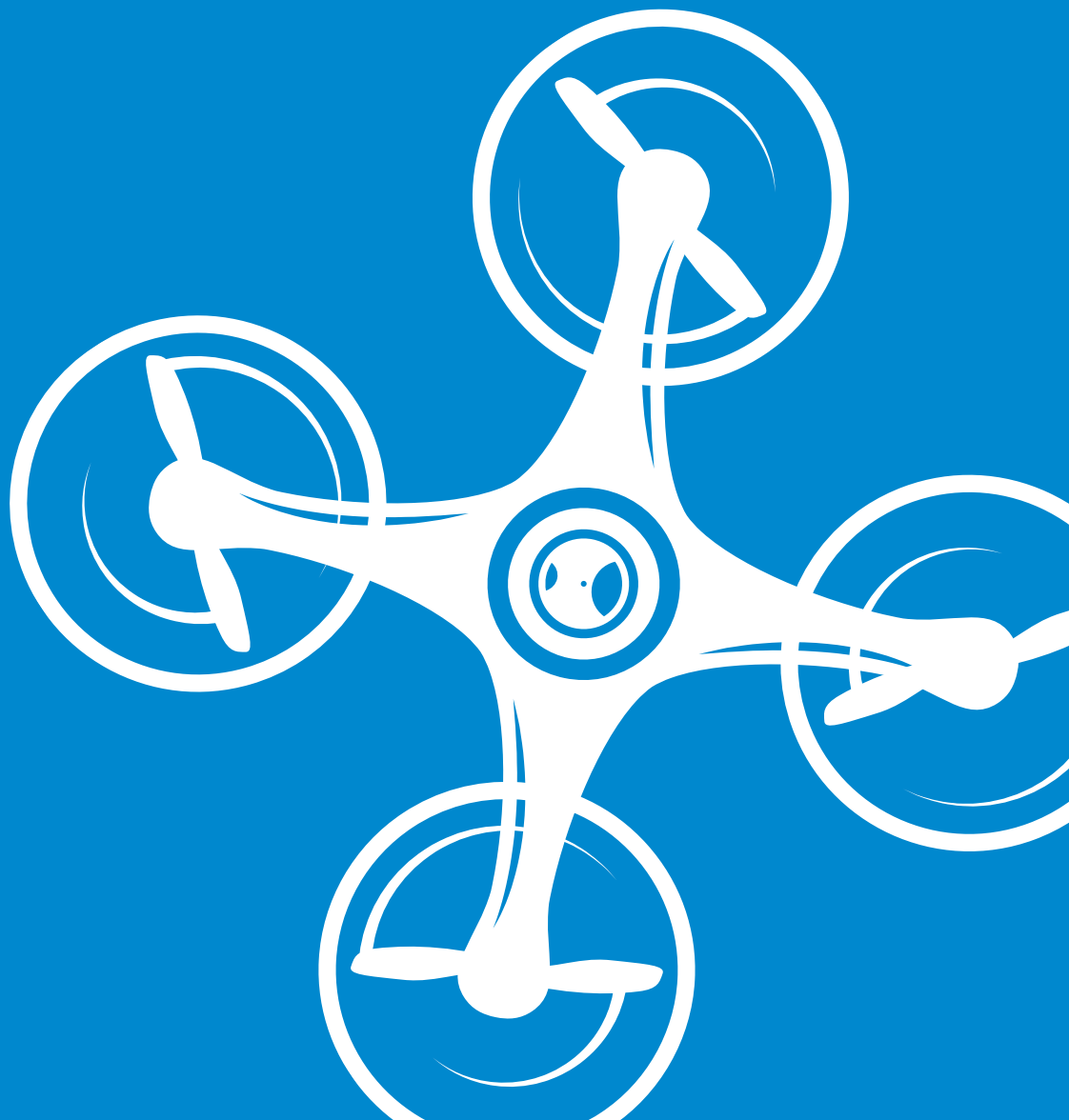




EASA
European Aviation Safety Agency

Concept of Operations for Drones

A risk based approach to
regulation of unmanned aircraft



1. Executive summary

Drones should be integrated into the existing aviation system in a safe and proportionate manner and this integration should foster an innovative and competitive European drone industry, creating jobs and growth, in particular for SMEs. The proposed regulatory framework should set a level of safety and of environmental protection acceptable to the society and offer enough flexibility for the new industry to evolve, innovate and mature. Therefore the exercise is not simply transposing the system put in place for manned aviation but creating one that is proportionate, progressive, risk based and the rules must express objectives that will be complemented by industry standards.

Considering the broad range of operations and types of drones, it is proposed to establish three categories of operations and their associated regulatory regime: Open, Specific and Certified. The Open operation category of drones, should not require an authorisation by an Aviation Authority for the flight but stay within defined boundaries for the operation (e.g. distance from aerodromes, from people, etc). The “specific” operation category will require a risk assessment that will lead to an Operations Authorisation with specific limitations adapted to the operation. The “certified” operations will be required for operations with a higher associated risk or might be requested on a voluntary basis by organisations providing services such as remote piloting or equipment such as “detect and avoid”.

Protection of other public interests such as privacy and security entailed by drone operations will need to be addressed at the same time as the safety risk and will be dealt with at National Level. The regulatory framework may envisage provisions to reduce that risks. The developing regulations needs to be complemented by safety promotion actions to support the Member States.

The further development of drones and their integration in non-segregated airspace will pose new challenges and a significant amount of further research needs to be performed. The ATM/ ANS aspect of the concept of operation will need to be further developed. Also the harmonization of regulations and availability of spectrum is fundamental to the success of drones. Finally the development of the drone market and the development of the technologies need to be carefully monitored and the planning adapted.

2. Background

Unmanned aircraft systems (UAS) are an aircraft and its associated elements which are operated with no pilot on board. Remotely piloted aircraft systems (RPAS) are a set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other system elements as may be required, at any point during flight operations. RPAS are a sub-set of UAS. These terms that are coming from the ICAO circular 328-AN/190 are replaced in the common language by the word drone and this document will accordingly use drones to speak of UAS and RPAS. A drone operator is a person, organization or enterprise engaged in, or offering to engage in a drone operation. It should be noted that this concept in most of its paragraphs except in the outlook paragraph assumes drones to be remotely piloted and with no people on board.

Drones are not a new phenomenon as they date back to the mid-1800 but their development in the civil market is relatively recent. 2013 has been qualified by some as the year of the drones.

Indeed, the use of drones is developing at a quick pace worldwide and in particular in EASA Countries. The use of drones is extremely varied. Some examples are: precision agriculture, infrastructure inspection, wind energy monitoring, pipeline and power inspection, highway monitoring, natural resources monitoring, environmental compliance, atmospheric research, media and entertainment, sport photos, filming, wildlife protection and research, hunting and anti-hunting monitoring, disaster relief. Experiments to carry small cargo are on-going in Germany and France. Size, configuration and complexity of drones are also extremely varied. They are developed by not only classical aviation companies and but also by non-aviation companies, usually Small and Medium-sized Enterprises (SME).

Some numbers may testify of this development. In EASA countries, there are 2495 operators and 114 RPAS manufacturers of very small to small RPAS with a maximum take-off mass (MTOM) up to 150kg. This compares to 2342 operators in the rest of the world (2000 in Japan only)¹. Concerning RPAS with a MTOM above 150 kg, 76% of the respondents to a survey conducted by the European Commission last year indicated that they thought a swift development of such drones was likely in the coming years.

1 Data provided by UVS international

3. Concept of Operation

The operation of drones should be regulated in a manner proportionate to the risk of the specific operation. Considering the broad range of operations and types of drones, it is proposed to establish 3 categories of operations and their associated regulatory regime: Open, Specific and Certified.

The Open operation category of drones, should not require an authorisation by an Aviation Authority for the flight but stay within defined limitations for the operation (e.g. distance from aerodromes, from people, etc.).

The “specific” operation category will require an Operations Authorisation by an Aviation Authority with specific limitations adapted to the operation.

Certification will be required for operations with a higher associated risk due to the kind of operation or might be requested on a voluntary basis by organisations providing services such as remote piloting or equipment such as detect and avoid...

This concept has been developed to address two main goals:

- a) Integration and acceptance of drones into the existing aviation system in a safe and proportionate manner.
- b) Foster an innovative and competitive European drone industry, creating new employment, in particular for SMEs.

To achieve both goals simultaneously, the regulatory regime needs to set a level of safety and of environmental protection acceptable to the society as well as provide protection of other public interests, such as privacy and security on the one hand, and to offer enough flexibility for the new industry to evolve, innovate and mature on the other hand. The regulatory framework should not simply transpose the system put in place for manned aviation but must therefore be proportionate, progressive, risk based and the rules must express objectives that will be complemented by industry standards. Only this way can we address the challenges posed by the wide variety of drones and their operation and support SMEs to learn and progress from simple operations to higher risk operations as they gain experience allowing them to increase the range of operations and application. The regulatory framework must be an enabler and not an impediment; hence striking the right balance between innovation and the societal concerns about safety, environmental protection, privacy and security. With this approach mentioned above the regulatory framework will render obsolete the limit of 150 kg included in Annex II of the EASA Basic Regulation separating drones regulated nationally and those regulated at European level. Furthermore, this approach will allow to put on equal footing commercial and non-commercial operations (including classical aero models or toys). This concept focuses on safety risks but recognises the importance of risks to privacy and security. These subjects are briefly addressed at the end of the paper.

The safety risks considered must take into account:

- Mid-air collision with manned aircraft,
- Harm to people, and
- Damage to property in particular critical and sensitive infrastructure.

3.1 Open category

The open category is for the very low risk drone operations, therefore without involvement of Aviation Authorities, even for commercial operations. No airworthiness approval is foreseen and there are also no approvals or licenses for operators and pilots. It is designed to allow simple operations and for the small and medium-sized enterprises to gain experience. The risk for other airspace users is mitigated through separation with manned aviation. The drone must be flown:

- Under direct visual line of sight (VLOS): 500m
- At an altitude not exceeding 150 m above the ground or water
- Outside of specified reserved areas (airport, environmental, security)

The risk for the people on the ground is mitigated through the use of low energy aircraft and by establishing minimum distances with respect to the people on the ground. Flights above crowds are prohibited, but flights above people not related to the operation in cities or populated areas is allowed. While there is no airworthiness approval required, industry standards could be applied. Drones are already today available on the market with a number of safety features like parachutes and/or mitigation of failures through software and redundancy. In populated areas drones must be compliant with an acceptable Industry Standard (e.g. EN) requiring adequate safety measures such as assistance to the drone operator to respect maximum altitude and/or to remain outside specified reserved areas. In addition, it is prudent to envisage a maximum mass limit for operations in populated areas. This mass would be defined as a result of the stakeholders consultation envisaged in Paragraph 7, Planning. The requirement to comply with an Industry Standard would not be applicable to toys of less than 500g designed to be operated by children of less than 14 years.

An open category for the operation which can be overseen through the police as for cars for instance, and does not require any authorisation by Aviation Authorities. This group of operations would only be submitted to a minimal aviation regulatory system, concentrating mainly on defining the limits of such a category of operations.

3.2 Specific operation category

The specific category should cover operations that do not meet the characteristics of the open category where a certain risk needs to be mitigated by additional operational limitations or higher capability of the involved equipment and personal.

The operator should perform a safety risk assessment, identifying mitigation measures, that will be reviewed and approved by the National Aviation Authority . The review of the safety risk assessment by the National Aviation Authority would not be necessary if the operator is approved and has the privilege to approve its own safety risk assessment. In case of operations in non-segregated areas, the operator can only approve its own risk assessment when it has received the agreement of the relevant Air Navigation Service provider.

As soon as an operation starts posing more significant aviation risks to persons overflown or involves sharing the airspace, the operation would be placed in a specific category. For these activities, each specific aviation risk would be analysed and mitigation would be agreed by the authorities before the operation can start, based on a safety risk assessment. This would be materialised by the issuance of an authorisation.

For the specific category an “Operations Authorisation” (OA) will be issued either by the National Aviation Authorities (NAA) possibly supported for technical tasks by Qualified Entities(QE) as defined today in the EASA Basic Regulation or by a specifically approved organisation. Such an organisation could be called an accredited body

(to differentiate from a qualified entity) and would have the possibility to perform legal acts such as issuing the authorisation. This option would necessitate a change to the EASA Basic Regulation. The OA should clearly specify the specific conditions and limitations for the intended operation and can be issued to authorise a single event or a series of operations under specified conditions.

The safety risk assessment has to address airworthiness, operating procedures and environment, competence of involved personnel and organisations as well as airspace issues and could be based on the one being defined by JARUS WG-7, or the FOCA-GALLO (guidance for an Authorisation for Low Level Operation) or equivalent processes acceptable to EASA either as Industry standards or acceptable means of compliance.

The minimum level of safety for airworthiness will be based on the results of the safety risk assessment. It may be defined and demonstrated through compliance to acceptable industry standards. It may be acceptable to compensate certain airworthiness risk factors by operational risk mitigating factors (specific limitations on the operations, special qualifications for the personnel, etc). Conversely, in some cases the outcome of the assessment might require a certification of the drone or of specific functions (e.g. safety devices) by the competent authority. Therefore, the issuance of related approvals to equipment suppliers at their request could simplify the operators' safety risk assessment and enable the operator to extend their scope of operations.

The airworthiness assessment is closely linked to the operational environment and procedures; e.g. the operation close to crowds could be acceptable when the vehicle has some additional functionality (e.g. automatic loss of link procedures, impact energy limiting devices) and the operation procedures are adequate.

The required competence of involved staff will also be established on the basis of the safety risk assessment. It could range from specific training up to an EASA licence. Standards can be developed for the assessment of pilots and staff based on which such staff may demonstrate a basic competence.

An operations manual will be required to define the operating procedures, required airworthiness level as well as required competence of involved staff; the type of airspace considering the results of the safety risk assessment.

When the aviation risks rise to a level akin to normal manned aviation the operation would be positioned in the category of **certified** operations. These operations and the aircraft involved therein would be treated in the classic aviation manner. Multiple certificates would be issued as for manned aviation plus some more specific to unmanned aircraft.

3.3 Certified category

This is the third pillar of the proposed regulatory framework. It would be quite comparable to what is done for piloted aircraft. It may be expected that the competent authorities would be the same as for manned aircraft. These competent authorities could rely as of today on Qualified Entities to perform technical tasks.

The need for this third pillar could be debated because one could imagine that the specific category would not have an "upper limit". However, this may be challenged for several reasons: a fully regulated approach may be necessary for political reasons or convenient for practical reasons. It would be difficult for the public to accept that a drone of the size of say an Airbus A320 or a Boeing 737 is not certified. Another reason is that the regulated approach could limit the number of safety risk assessments to be performed when they address comparable operations. The definition of the limit between specific and certified is still open at this stage but could be based on kinetic energy considerations, type of operations and complexity of the drone notably in terms of autonomy.

Pending this criterion is defined, EASA will continue to accept applications for drones of a MTOM above 150kg in accordance with the current scope of EASA activities i.e.

- they are not used exclusively for 'State' services
- the drone has not been designed or modified for research, experimental or scientific purposes

A Type Certificate also covering environmental certification, an individual certificate of airworthiness and individual noise certificate would be issued for each drone. Demonstration of capability for the designer and the manufacturer would take the form of design and production organisation approvals respectively. Combined approvals could be envisaged if there is a modification to the EASA Basic Regulation. Certification Specifications (CS) would be adopted to cover different configurations: fixed wing, rotorcraft, airship and powered lift. The CS would include the specifications for the control station and for command and control (C2). One point of debate could be what the certificate of airworthiness would cover: one combination aircraft-control station or a combination of one aircraft and multiple control stations. The possibility of an independent approval of a control station could be envisaged. For the small drones entering into that category, consideration would be given to apply some of the ideas proposed for light aircraft in the General Aviation Roadmap (e.g. CS containing only the safety objectives detailed by Industry Standards, Production and Maintenance outside approved organisations, etc...).

C2 and Detect and Avoid (D&A) functions could receive an independent approval as one could imagine that the same C2 or D&A system could be installed, of course with adaptations, to different drone Types. CS adopted by EASA or Industry Standards could be used for that independent approval.

Maintenance above a predetermined threshold would be performed in approved organisations and the maintenance personnel approving release to service would be licenced or otherwise authorised.

Pilots would be licenced and the operator would receive an organisation approval.

Integration in non-restricted airspace would be subject to a safety assessment of the ATS provider.

4. Safety promotion actions:

Developing regulations needs to be complemented by safety promotion actions that EASA could initiate to support the Member States. Three proposals could be made all for the open category:

- Develop a **leaflet listing 'do's and don'ts' for drone operators**. Such leaflets have already been developed by some Member States. They could be published on EASA and Member States' websites and with the support of the RPAS community be distributed when drones are bought. Such leaflet should be translated with the support of the RPAS community in all EU languages and cooperation from Member States would be needed.
- **Video** campaigns could also be organised.
- As the **police and other enforcement Agencies** are expected to play a key role in the oversight of the Open category, consideration should be given to provide them with an information manual and a training syllabus after coordination with Member States. There again it would be necessary to translate such manuals in all EU languages and cooperation from Member States would be needed.

Help and advice could be sought from the Federations, clubs and associations of model flyers throughout Europe.

5. Privacy/data protection, security and spectrum:

This concept paper has concentrated on the safety aspects which is a top priority for Aviation. However the risks entailed by drone operations will need to be addressed at the same time as the safety risk.

The privacy risk/ data protection will be dealt with at National Level. The regulatory framework may envisage provisions that could reduce that risk and also the security risk. For example, the risk regarding privacy (data protection) could be mitigated through the operators self-registration in a web based application maintained by the local authorities. Another solution would be to install chips/ Sim cards in drones. Such a web based application or chip/ Sim cards could also contribute mitigating the security risk.

It should be noted that operators may use the same process for safety, privacy and security risk management by taking an integrated approach.

To be able to endorse the regulations for the open category and to give information to the operators on applicable local regulations and restrictions, a standardised web portal could be established. This portal could inform about local regulations and temporary restrictions e.g. due to security issues.

A registration of operations could solve some privacy, security and enforcement issues. For example a requirement in certain areas could be to have signed print of the registration with the applicable conditions.

The availability of spectrum is fundamental to the success of drones. Spectrum decisions are taken in the ITU (International Telecommunication Union). The continuation of the active coordination of Member States already existing in the European Aeronautical Spectrum Frequency Consultation Group (ASFCG) is strongly recommended so that Europe speaks with a single voice and the necessary spectrum is allocated to drone operations.

Additionally and similarly to model aircraft flying today in most of the Member States, a third party liability insurance is foreseen for the 3 categories of operation. Current Regulation (EC) No 785/2004 on insurance requirements for air carriers and operators does not require insurance for model aircraft of less than 20 kg.

6. Outlook:

The further development of drones and their integration in non-segregated airspace will pose new challenges. While today flying a single drone in non-segregated airspace with cooperative aircraft can be done with appropriate coordination and special procedures, operation of several of them possibly with non-cooperative aircraft will be much more complicated and will require additional measures. The concept of operations will need to be further developed to address the issues related to operations of fleet of drones in the non-segregated airspace. These operations of fleet of drones will pose new challenges not yet explored with manned aircraft operations. This integration will need to be done in full coordination with the expected development of the ICAO Aviation System Block Upgrades (ASBU) being implemented in Europe by the SESAR programme.

The key research areas for the integration in non-segregated airspace are as follows:

- Detect & avoid
- Airspace and Airports access
- Command and Control (C2) communications
- Human factors
- Contingency
- Security
- Autonomy

This will need a significant amount of further research to be performed in particular by SESAR and the European Defence Agency (EDA). Cooperation will be necessary to augment synergies and avoid duplications of work.

Factors to be taken into account could be the following (non-exhaustive list):

- Transfer of drones from one control station to another: some drones have a significant range and the transfer from one control station to another needs to be envisaged. The present SESAR experiments have already shown that such transfer should not coincide with the transfer from one ATC sector to another
- Operational Control of several drones from one control station: this is a real possibility and would lead to formation flights, with coordinated flights of the various drones for example to attack efficiently a fire or for crop-spraying
- ATC and operational control done by the same person: this would be an extension of the previous case but will entail new risks and pose new liability issues
- Communications with ATC with an acceptable time of latency
- Full autonomy and cooperative operations (e.g. operation in swarms; network centric operations)
- Extreme endurance (several days even months) at very high altitude (20.000m): how to maintain the necessary vigilance to face emergencies

Integration in non-segregated airspace will require for the Air Navigation Services and the Operators:

- Minimum Navigation, Communication and Surveillance Performance standards
- Adaptation of the Infrastructure
- New Procedures
- Adapted Training

The ATM/ ANS aspect of the concept of operation will need to be further developed or a separate ATM/ANS concept of operations will need to be established which should address short, mid and long term perspectives. However, these perspectives should be based on the development of the drone market and the development of the technologies. These should be carefully monitored and the planning adapted as a consequence.

7. Planning:

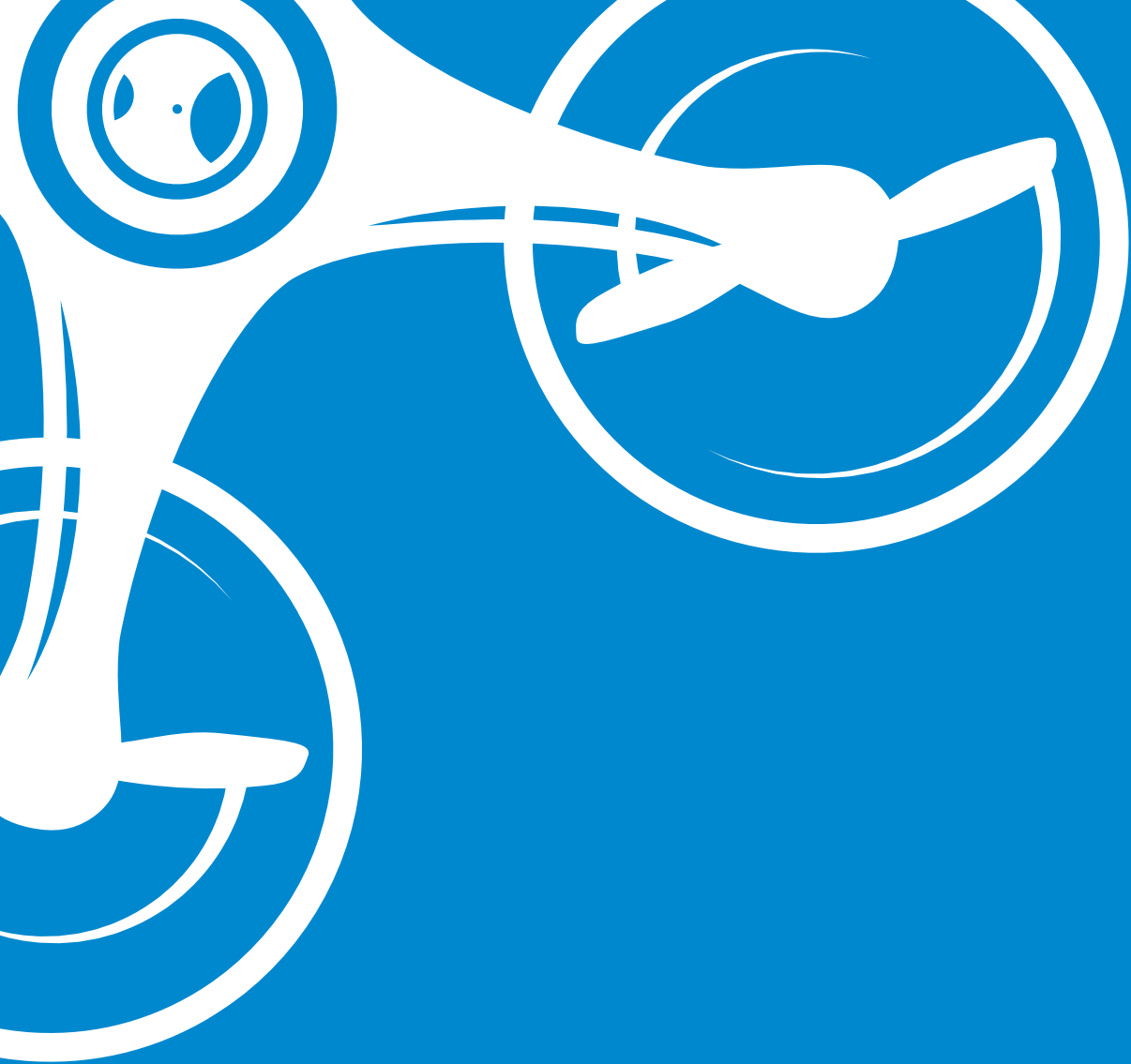
The planning will reflect a progressive introduction in the non-segregated airspace. The development of the rules will be 'market driven' so a detailed mid/long term planning is not provided here, however the following short term actions are identified:

- **Stakeholder consultation on the regulatory framework taking into account the discussions at the Riga Conference to be published for consultation by middle of 2015**
- **Stakeholders consultation on concrete regulatory proposal for open category based on the relevant elements of the regulatory framework and existing National rules to be published for consultation in June 2015**
- **Draft regulatory framework to be presented to the Commission by end 2015**
- **Concrete regulatory proposals for open category to be presented to the Commission in December 2015**

These actions are considered priority actions for 2015, as they address the foundation of the Regulations for drones and the pressing need to harmonise operations of small drones in Europe. This harmonisation has been identified as a key priority by operators of small drones.

A communication plan should be developed in coordination with the European Commission and the Member States to explain and promote the concepts included in the regulatory framework.

Harmonisation of drones rules are a must which is recognised by all parties. This concept for a regulatory framework will be proposed to JARUS and ICAO as the European input thus contributing to global harmonisation.



European Aviation Safety Agency
Ottoplatz, 1
D-50679 Cologne, Germany
easa.europa.eu

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