European Aviation Safety Agency

Notice of Proposed Amendment 2017-05 (B)

Introduction of a regulatory framework for the operation of drones

Unmanned aircraft system operations in the open and specific category

RMT.0230

EXECUTIVE SUMMARY

In accordance with Regulation (EC) No 216/2008 (hereinafter referred to at the 'Basic Regulation'), the regulation of unmanned aircraft systems (UAS) with a maximum take-off mass (MTOM) of less than 150 kg falls within the competence of the European Union (EU) Member States (MSs). This leads to a fragmented regulatory system hampering the development of a single EU market for UAS and cross-border UAS operations. A new proposed Basic Regulation (hereinafter referred to as 'the new Basic Regulation'), currently under discussion between the Council, the European Commission, and the European Parliament, aims to solve this issue, by extending the competence of the EU to regulate all UAS regardless of their MTOM.

In view of the adoption of this new Regulation, the objective of this Notice of Proposed Amendment (NPA) 2017-05 is:

— to ensure an operation-centric, proportionate, risk- and performance-based regulatory framework for all UAS operations conducted in the open and specific category;
— to ensure a high and uniform level of safety for UAS;
— to foster the development of the UAS market; and
— to contribute to enhancing privacy, data protection, and security.

This NPA proposes to create a new regulation (hereinafter referred to as 'Regulation (EU) 201X/XXX') defining the measures to mitigate the risk of operations in:

— the open category through a combination of limitations, operational rules, requirements for the competence of the remote pilot, as well as technical requirements for the UAS; and
— the specific category through a system including a risk assessment conducted by the operator before starting an operation, or the operator complying with a standard scenario, or the operator holding a certificate with privileges.

Regulation (EU) 201X/XXX will provide flexibility to MSs mainly by allowing them to create zones on their territory where the use of UAS would be prohibited, limited or on the contrary facilitated.

Pursuant to new Basic Regulation, market product legislation (CE marking) ensures compliance with the technical requirements for mass-produced UAS operated in the open category. A dedicated Annex (Part-MRK) to Regulation (EU) 201X/XXX is proposed to define the conditions for making UAS available on the market.

Regulation (EU) 201X/XXX is expected to increase the level of safety of UAS operations, harmonise legislation among the EU MSs, as well as create an EU market that will reduce the cost of the UAS and allow cross-border operations.

Note: sub-NPA 2017-05 (A) contains the explanatory note and the proposed draft rules, whereas sub-NPA 2017-05 (B) contains the full impact assessment (IA) for this RMT.

Action area:	Civil drones (UAS)		
Affected rules:	N/a		
Affected stakeholders:	Operators (private and commercial); competent authorities; MSs; flight crews; remote pilots; maintenance staff; UAS manufacturers; other airspace users (manned aircraft); service providers of air traffic management (ATM)/air navigation services (ANS) and other ATM network functions; air traffic services (ATS) personnel; aerodromes; general public; model aircraft associations		
Driver:	Efficiency/proportionality; safety	**Rulemaking group:**	No, but expert group
Impact assessment:	Full	**Rulemaking procedure:**	Standard

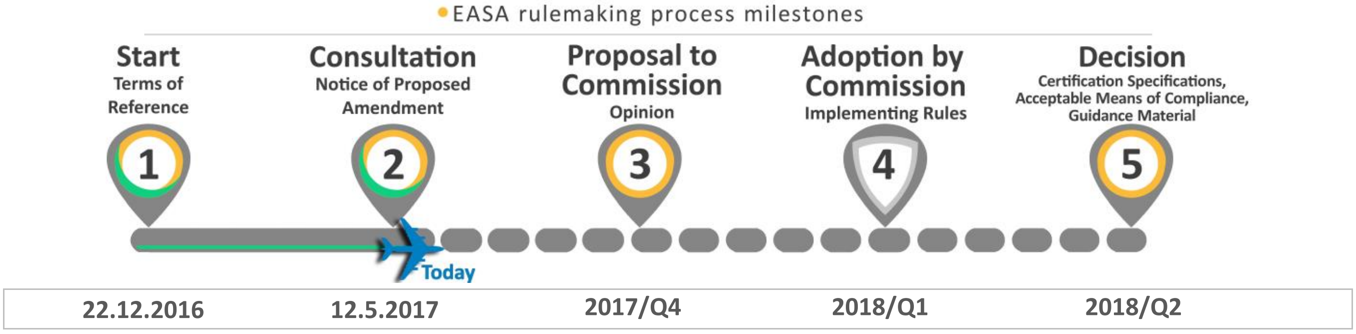

Table of contents

Summary

Unmanned aircraft systems (UAS) can offer a great potential in various sectors due to the services they provide; precision agriculture, inspection, and delivery are only some of the examples of how various sectors could be affected by UAS. The use of UAS can bring the following benefits:

— a safer way to do business without risk to human lives;

— additional business (e.g. new services);

— efficiency; and

— creation of employment opportunities.

However, operating UAS in the present aviation environment raises concerns about safety, security, privacy, data protection, and the environment. The challenge is therefore to develop rules that will satisfactorily address those concerns, allowing at the same time the market for UAS services to fully develop.

The purpose of this impact assessment (IA) is to provide:

— a quantitative and qualitative analysis, based on which the most beneficial rulemaking option is selected; and

— an understanding of the various impacts of all analysed options.

As already explained, the new Basic Regulation would extend the competence of the EU to regulate all UAS regardless of their MTOM (also UAS of < 150 kg). An IA in this regard has already been prepared by the European Commission to support such an extension.

This IA focuses on the operation of UAS in the open and specific category[1] under this Subtask (SubT) 1 of the rulemaking task (RMT.0230).

The general issue related to this IA is outlined above. The specific issues identified and detailed in the IA are the following:

— lack of clarity and non-harmonised definition of categories of UAS operation boundaries, including disproportionate rules for special categories;

— lack of protection of sensitive areas;

— inadequate technical requirements;

— lack of airspace classification and of rules for low-level operations;

— inadequate competences of remote pilots; and

— need for registration and identification.

These issues are also included in a 'problem tree'[2] with a view to clarifying their primary causes (drivers) as well as their consequences. These consequences are grouped as follows:

— ground risk (accidents/incidents involving persons on the ground or sensitive areas);

[1] The open and specific category are defined in Section 1.1.2.1.2.

[2] See Section 1.2.3.

— air risk (collision risk, air proximity, accidents and incidents with manned aircraft);

— violation of privacy, data protection, and security; and

— barriers to the market, burden for industry, locked potential for innovation and development.

The first two consequences are strictly linked to safety and they have been analysed in a detailed safety risk assessment showing an exponential increase of sightings of UAS by manned aircraft. It is evident that there is a potential high safety risk, in particular considering the fast-developing UAS market.

In order to address the risk identified, three sets of options are proposed, together with the corresponding analysis of impacts based on various criteria (social, economic, safety[3]). These sets of options that complement but not substitute each other cover the following areas:

— open category: the aim of the analysis is to find a balance between operational limitations (UAS MTOM, UAS distance from crowds, height of the UAS), remote-pilot competence and age, as well as technical requirements;

— registration: the analysis is horizontal across categories, mainly addressing security and privacy risk; and

— specific category: a proportionate approach is sought for the authorisation of such operations.

The analysis of the impacts is supported by qualitative and quantitative data, making use of the input received from a dedicated expert group as well as of the results of surveys sent out to, and responded to by, competent authorities, manufacturers, operators, model aircraft associations and training schools.

Based on the analysis, the preferred options for each area are the following:

— **Open category**: Option O3, corresponding to a proportionate approach between UAS technical requirements, operational limitations, and remote-pilot competence, strikes the best compromise between safety and cost, having also a good social impact. Subcategorisation and definition of airspace areas or special zones provide flexibility to the MSs. Option O3 was generally supported by the UAS expert group[4].

— R**egistration**: through Option R3, corresponding to the registration of all operators conducting unmanned aircraft (UA) with an MTOM greater than 250 g as well as the registration of the UA itself when it has an MTOM greater than 900 g, a good balance between the size of the UAS, proportionate to its potential hazard, and the related economic impact is achieved. In general, registration as an option is mainly driven by law enforcement considerations as well as by the security and privacy risk. In that respect, Option R3 strikes the best compromise between cost and mitigation of those risks, considering that UAS with an MTOM of less than 900 g account for circa 50 % of the current market.

— **Specific category**: Option S3 follows the most cost-effective approach. It proposes to complement the authorisation required to conduct UAS operations with standard scenarios issued by EASA, thus substantially reducing the burden for operators and competent authorities. In addition, the operator may choose to apply for a light UAS operator certificate (LUC) with the ultimate privilege to approve its own operations.

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[3] A brief analysis of proportionality and environmental aspects has been added as well, where relevant.

[4] See Section 2.3.1.1 of sub-NPA 2017-05 (A).

1. Problem definition

1.1. Overview of the issue and main principles

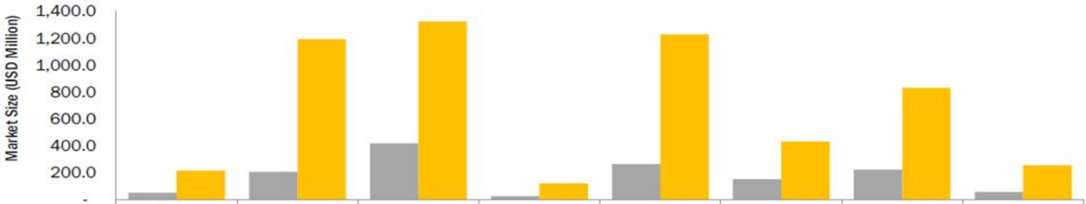
1.1.1. Background

UAS are not a new phenomenon as they date back to the mid-18th century, but their development in the civil market is relatively recent. Until a few years ago, UAS were being developed and used almost exclusively in the military sector. Their great potential for developing innovative applications, however, is now recognised also in the civil sector, in terms of performing useful tasks and creating new jobs. UAS, rapidly expanding in EASA MSs[5] and worldwide, are used in various areas as, for example the following: precision agriculture, infrastructure inspection and monitoring, natural-resources monitoring, environmental compliance, atmospheric research, media and entertainment, sport photos, filming, wildlife protection and research, disaster relief etc. Size, configuration and complexity of the UAS are extremely varied as well, and correspond to different types of operations and users. They are designed and manufactured not only by classical aviation companies but also by others, in many cases small and medium-sized enterprises (SMEs)[6].

Technology has then allowed to explore new uses of drones for civil applications. In Appendix I (see Section 9.1), detailed examples on the uses of UAS based on a questionnaire sent by EASA to UAS operators are presented.

1.1.1.1. UA market outlook — Important growth over the next years

Looking at the evolution of UAS for the period 2015-2020, described in a worldwide market research focussing on UAS below 25 kg, in 2015, media and entertainment seem to account for the highest market share with a compound annual growth rate (CAGR) of 26 % (2020 forecast value: circa USD 1,3 billion), followed by inspection/monitoring, and hobbyist & DIY (do-it-yourself). According to the forecast values for 2020, media and entertainment could still be on top of the list, followed by inspection/monitoring and precision agriculture. More details are included in Graph 1a below:



	Law Enforcement/ Public Safety	Precision Agriculture	Media and Entertainment	Retail	Inspection/Monitoring	Surveying/Mapping	Hobbyist and DIY	Education
2015	49.3	204.9	416.8	24.0	262.6	149.9	221.9	55.0
2020	212.9	1,193.5	1,323.8	119.7	1,228.9	430.8	831.3	254.2
CAGR % (2015-2020)	33.99%	42.25%	26.00%	37.89%	36.16%	23.50%	30.23%	35.81%

Graph 1 — Global UAS market size, by application, 2015-2020 (in USD million). Source: market research report 'UAV Drones Market by Type (Fixed wing, Rotary Blade, Nano, Hybrid), Application (Law Enforcement, Precision

[5] The 28 EU MS plus Iceland, Lichtenstein, Norway, and Switzerland.

[6] See 'Concept of Operations for Drones — A risk based approach to regulation of unmanned aircraft', available at https://www.easa.europa.eu/system/files/dfu/204696_EASA_concept_drone_brochure_web.pdf.

Agriculture, Media and Entertainment, Retail) & Geography (Americas, Europe, APAC, Row) — Analysis & Forecast to 2020' MarketsandMarkets, 2015.

Application	2014	2015	2016	2017	2018	2019	2020	CAGR (2015–2020)
Law Enforcement/Public Safety	15,753	37,670	63,769	93,406	124,575	158,572	198,489	39.43%
Precision Agriculture	41,212	94,429	177,837	284,589	408,942	554,703	733,356	50.68%
Media and Entertainment	157,921	290,567	449,414	600,057	727,574	839,398	948,953	26.71%
Retail	8,331	16,662	28,054	40,849	54,130	68,429	85,031	38.54%
Inspection and Monitoring	92,533	183,036	304,970	439,683	577,203	723,215	891,135	37.24%
Surveying and Mapping	53,151	98,658	151,885	201,723	243,106	278,506	312,293	25.92%
Hobbyist and DIY	81,872	156,499	252,050	351,389	446,223	541,018	645,275	32.75%
Education	19,405	38,807	65,313	95,046	125,858	158,966	197,341	38.44%
Total	**470,176**	**916,329**	**1,493,290**	**2,106,742**	**2,707,611**	**3,322,807**	**4,011,873**	**34.36%**

Table 1 — Global UAS market size, by application, 2015-2020 (in USD million). Source: market research report 'UAV Drones Market by Type (Fixed wing, Rotary Blade, Nano, Hybrid), Application (Law Enforcement, Precision Agriculture, Media and Entertainment, Retail) & Geography (Americas, Europe, APAC, Row) — Analysis & Forecast to 2020' MarketsandMarkets, 2015.

UAS can vary according to several parameters such as:

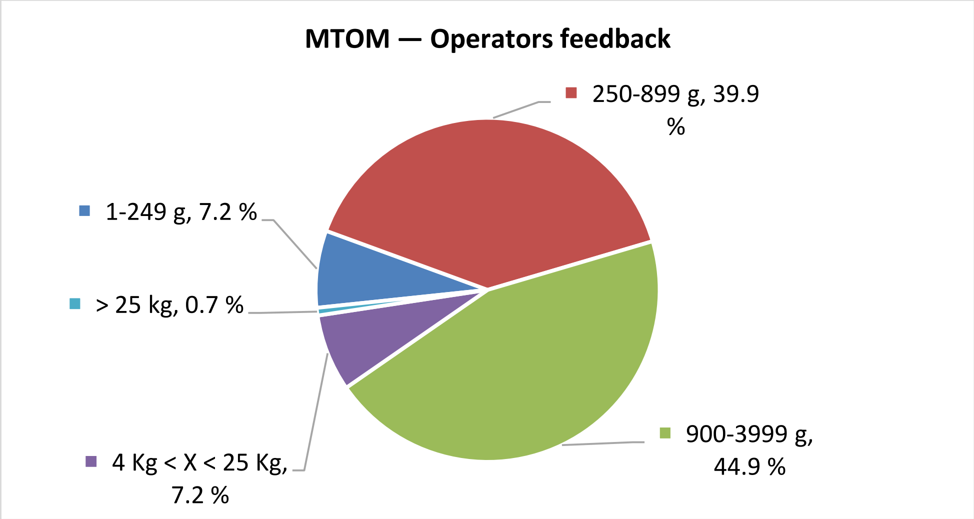
— MTOM: from a few grams up to hundreds of kilograms;

— type: rotary wing, fixed wing, hybrid, nano[7]; and

— function: monitoring and surveillance, parcel transport, etc.

In terms of weight, in the segment of small-UAS of less than 25 kg, more than 90 % of them have an MTOM between 0 and 4 kg, according to the replies received on an EASA questionnaire (see Section 1.1.6 'EASA consultation strategy'). The following diagram shows a graphical representation of these replies and it refers only to the UAS types (production units are not considered); the MTOM categories have been defined in a way to help analyse the impacts of the options proposed.

[7] Palm-sized UAS with an MTOM of less than 30 g (approximately 1 oz), which have more capabilities than many larger UAS. They utilise advanced navigation systems, full-authority autopilot technology, digital data links, and multi-sensor payloads. The operational radius is more than 1.5 km, and they are flown safely in strong wind. Future development will yield even smaller and more advanced nano UAS with indoor capability and a high level of autonomy.



Graph 2. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

Among the various types of UAS, the one with the highest number of units worldwide is the rotorcraft type, followed by the fixed-wing type, and the nano-type. Further details are presented in Table 2 below:

Type	2014	2015	2016	2017	2018	2019	2020	CAGR (2015–2020)
Fixed Wing	9,826	17,698	26,700	34,630	40,577	44,943	48,365	22.27%
Rotary Blade	460,351	887,755	1,442,558	2,029,252	2,600,367	3,181,745	3,830,073	33.96%
Nano	-	8,110	14,849	23,268	32,902	44,080	57,721	40.41%
Hybrid	-	2,771	9,198	19,624	33,820	52,124	75,837	69.45%
Total	**470,176**	**916,333**	**1,493,306**	**2,106,775**	**2,707,666**	**3,322,892**	**4,011,995**	**34.36%**

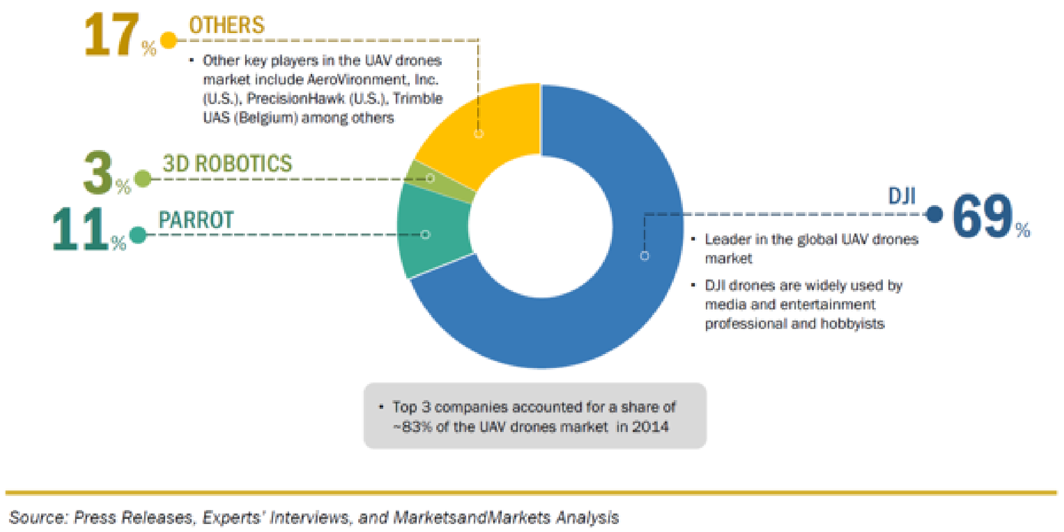
Table 2 — Global UAS market size, by type, 2014-2020 (units). Source: market research report 'UAV Drones Market by Type (Fixed wing, Rotary Blade, Nano, Hybrid), Application (Law Enforcement, Precision Agriculture, Media and Entertainment, Retail) & Geography (Americas, Europe, APAC, Row) — Analysis & Forecast to 2020' MarketsandMarkets, 2015.

As regards the geographical distribution of UAS worldwide, in 2018, the Americas (USA, Canada, Mexico, and Brazil) is the area expected to account for the largest share of the global commercial UAS market, followed by Asia-Pacific (APAC), and Europe.

Region	2014	2015	2016	2017	2018	2019	2020	CAGR (2015–2020)
Americas	467.4	896.9	1,449.4	2,026.6	2,580.0	3,134.6	3,744.6	33.09%
Europe	129.3	234.1	355.7	465.9	553.4	624.5	689.5	24.12%
APAC	85.9	172.9	291.6	423.6	558.0	698.7	857.2	37.74%
RoW	42.6	80.6	128.2	176.0	219.5	260.7	303.9	30.39%
Total	725.2	1,384.5	2,224.9	3,092.1	3,910.9	4,718.5	5,595.2	32.22%

Table 3 — Global UAS market size, by region, 2014-2020 (USD Million) Source: market research report 'UAV Drones Market by Type (Fixed wing, Rotary Blade, Nano, Hybrid), Application (Law Enforcement, Precision Agriculture, Media and Entertainment, Retail) & Geography (Americas, Europe, APAC, Row) — Analysis & Forecast to 2020' MarketsandMarkets, 2015.

Apart from being fast-evolving, the UAS market is characterised by the presence of many actors relatively new to the aviation sector. This relates for instance to UAS manufacturers. Indeed, as shown in Graph 3 below, an important market share is accounted for by companies that are not familiar with aviation regulation.



Graph 3 — Global commercial drone market share analysis by key player, 2014. Source: market research report 'UAV Drones Market by Type (Fixed wing, Rotary Blade, Nano, Hybrid), Application (Law Enforcement, Precision Agriculture, Media and Entertainment, Retail) & Geography (Americas, Europe, APAC, Row) — Analysis & Forecast to 2020' MarketsandMarkets, 2015.

Conclusions:

— The great variety of UAS MTOM/size implies different level of risks, therefore, regulation must be risk-based.

— The importance of the development of precision agriculture and infrastructure inspection highlights the need to have an efficient specific category, especially when important areas need to be monitored.

— UAS is a rapidly evolving market, as shown by the number of UAS expected in the next years[8].

— Hobbyist activities account for an important market share, which should be therefore taken into account in the regulation.

— UAS with an MTOM of less than 4 kg operated in the open category will continue to represent a very important part of the market. This limit indicates that a subcategory of approximately 4 kg MTOM should be also considered.

— The UAS market involves many actors that are completely new to the aviation sector[9].

1.1.1.2. SESAR Outlook Study10

In November 2016, the Single European Sky ATM Research (SESAR) Joint Undertaking (SJU) issued the 'European Drones Outlook Study: Unlocking the value for Europe' providing insights into the use of UAS. The forecast reaches 2050 and focuses on UAS operation within European skies, including economic indicators reflective of European demand. The study includes the following interesting information:

— Europe is a growing UAS marketplace with potential; European demand may exceed the value of EUR 10 billion on an annual basis in nominal terms by 2035, and that of EUR 15 billion by 2050.

— Indirect macroeconomics and societal externalities of a potential UAS industry to be considered:

- increasing the success of search and rescue (SAR) missions;
- preventing chemicals impacting natural environments through precision agriculture; and
- software developers creating applications for UAS.

— The UAS industry impact on the labour market could be the creation of an additional 250 000-400 000 jobs.

— Some 7 million consumer leisure UAS are expected to be operating across Europe, and a fleet of 400 000 is expected to be used for commercial and government missions in 2050.

— In the longer term, larger commercial UAS are gradually expected to be equipped with initial versions of optionally piloted systems, estimated for some time after 2030, first impacting cargo transport and then moving slowly towards the transport of passengers. The feasibility of such solutions will require significant societal acceptance as well as a number of critical advancements in technology and regulation.

— There are new aviation actors, including new ventures and industrial leaders considering the use of UAS for their business.

— UAS technology supports the development of new solutions, such as the provision of communication access, or of wind energy using UAS attached to the ground.

The following Figure 1 summarises the main outcomes of the study:

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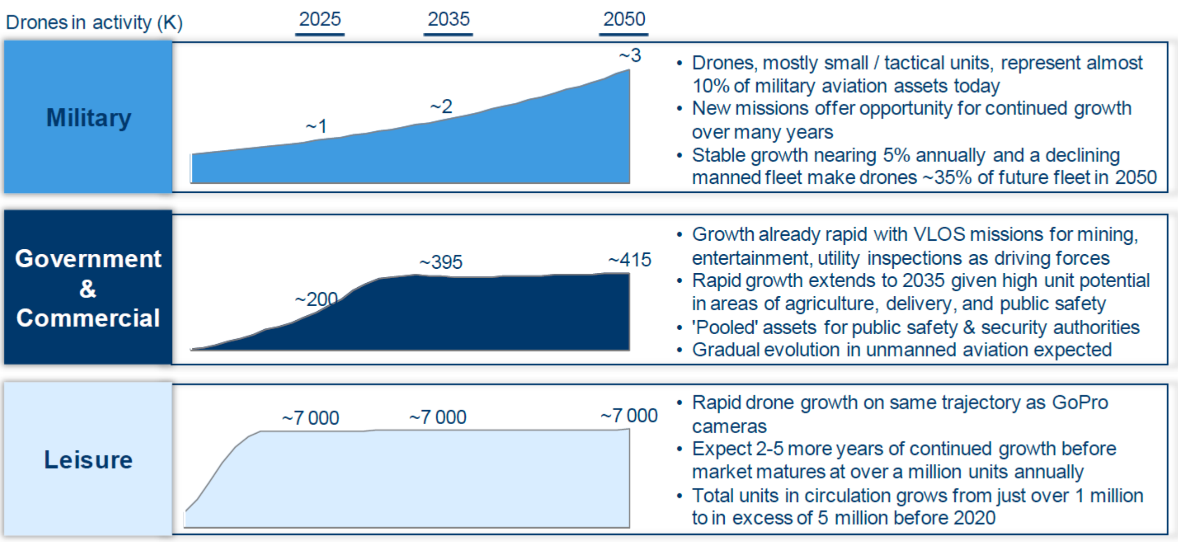
[8] See also Section 1.2.3.1.3 'Driver 3 —rapidly changing UAS technologies and fast-evolving UAS market'.

[9] See also Section 1.2.3.1.2 'Driver 2 — New actors compared to manned aviation and different uses (commercial/leisure)'.

[10] http://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf

Figure 1. Source: SESAR Outlook Study.

As regards the evolution of the market, the following Graph 4 shows the total UAS fleet size (forecast until 2050) for military, government, commercial and leisure operations, including some detailed comments:



Graph 4. Source: SESAR Outlook Study.

Conclusions:

— This study confirms the conclusions drawn from Section 1.1.1.1, notably on inspection, precision agriculture and hobbyist activities.

— Research and development (R&D) investment will identify new technologies and operations, which justifies the need for performance-based regulations.

— The study envisages the invention of passenger-carrying UAS, which would be most likely addressed under the certified category.

— The UAS market is rapidly evolving not only with respect to leisure operations but also for governmental, commercial, and military uses. In addition, it involves actors that are new to the aviation sector.

1.1.2. Current EU framework

1.1.2.1. Review of the Basic Regulation

The Basic Regulation establishes the main principles and rules for civil aviation in the EU. It also defines the area of competence of the EU and the MSs, listing the categories of aircraft regulated at national level. Among them are UA with an MTOM of less than 150 kg. This has created disharmonisation across the EU, hampering the growing business of civil unmanned aviation.

To solve this issue and foster this promising business, unmanned aviation was included into the **new European Aviation Strategy**, as one of its key elements, in line with the Riga Declaration on remotely piloted aircraft (drones)[11].

A proposal for a new Basic Regulation is currently under discussion between the Council, the European Commission, and the European Parliament.

The proposal includes the following key elements on UAS:

— extend the EU competence to regulate all UAS; and

— provide the regulatory framework for a risk-based approach allowing use of market product regulation for enforcing technical requirements on UAS.

Even if this Regulation is still under discussion, it was agreed that EASA would issue an NPA proposing a new implementing regulation on UAS in order to be able to issue the related opinion as soon as the new Basic Regulation is adopted.

1.1.2.2. A-NPA 2015-10 and Technical Opinion

Further to the publication of Advance Notice of Proposed Amendment (A-NPA) 2015-10[12] on 31 July 2015, EASA issued a Technical Opinion in December 2015[13]. The Technical Opinion proposes a risk-based, operation-centric concept, by grouping UAS operations into the following three main categories:

— **open category** operations, considering the risks involved, require neither an authorisation by the competent authority nor a declaration by the UAS operator before the operation takes place;

— **specific category** operations, considering the risks involved, do require an authorisation by the competent authority before the operation takes place and take into account the mitigation measures identified in an operational risk assessment, except for certain standard scenarios for which a declaration by the UAS operator is sufficient.; and

— **certified category** operations that, considering the risks involved, require the certification of the UAS and its operator, as well as licensing of the flight crew.

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[11] http://ec.europa.eu/transport/sites/transport/files/modes/air/news/doc/2015-03-06-drones/2015-03-06-riga-declaration-drones.pdf

[12] https://www.easa.europa.eu/system/files/dfu/A-NPA%202015-10.pdf

[13] https://www.easa.europa.eu/system/files/dfu/Introduction%20of%20a%20regulatory%20framework%20for%20the%20operation%20of%20unmanned%20aircraft.pdf

1.1.2.3. Prototype Regulation

Further to A-NPA 2015-10 and the Technical Opinion, the European Commission published a road map[14] that included a plan for developing the operation-centric concept. In order to provide the basis for an advance discussion, EASA developed a 'Prototype' Regulation[15] on UAS, deviating from its rulemaking process. Comments from stakeholders where collected and analysed, including more than 1 100 emails, 70 % of which were from hobbyists (model and privately built aircraft). Furthermore, organisations, manufacturers and competent authorities commented on the Regulation (total number of comments: 550 approximately). All the input received was taken into consideration for the development of this NPA.

1.1.2.4. Focus of this sub-NPA 2017-05 (B)

This proposal and, therefore, this IA focuses on UAS operated in the open and specific category. The UAS operation in the certified category will be the subject of future NPAs[16].

1.1.2.5. European Commission IA

In support of its proposal submitted to the European Parliament and the Council in December 2015, the European Commission published its IA[17] for the new Basic Regulation. The document analysed the following main issues:

— the current regulatory system hampers the UAS market development; and

— UAS operations cause risks not adequately addressed by existing rules.

The identified drivers of these issues are:

— the responsibilities for regulating UAS are divided between EU and MSs, which leads to diverging requirements in the internal market;

— the individual authorisations are too costly, too time-consuming and resource-intensive;

— the existing methods of civil aviation regulation are not always suited to the specificities of UAS; and

— the oversight and law enforcement authorities lack proper information and instruments.

This IA proposed as preferred option a risk-based EU legislation on UAS and EU product legislation for the case of low-risk UAS operations. This would allow to tackle safety risk in a less burdensome way.

The above-mentioned document was taken into consideration as one of the key inputs for developing this IA and is, therefore, largely reflected throughout this NPA.

More precisely, the aforementioned drivers have been addressed as follows in the NPA:

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[14] It was developed during three workshops held with MSs (in March, April, and May 2016, respectively), and presented to industry at a dedicated workshop in June 2016.

[15] http://www.easa.europa.eu/system/files/dfu/UAS%20Prototype%20Regulation%20final.pdf

[16] For further reference, see the related Terms of Reference (ToR) RMT.0230 Issue 1 at: https://www.easa.europa.eu/system/files/dfu/ToR%20RMT.0230%20Issue%201.pdf.

[17] http://ec.europa.eu/transparency/regdoc/rep/10102/2015/EN/SWD-2015-262-F1-EN-MAIN-PART-2.PDF

— divided responsibilities: the objective of this NPA is to propose a common rule for all UAS operations;

— individual authorisations: a proportionate approach is envisaged with alternative solutions;

— not always suitable traditional methods and processes: an operation-centric approach is followed; and

— oversight and law enforcement: a system of registration and electronic identification is proposed.

1.1.2.6. Safety promotion

Safety promotion is a useful tool that can help to provide both the public and commercial UAS operators with a better understanding of how to use UAS safely.

EASA has initiated so far several safety promotion activities in that respect.

Past/current activities

The following EASA safety promotion material has been published on the EASA 'Civil drones (Unmanned aircraft)' webpage[18]:

— a poster[19]; and

— a video[20].

1.1.2.7. New programmed activities

According to the 2017-2011 Rulemaking and Safety Promotion Programme including the European Plan for Aviation Safety (EPAS)[21], a project for coordinating activities at European level to promote the safe operation of UAS to the general public is planned for 2018.

In addition, the following safety promotion activities might be considered:

— a 'Single Europe' campaign with shared materials between EASA and MSs;

— individual national campaigns with tailored material sharing as many resources as possible;

— gathering best practices on the safety promotion of UAS among the European Civil Aviation Conference (ECAC) MSs; in the UK, for instance, a website was designed to reach new audiences, encourage uptake of the information, and ensure that UAS users can easily access the information they need about how to fly their UAS safely and legally without endangering the others[22]; and

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[18] https://www.easa.europa.eu/easa-and-you/civil-drones-rpas and https://www.easa.europa.eu/easa-and-you/safety-management/safety-promotion

[19] https://www.easa.europa.eu/system/files/dfu/EASA%20Drone%20Safety%20Leaflet_web.pdf

[20] https://www.youtube.com/watch?v=5Xs_eVx4nuw&feature=youtu.be

[21] http://www.easa.europa.eu/system/files/dfu/RMP-EPAS_2017-2021.pdf (see p. 56).

[22] http://dronesafe.uk/

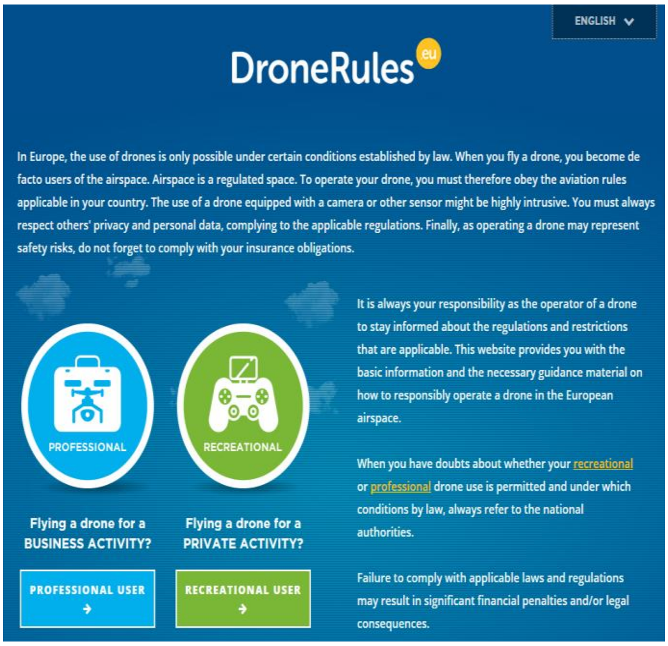
— action has been taken within the safety promotion network (SPN) to collect MSs' best practices[23].

1.1.2.8. DronesRules.eu[24]

Apart from EASA initiatives on safety promotion, the European Commission (i.e. Directorate General (DG) Growth) is developing a multilingual portal, the DronesRules.eu website, under the COSME programme, aiming to support stakeholders' awareness of, and access to, the regulatory framework for UAS operations.

The programme covers both recreational and professional UAS operations, and focuses on key aspects such as data protection and privacy, safety, as well as liability and insurance.

The website will progressively be updated with e-learning material such as a quick-start guide, handbooks, case studies, quizzes, tutorials, etc. This material will provide (in the three domains covered: safety, privacy, and insurance) a basic understanding of the UAS rules, concrete examples of low- and high-risk practices, a code of conduct, tips and general principles for lowering the risk, and specific tools such as a checklist for a privacy IA. It also aims at creating a one-stop shop providing anybody in Europe with easy access to practical information about European authorities and NAAs, legislation, procedures, and support material.



In the last months of the programme, extensive promotional campaigns will be conducted to ensure high visibility of the website and an extensive use across Europe. The website should become the reference for the regulation of UAS in Europe, having the unique feature to bring together all EU and national rules under the aspects of safety, privacy, and insurance.

This EUR 1-million programme started in October 2015 and will end in December 2017. The European Commission is the owner of the material produced that will allow to build future awareness and take action for training.

To reinforce the privacy and data protection dimension of the Dronerules.eu programme and support UAS businesses in complying with their obligations, DG GROWTH launched a call for tender (end date 4 April 2017) dedicated to the development of advanced e-learning and training tools in the privacy and data protection area.

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[23] https://www.easa.europa.eu/easa-and-you/safety-management/safety-promotion/safety-promotion-network-spn
[24] http://dronerules.eu/en/

1.1.3. International Civil Aviation Organization (ICAO)

In 2011, ICAO issued Circular 328 AN/190)[25], considered as a first attempt to develop an international regulatory framework towards global harmonisation in the regulation of UAS.

Integration will require the implementation of harmonised Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS). The ICAO Remotely Piloted Aircraft Systems (RPAS) Panel is working on these deliverables, and the first SARPS are expected to be published in 2018 (remote-pilot licence). The scope of the ICAO RPAS Panel is currently limited to certified RPAS operating internationally under instrument flight rules (IFR) in non-segregated airspace and at aerodromes.

Furthermore, ICAO has developed an online UAS toolkit[26] to assist States in developing national regulations for domestic UAS operations.

1.1.4. JARUS

The Joint Authorities for Rulemaking on Unmanned Systems (JARUS)[27] is composed of a group of experts from national aviation authorities (NAAs) and regional aviation safety organisations. EASA is an active participant of the group, whose aim is to develop harmonised rules for UAS, by recommending technical, safety and operational requirements for the certification of UAS and their safe integration into airspace and at aerodromes. JARUS has developed several documents for the development of a Regulation (EU) 201X/XXX, such as on the initial operation-centric approach for categories, and is developing the SORA for the specific category.

1.1.5. Current regulatory framework at MS level

As the regulation of UAS with an MTOM of less than 150 kg falls within the MSs' competence pursuant to the Basic Regulation, at least 19 MSs have already adopted and implemented, or are currently developing, legislation related to UAS.

Appendix V[28] provides an overview of the existing UAS regulations in 19 MSs. It may not provide a full picture of the EU market, but it contains useful information on the current situation.

The analysis shows a fragmentation at EU level in terms of categorisations, operational limitations and remote-pilot competence required.

Some important elements of these national regulations in place are the following:

— Most regulations **focus on the professional use of UAS**. For recreational use, most MSs give some basic recommendations through leaflets, educational videos, etc.

— Most regulations focus on **small UAS** (in most cases, the threshold is an MTOM of 25 kg). Larger UAS usually require an authorisation on a case-by-case basis (including a certificate of airworthiness (CofA) or permit to fly).

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[25] http://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf

[26] The UAS toolkit is accessible at www.icao.int/rpas.

[27] JARUS is a cooperation of around 50 civil aviation authorities worldwide, including EASA and EUROCONTROL. JARUS published several related documents available at http://jarus-rpas.org/

[28] Main source used is the SESAR Outlook Study, but other sources have also been taken into account.

— The operations allowed are usually in **VLOS**, but BVLOS operations may also be allowed or authorised in specific cases.

— A **maximum height (above ground level (AGL)) for UAS operations** is established in most cases. The most common values for operations outside segregated airspace are the following:

- 400 ft/120 m (e.g. Ireland, Malta, the Netherlands, Spain, Sweden, the United Kingdom (UK));
- 500 ft/150 m (e.g. Finland, France, Italy); and
- 300 ft/100 m (e.g. Belgium, Czech Republic).

Height restriction, however, could significantly limit beneficial uses of UAS.

— A **maximum distance of the UA to the remote pilot** is established in most cases. For VLOS operations, a number of national regulations just indicate that the UA must be within the visual line of sight of the remote pilot.

— A **minimum distance to aerodromes** is also defined in most regulations. There is a variety of values across the various national regulations. The most common value is 5 km (e.g. Denmark, Finland, Italy, Norway, Poland, Switzerland). The reference point from which the distance is measured is not always clearly indicated.

— **Remote-pilot competence**: several MSs require a pilot certificate/license based on risk for example. In some cases, self-study or online training or an examination is required. Some MSs mandate also a medical check.

— **Definition of categories**: some MSs define several subcategories while others only have one for UAS with an MTOM of 25 kg.

— **Registration and an identification (ID) plate** is required in several MSs.

— **Technical requirements**: only in few MSs (Italy and France), technical requirements are in place.

The information included in Appendix V forms the basis for defining Option 0 (the 'baseline scenario') and its impacts, and helps compare the baseline scenario with other options proposed. Overall, Appendix V shows that there are:

— MSs with strict requirements;

— MSs following a simple and not very demanding approach; and

— MSs taking a mixed approach.

Assessing the dynamic aspect of the baseline scenario — how the situation would evolve if no action is taken — is challenging because it is not easy to predict what each MS would decide to do. Nevertheless, a brief analysis of this aspect of the baseline scenario is provided in several parts of Section 1.2.4.

This Section 1.1.5 confirms the fragmentation of UAS regulation in Europe, which is further discussed in Section 1.2.3.1.1 'Driver 1 — Need for cross-border UAS operations and for EU market requirements'.

1.1.6. EASA consultation strategy

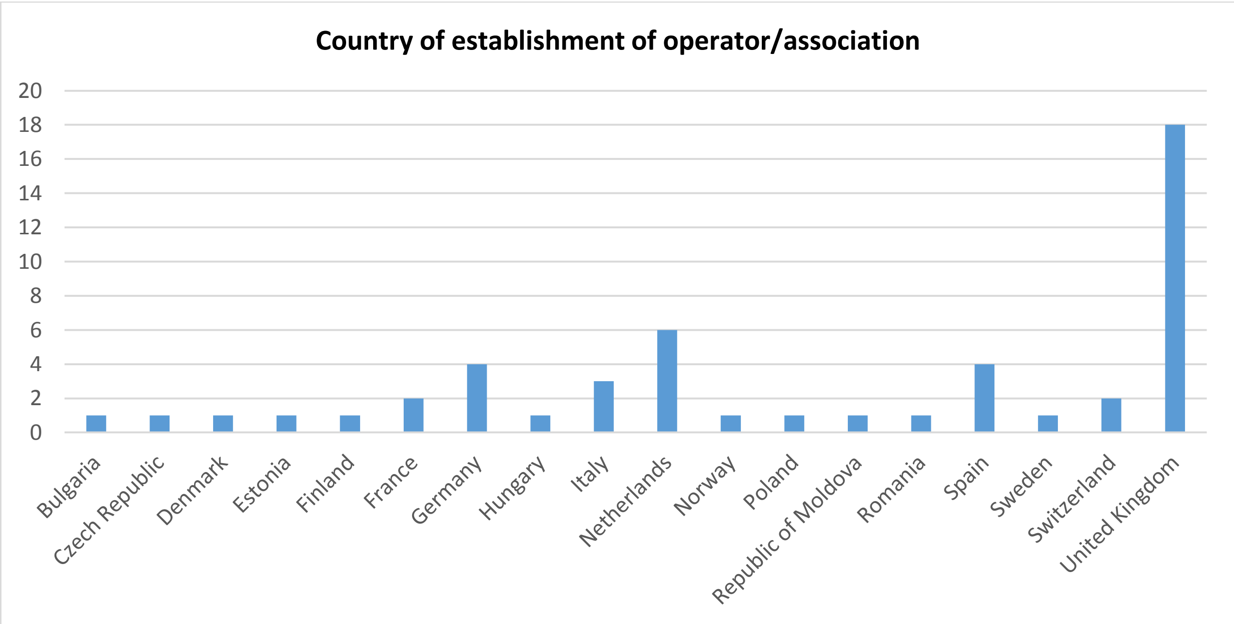
EASA consulted stakeholders in several ways throughout the development of this NPA. The following is only a brief overview:

- UAS questionnaire for operators;
- UAS questionnaire for manufacturers;
- UAS questionnaire for authorities;
- UAS questionnaire for training schools;
- feedback from expert group;
- contacts with manufacturers; and
- UAS questionnaire for model aircraft associations.

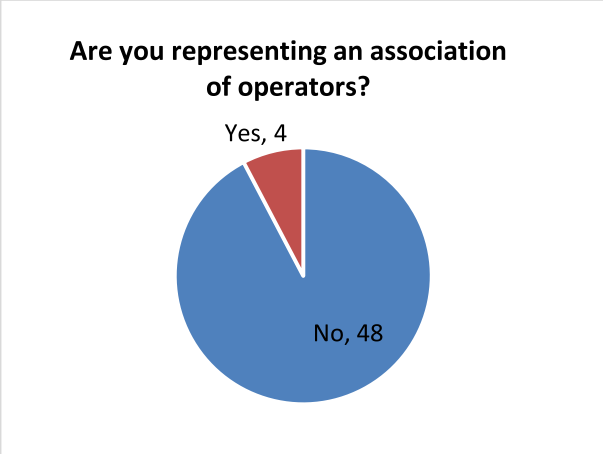
The results of the various consultations are presented throughout this NPA, e.g. in several graphs or quoted comments from stakeholders. The following Sections contain a brief description of each questionnaire.

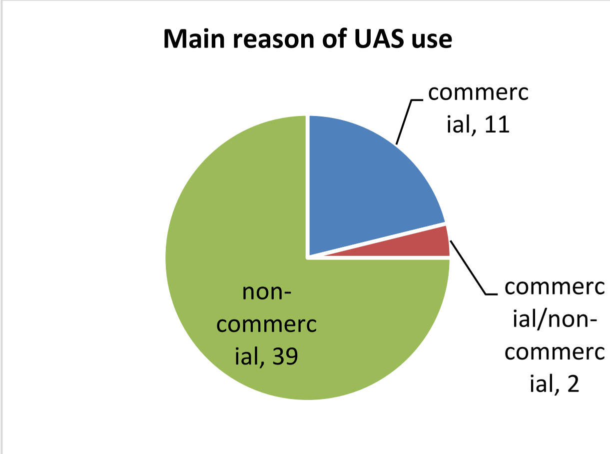
1.1.6.1. UAS questionnaire for operators

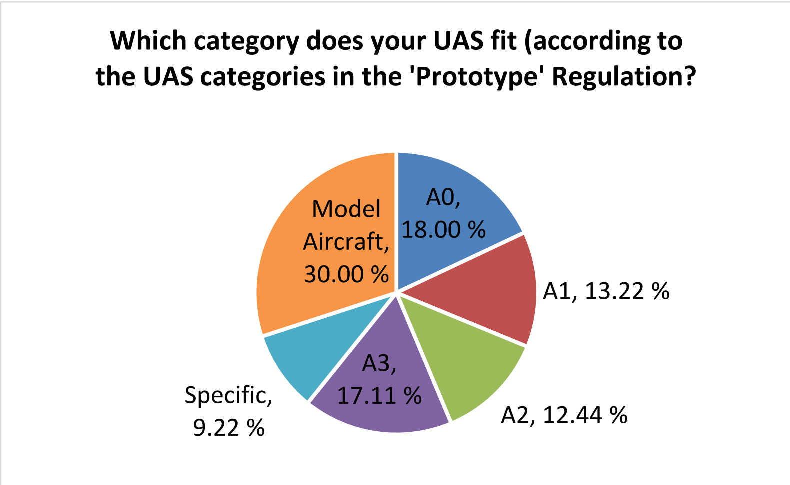
A survey was sent to a group of operators (individuals and associations) with the possibility to reply during the month of December 2016 via the EU survey tool. A total of 52 replies were received from both commercial and non-commercial operators across several EASA MSs, Several Sections of the IA have been developed, also based on these replies. The followings graphs show the characteristics of the respondents to the survey:



Graph 5 — Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.



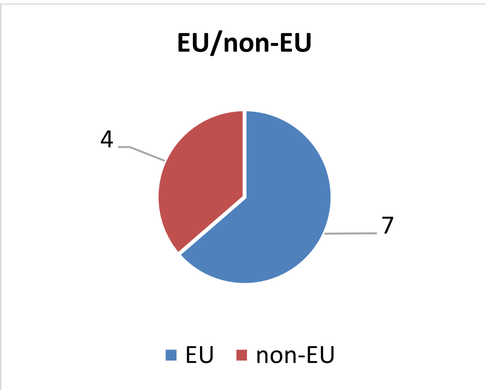


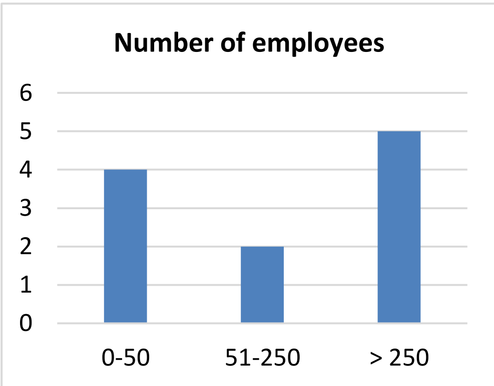


Graph 6. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

1.1.6.2. UAS Questionnaires for manufacturers

A survey was sent to a group of manufacturers (individuals and associations) with the possibility to reply during the month of December 2016 via the EU survey tool. A total of 11 replies were received from both European and Non-European manufacturers, small and large companies. The replies contributed to developing several Sections of the IA. Some manufacturers were also contacted via phone to better understand their input, and to request further information. The following graphs show the characteristics of the respondents to the survey:





Graph 7. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA.

1.1.6.3. UAS Questionnaire for NAAs

A survey was sent to NAAs with the possibility to reply during the period October-November 2016. A total of 16 replies were received from both small and large countries across the EU. The replies contributed to developing several Sections of the IA, such as the resources estimate considered for several calculations in the economic impacts of the proposed policy options.

1.1.6.4. Other consultations

Expert group

A total of five meetings were held with a group of experts. The group was composed of NAAs representatives, members of the manned and unmanned aviation community, members of model aircraft and sport flights associations, and manufacturers of manned and unmanned aircraft, including toys.[29]

The comments received on the IA helped to further improve the text. In addition, information provided by the group in the meetings or via email, e.g. on occurrences, was also beneficial.

Training schools

A survey was sent to a group of training schools in various MSs. The results helped to better understand the training currently provided at EU level, including the costs for theoretical and practical tests. This information was used in the analysis of the various IA options.

Model aircraft associations

A survey was sent to model aircraft associations. The feedback provided by 18 MSs helped to better understand the current situation with respect to model aircraft in several MSs. Many of the graphs included in Chapter 1 ‘Problem definition’ are based on the results of this survey.

1.2. Issues analysis

1.2.1. Introduction to issues analysis

Due to the complexity of the issues definition and in order to help the reader understand the issues, this Section introduces a problem tree, followed by a detailed description of its key elements:

— drivers of the issues,

— issues, and

— consequences of the issues.

[29] The group was composed of representatives of the following: Federal Office of Civil Aviation (FOCA) of Switzerland, Finnish Transport Safety Agency, Ministry of Infrastructure and the Environment of the Netherlands, Ente Nazionale per l’ Aviazione Civile (ENAC) of Italy, Austro Control GmbH, Direction Générale de l’ Aviation Civile (DGAC) of France, Civil Aviation Authority (CAA) of the UK, CAA of Lithuania, Ministry of Transport of Germany, European Commission (DG MOVE and DG GROWTH), EASA, European Helicopter Association (EHA), Drone Alliance Europe, Fédération Aéronautique Internationale (FAI), Europe Air Sports, Civil Air Navigation Services Organisation (CANSO), Eurocontrol, European toy industries; UVS International, Aerospace and Defense industry (ASD), European Cockpit Association(ECA), and Drones Manufacturers Alliance Europe (DMAE).

However, an advance brief definition of the principles on which the issues analysis is based is provided for better understanding.

1.2.2. Transversal concepts

The following key concepts apply to all the issues detailed below and summarised in the problem tree.

Concept of performance-based rules

The dynamism of UAS technology shall be taken into account when developing Regulation (EU) 201X/XXX. Prescriptive rules could hamper the development of new technologies. Thus, it is necessary to find an appropriate balance in the regulatory approach to describe the performance required to mitigate the risk.

The UAS regulatory framework should achieve a high level of safety and have at the same time the flexibility to allow the new industry to evolve, innovate, and mature. Therefore, the aim is not simply to incorporate the existing rules for manned aviation into the new Regulation (EU) 201X/XXX, but to create proportionate, progressive, and risk-based rules that include objectives to be complemented by industry standards.

Operation-centric concept

The approach to safety for UAS operations differs considerably from the one for manned aviation. So far, the focus was on protecting the aircraft and its occupants, considering that in this way, also the third party would be protected.

UAS allow to follow a different approach since there are no humans on board and, therefore, the risk is highly dependent on the area of operation (both ground and air risk should be taken into account). Hence, the requirements and limitations can be defined using an operation-centric approach.

1.2.3. Problem tree[30]

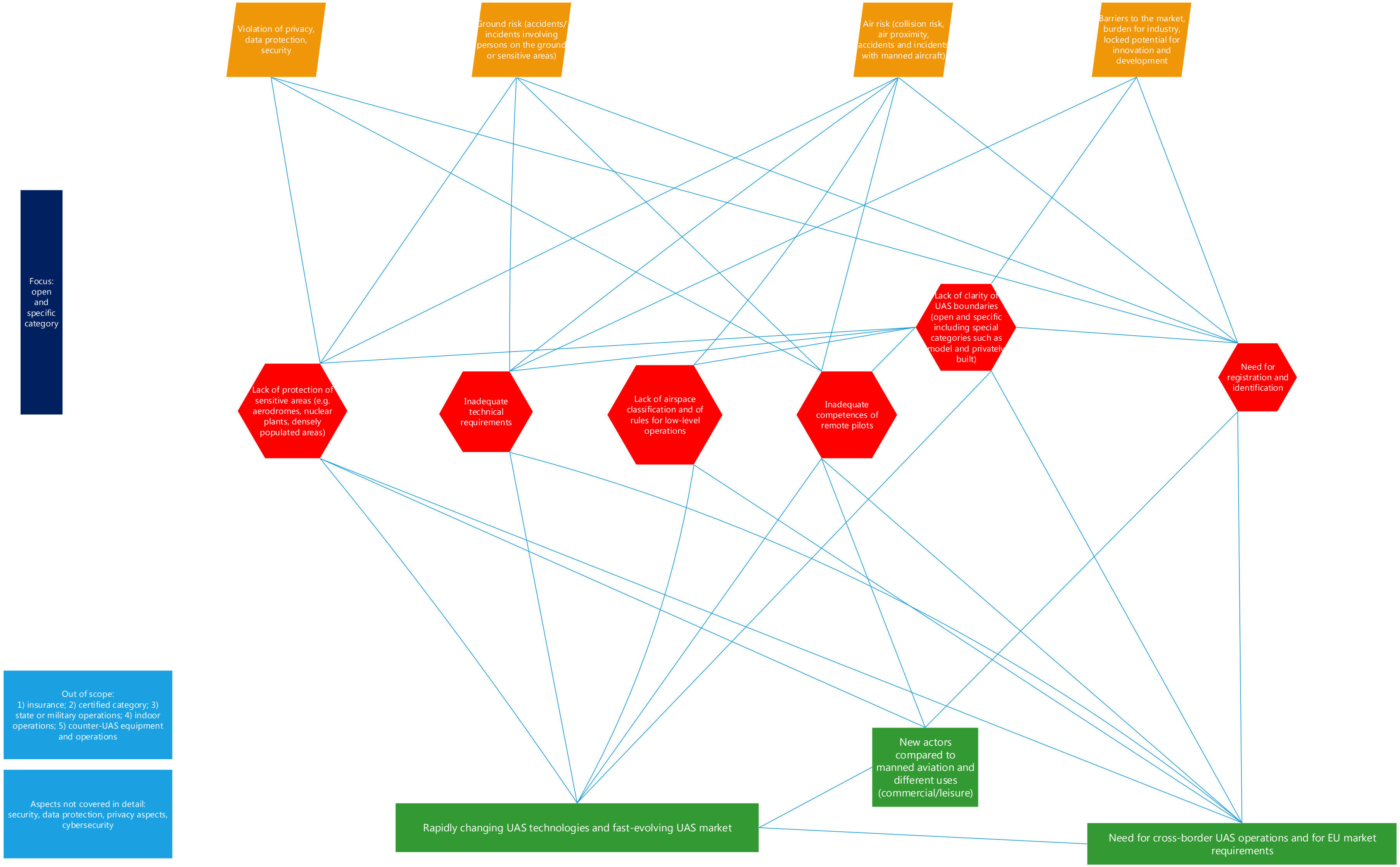
The problem tree helps to better visualise the links between the drivers of the issues (green boxes), the issues themselves (red boxes), and their consequences (yellow boxes).

The drivers are indeed the root causes of the issues, which in their turn have certain consequences. The lines in the graph indicate the links between e.g. a driver and an issue, or an issue and its consequence. The number of links between drivers/issues/consequences varies according to the specific issue at stake.

The graph also includes a reference to the issues that are considered out of the scope of this RMT.

All the issues are linked to the core issue, which is the ‘lack of clarity of UAS boundaries’.

[30] To ease visualisation, the issue of ‘disproportionate rules for special categories’ has been included under the core issue of lack of clarity of UAS boundaries given the strong interlinkage between those two issues.



Graph 8 — Problem tree

1.2.3.1. Drivers

Three issue drivers have been identified and analysed in this IA. These drivers are the main causes of the issues identified and detailed in the following sections. They should be kept in mind when considering the different options in order to understand to what extent the options represent solutions to the issues and therefore to the drivers as well. The drivers of the issues are the following:

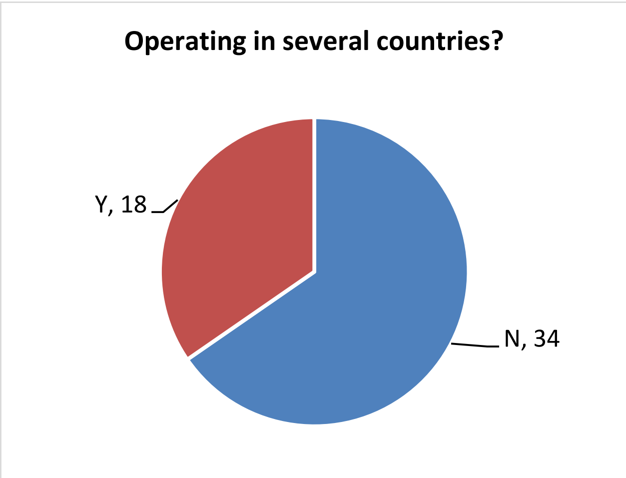
— the need for cross-border UAS operations and for EU market requirements;

— new actors compared to manned aviation and different uses (commercial/leisure); and

— rapidly changing UAS technologies and fast-evolving UAS market.

1.2.3.1.1 Driver 1 — Need for cross-border UAS operations and for EU market requirements

As explained above, the fragmented regulatory framework for UAS at EU level leads to a lack of clarity and inconsistencies of rules across MSs, hampering cross-border UAS operations. 'Cross-border' refers both to a UAS flying across the border and to the operation of a UAS in multiple MSs. The fragmented rules create a substantial burden for operators and manufacturers, who need to be aware of, and eventually comply with different national rules, by adapting their product to those national rules. Many stakeholders confirmed that they operate in several MSs for commercial and non-commercial purposes, which makes the need for harmonised EU rules even more urgent. Indeed, the replies received on the questionnaire for operators[31] showed the need or interest to operate in different MSs both for business and leisure. See also Graph No 8 below:



Graph 9. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

Several stakeholders expressed the importance of having EU rules: *'it will be necessary in the future to define common policies/guidelines so that the NAAs' responses be coherent across Europe'*. A stakeholder from a training school stated that their country lacks detailed guidelines, which creates confusion, the regulatory framework has several gaps, and the national authority did not deal at best with UAS.

[31] Further details on the questionnaire (e.g. number of respondents) are included in Section 1.1.6. 'EASA consultation strategy'.

With regard to the need for EU requirements, the EU citizens' concern that the UAS development may pose a risk to their **security** and fundamental rights (e.g. **protection of personal data**, **privacy)** should also be taken into account.

In order to address this concern, the UAS legal framework should contribute to addressing the security threat and support the enforcement of the existing privacy and data protection legislation.

1.2.3.1.2 Driver 2 — New actors compared to manned aviation and different uses (commercial/leisure)

Another main driver of the issues is the fact that UAS operators and manufacturers are in often new actors in the aviation market. Manufacturers develop UAS with automatic features that assist the remote pilot in conducting the flight, not requiring the remote pilot to have special skills, and that allow the remote pilot to concentrate on managing the payload. In some cases, the UA may even automatically follow the remote pilot or track persons or objects. Therefore, the remote pilot could be interested not primarily in flying the UA but in its image-recording capabilities for the aerial imagery and other uses, and, therefore, in operating these products in a wide variety of locations.

This wider public interest makes drones rapidly proliferate, while the remote pilots have, on average, less awareness of the aviation safety culture, as well as a lower level of competences than the model aircraft community. Consequently, these newcomers are deemed to present a higher risk for sensitive areas and zones. Compared to manned aviation:

— many remote pilots do not have sufficient skills/competences for the aviation world;

— the spectrum of UAS uses is very broad; and

— the risk of remote pilots showing reckless behaviour is higher.

1.2.3.1.3 Driver 3 — Rapidly changing UAS technologies and fast-evolving UAS market

The UAS market is expected to boom over the next years as the UAS technology will evolve. Regulation (EU) 201X/XXX needs to be drafted in a way that will not impede innovation in the following areas:

— development of new characteristics or functions of UAS;

— enhancement of already existing features (e.g. geofencing, auto-return); and

— development of new types of UAS operations and/or openings for new users.

Furthermore, the outcome of a high-level conference held in Poland was the 'Warsaw Declaration'[32] urging for further development of the significant potential of the UAS services in order to support EU's competitiveness and global leadership. It 'called for a swift development of a UAS ecosystem that is simple to use, affordable, commercially and operationally friendly, yet capable of addressing all societal concerns such as safety, security, privacy and environmental protection'. It also 'welcomed the progress being made towards a flexible framework of safety regulation at EU level based on the operation centric approach …'.

Therefore, it is important that UAS legislation is future-proofed adapting to fast-developing technologies, and takes at the same time into consideration the key principle of guaranteeing safety,

[32] 'WARSAW DECLARATION "Drones as a leverage for jobs and new business opportunities" Warsaw - 24 November 2016'.

addressing also economic, environmental and social concerns, including the societal acceptance of critical technological advancements.

An important aspect that affects this driver is the development of a traffic management system for low-level UAS operations, referred to as unmanned aircraft traffic management (UTM) or U-Space (see Section 1.2.4.4 'Issue 4 — Lack of airspace classification and of rules for low-level operations').

1.2.3.2. Issues

The problem tree shows the three drivers behind the issues listed below and analysed further in dedicated sections. The list of issues is the result of brainstorming activity in EASA and has been confirmed by the expert group:

— lack of clarity and non-harmonised definition of categories of UAS boundaries (within the open, and across the open and specific category);

— lack of protection of sensitive areas;

— inadequate technical requirements;

— lack of airspace classification and of rules for low-level operations;

— inadequate competences of remote pilots; and

— need for registration and identification.

1.2.3.3. Consequences

The aforementioned issues have four consequences:

— ground risk (accidents/Incidents involving persons on the ground or sensitive areas;

— air risk (collision risk, air proximity, accidents and incidents with manned aircraft);

— violation of privacy, data protection, security; and

— barriers to the market, burden for industry, locked potential for innovation and development.

1.2.3.3.1 Ground risk (accidents/incidents involving persons on the ground or sensitive areas)[33]

The ground risk involves the probability of a UAS crashing into persons or property on the ground causing injuries/fatalities or damage. The risk is highly dependent on the area overflown, in terms of population density, or presence of properties and sensitive areas.

The risk is normally higher in urban environments not only due to the higher population density but also the presence of obstacles during navigation (e.g. buildings, barriers, etc.).

Assessing the ground risk is a relatively new topic for the aviation community that was so far focused on protecting the aircraft and its occupants. Such a shift in perspective can be addressed through an operation-centric approach.

[33] Further data are included in Section 1.2.7 'Safety risk assessment'.

1.2.3.3.2 Air risk (collision risk, air proximity, accidents and incidents with manned aircraft)[29]

The exponential increase in the number of UAS in the airspace raises concerns about an increased risk of mid-air collisions with manned aircraft, and occurrences resulting in collision avoidance manoeuvres seriously affecting traffic management. Even light UAS may cause serious incidents or accidents. Several research projects are ongoing to better determine the consequences of a UAS collision with various parts of a manned aircraft, such as cockpit windows, rotorcraft transmission, engines, as well as leading edges of wings and empennages.

1.2.3.3.3 Violation of privacy, data protection, and security

Due to sensors and cameras becoming smaller and smaller, and batteries having an increasing life duration, especially small UAS equipped with a high resolution camera are potentially more and more intrusive as regards citizens' privacy. Densely populated areas might suffer more from such a phenomenon, which increases the risk of violation of privacy and data protection.

Opinion 01/2015 on Privacy and Data Protection Issues relating to the Utilisation of Drones[34], highlighted the following two elements:

— the Importance of focusing on the large-scale deployment of drone and sensor technology that could create challenges for individuals' privacy and civil and political liberties; and

— privacy risks with respect to processing of data, e.g. due to the difficulty to identify the UAS, its data processing equipment on-board, for what purpose personal data are being collected, and by whom.

Moreover, the UAS technology creates a potential security risk. The evolution of the geopolitical environment and the recent terrorist attacks have led citizens to consider UAS as a new potential threat to security in Europe.

In that context, the following incidents or minor attacks involving UAS misuse were recorded in the past[35]:

— in 2011, a physics graduate student from Massachusetts was arrested for planning a terrorist attack on the Pentagon and the US Capitol using a UAS;

— in 2014, UAS were flying simultaneously over several nuclear power plants in France;

— in 2014, the Federal Bureau of Investigation (FBI) identified a man plotting an attack to a school with UAS-like toy aircraft carrying bombs; and

— on 22 April 2015, an unmanned aerial vehicle (UAV) landed on the office of Japan's Prime Minister in Tokyo carrying a small amount of radioactive material.

The probability that UAS (even simple consumer drones) could be used by terrorists has increased drastically over the recent years. Hostile use of UAS could consist in attacks with improvised explosive

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[34] Published by the Article 29 Data Protection Working Party, an independent European advisory body with representatives from all national data-protection authorities, on 16 June 2015 (http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2015/wp231_en.pdf).

[35] Larcher M., Valsamos G., Solomos G., JRC98222 'Misuse of drones by terrorists as a new threat', Ispra (Italy), European Commission, 2016.

devices (IEDs), chemicals, or using an intelligence-gathering system (intelligence, surveillance and reconnaissance (ISR)). There are UAS available today on the market that are capable of carrying an explosive payload equivalent to a pipe bomb of 1-4 kg or a suicide vest of 4-10 kg. Many more types of UAS could be modified using readily available components to increase their stated payload capacity.

According to a recent risk assessment study[36], the threat from terrorist organisations and insurgent groups using UAS is high.

Some MSs, for example France, have already adopted related legislation consisting of technical requirements on UAS in order to address this issue.

1.2.3.3.4 Barriers to the market, burden for industry, locked potential for innovation and development

Non-harmonised and/or rigid and too prescriptive UAS rules might create barriers to the market, especially for SMEs. This implies the following:

— high investment for companies in order to adapt their products to the various regulatory systems of the MSs;

— burden for companies required to comply with different technical requirements;

— eventually, a reduction in the amount spent on research and development; and

— a combination of the above that could prevent from advancing solutions that would improve the level of safety or help to develop new markets.

Barriers to the UAS producers could also have negative consequences for all the actors in the UAS services market.

1.2.4. Detailed analysis of the issues

1.2.4.1. Issue 1 — Lack of clarity and non-harmonised definition of categories of UAS boundaries (within the open, and across the open and specific category)

1.2.4.1.1 Drivers

The main drivers of this issue are the following:

— the need for harmonised EU UAS market requirements and for cross-border UAS operations; and

— rapidly changing UAS technologies and fast-evolving UAS market, which requires a clear definition of boundaries that fit the fast-developing market.

1.2.4.1.2 Description

As already explained above, the regulation of operations of UAS with an MTOM of less than 150 kg currently falls within the MSs' competence, which creates a fragmented regulatory framework. In that context, the use of UAS promises to expand in the most disparate fields of application due to the convergence and rapid evolution of key technologies. Consequently, the regulatory framework must:

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[36] HOSTILE DRONES: January 2016 THE HOSTILE USE OF DRONES BY NON-STATE ACTORS AGAINST BRITISH TARGETS, January 2016 (http://remotecontrolproject.org/wp-content/uploads/2016/01/Hostile-use-of-drones-report_open-briefing.pdf).

— define a categorisation such that UAS operations with limited or no risk are allowed without unnecessary authorisation; and

— be proportionate to the risk related to the operation; in particular, ground and air risk must be proportionate to:

- the MTOM or kinetic energy of the UA and its size;
- the area/airspace in which the operation takes place (population density, presence of manned aircraft traffic, distance from airports, etc.);
- the operational limitations;
- the competence of the remote pilot; and
- any technical requirements for the UA.

The UAS categorisation issue is therefore the first issue to address since it is linked to all other issues (see also Graph No 7 — Problem tree, p. 23). In particular, the following boundaries need to be defined:

— an MTOM limit of 25 kg between the open and specific category, which corresponds to the one already defined by several MSs; and

— various limits for the subcategories of the open category.

This categorisation (distinction between the open, specific and certified category, including the subcategorisation of the open category) should maintain an acceptable level of risk across categories/subcategories, while covering UAS operations and market segments to the greatest extent possible.

To mitigate the risk of mid-air collision with manned aircraft, VLOS remains the fundamental means until the U-Space is developed. U-Space will allow UAS to safely use airspace used by manned aircraft on a regular basis, and will rely on a proper mix of technologies (such as electronic identification and geo-limitation or geofencing, but possibly also detect and avoid (DAA) and/or cellular-network technology).

The risk is proportionate to the kinetic energy of the UAS (the MTOM value is used as a proxy), therefore, the requirement enforcing height limits should be defined in a proportionate way. Also for the ground risk, the technical requirements should be customised to the operation (i.e. designed to limit injury inflicted by blades or injury to people hit by a UAS). Injury criteria such as the abbreviated injury scale (AIS) or the kinetic energy transferred to a human body through the UAS operation could be used for categorisation. Compared to MTOM, the AIS methodology is more complex and entails elaborate testing; on the other hand, it may be more flexible for manufacturers. More details are provided in Appendix II[37] and VI.

Boundaries based only on MTOM are not proportionate since some categories have specificities, for example small toys and/or nano-UAS, which are both very light, but have very different performance.

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[37] Appendix II includes an EASA paper on the rationale behind MTOM and energy thresholds identified with regard to the danger posed by blunt-trauma injury (non-penetrating injury) to people hit by a UAS.

1.2.4.1.3 Background

As explained in Section 1.1.5, the current EU regulatory framework is highly fragmented.

Some MSs have defined their regulation in more details and developed scenarios for authorising specific operations. Italy and France developed sample scenarios defining limitations for:

— overflown areas (e.g. urban areas, not over uninvolved people); and

— MTOM, height, speed, minimum distance from people, technical requirements (e.g. loss-of-data-link recovery), and remote-pilot competence.

1.2.4.1.4 Consequences

The main consequence of this issue is the creation of barriers to economic development. Operators willing to operate in different MSs need to comply with different technical requirements and operational limitations, as well as understand and apply different rules and administrative processes. This would lock the potential for further innovation in the domain of UAS technologies and operations.

Secondarily, non-harmonised EU regulation may not ensure the same level of safety.

1.2.4.1.5 Development of the issue if no action is taken

If there is no clear definition of categories at EU level, the current situation might evolve as follows:

Manufacturers would need to comply with different technical requirements imposed by different MSs. The UAS market would remain fragmented, and the cost for UA would increase.

This would seriously inhibit small manufacturers and operators from growing and investing in research and development.

Operations would be performed at different levels of safety in different MSs, and this may give an economic edge to some MSs with respect to others where the NAA is less restrictive (e.g. less requirements that could facilitate the placement of products on the market).

Operators would also face barriers within the EU internal market due to the lack of mutual recognition of authorisations, as well as the need to invest time and bear the administrative burden in order to comply with the various national rules.

This could negatively impact the competitiveness of companies across MSs, leading to the difficulties of having economies of scale due to the various obstacles in several markets.

Furthermore, the risk of having prescriptive, rigid and disproportionate rules in some MSs would remain, which would lock the potential of the EU UAS market, including its related services.

1.2.4.2. Issue 2 — Lack of protection of sensitive areas

1.2.4.2.1 Drivers

The issue of requiring restricted airspace areas/special zones where UAS operations are limited or prohibited is driven by a combination of factors, the main of which are the following:

Need for cross-border UAS operations and for EU market requirements

The current MS rules on the protection of sensitive areas do not cover all types of those areas and are non-harmonised across the different MSs.

The regulatory gap in the protection of sensitive areas and zones creates evident safety and security risks. Besides, the lack of harmonisation may have a significant impact on operators wishing to operate in more than one MS, as well as on manufacturers, which may have to comply with different technical requirements across the EU.

New actors compared to manned aviation and different uses (commercial/leisure)

The presence of new actors, as discussed in Section 1.2.2.2.2, creates a potential treat of having operators that are not familiar with the risks linked to flying an aircraft. In that respect, it is required to protect sensitive areas.

Rapidly changing UAS technologies and fast-evolving UAS market

A sensitive area can be protected using different technologies. The regulator should define rules in a performance-based way to allow industry to improve its technology in order to meet the requirements. This impacts the protection of sensitive areas and zones as the future state of the art, even in the short-medium term, cannot be predicted due to the rapid evolution of both technology and market. Consequently, the ability to plan for efficient and relatively future-proof protection strategies is limited.

1.2.4.2.2 Description

Even small UAS may be equipped with advanced features that allow the user to operate the UAS out of their VLOS, relying on the guidance and navigation control system of the UA, which usually provides self-stabilisation and some automated functions.

Those performance capabilities, coupled with the installation of cameras or other sensors, which are becoming more and more advanced and cost-effective, make these small UAS very attractive for both commercial and non-commercial operations; this explains also their fast proliferation.

Even if the vast majority of UAS are expected to be safely operated by responsible operators, there are some areas (e.g. protection of aerodromes and their associated airspace, critical infrastructure, prisons, military facilities, densely populated areas or assemblies of people in outdoor events, concerts, demonstrations, etc.) where uncontrolled access for UA has the potential to create severe safety, privacy, data protection and security hazards.

Consequently, mitigation measures need to be taken to reduce the risk of intentional or unintentional loss of control to an acceptable level.

The following elements can contribute to the protection of areas:

— UAS operators having up-to-date, accurate and easily understandable limitations information that helps them to identify restrictions or requirements in effect at the location where they wish to operate. Alone the provision of this information might substantially reduce unintended infringements of those limitations. UAS operators can have such information in a more convenient manner, by integrating it into the remote-pilot station or by making it accessible through a stand-alone portable application device (several initiatives, as well as products based on applications for tablets or smartphones, already exist).

MSs are responsible for identifying sensitive areas, defining the level of required protection, and providing up-to-date and verified information on those areas. Some of the MSs and others outside Europe already provide such information via websites or applications.[38]

— Geofencing and automatic performance limitations of UAS or advisory system:

This function requires position determination (e.g. using a global navigation satellite system (GNSS) or other means), a database of geo-limitation data, and control functions in order to comply with any restrictions on the time and location of UAS operation. When the UA takes off from, or approaches to, a zone subject to UAS restrictions, the remote pilot may receive an advisory or the UAS itself may be designed not to exceed those limitations.

A number of consumer UAS are already equipped with some 'geofencing' and positioning-related performance limitation capabilities[39]. However, it should be noted that although technology enabling geofencing and performance limitation features already exists, there are still a number of shortcomings in the effective implementation of these functions. In particular, there is a lack of standards and validated data to feed these functions.

In addition, not all UAS can be fitted with such technology since they need to be equipped with a flight control system, which in some cases, considerably increases the cost or is unfeasible with the type of operations (e.g. model aircraft).

As mentioned above, there is currently a lack of standards applicable to positioning limitations for UAS operations. Some standardisation aspects are the following:

— terminology and concepts;

— sensitive areas/zones: categories and main characteristics (e.g. two-dimensional (2D)/three-dimensional (3D) definition, shapes, associated zone requirements, etc.);

— limitations data generation and management (e.g. digital-data format and quality requirements for aeronautical and non-aeronautical limitations, geographical reference system, data presentation and symbology, data update procedures, data service provision to operators, etc.);

— geographical and performance limitation functions (i.e. geofencing, performance limitation functions); and

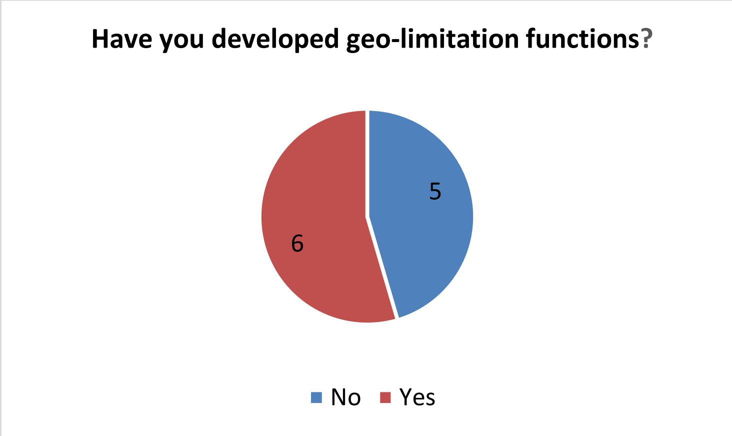
— architectures and supporting technologies, compliance with performance requirements (including safety and security), etc.

Data on the current geo-limitation[40] solutions available has been gathered via the questionnaire for manufacturers.

[38] For example France (https://www.geoportail.gouv.fr/donnees/restrictions-pour-drones-de-loisir), the Netherlands (https://kadata.kadaster.nl/dronekaart/), and the USA (https://www.faa.gov/uas/where_to_fly/).

[39] Some manufacturers consider geofencing as the set-up of a cylinder resulting from the combination of limitations in distance of the UA to the control station and UA height, which could be considered as more of a performance limitation function related to positioning.

[40] Means of implementing geographical and/or performance limitations.



Graph 10. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA.

UAS manufacturers questionnaire

Which technologies are used (e.g. sensors, software functionalities, user interface (UI) and setting capabilities)?

— Airspace and ground mapping databases for specific MSs with designated geofenced zones accessible via the UAS. This system is already embedded in the latest UAS chipset generation, for example to geofence UK prisons.

— Software functionality and UI.

— The geo-limitation is based on the position estimation of the UAS and the remote pilot. Position estimation is based on GNSS technologies for the UAS, whereas for the remote pilot, a phone positioning system may also be used. For altitude pressure, sensors are used.

— Live data feed via internet for airspace information. GNSS for aircraft position. Smartphone applications for UI. Data link for user account verification and authorisation. Combination of hard-coded no-fly zones and live airspace information to create actual geo-limitation zones. Data link between aircraft and controller for UI interaction with geo limitation zones that can be self-authorised.

What main challenges do you foresee when implementing these geo-limitation functions in your products?

— Build a harmonised database at EU level.

— Define minimum operational performance standards for a geofencing system.

— A worldwide standard for accurate maps (still missing) is needed.

— What is a no-fly zone? How to unlock the limitation? Who unlocks the limitation?

— The main challenge is that the UAS manufacturer cannot guarantee geo-limitation in all conditions. Geo-limitation requires several elements which can be missing, damaged, or spoofed, for which the UAS manufacturer is not liable. The remote pilot is ultimately responsible for flying safely.

'Anti-UAS' solutions

An increasing number of solutions are proposed to detect an intruder UAS in a sensitive zone and to disable it by various means, such as jamming or spoofing the UAS (e.g. their command and control (C2) link and/or GNSS signal), capturing in flight the UAS (e.g. via nets carried by another UAS or using 'UAS falconry' with large predatory birds), or destroying it (e.g. using firearms, electromagnetic pulse, lasers, etc.).

It should be noted that there are already plans to install 'anti-UAS' solutions in a number of aerodromes worldwide. However jamming, and even more spoofing, may disturb aircraft avionics and communications (CNS) systems, and thus impair aviation safety. The installation of 'anti-UAS' systems near airports needs therefore careful consideration.

None of these systems have been considered in the rule text of the NPA (see sub-NPA 2017-05 (A)).

Link of lack of protection of sensitive areas with other issues

The lack of protection of sensitive areas is linked with some of the issues highlighted through the definition of the boundaries. More precisely:

Inadequate remote-pilot competences

As already described in Section 1.2.3.5, the remote-pilot competencies of typical users of small UAS operating under the open category are currently deemed inadequate to ensure compliance with the requirements for protecting sensitive areas and zones.

Inadequate technical requirements

As previously explained, UAS technology is rapidly evolving, not only making small UAS more capable and easier to use, but also enabling the remote pilot to easily enter sensitive areas and zones. As indicated in Section 1.2.3.3, solutions like geofencing may effectively assist the user in complying with the protection limitations; however, such solutions could be made cost effective by limiting the scope of the requirement and by providing a period to comply.

Registration and identification

The possibility to identify the UA is another means of guaranteeing that those aircraft do not operate in unauthorised areas.

There are not yet solutions in place in the civil market, but several initiatives are underway[41]. As for geographical and performance limitations, no standards are currently available and those need to be developed.

Lack of airspace classification and rules for low-level operations

Both geographical and performance limitations and in-flight identification are expected to be part of the functions and services of a future UTM or U-Space system that enables safe operations of UAS in very-low-level (VLL)[42] airspace.

Therefore, a trade-off should be considered between the above issues in order to establish requirements to effectively protect sensitive areas and zones, while respecting the principle of proportionality.

[41] For example, in France (Fédération Professionnelle du Drone Civil (FPDC) working group) and in Italy to comply with their national requirements.

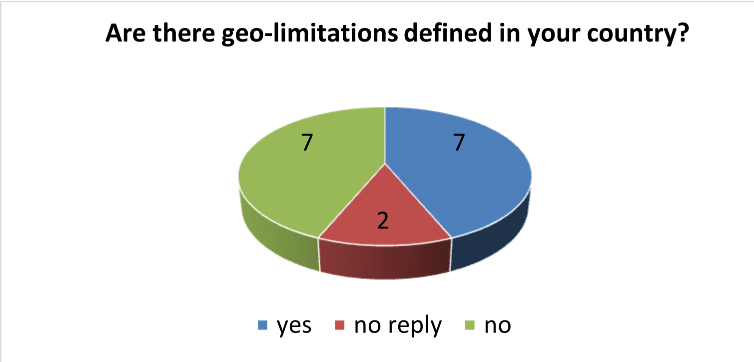
[42] In this context, VLL refers to the portion of airspace below the minimum height allowed for visual flight rules (VFR) flights (typically 500 ft).

1.2.4.2.3 Background

At EU level, the current protection of sensitive areas from an air operations perspective (in particular, through the definition of restricted and prohibited areas) is addressed in the SERA Regulation[43].

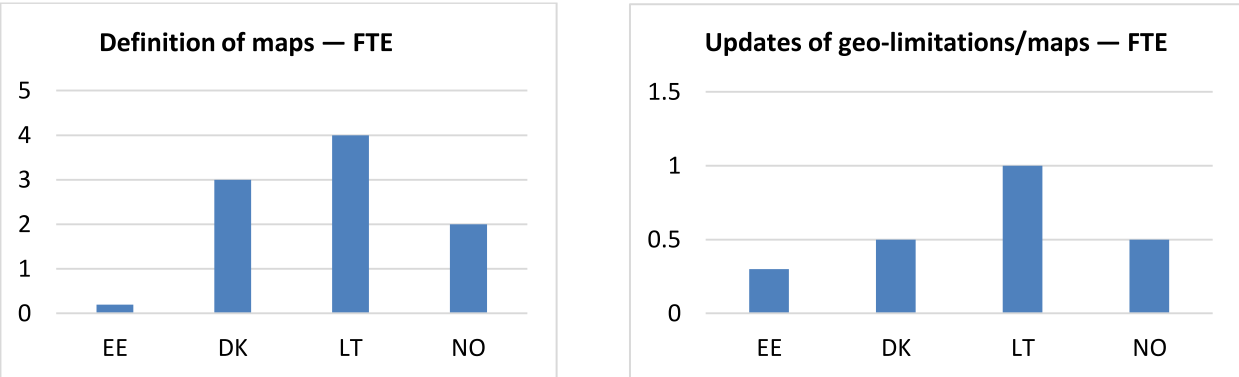
However, UAS operations and, more particularly, those conducted at VLL have specific challenges that need specific requirements. In particular, sensitive areas to be protected from UAS operations might be required for reasons other than safety. MSs are already considering to mandate geographical and performance limitation functionalities, and are developing and publishing online their limitations for the protection of sensitive areas[44].

The following is a graphic representation of geo-limitations across MSs:



Graph 11. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA.

In the NAAs questionnaire, detailed questions were posed on the estimated resources (full-time equivalent (FTE)) for the definition of maps and the update of zones:



Graph 12. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA.

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[43] Commission Implementing Regulation (EU) No 923/2012 of 26 September 2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010 (OJ L 281, 13.10.2012, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1493482858499&uri=CELEX:02012R0923-20160818).

[44] For instance, see the Swiss as well as the French website, respectively:
- https://map.geo.admin.ch/?topic=aviation&bgLayer=ch.swisstopo.swissimage&layers=ch.bazl.luftfahrthindernis,ch.bafu.schutzgebiete-aulav_jagdbanngebiete,ch.bafu.bundesinventare-vogelreservate,ch.bafu.bundesinventare-jagdbanngebiete,ch.bazl.einschraenkungen-drohnen&lang=en&layers_opacity=1,0.75,0.75,0.75,0.6&catalogNodes=1379; and
- http://www.developpement-durable.gouv.fr/drones-loisir-et-competition.

1.2.4.2.4 Consequences

The consequences of the violation of sensitive areas depend on the nature of these areas:

— **Air risk (collision risk, air proximity, accidents and incidents with manned aircraft)**: a lack of protection of aerodromes and their related airspace might lead to conflicts with other airspace users, with the potential consequence of collision. The highest concern is about air transport operations and, consequently, operations related to aerodrome areas (with particular emphasis on major aerodromes) and, more generally, UAS operations taking place in the whole airspace where manned aircraft operate.

— **Ground risk**: a lack of protection of densely populated areas or where critical infrastructure is located might lead to a risk on the ground in the event of loss of control of the UA. This risk includes areas requiring protection due to their recognised natural, ecological and/or cultural values. Access to those areas might be linked to the risk of the operation depending on the categorisation.

— **Violation of privacy, data protection, security**: there is a wide variety of areas and facilities that are considered security-sensitive by MSs due to their particular nature (e.g. governmental, including military and law enforcement, facilities and areas, prisons, etc.).

1.2.4.2.5 Development of the issue if no action is taken

In case no action is taken at EU level, it is expected that MSs will continue developing their national regulatory framework for the protection of sensitive areas and zones under their territory.

This is likely to further fragment MS legislation across the EU, having an adverse impact on the EU market. Manufacturers will be required to develop different technical solutions to comply with the national requirements, and operators would need to understand and comply with the national regulations. Furthermore, it would not be ensured that sensitive areas are sufficiently protected against UAS at EU level.

1.2.4.3. Issue 3 — Inadequate technical requirements

1.2.4.3.1 Drivers

The drivers of this issue are the following:

Need for cross-border UAS operations and for EU market requirements

Different technical requirements in MSs impede the creation of a common UAS market and inhibit operators from conducting operations in different MSs.

Rapidly changing UAS technologies and fast-evolving UAS market

Technical requirements need to be performance-based in order to adapt to the fast-evolving UAS technologies.

1.2.4.3.2 Description

Technical requirements are one of the main elements that can be used to achieve proportionality. Due to the rapidly evolving technology, UAS regulation should follow a performance-based approach to prevent obsoleteness. Therefore, the aim is to find the right balance of technical requirements.

EU technical requirements might help mitigate the safety risk (both air and ground collision), even though nowadays there is a lack of information on how this can be achieved. As for the other issues of the analysis, each MS adopted a different approach.

The following is a list of the most common technical requirements that might be used to mitigate the inherent risk of UAS operation:

— Positioning limitations include both geographical limitations (defined using geographical coordinates) and non-geographical limitations, based on the positioning of the UA, such as height/altitude or range (see also Section 1.2.4.2).

— Flight control technology: UA sold on the market differ from classical model aircraft particularly because the internal flight control loop is automatically addressed by the system, and the remote pilot does not therefore need to have skills to stabilise the aircraft during flight.

— Energy limitation: it refers to limiting the kinetic energy transmitted by the UA during a collision. In general, this may include the global energy level and/or the energy per unit of surface of the impacted element (a person on the ground or another aircraft). This may leverage the use of soft/absorbing materials, special designs that facilitate the detachment of UA parts during a collision, blades protections, technologies that stop the rotors on impact, or any other technology that industry may develop in the future.

— Collision avoidance: it refers to systems that help to steer the UA away from an upcoming collision (with another aircraft but also with people or infrastructure on the ground). They may either provide to the pilot a warnings in case of an imminent collision, or automatically steer the UA away through flight controls. DAA technology is not yet mature for small UAS.

— Automatic take-off and landing system (ATOL): it refers to the UA taking off from, or landing on, a desired spot without the need of remote pilot intervention. A study on ATOLs has been commissioned by the European Defence Agency (EDA).

— Loss-of-data-link management: it refers to the UA automatically following a pre-established behavioural pattern (e.g. auto-return home) when the data link connecting the control station to the UA is interrupted. The preprogrammed behaviour may be set by the operator based on the characteristics of the area of operation.

— Electronic identification: it refers to making available data about the UAS operator and the UAS itself. Although this would address security concerns, safety might be indirectly positively affected as a remote pilot would be discouraged to show inappropriate behaviour knowing that identification by the authorities is possible.

1.2.4.3.3 Background

The proposal for the new Basic Regulation includes the essential requirements for UAS in Annex IX, authorising operations in the EU airspace. Especially for the open category, said Regulation introduces the possibility to use Regulation (EC) No 765/2008[45] on the marketing of products (e.g. UAS), allowing

[45] Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93 (OJ L 218, 13.8.2008, p. 30) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1493654158057&uri=CELEX:02008R0765-20080813).

manufacturers to apply market product regulation processes to demonstrate compliance with the EU requirements.

One important aspect of any market product legislation is the selection by the regulator of the appropriate conformity assessment procedures (modules) that the manufacturer is required to comply with. The module may range from a simple declaration of conformity submitted by the manufacturer to a thorough verification by a notified body based on a full quality assurance provided by the manufacturer and an assessment of the design made by a body notified by the MS. The selection of the conformity assessment procedure depends on the type of product(s) and industry involved, the complexity of the requirements, and the level of risk of the product(s).

In order to facilitate the implementation of the conformity assessment procedures, industry standards may be developed under the responsibility of the European Standardisation Organisations (ESOs), such as the Centre Européen de Normalisation (CEN), the Centre Européen de Normalisation for electrical product (CENELEC), and the European Telecommunications Standard Institute (ETSI). ESOs may cooperate with other Standardisation Bodies (e.g. European Organisation for Civil Aviation Equipment (EUROCAE), SAE, Radio Technical Commission for Aeronautics (RTCA), ASTM, etc.).

Privately built UAS and UAS with a CE marking, modified by a person other than the manufacturer, are outside the scope of Regulation (EC) No 765/2008.

1.2.4.3.4 Consequences

The main consequences of this issue are the following:

— ground risk: risk of UA crashing due to technical failures;

— air risk: risk of losing control of the UA;

— violation of privacy, data protection, and security; and

— barriers to the market: prescriptive requirements could be obsolete due to rapidly evolving UAS technologies.

1.2.4.3.5 Development of the issue if no action is taken

If no action is taken, the number and extent of technical requirements would be different in each MS. The way technical requirements would be drafted would have an impact on the market. Indeed, rigid and disproportionate requirements could incur higher costs for manufacturers and, therefore, negatively affect operators.

1.2.4.4. Issue 4 — Lack of airspace classification and of rules for low-level operations[46]

1.2.4.4.1 Drivers

The drivers of this issue are the following:

— **Rapidly changing UAS technologies and fast-evolving UAS market**: the need to integrate the UAS into the existing airspace structure is driven by the increasing number of UAS and the subsequent potential for a higher number of occurrences.

[46] This issue relates to the integration of UAS into the existing airspace structure and rules for low-level UAS operations.

— **Need for cross-border UAS operations**: the aim is to provide clarity of the rules for UAS operations across MSs.

1.2.4.4.2 Description and background

A strong increase of UAS activities and of the number of UAS in operation is forecast by the vast majority of look-ahead studies. The SESAR outlook study, for example, envisages the following for 2035:

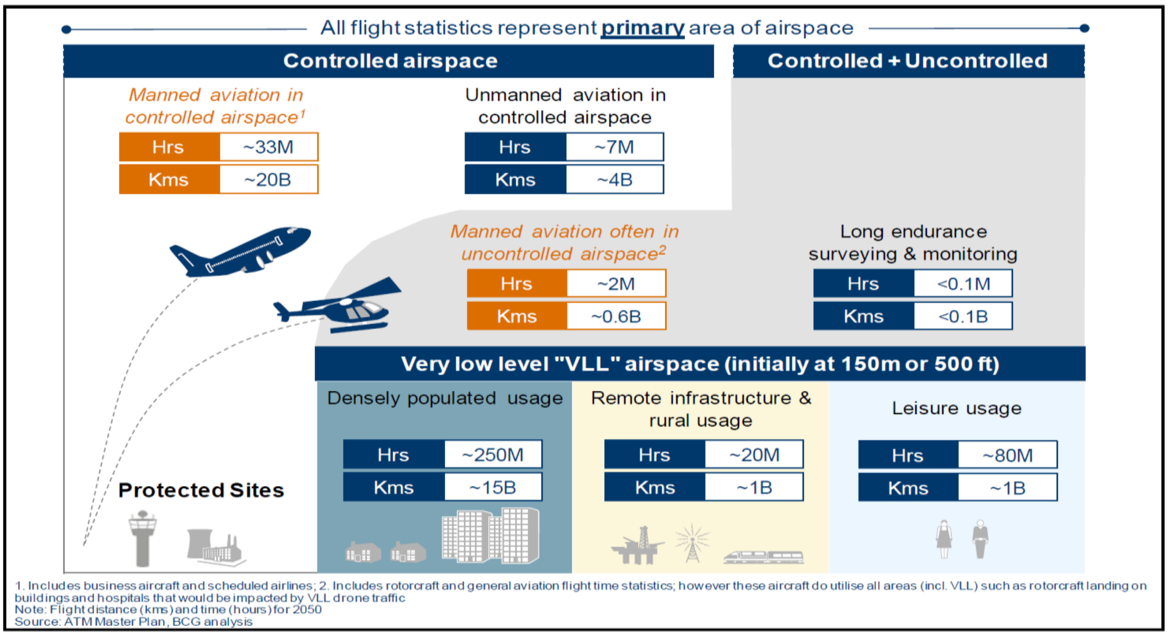


Figure 9 — Impact of UAS on airspace measured in flight hours and distances. Source: SESAR Outlook Study.

Figure 9 above shows very clearly the need to develop an ATM concept of operation (CONOPS) for the integration of UAS into the airspace: the VLL airspace; the 'classical' airspace, and the very high level (VHL) airspace (above flight level (FL) 600). The existing flight rules (VFR, IFR) were designed to accommodate manned aviation and therefore they do not provide for effective mitigation against the risks involved. Those rules may not be fully suit for the UAS operation for which a new approach should be developed.

There is a need to provide both vertical and horizontal separation between:

— UAS and UAS;

— UAS and manned aircraft flying under IFR; and

— UAS and manned aircraft flying under VFR (this will be the case even if the UAS are not granted access to controlled airspace since airspace infringements and conflicts will anyway be possible).

An ATM CONOPS could be defined as a basis for further development of airspace and ATM/ANS requirements. Failure to meet the performance needed to support the ATM/ANS functions may lead to the reduction of the capacity of that ATM system and to the need for an increased separation between aircraft.

Consideration should be given to the level of protection that a given category of airspace users would be entitled to. (commercial air transport (CAT), general aviation (GA), etc.).

When defining the severity of the problem, the following aspects need to be considered:

— scale of risks to manned aviation (including CAT and GA);

— scale of risks to persons on the ground and to property; and

— risk of the current ATM/ANS technological and operational infrastructure not being able to accommodate the increasing amount of airspace users.

EUROCONTROL has recently published a CONOPS[47] addressing the entire airspace from VLL (below 500 ft) to VHL (above FL 600). Also ICAO is currently developing a CONOPS focusing on the operations of certified UAS under international IFR.

The majority of UAS operations will be conducted at VLL especially in densely populated areas, where risk levels will be increased. The use of UAS in all possible areas of the airspace highlights the critical nature of ATM. UAS operations have the potential to account for the majority of total flight time across the entire airspace.

In accordance with the Standardised European Rules of the Air (SERA), operations conducted below 150 m require a permission from the competent authority except when necessary for take-off or landing. This means that even if less manned-aircraft operations are conducted in this layer of airspace, this airspace cannot be considered as dedicated to UAS.

Subtask (SubT) 4 of this RMT.0230 will address the safe integration of UAS. Eventual amendments to SERA should be done without reducing the safety level for other airspace users.

The next set of actions is to determine how UTM should be organised starting with the VLL as the UAS traffic will be intense in certain areas (e.g. cities where the delivery of goods by UAS is expected to develop fast). There are several ongoing activities to define such UTM around the world: in the USA, the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA) have established a partnership to progress the matter. They set up a Global UTM Association (GUTMA) that recently published a CONOPS. UTM generates particular interest among the classical air navigation service providers (ANSPs) as well as mobile telecommunication service providers.

SESAR Joint Undertaking (SJU) and the Commission with the cooperation of EASA have set up an activity to integrate UAS into the ATM Master Plan, by creating an addendum to this Plan, the ‘U-space’. This addendum should be adopted by the end of 2017.

The first draft of the U-Space (the ‘blueprint’) was presented by the Directorate General (DG) Move of the European Commission at a workshop held on 20 April 2017 in the Hague, and has the following characteristics:

— it is a set of services not linked to a specific part of the airspace, delivered by a set of providers;

— it relies on a high level of digitalisation and automation of functions;

— it is able to support commercial or non-commercial UAS operations in all operating environments and in all types of airspace;

[47] Available at: http://www.eurocontrol.int/publications/remotely-piloted-aircraft-systems-rpas-atm-concept-operations-conops.

— it provides an extensive and scalable range of services, including the following three fundamental ones: electronic registration, electronic identification, and geofencing; and

— it follows a stepped approach.

More specifically:

- U1: the U-Space fundamental services provide electronic registration, electronic identification, and geofencing.
- U2: the U-Space initial services support the management of UAS operations and may include flight planning, flight approval, tracking, airspace dynamic information, as well as procedural interfaces with air traffic control (ATC).
- U3: the U-Space advanced services support more complex operations in densely populated areas and may include capacity management and assistance in conflict detection. Indeed, the availability of automated DAA functionalities, in addition to more reliable means of communication, will lead to a significant increase of UAS operations in all environments and may require a more robust framework.
- U4: the U-Space full services, particularly services providing integrated interfaces with manned aviation, support the full operational capability of U-Space and rely on a very high level of automation, connectivity and digitalisation of both the UAS and the U-Space system itself.

Between U-Space, which should be further developed, and this NPA there is strong interface. For the first step of the U-Space implementation, the blueprint considers electronic registration, electronic identification and geofencing as foundation services, which is consistent with this NPA's proposal. For the subsequent steps, a list of gaps/differences has been identified (see Section 7.1 'Differences between the U-Space blueprint and the NPA' of sub-NPA 2017-05 (A). These gaps /differences will be addressed in cooperation with the European Commission and SJU and, taking into account comments received during the NPA and blueprint consultations.

The set-up of the U-space will of course necessitate rulemaking activities and the associated development of industry standards, e.g. concerning service providers or rules of the air. EASA is currently discussing those issues with the European Commission and SJU to establish a road map.

That rulemaking will not only be of a technical nature but will also need to address funding issues.

The new ATM requirements might create the need for training of the affected personnel, thus introducing additional costs.

Regarding manufacturers, they may have to invest in the development of new technologies.

As for authorities, they will have to be able to assess, validate or accept new equipment and procedures, as well as exercise effective oversight. This will increase both workload and the associated costs.

1.2.4.4.3 Consequences

Air risk (collision risk, air proximity, accidents and incidents with manned aircraft): a lack of safe integration of UAS into the airspace could lead to conflicts with other airspace users, such as collisions.

1.2.4.4.4 Development of the issue if no action is taken

The growing number of UAS will create a hazard to air traffic, persons and property if not addressed through appropriate mitigating measures. In the absence of those, UAS operations can be allowed only in VLOS through airspace segregation, resulting in reduced airspace capacity in controlled airspace or limited/denied access to uncontrolled airspace for other airspace users.

The absence of a European-wide approach would result in a non-harmonised implementation or application of national rules of, having an impact on cross-border UAS operations and a potential safety impact on the integration of UAS operations into the manned-aviation airspace due to the use of different procedures and technology.

1.2.4.4.5 Expected impacts

Since the U-Space concept is still under development and considering that it will be addressed by the various initiatives mentioned above, a more detailed analysis is not possible especially when any changes to the existing rules or the creation of new legislation are still in progress.

Overall, the issue of the safe integration of UAS into the existing airspace structure calls for a global holistic approach, as well as the need for action. As the U-Space is still under development, it is not taken into consideration in the analysis of the proposed policy options and their respective impacts in this NPA.

1.2.4.5. Issue 5 — Inadequate competences of remote pilots

1.2.4.5.1 Drivers

The main drivers of this issue are the following:

— **Rapidly changing UAS technologies and fast-evolving UAS market**: the new characteristics and the evolution of UAS require UAS operators and remote pilots to have an adequate level of knowledge, especially with regard to safety, security, and privacy issues.

— **New actors compared to manned aviation and different uses (commercial/leisure)**: this is the key driver of this issue. The lack of knowledge in the area of UAS is much more evident compared to manned aviation as in many cases, the operators are non-experts or even minors.

— **Need for cross-border UAS operations and for EU market requirements**: this is an important driver as without a clear and consistent EU framework for the regulation of competences in the area of UAS operations, there might be regulatory gaps across MSs. In addition, in case of cross-border operations, the operators would need to invest more (e.g. small operator applying for a medical certificate in more than one MSs) in order to comply with various national rules.

1.2.4.5.2 Description

As UA become more and more popular, it is important for remote pilots to be aware of and comply with the UAS regulations, and for UAS operators to receive adequate training, when relevant, and raise their awareness. Attractive prices make UAS easily accessible to people with little or no understanding of the aviation system.

Not knowing how to properly set up a UA for flight can be very dangerous. If a remote pilot does not calibrate the UA correctly, or the UAS batteries are partially charged, serious problems might arise.

Furthermore, an inexperienced remote pilot might not be fully aware of, and knowledgeable about, the safety risks related to collision with manned aircraft, for instance.

Age limit

The main concern is not about the skills of minors probably considering UAS operations as playing videogames, but about the high probability of young hobbyists not being able to properly assess the risk. Many NAAs have set age limits on licenses for commercial UAS in their national legislation.

Training types

In many MSs, several types of training, both practical and theoretical, are provided by training schools.

Practical training could also be provided using a simulator, allowing the student to show their behaviour in case of an emergency. This would help to raise the student's awareness of possible risks and further develop their decision-making skills.

In order to better understand the typology of training provided across MSs, and the related costs, a questionnaire was sent to a group of training schools across the EU. The following survey results give some information on the trainings already provided:

— several schools offer both classroom and online training;

— in many cases, schools offer both practical and theoretical training, often as two separate modules;

— the length of the training course varies from some hours (e.g. 8-10) to several days (e.g. 4);

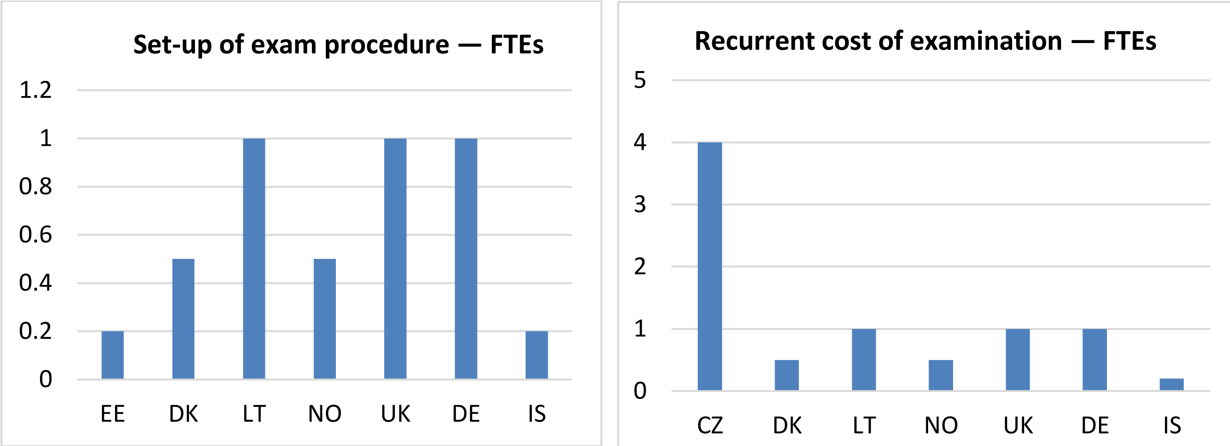
— in some cases, the fee for the final test is included in the general cost;

— as regards the practical part of the training course, there are differences across schools: in some cases, a minimum of 30 missions (10 minutes each) dispersed over several days is required; and

— the syllabus varies in several cases.

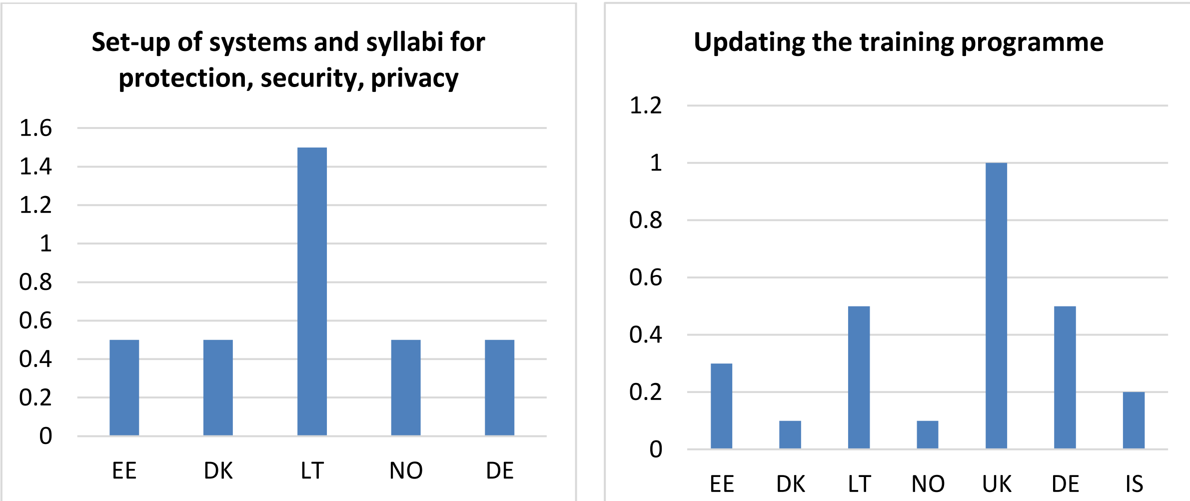
Appendix III provides further information on the cost of training courses, as well as the authorities' and operators' feedback on different training types.

Providing training has an important impact on authorities. Many authorities have already started defining the remote pilots' competences and the way they should be checked. In this regard, authorities were requested to provide their feedback on the resources dedicated and/or planned to dedicate to several tasks linked with training in the EASA UAS authorities questionnaire 2016 (see Graph 13 below). The following is a graphical representation of the resources (FTEs) across MSs (each column represents an MS) related to training;



Graph 13. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA.[48]

This information is good evidence for quantifying the impacts of several options proposed in this IA.



Graph 14. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA.

1.2.4.5.3 Background

Looking at UAS legislation across MSs, it is evident that the approach taken by different MSs varies in several aspects (training type, need for an examination and examination type, and age limit).

The Dronerules.eu website provides the related safety promotion activities (see Section 1.1.2.1.7).

Several manufacturers provide their products with leaflets containing general guidelines for users. Following the consultation with the manufactures (communication via telephone), it was clarified that

[48] With regard to Germany (DE): a total estimate of 3-4 FTEs covering various aspects of the training program. The following assumption was made in that context:

— 1 FTE for the set-up of examination procedures;
— 1 FTE for the recurrent cost of examinations;
— 0.5 FTE for the set-up of the training system (and syllabus); and
— 0.5 FTE for the translation of the syllabus.

the leaflets for many products are standardised across the EU; therefore, regulatory differences across MSs were not taken into consideration.

1.2.4.5.4 Consequences

The following is a list of the consequences of this issue:

— **Violation of privacy, data protection, security**: the lack of adequate knowledge of the UAS use might lead to the violation of privacy, data protection, and security.

— **Ground risk**: the lack of skills (e.g. how to regain control of a UAS or how to deal with emergency situations), or the use of UAS in prohibited areas, as next to sensitive buildings, aerodromes, nuclear plants, poses a significant safety risk.

— **Air risk (collision risk, air proximity, accidents and incidents with manned aircraft)**: some occurrences included in the safety risk portfolio (see Section 1.2.7 'Safety risk assessment') refer to human factors; most of these occurrences took place at a height of more than 150 m bearing a high risk for manned aviation.

1.2.4.5.5 Development of the issue if no action is taken

The increase in UAS operations and the proliferation of inexperienced remote pilots could lead to an increase of occurrences due to lack of competences if the issue is not appropriately addressed by all MSs.

In addition, the strict requirements laid down by some MSs might imply high costs for operators (e.g. training costs, examination costs) with a possible duplication of those costs in case of cross-border UAS operations. For instance, the certificate of competence issued in an MS might not be accepted in another one, thus negatively affecting operators.

1.2.4.6. Issue 6 — Need for registration and identification

1.2.4.6.1 Drivers

The main driver of this issue is the increasing number both of the new UAS users compared to manned aviation and of the UA themselves, which poses a potential threat. Another driver of this issue is the need for cross-border UAS operations. The operator should be able to operate all over the EU bearing a single registration recognised by all MSs. The law enforcement authority should have access to the UAS operator database to extract the operator's information when needed. In that respect, the identification requirements should also be harmonised across the MSs.

1.2.4.6.2 Description

Registration and identification are essential elements for law enforcement. In case a UA is operated in a way that endangers persons or property on the ground or another aircraft, the law enforcement authority should be able to identify the responsible person and impose sanctions.

Registration

The registration can also be considered as a deterrent, knowing that a possible misbehaviour could be identified and prosecuted.

This is applicable not only to safety risk but also to risk for privacy, data protection, and security. In particular, security authorities could require that not only the UAS operators but also all UA are registered in order to have a greater awareness of the situation.

Another benefit of registration is the possibility for the authorities to be linked with the operator and provide safety information when needed. In any case, it should be borne in mind that operator and remote pilot could be two different persons, but the operator is responsible for the activities of the employed remote pilot.

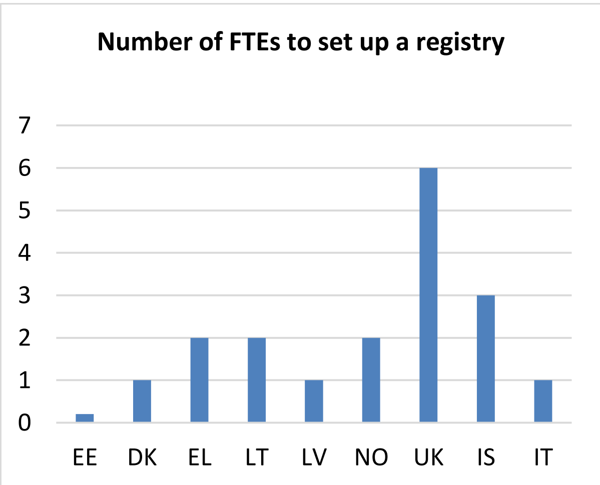
There are many ways to build a database and collect information for the purpose of registration. Some MSs have already set up registration systems, mostly online, but those systems are not coordinated across MSs. Consequently, an operator would need to register anew, when required, in each MS it intends to operate. Moreover, a fee is often required for registration.

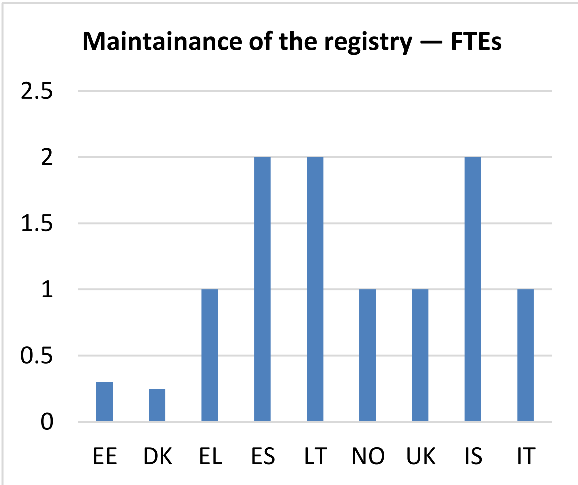
Furthermore, MSs may require registration of both the operator and the aircraft. This implies that every time the operator operates a new UAS, it needs to have it registered, and possibly pay a further fee.

Additionally, it is important that the databases are kept up to date since the life of a UAS is typically around 30 months. The UAS operator should be required to review and update its information (both on itself and the UA) within a defined time frame.

The registry could be set up at MS or at EU level. The economic benefit of a database at EU level is evident, but MSs have additional considerations related to security.

A survey conducted by EASA provides the following information on registration costs for authorities:



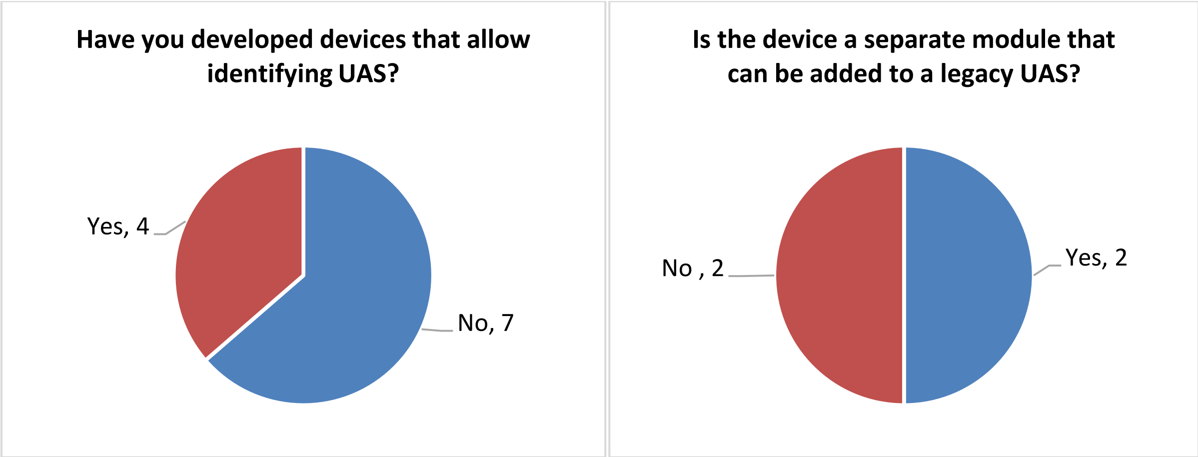


Graph 15. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA.

Identification

Identification can be made either by labelling the UA with a registration number or through a system broadcasting flight data, the remote pilot's data, and their position. For the latter case, several technologies are being developed from a simple squitter to more sophisticated systems using the mobile network. The mobile operator could act as the intermediary between the UAS operator and the law enforcement authority.

According to the EASA survey, some manufacturers already equip their UAS with an electronic identification system.



Graph 16. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA.

There are some privacy concerns related to the UAS operator information transmitted via the internet. The system could broadcast only the operator's code so that only the law enforcement authority would be able to identify the owner; the same system is used for number plates. The system could also be integrated with the future U-Space providing information in a centralised manner.

1.2.4.6.3 Background

Some MSs may already have a clear mandate from the security authority to require registration and electronic identification even for the lighter UAS (with an MTOM of more than 250 g). Other MSs are discussing which is the cost-effective MTOM threshold considering the size of the payload to be carried. MSs are also considering the availability on the market of UAS having a camera with a resolution high enough to collect personal images from distance, or a sensor like a microphone, which could create a privacy or data collection risk.

1.2.4.6.4 Consequences

The main consequences of this issue refer to the need of the law enforcement authority to identify a UAS operator conducting an unlawful operation, with regard to:

— violation of privacy, data protection, security;

— ground risk (accidents/incidents involving persons on the ground or sensitive areas, e.g. chemical plants);

— air risk (collision risk, air proximity, accidents and incidents with manned aircraft); and

— barriers to the market; this is also considered a consequence because of the following:

- the possible prescriptive requirements that impede technology innovation; and
- the burdensome requirements for (multiple) registration.

1.2.4.6.5 Development of the issue if no action is taken

Individual registration at MS level requires resources from both the MSs and the UAS operators. The latter would need to have multiple registrations to operate in more than one MSs.

Furthermore, some MSs requirements for electronic identification and registration might not ensure full protection against the safety and security risk.

1.2.4.7. Issue 7 — Disproportionate rules for special categories (privately built and model UAS)

1.2.4.7.1 Drivers

The main driver of this issue is that new technology allows to extend hobbyist flights to other types of aircraft apart from classic models.

1.2.4.7.2 Description

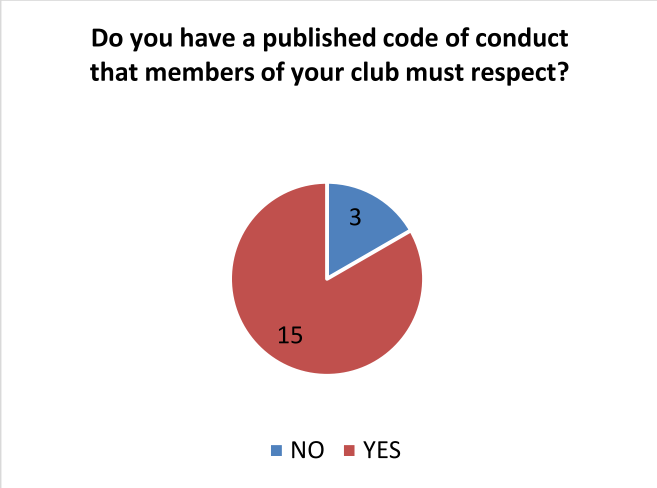
Model flying is an activity with a long history. Many of the aviation pioneers developed their designs based on tests conducted with models, and model aircraft remain an important element of aerospace education. They range from 'free-flight' aircraft weighing little more than a gram up to complex turbine-powered aircraft with an MTOM of 150 kg.

Model aircraft activities have a good safety record due to the safety culture developed by the model clubs as well as national and international model aircraft associations.

UAS can be considered as an evolution of model aircraft. Modern technology can greatly assist remote pilots, thus drastically reducing the skills required to operate a UAS. Almost anyone can operate a UAS both for leisure or commercial purposes, however, the nature of the operation does not change the risk posed to third parties. Model aircraft have therefore lost their monopoly on leisure flights with remotely piloted aircraft.

A definition distinguishing between model aircraft and UAS cannot be easily developed also because some model aircraft are equipped with some form of an assisted flight control system. On the other hand, some model pilots argue that they would be reluctant to use such a technology assisting them in flying the aircraft (e.g. a flight control system) since this would reduce their pleasure. However, this technology is widely used in UAS since the remote pilot in that case is likely more interested in the payload (e.g. a camera) than in flying the UA. Therefore, a definition of UAS, to differentiate them from model aircraft, could be based on the presence of a flight control system that allows a UAS to fly in BVLOS range.

This approach was rejected since it was considered that automation can also be integrated with model aircraft to a certain extent. Moreover, the code of conduct developed by the model clubs and associations is what contributes to the safety of hobbyist operations and not the type of aircraft used. In most cases, model clubs and associations have operating procedures and they raise awareness, and in some cases, they also provide their members with training, thus creating a safety framework.



Graph 17. Source: EASA model aircraft associations questionnaire 2017. Elaboration: EASA.

Another category of UAS to be considered are the 'privately built' ones, not available on the market but built by individuals. The risk posed by these systems is that there are no means to ensure their reliability. Although aircraft of this type are mostly operated by model clubs, there are hobbyist UAS operators not willing to join model clubs and/or associations.

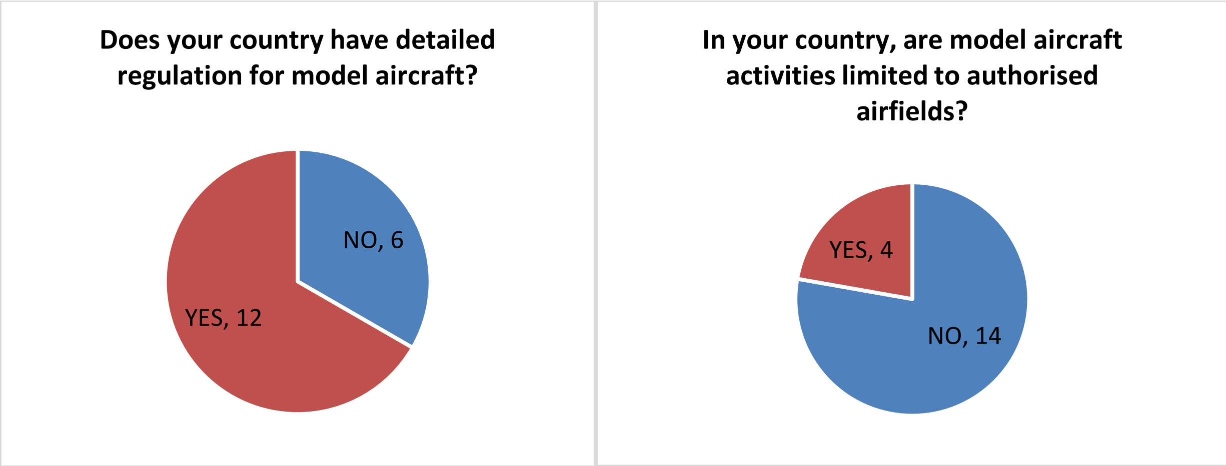
From the above, it is clear that model aircraft operators and new UAS operators have generally a different starting point in terms of risk awareness and remote-pilot competences as many clubs publish the code of conduct that their members must respect. Therefore, the main issue is how to find a balanced and proportionate approach for special categories of UAS as model aircraft.

1.2.4.7.3 Background

Model aircraft

In some MSs, model aircraft operations are clearly defined and regulated by established model clubs and associations, in accordance with the regulatory framework of their NAA. These national regulations are mostly considered to be fit for purpose by both the remote pilots and their NAA. Based on the replies provided by model aircraft associations, a total number of 1.5 million model aircraft across the EU could be estimated.

A series of detailed questions were posed to model aircraft associations in order to better map the situation. Graph 18 shows the importance of model aircraft, considering the high number of EU operators.



Graph 18. Source: EASA model aircraft associations questionnaire 2017. Elaboration: EASA.

Graph 19. Source: EASA model aircraft associations questionnaire 2017. Elaboration: EASA.

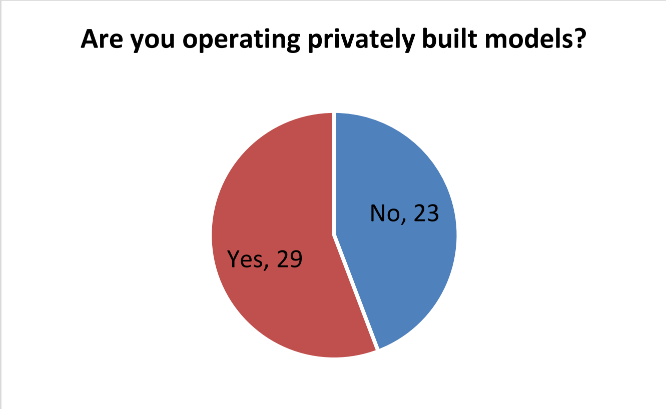
As regards the registration of model aircraft, the following comments were received, among others:

— all models have to carry the identification of the owner/pilot; and

— the models of club members are not registered; only models for competitions bear the license number of the competitor.

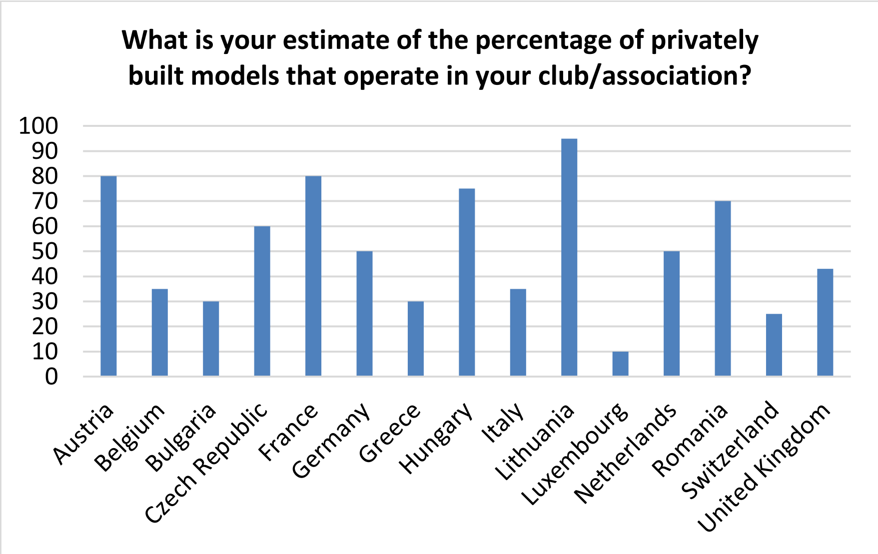
Privately built UAS

According to the replies received on the EASA UAS operators questionnaire 2017, privately built UA are used by many operators.



Graph 20. Source: EASA UAS operators questionnaire 2017. Elaboration: EASA.

Privately built models could be used also in model aircraft associations:



Graph 21. Source: EASA model aircraft associations questionnaire 2017. Elaboration: EASA.

1.2.4.7.4 Consequences

The main consequence of this issue is the barrier to the market. If model aircraft would be required to comply with the same requirements mandated for UAS, they could be even prohibited or at least a disproportionate burden could be imposed on them. For this reason, some special alleviations need to be identified for this aircraft category.

1.2.4.7.5 Development of the issue if no action is taken

In case no regulatory action is taken at EU level and MSs keep their national regulation for model aircraft, some MSs might require clubs and associations to comply with technical requirements, altering the nature of model flights, or mandate operators to apply for an authorisation in order to operate in the specific category, and carry out a risk assessment.

A technical requirement, such as an auto-return function, would require the operator to equip the aircraft with a flight control system that would change the way and philosophy a model aircraft is conducted. In practice, this hobby would be prohibited.

On the other hand, the requirement for an authorisation for a model aircraft to be operated in the specific category could be not proportionate considering the current satisfactory safety framework and records of model clubs and associations.

In some MSs, operators might be obliged to be registered with a model club to operate their UAS. This would not only represent an additional cost as they would have to pay a membership fee, but would also restrict their operations within specific areas.

1.2.5. Conclusions

Chapter 1 contains a selection of information on the current UAS market, showing the importance of the three main drivers of the seven issues analysed above. Tables and graphs help visualise the following elements:

— the fast-evolving market in terms of UAS numbers and UAS uses in various sectors over the next years (Driver 3);

— the new actors in the market, e.g. looking at the largest manufacturers (Driver 2); and

— the need for a UAS regulatory framework at EU level (Driver 1).

Moreover, it introduced all the key horizontal activities that are already ongoing, such as safety and awareness promotion (e.g. DronesRules.eu). Under each of the seven issues analysed, information on the current situation is presented (e.g. on existing technologies in Section 1.2.4.3 'Issue 3 — Inadequate technical requirements'). All this clarifies the past and current situation in the EU, and helps identify the potential for further action, e.g. towards expanding the UAS market, taking into account safety. Additionally, information on the current initiatives at international level is provided, which might directly or indirectly affect Europe (e.g. ICAO, JARUS, or third countries).

Furthermore, information on the current regulatory framework in several EASA MSs is offered. The cross-MS analysis clarifies the high level of regulatory fragmentation at EU level, which might pose obstacles for e.g. cross-border UAS operations.

Each issue description has been complemented by the results of the questionnaires sent to various stakeholders. The feedback received not only helped to further analyse the problems but it is also considered in the quantification of the impacts of the various options proposed in this IA (e.g. the number of FTEs for specific tasks at authority level).

Lastly, the problem tree proposed helps visualise the overall rationale behind this IA.

In summary, this Chapter identified the key issues for which solutions (options) are proposed in Chapters 3-6. A clear and in-depth view of those issues is necessary to define the objectives (Chapter 2) and the options, as well as to understand the efficiency and effectiveness of these options in solving the issues (Chapters 3-6).

1.2.6. Who is affected?

General public: all EU citizens impacted by risks related to UAS operations, either as clients of UAS services or UAS users for private purposes. UAS could support innovative services with a high potential for welfare and new jobs; however, they pose a safety, security, and privacy risk.

UAS manufacturers: UAS manufacturers, including many SMEs and start-ups. Manufacturers (especially SMEs) might be impacted by additional technical requirements in the regulatory framework. Indeed, it could be very costly to implement those requirements. Furthermore, the limitations imposed might have a negative effect on the operators' demand for UAS, and therefore negatively impact the manufacturers as well. This stakeholders' category includes manufacturers of various UAS types, such as toys and/or models.

UAS operators: commercial and non-commercial operators. They are also affected as they would have to comply with requirements for training or operational limitations. All this could create a barrier to some users.

MSs: (civil aviation, aviation, data protection, market, privacy or security authorities). Authorities would need to deal with the demands and expectations of the growing UAS sector, develop regulations, organise UAS licensing and oversight, check declarations and authorisations, issue certificates, address registration issues, set up training for UAS operators and train their employees. In addition, authorities would need to enforce public policy, with regard to safety, privacy, and security matters. The authorities concerned are at local, national and EU level (EASA).

Economy: Many businesses may include the use of UAS in their business model. This could lead to lower costs and/or innovative services. Typical examples are the agricultural, energy, and delivery sector.

Airspace users: they are quite affected by UAS as shown by the number of UAS occurrences above a certain altitude. The future definition of a UTM system will definitely affect them.

The UAS market includes a list of services with a high potential for development. The following is a graphical representation of the importance of UAS from the service market point of view:

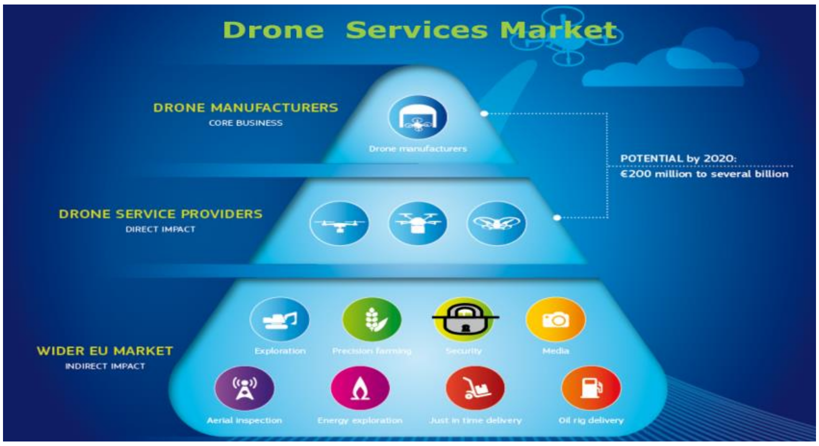


Figure 2. Source: presentation of the European Commission at the Warsaw conference[49].

[49] https://www.easa.europa.eu/newsroom-and-events/events/high-level-conference-%E2%80%9Cdrones-leverage-jobs-and-new-business
https://www.easa.europa.eu/system/files/dfu/1WelcomeVioletaBulc.pdf

1.2.7. Safety risk assessment[50]

The analysis of RPAS (UAS) occurrences for the period 2010-2016, extracted from the European Central Repository (ECR), identified 2141 occurrences of all severity levels. 38 occurrences had been classified as accidents, none of the accidents involved fatalities, and there were only 4 minor injuries inflicted to people on the ground. The collection of data on RPAS occurrences is in its infancy and there is still work to be done to ensure the correct application of taxonomy terminology to RPAS. The definition of RPAS accident has improved since new definitions were provided in ICAO Annex 13. However, the ECR data covers a period before the ICAO definitions were published; therefore, the definition of accident may not have been correctly captured in some of the older data.

Furthermore, the aforementioned data originate in most cases from pilot reports. When judging the reliability of this information, the following should be taken into consideration:

— the difficulty in precisely identifying a small UAS at a distance (e.g. it could be some other object similar to a UAS);

— the fact that many of the reports refer to high-altitude occurrences, therefore, focusing rather on air risk and not on collision with persons on the ground;

— the lack of reporting, especially in those MSs where there is little experience in UAS occurrences; and

— the lack of data, especially on occurrences with persons on the ground.

Figure 3 below shows that there has been a very significant increase in the number of occurrences in 2016. Nevertheless, the focus should be on the occurrence data themselves and their reliability.

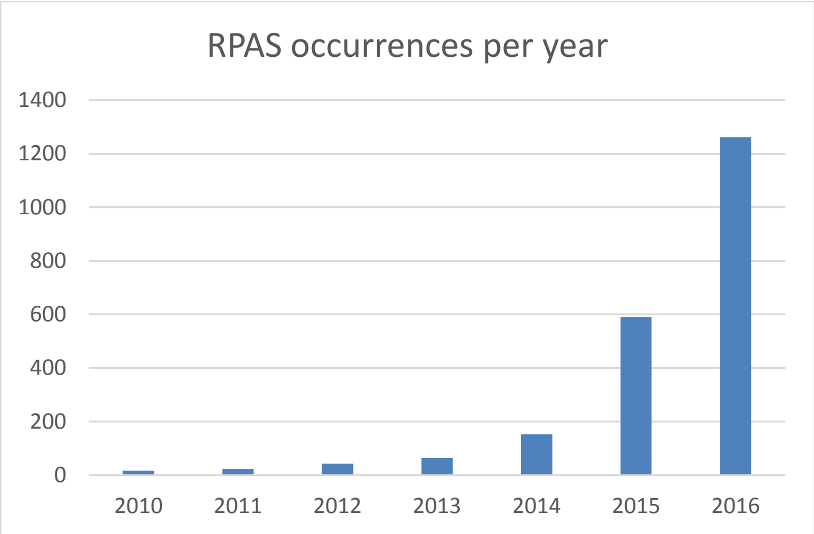


Figure 3 — Reported RPAS occurrences per year. Source: ECR.

50 Sources: EASA Annual Safety Review 2016 (https://www.easa.europa.eu/document-library/general-publications/annual-safety-review-2016), Report: UAS Safety Risk Portfolio And analysis (https://www.easa.europa.eu/system/files/dfu/UAS%20Safety%20Analysis.pdf), and https://www.easa.europa.eu/document-library/general-publications/uas-safety-risk-portfolio-and-analysis.

Figure 4 below shows the distribution of the reported occurrences among occurrence classes. Most of them are considered to be incidents and the rest is spread over the other classes.

UAS accidents occur mainly when the UAS crashes and is severely damaged due to loss of control, mechanical failure, controlled flight into terrain (CFIT), or mid-air collision with another aircraft. The most common serious incidents are near mid-air collisions. This incident type includes also loss of control and loss of data link cases.

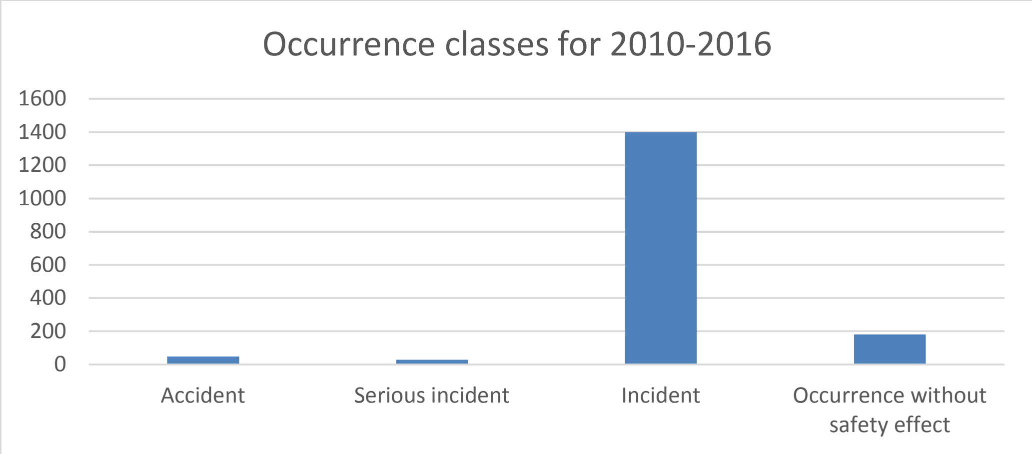


Figure 4 — Occurrence classes for 2010-2016

Figure 5 below shows the distribution of reported occurrences in the ECR over the EASA MSs. Most of the occurrences by far were reported in the UK. Figure 5 shows also the exponential growth in the number of reports. It is also worth noting that all data originate from operators through their NAAs. Data on ground risk involving flying at a low altitude in sensitive areas, like in proximity to nuclear power plants, crowds and densely populated areas are not shown in Figure 5 and no record thereof is available. It is likely that such information will continue to be unavailable in the near future as people might not be willing to report such occurrences.

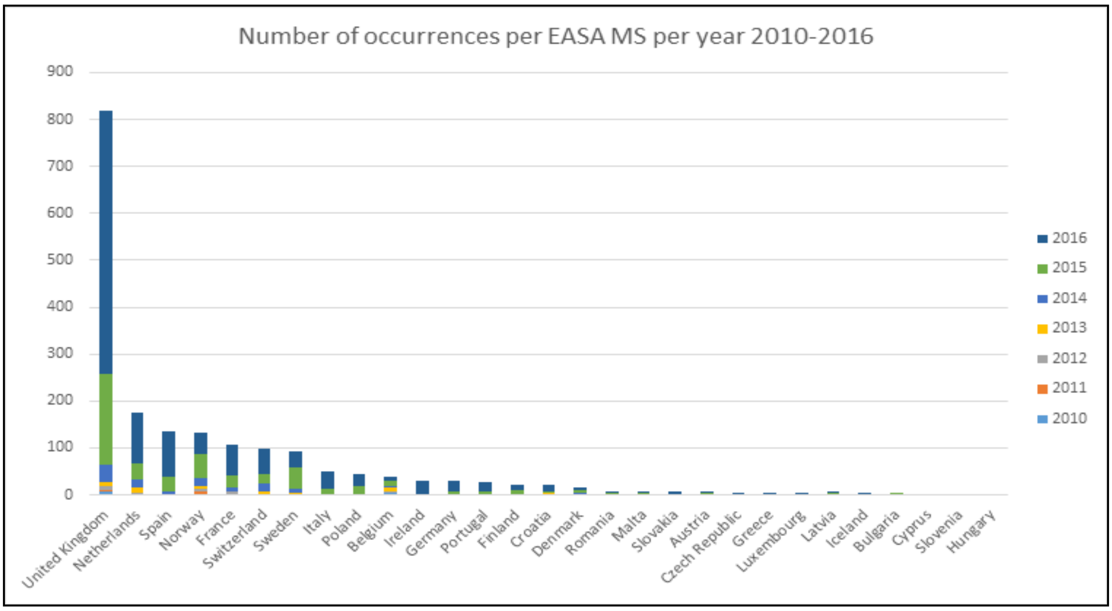


Figure 5 — Distribution of reported occurrences over the EASA MS (2010-2016).

Among the occurrences shown in Figure 6 below, there were 38 accidents, the majority of which resulted from the UAS crash due to technical reasons or loss of control. None of these occurrences involved fatalities or major injuries.

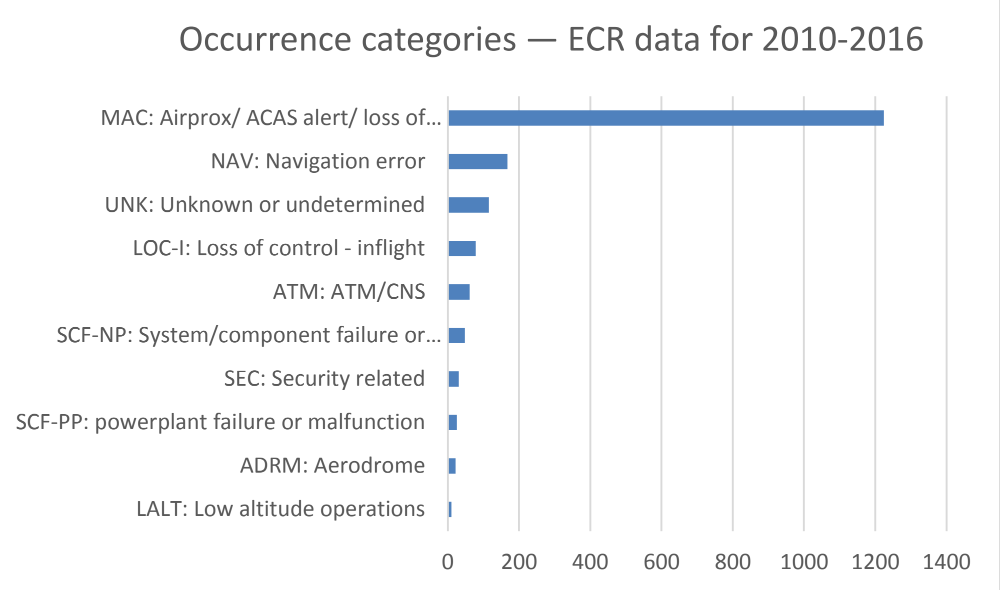


Figure 6 — Occurrence categories of the reported RPAS occurrences (2010-2016)

Figure 7 shows the ECR-reported occurrences as well as occurrences reported directly by operators that have encoded altitude information. Estimation is based on reports' narrative on how close the drone was to the aircraft. Figure 7 shows the altitude at which the UAS was encountered vs the vertical distance from the manned aircraft. As UAS are usually relatively small, they are mostly sighted when they are quite close to, and flying in a similar altitude as, the manned aircraft; which implies that the actual number of flying UAS is significantly higher. However, Figure 7 shows that the frequency of sightings varies at different altitude levels (e.g. 0-1 000 ft vs 1 000-2 000 ft from the aircraft).

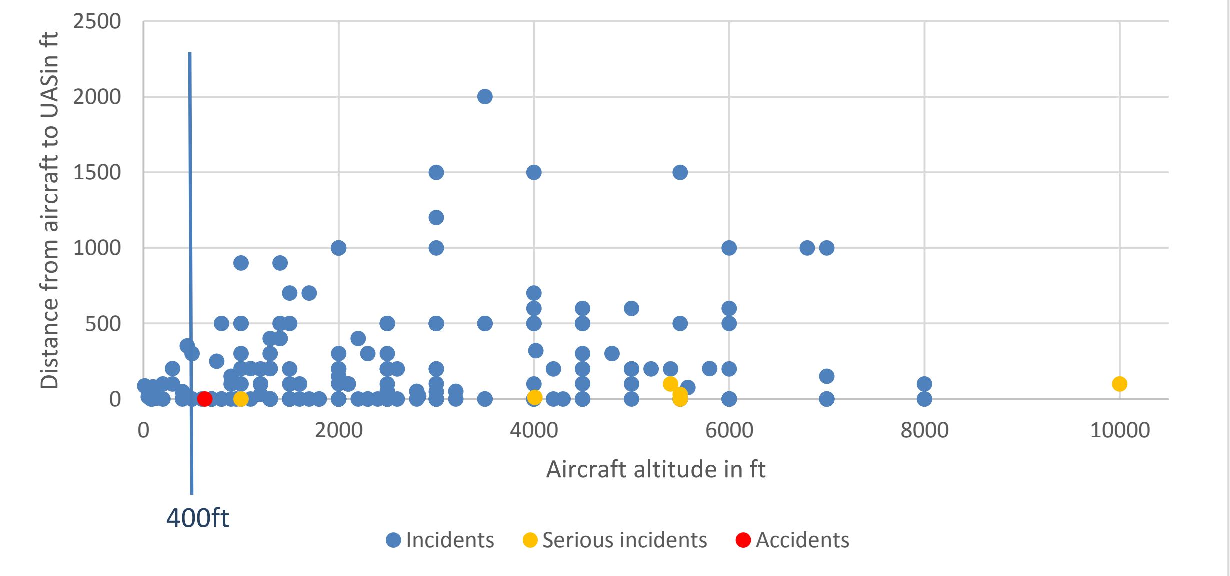


Figure 7 — Distribution of RPAS occurrences involving manned aircraft: actual aircraft altitude vs distance to the UAS (2010-2016).

The UAS Safety Risk Portfolio (SRP) has been updated with the currently available data from the ECR. The number of non-fatal accidents is 33 for the period 2012-2016[51]. The identified safety issues (in the far left column) have been mapped on to relevant event types of the ECR taxonomy.

	RPAS								
Outcome Percentage of Fatal Accidents (2012-2016)	0			0%	0%	0%	0%	0%	0%
Outcome Percentage of Non-Fatal Accidents (2012-2016)	33			91%	13%	10%	4%	2%	1%
Safety Issues	Total number of occurrences in 2012-2016 per safety issue			Key Risk Areas (Outcomes)					
	Incidents	Serious Incidents	Accidents	Airborne Conflict	Aircraft Upset	Other System Failures	Terrain & Obstacle Conflict	Engine Failure	Third Party Conflict
Operational									
RPAS Proximity with Other Aircraft in Uncontrolled Airspace	505	19	15	•	•	•			•
RPAS Handling and Flight Path Management	9	0	11		•	•			
RPAS Infringement of Controlled Airspace	373	9	2	•	•				•
Recognition and Recovery from Abnormal Attitudes	2	0	2		•	•		•	
Technical									
Failure of Propulsion System	27	2	14		•	•	•		
Failure of Guidance and Control System	21	2	7		•	•	•		
Failure of Power Sources	10	0	0		•	•			•
Human									
RPAS Operator Knowledge of Aviation System	20	0	3	•	•	•			
Pre-Flight Planning and Prepration	16	0	3		•	•			
Maintenance/manufacturing	13	0	2	•	•	•	•		

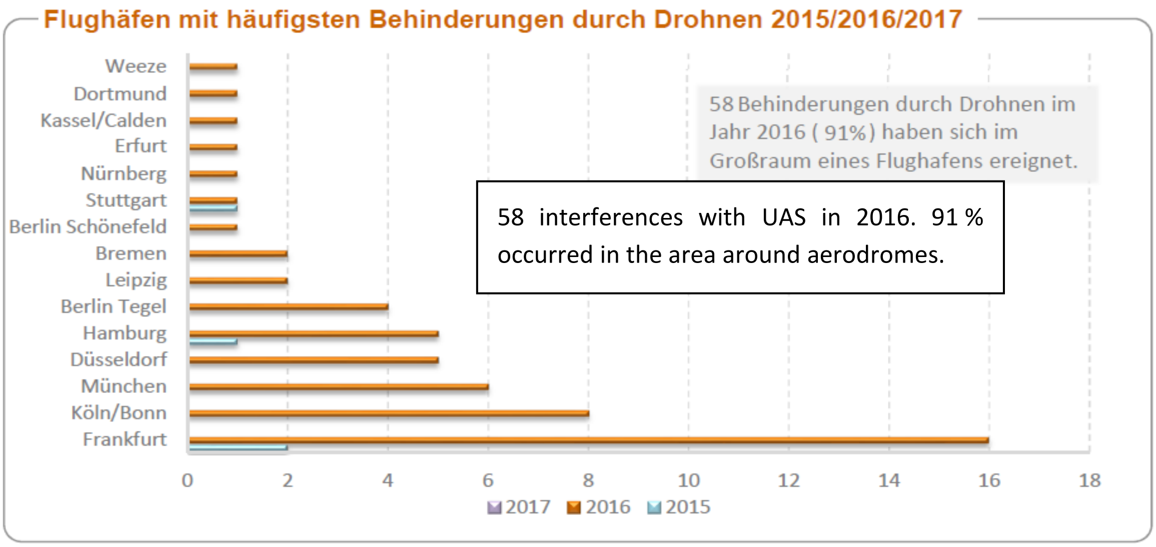
Figure 8 — Extract from the Safety Risk Portfolio.

Note 1: the number of accidents should take into consideration the difference in severity between UAS accidents (e.g. only UAS crash with no fatalities) and UAS accidents with manned aircraft (involving in several cases many fatalities).

Note 2: there are few UAS occurrences caused by human factors. This could be explained by the fact that most of the time, the related reports are sent by the manned-aircraft pilots, and only little information is provided by the UAS remote pilots.

Further evidence on the risk of accidents/incidents in sensitive areas as aerodromes has already been verified and mapped by some MSs. The following is a graphical representation provided by DFS Deutsche Flugsicherung GmbH:

[51] This number of accidents (33) does not coincide with the number of accidents mentioned earlier in the text (38). This is because the first number refers to accidents with UAS registered in EASA MSs. The difference is due to UAS that are not registered in one of the MSs. In addition, the time frame considered is shorter (2012-2016). The SRP shown is the latest available draft; further updates will be provided in the EASA Annual Safety Review to be published soon.



Graph 22 — Interferences with UAS in the area of aerodromes (2015/2016/2017). Source: Drohnen Report, January 2017, DFS Deutsche Flugsicherung GmbH.

Positive aspects of UAS in terms of safety

The safety risk assessment focused, expectedly, on the risks posed by UAS. However, these risks should not overshadow the fact that UAS can actually save lives by replacing manned aircraft or humans in certain activities.

For example, a UAS used for filming (news or movies) will reduce the risk for victims in case of accidents.

In addition, using a UAS for dangerous infrastructure inspection will release people from having to climb up the structure, thus offering a potential for accident reduction.

Overall, using UAS for dangerous missions such as gathering data from a volcanic eruption or chemical/radioactive leak will be beneficial for safety.

Finally, UAS can be deployed quite quickly in disaster areas and enhance the efficiency of the rescue operations.

1.2.8. UAS in third countries

UAS legislation has been or is being developed in many countries outside the EU. Appendix V provides a brief overview of some key elements of UAS legislation developed in selected non-EU countries.

1.2.9. UAS operations aspects not covered in detail and issues considered to be outside of the NPA scope

The security, privacy, and data protection risks are aspects not detailed in this IA; they will be addressed both at MS and EU level. Nevertheless, some elements such as registration, electronic identification or geofencing analysed in this document are also related to these aspects.

On the other hand, the following issues were considered to be out of the scope of this NPA:

— the certified UAS category;

— state and/or military UAS operations;

— UAS insurance;
— indoor UAS operations; and
— counter-UAS equipment and operations.

2. Objectives

2.1. General objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. The general objectives of this RMT are the following:

— ensure an operation-centric, proportionate, risk- and performance-based regulatory framework for UAS;

— ensure a high and uniform level of safety for UAS operations;

— foster the development of the UAS market; and

— contribute to a high level of privacy, data protection, and security.

2.2. Specific objectives

The specific objectives of the this RMT are the following:

— ensure a high level of protection of sensitive areas (e.g. nuclear plants, aerodromes);

— develop proportionate technical requirements taking into consideration the safety risk and rapidly changing UAS technologies;

— contribute to a system for low-level UAS operations;

— ensure a proportionate and adequate level of remote-pilot competences, taking into account the new actors in the market (vs manned aviation);

— define a clear set of boundaries between the open and specific category, and among the open subcategories;

— clarify to what extent registration and electronic identification are needed;

— develop a proportionate regulatory framework that takes into account special categories such as model aircraft;

— harmonise the UAS regulation across MSs especially for cross-border UAS operations; and

— contribute to the development of an EU-wide UAS services market (Riga Declaration).

3. Introduction on options

Further to Chapter 1 'Problem definition' (defining what the problem is) and Chapter 2 'Objectives' (explaining what needs to be achieved), the following Chapter 4 describes ways to achieve the objectives in order to solve the issues.

Three sets of options were developed in the following order:

— options for the open category;

— options for registration; and

— options for the specific category.

For all options, it was considered that they would enter into force 3 years after the publication of Regulation (EU) 201X/XXX.

The options were developed taking into consideration the following sources:

— EASA expertise (several UAS experts);

— feedback collected via consultations (e.g. questionnaires, feedback on the 'Prototype' Regulation); and

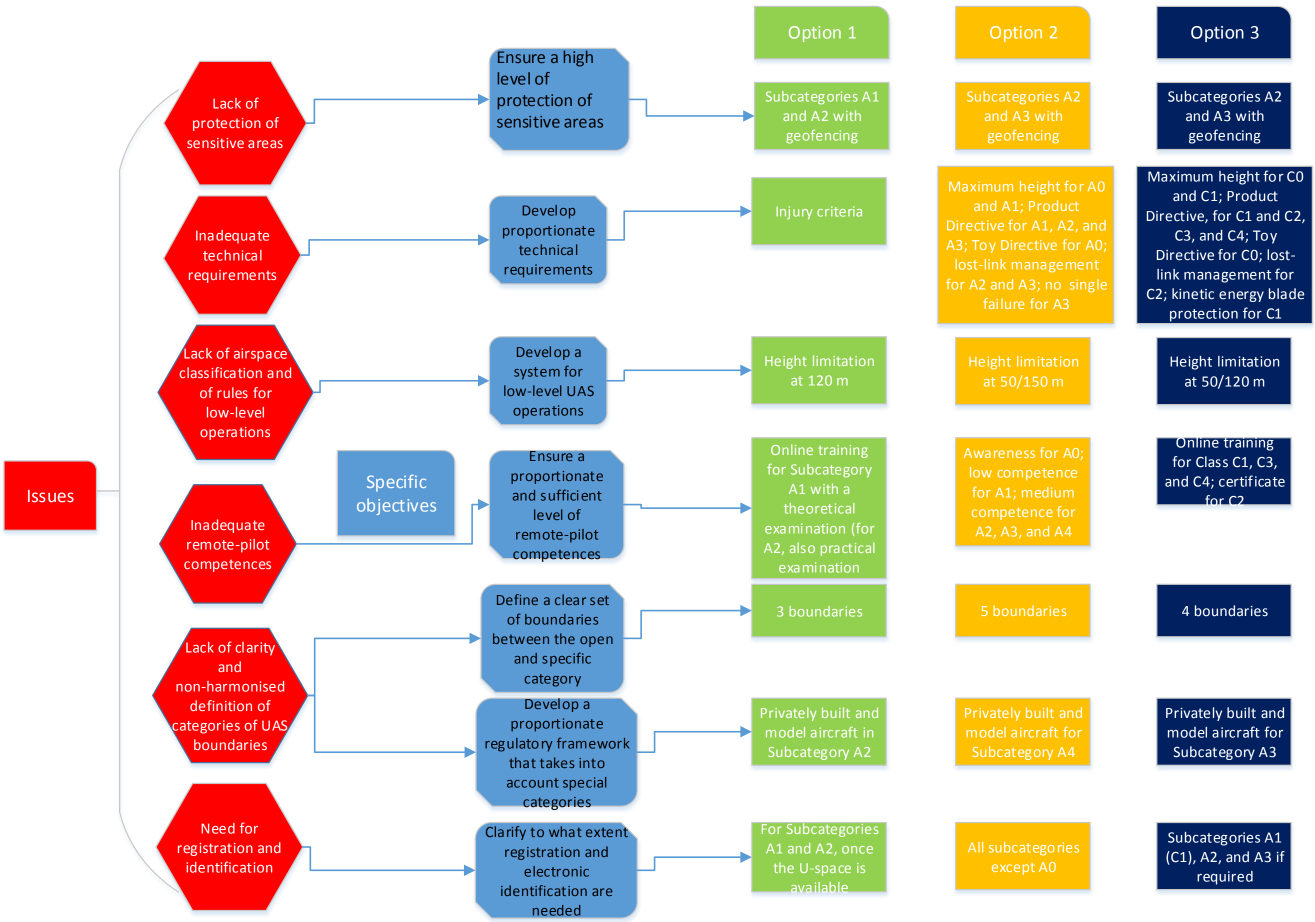
— expert's input received during the expert group meetings held on the EASA premises (Option O1, for example, was proposed by those experts).

4. Open category

4.1. Open-category options

As shown in the problem tree, the issue of subcategorisation in the open category is interlinked with the other issues. Therefore, the open-category options were developed applying a holistic approach that takes into account all different elements in order to mitigate the safety risk (both ground and air risk), as well as to contribute to the mitigation of the privacy and security risk. Different options are based on different combinations of technical requirements, operational limitations, and remote-pilot competences, with the aim of finding the right balance that better meets the objectives of this IA. A total of three options were analysed for the open category, as described in Table 3 below.

Before exploring each option separately, the following Graph 23 is included to illustrate the link between the issues, objectives and options (e.g. the 'intervention logic'):



Graph 23 — Intervention-logic graph showing the link between problems, objectives and options.

Table 3 — Selected policy options for the open category

Option No	_Short title_	_Description_
O0	Do nothing	No change to the rules; risk remains as outlined in the issue analysis. The EU regulatory framework would remain fragmented with some MSs having stricter requirements than others.
O1	Focus on remote-pilot responsibility	A 'light' approach in terms of technical requirements. Risk is mitigated through remote pilot responsibility
O2	Focus on technical requirements	Detailed subcategorisation with several technical requirements and strict knowledge requirements in order to maximize safety benefits.
O3	Balanced requirements	Balanced set of technical requirements and pilot competence.

Two additional options were taken into consideration at the beginning but then discarded. (see Section 1.3.5 'Discarded options' for details).

The following is a list of elements on which the proposed options are based:

— UAS MTOM, including payload;

— UAS kinetic energy (in Joule (J)) transferred to the human body, as an alternative criteria to MTOM;

— distance from involved/uninvolved persons or crowds;

— UAS classes defining the set of requirements for UAS operation in each subcategory;

— maximum height of the operation: maximum height limitation (operational limit);

— remote-pilot competence: level of practical skills and theoretical knowledge;

— age of the remote pilot: minimum age to operate a UAS;

— applicable according to product regulation.

— applicability of the electronic-identification/geofencing requirements.

4.1.1. Option O0 — Do nothing

Pursuant to the new Basic Regulation, regulation of all UAS (irrespective of their MTOM) falls within EU competence. This sets the course for a risk-based approach applied to the three main categories: open, specific and certified. In addition, the new Basic Regulation requires compliance with Regulation (EC) No 765/2008 on the marketing of products and Regulation (EU) No 376/2014 on occurrence reporting; the latter applies to the open category in case of an accident '*resulted in a fatal or serious injury to a person or it involved aircraft other than unmanned aircraft*'.

Nevertheless, it was decided to retain Option O0 for the case where no EU UAS Regulation would be adopted and the UAS regulation would remain within the competence of the MSs (various national rules). The main reason for retaining this Option is to use it as a benchmark against which alternative options could be compared, thus assessing the improvement (or not) achieved through those alternative options. More details on Option O0 have been already presented in Section 1.2 'Issues analysis'. Indeed, this option uses information on the regulatory framework at MS level, which, however, is rapidly changing in order to adapt to the rapidly evolving market. Therefore, this information might be (partially) outdated, providing mainly a general view on the trends across MSs[52]. Some key points are listed below:

Categorisation

Most MSs have incorporated into their rules a subcategorisation based on MTOM, which varies considerably across MSs, especially with regard to the subcategorisation of the specific and the open category. No common limits exist: e.g. 0.3 kg, 1 kg, 1.5 kg, 5 kg, 7 kg, 20 kg, 25 kg.

Distance from people

Some MSs' rules include the concept of distance from people, or assemblies of people, or densely populated areas, persons, congested areas, crowds, roads, or make no relevant reference.

Maximum height

In many MSs, the maximum limit is set at 120 m, in others at 150 m, 100 m or 50 m, depending on the scenario.

Competence

Overall, some MSs have strict rules, while others have limited requirements. An example: the higher the risk, the more the requirements: e.g. more qualifications, a medical certificate, as well as a theoretical and/or practical test would be required.

Technical requirements

So far, almost no technical requirements have been incorporated into the MSs' rules.

Operational limitations

Many MSs have limitations in terms of distance from aerodromes (e.g. 1.5/2.5/5/8 km) or congested areas (50 m from buildings, persons, animals; not over densely built-up areas, camping sites, industrial areas, railways).

[52] A detailed cross-MS overview is provided in Section 1.1.5. 'Current regulatory framework at MS level' (see Appendix V).

4.1.2. Option O1 — Focus on remote-pilot responsibility

This Option was proposed by stakeholders and analysed in detail. Its key elements are summarised in the following table[53]:

Table 4

UAS subcategory	UAS MTOM (AIS)	Distance from people	Maximum height of the operation	Remote-pilot competence	Age of the remote pilot	Electronic identification/ geofencing	Technical requirements
A0 **Flight over people**	< 250 g or AIS < 3 *Note (a)*	No limitation	VLOS and in no case higher than 30 m below the ICAO visual flight rules (VFR) minimum altitude, normally 120 m	None	Decided by MSs *Note (c)*	No (or on a voluntary basis)	Yes, if AIS < 3, or Directive 2009/48/EC[54] *Note (b)*
A1 **Fly close to people**	250 g to 25 kg *Note (a)*	More than 50 m away from crowds		Online training *Note (e)*		Yes, if U-Space available *Note (d)*	No *Note (b)*
A2 **Fly far from people**	250 g to 3 kg *Notes (a) and (b)*	Less than 50 m, but not directly above crowds		Examination including theoretical and practical skills *Note (f)*			

[53] Notes to Table 4:

(a) It applies to model aircraft and UAS; emergency recovery systems may be excluded up to a certain limit.

(b) Not directly over people (without EC marking, with AIS < 3): the main driver of the complexity of the draft rule is the subcategorisation in the open category, as well as the link with the EU harmonisation legislation (CE marking). The use of CE marking complicating the draft rule can only be justified for flights directly over people. Furthermore, US Code of Federal Regulations (CFR) 14, Part 107 does not address the safety of the UAS as a product for operations that are not conducted directly over people. Thus, the CE marking should only be used to confirm that a UAS can be operated safely directly over people (i.e. it complies with the applicable AIS requirement).

(c) According to current experience, there is no correlation between the age of the UAS pilot and the risk to uninvolved people.

(d) Alignment of the regulatory approach with the U-Space: all electronic-identification and geofencing requirements must only require a connection to the U-Space. Installing equipment for electronic identification or geofencing that is not compatible with the U-Space is unjustifiable, considering the time frame set for the creation of the U-Space (2019).

(e) Online training approved by a competent authority or qualified entity: theoretical remote-pilot competence is an essential element in ensuring safety in the open category.

(f) Examinations can be provided by a competent authority or qualified entity.

[54] Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys (OJ L 170, 30.6.2009, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1493656682583&uri=CELEX:02009L0048-20140721).

The main elements of Option O1 are the following:

— no technical requirements and CE marking are mandated except for Subcategory A0;

— remote-pilot proof of competence, including a theoretical and practical test, is required only in case the operation is conducted in proximity to crowds since experience showed that specific skills are required to maintain the UA at a safe distance from people, especially in case of failures;

— the air risk is mitigated through the height limitation of 120 m and the requirement for an online course;

— electronic identification and geo-limitation are not mandated at this stage since they will be incorporated in the U-Space requirements;

— the MSs should decide on the minimum age for UAS operations; and

— UAS with an MTOM greater than 3 kg are not allowed for operation in proximity to crowds.

The following list shows how each of the issues analysed in Section 1.2 is addressed by the main elements of this Option.

(a) Lack of protection of sensitive areas (e.g. aerodromes, nuclear plants, densely populated areas):

— MSs have limited flexibility to define zones for certain UAS operations; and

— geofencing for Subcategories A1 and A2 will be mandated only when the U-Space will be available, providing a real-time update.

(b) Inadequate technical requirements:

— geofencing, injury criteria for Subcategory A0; and

— no other technical requirements are mandated.

(c) Inadequate remote-pilot competences (complexity of the system):

— online training for Subcategory A1 (250 g < X < 25 kg);

— exam, including theoretical and practical skills, for Subcategory A2 (250 g < X < 3 kg); and

— age limit decided by MSs.

(d) Lack of clarity of UAS boundaries (in the open and specific category, including special categories such as model and privately built UAS):

— when MTOM > 25 kg, boundary for open/specific category, VLOS, and operational limitations ; and

— boundaries within the open category: MTOM < 250 g, 250 g < X < 25 kg (A1), 250 g < X < 3 kg (A2).

(e) Electronic identification:

— for UAS with an MTOM of more than 250 g, only once the U-Space will be available.

(f) Disproportionate rules for special categories:

— privately built UAS and model aircraft allowed in Subcategory A2; exemption possible for modellers (e.g. regarding altitude) and tethered operation.

Link with the specific category

The operations are less restricted compared to those under Options 2 and 3: it is possible to fly over people (keeping a distance of 50 m from crowds) with an MTOM of up to 25 kg. As some MSs expressed their safety concerns in this regard, the solution would be to limit the operations by defining zones and move some of the operations under the specific category.

4.1.3. Option O2 — Focus on technical requirements

This Option follows to a certain extent the approach implemented in the 'Prototype' Regulation.

Table 5

<table>
<tr><th>UAS subcategory/ class</th><th>UAS MTOM (AIS)</th><th>Distance from people</th><th>Maximum height of the operation</th><th>Remote-pilot competence</th><th>Age of the remote pilot</th><th>Main technical requirements (CE marking)</th><th>Electronic identification, geofencing</th></tr>
<tr><td>A0/Class 0</td><td>< 250 g</td><td rowspan="2">No flight over open assemblies of people</td><td rowspan="2">50 m</td><td>None</td><td>No limitation</td><td>First-person-view (FPV)/ follow-me mode, Directive 2009/48/EC, maximum height 50 m</td><td>No</td></tr>
<tr><td>A1/Class 1</td><td>< 80 J or 900 g</td><td>Familiarisation</td><td>14 years</td><td>FPV/follow me mode, maximum height 50 m</td><td>Yes, marked with operator ID</td></tr>
<tr><td>A2/Class 2</td><td>900 g to 4 kg</td><td rowspan="2">20/50 m distance from uninvolved persons[55]</td><td rowspan="3">150 m</td><td rowspan="3">Certificate of competence after theoretical and practical test</td><td rowspan="3">16 years</td><td>Geofencing, auto-return home, lost-link mamagement</td><td>Yes, marked with operator ID, unique hardware number</td></tr>
<tr><td>A3/Class 3</td><td>< 25 kg</td><td>Geofencing, auto-return home, lost-link, management, no critical single failure</td><td>Yes, marked with operator ID, unique hardware number</td></tr>
<tr><td>A4/Class 4</td><td>< 25 kg</td><td>Only in remote areas</td><td>N/a</td><td>Yes, marked with operator ID</td></tr>
</table>

[55] Definition: 'uninvolved persons' means anyone that is not directly taking part in an operation. Due to the large number of possible circumstances, only general guidelines can be provided. An involved person is someone who can reasonably be expected to follow directions and safety precautions provided by the person controlling the operation, to avoid unplanned interactions with the UAS.

The main elements of Option O2 are the following:

— for each subcategory, technical requirements are mandated through Regulation (EC) No 765/2008 (except for Subcategory A4);

— air risk is mitigated through the height limitation of 150 m, the technical requirements, and a certificate of competence, including a theoretical and practical test;

— ground risk is mitigated through technical requirements and different levels of remote-pilot competence based on the size and/or kinetic energy of the UAS;

— electronic identification and geofencing are mandated for UAS with an MTOM greater than 900 g;

— no technical requirements are mandated for flying in non-populated areas; and

— minimum allowed age to fly UAS other than toys is 14 years, and 16 years to receive a certificate of competence, unless supervised by a person holding a certificate of competence.

This approach makes use of Regulation (EC) No 765/2008 to mitigate risks (safety, privacy and security) and provides tools for law enforcement and market development. It defines 5 subcategories, allowing MSs the maximum flexibility to define zones for certain UAS classes only. Moreover, the MTOM limitation is complemented by other design requirements based on kinetic energy.

The following list shows how each of the issues analysed in Section 1.2 is addressed by the main elements of this Option:

(a) Lack of protection of sensitive areas (e.g. aerodromes, nuclear plants, densely populated areas):

— advisory geofencing and electronic identification are required for Subcategories A2 and A3; and

— MSs have the flexibility to define zones for some UAS classes only.

(b) Inadequate technical requirements:

— detailed technical requirements are defined for all subcategories based on their risk;

- geofencing is mandated for Subcategories A2 and A3;
- a maximum height of 50 m is allowed for Subcategories A0 and A1;
- product safety legislation must be complied with for Subcategories A1, A2, and A3;
- Directive 2009/48/EC must be complied with for Subcategory A0;
- auto-return home/lost-link management for Subcategories A2, A3; and
- no critical single failure for Subcategory A3.

(c) Inadequate competencies (complexity of the system):

The following tables provide detailed information on the level of competences required per each subcategory:

Table 6

	Remote-pilot competence	Medical check	Age of the remote pilot
A0	Safety awareness	No	No limitation
A1	Low competence (familiarisation)	No	14 years, unless supervised (since such UAS is not compliant with Directive 2009/48/EC)
A2	Medium competence (certificate of competence)	No	16 years, unless supervised by a person with a certificate of competence[56]
A3	Medium competence (certificate of competence)	No	As for A2
A4	Medium competence (certificate of competence)	No	As for A2

The following are different definitions of the remot-pilot competence for each subcategory:

Table 7

	Safety awareness	Low competence (familiarisation)	Medium competence (certificate of competence)
Training	Leaflet	Self-study/online	Self-study ; a declared or approved training organisation (DTO or ATO) could provide training (not mandatory)
Theoretical test	No	No	Yes, in an NAA-approved organisation
Practical test	No	No	Yes
Proof of evidence	No	No	Certificate of competence issued by the NAA or a qualified entity
Medical check	No	No	No
Limited validity of certificate	N/a	N/a	3 years
Renewal	N/a	N/a	Online training/awareness: confirmation of theoretical knowledge
MS oversight over remote pilot	N/a	N/a	Yes, i.e. request for documentation in case of misbehaviour
DTO/ATO	N/a	N/a	Yes

[56] Consistent with the light aircraft pilot licence (LAPL) (S) and (B), balloon pilot license (BPL), and sailplane pilot license (SPL) certificates.

(d) Lack of clarity of UAS boundaries (in the open and specific category, including special categories such as model and privately built UAS):

— boundaries are specified both between the open and specific category (open < 25 kg < specific) and for the various subcategories in the open category (< 250 g, < 900 g, < 4 kg, < 25 kg).

(e) Electronic identification:

— electronic identification required for Subcategories A1, A2, A3, and A4 even before the implementation of the U-Space.

(f) Disproportionate rules for special categories:

— subcategory A4 is dedicated to privately built UAS and model aircraft.

Link with the specific category

Option O2 would also affect the various options in the specific category: UAS with an MTOM between 4 and 25 kg could fly up to 20 or 50 m away from uninvolved persons. Based on the replies received on the UAS operators questionnaire, not many UAS would fit in this MTOM range; however, this category allows to develop various commercial applications. Compared to Option O1, the UAS with an MTOM between 3 and 4 kg would be allowed to fly in proximity to people.

4.1.4. Option O3 — Balanced requirements

Based on discussions during the expert group meetings, a new Option O3 was developed, including elements from both Option O1 and Option O2. It proposes three operational UAS subcategories, to be simple as Option O1 on the one hand, and includes some technical requirements for risk mitigation, as Option 2 on the other. This proposal has been developed applying an operation-centric approach.

Table 8

<table>
<tr><th>UAS subcategory</th><th>UAS class</th><th>MTOM/ Joule (J)</th><th>Distance from people</th><th>Maximum height of the operation</th><th>Remote-pilot competence</th><th>Age of the remote pilot</th><th>Main technical requirements (CE marking)</th><th>UAS registration</th><th>Electronic identification (EI), geofencing (G)</th></tr>
<tr><td rowspan="3">A1
Fly over people</td><td>Privately built</td><td rowspan="2">< 250 g</td><td rowspan="3">Fly over uninvolved people (not over assemblies of people)</td><td rowspan="2">< 50 m</td><td rowspan="2">Leaflet</td><td rowspan="2">No limitation</td><td>N/a</td><td rowspan="2">No</td><td rowspan="2">No</td></tr>
<tr><td>C0</td><td>Toy regulation, no sharp edges, awareness leaflet</td></tr>
<tr><td>C1</td><td>< 80 J or 900 g</td><td>< 120 m or up to 50 m above a higher obstacle, at the request of the owner of the object</td><td>Leaflet plus online training with a test</td><td>14 years or with supervisor</td><td>Kinetic energy, no sharp edges, selectable height limit, awareness leaflet</td><td>Only for operator</td><td>EI if with a camera of > 5 MP or an audio sensor, EI and G if required by the zone of operations</td></tr>
<tr><td>A2
Fly close to people</td><td>C2</td><td>< 4 kg</td><td>Fly intentionally in proximity to but at a safe distance from uninvolved people (> 20 m for rotorcraft UAS or > 50 m for fixed-wing UAS)</td><td>< 120 m or up to 50 m above a higher obstacle, at the request of the owner of the object</td><td>Leaflet plus certificate of competence (theoretical qualification) and exam in an approved centre</td><td>16 years or with supervisor</td><td>Mechanical strength, lost-link management, selectable height limit, awareness leaflet</td><td>Operator and UA</td><td>Yes</td></tr>
<tr><td rowspan="3">A3
Fly far from people</td><td>C3</td><td rowspan="3">< 25 kg</td><td>Fly in an area where it is reasonably expected that no uninvolved person will be present</td><td rowspan="3">< 120 m or up to 50 m above a higher obstacle, at the request of the owner of the object</td><td rowspan="3">Leaflet plus online training with a test</td><td rowspan="3">16 years or with supervisor</td><td>Lost-link management, selectable. height limit, awareness leaflet</td><td rowspan="3">Operator and UA</td><td rowspan="3">If required by the zone of operations</td></tr>
<tr><td>C4</td><td rowspan="2">In addition to the above, keep a safety distance from the boundaries of congested areas of cities, towns or settlements, or aerodromes</td><td>Operational. Instructions, awareness leaflet</td></tr>
<tr><td>Privately built</td><td>N/a</td></tr>
</table>

Within each subcategory, one or more UAS classes may be operated:

— A1 — fly over people: operations in Subcategory A1 can be conducted only with lighter UAS (Class C0, or privately built with an MTOM of less than 250 g, or Class C1 with an MTOM of less than 900 g).

— A2 — fly close to people: operations in Subcategory A2 can be conducted with a UAS Class C2, having an MTOM of up to 4 kg.

— A3 — fly far from people: operations in Subcategory A3 can be conducted with a UAS Class C3, Class C4, or privately built with an MTOM of less than 25 kg.

The requirements for the remote-pilot competence are based on a more proportionate approach.

The remote-pilot is required to successfully complete an online training and test, focused on the following:

— the main elements of Regulation (EU) 201X/XXX;

— instructing the remote pilot to identify in the UAS instruction manual the main characteristic of the UAS; and

— identifying a safe area where the remote pilot may conduct the initial flights to familiarise themselves with the UAS.

After successful completion of the online test, the remote pilot is allowed to conduct operations at a maximum height of 120 m in non-populated areas unless a Class C0 UAS is being operated.

Lastly, if the remote pilot is operating a UAS Class C2 in Subcategory A1 and intends to fly in proximity to people (up to 20 m for rotary-wing and 50 m for fixed-wing UAS), it is required to obtain a certificate of competence, by passing a theoretical examination in an approved centre.

The following list shows how each of the issues analysed in Section 1.2 is addressed by the main elements of this Option.

(a) Lack of protection of sensitive areas (e.g. aerodromes, nuclear plants, densely populated areas):

— advisory geofencing and electronic identification are required for Subcategory A2 or when mandated by MSs in the zone of operation; and

— MSs have the flexibility to define zones for certain UAS classes only.

(b) Inadequate technical requirements:

for each category technical requirements are defined in balance with remote-pilot competence and operational limitations:

— geofencing for Classes C1 and C3 (if required by the zone) or C2 is mandated;

— a maximum height of 50 meters is allowed for Class C0;

— Annex II to Regulation (EU) 201X/XXX must be complied with for all UAS classes, and Directive 2009/48/EC (the ‘Toy Directive’) for Class C0;

— requirements for kinetic energy, blade protection, battery status, and height limitation for Class C1 are laid down; and

— requirements for lost-link management, battery status, height limitation are laid down for Class C3, while for Class C2, some additional technical requirements are mandated to mitigate the risk of flying in proximity to persons, such as mechanical strength.

(c) Inadequate competences (complexity of the system):

— a leaflet to be included by the manufacture in each UAS package;

— for Class C0, reading the leaflet will be the only competence required[57];

— online training, including a test for Class C1, and for operations in Subcategory A3 is mandated;

— for Class C2, a certificate of competence (theoretical qualification) and an examination in an approved centre is required; and

— some stakeholders (e.g. NAAs) believed that the level of training would not be sufficient, requiring instead a license for flying in proximity to people; however, the majority of the expert group was in favour of the training option.

(d) Lack of clarity of UAS boundaries (in the open and specific category, including special categories such as model and privately built UAS):

boundaries are specified both between the open and specific category (open < 25 kg < specific) and for the various subcategories in the open category (< 250 g, < 900 g, < 4 kg, < 25 kg).

(e) Electronic identification:

electronic identification mandated for Subcategories C1 and C3, if required by the zone of operations, and in any case for Class C2, taking into account the higher risk of this Subcategory.

(f) Disproportionate rules for special categories:

Subcategory A3 has been designed to offer the possibility to model aircraft pilots not willing to join a model club or not flying the dedicated zones defined by the MS, to operate in the open category. Operations in Subcategory A3 may be conducted with privately built UAS, or UAS Class C3 or Class C4. This last class was developed with a minimum set of technical requirements focusing mainly on providing the remote pilot with operational instructions issued by the manufacturer, as well as on raising the remote pilot's awareness of the EU regulations through a leaflet. The only constraint is that mass-produced model aircraft must comply with Class C4 requirements. However, this will create a negligible additional burden for manufacturers. Indeed, model aircraft currently available on the market are already required to display a CE

[57] Some stakeholders advocated for stricter requirements than a leaflet, such as for an online training even for Class C0. An association commented the following in this regard: 'Too many people will not read it or will not focus on what they read/see especially when they are in the hurry of opening a gift and trying it.'

marking to show compliance with the applicable regulations (e.g. Directive 2014/53/EU[58] on radio equipment).

Link with the specific category

Option O3 would also affect the specific category: all UA with an MTOM between 4 and 25 kg to be operated in proximity to people would fall into the specific category. According to Graph 2 on MTOM, this does not represent an important segment of the UAS market (many UAS would have an MTOM of < 4 kg and therefore fit in Class C2).

4.1.5. Discarded options

The following two options were discarded following a consultation with the expert group. Both of them would be not very proportionate and would incur more costs compared to their potential benefits. Therefore, those options are not analysed but only represented on a three-dimensional graph showing how risk is managed through subcategories and their operational limitation, the contribution of the remote-pilot competence, as well as the MSs flexibility to define zones.

With regard to the remote-pilot competence, the following definitions are provided:

— 'no competence requirements' means that the remote pilot is only required to read the leaflet included in the package of the manufactured UAS without any additional training;

— 'familiarisation' means that the remote pilot is required to instruct themselves in the use of the UAS (minimum competence) and familiarise themselves with the UAS before the first flight;

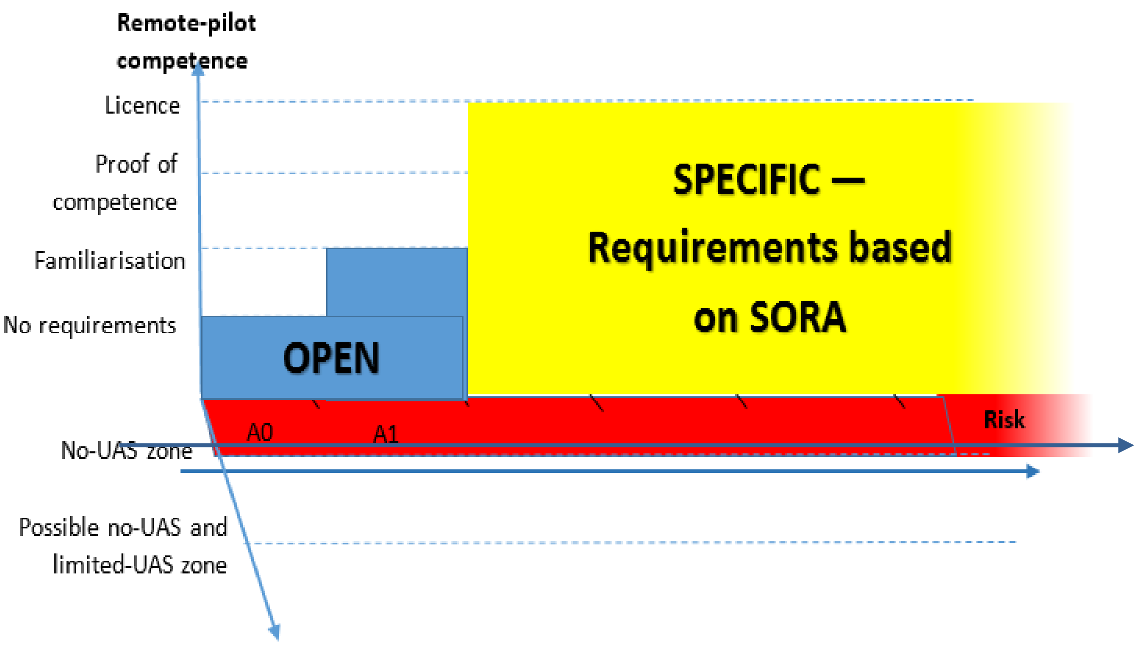
— 'Certificate of competence' means that the remote pilot is required to demonstrate their skill by successfully completing an examination; and

— 'license' means a full license similar to the ones issued for manned aviation.

[58] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC (OJ L 153, 22.5.2014, p. 62) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1493633541462&uri=CELEX:02014L0053-20140611).

4.1.5.1. Discarded Option 1 — only operation with negligible risk allowed in the open category

Figure 10 — Graphical representation of discarded Option 1



Only operations with very light UAS are authorised in the open category (toys with an MTOM of < 250 g in Subcategory A0, low-energy UAS or UAS with an MTOM of up to 900 g in Subcategory A1). This Option would be easy to implement, creating however a huge burden for operators and NAAs since most of the operations would fall into the specific category[59]. Also for model aircraft and privately built UAS, it would provide limited possibilities. Moreover, the MSs flexibility to define no-UAS zones would be limited since it could be difficult to identify subcategories allowed in the different areas. No remote-pilot competence is required to operate a Subcategory A0 UAS, whereas familiarisation is mandated to operate a Subcategory A1 one.

4.1.5.2. Discarded Option 2 —Remote-pilot competence as main safety barrier

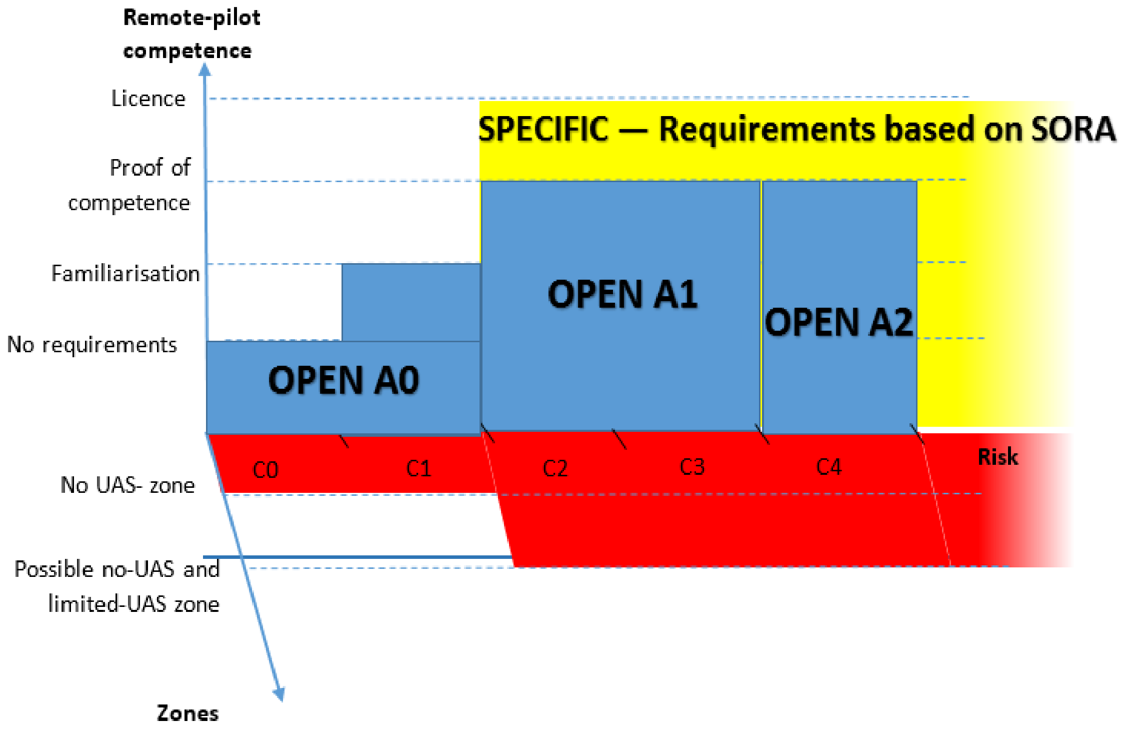
Two big subcategories are proposed in the open category. For the second one, a pilot proof of competence is required without any additional technical requirements.

This Option would be easy to implement, allowing certain professional operations in the open category. In addition, model aircraft and privately built UAS could also be operated in the open category.

Nevertheless, this Option was also discarded by the expert group since the remote-pilot competence as the sole safety barrier was not considered sufficient to ensure a satisfactory level of safety. Also in this case the MSs flexibility to define zones, where certain UAS operations only are allowed, would be limited since it could be difficult to identify subcategories allowed in the different areas.

[59] The specific category would be based on SORA.

Figure 11 — Graphical representation of discarded Option 2



4.2. Open-category impacts

The analysis of the impacts of the retained options is focused on safety, social,and economic aspects; on the environmental aspects only some general information is provided.

The analysis is performed using quantitative data, where available, complemented by qualitative statements. In several cases, the analysis is the outcome of the expert group input and discussions within EASA.

As already explained, Option O0 was not analysed in-depth; a general overview per criteria has been provided in order to ease the comparison of the various options.

4.2.1. Safety impact

Unlike classical manned aviation, safety for UAS is considered in two dimensions:

— air risk, that is the risk to other traffic, both manned and unmanned; and

— ground risk, that is the risk to people and property overflown.

Ground risk is typically not considered in the classical manned aviation since it is assumed that this risk is indirectly mitigated by protecting the people on board the aircraft and the aircraft itself. For UAS, on the contrary, a proportionate approach could be applied, basing risk mitigation on the risk posed in each operation. Ground risk depends on various factors, such as the characteristics of the overflown area (e.g. population density, critical infrastructure, etc.), or the size and energy of the UA.

For each retained option, the analysis of safety impacts has been performed based on the two above-mentioned dimensions. For all options, the role of competent authorities, including local ones, in law enforcement and oversight is fundamental.

4.2.1.1. Option O0 — Do nothing

Under this Option, both air and ground risk would overall be addressed differently by the MSs. As shown in the MSs overview, some of them have already operational limitations (e.g. distance from aerodromes and sensitive areas), whereas only few have also technical requirements in place. Some MSs have strict requirements for the remote-pilot competence, which could have a positive effect on safety (especially on occurrences due to human factors).

The MSs' perspective is expected to change in the short- and/or mid-term, therefore, it is a difficult challenge to define the future safety impacts. The following are mere assumptions:

— MSs having less pilot/product requirements and operational limitations; or

— MSs having more stringent pilot/product requirements and stricter operational limitations.

For the first group, there might be negative safety impacts, especially considering the booming UAS market. On the other hand, MSs with more stringent requirements would potentially benefit from the additional safety barriers.

4.2.1.2. Option O1 — Focus on remote-pilot responsibility

The air risk would be mitigated through the VLOS requirement, an online training course, as well a height limitation of 120 m. This limitation provides a buffer of 30 m against the minimum VFR limit of 150 m for manned aviation, as prescribed by SERA.

Ground risk is mitigated through a combination of an MTOM limitation and a population-density criterion, as well as through the remote-pilot competence demonstrated via a theoretical and practical test.

This Option could have the following negative safety impacts:

— There would be no strong focus on technical requirements that could help mitigate the safety risk. For Subcategory A1, ground risk is mitigated by relying only on the skills of the remote pilot to maintain the minimum distance of 50 m from crowds. No additional technical requirements are required to reduce the number of failures. Furthermore, as regards air risk, the remote pilot is not assisted by an altitude device (height limitation) that could prevent the remote pilot from inadvertently violating the 120-m limit.

— The air risk would only be mitigated through VLOS and a buffer of 30 m below the minimum VFR height (150 m, as prescribed by SERA for manned aviation). This mitigation measure might not be sufficient since manned aviation and UAS define altitude using different systems (pressure vs global positioning system (GPS) data) with limited accuracy. Many air proximity events with UAS and manned aircraft have occurred at altitudes of much more than 150 m, as shown in Figure 7 on the occurrences according to the height limit. Additional safety barriers may be required.

— The definition of 'assemblies of people' could vary among MSs, making it difficult to enforce the related requirements.

— Electronic identification and geofencing would be in place only when the U-Space would also be available. Considering that the U-Space will be fully defined in the short term, a gap might be created in the meantime, where UAS operations need to be regulated and the UAS market to grow. Therefore, UAS would operate without geofencing devices until the UTM system is in place; this could pose a high risk in terms of safety, especially due to the lack of protection of sensitive areas (e.g. aerodromes), as well as in terms of security.

The potential positive safety impacts of this Option are the following:

— This is a quite simple option, therefore quite straightforward to enforce. In addition, it would be easy to apply also for UAS operators. This could have a positive impact compared to other options where the regulation might be perceived as more complex and difficult to apply, potentially leading to safety issues.

— This Option provides MSs with the flexibility to define limited-UA zones. These limited or no-UA zones could ensure a high level of safety, especially when restricting sensitive areas such as aerodromes or sensitive infrastructure (e.g. nuclear plants).

Therefore, the overall safety impact of Option O1 could be considered as neutral (both positive and negative aspects are included).

4.2.1.3. Option O2 — Focus on technical requirements

The air risk would be mitigated through technical requirements: height limitation and certificate of competence obtained through a theoretical and practical test.

The ground risk would be mitigated through a combination of the following:

— technical requirements proportionate to the UAS MTOM, and to the population density; and

— the remote-pilot competence demonstrated by successfully completing a theoretical and practical test.

Several subcategories under this Option would have a level of complexity that could make their regulation difficult to implement (e.g. operators would have difficulties to comply with a list of requirements), compared to the other options, which could have a negative safety impact.

Positive safety impacts of this Option could be expected through the following:

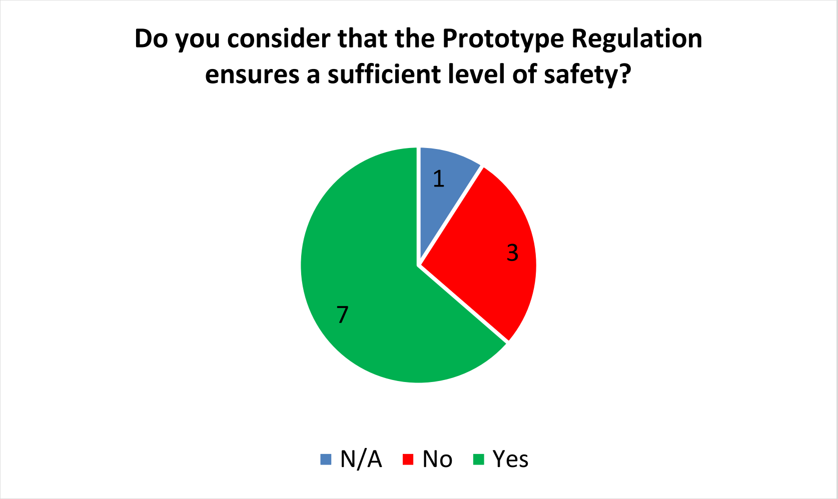
— technical requirements that help to achieve a high level of safety; more precisely:

- geofencing for Subcategories A2 and A3, protecting sensitive areas such as aerodromes and nuclear plants;
- lost-link management for Subcategories A2 and A3, reducing the risk of losing control of the UA; and
- no critical single failure for Subcategory A3, reducing the number of critical technical failures leading to a UA crash;

— detailed training needed for high-risk Subcategories A2 and A3; and

— a 50 m height limit for Subcategory A0, with no demonstration of remote-pilot competence required.

This option is in line with the proposals of the 'Prototype' Regulation. In this context, the results of the feedback provided by several manufacturers on their perception of safety in the 'Prototype' Regulation are shown below:



Graph 24 — Perception of safety according to the 'Prototype' Regulation. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA.

Therefore, the overall safety impact of Option O2 could be considered as very positive.

4.2.1.4. Option O3 — Balanced requirements

Since Option O3 is an evolution of Option O2, they are assessed in comparison with each other.

In addition to Option O2, the air risk under Option O3 is mitigated through an extra buffer of 30 m between the maximum UA height allowed (120 m) and the minimum VFR height (150 m). Only the successful completion of a theoretical test is required for obtaining the certificate of competence.

The subcategories are grouped and defined in a way to facilitate their understanding by the operators.

Remote-pilot competence is defined in a more proportionate way with respect to ground and air risk.

This Option could have negative safety impacts due to the following:

— the requirements maintain a certain level of complexity, with operators having difficulties in complying with them, and authorities in enforcing them, with possible negative consequences on safety; and

— the remote pilot is required to hold a certificate of competence only in case operations are conducted in proximity to people.

Positive safety impacts of this Option could be expected through the following:

— several barriers for air risk: VLOS, pilot competence, technical requirements and 30-m buffer from the minimum VFR height; and

— operations of UAS with an MTOM of more than 4 kg, flying in proximity to people, would fall into the specific category; this could have positive safety impacts especially if these UAS would need to comply with standard scenarios including stricter requirements than the ones in the open subcategories, or apply for authorisations.

Therefore, the overall safety impact of Option O3 could be considered as positive.

4.2.2. Environmental impact

No major differences are expected across all options.

Positive environmental impacts:

— reducing CO_2 emissions: UAS will replace other heavier transportation means with higher CO_2 emissions, or road vehicles, having less congested roads and less traffic incidents;

— accelerating the ability to use renewable energy, by optimising solar-panel networks, improving wind turbine maintenance, and offering new potential forms of wind energy generation); and

— reducing the use of soil-contaminating chemicals, as well as increasing productivity, in agriculture.

Negative environmental impacts:

— flying in proximity to people could generate very annoying noise emissions, which could be mitigated through requirements for maximum height, distance from people, and geofencing; and

— visual pollution, which could also impact the migratory routes and daily life of animals (e.g. birds) living in affected areas.

4.2.3. Social impact

The following impacts are considered:

— impacts on education/knowledge (e.g. remote-pilot competences); and

— impacts on employment (including quality of work).

The impact on employment would of course depend on how quickly the UAS market would grow, considering both small and large companies. Furthermore, the impact on employment for operators across all options would be twofold. On the one hand, there might be a decrease in the number of jobs as UAS would substitute people in certain tasks. On the other hand, employment could increase as UAS would improve a company’s efficiency, resulting in a possible business expansion, and therefore creation of new jobs. Moreover, dangerous operations performed by UAS would also lead to better working conditions. The employment impacts on operators and manufacturers are difficult to quantify due to lack of data, however, a general analysis of this aspect is provided below.

The analysis of social impacts also includes aspects related to security, privacy, and data protection.

4.2.3.1. Option O0 — Do nothing

The MSs focusing primarily on the remote-pilot competence could achieve a positive social impact in terms of improvement of the remote-pilot skills (practical and theoretical).

As for employment, in the MSs where more involvement of authorities is expected (e.g. more cases of UAS operations requiring standard scenarios, therefore, more training requirements to define), additional human resources might be needed, having a positive impact in terms of job creation at authorities level. In the same MSs, there might also be negative social impacts for operators and manufacturers in terms of employment as many requirements are imposed to them, possibly leading to closure of their business.

Overall, the social impacts would vary across MSs, depending on their national regulatory framework.

4.2.3.2. Option O1 — Focus on remote-pilot responsibility

This Option could have the following negative social impacts:

— the focus is mainly not on the skills and knowledge of the operator: in Subcategory A1, covering 50 % of the market, only an online training is required;

— no technical requirements on security are defined, potentially leading to security threats (geofencing and electronic identification would be included only once the UTM is in place); and

— without clear technical requirements, UAS could possibly enter areas where privacy might be affected.

This Option could have the following positive social impacts:

— in terms of employment, authorities would also need to dedicate resources for the creation of no-UAS zones; further quantification is provided under the economic impact;

— slight increase in employment due to the development of geofencing and electronic-identification functionalities; however, the extent of this impact is uncertain since many manufactures might still wait for the development of the UTM; and

— increase in employment for professional operators considering the lower cost (few technical requirements) and therefore the possibility to expand their business; especially UAS not used above crowds could benefit from this Option as those would be limited to Subcategories A0 and A1.

Therefore, the overall social impact of Option O1 could be considered as neutral (both positive and negative aspects are included).

4.2.3.3. Option O2 — Focus on technical requirements

This Option could have the following negative social impacts:

— due to burdensome technical requirements, some manufacturers might have to reduce costs linked for example with investment for innovation, and therefore reduce personnel costs by cutting down on jobs; and

— some operators might have to cease their activities due to the limitations of operations, e.g. for photographers in Subcategory A1, Class 1 with a UAS MTOM of less than 900 g, or in Subcategory A2, Class 2 with a UAS MTOM of 4 kg at least at a distance of 20 m from persons.

This Option could have the following positive social impacts:

— MS authorities would need to need to dedicated more resources to several areas; further quantification is provided under the economic impact;

- employment increase in training organisations;
- familiarisation required for Subcategory A1, Class 1, for higher classes, a certificate of competence after assessment; this has a positive educational and therefore social impact on operators; the information that operators would need to acquire in order to get the certificate of competence is basic information on Regulation (EU) 201X/XXX about the privacy and security risk, familiarisation with the UAS, and performing the first flights safely;
- electronic identification as well as additional skills and knowledge of the operator could have a positive impact on both security and privacy, compared to Option O1; and
- some training elements might help in preventing privacy issues.

Under this Option, a different level of remote-pilot competence is required based on the risk of each subcategory.

Therefore, the overall social impact of option O2 could be considered as positive.

4.2.3.4. Option O3 — Balanced requirements

Option O3 is similar to Option O2 in terms of employment, but slightly less positive in terms of education. Although an online training is required for Subcategory A1, the certificate of competence is not anymore required for Subcategory A3. Moreover, for Subcategory A2, only a theoretical examination is required for obtaining the certificate of competence.

4.2.4. Economic impact

The economic impacts assessed are only the major ones. Several stakeholders are taken into account: authorities, operators, and manufacturers. In some cases, quantitative evidence was gathered also through the various consultations. In other cases, the analysis is qualitative due to lack of data. More details on each stakeholder are presented below:

Authorities

Further to the feedback received by authorities via the questionnaire, a model has been defined in order to quantify the resources that authorities would need to dedicate to the tasks linked to UAS.

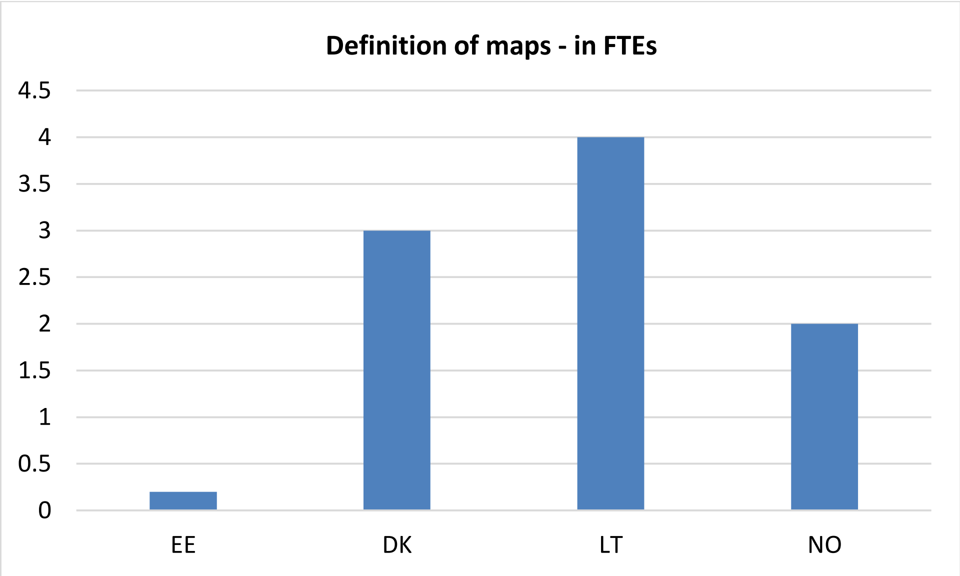
<u>Assumptions and inputs for the calculations</u>

The following assumptions and inputs were considered for the calculation. A major part of the information used for this calculation was either provided by an MS authority or gathered via the questionnaire (see Table 4 below). Whenever an assumption is made, this is clearly indicated.

Table 9

Cost description (M = MS feedback, Q = questionnaire, A = assumption)	**Amount (FTE in EUR) in one sample MS**
Administrative personnel (M)	25 000 EUR per year + 40 % additional indirect cost[60]
Technical personnel (M)	50 000 EUR per year + 40 % additional indirect cost
Examining applications (M)	2 FTEs of an administrative staff, 8 FTEs of a technical expert per year
Issuance of a LUC (M)	4 FTEs of a technical expert per year
Oversight activity (M)	5 FTEs of a technical expert per year
Training for authorities employees (M)	2 000 EUR for a technical expert (one-off)
Training/update for authorities employees (A)	1 000 EUR for a technical expert (yearly)[61]
Training set-up (syllabus, examination procedure) (Q)	2 FTEs of an administrative staff and technical expert (one-off)
Update of training system/syllabus (Q)	1 FTE of an administrative staff (yearly)
Definition of maps (Q)	2 FTEs of a technical expert (one-off)
Update of maps (Q)	0.5 FTE of a technical expert (yearly)

The following Graph shows the distribution of replies gathered via the questionnaire on the definition of maps, which contributed to making the above-mentioned assumptions:



Graph 25. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA. X-axis: MSs, Y-axis: FTEs.

[60] Indirect cost includes costs for human resources, sickness leaves, contingencies, renting and movable assets.
[61] The assumption was made considering a much lower amount than the initial one-off cost.

Considering the fact that the replies were provided to the survey on the 'Prototype' Regulation, and given the similarities between the 'Prototype' Regulation and Option O2, the following methodology was applied:

— impacts were quantified for Option O2 (complemented by the above-mentioned assumptions);

— the total was calculated by either multiplying the sample value per the number of MSs (when fixed per MS) or by considering the amount of population at EU level (when the value per MS is based on the amount of operators, for example); therefore, the total costs presented in the tables further below show the cost for all EASA MSs authorities[62]; and

— the differences between Options O1 and O3 on the one hand and Option O2 on the other are highlighted, without the need to repeat the whole analysis under each option.

Therefore, it might be advisable to go through the analysis of Option O2 first and proceed with the analysis of Options O1 and O3 afterwards.

General remark: some of the FTEs included in this analysis might actually be temporarily redeployed to other departments without the need to hire new personnel in the short term (so the cost would not be visible in the first year but in the following ones). Furthermore, several MSs have already resources dedicated to UAS; some have already started defining the framework in detail. Therefore, for several authorities activities, the total number of FTEs has substantially decreased compared to the situation with no FTEs currently dedicated to UAS.

Manufacturers

Information gathered via questionnaires, telephone calls and meetings was considered for estimating the economic impacts (e.g. questionnaire replies on the cost of a specific requirement).

Operators

Information gathered via the operators questionnaire and feedback provided by authorities (e.g. number of operators in an MS) were used to substantiate the quantitative analysis.

4.2.4.1. Option O0 — Do nothing

This Option has a very negative impact for operators as they would have to adapt to several regulatory frameworks across the EU, combined with higher costs, e.g. for trainings, authorisations/declarations, or for developing products with different product requirements for each MS.

Furthermore, the economic impact could be very negative for several businesses (e.g. professional operators in agriculture or inspections, and photographers) due to the higher cost of operation in more than one EASA MS, especially for SMEs. This would also have a negative impact for service providers linked to the UAS business.

The impact for authorities would also be very negative as they would need to invest a high amount of resources in setting up a detailed framework. In some MSs, UAS rules have already been developed up to a certain extent, but in others, there might be a need to develop those rules in further detail. Some of the following activities would need to be set up: a registration system, maintenance of said system,

[62] EU-28 plus Iceland, Lichtenstein, Norway, and Switzerland.

an authorisation system, oversight, training requirements, as well as a communication system to gather information about the different systems in other MSs.

Finally, the impact for manufacturers would also be very negative as they would need to adapt their products to the different technical requirements mandated in each MS. In addition, they might not be able to satisfy part of the demand through their current production due to the operational limitations (e.g. distance from people, maximum height, no-UAS zones, etc.).

4.2.4.2. Option O1 — Focus on remote-pilot responsibility

Authorities

The costs of Option O1 for authorities would be lower than for Option O2 because much less resources would be required to set up the training/examination procedures and their updates. The following is a list of the expected FTEs for training set-up[63]and update:

Training programme	Periodicity	FTEs[64]	Total cost for EASA MSs[65]
Training programme	one-off	8	EUR 420 000
Training programme	yearly	8	EUR 280 000

Compared to Option O2, the following cost savings are estimated:

— a decrease of EUR 420 000 of the initial cost; and

— a decrease of EUR 280 000 of the recurrent cost (per year).

Manufacturers

Manufactures would not need to invest high amounts to comply with the technical requirements (only geofencing and electronic identification is mandated in some subcategories).

On geofencing in particular, interesting input has been received through the manufacturers questionnaire. The following Graphs 26 and 27 show the low implementation and design cost of geofencing:

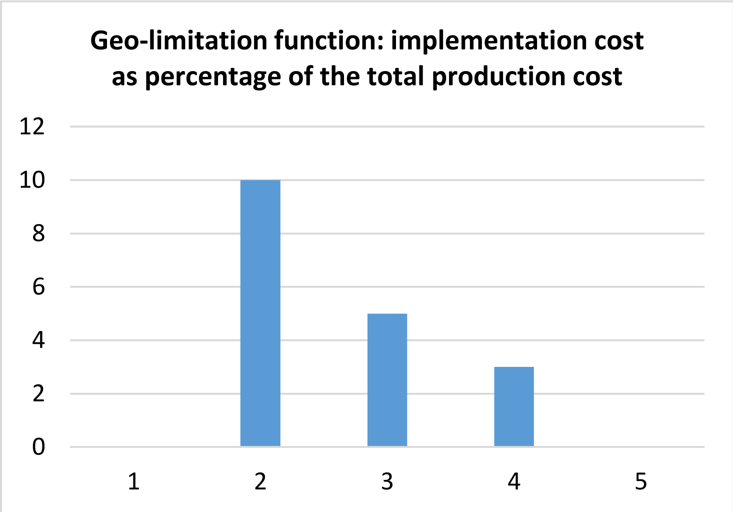
[63] A description of each type of activity is provided under Option O2.

[64] The one-off number of FTEs originally estimated was divided by 4 (assuming that staff is redeployed, and that some MSs have already FTEs working on UAS, temporarily redeployed from other departments). The same reasoning applies to the calculation of the initial one-off FTE per activity, for Options O2 and O3. For the recurrent cost (per year), the FTE originally estimated was divided by 2 (assuming that there would not be any temporary staff deployment to cover gaps, but that some officers were originally assigned to UAS).

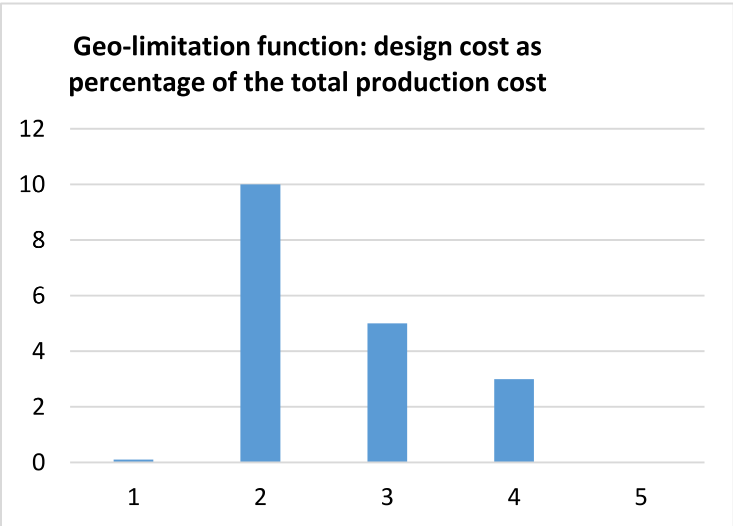
[65] The total cost depends also on whether administrative and/or technical experts would be involved. Different salary estimates have been considered. See also Table 4 above.

Geofencing cost

According to the UAS manufacturers questionnaire, the design and implementation costs of geo-limitation functions would not represent a high percentage of the total production cost:



Graph 26. Source: EASA UAS questionnaire 2016. Elaboration: EASA.

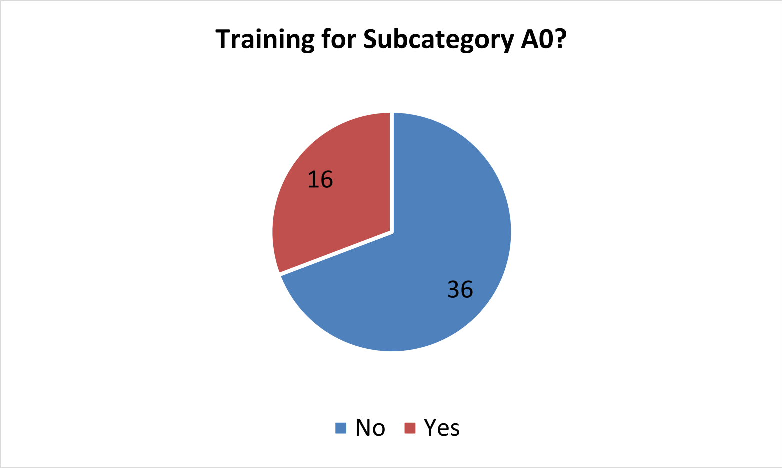


Graph 27. Source: EASA UAS questionnaire 2016. Elaboration: EASA.

However, some commenters stressed the difficulty of installing geo-limitation devices into UAS.

Operators

The cost of training for all UAS falling into Subcategory A1 would be low (only online training with no test required). No training is mandated for Subcategory A0, which was supported by several stakeholders in the questionnaire:



Graph 28. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

Considering that there are only few technical requirements, the total cost of the products in the market should not be largely affected.

More operations would be allowed under Option O1, compared to Option O2, allowing operators to save capital that would otherwise need to be spent for the authorisations.

4.2.4.3. Option O2 — Focus on remote-pilot responsibility

Authorities

The assumptions of Table 4 apply also to Option O2.

Training/Examination set-up

Training set-up: the cost incurred includes resources involvement in the definition of a training programme, an examination procedure, as well the tests content. The recurrent cost of updating the programme is presented below (the cost per FTE is much lower in this case):

Training programme	Periodicity	FTEs	Total cost for EASA MSs[66]
Training programme	one-off	16	EUR 840 000
Training programme	yearly	16	EUR 560 000

The number of FTEs included in the assumption is higher for initial set-up than for the update of the programme, however it was additionally assumed that several MSs already dedicate staff to the development of training programmes.[67] Therefore, the initial cost for the total number of FTEs is considerably reduced.

[66] The total amount per line is different even if the number of FTEs is the same, as the for the updates (e.g. update of maps after the first year) the salary of administrative (and not technical) staff was considered in the calculation.

[67] For this reason, the total number of FTEs: 64 (2 per 32 EASA MS) was divided by 4 (assumption explained earlier in the text). For the following years, however, the number was divided by 2 (e.g. temporarily redeployment of staff that would be replaced by new resources).

Definition of zones

As highlighted by some authorities' representatives in the expert group meetings, the definition of zones (e.g. no-UAS zones such as aerodromes) is a key element in estimating the economic impacts. This also implies information feeding applications/geo-limitation functions, which requires a high number of FTEs. The following is an estimate of the cost:

Definition of zones	Periodicity	FTEs	Total cost for EASA MSs
Initial set-up	one-off	16	EUR 1 120 000
Update of maps/zones	yearly	8	EUR 560 000

As for the training programme, the total resources considered the existence of authorities already having staff dedicated to this.

Furthermore, Regulation (EU) 201X/XXX on UAS operations requires MSs to organise the market surveillance of consumer UAS. MSs will need to allocate specific resources to that end in line with the strategies defined in their national market surveillance programmes. Based on a comparison with the market surveillance activities conducted in the framework of Directive 2009/48/EC[68], the estimated necessary resources are less than 0.5 FTE per MS.

The overall economic impact for MSs would be negative. Assuming that the total budget of all MSs' NAAs is EUR 1 billion:

- the initial cost of around EUR 2 million[69] would amount to approximately 0.2 % of the NAAs turnover, having a low negative impact; it is considered that several MSs have already developed a legal framework; and
- the recurrent cost of around EUR 1 million[70] would amount to approximately 0.1 % of the NAAs turnover, having a low negative impact as well.

Operators

Regarding training cost, it is assumed that an average training lasts 2.5 days. The following example[71] of training cost is based on the feedback received by training schools:

Training length	Training cost	Tests cost (practical and theoretical)	Total
2.5 days	EUR 1 000	EUR 400	EUR 1 400

For those operators that decide to only take the examination, the fees charged by training schools, according to the information[72] received, could be the following:

68 See the related report at http://ec.europa.eu/DocsRoom/documents/13903/attachments/1/translations.

69 This is the sum of the costs for the training programme (EUR 840 000) and for the definition of zones (EUR 1,1 million for the initial set-up).

70 This is the sum of the costs for the training programme (EUR 560 000) and for the definition of zones (EUR 560 000).

71 This costs varies considerably across EU training schools. For further reference, see Appendix III.

Type of test	Cost range
Theoretical test	EUR 300-550
Practical test	EUR 200-400[73]

If for the total training cost (including the test) for professional operators the following is assumed:

— the training cost is EUR 1 400;

— 50 % of the professional operators use UAS falling into Subcategory A2 (requiring a certificate of competence)[74];

— the total number of operators is around 40 000[75]; and

— only half of the professional operators receive the training,

this cost would be as presented in the box below:

1 400 * (40 000 * 0.5) * 0.5 = 14 000 000 EUR

For calculating the total tests cost (without the training cost) for professional operators, similar assumption as above were made, except that the training-courses cost was replaced by the following tests cost:

— theoretical test: EUR 475 (average of the cost range presented in the table above); and

— practical test: EUR 300 (average of the cost range presented in the table above).

775*(40 000 * 0.5)*0.5 = 7 750 000 EUR

Operators might bear additional costs for the purchase of the UAS due to the technical requirements that would lead to an increase of the final price of the products; this refers especially to Class C3, for which the requirement on 'no critical single failure' is mandated. On the other hand, it is assumed that UAS in Class C3 would be used by professional operators that might be more willing to invest than other UAS operators.

Training schools/training organisations

Training is a key element for Option O2. A certificate of competence is required for Subcategories A2, A3, and A4. Even if no training course is mandatory, many operators might decide to take it. In addition, they would need to take an examination (the examination cost is provided above), which would have a positive economic impact for training schools.

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[72] This information is based on the feedback provided by some training schools across the EU.

[73] No precise information on the practical test cost could be gathered. It is assumed that the cost of just taking the test could be half of the cost of the practical course that includes the test, equal to EUR 600 EUR, according to the feedback received.

[74] This assumption is based on the distribution of UAS types according to their MTOM (source: EASA UAS operators questionnaire 2016).

[75] The total number of operators is based on the stakeholders' feedback via questionnaires/emails.

Manufacturers

The manufacturers would bear the cost of adapting their UAS to additional technical requirements different for each UAS class. Based on one manufacturer's feedback:

— an active altitude limitation would need one month for engineering and one month for validation;

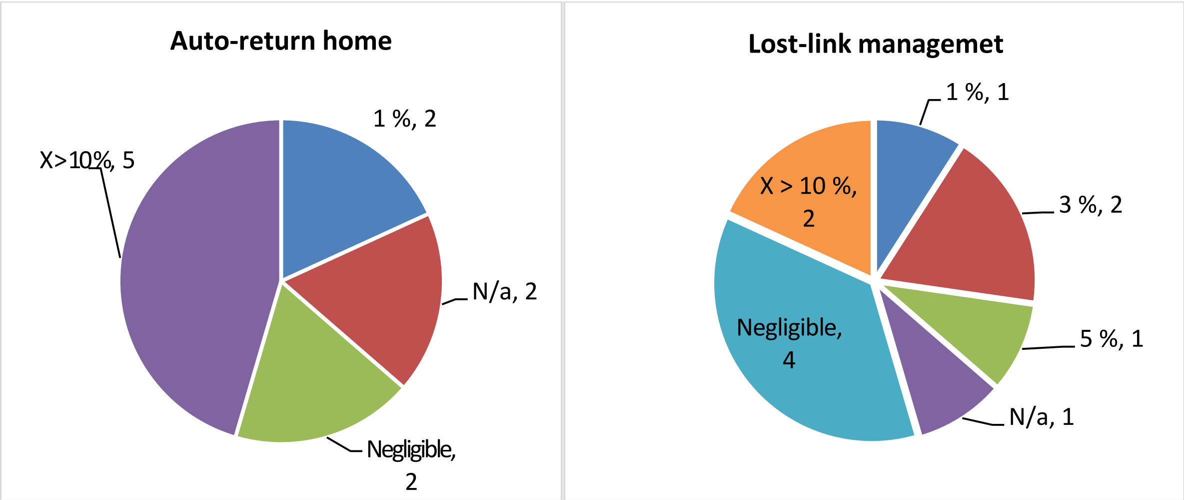
— a simple low-battery warning system based on voltage only would not be very precise, and a more reliable system would have a higher cost;

— the requirement on 'no single critical failure' would be very costly and would entail redundancies that would make the system heavier as well;

— blade protection or a system to reduce the injury inflicted by a blade would cost around 5 % of the production cost to implement it; and

— many UAS in the market are already equipped with a lost-link management system with an auto-return home function option.

A graphical representation of the replies provided by UAS manufacturers to questions on the cost of devices/functions is provided below:



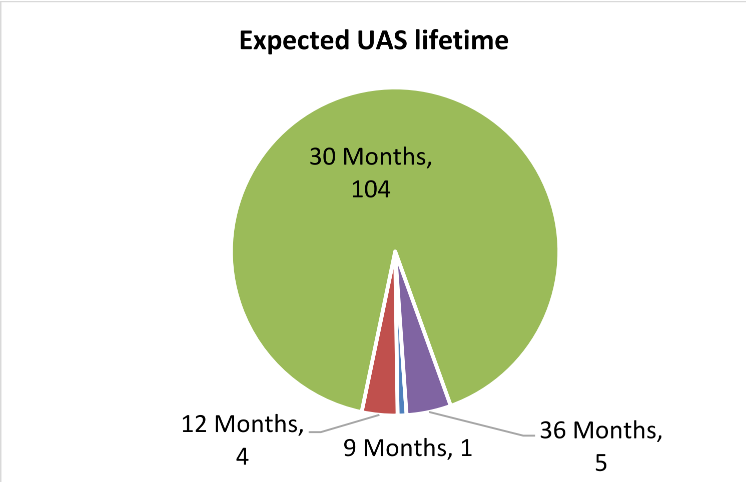
Graph 29 and Graph 30. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

Some manufacturers (e.g. toy manufacturers) found the height limit of 50 m too restrictive. A toy has typically very limited performance and autonomy, so the probability of climbing higher than 50 m is very low. Moreover, their MTOM, normally less than 250 g, poses a very limited risk to other flights. Toy manufacturers stated that limiting the maximum height would require the use of additional equipment, such as a barometric sensor, making the cost prohibitive.

Use of Regulation (EC) No 765/2008 (CE marking) would help to ensure market standardisation and compliance with the essential requirements on UAS. Several manufacturers emphasised the importance of standardisation enabling economies of scale and therefore having a positive impact on the final cost of products. On the contrary, complying with local/fragmented requirements would incur a high cost for manufacturers.

Manufacturers might have a comparative disadvantage against those selling UAS outside the EU. The additional technical requirements might incur extra UAS production costs, compared to the UAS sold outside the EU. This might slow down the development of the EU UAS service market in case those manufacturers would decide to invest more in production in third countries.

The technical requirements of Regulation (EU) 201X/XXX would in principle affect also UAS in use before the Regulation enters into force. However, based on the feedback received from UAS manufacturers, this would not have a major impact as the expected lifetime of UAS is around 30 months, which is less than the transition period indicated in said Regulation. The following is a representation of the average expected lifetime of UAS, according to the replies received on the UAS manufacturers questionnaire:



Graph 31. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

Overall, this Option O2 would have a negative economic impact, considering the high costs for manufacturers, operators and authorities.

4.2.4.4. Option O3 — Balanced requirements

Authorities

The costs for authorities would be similar to those for Option O2, slightly reduced in respect of the training set-up, but in general higher than those for Option O1. However, operations of UAS with an MTOM of 4-25 kg in proximity to people would have a negative economic impact for authorities and operators as these operations would fall into the specific category requiring either a declaration or an authorisation (greater involvement of both authorities and operators needed due to the possible higher number of authorisations).

Operators

Compared to Option O2:

— Operators would need to receive online training for UAS Class C1 (with an MTOM of less than 900 gr), which could increase the cost and be an additional time investment. On the other hand, operations in Subcategory A2 do not require a practical examination, while for Subcategory A3, an online test is mandatory.

— Less operations would be allowed as the maximum height is lower: 120 m (150 m for Option O2). This could negatively impact operators that need to operate their UAS higher than 120 m.

— Operators that need to operate a UAS with an MTOM of 4-25 kg in proximity to people would need to check the standard scenario or apply for an authorisation. The resources and time spent for preparing and applying for authorisations or complying with requirements of scenarios would increase the incurred cost.

— Model aircraft would be required to be supplied with a manufacturer instructions manual and an awareness leaflet. This would imply a negligible economic impact.

With respect to Option O1, operators would not need to successfully complete a practical test to operate in Subcategory A2 ('Fly close to people'), therefore, the cost for operators in an important segment of the small-UAS market would be much lower.

Manufacturers

Compared to Option O2:

— Electronic identification for UAS Class C1 would be needed, if required by the zone of operations. The cost for manufacturers would be higher (even if minor) as they would need to equip the UAS affected with an electronic-identification system.

— The technical requirements for UAS with an MTOM of more than 4 kg, in particular the 'no single critical failure' one, would be removed. This would significantly affect cost, according to the feedback received by manufacturers.

Overall, this Option O3 would have a positive economic impact, considering the proportionate set of requirements (both technical and on competence).

4.2.5. Proportionality impact

The proportionality impacts are already captured, directly or indirectly, under Section 1.4.4 'Economic impact'. Overall, Option O2 would have a very negative impact, considering the high cost of complying with certain requirements (e.g. 'no critical single failure'). Options O3 and O1 would be a good compromise also for small companies, considering the few and non-prescriptive requirements. This would apply to both SMEs that produce UAS and to professional operators of SMEs, using UAS for their main activities.

4.3. Comparison of options — Open category

Table 10

	Option O0 Do nothing	**Option O1** Focus on pilot responsibility	**Option O2** Focus on technical requirements	**Option O3** Balanced requirements
Safety impact	0	+/–	+ +	+
Social impact	0	+/–	+	+/–
Economic impact	0	+	– –	+
Proportionality impact	0	+	–	+
Total	0	+/–	+/–	+

Overall, Option O3 follows a more balanced approach towards risk mitigation for third parties on the ground and other airspace users, compared to Options O1 and O2. Option O1 provides a simple solution that could be easily understood and implemented by operators, but does not include many technical requirements that could help to prevent UAS occurrences (accidents and incidents) mainly due to technical failures. Option O2 focuses on a greater number of as well as on stricter requirements for several subcategories than Option O1, however, its approach is disproportionate, considering that some requirements might be quite costly for manufacturers to implement (e.g. the installation of 'no critical single failure' equipment).

On the contrary, Option O3 achieves a balance between a greater number of technical requirements compared to Option O1 and a proportionate level of remote-pilot competences (e.g. obtaining a certificate of competence does not always require a practical test that could be quite costly for operators). Moreover, through Option O3, the general and specific objectives of this RMT are better achieved and the issues analysed are addressed in a more effective way than through the other options.

Furthermore, Option O3 would allow:

— authorities not to dedicate too many resources, as for Option O2;

— manufacturers to develop UAS with proportionate technical requirements, thus supporting the development of the UAS market;

— SMEs not to have to comply with high-cost requirements; and

— operators to fly UAS in various circumstances (detailed subcategorisation according to the distance from people).

Finally, Option O3 is widely supported by the expert group and several stakeholders.

5. Registration

5.1. Options

This Chapter presents the different registration options as well as the possible ways of their implementation. Registration could be mandated only for the operator or both the operator and the UAS. In both cases, registration would be conducted in the MS of residence of the operator or where the operator has its place of business, by an entity being a service provider and not necessarily by an authority. The possibility of EASA setting up the registration database is also considered in one of the options.

Table 11 — Selected policy options for registration

Option No	Short title	Description
R0	Do nothing	Registration is defined at MS level.
R1	Operator	Only the operator must register.
R2	Operator and UA (not for toys)	Both the operator and the UA must be registered (except toys).
R3	Operator and UA (not for toys and UA Class 1)	Both the operator and the UA must be registered (except toys and UA Class C1).
R4	EASA registration	The registration system is designed at EU level (EASA).

5.1.1. Option R0 — Registration at MS level

In accordance with the current regulatory framework, not all MSs require registration of UAS, or not of the same types of UAS (e.g. in certain MSs, registration is only required for professional use). In addition, some MSs require registration for the operator only, while others for the UAS as well. For example, in the Czech Republic, Denmark, Finland, the Netherlands, or Iceland, registration is required for the operator. In Spain, registration is required only for UAS with an MTOM of more than 25 kg and in Italy, for non-recreational uses of UAS and for the UAS itself.

5.1.2. Option R1 — Registration of the operator only (except for UAS Class C0)[76]

Under this Option, only the operator would be registered, except when using a UAS Class C0. Therefore, in case an already registered operator would start operating a new UAS, the UAS would not have to be registered.

[76] UAS Class C0 have an MTOM of less than 250 g and are not equipped with an audio system or camera with a resolution of less than 5 MP.

5.1.3. Option R2 — Registration of both the operator and the UAS (except for UAS Class C0)

Compared to Option R1, the operator would need to register also the UAS except in case of a UAS Class C0. Under this Option, much more information on the UAS used in the EU market would be available.

5.1.4. Option R3 — Registration of both the operator and the UAS (except for Classes C0 and C1)[77]

Compared to Option R1, the operator would need to register also the UAS except in case of a UAS Class C0 or Class C1.

5.1.5. Option R4 —EU registry (instead of a national one)

This Option is complementary to the above ones. It proposes an EU registry that could be designed by EASA, ensuring data consistency and a higher level of harmonisation across the EU. This Option was added following a proposal submitted by the European Parliament.

5.1.6. Additional non-analysed option

Further to the above options, consideration was given to the possibility of requiring operators to register (except for toys), allowing the MSs to decide which UAS should be registered. Those registers would still need to be interoperable based on EASA standards. This possibility would provide MSs with the flexibility to decide which UAS should be registered based on the national situation, for example in terms of security. Nevertheless, a negative aspect of this option would be that fragmentation across MSs would continue. Furthermore, authorities would need to invest to adapt their registration system to local needs. As for operators, they would face difficulties as they would need to check which conditions apply in their MSs of operation and adapt to those conditions, if needed, which could lead to extra costs for additional local registration. This option was therefore considered to be disproportionate and was not analysed in depth.

5.2. Registration impacts

5.2.1. Safety impact

No major impacts are expected for Options R1, R2, and R3, where law enforcement would be ensured through the identification of the operator as the responsible entity for the operation. Therefore, this Option would ensure a higher level of safety than Option R0, where some MSs might have requirements for partial registration or no registration at all.

5.2.2. Social impact

Option R2 would have a positive social impact for authorities as additional employment would be created by dedicating more resources to the set-up and maintenance of a registry containing information on both the operator and the UAS. At the same time, a negative social impact might be expected for operators as they would dedicate more time and perhaps resources in order to apply for

[77] UAS Class C1 have an MTOM of less than 900 g or are designed in a way that the kinetic energy transferred to the human body in case of impact with a person is less than 80 J.

registration of a new UAS. This could lead to closure of the operator's business and consequently to loss of employment.

Under the social impact, there is a special focus on security, data protection, and privacy. Option R2 would have a very high positive impact as registration of all UAS with the exception of UAS Class C0 would help law enforcement for security purposes as authorities would be aware of the types of UAS being operated. Moreover, local authorities would be aware of UAS that could pose a threat from a security point of view. Option R3 would still ensure a higher security level, compared to Option R1, but lower than Option R2.

Option R0 has in general a neutral social impact.

5.2.3. Economic impact

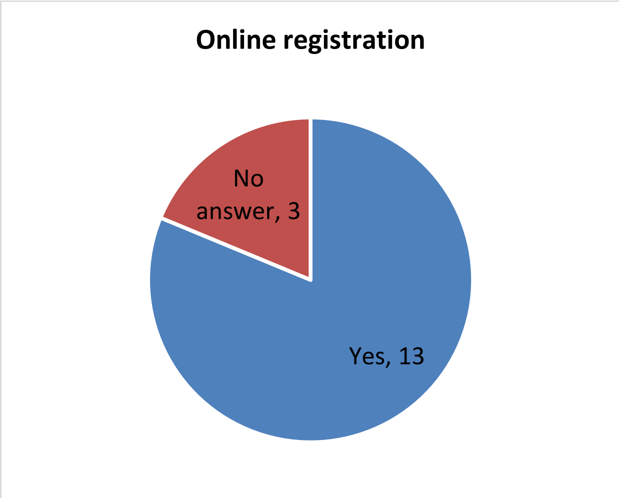
The following assumptions and inputs[78] were considered for the calculation, taking also into account the feedback received via the authorities questionnaire. Further information is provided in Section 1.2.4.6 'Issue 6 — Need for registration and identification'.

Table 12

Cost description (M = MS feedback, Q = questionnaire)	**Amount (FTEs in EUR)**
Administrative personnel (M)	EUR 25 000 per year + 40 % additional indirect cost[79]
Technical experts (M)	EUR 50 000 per year + 40 % additional indirect cost
Registry maintenance (Q)	2 FTEs of an administrator (yearly)
Registry set-up (Q)	2 FTEs of an administrator (one-off)
IT tools for registry and applications (M)	EUR 2 500 per activity

The total number of FTEs for registration is quite low, considering also that registration will be conducted through an online system, which seems to be the preferred option. The following is a graphical representation of the replies of several EU NAAs:

[78] The same methodology as for assessing the economic impacts of the open-category options has been applied.
[79] Indirect cost includes costs for human resources, sickness leaves, contingencies, renting, and movable assets.



Graph 32. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

Several MSs are in favour of a simple system for registration. To quote a comment received: 'keeping a registration system same as for general aviation will not work anymore with UAS'. Some NAAs consider the online registration of the UAS after purchase as the preferred registration method as a high number of UA are purchased online. The NAAs should create an easy-to-use tool for online registration in order to encourage people to register.

The NAAs could cover the registration cost by charging a registration fee. This is not included in the proposed options but it is left to the MSs to decide. The registration fee could reflect the time spent by NAAs on registration. An amount for an 'insurance fund' could also be part of the registration fee, which might further increase the overall registration cost.

The differences across options reflect mainly the differences in the involvement of authorities' resources in registration.

Option R0 has in general a neutral economic impact.

Option R1

<u>Authorities</u>

Considering that the above-mentioned assumptions are based on the feedback received further to the 'Prototype' Regulation, the information could be used to quantify the economic impact of Option R1. Using Option R1 as starting point, the impacts of Options R2 and R3 were also calculated.

For the first year:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry set-up (one-off)	One-off	16	EUR 560 000
Costs for consultants, registry set-up, IT tools, etc.	One-off/yearly	N/a	EUR 40 000
			EUR 600 000

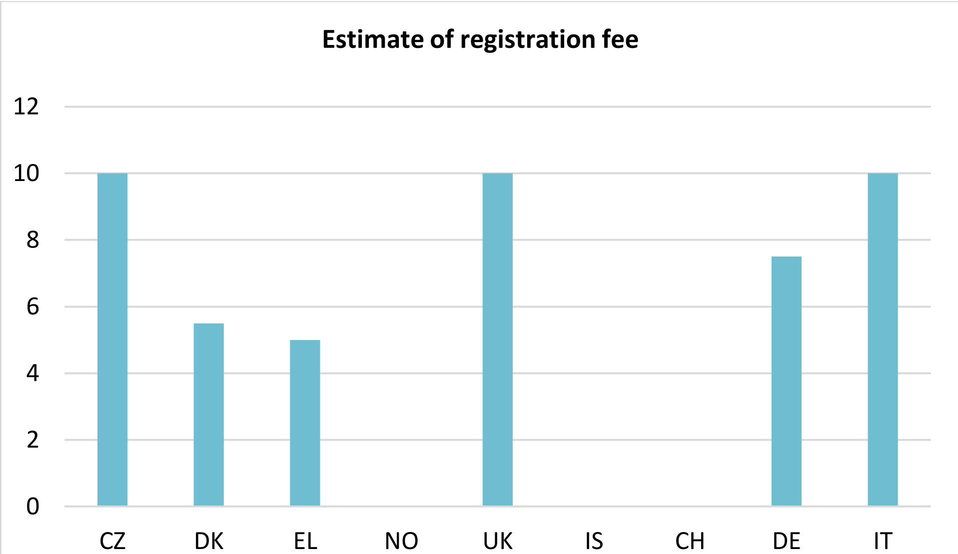
For the following years:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry maintenance (yearly)	Yearly	11	EUR 380 500

Operators

The cost for operators would mainly depend on the registration cost. Assuming that the fee would be around EUR 5 for each of a total of 1.5 million consumer UAS on the current market[80], 90 % of which would require registration based on their MTOM, the total registration cost at EU level would be EUR 7.5 million approximately. This figure could be much lower in reality, considering that several operators might have more than one UA; however, concrete data would be needed to calculate this.

The following is a graphical representation of some MSs replies showing variations across the EU; when no column is depicted, no registration fees are so far required in those MSs, according to the feedback received[81]:



[82]

Graph 33. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA. Each segment represents a reply.

Option R2

Authorities

Under Option R2, operators would need to dedicate more time to registration and bear a higher cost, which would depend on the fee imposed by the MSs, possibly higher than for registering only the operator. The total amount spent by operators for registration would be considerably higher compared to Option R1 (about 90 % of the UAS currently on the market would need to be registered). The economic impact for operators would depend on the MSs registration fee.

80 SESAR Outlook Study, see also the related Section 1.1.1.2.
81 Feedback received in 2016. Possibly, the current situation in some MSs might have (slightly) changed.
82 For some replies, the fee is an estimate and/or an upper limit (e.g. 10 could stand for < 10).

For the first year:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry set-up (one-off)	One-off	24	EUR 840 000
Costs for consultants, registry set-up, IT tools, etc.	One-off/yearly	N/a	EUR 40 000
			EUR 880 000

For the following years:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry maintenance (yearly)	Yearly	16	EUR 570 700

Operators

Compared to Option R1, the cost under Option R2 would increase as both the operator and the UA would have to be registered. However, this cost may vary depending on the number of UAS each operator has.

An additional element to consider in that respect is whether an MS would require a registration fee each time a new UA is operated by the same operator.

Option R3

Authorities

The cost under Option R3 would be lower, compared to Option R2. Indeed, UAS Class C1 would not need to be registered. Taking into account Graph 2 on the distribution of UAS types based on the operators questionnaire, many UAS would still fit in this category (about 50 % of the UAS currently on the market would need to be registered).

For the first year:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry set-up (one-off)	One-off	20	EUR 700 000
Costs for consultants, registry set-up, IT tools, etc.	One-off/yearly	N/a	EUR 40 000
			EUR 740 000

For the following years:

Registration	Periodicity	FTEs	Total cost for EASA MSs
Registry maintenance (yearly)	Yearly	14	EUR 475 500

However, this cost would be much lower in case the registration would be handled at EASA level.

Operators

The cost would be higher than under Option R1, but lower compared to Option R2 as UAS Class C1 would not need to be registered.

Option R4

Compared to the previous options, and considering that possibly EASA would be in charge of the EU registry, much less NAAs FTEs would be required under this Option, while EASA would invest considerably more. However, the NAAs would be responsible for the registry maintenance. An EU UAS register would ensure consistency and interoperability of data across MSs.

5.3. Comparison of options — Registration

Table 13

	Option R0 Do nothing	**Option R1** Operator only (not for UAS Class C0)	**Option R2** Operator and UAS (not for UAS Class C0)	**Option R3** Operator and UA (not for UAS Class C0 and C1)	**Option R4** EU registry
Safety impact	0	+	+	+	N/a
Social impact (including privacy and security)	0	+/–	++	+	N/a
Economic impact	0	+	– –	+/–	++
Total	0	+/–	+/–	+	++

Option R3 is the preferred one as a good balance is achieved between the UAS MTOM and its potential threat on the one hand and the economic impact on the other.

In addition, it was considered that registration at EU level could save cost and resources for authorities. Even if this Option has a comparative merit, there are other considerations in this regard, currently under discussion between the Council, the European Commission, and the European Parliament.

6. Specific category

6.1. Options

A set of options has been defined also for the specific category. The description and analysis of those options is not as detailed as for the open-category ones as MSs lack experience and therefore data in this domain. Furthermore, the standard scenarios that constitute the core of two options out of four have not been fully developed yet.

Table 14 — Selected policy options for the specific category

Option No	Short title	Description
S0	Do nothing	The new Basic Regulation would not extend EASA's competence to UAS of 150 kg or less, or the specific category would still be regulated by MSs' rules. The regulatory framework at EU level would remain fragmented, with some MSs having standard scenarios and/or stricter requirements than others.
S1	Authorisation for all operations	All UAS operations in the specific category would need an authorisation.
S2	Authorisation and standard scenarios	Two types of standard scenarios would be defined, the former requiring the operator to submit a declaration, and the latter requiring the competent authority to issue an authorisation.
S3	Authorisation, standard scenarios, and LUC	In addition to Option S2, the operator would have the possibility to apply for a LUC with privileges to authorise its operations.

6.1.1. Option S0 — Do nothing

Under this Option, no change to the rules at EU level is required; all MSs would continue to develop their own regulatory framework with respect to the specific category. Some MSs might have a more strict approach, requiring full authorisation in most, if not all, of the cases, while others might adopt a more flexible approach, using a declaration system; certain MSs already follow this latter approach.

6.1.2. Option S1 — Authorisation for all operations

According to this Option, for all UAS not falling into the open category, an authorisation would be required, including a risk assessment that would contain the following information:

— the operational area of the UAS and the related conditions;

— the category of airspace, as well as the effects of the UAS operation on other air traffic and ATM in cooperation with the relevant ANSP;

— the design features and performance of the UAS;

— the type of UAS operation;

— the level of remote-pilot competence;

— organisational factors; and

— effects of the UAS operation on the environment.

6.1.3. Option S2 — Authorisation and standard scenarios

This Option includes the possibility of having standard scenarios issued by EASA in the form of AMC to Annex I (Part-UAS) to Regulation (EU) 201X/XXX. This standard scenario would include a predefined risk assessment for the specific type of UAS operation as well a list of mitigation measures to be taken by the operator in order to carry out the operation. Those mitigation measures are defined in terms of:

— operational limitations,

— technical requirements, and

— remote-pilot competence.

Based on the complexity of the mitigation measures, the standard scenario determines whether the operator is required to issue a simple declaration or has to apply for an authorisation by the competent authority of its MS of residence. In the case of a declaration, the competent authority is only required to examine if the data provided by the operator are complete, and inform the operator only if data is missing. In case the operator intends to conduct an operation in another MS, the operator has to send the declaration also to the competent authority of the MS of operation. That authority is not required to examine the data as this is already done by the competent authority of the MS of residence.

In case the standard scenario mandates an authorisation, the competent authority is required to review the documentation provided by the operator. When the operator intends to conduct an operation in another MS, it has to send the authorisation to the competent authority of the MS of residence. It is the responsibility of that authority to coordinate with the competent authority of the MS of operation to verify if local conditions are satisfied.

6.1.4. Option S3 — Authorisation, standard scenarios and LUC

Compared to Option S2, this Option includes the additional possibility for the operator to obtain a LUC from the competent authority. The LUC is not mandatory but it provides the operator with the privilege to authorise its own operations. This allows more flexibility to operators performing operations covered by standard scenarios requiring an authorisation by the competent authority, or operations not covered by a standard scenario.

In order to obtain a LUC, the operator should demonstrate that it has the organisational structure to assess the risk and identify appropriate mitigation measures. Finally, a LUC issued to an operator by the competent authority of its MS of residence, would be recognised by the competent authorities of the other MSs. The operator is not required to coordinate with the competent authority of the MS of operation, but only check the local conditions.

6.2. Specific-category impacts

6.2.1. Safety impact

6.2.1.1. Option S0

The safety impact of this Option depends on the measures that each MS would take. It is still too early to assess the impact of recently defined scenarios in some MSs due to small number of occurrences so far. However, in those MSs where both the requirements and the procedure for obtaining an authorisation are less strict, negative safety impacts could be expected.

In addition, operators might not be fully aware of all the local conditions within a fragmented regulatory framework, which could have a negative impact on safety.

6.2.1.2. Option S1

The safety impact of this Option depends on the way the competent authorities examine the authorisations. The more stricter/detailed this examination is, the higher the positive impact on safety could be.

6.2.1.3. Option S2

Compared to Option S1, this Option might have a slightly less positive safety impact. Some operators might submit a declaration to be included in a standard scenario even if their operation would not fit completely in this scenario, posing a potential safety risk.

6.2.1.4. Option S3

Compared to Option S2, this Option might have a slightly positive safety impact as competent authorities could focus their resources on checking the operations carried out by operators not having a LUC.

6.2.2. Social impact

6.2.2.1. Option S0

The social impact of this Option depends on each MS's requirements. The competent authorities of MSs with stricter requirements covering a higher number of UAS would need to dedicate more resources to issuing the authorisations.

In all MSs, regardless of the stringency of their national rules, some operators could refrain from conducting cross-border operations (e.g. professional users as photographers that could do business in several MSs) as they would need to comply with quite different requirements across MSs even for conducting similar operations. This might have a possible negative impact in terms of employment.

6.2.2.2. Option S1

This Option might have a social impact for the following stakeholders:

— Authorities: they would need additional resources (e.g. technical personnel) to deal with the increased workload of reviewing the applications for authorisations. Further information on the quantification of costs for authorities is provided under the economic impact of this Option.

— Operators: applying for an authorisation requires additional time for preparing and following up the application. The impact in terms of the operator's skills/knowledge would depend on the skills/knowledge required for obtaining the authorisation.

6.2.2.3. Option S2

Compared to Option S1, this Option might have the following social impacts for the various stakeholders:

— Authorities would need to dedicate less resources to issuing authorisations as many operations would fall into the standard scenarios. On the other hand, they would need to dedicate resources to the development of these scenarios. A quantification of the costs is provided under the economic impact of this Option.

— Operators would need to dedicate less time and resources as they would have the possibility to conduct a UAS operation using a standard scenario without applying for an authorisation. This could extend the use of UAS to jobs that are considered dangerous when performed by persons, such as inspections of power plants/buildings. The impact in terms of the operator's education would depend on the skills/knowledge required by authorities for obtaining an authorisation as well as on the requirements of the standard scenarios.

6.2.2.4. Option S3

Compared to Option S2, this Option might have the following social impacts for the various stakeholders:

— Authorities would need to dedicate less resources to examining authorisations as many authorisations would be replaced by a LUC. On the other hand, some additional resources would be required to examine the applications for a LUC.

— The possibility to apply for a LUC to obtain an authorisation for UAS operations might encourage more people to use UAS, leading to an increasing demand in the market. In addition, through this new possibility, it would be less burdensome for operators to operate several UAS. All this would have a positive impact for manufacturers in terms of business and therefore employment.

— Operators would need to dedicate some more resources to applying for a LUC, but they would save a considerable amount of resources by avoiding authorisations, which could help the UAS market expand. In addition, the impact on the operators' quality of work would also be positive as several dangerous tasks, such as inspections, would be performed by UAS.

6.2.3. Economic impact

The calculation of the authorities resources[83] was based on the feedback received via the authorities questionnaire. Considering that this feedback relates to the 'Prototype' Regulation, and that the 'Prototype' Regulation's proposal is similar to Option S3, the main analysis of the economic impacts is included in Option S3; for Options S1 and S2, only the differences in terms of resources were identified

[83] The same methodology as for assessing the economic impacts of the open-category options has been applied.

and presented in the analysis. Further assumptions on the resources estimates are provided under the economic impacts of the open category (see Section 4.4.4 'Economic impact').

As for oversight, no difference is expected across the various options of this category[84]. Therefore, no quantification of the resources dedicated to oversight is provided even though this is an important element for authorities.

6.2.3.1. Option S0

Like for the social impact, the economic impact of this Option depends on each MS's requirements.

In MSs with stricter requirements for complying with a scenario and/or obtaining an authorisation, high costs could be expected for authorities (i.e. resources needed) and operators (i.e. high cost to comply with the requirements).

On the other hand, MSs following a less stringent approach might not bear the high costs mentioned above.

Therefore, the overall economic impact of option S0 can be considered to be neutral.

6.2.3.2. Option S1

Authorities

Compared to Option S3, this Option has the following economic impact for authorities:

— more employees would be dedicated to preparing authorisations;

— no employees would be needed for assessing applications for a LUC; and

— higher training costs would be incurred as more employees would be needed for preparing the authorisations.

Moreover, a higher amount of resources would need to be dedicated to reviewing the authorisations, which could incur additional costs:

For the first year:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examination of applications and issuance of authorisations	One-off	54	EUR 3 423 913

For the following years:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examination of applications and issuance of authorisations	Yearly	109	EUR 6 867 826

84 In the open category, no oversight is foreseen.

The main difference in terms of FTEs is due to the assumption that several MSs already have employees dedicated to these activities, some of which could be temporarily redeployed. Therefore, the total number of FTEs for the first year has been reduced[85].

For the first year:

Horizontal costs	Periodicity	FTEs	Total cost for EASA MSs
Initial training	One-off	43[86]	EUR 86 956

For the following years:

Horizontal costs	Periodicity	FTEs	Total cost for EASA MSs
Training updates	Yearly	87	EUR 87 000

Assuming that the total budget of all MSs' NAAs is EUR 1 billion:

- the initial cost of around EUR 3.5 million would amount to approximately 0.35 % of the NAAs turnover, having a medium negative impact; it is considered that several MSs have already developed a legal framework; and
- the recurrent cost of around EUR 7 million would amount to approximately 0.7 % of the NAAs turnover, having a very high negative impact.

EASA

EASA would develop standard scenarios to be applied at EU level, which would entail the following:

— evaluating input from operators and MSs;

— assessing the risk of operations;

— assessing proposed mitigations; and

— issuing the standard scenario in the form of an AMC to Annex I (Part-UAS) to Regulation (EU) 201X/XXX.

Type of cost	FTEs at EU level (EASA)
Input evaluation	1 yearly
Risk assessment and mitigations	1 yearly
Total	2 yearly

EASA would bear this cost in the first years as several standard scenarios would need to be defined.

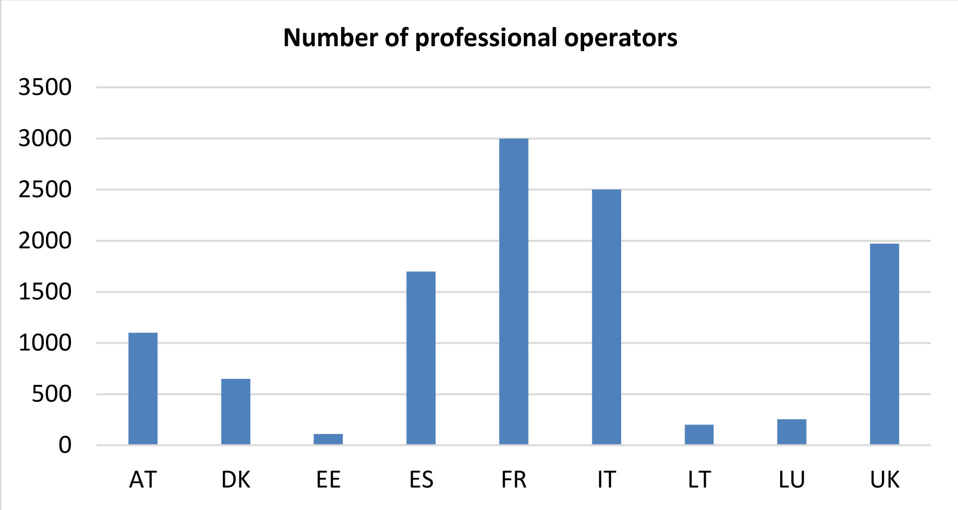
Operators

Assuming that:

[85] As for the several resources calculations in the open category, the total number of FTEs has been divided by 4 (assumption considering temporary redeployment of as well as already involved staff).

[86] Less than the total number of FTEs mentioned in the previous box as training is expected to be required for technical experts only.

- there are circa 40 000 professional operators in the EU[87] that would need to comply with a standard scenario (the following is a graphical representation of the numbers of operators per MSs); and



Graph 34. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

- the average cost of an authorisation based on a standard scenario would be EUR 200[88],

the total cost would be around EUR 8 million[89] for obtaining authorisations for all UAS in the EU. This amount would compensate for an important part of the costs incurred by authorities.

Additionally, operators would need to dedicate time to performing a risk assessment in order to be able to apply for an authorisation.

Manufacturers

This Option would probably create barriers for SMEs that are new to the aviation sector, compared to stakeholders that are familiar with the established authorisation/certification system for manned aviation.

6.2.3.3. Option S2

Authorities

Compared to Option S3, this Option has the following economic impact for authorities:

— more employees would be dedicated to preparing authorisations, but fewer than under Option S1;

— no employees would be needed for assessing applications for a LUC; and

[87] Assumption based on feedback received from EU NAAs.

[88] These figures are based on assumptions further to feedback received via the authorities questionnaire as well as from EASA experts.

[89] This was calculated assuming that each operator would obtain one authorisation only.

— higher training costs would be incurred as more employees would be needed for preparing the authorisations, but not as many as for Option S1.

For the first year:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examination of applications and issuance of authorisations	One-off	41	EUR 2 568 000

For the following years:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examination of applications and issuance of authorisations	Yearly	82	EUR 5 155 870

For the first year:

Horizontal costs	Periodicity	FTEs	Total cost for EASA MSs
Initial training	One-off	32	EUR 65 200

For the following years:

Horizontal costs	Periodicity	FTEs	Total cost for EASA MSs
Training updates	Yearly	65	EUR 65 200

The overall economic impact of this Option would be negative for MSs. Assuming that the total budget of all MSs' NAAs is EUR 1 billion:

- the initial cost of around EUR 2.6 million would amount to approximately 0.26 % of the NAAs turnover, having a low/medium negative impact; it is considered that several MSs have already developed a legal framework; and
- the recurrent cost of around EUR 5.2 million would amount to approximately 0.5 % of the NAAs turnover, having a medium negative impact.

Operators

Several operators could avoid the authorisation costs, by fitting in one of the standard scenarios. There are no clear historical data at EU level, based on which the number of operators that would fit in one of the standard scenarios could be estimated as those scenarios are currently being developed. However, it is clear that the operators would not in general bear a higher cost, compared to Option S1.

Manufacturers

Considering the lower cost for operators, the demand for UAS could increase, having a positive economic impact for manufacturers, compared to the case of a full authorisation. Nevertheless, the impact would also depend on the content of the standard scenarios as they might include burdensome technical requirements for manufacturers. Therefore, both positive and negative economic impacts for manufactures are expected under this Option.

6.2.3.4. Option S3

Authorities

For the first year:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examination of applications and issuance of authorisations	One-off	27	EUR 1 712 000
Issuance of LUCs	Yearly	11	EUR 760 870
Total			EUR 2 472 870

For the following years:

Authorisation	Periodicity	FTEs	Total cost for EASA MSs
Examining of applications and issuance of authorisations	Yearly	54	EUR 3 423 900
Issuance of LUCs	Yearly	22	EUR 1 521 750
Total			EUR 4 945 650

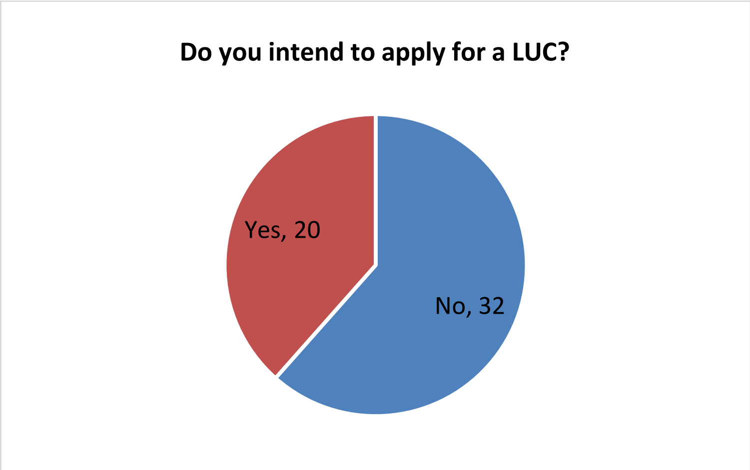
The training costs would be the same as for Option S2.

The overall economic impact of this Option would be negative for MSs. Assuming that the total budget of all MSs' NAAs is EUR 1 billion:

- the initial cost of around EUR 2.5 million would amount to approximately 0.25 % of the NAAs turnover, having a low/medium negative impact; it is considered that several MSs have already developed a legal framework; and
- the recurrent cost of around EUR 5 million would amount to approximately 0.5 % of the NAAs turnover, having a medium negative impact.

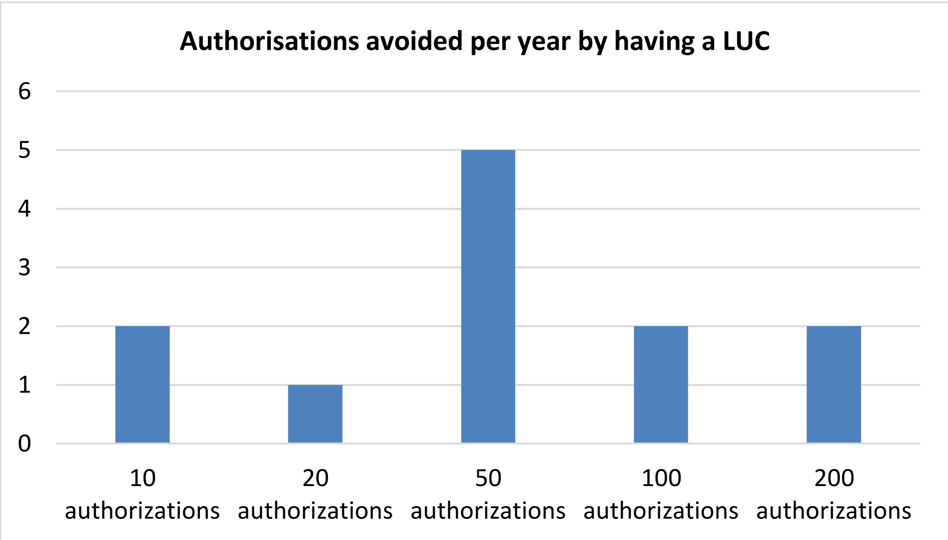
Operators

Compared to Options S1 and S2, operators under this Option would benefit from the possibility to apply for a LUC. Several respondents to the operators questionnaire agreed on the option to apply for a LUC. However, it should be noted that the majority of those replies referred to non-commercial operators that probably do not have many UAS or do not conduct various types of operations.



Graph 35. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

In addition, some respondents indicated how many authorisations they would yearly avoid by applying for a LUC:



Graph 36. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA. Each segment represents a number of replies.

Considering the above feedback, the following calculations were made comparing the cost of a LUC and of authorisations for a sample operator:

Assuming that:

— the authorisations avoided per operator could be 50[90]; and

— the cost of a LUC is set at EUR 2 500[91]:

[90] Based on many replies received from different operators.

[91] Based on expert judgement.

	Authorisations	LUC
Cost	EUR 200	EUR 2 500
Total number of authorisations/LUCs per operator	50 authorisations	1 LUC[92]
Total cost per operator	Circa EUR 10 000	Circa EUR 2 500

the sample operator could save EUR 7 500.

Manufacturers

The lower cost for operators (saved cost of authorisations) under this Option could enhance the demand for UAS, having a positive economic impact for the manufacturers' business.

6.3. Comparison of options — Specific category

Table 15

	Option S0 Do nothing	**Option S1** Authorisation for all operations	**Option S2** Authorisation and standard scenarios	**Option S3** Option S2 and a non-mandatory LUC
Safety impact	0	++	+/–	+
Social impact	0	+	+	+
Economic impact	0	– –	+/–	++
Total	0	–/+	+	++

Option S3 is the preferred one as it allows the UAS operator to apply for a LUC and/or submit a declaration if a standard scenario is applicable. This would have the following impacts:

— authorities would not need so many resources as for Option S1; and

— operators would save the cost for the various authorisations required under Option S1, by either applying for a LUC or by submitting a declaration based on a standard scenario.

[92] It is assumed that an operator, instead of applying for 50 authorisation, would go for one LUC.

7. Conclusions

The analysis of the impacts of the proposed options for all categories shows that the preferred ones are the following:

— For the **open category**, Option O3 follows a balanced approach, taking into account both technical requirements for the UAS and the remote-pilot competence. It strikes the best compromise between safety and cost, having also a positive social impact.

— For **registration**, Option R3 requires registration of all operators conducting UA with an MTOM greater than 250 g as well as registration of the UA itself having an MTOM greater than 900 g. This Option is mainly driven by the security and privacy risk, striking the best compromise between cost and risk mitigation.

— For the **specific category**, Option S3 proposes to complement the authorisation required to conduct operations, with standard scenarios issued by EASA, thus substantially reducing the burden for operators and competent authorities. In addition, the operator may choose to apply for a LUC with the privilege to approve its own operations. This Option follows the most cost-effective approach of all options in this category.

This set of options represents a proportionate solution for all stakeholders mostly affected by the proposed Regulation (EU) 201X/XXX on UAS, namely authorities, manufacturers, operators, and citizens. Overall, the options proposed would reduce the cost for manufacturers, competent authorities and operators, maintaining at the same time a high safety level ,not only by protecting other airspace users and uninvolved persons from the risk to be injured by a UA, but also by mitigating the privacy and security risk.

For operators, in particular, several sectors might benefit from the options proposed. The following is a list of the market sectors mostly affected by the proposed options, expected to have the biggest share in the future UAS market, as highlighted in Chapter 1 'Issues definition' of this sub-NPA 2017-05 (B).

— **Media and entertainment**: some operations in this sector could be conducted in the open category, especially in Subcategory A2. In case the operator wishes to exceed the limitations of the open category, the operation falls into the specific category, where the operator could comply with a standard scenario or has the possibility to apply for a LUC, thus avoiding the cost of multiple authorisations. The reduced cost will foster operations in this sector, having a very positive impact in several domains, such as on the reduction of acoustic noise and noise pollution; operations with manned rotorcraft, for example, could be partially taken over by much smaller UAS.

— **Precision agriculture**: operations in this sector would be conducted in rural areas, therefore, most of them would fit in Subcategory A3 (open category). In case the operator wishes to exceed the limitations of the open category, it may operate in the specific category, using standard scenarios, possibly requiring a declaration only, thus drastically reducing the related burden and cost.

— **Inspection/monitoring**: there are various expected benefits for this market sector, e.g. the possibility to conduct an operation over obstacles higher than 120 m at the request of the owner of the object. Depending on the specific type of such operation, it can be conducted either in the open or in the specific category. In the latter case, a standard scenario could be developed to reduce the burden for both the operator and the competent authority. The operator has also the option to apply for a LUC. The proposed set of options will foster this kind of operations, by considerably reducing the number of physical inspections performed by humans, thus mitigating the risk to human life. Furthermore, the use of UAS reduces the time needed to reach the area to be inspected, thus improving efficiency.

— **Hobbyists**: good flexibility is provided to this group, offering a variety of choices to operate UAS. Operators in this sector may typically use several UAS types:

- UAS put on the market, bearing a CE marking (for Classes C0, C1, C2, C3 or C4);
- privately built UAS; and
- model aircraft either privately built or put on the market without bearing a CE marking.

A dedicated Class C4 under Subcategory A3 has been developed in the open category, allowing hobbyists and model aircraft pilots to enjoy their operations in areas where they pose limited risk to third parties. Class C4 UAS are required to be supplied with a manufacturer instructions manual and an awareness leaflet. As an alternative, MSs have the flexibility to define zones dedicated to UAS hobbyist flights only, where different limitations may be established. Moreover, MSs may recognise the ability of model clubs and associations to create a safety culture among their members, by issuing a special authorisation to the club or association allowing deviations from Regulation (EU) 201X/XXX. In this way, hobbyist flights may continue to be conducted as today.

Finally, the set of options proposed in this NPA will also contribute to achieving the objectives of the European Commission IA[93], such as:

— enabling the development of UAS and UAS services in a safe, secure, and sustainable manner;

— eliminating the regulatory obstacles currently hampering the manufacture and operation of UAS so that manufacturers may easily put their products on the market and operators may provide their UAS services to the economy; and

— mitigate the specific risks and issues arising from the use of UAS, notably in the field of safety, security, privacy and data protection, as well as environment.

Request to stakeholders

Stakeholders are invited to provide:

— quantified justification elements on the possible impacts (e.g. economic, social, safety) of the options proposed, or alternatively to propose a justified solution to the issue;

— any other information they may find necessary to bring to the attention of EASA; as a result, the relevant parts of the RIA might be modified on a case-by-case basis.

[93] Further information is provided in Section 1.1.2.5 'European Commission IA'.

8. Monitoring and evaluation

Monitoring

Monitoring is a continuous and systematic process of data collection and analysis with regard to the implementation/application of a rule/activity. It generates factual information for future possible evaluations and IAs and helps to identify actual implementation issues. Based on the preferred set of options of this NPA, EASA proposes the following monitoring plan:

Table 16

What to monitor	How to monitor	Who should monitor	How often to monitor
Number and main cause of occurrences (accidents/serious incidents) caused by UAS and involving manned aircraft	Reports in ECCAIRS and information collected at MS level	EASA and NAAs	On a recurrent basis
Number and main cause of occurrences (accidents/serious incidents) caused by UAS and involving third parties on the ground	Reports in ECCAIRS and information collected at MS level	EASA and NAAs	On a recurrent basis
Number of UAS in each subcategory	Market analysis to monitor how new technologies cope with the regulatory framework	EASA and NAAs	To be defined
Qualitative assessment of the operators feedback on the implementation of the rules	Survey/meetings; number and qualitative assessment of the AltMoC to the UAS rules	EASA and NAAs	To be defined
Qualitative assessment of the authorities feedback on the implementation of the rules	Survey/meetings; number and qualitative assessment of the AltMoC to the UAS rules; requests for exemptions pursuant to Article 14 of the Basic Regulation	EASA and NAAs	To be defined
Qualitative assessment of the manufacturers feedback on the implementation of the rules	Survey/meetings; number and qualitative assessment of the AltMoC to the UAS rules	EASA and NAAs	To be defined

Evaluation

This proposal might be subject to interim/ongoing/ex post evaluation that will assess the performance of the adopted rules, taking into account any predictions made in this IA. The decision whether an evaluation is necessary will also depend on the monitoring results.

9. Appendices

9.1. Appendix I — Example of UAS operations

Based on the feedback received via the UAS operators questionnaire[94], the following is a sample list of the reported types of UAS operations:

— **non-commercial**: landscape photography, hobby cinematography, UAS racing; and

— **commercial**: inspections, photography (including for marketing purposes), film, search and rescue (SAR) (more efficient than rotorcraft as less costly and safer for operators), surveillance, documentation, (aerial) mapping, thermal imaging for civil engineering research, (land/geographical) surveying, videos for tourism or archaeological purposes, design, manufacturing, media, streaming, industry, still photography for larger building sites, protection of critical infrastructure as power plants and government buildings, aviation, land and maritime transport (including package delivery), aerial imaging (daylight and multispectral), and atmospheric measurement and research (meteorology, weather forecast).

9.2. Appendix II — Rationale behind MTOM/energy thresholds for UAS Class C0 and C1

MTOM/energy thresholds are one of the criteria for the subcategorisation of UAS in the open category. These criteria are used together with others in order to define subcategories of operations and UAS classes. This paper intends to provide the rationale behind the masses and energy thresholds defined with regard to the risk posed by blunt-trauma injury (non-penetrating injury) inflicted on people by a UAS. It focuses on Subcategory A1, Classes C0 and C1:

Table 17

Cat.	Class	Mass	Distance from people	Height	Pilot Competence	Age	Main Tech req. (CE mark)	Registr.	E-Identif geofencing
A1 Fly over people	Homebuilt	<250g	Fly over uninvolved people (not over assemblies of persons)	<50m	Leaflet	//	//	NO if without camera >5MP or audio sensor	NO
	C0						Toy regulation or no sharp edges		
	C1	<80J or 900 g		<50m	Leaflet	14/ sup	Kinetic energy, no sharp edges, selectable height limit	Only operator	If required by the zone of ops

Penetrating injuries should be prevented by a UAS design that does not expose uninvolved persons to the risk of injury inflicted by acuminated parts or cutting edges, for example, blade protection. But this aspect is not addressed by this paper.

Subcategory A1, Class C0

This UAS Subcategory and Class can be operated by minors, without any training required. Occasionally, UAS might fly over assemblies of people. In view of the above, a UAS of this Subcategory

[94] Further details on the questionnaire are included in Section 1.1.6. 'EASA consultation strategy'.

and Class must be intrinsically unable to harm people in case it collides with people due to remote-pilot error or UA failure. The 250-g MTOM threshold is proposed as a conservative mass to prevent significant blunt trauma. This threshold is justified by the following:

— It has been adopted for the smallest proposed category by the FAA Micro ARC of the March 2016, aimed at making a recommendation for a future FAA rule for UA allowed to fly over people.

— It is the MTOM threshold identified by the FAA registration task force: UA with an MTOM of less than 250 g are not registered. To identify this MTOM, the risk equation was applied.

— Considering RCC studies-based estimates, it has been shown that a kinetic energy of 44 J impacting a human body, averaged on the body of a person standing, would result in a probability of fatality (PoF) of 1%. From a linearisation of the relationship between MTOM and terminal kinetic energy, valid for small rotorcraft, this equates to about 250 g. There is some evidence that RCC studies are overly conservative if applied to UAS collisions with people, however, given the scope of this Subcategory and Class, it is preferred to retain a very conservative value.

Subcategory A1, Class C1

In this case, a minimum age and a minimum level of knowledge would be required for operating the UA, and flying over crowds, even occasionally, would be prohibited; it would be allowed to fly the UA only over isolated people and at a safe distance. A kinetic-energy value was calculated based on experiments that better resemble the possible UAS impact on a person.

The impact scenario considered is that of a multi-rotor UA[95] falling from the maximum allowed altitude and reaching a person's head at a 45 ° angle with respect to the vertical.

Among available data from literature, it is proposed to consider the Gurdjian experiments[96] with real embalmed human heads being dropped from a certain height on a solid, not moving plate. 17 specimens were impacted on the anterior parietal zone, 10 on the posterior parietal zone. The frontal zone is not considered as people would normally spot a UAS approaching, with their frontal zone facing the UAS, and would either shift or cover themselves with their hands. Temporal data are not available.

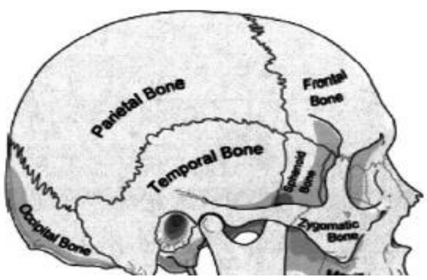


Figure 12

[95] This is the most common configuration of UAS operated in the open category.

[96] Gurdjian, E.S., 'Studies on skull fracture with particular reference to engineering factors', The American Journal of Surgery, Vol 78, Issue 5, November 1949.

From the reported terminal speeds, when the initial fracture was recorded, as well as from the weight of the specimens, it is possible to derive the kinetic energy at impact and take the overall average. The result is about 80 J.

A Monash University paper[97] refers to computer simulation of head impacts on a flat rigid structure, yielding energy values between 80 and 95 J, to start seeing skull fractures. This information seems to conservatively confirm the 80 J identified through the Gurdjian experiments.

Other fracture experiments are also available in literature, where pressure was applied to various parts of the skull:

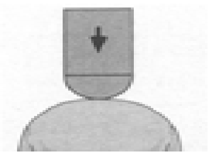


Figure 13

In some cases, recorded data include peak forces and accelerations, but the skulls seem to have been compressed on relatively smaller areas. It is believed that between the two kinds of experiments, those involving collision with a flat surface have a better resemblance with the blunt trauma resulting from a possible UAS impact.

In the Gurdjian experiments, the energy is fully transferred to the head as there is no deformation or movement of the surface impacted. In conclusion, **the value of 80 J is retained as the threshold kinetic energy that the head of the average person would be able to absorb without the skull being fractured**.

It is difficult to associate a PoF with this threshold, but there are reasons to consider the above estimate as conservative:

— the experiments with the skull specimens included several impacts before fracture; as a consequence, it may be assumed that the skulls could have been weakened before reaching the rupture threshold;

— a living person's head should be more resistant than the embalmed heads used in the experiments; and

— the rupture of the skull does not necessarily lead to a fatality (although it would certainly be a major trauma).

This substantiates the 80-J threshold value of absorbed kinetic energy as an acceptable one for Class C1. In a collision with a UA, only a fraction of the UA kinetic energy would be transferred to the head. As described further in the text, the kinetic energy absorbed in average by a human head hit by a UA in free fall is estimated to be 46.5 % of the terminal kinetic energy of the UA, expressed as half of the aircraft MTOM multiplied by the square of its terminal velocity (reaching ground). This fractional value

[97] https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/airworth/papers/human-injury-model-small-unmanned-aircraft-impacts.pdf

may have been conservatively calculated, and, given the uncertainties of collision dynamics, other assumptions may be possible.

A terminal kinetic energy under 80/0.465 = 172 J for the UA would be therefore allowed. Using a linear approximate relationship between terminal kinetic energy and MTOM (about 48 J for every 250 g of MTOM of relatively small multicopter currently available on the market), the 172-J threshold equates to an MTOM of approximately 900 g.

In conclusion, an MTOM of 900 g can be considered as a good threshold to allow a Class C1 UA to be flown over isolated people. UAS with a greater MTOM could also qualify if the manufacturer demonstrates that the kinetic energy transmitted to the head would be less than 80 J.

Note: on 28 April 2017, the final report of the FAA UAS Center of Excellence Task A4 'UAS Ground Collision Severity Evaluation' was published[98]. This very detailed and rich in information report will be analysed by EASA during the public-consultation period of this NPA, to assess potential implications for the thresholds established above.

Considerations on the kinetic energy transferred to a human head during a collision with a vertically falling multicopter.

The most common mass-produced multicopter UA on the market, with an MTOM between 250 g and 2 kg, is the Phantom DJI. Its dimensions are approximately the ones provided in the following picture:

Figure 14

In general, it is assumed that if the UA hits a person's head with one of its arms, the UA would rotate away and a relatively small fraction (F1) of the impacting kinetic energy would be transferred during the impact. The fraction would be much higher (F2) if the collision would occur at the center of or within the square area of the 145-mm side in the example above. The following is an evaluation of those values (F1 and F2):

For value F1 and based on information presented during expert meetings on the subject of small UA and energy balances that could be considered during a collision, as well as on engineering judgment, it

98 http://www.assureuas.org/projects/deliverables/sUASGroundCollisionReport.php

is considered that by hitting exactly in the centre, the UA would partially bend or be destroyed, absorbing in the process about 7 % of the impacting kinetic energy:

Kinetic energy transferred = 0.93 x impacting kinetic energy

As for value F2, if the UA would hit the head with its terminal part of the arm (tip), the transferred kinetic energy would tend to zero as the UA would most likely rotate away.

In order to simplify those two scenarios, a linear behaviour of the kinetic energy transferred to the person's head between the following two extremes is assumed:

— impact at the centre: 0.93 x impacting kinetic energy; and

— impact at the tip: 0.

The average would therefore be (0.93 x impacting kinetic energy + 0)/2 = 0.465 x impacting kinetic energy.

The impacting kinetic energy of a UAS in free fall can be conservatively considered to be its terminal kinetic energy.

In conclusion, according to the above estimates, it is considered that the kinetic energy of a UA in free fall transmitted to a person's head would be in average 46.5 % of the UA terminal kinetic energy.

9.3. Appendix III — Training

Training costs

The following table provides an overview on the theoretical training (including cost and length) required for UAS operators:

MS of training school	Number of days	Cost (EUR)	Training type	Cost per day (EUR)
Italy	2.5	800	classroom	320
Spain	2.5	1 000	classroom	400
Belgium	4	1 980	classroom and online	495
The Netherlands	4	1 980	classroom and online	495

The following table provides an overview of the practical training required for UAS operators:

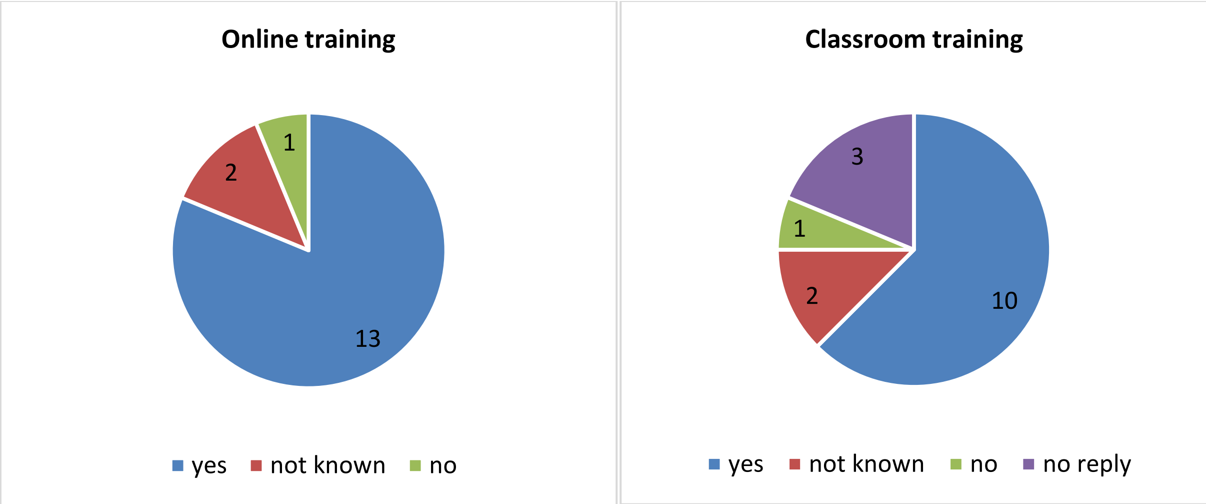
MS of training school	Number of days	Cost (EUR)
Belgium	6	930
The Netherlands	6	930
Italy	30 sessions of 10 min each	600

In addition, a very detailed overview on trainings provided by training schools in France has been provided by stakeholders. The following table provides a summary in an aggregated form:

Cost range	EUR 900-6 000
Theoretical courses only	13.3 % of the training schools
Theoretical and practical courses	86.7 % of the training schools
Length of training	4-23 days
Schools providing only classroom training	69 % of the training schools
Schools providing both online and classroom training	31 % of the training schools

Authorities and operators feedback on the typology of training

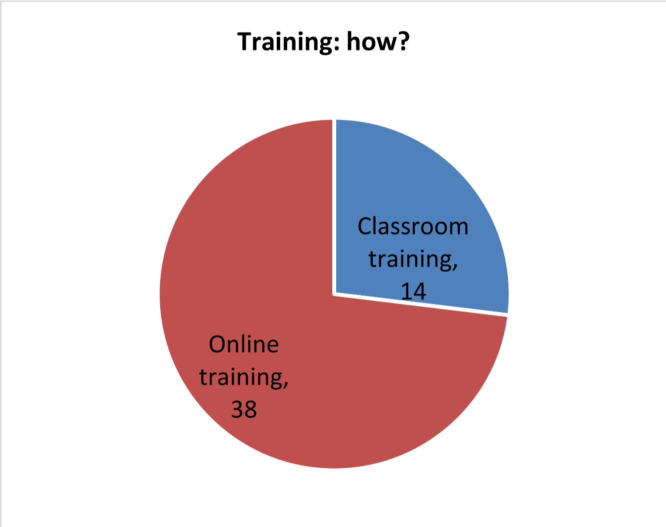
EASA MSs authorities were requested to provide feedback on their preference for either classroom or online training. The following Graph 37 provides a graphical representation of the results:



Graph 37. Source: EASA UAS authorities questionnaire 2016. Elaboration: EASA. Replies to the question on training types (classroom or online).

It is expected that the preference for a specific training type will depend on the UAS type.

The same question on the preference for a training type was posed to operators as well. The following Graph 38 provides a graphical representation of the results:



Graph 38. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

Is should be noted that most of the replies were provided by operators of small non-commercial UAS.[99].

The following is a list of original operators comments on classroom training:

— ‘Online training would not be appropriate as it leaves more scope for operators to skip important elements or get somebody else to fill the online assessment in with them or for them without actually doing it themselves.’

— ‘Classroom training should be a requirements, since it allows the instructors to evaluate each candidates performance.’

— ‘Flying a UAV is a very practical thing that needs training in the field as much as in theory. I can be easily achieved with an instructor and supervision during 1-3 days of training.’

The following is a list of original operators comments on online training:

— ‘It would be very easy to set up an online competency test, this would make it accessible to everyone.’

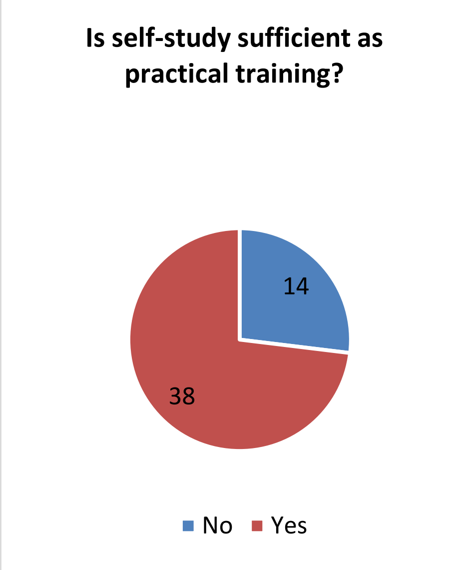
— ‘You should provide online tutorials about safety and regulations.’

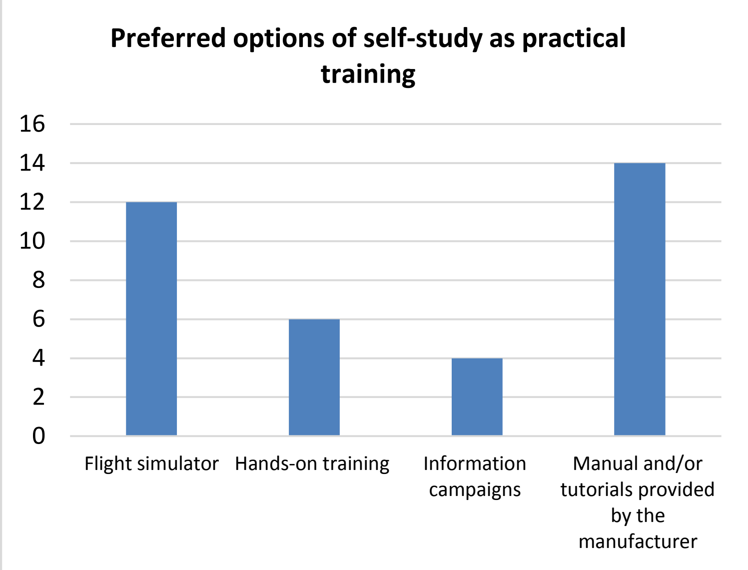
— ‘The online training cut the cost and this cost can't be more than a 30% of the drone cost.’

— ‘Both online and classroom training should be provided. For an experienced pilot (e.g. model airplane or full scale pilot) an online training should be sufficient, for a complete beginner a classroom training is recommended.’

In addition, feedback was received on the possibility of self-study as practical training as well as on the preferred options of self-study as practical training:

99 Further details on the questionnaire are included in Section 1.1.6. ‘EASA consultation strategy’.





Graph 39. Source: EASA UAS operators questionnaire 2016. Elaboration: EASA.

9.4. Appendix IV — Third-country regulatory framework for UAS operations[100]

A regulatory framework for UAS operations has already been or is currently being developed is several countries outside the EU. The following examples show how certain countries around the world have addressed the issues analysed in this sub-NPA 2017-05 (B). It is highly possible that legislation in some coutries might have changed in the meantime; therefore, the information provided might not be fully representative of the current regulatory framework in those countries.

Overall, there are several differences across the countries selected. The following are some general remarks based on some countries' rules:

— different approach across countries with regard to the level of competence of the competent authority: e.g. a local authority may decide to grant an authorisation or not;

— the level of detail regarding the required registration information and labelling varies across countries (e.g. name and telephone number of the operator, registration number, etc.);

— different remote-pilot qualifications required (e.g. training to complete, hours of flight experience);

— different requirements for obtaining a UAS certificate (e.g. medical check-up, insurance, etc.);

— as for VLOS, it should be maintained unless a prior authorisation is issued, or the UAS should be operate only in daytime; and

— with respect to privacy, flights above another person's property are considered infringement of personal rights, or recording images are deemed to be breaching certain rules (e.g. aerial photography/aerial surveys are prohibited without an authorisation).

[100] An important source of information for this Appendix IV is the following: https://www.loc.gov/law/help/regulation-of-drones/regulation-of-drones.pdf.

USA[101]

The FAA published Part 107 for the regulation of small-UAS operations (with an MTOM of 55 lb which is equivalent to 25 kg), which became applicable in August 2016. Some key elements are the following:

— VLOS only;

— no flying over persons not directly participating in the operation;

— daylight operations only or in civil twilight with anti-collision lighting;

— right of way to other aircraft; and

— remote-pilot certificate obtained by demonstrating aeronautical knowledge.

Compared to the EASA open-category proposal, there are some differences that are detailed in NPA 2017-05 (A) (see p. 5-6).

Canada[102]

There is a clear distinction between recreational and non-recreational operations among the various MTOM categories. Exemptions are also applicable. If a UAS's MTOM is less than or equal to 35 kg, a certificate is required.

A new risk-based regulatory framework is currently under development, which does not distinguish between recreational and non-recreational operations.

South Africa

The level of technical and operational requirements depends on the type of operations. Private operations, for instance, are exempt from several requirements (e.g. no letter of approval or operator certificate required). There are further restrictions for operations in controlled airspace and BVLOS.

[101] https://www.faa.gov/news/press_releases/news_story.cfm?newsId=20515

[102] https://www.tc.gc.ca/eng/civilaviation/opssvs/getting-permission-fly-drone.html

9.5. Appendix V — Overview of EASA MSs UAS regulatory framework[103]

	AT	BE	CH	CZ	DK	FI	FR	DE	IE	IT	LT	MT	NL	PL	PT	SI	ES	SE	UK
MTOM limit	150 kg	150 kg	150 kg	150 kg	> 25 kg need authorisation	25 kg	150 kg	25 kg	150 kg	As per the Basic Regulation	> 25 kg need registration	150 kg	150 kg	150 kg	> 25 kg authorization; toy < 1 kg	150 kg	150 kg	150 kg	150 kg
Categories	5 kg, 25 kg	< 1 kg recreational; < 5 kg (Class 2); > 5 kg (Class 1)	Open: maximum 30 kg, 100 m outside crowds VLOS, specific = else	0.91 kg; 7 kg; 20 kg	1A: < 1,5 kg 1B: < 7 kg 2: 7-25 kg 3: BVLOS	7 kg over densely populated areas	Yes: captive RPAS and RPAS < 2 kg, < 25 kg and above 25 kg	2 main categories: below/above 25 kg	Yes: 1.5, 7, and 20 kg	Yes: 0.3/2/25 kg	1. Up to 300 g; 2. 300 g to 25 kg; 3. over 25 kg		no	25 kg	Toy < 1 kg ; above 25 kg with special authorisation		< 2; < 25, and > 25 kg	1A: 0-1,5 kg / max 150 J / VLOS 1B: 1,5-7 kg / max 1000 J/ VLOS 2: 7-150 kg / VLOS 3: BVLOS	Yes, 20 kg or less > 20-150 kg
License	More risky categories with an increase of pilot qualification	Yes for Class 1 (including LAPL medical); Class 2: practical examination with certificate (no medical)	Pilot skills in the total hazard and risk assessment (GALLO)	RPA for professional use needs special authorisation. Pilot passes practical and theoretical tests	For commercial use in populated areas, permission is needed. Applicants need to deliver and have an operations handbook and pass a practical test	No	In some operational scenarios, theoretical certificate, and practical test for scenario S1, S2, and S3). For scenario S4: theoretical certificate + manned aviation license. RPAS > 25 kg need a remote-pilot license	Theoretical and practical requirements above 5 kg	No, but theoretical and practical requirements	Yes, pilot certificate for VLOS and < 25 kg, otherwise license. Medical class LAPL/3.	Yes, requirements set up in conditions for conducting commercial flights	Medical declaration	Yes	Certificate of qualification, including medical for commercial pilots	Case by case > 25 kg	Yes	< 25 kg theoretical knowledge + practical course on RPAS + LAPL; > 25 kg pilot license	Yes > 7 kg	> 20 kg or BVLOS; < 20 kg VLOS: pilot competency assessment required if requesting a permission
VLOS	Yes	Yes	Yes	Yes	Yes	Yes	Yes (in scenarios S1 and S3)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes

[103] An important source of information for this Appendix V is the SESAR Outlook Study: http://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf.

BVLOS	Yes, detailed regulation pending	Yes, requiring prior authorisation. It is immediately Class 1Aa (high risk)	Yes, GALLO required	Yes, only in segregated airspace and over clear ground	Yes, with special permission	Yes, only in areas reserved	Yes (in scenarios S2 and S4)	Yes, only in segregated airspace	Yes, if DAA	Yes, EVLOS possible	Yes, in segregated areas		No	Yes, in segregated airspace only	Yes. Segregated Airspace inside controlled airspace after CAA authorisation and ANSP approval; free in G airspace up to 120 m;		Yes < 2 kg	Yes, in segregated airspace	Yes with DAA in segregated airspace
Height limit	150 m AGL	300 ft AGL	No limit. Depending on GALLO.	300 m AGL. In CTR, maximum 100 m AGL	100 m	150 m	150 m (50 m, scenario S2, RPAS > 2 kg)	100 m	120 m for < 20 kg	150 m	400 ft	400 ft	120 m		120 m; toy 30 m maximum outside controlled airspace		120 m	120 m	400 ft (7/20 kg); < 7 kg VLOS
Operational limitation	4 categories: undeveloped; unsettled; settled; densely populated areas. < 2500 m from aerodrome with permission of the owner	>1.5 NM from aerodromes; > 0.5 NM from heliports; > 50 m from buildings, persons, animals, not in controlled airspace	> 100 m away from crowds; BVLOS requires authorisation; > 5 km from airfields	Class G freely. No flight within predefined buffer zones. If RPA > 7 kg keep > 100 m from persons and > 150 m from congested areas. All RPAS should keep safe distances (2 times the actual height).	> 150 m distance from built-up areas and major public roads; > 5 km from civil aerodromes; > 7 kg or jet engine only allowed from model airfields. Not over densely built-up areas, areas with weekend cottages, camping sites, large open air assemblies of persons. With special permission, down to 15-m distance.	Stricter conditions to operate over densely populated areas (e.g. MTOW < 7 kg)	Special conditions for model aircraft (VLOS, day flights, not in public space in populated areas, away from aerodromes, etc). Professional users can choose among 4 scenarios	> 1.5 km from aerodromes. Not above crowds of people, accident areas, industrial areas. Model aircraft > 5 kg needs permission	> 8 km from aerodromes; 150 m from assemblies of people; not over congested areas; > 2 km from aircraft in flight; > 20 kg, specific approval required	> 150 m from congested areas; 50 m from persons and property. > 8 km from aerodromes	> 50 m from vehicles, people, buildings; > 1.8 km from airfield; 1 to 3 NM from obstacles	> 150 m from congested areas, infrastructure, assemblies of persons, > 7.5 km from aerodromes, > 50 m from persons	> 150 m from build-up areas, crowds of people, main roads; > 50 m from railways	> 5 km from aerodromes; safe enough distance from people and property	BLOS and night flight allowed inside segregated airspace;	Daylight VFR, > 300 m above crowds, > 50 m from roads, railways	> 8 km from aerodromes; not over urban areas or people concentrations, not at night	No flight in controlled airspace, > 50 m from people, animals, property	< 20 kg not over or within 150 m of 1000 + persons, or from congested areas; not within 50 m from persons, objects. > 20-150 kg dependent on an *Operating Safety Case* assessment

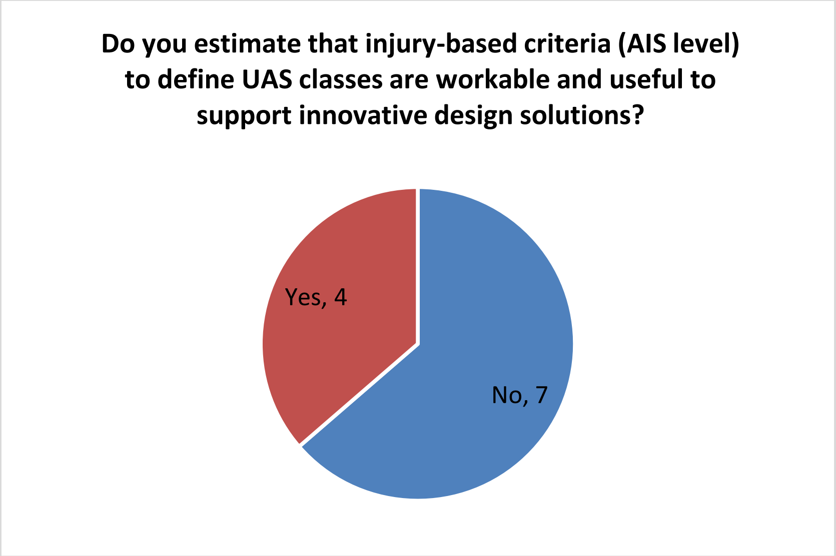
9.6. Appendix VI — Abbreviated injury scale (AIS)

AIS is an anatomy-based coding system created by the Association for the Advancement of Automotive Medicine (AAAM) to classify and describe the severity of injuries. It grades injuries in six levels, on a scale of 0 (minor) to 6 (fatal).

These six AIS levels can be loosely correlated with the following PoF:

AIS = 1, PoF = 0 %; AIS = 2, PoF < 1 %; AIS = 3, PoF < 10 %; AIS = 4, PoF < 30 %; AIS = 5, PoF < 50 %; AIS = 6, PoF < 100 %.

The following is a graphical representation of the feedback received from manufacturers on AIS; the majority of the replies were not in favour of this method:



Graph 40. Source: EASA UAS manufacturers questionnaire 2016. Elaboration: EASA.

AIS might be complex, time consuming and costly, but provides flexibility to manufacturers. On the contrary, other criteria such as the MTOM could be less costly and easier to apply but more rigid.

Due to many negative comments, e.g. on the potential high cost for demonstrating compliance, AIS was not taken into consideration anymore. The following are some manufacturers replies received via the online questionnaire, welcoming alternative simpler criteria such as MTOM or kinetic energy:

— ‘Kinetic energy as some drone have parachute systems for system failures.’

— ‘Not sure that current testing levels would be sufficient to demonstrate compliance with a given AIS category. In this context, developing new tests and standards will be long and costly, and the benefit is unclear if the rules framework sufficiently protects against the likelihood of an impact.’

— ‘Possibility for Kinetic Energy Density is important as it is more realistic then using weight and kinetic energy alone.’