reception service providers within the ICAO drone concept of operation.

SCOPE 5: Safety

Ensure that Safety in the field of activities carried out with drones/UAS reaches a level comparable to that of manned aviation.

INTERNATIONAL SCENARIO

- Annex 19 of the International Civil Aviation Organization (ICAO) aims to harmonize the practices of the States in Operational Safety, establishes a State Operational Safety Program (SSP), and requires the stakeholders involved to apply Operational Safety Management Systems (SMS) in which the policy, objectives, management, assurance, and promotion carried out by said stakeholders are indicated.
- The drones/UAS Manual published by ICAO establishes the responsibilities and roles of the State and Service Providers for the Safety of drones/UAS. It covers the application of SSPs and SMS, as well as the privileges of drone/UAS operators, and indicates the need for an event reporting system in order to identify hazards, assess associated risks, and develop appropriate mitigation measures. However, it does not indicate the methodology to follow to achieve these objectives.

- JARUS is updating the SORA methodology in different aspects to adapt it to the trends of greater future projection of drones/UAS currently, and in accordance with the development and implementation actions of the regulatory framework for drones at an international level: autonomous, swarms, transport...

EUROPEAN SCENARIO

- EASA has established a system of categorization of operations based on operational risk, using a proportional and progressive system; this is reflected in the publication of the Commission Delegated Regulation (UE) 2019/945 and Commission Implementing Regulation (UE) 2019/ 947 and its modifications. Three categories have been established: open, specific, and certified, with ascending levels of associated risk. EASA recommends the SORA methodology for conducting safety studies in a specific category.
- Work is underway to harmonize the regulations of international regulatory entities in order to define Acceptable Means of Compliance (AMCs) and Guide Material (GM) from the point of view of safety, homogeneous for all.
- EASA has published the European Plan for Aviation Safety (EPAS) 2022-2026, where direct and integrated reference is already made to the operational Safety of drones in different fields (drones/UAS in general, eVTOL, U-Space, C- drones/UAS.

NATIONAL SCENARIO

- The risk-based approach of the European Union for operations regulated by EASA has been implemented, which has meant an opening to the operation, maintaining the level of security.
- For NON-EASA operations, work is being done along the same lines for the national regulations that Will be established through a new "Spanish Royal Decree".
- A specific taxonomy is being developed for the notification of incidents with drones.

IDENTIFIED OBJECTIVES FOR 2022-2026	R&D NEEDS
- Integrate drones/UAS into the "State Operational Safety Program" (PESO by its acronym in Spanish). - Advance in the system of notification, treatment, and analysis of security incidents for unmanned aircraft. - Promote the integration of drones/UAS in different areas of society, facilitating the Operational Safety Management process for operators. - Implement Safety Tools and Risk Analysis Methodologies (MEDUSA by its acronyms in Spanish) at U-Space.	- Carrying out simulations in new operational scenarios for the definition/verification of acceptable security levels in new drone/UAS and U-Space applications in accordance with the provision of the "State operational Safety Program" (PESO by its acronym in Spanish). - Development of use cases for the purpose of integration into the Operational Safety Management Systems (SMS). - Establish collaborations with other National Aeronautical Authorities to seek homogenization in terms of Operational Safety according to the different SSP and SMS. - Development and verification of the SORA methodology to adapt it to the trends of greater future projection of drones/UAS currently: autonomous drones, swarms, and transport.

SCOPE 6: Security and Cybersecurity

Promote the development of an integrated concept of security in drone/UAS operations that mitigates risks to levels acceptable to society.

INTERNATIONAL SCENARIO

- Absence of a complete holistic analysis of security (risks, threats, mitigation measures, residual risks, etc.) that also includes human factors from the point of view of "security".
- The European Center for Cybersecurity in Aviation (ECCSA), created in 2017 as a result of a cooperation agreement between EASA and EU-CERT, does not have any specific activity related to drones/UAS.
- The European project SECOPS, ongoing in the field of SESAR, tries to define an integrated concept of security that identifies mitigation measures that keep security risks related to drones/UAS at acceptable levels.
- A new draft of Annex E on cybersecurity included in the SORA Methodology.
- Remote identification of drones/UAS is one of the highest priority activities in the short term.
- Introduction of the concept of "geo-awareness" in the EASA regulation so that the RPAS pilot is alerted to overflight restrictions.
- The JARUS SORA methodology for risk assessment in drone/UAS operations is focused on Safety and not on aspects of external security threats. It only establishes that for medium and high-risk operations, the status of the external systems on which the operation depends, such as GNSS systems, must be independently monitored.
- Some airports have had to paralyze their operations due to the unauthorized presence of drones/UAS in their vicinity.
- Many of the countries in the ECAC environment have carried out an analysis and mitigation of drones/UAS risks.
- Introducing drones/UAS in the safe aviation ecosystem may lead to new threats, which must be explored and identified. In parallel, it may increase the risk that some of the existing ones could be materialized. In the case of cyber threats, the fact that there is no human presence "on board" somewhat reduces the detection or response capacity, which makes the system more vulnerable. For this reason, cybersecurity is considered a key factor in drones/UAS due to its almost exclusive dependence on the use of technology. If cybersecurity is considered fundamental in all aviation, in the case of drones/UAS, it goes one step further.

- Commission Implementing Regulation (EU) 2021/664, which establishes a regulatory framework for U-Space, which also establishes cybersecurity requirements indirectly for U-Space service providers through the requirement that they have a security management system in accordance with point ATM/ANS.OR.D.010.

- ICAO adopted at the 5th meeting of the ICAO Council at its 222nd session on 1st March 2021 the International Standards and Recommended Practices, Annex 10 — Aeronautical Telecommunications, Volume VI — Communication Systems and Procedures relating to Remotely Piloted Aircraft Systems C2 Link. The annex states the importance of avoiding unauthorized interference in the exchange of information between the remote pilot station (RPS) and the remotely piloted aircraft (RPA) for the Safety of operations. Therefore, it establishes high-level SARPs that address the need to avoid interference from drones/UAS. The drone/UAS C2 link design, monitoring system, and operating procedures shall be such as to minimize the possibility of any unauthorized control of the RPA or RPS during any operational phase.
- The C3 concept is currently being introduced, in which command and control include "communications," among others, with ATC and the control unit. This introduces new risks in cybersecurity.
- Drones/UAS face threats not only very similar to those of manned aviation but also to information systems and those derived from the location of the remote pilot in open spaces instead of the protected space of the cockpit. Attacks can range from remote code injection, denial of service to the disclosure of confidential information, identity theft, interference, manipulation, etc.
- Measures are being introduced to intercept drones/UAS in critical infrastructures through the so-called anti-drone systems.

NATIONAL SCENARIO

- Both Commission Implementing Regulation (EU) 2019/947 and Spanish Royal Decree 1036/2017 establish the need to adopt appropriate measures to protect aircraft from acts of unlawful interference during operations.

- The Strategic Plan for developing the civilian sector of drones in Spain recognizes that the risks associated with the violation of privacy, the use of drones for terrorist purposes, flights in protected environments for security reasons, and cyber security must be adequately managed to avoid negative impacts on civil society.

- Projects are underway to develop effective technologies for the non-cooperative detection of drones/UAS.
- The establishment of protocols in the case of non-collaborative use of drones/UAS in controlled environments has been implemented in national regulations

IDENTIFIED GOALS FOR 2022-2026	R&D NEEDS
Develop a complete security risk analysis of drones/UAS operations to establish the requirements that all system elements must meet, as well as their validation and approval procedures from the "security" point of view. Support the implementation of electronic remote identification systems for drones/UAS (except for recreational purposes). The drone/UAS is developed using security-by-design principles to ensure that each element/subsystem has basic cyber resilience to achieve the required level of security Analyze scenarios in which a drone/UAS suffers a cyberattack and assess its impact Support the inclusion of security measures throughout the life cycle, which cover not only the period of operation but also manufacturing (of systems and components), maintenance, provision, storage, and transportation of spare parts, and end of life of the product. Educate the public to prevent and reduce the misuse of drones. Prepare aerodromes to mitigate the risks of unauthorized use of drones. Support the National Security Bodies in their work of detecting, monitoring, and mitigating threats related to drones/UAS. Creation of a culture of protection against security threats in drone/UAS operations.	Contribute to the complete analysis of security risks of drone/UAS operations and their mitigation. Stimulate and support the development of protection technologies against cyber threats in the field of drones/UAS, including interference with communications and navigation systems. Stimulate and support the development of drone detection technologies to protect critical infrastructures.

SCOPE 7: Traffic Management

Facilitation and management of unmanned operations in all types of airspace. Automation of the provision of traffic management services: UTM and U-Space.

THE CURRENT SITUATION

- The current authorization of unmanned operations outside of open category operations or under standard scenarios requires an inefficient process for the sector's needs.
- Airspace access requirements may be too demanding for many business models, especially those requiring immediacy.
- The lack of approved "Detect & Avoid" subsystems makes it difficult to integrate unmanned operations in airspace volumes shared with non-collaborative traffic.
- ENAIRE, the official provider of aeronautical information (AIS), makes the ENAIRE/Drones tool available to the public, which offers at this stage a "geo-awareness" service limited to information from strictly aeronautical sources and ENAIRE PLANEA, which facilitates operational coordination and repository of data and information of the requests coordinated with ENAIRE.
- In response to the new U-Space regulatory framework, ENAIRE is developing the CIS (Common Information Service) platform, including other USSPs (U-space Service Providers), and thus will start operating under U-Space in 2023.
- There is no standardized system for tracking and identifying small unmanned aircraft. Therefore, different options are currently being evaluated with the final objective that manned traffic, ATS providers, and National Security Bodies have practical mechanisms to know the precise location of potentially dangerous unmanned aircraft.
- The Ministry of Transport, Mobility and Urban Agenda (MITMA by its acronyms in Spanish), through the General Directorate of Civil Aviation (DGAC by its acronyms in Spanish), prepared the Strategic Plan for the development of the civil sector of drones in Spain 2018-2021. This plan contained the first national initiatives in the drones/UAS sector and the definition and implementation of UTM/U-Space in Spain.
- MITMA is promoting drones/UAS through all its companies and organizations, as reflected in the 2030 Safe and Sustainable Mobility Strategy.
- With the new U-Space regulatory framework published MITMA in collaboration with the Ministry of Defense, has published the U-Space National Deployment Action Plan in 2022.

- The European regulation for the digital traffic management of drones in the airspace, called the U-Space Regulatory Package, has been approved and includes the Commission Implementing Regulations 2021/664, 2021/665, and 2021/666. This set of regulations will enter into force in January 2023

- SESAR JU is coordinating many R&D projects on U-Space, both at a technological level and in demonstrations, to gain operational experience. The CORUS project published its final version of the U-Space CONOPS at the end of 2019. The first test flights aimed at demonstrating the safe and orderly integration of Urban Air Mobility (UAM) operations are taking place throughout 2022 under U-Space infrastructure.

- Several public entities, technological centers, and Spanish companies have participated, or continue to participate, in CEF/SESAR projects for the demonstration of UTM/U-Space systems (DOMUS, SAFEDRONE, CORUS-XUAM, AMU-LED, USPACE4UAM...) as well as in projects SESAR ER4 for research and innovation at U-Space (BUBBLES, DACUS…).

- The PERTE for Aerospace includes the project that ENAIRE is carrying out "actions for the Development of the Single European Sky that will allow an ecological transition of the air transport sector, including drones/UAS".

IDENTIFIED GOALS FOR 2022-2026	R&D NEEDS
▰ Simplification of requirements and automation of procedures for authorization and access of drones/UAS operations to airspace ▰ Definition of airspace structures and their hierarchical system of authorization of drones/UAS operations through the drones/UAS Geographical Zones. ▰ Implementation of the European drone/UAS identification and monitoring system in accordance with regulations. ▰ Availability of initial U-Space basic services through certified systems operated provided by certified USSP providers. ▰ Continue with the implementation for ATS providers of semi-automatic tools for the management and authorization of unmanned operations	▰ Continuous improvement in applications for web automation, and with dedicated APPs, of the current processes of evaluation, authorization, and coordination of operations. ▰ Definition of standards, development (technical and regulatory), and implementation of electronic remote identification systems and monitoring of unmanned aircraft in accordance with European regulations. ▰ Information of drone/UAS operations to other traditional airspace users, especially at low altitudes such as general aviation. ▰ Foster coordination between the different stakeholders in drone/UAS operations, including Public Administrations, to define airspace volumes and overflight authorizations for drone/UAS operations. ▰ Development of technologies that allow, under the U-Space paradigm, the management, and integration of traffic with advanced autonomous flight capabilities. ▰ Development and implementation of ATM interfaces for the exchange of messages and information on tracking, surveillance, authorizations, flight plans/operations, and management of possible conflicts between the Spanish ANSPs and the future Spanish UTM/U-Space ecosystem, in accordance with the services from U-Space. ▰ Interoperability between the U-Space ecosystem and non-cooperative traffic surveillance systems. ▰ Development of CNS instrumentation, infrastructure, and equipment for operations in U-Space airspace, especially in urban environments.

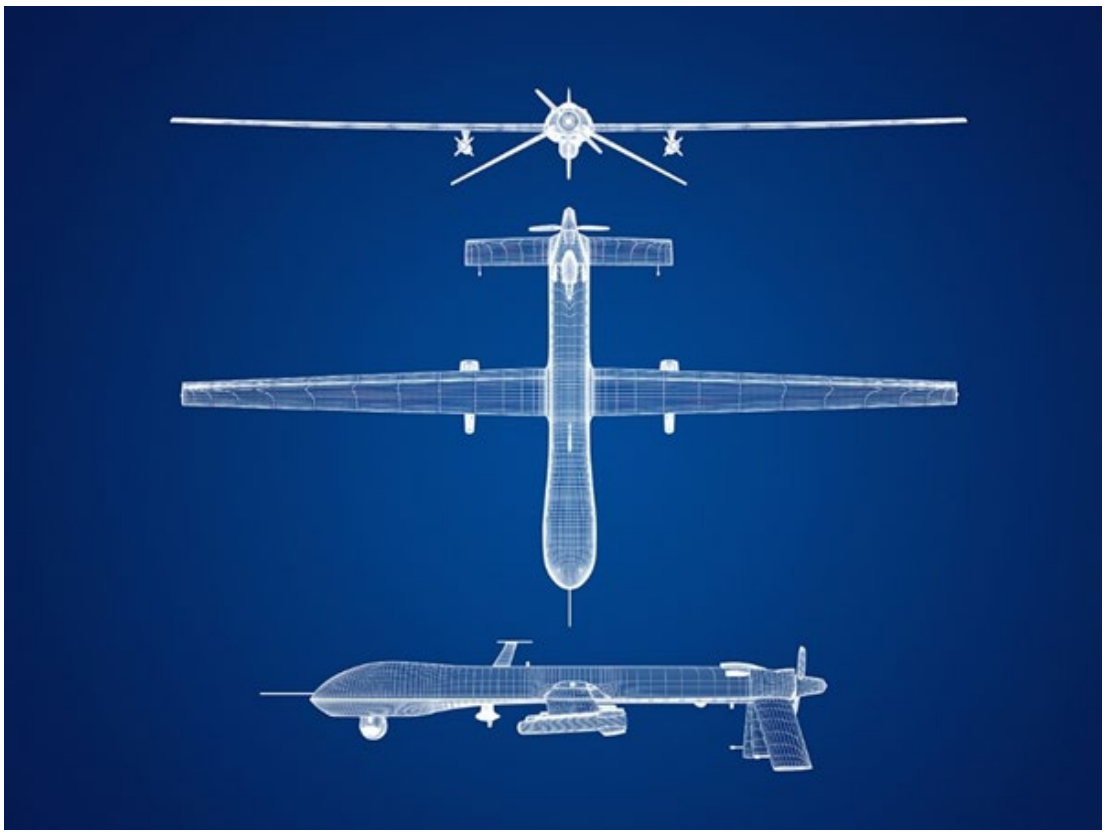
SCOPE 8: Technology and Technological Change

Drones/UAS benefit from transversal technological evolution in many different areas. All of them are experiencing rapid growth, generating opportunities for disruptive solutions in the market. Spanish initiatives in the sector are beginning to stand out in the international arena. Appropriate coordination between the different agents is required to enhance both their structures and R&D resources, as well as the growth of a specialized business network. The areas that are considered strategic in the sector are operations beyond visual line of sight, Safety, or highly autonomous systems that perform increasingly complex and specialized tasks in operating environments with special characteristics.

THE CURRENT SITUATION

- The Spanish innovative nature of the sector, made up of university research groups, technology centers, or specialized SMEs, has begun to provide value and differentiation on an international basis.
- It is necessary to strengthen participation in European initiatives in the coming years to promote the development of technologies that will promote the drone industry's growth.
- The Spanish aeronautical ecosystem has participated, and in some cases led, for the last 20 years, projects of the European framework programs related to drones/UAS, which have increased significantly in the last 5 years.
- The Center for Technological and Industrial Development (CDTI by its acronyms in Spanish) has approved different projects related to drones/UAS in the last 5 years, also investing in SME capital in the sector.
- A significant percentage of the drone/UAS R&D budget has been focused on large programs without clear coordination between them.
- Spain has Academia research groups, technology centers, and specialized companies, international leaders in specific technologies (such as aerial robotics, infrastructure inspection, or flight electronics). However, there is no defined plan for strengthening the R&D fabric that allows the creation of relevant actors at an international level and increases the specialized business fabric in a coordinated manner.
- The national industry of drones/UAS currently presents a low level of technology investment.
- The already existing Experimental Flight Centers are used rarely by the national industry.

- Through FEDER[2] funds, as part of the scientific-technological initiatives, the facilities for experimentation in the field of drones/UAS are being reinforced through the UAVs-CEUS Experimentation Center, which will be added to the rest of the experimentation centers already existing. In this center, the Air Research Platform has also been projected, which aims to offer a space for research on environmental aspects, climate change, and other useful applications related to aircraft.



[2] FEDER is the Spanish acronyms for “European Regional Development Fund”

IDENTIFIED GOALS FOR 2022-2026
➢ Increase the growth and competitiveness of the sector, integrating new technologies into its products and services. ➢ Develop a plan for the empowerment of stakeholders at the international level in certain specific fields. ➢ Increase Spanish participation in European R+D+i programs of all kinds. ➢ Develop enabling technologies in the three identified segments (VLL, VHL, and IFR). ➢ Promote the use of Experimental Flight Centers for the development of new technologies. ➢ Promote and make visible the new technological developments of the sector in Spain, promoting coordination between initiatives. ➢ Stimulate the creation of a coordinated network of technological SMEs with innovative capacity.
R&D NEEDS
➢ Solutions that increase operational Safety with drones/UAS, including intrinsic Safety and other systems that allow, for example, the detection and avoidance of collisions with obstacles. ➢ Systems for detection and avoidance embarked on small and light aircraft that allow safe flight Beyond Visual Line of Sight (BVLOS). ➢ More efficient unmanned aircraft with greater autonomy in flight time. ➢ Aerial robotics and increased level of aircraft autonomous decision-making capacity, including the ability to react to changes in the environment and safe landing in various conditions, including landing for automatic battery recharging or replacement. ➢ Technologies that facilitate autonomous coordination between several drones/UAS or between drones/UAS and other robotic systems to improve the efficiency of certain missions. ➢ Advanced interfaces on round making use of new transversal technologies (augmented reality, haptic devices, etc.). ➢ New real-time support services for complex operations with drones/UAS: high-resolution maps, local weather, occupancy density per person, etc. ➢ Development of technologies that allow VLL flights (below 150 m), including new functionalities in U-Space/UTM.

- Technologies that facilitate the realization of IFR flights at the level of commercial flights.
- Precision navigation systems in urban environments and in operations near infrastructures.
- Technology to minimize the noise footprint in urban environments.
- Technologies that allow flight in confined spaces in a robust and safe way, even without prior knowledge of the environment.
- Systems and tools that facilitate the agile approval of hardware and software systems (HW and SW) for medium and high-risk operations (SORA levels M and H).
- Robust communications for BVLOS operations and autonomous systems.
- Use of 5G technologies and mobile phone networks for the development of the drones/UAS industry.
- Use of transversal technologies for the generation of highly specialized innovative solutions.
- New technologies allow autonomous changes in the aircraft's configuration in flight.
- New HAPS platforms for operations above 60,000 feet (VHL).
- New technologies to increase the intrinsic Safety of aircraft, including the absorption and dissipation of energy in impacts.
- Application of bio-inspired concepts to increase the efficiency and Safety of new drones/UAS.
- New developments allow the operation of large autonomous swarms.
- Develop technologies that allow disruptive applications in operations within VLOS (Visual Line of Sight) or autonomous operations in proximity range, such as physical interactions with people.

SCOPE 9: Mobility, Transport, and Integration with Infrastructures "Smart-Cities"

We are at the dawn of a completely new industry: Urban Air Mobility (UAM). Cities are increasingly populated and centralized. This leads to increasing congestion and unprecedented mobility needs. Urban Air Mobility is one part of the solution.

The biggest challenges in transportation and mobility are facilitating 2D and 3D transportation, providing access to public services, and environmental sustainability.

New technologies (propulsion, structures, avionics / autonomous systems), infrastructures, and business models will make it possible to radically rethink the urban and aerospace space

The airports of the future will be all around us, in our homes and workplaces, on the roofs of buildings, and on top of delivery vans and fire trucks. The UAM not only changes the way we travel but also the way we live.

"Smart Cities" lead the transformation of smart mobility: the application of digital applications (digital technology and business models) improves the efficiency and effectiveness of transport in smart cities, with the aim of reducing congestion and emissions. CO2 due to mobility

Urban space needs to be globally harmonized, accessible, and future-proof.

Improving public acceptance: uniting the EU, cities, industry, and citizens as co-creators of the future of Urban Air Mobility and smart cities (Ref. to "Study on the societal acceptance of Urban Air Mobility in Europe" EASA)

Passenger eVTOL operations must be safer than surface operations to gain public trust.

The cost of eVTOL transport must be comparable to that of current land transport means.

THE CURRENT SITUATION

- Developments in Urban Air Mobility are driven by the increasing limits in surface systems and the democratization of the 3rd dimension.
- It is powered by the birth and convergence of disruptive technologies: digitization, electrification, autonomy, new categories of airspace, and new business opportunities.
- The global "Smart Cities" market will grow from $457 billion in 2021 to $873.7 billion in 2026.
- The Spanish Network of Smart Cities is made up of 89 cities.
- The EU Smart Cities Marketplace consolidates the EIP-SCC and SCIS projects, bringing cities and sectors together.
- Many of the funded projects have not finished or have not started.
- Currently, urban operations are highly conditioned and at low altitudes are practically limited to VFR manned traffic, and there is no specific regulatory framework for air pollution and noise.
- Need to extract the maximum value from the large demonstrators in progress or planned: AMU_LED, CORUS-XUAM, SAFIR-MED, etc.
- There are multiple digital platforms, architectures, and service models from different actors: agencies, cities, academia, and industry.
- There is a lack of standards to assess the performance and quality of Urban Air Mobility.

IDENTIFIED GOALS FOR 2022-2026

- Carry out demonstrators in Spanish cities, increasing their reach, relevance, and ambition.
- Implement a multimodal system in several Spanish cities.
- Engage civil society to address public trust, acceptance, and adoption.
- Address security challenges.
- Develop digital platforms, architectures, and services.
- Develop models and simulations to accelerate the maturation of advanced urban systems.
- Develop standards for critical domains such as Certification, Security, or Interoperability

R&D NEEDS

- Promotion of R&D projects in controlled environments and in the long term to generate a volume of flight data necessary to improve operational procedures and technology of future drone services in cities.
- Creation of spaces for collaboration between operators, infrastructure, cities, research centers, universities, etc., so they can advance in their respective domains.
- Establish and validate digital information exchange protocols that allow communication and coordination between all the agents involved (ground and air segment), including those used by the National Security Bodies.
- Need for development and integration of technologies related to drones/UAS: noise management, electrification, autonomy, ATM/U-SPACE, connectivity, cybersecurity and data, process automation, structures and systems, avionics, and sensors.
- Need for convergence of architectures (Infrastructure / Data / Services / Providers / Management layers.
- Air Segment: Integrated ATM + UTM, as digitized and automated services, within an ecosystem to maximize flexibility and efficiency, in an environment driven by satellite-based CNS, performance-based operations, and personalized services
- Ground Segment: Ground infrastructure, integrated with existing conventional transport infrastructures (ground and air):
  - Future connectivity: low latency services, 5G, guaranteed quality of service, low cost.

- Interfaces with public transport and air transport, including existing and future configurations.
- New ground infrastructure to be integrated: vertiports, landing hubs, charging stations

- Vertiports should be strategically located at key destinations.
- Need to combine innovation and security to create opportunities for collaboration and guarantee safe flight operations, including Artificial Intelligence/Machine Learning, Big Data, and Blockchain technologies to multiply the flight "experience".
- Modelling and simulation, fed with urban flow data, which allow an understanding of how to add mobility solutions to existing and future city networks.
- Identify and develop the value chain: Urban Aircraft, Support and Service, Flight Operations, UTM + ATM, Ground Infrastructure, User Experience (UX), and Passenger Solutions.
- Deploy mobility as a service (e.g., mobility platforms, seamless mobility, cyber-security, insurance, legal, and transport operations).

SCOPE 10: Sustainability

The use of drones/UAS currently stands out for its low environmental footprint. Used to replace procedures that generate a greater impact, or as disruptive environmental management tools, they become a very valuable resource for the global sustainability of the planet.

THE CURRENT SITUATION

The current deployment of drone operations is an activity with negligible environmental impact compared to the technologies it replaces, such as manned aviation or deployment of personnel with land vehicles. Statistically, there is no notable generation of waste, emissions, or noise pollution associated with the manufacture or operation of drones/UAS in our country.

Given their lower impact on fauna, they are also useful for carrying out environmental management tasks that are unapproachable by traditional means due to their high costs, such as monitoring discharges in water, erosion, or environmental studies.

INTERNATIONAL SCENARIO

The European Commission is developing "A drone Strategy 2.0 for Europe" for a smart and sustainable drone ecosystem in Europe. Its publication is recently published.

There are no specific environmental regulations regarding drones/UAS, emissions, radioelectric contamination, manufacturing, and recycling, except for the noise level in the draft of future regulations.

The fleet in use emits less noise than manned aviation or wheeled vehicles that it replaces, although work is being done on analyzing emissions at atypical frequencies and on the repercussion of their escalation in urban areas. No specific regulations have been approved that regulate the measurement of individual noise or collective prediction of drones. The noise impact of drones and eVTOL aircraft is further influenced by the environment and changing environmental conditions. It is advisable to collect data and make regulations more flexible until significant data is obtained.

NATIONAL SCENARIO

The manufacture of drones/UAS platforms in our country is included within industry 4.0, which can be considered clean, and they work with electricity, without emissions, and with a low acoustic footprint.

The use of combustion-powered appliances is residual compared to electric ones, so emission and noise levels are kept to a minimum. In any case, considering the global impact of their activities compared to the procedure they replace, the positive balance for the planet's sustainability is unquestionable. Examples of this type of activity: are the inspection of power

lines, the location of spills, an inspection of catenaries, detection and fight against forest fires, search work (rescue), support for agriculture, etc.

The aerospace PERTE, within its aeronautical Pillar, includes the initiative that focuses on aspects of sustainability throughout the life cycle of the drone, promoting the use of sustainable propulsion systems (electrification, H2...), the application of more innovative manufacturing, and the use of disruptive technologies such as Artificial Intelligence.

IDENTIFIED GOALS FOR 2022-2026	R&D NEEDS
▰ Promote the trend towards electrification of the sector and explore the feasibility of other vectors, such as hydrogen. ▰ Promote using drones/UAS to replace technologies and activities with a greater environmental impact. ▰ Promote drones/UAS as advanced environmental analysis and management tools. ▰ Promote, communicate and authorize drone services that benefit the sustainability of human activities. ▰ Promote the sustainable use of drones/UAS in all types of spaces, including Protected Natural Areas, in collaboration with the environmental authorities. ▰ Maintain minimum impact standards of these prototypes in the environment. ▰ Promote the tren towards electrification of the sector and explore the viability of other vectors, as hydrogen.	▰ Promote projects that focusin on environmental aspects: ▪ Noise studies for larger prototypes and UAS concentrations. ▪ Studies of the complete life cycle of the drones/UAS (development, raw materials, manufacturing, distribution, use and maintenance, and recycling or final disposal) and the applicability of the circular economy within the sector itself or others. ▪ Sustainability chain analysis for different drones/UAS (long-chain). ▪ Include sustainability criteria in the U-Space design that considers the environmental needs depending on the area: areas of operation, traffic density, reduction of disturbances ▰ Progress in low noise footprint systems for inhabited environments. ▰ Generate an acoustic database that allows analysis and decision-making, with measurements of different environments, structures, etc. ▰ Organizational measures that minimize environmental impacts and favour the collective operation of drones (swarms). ▰ Develop UAS platforms and transversal technologies useful as advanced environmental management tools that improve efficiency or are applied to new areas of specialization. ▰ Promoting electrification, miniaturization, and automation in drone/UAS platforms dedicated to working in wilderness areas.

FRAMEWORK

SCOPE	FRAMEWORK
2	European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace, 2017 European Drones Outlook Study, November 2016 Declaration of Amsterdam, EASA High-Level Conference on Drones, 28th November 2018 The European Drone Industry, Drone Industry Barometer 2020 https://www.josepauloecon.com/wp-content/uploads/2020/11/Droneii-The-Drone-Industry-Barometer-2020.pdf?x58954
3	Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and third-country operators of unmanned aircraft systems. Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft.
4	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency (…) Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems. Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for U-space. Certified Category. Concept Paper EASA IACO Annexes

5	- Annex 19 ICAO: Safety Management (2nd ed 2016) - ICAO Doc 10019: Manual on RPAS (2015) - JARUS doc 06(WG6) SORA (Package) and Standard Scenarios - Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems. - Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. - Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for U-space - EASA NPA 2021-14 Development of acceptable means of compliance and guidance material to support the U-Space regulation
6	- Spanish Royal Decree 1036/2017, of 15th December, regulating the civil use of remotely piloted aircraft and amends the Spanish Royal Decree 552/2014, of 27th June, which develops the Rules of the Air and common operating provisions for air navigation services and procedures and the Spanish Royal Decree 57/2022, of 18th January, by which the Air Traffic Regulations are approved. - Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems. - Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. - Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for U-space. - ICAO Annex 10 — Aeronautical Telecommunication, Volume VI — Communication Systems and Procedures relating to Remotely Piloted Aircraft Systems C2 Link - PART-IS (Currently Opinion 03-2021) - Opinion 01/2018 EASA - Introduction of a regulatory framework for the operation of unmanned aircraft systems in the 'open' and 'specific' categories

7	• Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for U-space • Commission Implementing Regulation (EU) 2021/665 of 22 April 2021 amending Implementing Regulation (EU) 2017/373 as regards requirements for providers of air traffic management/air navigation services and other air traffic management network functions in the U-space airspace designated in controlled airspace • Commission Implementing Regulation (EU) 2021/666 of 22 April 2021 amending Implementing Regulation (EU) No 923/2012 as regards requirements for manned aviation operating in U-space airspace. • Spanish Royal Decree 1036/2017, of 15th December, regulating the civil use of remotely piloted aircraft […]. • Acceptable Means of Compliance and Guide Material for U-Space Regulation. • High-Level Conference on Drones. Declarations of Riga, Warsaw, and Helsinki. • SESAR Joint Undertaking. U-Space blueprint. • European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace. • NASA UTM definition.

9	- SESAR Joint Undertaking- European ATM Master Plan, Section 4.2(Drone Outlook Study including UAM) - Declaration of Amsterdam, EASA High-Level Conference on Drones, 28th November 2018 - EIP-SCC- "UAM Initiative on Smart Cities and Communities" - National Plan for Smart Cities in Spain (within Spanish Digital Agenda) and Spanish Network of Smart Cities (RECI by its acronyms in Spanish)) - ACI EUROPE POSITION-Urban Air Mobility - Socio-economic context - Integrated planning, policy, and regulation. - Decarbonization: Global solutions to reduce emissions; intermodal changes. - Digitization: connected vehicles, intelligent transport, collaborative economy, drones. - Investment: innovative financing mechanisms, investment in infrastructure, research, and innovation. - People: Safety and security, passengers' rights, employment.
10	- Approaching birds with drones: first experiments and ethical guidelines (E. Vas, A. Lescroël, O. Duriez, G. Boguszewski, D. Grémillet) - Assessment of UAM and drone noise impact on the environment based on virtual flights (H.Bian , Q.Tan , S.Zhong , X.Zhang) - Optimization of the assembly process and environmental impact using DFMA and sustainable design analysis: Case study of drone. Z. M. Zhafri, M. S. M. Effendi, M. F. Rosli - Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO_2 emissions in the delivery service industry. A.Goodchild , J.Toy

ACRONYMS

AMC/ GM	Acceptable Means of Compliance/ Guide Material
BVLOS	Beyond visual line of sight
EIP-SCC:	European Innovation Partnership in Smart cities and Communities
ETSO	European Technical Standard Order
e-VTOL	All-electric Vertical Take-Off and Landing
IA	Spanish Acronym for Artificial Intelligence
PERTE	Spanish Acronym for Strategic Project for Recovery and Economic Transformation
RPAS	Remotely Piloted Aircraft System
UA	Unmanned Aircraft
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
UAS Regulation	Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft.
UTM	Unmanned Traffic Management
U-Space	Set of new services and specific procedures designed to support safe and efficient access to airspace for large numbers of drones.
USSP	U-Space Service Providers
VLL	Very low level