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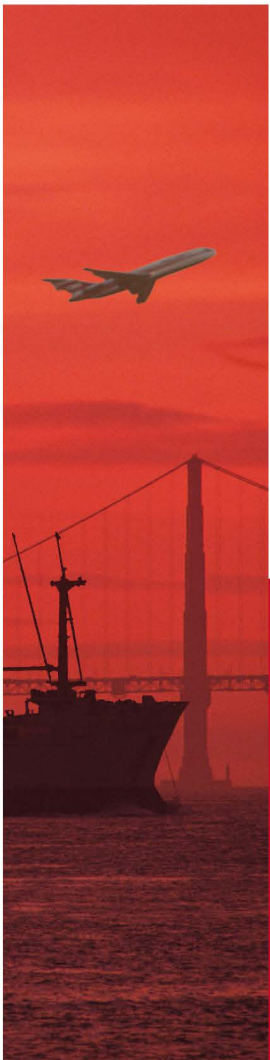

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RESEARCH FOR TRAN COMMITTEE: SAFE INTEGRATION OF DRONES INTO AIRSPACE

STUDY

EN

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Abstract

This paper details the major safety risks associated with the use of drones into airspace and identifies the technical solutions that could address these risks. It also examines to what extent existing/proposed aviation regulations are appropriate to ensure the safety of drone operations and makes recommendations on this matter.

IP/B/TRAN/IC/2016-104 September 2016

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CONTENTS

LIST OF ABBREVIATIONS

AIS	Abbreviated Injury Scale
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
BVLOS	Beyond Visual Line-of-Sight
DAA	Detect and Avoid
EASA	European Aviation Safety Agency
EGNOS	European Geosynchronous Navigation Overlay Service
FAA	Federal Aviation Administration (in the USA)
ICAO	International Civil Aviation Organisation
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
NATO	North Atlantic Treaty Organisation
PIC	Pilot in Command
QE	Qualified Entity
RP	Remote Pilot
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPS	Remote Pilot Station
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
VLOS	Visual Line-of-Sight

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Background

Unmanned aircraft systems (UAS or "drones") are quickly developing worldwide. They are used for a number of applications ranging from surveillance and security to aerial photography, pipeline and power-line inspection, precision agriculture, media and entertainment, and many others. The risks associated with the operations of drones are already well defined and are being addressed globally. The main risks from the societal point of view include:

- Safety Risks
  - People and properties on the ground
  - Other Airspace Users
  - Critical infrastructure and mass meetings
- Other Risks
  - Privacy
  - Security
  - The environment

Third party liability and insurance are also part of the most significant societal concerns, as underlined in the European Parliament Resolution of 29 October 2015.

Aim

This note attempts to give some organisation to the long list of issues to be addressed, to identify how much the current regulatory framework and technology enablers are contributing to address these issues and to propose recommendations for corrective actions.

The analysis highlights that, from a regulatory perspective, the proposal for a new regulation on common rules in the field of civil aviation, currently undergoing the EU legislative process, already addresses most of these issues. However, some improvements could be considered to better cope with the identified safety risks.

In particular, there could still be the opportunity to clarify the text of such a new aviation regulation by:

a) Including additional definitions for "manned aircraft" to clearly distinguish them from drones (currently it is not clear how optionally piloted aircraft are classified) and for "model aircraft", which would otherwise need to be mentioned in several implementing rules;

b) Extending a definition to encompass new providers that are going to be responsible for the provision of services to drones such as Command & Control Link or Traffic Management;

c) Referring to security, e.g. aspects linked to personnel (e.g. giving them a badge after proper checks) and to physical protection of equipment (e.g. storing the small UAS when not in use and controlling access to the station on the ground);

d) Clarifying the role and privileges of Qualified Entities, including the assessment of competence of the remote pilots;

e) Mandating that even UAS in the "open" category, when marked and registered, be recorded in the repository established by the legislative proposal. In fact, drones in such a category can weigh up to 25 kg (i.e. capable of fatally injuring a person, as well as to carry a payload of a few kilos), and it would be desirable, to protect citizens even beyond safety, to include them in the common repository.

In addition, it might also be relevant to include the same definition of "model aircraft" in Regulation 785/2004 to clearly define what is excluded from the obligation to hold insurance.

Finally, it could be clarified that flights carried out by EU Agencies are subject to civil rules, since they are not under the responsibility of any Member State.

The regulatory framework envisaged above would be supported by appropriate implementing measures (EASA has already published "prototype rules") and mature technical solutions which could support in the mitigation of the safety risks associated with the use of drones in airspace. Industry has a leading role in the development of these technical solutions through standardisation bodies, such as CEN, CENELEC, ETSI, EUROCAE, ISO and others, most desirably in coordination with EASA. Public funding could speed up the development and reduce the time required to reach an adequate level of maturity. In this respect, European Agencies and SESAR JU in particular might continue fostering research initiatives on drones in both the short and the long term.

1. INTRODUCTION

1.1 Background

The development of unmanned aircraft systems (UAS or "drones") constitutes a disruptive innovation [5] *(numbers in [brackets] refer to the list of references on page 49)* in the aviation market, whose numbers already exceed the number of traditional "manned" aircraft[1].

The associated risks are high on the agenda all around the world. It is important to note that societal concerns go beyond safety - while, as stated by the Riga Declaration [60], public acceptance is key to the growth of UAS.

1.2 Scope of the note

This note covers the major safety and security risks associated with the use of drones into airspace (regardless of the size/weight or the type/place of operation of the UAS), namely:

a) Injuries to people and properties on the ground;

b) Mid-air Collision (MAC);

c) Critical infrastructure;

d) Security;

e) Damage compensation;

f) Enforcement.

The note does not address issues relating to the environment and to privacy and data protection[2] which fall under different fields. It also does not address uncontrolled crash of drone when this event neither causes harm to people, nor risk for other airspace users or damage to critical infrastructure.

1.3 Objectives of the note

This notes fits into the context of the proposal for a "Regulation of the European Parliament and of the Council on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008" [27] and the related legislative procedure [2015/0277(COD)].

The note aims to:

a) Structure and detail the major risks associated with the use of drones into airspace and derive from them measures to mitigate these risks;

b) Examine to what extent existing and proposed aviation safety rules are appropriate to the safe integration of drones into airspace and make recommendations in this matter;

c) Identify the technical solutions which could address the major risks associated with the use of drones into airspace and their current status of development;

d) Highlight the key issues to be considered by the Legislator and other major stakeholders (e.g. Member States or EASA).

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1 For instance, 400,000 UAS (>250 gr) were registered in the USA in the first four months of 2016, against around 300,000 manned aircraft registered by the FAA in its entire history (Mr. S. Creamer, Director Air Navigation at ICAO, Verbal statement at the ICAO Symposium on Remote Technologies in Stockholm, 09 May 2016).

2 About privacy and data protection, please refer to Privacy and Data Protection Implications of the Civil Use of Drones, European Parliament (2015).

The note takes into account current works/discussions about safety regulation of drones into airspace, including at ICAO, global (e.g. USA), JARUS and EU level, as well as in the Member States. It also considers the EASA taskforces[3] on the risk of mid-air collision with drones [15] and on "geo-fencing" [70], as well the Agency's "Prototype rules" [14] published on 22 August 2016.

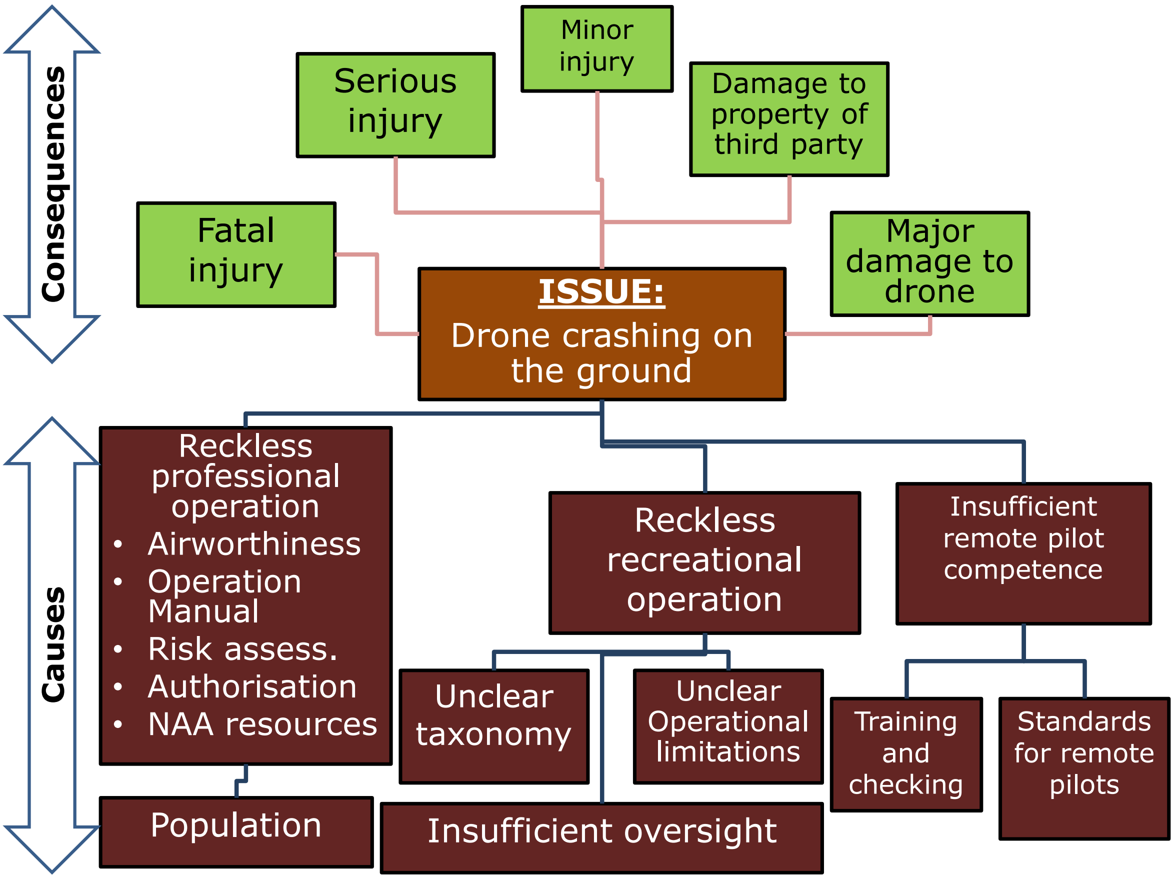
3 Please note that mid-September 2016, the EASA has still not released the final reports originating from these taskforces.

2. MAJOR RISKS ASSOCIATED WITH DRONE OPERATION

2.1 Drone crashing on the ground

When a drone crashes, it may cause injuries, serious or even fatal, to one or more people. The impact may well destroy the drone. Furthermore, in the impact, the drone may damage property on the surface, but this aspect is covered in Point 2.5 in relation to damage compensation.

Figure 1: Drone crashing on the ground - Causes and consequences

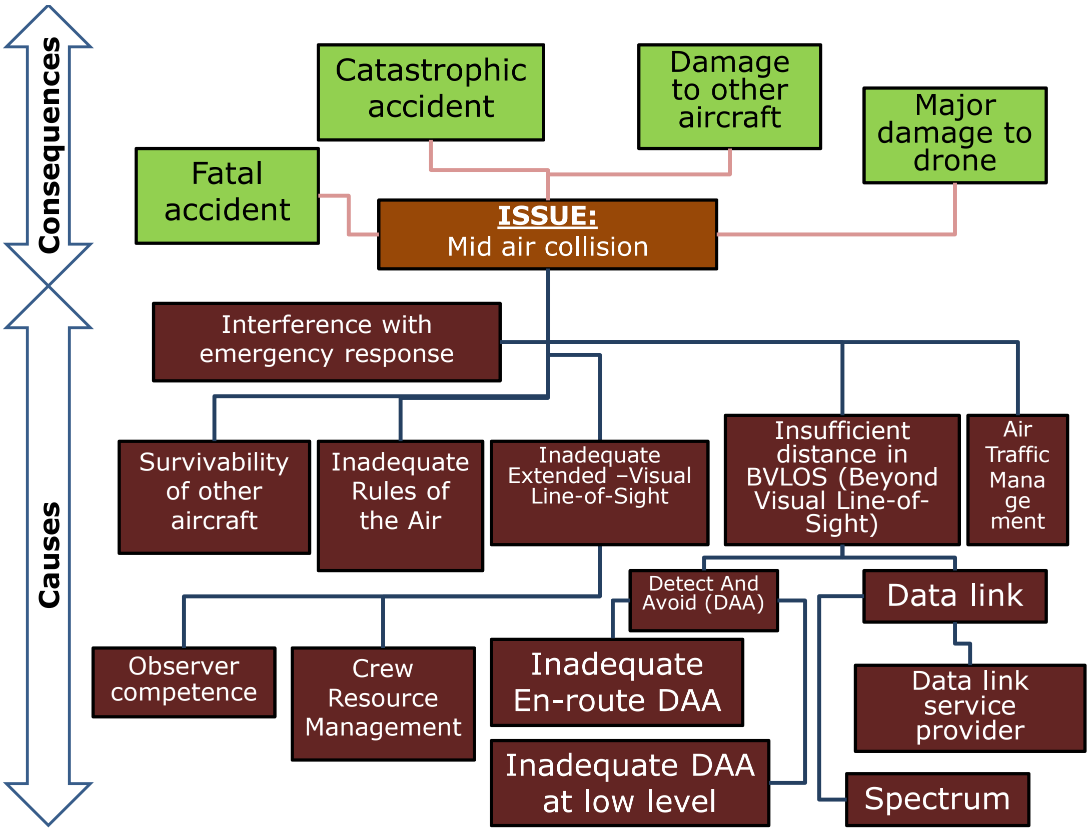


2.2 Mid-air collision

Mid-air collisions may lead not only to major damage to the drone but, even more dangerously, to damage to other aircraft or even to a fatal or catastrophic accident[4]. Until now, no fatal collision between an aircraft and a drone has been reported.

[4] E.g. a drone of a few kilos, which infringes the windshield of a helicopter flying at low level, injuring the pilot and impairing her/his capability to continue safe flight.

Figure 2: Mid-air collision - Causes and consequences



2.3 Critical infrastructure

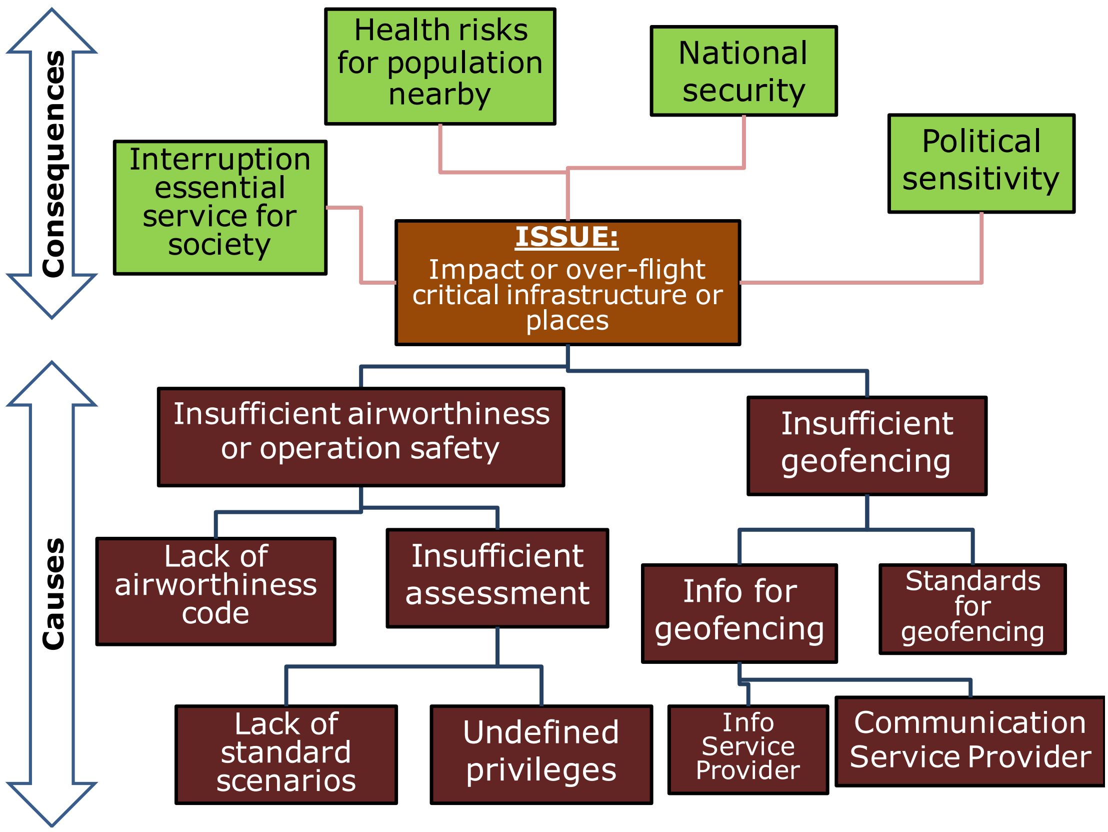
There are risks connected to possible impact or improper over-flight of critical infrastructures (critical because of the potential safety risks or because of political sensitivity) or even of temporary gatherings of masses of people (e.g. rallies, open-air concerts, sport events, etc.).

Potential consequences of a drone crashing over sensitive places could range from interruption of an essential service for society (e.g. electric power supply), to health risks for the population nearby (e.g. in the case of chemical plants or reservoirs of flammable or toxic substances, or even only crashing over a crowd), to political issues or breaches to national security, as depicted in the following figure.

Several examples of small drones flying in airspace volumes forbidden to them have been reported, especially in close proximity to aerodromes; in some cases reporters also referred to a collision.[5]

[5] Police investigate Heathrow incident (BBC News, 18.4.2016).

Figure 3: Impact on/overflight of critical infrastructure - Causes and consequences



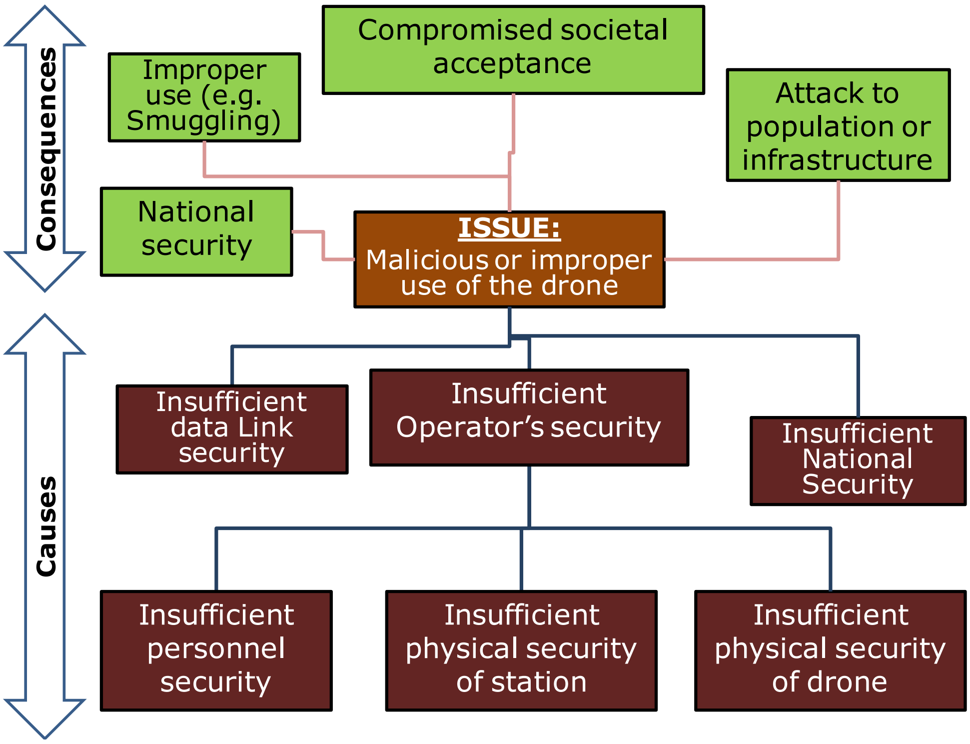
2.4 Security

A security breach may lead to jeopardising the protection of citizens. Separating safety from security in relation to modern technologies is extremely difficult; it is noteworthy that the European Commission has proposed to extend EASA competences to this domain (by means of the legislative proposal [27] currently under discussion).

For example, a small drone landed on the roof of the Prime Minister's office in April 2015 in Japan[6], causing significant concern and leading the Japanese Ministry of Transport to quickly promulgate rules on the use of small drones, which previously were not available.

[6] Drone on Japanese Prime Minister's roof (The Independent, 25.4.2015).

Figure 4: Security breach - Causes and consequences

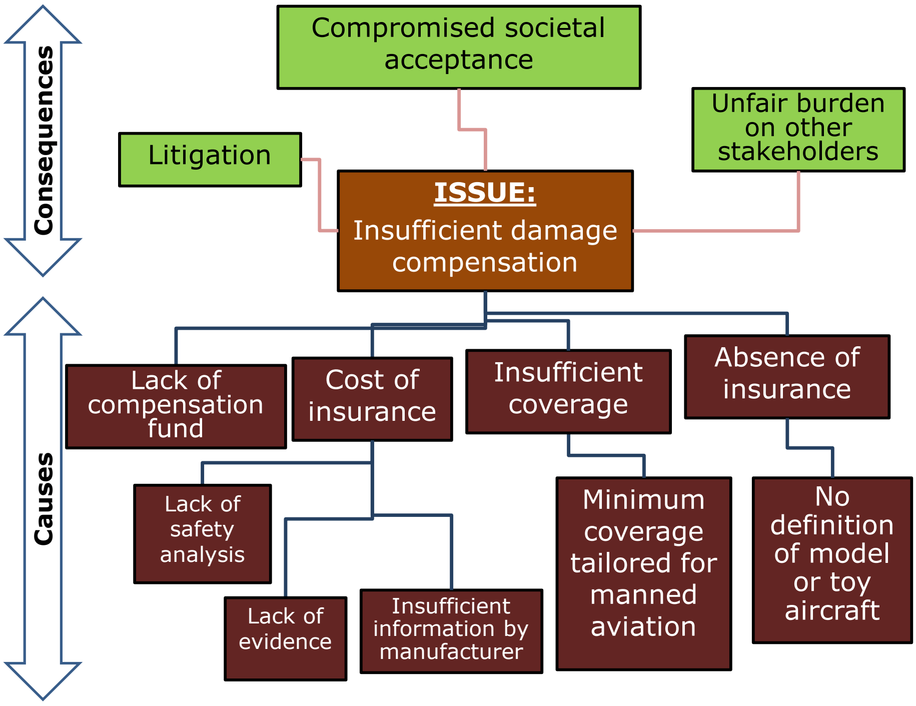


2.5 Damage compensation

In 2014, the European Commission stated in its Communication on sustainable development of remotely piloted aircraft systems (RPAS) [26]:

> "The progressive integration of RPAS into the airspace from 2016 onwards must be accompanied by adequate public debate on the development of measures which address societal concerns including safety ... third-party liability and insurance or security."

Figure 5: Insufficient damage compensation - Causes and consequences



2.6 Enforcement

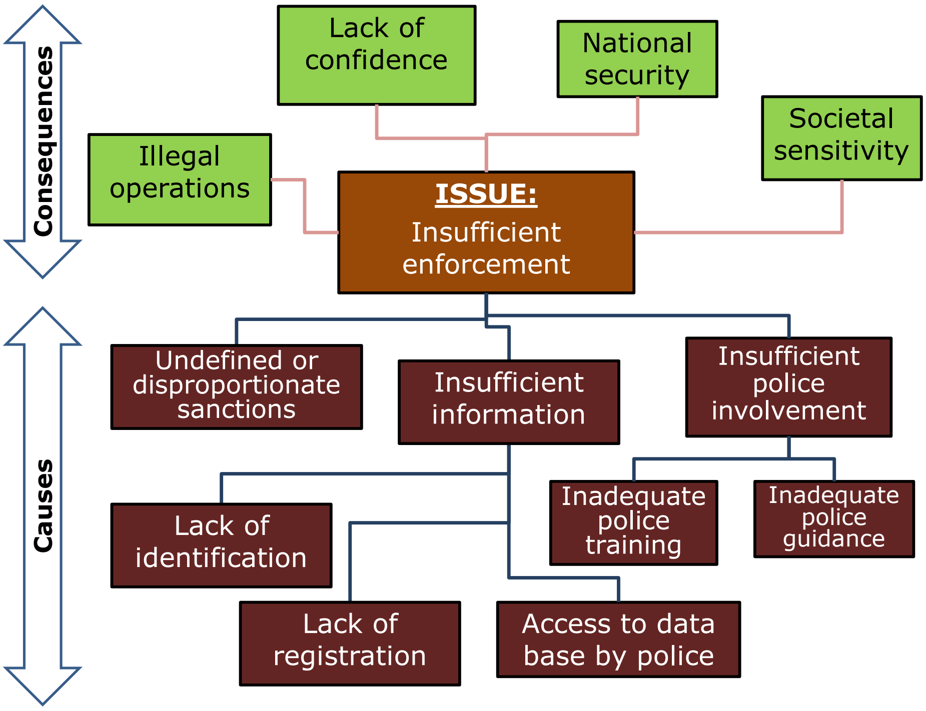
Drones are used by police or similar entities for law enforcement purposes. According to a JRC report [59] on social and ethical aspects of RPAS, concerns have been raised about the use of civil drones for law enforcement purposes. Law enforcement applications remain however outside the jurisdiction of the European Institutions, falling instead to Member States and hence this aspect is not further assessed in this paper.

However, citizens may also be concerned about seeing drones flying around at very low level (VLL) and operated by private remote pilots or commercial drone operators. Citizens may in fact perceive their safety or privacy possibly jeopardised. In the regulatory framework envisaged by EASA in its Technical Opinion [12] and prototype rules [14], for low or medium risk categories of drones, there should be a limited level of involvement by aviation authorities. This means that the European Commission and the market surveillance authorities should implement proper administrative enforcement.

However, market surveillance authorities cannot prevent illegal use of small drones, including when flying where they should not. Clearly, the aviation authorities neither have the mandate nor the resources to patrol the territory. Hence, in paragraph 2.3.6 of its Technical Opinion [12], EASA highlights that any rules have to be enforced by national forces designated by the Member States (e.g. Police). As the police and other law enforcement agencies should play a key role in the oversight of the "open" category of drones, they should be involved in the development of rules specific to their needs.

For example, the Italian Ministry of Interiors has already published a "vademecum" for police official [50].

Figure 6: Insufficient enforcement - Causes and consequences



3. MEASURES TO MITIGATE THE RISKS ASSOCIATED WITH DRONE OPERATION

The risks associated with drone operation identified in Chapter 2 can be mitigated by the ten main measures identified in this Chapter 3. Most of these measures are already implemented, or in progress. However, there are still regulatory gaps to be closed (Chapter 4) and technical solutions to be developed (Chapter 5). The different categories of drones are those proposed by EASA.

Box 1: EASA Proposal for drone categories

Proposal: Establish three categories for the operation of unmanned aircraft taking into account the nature and risk of the particular activity.

- **"Open" category (low risk)**: Safety is ensured through compliance with operational limitations, mass limitations as a proxy of energy, product safety requirements and a minimum set of operational rules.
- **"Specific" category (medium risk)**: Authorisation by a national aviation authority (NAA), possibly assisted by a Qualified Entity (QE), following a risk assessment performed by the operator. A manual of operations lists the risk mitigation measures.
- **"Certified" category (higher risk)**: Requirements comparable to those for manned aviation. Oversight by NAA (issue of licences and approval of maintenance, operations, training, ATM/ANS and aerodromes organisations) and by EASA (design and approval of foreign organisations).

Source: EASA Technical Opinion of 18 December 2015 [12]

Table 1: Risk causes and mitigation measures, per category of drone

UAS CATEGORY	RISK CAUSES	MITIGATION
Open	Unclear taxonomy (e.g. model aircraft, toys, recreational, etc.) which could for example lead to small drones escaping rules on insurance, or to imposing disproportionate rules on large model aircraft.	**1. Establish market surveillance mechanisms, covering commercial, non-commercial and recreational operations and including vendors and importers obligation to provide information to consumers on the class of the drone and related operational limitations, as well as clarification of regime for "large" model aircraft (e.g. above 25 kg)**
	Insufficient safety of industrial products which could for example lead to marketing drones of a few kilos as "toys"without warning the customer of the applicable operational limitations.	
Open and Specific	Resilience of manned aircraft to collision with a small drone which, contrary to the case of birds, is currently not considered.	**2. Assess the need to amend EASA Certifications Specifications for manned aircraft in relation to drone impact**

UAS CATEGORY	RISK CAUSES	MITIGATION
	Flying beyond limitations (open category) or (specific category) beyond the terms of authorisation or declaration which may escape enforcement if the drone and the operator are not identifiable.	**3. Limit the case of declarations (ref. Article 46.2 of the legislative proposal [27] under discussion) to standard scenarios and organise registration and identification processes, involving law enforcement agencies**
	Interference with emergency operations during which drones are more and more used, but which of course may also attract media, with possible drone traffic congestion.	
	Lack of registration and identification, which would make any enforcement or damage compensation extremely difficult.	
	Overflying urban or congested areas in the absence of proper risk assessment and mitigation.	
	Undefined or disproportionate sanctions for illegal use which also would make enforcement more difficult to implement in practice.	
	Lack of access by law enforcement agencies to aviation databases which would make it more difficult to assess whether the drone was operated inside the applicable limits or beyond.	
	Lack of guidance for law enforcement agencies which could lead them to not take action.	
	Lack of training for law enforcement agencies, for which drones are a new social phenomenon.	
Certified	Insufficient assessment of initial airworthiness because of lack of rules on manufacturing and commercialisation of drones.	**4. Limit privilege[7] to carry out safety assessment, out of standard scenarios, to accredited organisations and include obligations for manufacturer, Operation Manual, security of personnel**
	Insufficient information delivered by manufacturer or vendor to consumer, on class of the drone and applicable limitations, because not mandated by rules.	

[7] A "privilege" is the authority conferred to a person or organisation to conduct defined activities which would otherwise be forbidden.

UAS CATEGORY	RISK CAUSES	MITIGATION
	Insufficient continuous airworthiness due to lack of organisation of the operator of the drone.	**and equipment and continuous airworthiness**
	Insufficient or non-existent Operation Manual, if not required by common rules.	
	Lack of standard scenarios to facilitate risk assessment, which would otherwise become cumbersome due to the need to reiterate for several similar cases.	
	Insufficient specific operations risk assessment, because they're carried out by insufficiently skilled personnel or organisations.	
	Insufficient personnel security or insufficient physical security of drone or station, because of the lack of requirements on the operator's organisation.	
	Insufficient quantity of resources in aviation authorities, since resources for public sector are limited in all Member States and since the priority of the authorities is obviously commercial air transport and not operation of small UAS.	
	Insufficient information from manufacturer (e.g. Flight Manual) due to lack of applicable Certification Specifications.	**5. Promote use of industry standards for Flight Manual (or equivalent) and crew competence, delegating training responsibility to operators and assessment to Qualified Entities**
	Insufficient standards for crew competence due to the lack of published regulatory material.	
	Insufficient assessment of pilot competence due to insufficient regulation of flight instructors and flight examiners.	
	Insufficient observer competence, due to lack of provisions on operators to train and maintain competence of personnel.	
	Insufficient Crew Resource Management (CRM) in Extended-VLOS since the latter implies a real time communication between the	

UAS CATEGORY	RISK CAUSES	MITIGATION
	remote pilot in command and one or more observers, whose effectiveness and rapidity requires training.	
Certified	Lack of airworthiness codes specific for UAS, while the airworthiness codes for manned aircraft do not cover the specific UAS features (e.g. remote station; emergency recovery; data link; etc.).	**6. Provide guidance to facilitate the development of the UAS certification basis by the design organisation applying for type certification**
All categories	Data link used for Command and Control of the drone, implemented in electromagnetic spectrum not sufficiently protected for such application.	**7. Promote studies in ICAO, International Telecommunications Union, EASA and beyond, for the use of spectrum for data link and cyber-security**
	Insufficient data link security, which would make the drone more prone to malicious interference or hijacking.	
	Data link service provision under insufficient safety oversight in the absence of rules applicable to the service providers of this application.	**8. Establish provisions for oversight of Command and Control link and traffic information service provision**
	Insufficient provision of communication service to drone operators which may stem from the fact that traditional radio aids to air navigation, due to curvature of the planet and to obstacles, do not cover very low level altitudes away from aerodromes.	
	Insufficient organisation of providers of information for management of Very Low Level traffic, since the scope of such information (e.g. public emergency areas; politically sensitive locations; gatherings of crowds and similar) may well go beyond traditional aeronautical information.	
	Lack of published results of safety analysis which would make it difficult for insurers to assess respective financial risks.	**9. Promote safety analysis by authorities, while clearly defining model aircraft and considering compensation fund**
	Possibility of escaping insurance obligation for small unmanned	

UAS CATEGORY	RISK CAUSES	MITIGATION
	aircraft used for other than recreational purposes, since such aircraft may be confused with model aircraft.	
	Lack of compensation fund which could provide a minimum damage compensation even in cases of damage caused by a non-insured drone.	
	Lack of evidence of risk mitigation available to insurers due to fragmented and incomplete safety rules, leading to fragmented and possibly insufficient evidence.	
	Insufficient minimum insurance coverage, since the collision of even a small drone with a large aeroplane may cause enormous damage.	

Table 2: Risk causes and mitigation measures related to management of unmanned traffic

ALL UAS CATEGORIES	RISK CAUSES	MITIGATION
UAS Traffic Management	Inadequate rules of the air for VLOS and Extended-VLOS operations at Very Low Level (i.e. at a height less than 150m above ground level), since the rules of the air have been written throughout aviation history with aircraft at higher (except take-off and landing) altitudes in mind.	**10. Promote development of UTM concept, consequential amendments to rules of the air and development of industry standards for related technologies (e.g. geofencing; DAA; ADS-B) and operational procedures**
	Lack of standards for Geofencing (or Geocaging) which would make it more probable for a drone to exit the intended volume for operations, or entering airspace volumes from which the drone should instead stay out.	
	Inadequate "Detect and Avoid" (DAA) for en-route operations which would increase the risk of collision, including with large passenger aircraft.	
	Inadequate DAA for Very Low Level BVLOS operations, which would increase the risk of collision with small and less equipped manned aircraft (e.g. helicopters in emergency service) or with obstacles.	
	High drone traffic density at very low level, since in fact most drones fly below 150m to better capture data from the ground level, which in turn constitute a new air traffic scenario which should be managed.	
	Lack of proper technologies, regulatory framework and procedures to manage UAS and manned traffic at very low level, since the equipment and technologies traditionally used for large aeroplanes flying en-route, are too heavy, costly and power consuming for small aircraft, whether manned or unmanned. Furthermore "see and avoid" is unsuitable, since the small dimensions of the majority of	

	drones prevents the pilots on board a manned aircraft seeing them.	
	Lack of proper ATM procedures to accommodate very special drone operations at very low level, which in fact desire to fly the minimum heights applicable to manned aviation.	
	Mixed manned/unmanned traffic along routes or in Terminal Areas or Control Zones, where large passenger aeroplanes operate during take-off and landing phases of flight.	
	Mixed manned/unmanned traffic at aerodromes which would require technologies and procedures, e.g. for a drone to taxi in a queue with manned aircraft, minimising the risk of ground collision.	
	Insufficient provisions for very high-level traffic; e.g. solar powered drones loitering above Flight Level 600 (i.e. around 20 km), which is a new scenario for air traffic control.	

4. MITIGATING THE RISKS BY CLOSING REGULATORY GAPS - PROPOSAL FOR A NEW REGULATION ON COMMON RULES IN THE FIELD OF CIVIL AVIATION [2015/0277(COD)]

4.1 Market surveillance and model aircraft

Mitigation Measure 1 implies establishing market surveillance mechanisms, covering small drones used for commercial, non-commercial and recreational operations, and to include the obligation for vendors and importers to provide information to consumers, as well as clarification of the regime for "large" model aircraft (e.g. above 25 kg, or in any case beyond the open category).

4.1.1 Large model aircraft

Neither ICAO standards nor EU common rules defined "model aircraft" or "toy aircraft" until 2015. When drones proliferated, a consensus emerged that model aircraft are those used only for recreational activities, alias leisure flights, air displays, sport or competition activities, while toy aircraft are designed or intended for children under 14 years of age[8]. This intent is now captured, at the level of implementing rules, in Part C [28] of the Standard European Rules of the Air.

However, in practice it is extremely difficult to distinguish between a small UAS used for professional purposes or for the private pleasure of capturing images from the air. EASA Technical Opinion [12] states that the proposed regulatory framework, being risk-based, would apply to both commercial and non-commercial operations as an identical small drone might be used for both commercial and non-commercial activities with the same risk to uninvolved parties. However, EASA declared in the prototype rules [14] its intention to address the case of model aircraft in future implementing rules, recognising that the way the clubs for model aircraft are organised, their experience, their safety culture, etc. provide an equivalent level of safety to the one intended by the implementing rules.

The EASA position is certainly true for affiliates to such clubs, which often operate large model aircraft in segregated airspace. However, there is the case of several people purchasing a small UAS or a traditional model aircraft of small mass and operating it without any relation with any model club.

In summary the EASA Technical Opinion and "prototype" rules propose to treat model aircraft, toy aircraft and small UAS below 25 kg (i.e. in the "open" category) exactly in the same way. Conversely, "large" model aircraft above 25 kg may be subject to self-regulation by clubs, in line with the historical tradition, but they should not be confused with drones in the specific and certified category. This approach seems appropriate, also noting that a similar approach is pursued in the USA, based on Section 336 of the FAA modernisation act of 2012 [67].

4.1.2 Market surveillance

Article 46(3) of the legislative proposal currently discussed [27] envisages that, for the low risk (open) category, market surveillance mechanisms such as those for industrial products, and not traditional aviation administrative procedures, should be used. In this respect, one could note that the European Union has acquired considerable experience since 1985 and

[8] Based on Article 2(1) of the "Toy Directive" [35].

legislation is already in place [33] for market surveillance relating to the marketing of industrial products.

Experience shows that such market surveillance mechanisms, implemented through common EU rules and related technical specifications, are sufficiently safe, practicable for industry and acceptable by society. In addition, one could note that these mechanisms, differing from common aviation rules, swiftly allow imposing obligations on importers and vendors, including affixing the CE mark to attest compliance with applicable technical specifications.

This approach, for which EASA has already anticipated in the prototype rules [14], is considered sufficient to address the safety of products in the open category, taking into account that consensus based industry standards are already being developed by the International Organization for Standardization (ISO) [49], with significant participation from EU Member States, as well as from other continents, and that ISO is linked to European Standard Organisations, such as CEN, CENELEC and ETSI. It is known that other States (e.g. Qatar) are considering to impose some obligations on importers and vendors[9].

4.1.3 Information to consumers

In the open category, which includes small (currently envisaged of no more than 25 kg) drones, only ensuring the safety of the product (i.e. not of its use) through market surveillance mechanisms, is however not sufficient. In fact to properly protect citizens, and not only from the safety perspective, the use of the small drone shall also be considered.

Indeed, the legislative proposal [27] includes (paragraph 1 of Annex IX) essential requirements also applicable to such category. In particular, point 1(a) therein proposes that the person operating the drone must be aware of the applicable EU and national rules relating to the intended operations, explictly mentioning safety, privacy, data protection, liability, insurance, security and environmental protection.

Furthermore the person must be able to ensure the safety of operation and safe separation of the drone from people on the ground and from other airspace users. These essential requirements, coupled with the possibility that addressing importers and vendors referred to above, would allow the European Commission (on the basis of opinions developed by EASA) to adopt implementing rules which would oblige vendors to deliver simple information material (e.g. a leaflet with “dos and don’ts”) to consumer. This simple information material is expected to be based on operational limitations developed by EASA, to constitute a legal warning for the consumer and to facilitate law enforcement by appropriate agencies (e.g. the police).

In this context, it is deemed that a sufficient legal basis is provided for this to happen, which will sufficiently protect citizens and, on the other side, allow the imposal of obligations on economic operators, along the lines already drafted by EASA in Section 2 of Annex II to the prototype rules [14].

4.2 Resilience to collision with drones

Mitigation Measure 2 suggests assessing the need to amend EASA Certification Specifications for manned aircraft in relation to possible drone impact. Following cases of possible near Mid-air collision (MAC) reported by the media (one example in [6]), EASA already announced on 04 May 2016 the establishment of a task force [15] to:

a) Review all relevant occurrences including those collected by Member States;

b) Analyse the existing studies on the subject of impact between drones and aircraft;

[9] The related Qatar Notice of Proposed Amendment could be published in 2017.

c) Study the vulnerabilities of aircraft (windshields, engines, and airframe) taking into account the different categories of aircraft (large aeroplanes, general aviation, and helicopters) and their associated design and operational requirements; and

d) Consider the possibility to do further research and perform actual tests (for example on windshields).

EASA already has sufficient delegated powers to issue Certification Specifications or other "soft law", including for similar circumstances (e.g. bird strikes). There is therefore no need to amend EU law in this respect. The same idea of introducing specifications for the resilience of traditional aircraft in relation to impact with small drones is proposed in the USA (Section 2212 of the draft FAA Extension Act of 2016 [68].)

4.3 Regulatory processes and enforcement

Mitigation Measure 3, addressing low (i.e. open category) or medium (i.e. specific category) risks to society, suggests limiting the declarations mentioned in Article 46.2 of the legislative proposal [27] to (some) standard scenarios and to organise registration and identification processes, involving law enforcement agencies.

To pursue this objective, the following questions need to be considered:

a) The possibility that an operator will fly its drone beyond the applicable limitations (open category) or beyond the terms of authorisation or declaration (specific category), and the related need for registration and identification;

b) The proportionate sanctions for illegal use, including in case of interference with emergency response;

c) Enforcement, including access to databases, guidance and training for law enforcement agencies;

d) Overflying urban or congested areas, or executing other specific operations which may lead to medium risks to society;

e) Structuring the implementing rules on regulatory processes.

The idea of simplifying the regulatory processes when the operations fall into a standard scenario defined or accepted by the authority is already embedded in the French rules on UAS [7].

4.3.1 Registration and identification

Traditionally, registration and marking of aircraft has been implemented by the States following international standards of Annex 7 [46] to the Chicago Convention. This process is cumbersome however, and possibly costly for operators of small drones, or even legally not possible in the absence of a certificate of airworthiness.

EU Legislator could hence observe that in some countries, e.g. in the USA [38], a simpler, quicker and cheaper registration process has been implemented for small drones. A similar process has been implemented in Europe, e.g. by the Italian authority in the regulation on RPAS [17] currently in their competence.

However, children have flown kites, balsa wood gliders or other very light model aircraft for centuries without any administrative burden, and there is no evidence that society requires a stricter regime for these toys. For this reason, e.g. in the mentioned FAA Part 48 [38], registration below a certain mass (i.e. 250 gr) is not required. The same concept (i.e. registration and identification of all drones, but only above 250 gr) is already contained in the EASA prototype rules (UAS.OPEN.50 in [14]).

At the other extreme, international civil aviation operations of large drones of the certified category will be possible on the global scale based on the Chicago Convention and its Annexes (amendments to specifically cover drones are currently planned to be effective between 2018 and 2020). However, in its concept of operations [48], ICAO states that the specific and open categories will be outside its scope, since they are not relevant on the intercontinental scale. But the ICAO Manual [47] on the subject clarifies that countries may agree mutually, through bilateral or multilateral agreements or arrangements, on the operation of specific drones categories (namely the specific category), to facilitate crossing the borders on a regional scale. The same objective, still according to the aforementioned ICAO Manual, may be reached through regulatory measures at regional levels. Hence, common rules on registration and identification could facilitate intra-EU operations in the specific category. Further considerations are presented in Annex III.

4.3.2 Proportionate sanctions

Article 26 of Regulation 216/2008 [32] proposes to grant the European Commission, under proposal by EASA, the power to establish fines or periodic penalty payments to holders of certificates issued by the Agency. These penalties do not have the nature of criminal law. In addition, EASA may limit, suspend or revoke the certificates it has issued. The same principles are contained in the legislative proposal [27], just adding organisations having filed a declaration to EASA.

Consequently, most administrative sanctions (e.g. fines) related to UAS and their use would be established by the Member States, since the involved person or organisation would not hold any certificate or approval issued by EASA. Furthermore, even criminal law and processes are the competence of the Member States. Some of them (Vademecum example in [50]) have already published compilations of possible infringements and sanctions, based on already promulgated rules, although such sanctions may not be necessarily proportionate and tailored to the case of UAS.

Furthermore, UAS may be used for the purpose of protecting the public safety and welfare, including firefighting, law enforcement, or emergency response, as pointed out in Section 2205(b) of the FAA extension act 2016 [68]. The possibility exists that, to provide images to the media or just for curiosity, drones not involved in the emergency response may attempt to fly in the same area, possibly obstructing said emergency response, or even causing collisions. Therefore, in Section 2205(a) of same act, the US Legislator proposed a fine to punish such cases. Member States should bear in mind this possible infringement.

4.3.3 Enforcement

The term "enforcement" is used several times in the legislative proposal [27], but always in relation to aviation administrative procedures or safety measures and never in relation to law enforcement agencies.

In particular, proposed Article 63 in Chapter IV therein provides a clear legal basis for the EASA to establish at EU level a repository of information, including on the issued certificates and received declarations. This provision definitely affects all UAS and related owners and operators in the open and specific categories, which is a pre-requisite for joint oversight.

However, according to Article 46(3) of the legislative proposal [27], UAS in the open category are exempted from the provisions of Chapter IV and hence, even if registered, they would not necessarily be included in the EU repository. Taking into account that, according to EASA, drones in such category can weight up to 25 kg (i.e. capable of fatally injuring a person as well as carrying a load of a few kilos), it could be desirable, to protect citizens even beyond safety, to also include in the common repository registered (e.g. above 250 gr) drones belonging to the open category.

Additional words could be inserted in Article 63 of the legislative proposal [27] to include in the common repository also UAS in the open category, if registered:

63(1)(n) other information that may be necessary for ensuring the effective cooperation referred to in the first subparagraph, **including on unmanned aircraft marked and identified according to Article 47(1)(e)**

The need to allow law enforcement agencies to swiftly access information repositories, and also to provide to such agencies sufficient guidance and training, is clearly spelled out in paragraph 2.3.6 and Proposal 5 in the already mentioned EASA Technical Opinion [12]. No further specific action is therefore recommended at legislative level.

4.3.4 Specific operations and standard scenarios

In some countries, as presented in Annex IV, a declaration is sufficient when there is intention to operate in an already defined standard scenario. Otherwise, an application followed by an operational authorisation is necessary. The same principle is being discussed by JARUS and proposed by EASA in the prototype rules [14].

It is hence recommended that, in the specific category, the Legislator encourages the EASA intention to link the declaration to a published standard scenario, which for instance is already the case in France [7].

4.3.5 Structuring implementing rules on regulatory processes

In manned civil aviation, first an aircraft needs to be registered. Second some certificates have to be obtained from the competent authority (e.g. certificate of airworthiness) and finally, when this is the case, a flight plan has to be filed with the Air Navigation Services and accepted by them. Normally these three processes are clearly split and for each, a formal procedure is promulgated. In France, for instance, there is a specific rule to allow drones to access airspace [42] - which in fact means splitting the basic assessment of the safety of possible operations from the actual permit to access airspace.

In the prototype rules [14] published by EASA, the objective of proportionate rules is achieved not only by introducing the three main categories (i.e. open, specific and certified), but also by introducing four subcategories in the open category: A0 (harmless), A1 (risk of minor injuries in case of crash over people), A2 (medium severity injuries) and A3 (even fatal injuries possible). Furthermore, in the specific category, still according to the current EASA proposals, an authorisation process would normally apply, but, in the simpler cases, a declaration would suffice. The basic aviation regulatory processes can hence be mapped against the categories and subcategories, regardless of the precise thresholds between them which will be defined at the level of implementing rules. Table 3 presents the intentions declared by EASA in mentioned prototype rules [14], deemed reasonable by the authors of this note:

Table 3: Drone categories and aviation regulatory processes

CATEGORY or subcategory	Registration / identification	Decla ration	Authori sation	Certification (traditional)	Air Navigation permit

A0	NO/NO	NO	NO	NO	NO
A1	YES/YES	NO	NO	NO	If required by MS
A2	YES/YES	NO	NO	NO	If required by MS
A3	YES/YES	NO	NO	NO	If required by MS
Specific (Simple standard scenario)	YES/YES	YES	NO	NO	If required by MS
Specific (non standard or non simple)	YES/YES	NO	YES	NO	If required by MS
Certified	YES (per ICAO Annex 7)	NO	NO	YES	If required by MS

It is recommended to support the EASA intention of clearly identifying in the future implementing rules, the various regulatory processes:

a) Marking (registration) and identification applicable to all UAS, except the ones considered harmless (A0);

b) Declaration or authorisation (only applicable to the specific category);

c) Certification (only applicable to the certified category); and

d) Air Navigation permit, applicable under conditions decided and promulgated by Member States.

4.4 Organisations

Mitigation Measure 4 suggests limiting the privilege to carry out the Specific Operations Risk Assessment, out of standard scenarios, to accredited organisations and to include in future the common rules obligations for the manufacturer and for the operator (for the latter Operations Manual, security of personnel and equipment and continuous airworthiness).

To pursue this objective, the following questions need to be considered:

a) The total system approach and organisations;

b) The privileges of organisations;

c) The obligations of manufacturers; and

d) The requirements for operator organisations.

4.4.1. Total system approach and organisations

In its more than 100 years of history, aviation has learned that to achieve and maintain high levels of safety, not only the technical equipment and the skill of the individual are paramount, but also the organisations. For instance, already in 2001 EUROCONTROL [23] suggested to include in the safety risk assessment not only the equipment (hardware, software) and the human, but also procedural elements and the environment of operations. In other words, to consider the "total aviation system", it is necessary to provide adequate confidence that a product, a service, a system, but also an organisation achieves acceptable safety. This principle has already been acknowledged by the EU Legislator in recital (1) of the regulation [36] extending EASA competencies to ATM and aerodromes. As a consequence, today almost all relevant organisations (e.g. design organisations, aerodrome operators, aircraft operators, ANS providers, etc.) are subject to common aviation rules to provide a high and uniform level of safety to EU citizens.

4.4.2. Privileges of organisations and resources in authorities

A logical consequence of putting organisations under safety oversight by aviation authorities is not only imposing upon them responsibilities but also granting "privileges", which typically includes implementing "minor" changes without approval from the authority.

s already mentioned, the number of drones and involved operators may be one or two orders of magnitude larger than corresponding numbers in traditional manned aviation. This may well put the resources available inside the authorities under strain. For example, the legislative proposal [27] envisages wider privileges for the design organisations in Article 11, as well as considering the fact that Qualified Entities may be granted the privilege to issue, revoke and suspend certificates on behalf of EASA or of a national competent authority in Article 58.

However in the case of UAS, in particular in the specific category, a safety assessment is required, at least to operate outside the simplest standard scenarios. JARUS is developing guidance for this assessment [53], but the reality is that most operators of drones are Small or Medium-sized Enterprises, not necessarily suited to carry out risk assessment. Proposed Article 47(1)(d) already provides a legal basis to define responsibilities and privileges of operators, which means that not all of them may be eligible to conduct safety assessments. Even in the prototype rules [14], EASA does not propose to grant holders of the Light UA Operator Certificate (LUC) the privilege of assessing new types of operations.

For those not enjoying such a privilege, Qualified Entities (QEs) may help, as it is already the case in some Member States (e.g. Article 11.12 in the Italian rules [17]). But unfortunately, Article 58 of the legislative proposal [27] neither clarifies that QEs may be contracted by the applicant (which is already the case in Italy, UK and other Member States), nor delegates to the Commission the task to promulgate common rules including privileges and responsibilities of the QEs, which would open the internal market for them.

Additional words could be inserted in Article 58 (Qualified Entities) of the legislative proposal [27] to:

- Clarify that Qualfied Entities can be contracted by applicants, as it is already the case in some Member States;
- Create the legal basis for implementing rules including, inter alia, responsibilities and privileges for such Qualified Entities, like for any other aviation organisation in the internal market.

4.4.3 Obligations of manufacturer

Safety of traditional aviation is not only based on sound design and production followed by proper maintenance and safe operations, but also on information provided by the manufacturer to the operator (e.g. Flight or User Manuals, Instructions for Continuous

Airworthiness, Master Minimum Equipment List). No doubt that this tradition will be continued in the certified category. Conversely, industry standards may suffice in the open category, complemented by information to the consumer, which has been discussed already in 4.1.3.

The issue remains for the specific category, which presupposes that the operator will submit some documentation to the aviation authority. Some information (e.g. temperature range; maximum speed; maximum wind speed; etc.) would be extremely difficult to derive by the operator in the absence of information from the manufacturer, in some cases requiring extensive calculations or even laboratory or flight testing. It would hence be extremely desirable to mandate manufacturers to provide the minimum necessary information.

In the already mentioned FAA Extension Act 2016 [68], the US Legislator has in fact included the obligation for a manufacturer to provide to the buyer a "safety statement" (section 2203 reproduced in Annex V). This safety statement should include information on the applicable regulations (already covered in this note in 4.1.3) but also "recommendations for using" the small UAS, which can be interpreted as the equivalent of a Flight (or User as in the prototype rules [14]) Manual and which of course can only be compiled after an assessment of airworthiness aspects by the manufacturer.

Industry standards do already exist to compile such a Flight Manual in a way proportionate to small drones (e.g. published by an American standard making body [2]). Non-EU manufacturers may not be subject to EU common rules, but imposing on the operator in the specific category the obligation to attach a Flight Manual (or equivalent) to the declaration or application for authorisation will trigger market mechanisms, forcing the manufacturers to align, also because similar information would be required in the USA.

The EASA intention (UAS.SPEC.30 in the prototype rules [14]) to include in the implementing rules for the specific category a User Manual (or equivalent document which could be a Flight Manual) provided by the manufacturer, is hence supported. In practice, EU operators will request such a Manual from vendors and therefore market forces will also make this requirement applicable to non-EU manufacturers.

4.4.4 Requirements for operator organisation

Typical responsibilities of an aircraft operator, even in the specific category, include:

a) Maintaining the drone in conditions for safe flight (i.e. continuous airworthiness, one element of which is maintenance);
b) Conduct operations in safety, according to an Operations Manual, whose procedures encompass mitigations based on the safety assessment (or standard scenario); and
c) Ensure sufficient security of the personnel and physical security of the equipment.

Having read the Technical Opinion [12], one may conclude that EASA is fully aware of point a) above. However, the EASA intention to eliminate the requirement for an Operations Manual, in some cases in the specific category (i.e. UAS.SPEC.70 in the prototype rules [14]) should not be supported, since such a Manual contains fundamental information on the legal identity and commitment of the operator. In its absence, the operations could remain restricted into the open category, with subsequent severe limitations.

Furthermore, there are also security aspects linked to personnel (e.g. giving them a badge after proper checks) and to physical protection of equipment (e.g. storing the small UAS when not in use and controlling access to the station on the ground). These aspects should translate into obligations for the operator in the specific and certified categories. This topic was clearly identified in the draft JARUS-ORG (on Organisations) published for external consultation in 2014 [52], but it seems neither explicitly addressed in the legislative proposal [27] nor in the EASA Technical Opinion [12] nor in the prototype rules [14]. The latter, in fact, mention security several times but differing from the JARUS-ORG [52] does not contain any clear provision for the obligations of the operator in respect of security. More emphasis on security could be appropriate also at the level of the legislative proposal [27].

Additional words could be inserted in Article 47(1)(f) of the legislative proposal [27] to emphasise security:

47(1)(f) the conditions under which operations of unmanned aircraft shall be prohibited, limited or subject to certain conditions in the interest of safety **or security.**

4.5 Personnel competence and industry standards

Mitigation Measure 5 suggests promoting the use of industry standards for the Flight Manual (or equivalent, already covered in 4.4.3) and for crew competence, delegating training responsibility to operators and assessment to Qualified Entities.

To pursue this objective the following questions need to be considered:

a) Responsibilities of operators for personnel competence;

b) Industry standards for pilot competence;

c) Assessment of pilot competence.

4.5.1 Personnel competence

Proposal 19 in EASA Opinion [12] clearly highlights the responsibility of operators, in the specific category, for training and qualification of personnel (not only remote pilots), which requires for instance observers and crew resource management to work in team.

The legislative proposal [27] provides a legal basis for detailed common rules on these aspects, for which there is hence no gap at legislative level.

4.5.2 Industry standards for pilot competence

In 4.4.3, reference is already made to industry standards for the Flight Manual. More generally, following the principle of performance-based regulation, the Riga Declaration [60] clearly distinguishes between "rules" (in the EU case to be promulgated by the Commission or EASA) and industry standards.

The principle is already contained in Article 18(3)(f) of the legislative proposal [27] which mentions the development, with the involvement of standardisation and other industry bodies, of detailed technical standards to be used as a means of compliance. This would, in practice, save scarce resources available in EASA and other authorities, relying on industry to develop and publish voluntary standards having the status of Acceptable Means of Compliance with the rules, in particular in the open and specific categories.

In this respect, one could note that industry has already made available standards for the competence of remote pilots of small UAS (see for instance [37]).

It is hence recommended that EASA and other authorities rely as much as possible on industry standards, not only for technology but also for flight standards, refraining from directly drafting Acceptable Means of Compliance.

4.5.3 Assessment of pilot competence

In the open and specific categories, according to the EASA prototype rules [14], there is no formal pilot licence. However, this does not exclude assessment of the competence of the remote pilot (only for potentially lethal drones in the open category, and always in the specific category). Some authorities (UK guidance example in [66]) stress the need for the candidate pilot to be objectively assessed by a third party. In the EU, Qualified Entities are subject to the requirement of "independence" from operators and flight schools (Annex V in Regulation 216/2008 [33] to be replaced by Annex VI according to the legislative proposal [27]). In other words, they will ensure the maximum objectivity in pilot assessment.

It is hence recommended that the implementing rules following Article 58 of the legislative proposal include also the possible privilege for Qualified Entities to assess competence of remote pilots.

4.6 Certification basis for UAS

Mitigation Measure 6 suggests providing guidance to designers, to facilitate development of the certification basis for UAS in the certified category (type certification is only applicable to this category).

Today, no specific airworthiness code for any class of UAS is published by EASA. However, in 2009, the Agency published a "policy" [9] allowing the building of a certification basis for most UAS, starting from codes applicable to manned aviation.

Of course specifications written for manned aircraft do not cover peculiarities (e.g. the Remote Pilot Station) of UAS, but Certification Specifications are emerging from JARUS, and EASA is publishing several "special conditions" [13] which guide applicants for type certification well before dedicated Certification Specifications for drones could possibly be published by Agency. No gap requiring immediate attention by EU Legislator is hence present in this area, since several EASA Certification Specifications[10] are useful as a starting point and are already available. These specifications are already complemented by a number of the abovementioned special conditions covering some peculiarities of drones. Furthermore, JARUS has already published Certification Specifications for UAS which could be taken into account by EASA in the future, on the basis of the legislative proposal under discussion [27].

4.7 Spectrum and cyber-security

Mitigation Measure 7 suggests promoting studies in ICAO, International Telecommunication Union, EASA and others for the use of spectrum for Command and Control data link and cyber-security. To pursue this objective the following questions need to be considered:

a) Data link implemented in improper electromagnetic spectrum; and
b) Insufficient data link security.

4.7.1 Spectrum for Command and Control data link

At global level, the electromagnetic spectrum is not governed by ICAO but by the International Telecommunications Union through its Radio Regulations. Historically, communications possibly impacting safety of human life in civil aviation enjoyed a "special protection" in respect of other communications in adjacent frequency bands. This has led to mainly concentrating Aeronautical Radio Navigation and Aeronautical Mobile Service in dedicated and protected frequency bands.

These bands are today congested, with the exception of the C band around 5000 MHz. So it appears very difficult to accommodate additional spectrum for "Command and Control" data link for UAS. Therefore the Telecommunication Union Resolution 155, developed and agreed at the 2015 World Radiocommunication Conference, provides a carefully crafted

[10] https://www.easa.europa.eu/document-library/certification-specifications

comprehensive set of resolutions, invitations and instructions that will enable the use of the fixed-satellite service frequency bands by UAS, once work by ICAO and various Working Parties has been completed. Such new frequency bands do not enjoy the "special protection" granted to the traditional aviation bands.

In other words aviation is facing a dilemma: either risk not having enough spectrum for UAS data link, since its bands are already congested; or accept that an aviation service is provided in a non-protected band, which could entail security/safety risks and which might create a precedent in the history of the Radio Regulations. So far, experts in the EU have not yet reached a consensus on the matter.

However, several EU experts are contributing through ICAO bodies (e.g. working paper [57]) to further study the matter in preparation for the next World Radio Conference in 2019. The Commission should promote a common EU position not only in ICAO forums, but also through the European Conference of Postal and Telecommunications Administrations, in preparation of such Radio Conference.

4.7.2 Data link security

Industry has already developed standards for security of avionics (e.g. EUROCAE 202A [20]) to handle the threat of intentional unauthorised electronic interaction with aircraft, whether manned or unmanned.

However, UAS are more vulnerable since governing their flight is implemented through electromagnetic waves. ICAO is fully aware of this issue [58] and ICAO standards specifically covering the security of the data link are expected in 2020. EASA and EUROCONTROL are involved in this work in a prominent position.

Furthermore, security is mentioned in Article 4 (Principles) of the legislative proposal [27] and a specific Article 76 is dedicated to the subject. In conclusion, although the issue is extremely important and sensitive, work is underway and no gaps seem to exist at legislative level.

4.8 New service providers

Mitigation Measure 8 suggests establishing provisions for oversight of data link and information service provision. For the reasons detailed in Annex VI, it is recommended to amend Article 3(16) of the legislative proposal [27] to better include providers of data link and of information relevant for the safety of UAS traffic in the scope of the new legislative regulation:

Proposal for amendment of Article 3(16) of legislative proposal [27] to include new service providers:

3(16) "ATM/ANS" means the air traffic management functions and services as defined in Article 2(10) of Regulation (EU) No XXX/XXXX, the air navigation services defined in Article 2(4) of that Regulation, including the network management functions and services referred to in Article 17 of that Regulation, and services consisting in the origination and processing of data and the formatting and delivering of data to general air traffic for the purpose of safety-critical air navigation, **as well as Command and Control data link and provision of information for operation of unmanned aircrat**;

Finally, one may note that UAS navigation is heavily dependent on satellite navigation, but the most important system in that domain (i.e. the American GPS) is not under oversight by any civil aviation authority. EU Institutions should hence promote the exploitation of EGNOS (already certified by EASA, while its use for drones is being supported by the GNSS Supervisory Authority, e.g. through the REAL project [43]) and the certification of Galileo by EASA; the latter already possible under current legislation.

4.9 Liability and insurance

Mitigation Measure 9 suggests promoting safety analysis by authorities while clearly defining model aircraft and considering the creation of a compensation fund. To pursue this objective the following questions need to be considered:

a) Safety analysis;

b) Insurance of model aircraft; and

c) Compensation fund.

4.9.1 Safety analysis for UAS

Obviously the cost of insurance depends on the financial risk which is diverted from the operator to the insurer. This risk is in turn dependent on the probability that accidents or damages would occur, but also on the relevance of such damages. In other words, insurers need access to statistics based on safety analysis to possibly reduce the cost of respective coverage, which otherwise would be higher to acount for uncertainties.

Article 125 of the legislative proposal [27] states that the new regulation shall not apply to occurrences and other safety-related information involving drones for which a certificate or declaration is not required (i.e. open category), unless the occurrence or other safety-related information involving such UAS resulted in a fatal or serious injury to a person or it involved aircraft other than unmanned aircraft.

In other words, safety analysis to be organised by EASA would cover all UAS in the specific and certified categories (medium and high safety risk) and, in addition, some cases of occurrences related to drones in the open category.

For the time being, this is considered to be a reasonable compromise, not to unduly overload the safety analysis function.

4.9.2 Insurance of model aircraft

Regulation 785/2004 on insurance for air carriers and aircraft operators [36] includes the obligation for insurance coverage by operators of drones. However, Article 2(2)(b) therein excludes model aircraft with a mass of less than 20 kg. The issue is that the regulation does not define “model aircraft” - which cannot be characterised by the design of the drone but only by its use.

To limit the possibility that UAS operators in the open and specific categories escape the insurance obligation, pretending that their drone is a model aircraft, it is recommended to include in Regulation 785/2004 a definition of model aircraft, similar to that contained in Part C of the European rules of the air [28] but taking into account the prototype rules [14], where in fact categories are established at EU level and not left to Member States:

Proposal for definition of model aircraft to be included in Regulation 785/2004 and in the legislative proposal [27]:

Definition in European Rules of the Air:

"model aircraft" means an unmanned aircraft, other than toy aircraft, having an operating mass not exceeding limits prescribed by the competent aviation authority, that is capable of sustained flight in the atmosphere and that is used exclusively for display or recreational activities;

Proposed Definition:

"model aircraft" means an unmanned aircraft that is capable of sustained flight in the atmosphere and that is used exclusively for leisure flights, air displays, sport or competition activities.

4.9.3 Compensation fund

In 2014, the European Commission undertaken a study [63] on insurance and liability. One of the major findings in the study was that, even with improved enforcement, the low barriers to entry in the UAS sector mean that there is a risk that a proportion of operators may be uninsured, and therefore if the sector expands as expected, it is necessary to consider how to guarantee adequate compensation for any victims of damage. This could be achieved through a compensation fund, as used in the motor insurance sector, where insurance is also compulsory. The study hence recommended that the issue of whether a compensation fund is necessary and how it could work should be reviewed by the European Commission.

This note considers this recommendation reasonable.

5. MITIGATING THE RISKS THROUGH TECHNICAL MEASURES

KEY FINDINGS

- ***Finding 1:*** The development of technical solutions for the identification of drones, geo-fencing and emergency recovery is well advanced and progressing, even in the absence of significant public investment;
- ***Finding 2:*** Significant effort is still necessary in the domain of Command and Control data link and Detect and Avoid, where public investment may accelerate development or at least make the schedules more credible;
- ***Finding 3:*** SESAR JU should be encouraged to continue its effort in developing technologies and infrastructures to support UAS flight, even at very low level in the context of UAS Traffic Management and taking into account aspects linked to potential service providers;
- ***Finding 4:*** Further research efforts may be dedicated to automatic take-off and landing, automatic taxiing and in general to more advanced automation;
- ***Finding 5:*** It is recommended that public support continue for UAS related long-term scientific research.

It is obvious that the regulatory framework envisaged in Chapter 4 needs to be supported by mature technical solutions, which could address the safety risks associated with the use of drones in airspace. These possible technical solutions are highlighted in this Chapter 5.

5.1 Identification of drones (I-Drone)

One of the most important devices to be fitted on a registered drone is some form of electronic identification (alias I-Drone). The principle is already contained in Annex IX to the legislative proposal [27]. The same principle is being introduced in the USA, through Section 2202 of the FAA Extension Act of 2016 [68] (see box 2 below) and envisaged in EASA prototype rules [14]:

Box 2: Extract from USA Section 2202

IDENTIFICATION STANDARDS. (a) IN GENERAL.—

The Administrator of the Federal Aviation Administration, in consultation with the Secretary of Transportation, the President of RTCA, Inc., and the Director of the National Institute of Standards and Technology, shall convene industry stakeholders to facilitate the development of consensus standards for remotely identifying operators and owners of unmanned aircraft systems and associated unmanned aircraft.

Source: Draft FAA Extension Act 2016 [68].

One could note that in the US text, emphasis is put on the role of industry standard making bodies to develop technologies, which is perfectly in line with the performance-based regulation principle[11].

[11] Performance-based regulation means that the authority would insert in legally binding rules and in high level technical specifications, only the safety and performance objectives to be achieved (e.g. a certain level of safety or a certain accuracy of navigation) leaving to industry the publication of non-legally binding consensus-based standards, able to achieve the stated objectives. It is already applied e.g. for the Performance Based Navigation, for the safety assessment of complex systems and for the reform of the airworthiness code (FAR/CS-23) for general aviation aeroplanes undertaken jointly by EASA and FAA. It is also pursued by JARUS for Command and Control data link and for Detect and Avoid.

In general, there are three basic Radio Frequency Identification Device (RFID) technologies:

a) Passive RFID which has no on-chip power source. This RFID provides information purely by the backscatter or inductive coupling of radiation transmitted by an interrogator or reader. Some of the radio frequency energy transmitted to the tag is absorbed to power the RFID chip and the chip then returns a coded signal back to the interrogator/reader. Even simpler devices are bar codes or QR codes, which can be read by a scanner;

b) Battery-Assisted Passive RFID (BAP RFID) (sometimes known as a semi-passive RFID) which contains a small battery on the tag. None of the energy transmitted to the tag has to be absorbed to make the device work. Hence, a BAP RFID is capable of providing greater read range than the passive tag.

c) Active RFID which employs an integrated power supply or is connected to an external power supply to drive the device. It can then actively transmit its stored information rather than relying on the backscatter energy of the interrogator. Active RFIDs can transmit at a predetermined periodic polling rate or when activated by an interrogator device. Active RFID work at long range, mainly depending on the power. In the end, they are very similar to Automatic Dependent Surveillance[12].

Standardisation of an identification system for drones in Europe is in the scope of EUROCAE WG-RPAS [21] whose deliverable on the subject is expected in 2017. Meanwhile in some Member States (Italian example in [18]) a simple QR code is delivered to the applicant after registration. The QR code can be printed on a label and affixed on the drone.

The QR Code is however only a limited solution, since the label may not be affixed, may be easily damaged (unless technical specifications are fixed) and because it cannot be interrogated when the drone is in flight. Any device potentially interrogated when the drone is in flight, of course requires that the on-board device and the interrogator on the ground are designed according to the same technical standard. So one could recommend not to promote the permanent use of the mentioned Italian solution, but wait for further deliverables from EUROCAE.

The wide-spread use and maturity of these technologies and the relatively low estimated cost are in any case promising for their rapid standardisation and use in the context of drones.

5.2 Geo-fencing

"Geo-fencing" is a generic term indicating the capability of automatically maintaining the drone in a position compliant with some geometric or geographical limitations.

In the simpler case, one might call it "geo-caging", being the device able to limit the height of the drone and its distance from the take-off point. There are already several drones on the market providing such functionality.

Equally available on the market are more sophisticated systems (example from one manufacturer in [8]) based on geographical information and even on temporary restrictions (e.g. areas under fire), with the possibility for the pilot to lift some restrictions (e.g. if the drone is part of the emergency response).

Even in this case therefore, the industry is already offering this functionality, available on the market at reasonable cost. The issues are more linked to the concept of use (e.g. should the

[12] Between 1960 and 2000 the most spread equipment to track the position of aircraft in flight has been some form of ground based radar, which can measure distance and direction from the station. This form of surveillance was defined "independent" in the late '80s, since the geographical position of the aircraft is calculated on the ground. With the advent of satellite navigation, it became possible to calculate latitude and longitude on board. Using some form of data link, this position can be transmitted by the aircraft to the ground. Since the ATC on the ground would depend on the position calculated on board, this new form of traffic surveillance, which is spreading nowadays, is named "Automatic Dependent Surveillance".

remote pilot have authority to override geofencing, if necessary to avoid worst consequences?), to standardisation and to oversight of providers feeding the information. Oversight of providers of information has already been discussed in 4.8.

Standardisation of technologies for Europe is in the scope of the already mentioned EUROCAE WG-RPAS [21] whose deliverable is expected in 2017.

5.3 Secure Command and Control

More complex are the issues related to Command and Control data link which may also support communications with Air Traffic Services (ATS). These issues include security of the link and spectrum access, management and use, including in the 5030 – 5091 MHz frequency band, which is a protected aeronautical band.

Several deliverables are planned by mentioned EUROCAE WG-RPAS [21] in this segment, to be possibly completed in 2018, while work is underway also in the USA through RTCA. Public investment, if not accelerating the progress in this area, may at least reduce the risk of delays in the schedule.

5.4 Detect & Avoid

Detect and Avoid (DAA) is defined by ICAO in Annex 2 [45] to the Chicago Convention, as "the capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action". According to the ICAO RPAS Manual [47], DAA capabilities should be required to limit the risk from conflicting traffic, terrain and obstacles, hazardous meteorological conditions (i.e. thunderstorms, icing, turbulence), ground operations (aircraft, vehicles, structures or people on the ground) and other airborne hazards, including wake turbulence, wind shear, birds or volcanic ash.

Mature solutions to Detect and Avoid all the hazards listed above are not available on the market and it is doubtful if they ever will be. However, ICAO recognises that other mitigations (e.g. operational procedures) may be used to limit the risks.

Currently the industry is looking mainly at three different solutions for DAA:

a) Functionality sufficient for IFR (Instrument Flight Rules) operations (i.e. no need to actually see the other aircraft through television or similar devices and no need to maintain a minimum distance from clouds, which would be difficult for DAA) in controlled airspace Classes A, B and C, in which there is a very small proportion of manned VFR (Visual Flight Rules) traffic and where the majority of aircraft are equipped with a transponder which can reply to interrogations. Minimum Operational Performance Specifications for this solution are planned by RTCA in 2017 and by EUROCAE one year later; this solution is also being addressed by the European Defence Agency, since military services need this "dual use" technology when flying under General Air Traffic rules in the Single European Sky airspace;

b) However, nothing prevents a UAS flying in uncontrolled airspace (Class G) under instrument rules and lower than 150 metres above ground. In this case, the DAA shall be able to cope also with non-cooperative small general aviation manned aircraft. The issues here are linked to weight, volume and required power of the equipment on the drone, and possibly with the assessment of the need to impose at least some manned aircraft (e.g. helicopters in emergency services) to be equipped to become cooperative. The industry has already marketed solutions which seem economically acceptable even for small aircraft (e.g. FLARM [41]), but standardisation, certification and safety issues are still under consideration, including by EUROCAE;

c) In both cases a) and b), the main concern is represented by the possibility of mid-air collision. On the contrary for drone operations at very low level, below 150 metres (or even below only 70 or 30m) the main risk could be the collision with obstacles (e.g. buildings, cranes, masts, bridges and so on), which of course are unlikely to be equipped with any sort of device or transponder. These operations are often carried out with small UAS and implementing on them a radar of sufficient range may prove difficult to achieve. In this moment, the industry seems oriented toward solutions based on cameras and stereovision, possibly complemented by laser technologies.

For b) and c) EUROCAE plans to deliver separate specifications by 2019. However, since no solution for DAA is yet mature enough for certification and marketing, public investment would be very useful, if not to accelerate the schedule, at least to stick to it.

5.5 Communications, Navigation and Surveillance Infrastructure

As explained in Annex VII, UAS flying above 150m above ground level are expected to be equipped like manned aircraft for Communications, Navigation and Surveillance. Ground and space segments for these technologies are already available and evolve (e.g. mobile data link with manned aircraft), while their coverage in Europe is already sufficient today. No major issues hence exist in this respect, which is not considered specific for the drones, but applicable to the entire aviation domain.

Of course from the point of view of UAS industry, not all the drones will be large enough, and with enough power on board, to host all the required technologies. But for the moment the industry seems to demand more operations at very low level, including beyond visual line-of-sight (BVLOS) than civil long range operations by small UAS above 150m.

Below 150m and away from aerodromes, traditional aviation ground infrastructures (e.g. radars and radios) do not today provide sufficient coverage. It is unlikely that they ever will (except maybe ADS-Broadcast, which only requires omni-directional receivers), because the required number of stations will be huge and because user charges levied by major service providers are usually a function of the square root of the aircraft mass, being the latter negligible for small UAS (which means no economic incentive for the ATS providers to invest).

However, large areas of Europe are already covered by commercial technologies (e.g. WiFi and mobile telephone) which could support communications with ATS (not necessarily Command and Control data link) and surveillance (ADS, FLARM or other technologies based on the same principle that the UAS will transmit to the ground its identity and position).

Availability of technologies does not hence seem to be an insurmountable problem. In any case, SESAR JU has already launched a call for tender [62] to investigate also in the area of ground infrastructures suitable to support UAS. In the end, a risk assessment will be needed, to confirm that the performances offered by the proposed infrastructure, which may have been designed for commercial (not aviation) use, are acceptable[13].

The issue of the service providers able to feed information or signals remains, as discussed in 4.8. It is hence recommended that the SESAR JU effort continue, possibly also for deployment, taking into account not only the suitability of the technology, but also of the service provider(s).

5.6 UAS Traffic Management

Mitigation Measure 10 suggests promoting the development of a traffic management concept specific for UAS, consequential amendments to rules of the air and the development of industry standards for related technologies and operational procedures. It must be stressed

[13] For instance, EASA AMC 20-25 already allows the use of commercial non-certified portable electronic devices (e.g. "tablets") as Electronic Flight Bags, even in the cockpit of large aeroplanes used for commercial air transport, putting some limits on the hosted applications. (An Electronic Flight Bag is a portable electronic device (similar to a tablet, small portable personal computer or smart phone) storing information (e.g. charts and manuals) necessary for the pilot in flight in a much smaller volume than traditional paper documents).

that traffic "management" is a concept much wider that Air Traffic Control (ATC), the latter not necessarily being required below 150m and away from aerodromes.

This new concept is already covered by the mentioned SESAR JU call [62], paralleled by Sections 2208, 2209 and 2210 in the FAA Extension Act 2016 [68].

Work has hence been initiated in this area, but with the knowledge available today, much effort will be required in the years to come, to develop concepts and technologies able to safely accommodate not only drones at very low level, but also other civil traffic below 150m (e.g. search and rescue, firefighting, very light sport aircraft, emergency helicopters, etc.).

5.7 Automatic take-off and landing

Various technologies can be used for automatic take-off and landing of UAS. First, however, one has to note that for a relatively small drone, differently from a large manned aeroplane, landing may not be the most risky phase of flight. In fact, a significant proportion of fatal accidents to traditional aviation aircraft indeed occurred during the approach and landing phase, killing several passengers on-board. But, in the case of drones, there is no person on-board and, except in case of runway incursions, there is equally no person on the runway. Crashing the drone on landing may hence have operational and financial consequences, but most probably less severe consequences than a drone losing control in flight over a populated area.

Projects are already underway, e.g. to apply EGNOS to the landing of drones (for instance REAL [43]), while EUROCAE, building upon initiatives by the European Defence Agency, is expected to deliver specifications for automatic take-off and landing in the certified category by 2020. The absence of such functionality would not however prevent the initial development of the UAS industry; so it could not be considered a priority.

5.8 Automatic taxiing

Equally, automatic taxiing does not represent an immediate priority, while EUROCAE specifications for it are still planned by 2020.

5.9 Emergency Recovery Capabilities

As stated already in this paper, the crash of a drone in itself does not represent a danger for society, unless the drone hits persons on the surface with a kinetic energy[14] likely to cause serious injuries. Therefore JARUS, already in 2013, published a certification specification [51] which requires an Emergency Recovery Capability, to be obtained either:

a) Through a sequence of automated actions (e.g. in case of lost link) which may guide the drone to land, or even crash, at a predetermined site (e.g. at sea), where the risk of hitting a person is negligible;

b) A flight termination system, which may be based on cutting the power to the engines, possibly complemented by additional devices to reduce kinetic energy (e.g. a parachute); or

c) A combination of the two.

Solutions are already available on the market, so this area may not be a priority for public funding.

[14] Kinetic energy is only one of several factors (e.g. high speed rotating parts; hit district of the human body; angle of impact; shock absorbing structures; etc.) to be considered to determine the likelihood of serious injuries. However, several studies converge on the fact that a kinetic energy of less than 40 Joules is extremely unlikely to cause serious injuries.

5.10 Higher levels of automation

The range of possibilities which UAS may offer in the future, is extremely wide (e.g. one pilot governing swarms of drones; autonomous transport of small parcels along predefined routes; large aeroplane with one pilot on board and one on the ground; Detect and Avoid based on artificial intelligence; etc.). SESAR JU has included this topic in its already mentioned call [62]. Of course, public support should continue to be granted to long-term scientific research.

6. CONCLUSIONS AND RECOMMENDATIONS

Drones crashing on the ground and hitting a person with possible serious consequences as well as mid-air collisions and drones overflying critical, crowded or politically sensitive places are the main safety issues. However, privacy, liability and security should be considered as well. All these issues should be mainly considered with respect to the operations of drones in the "open" and "specific" categories as defined by EASA. **Within these categories, drones should in fact not be subject to current aviation regulations for manned aircraft but should be regulated through appropriate market surveillance mechanisms and specific declaration/authorisation procedures.**

The proposal that is currently undergoing the legislative process [2015/0277(COD)] addresses most of the main safety issues. However, as highlighted in this paper, **some improvements could be proposed to better mitigate the identified safety risks**. In particular, the establishment of market surveillance mechanisms, covering drones used for commercial, non-commercial and recreational operations (Article 46(3) of the legislative proposal [27]) and the inclusion of the obligation for vendors and importers to provide information to consumers (Paragraph 1 of Annex IX to the legislative proposal [27]) are already present and being progressed by EASA through the prototype rules [14]. There could however still be the opportunity to clarify and improve the text of the legislative proposal with the following suggestions:

a) An additional definition for "manned aircraft" to clearly distinguish them from drones (the way optionally piloted aircraft are classified is otherwise unclear);

b) An extended definition in Article 3(16) to encompass new providers responsible for the provision of services to drones such as Command and Control Link or Traffic Management;

c) An emphasis on security in Article 47, e.g. aspects linked to personnel (e.g. giving them a badge after proper checks) and to physical protection of equipment (e.g. storing the small UAS when not in use and controlling access to the station on the ground);

d) A clarification of the role and privileges of Qualified Entities in Article 58, including for the assessment of competence of the remote pilots;

e) An obligation that even UAS in the open category, when marked and registered, are recorded in the repository established by Article 63. In fact, drones in this category can weight up to 25 kg (i.e. capable of fatally injuring a person, as well as to carry a load of few kilos) and it would be desirable, to protect citizens even beyond safety, to include them in the common repository.

In addition, it is also suggested to include a definition of "model aircraft" both in the legislative proposal [27] and in Regulation 785/2004 in order to clearly define what is excluded from the obligation to hold insurance. Finally, a new recital in [27] should clarify that flights carried out by EU Agencies are subject to civil rules, since they are not under responsibility of a Member State.

As described in this note, several provisions that will ensure the safety of drones operations will come from the implementing rules developed by EASA. It is therefore suggested to consult as much as is needful the Agency during the legislative process, in order to develop a homogenous, consistent and complete set of rules.

Regarding the development of technical enablers, Members of the European Parliament should be aware of the current status of technology development and efforts by industry and possibly **consider Command and Control data link, UAS Traffic Management and Detect and Avoid as priorities for public investment.**

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ANNEX I SUMMARY OF PROBLEMS ASSOCIATED WITH THE USE OF DRONES INTO AIRSPACE AND THEIR CAUSES

PROBLEM	ROOT CAUSES
Injury to people on the ground	Insufficient assessment of initial airworthiness (medium and high risk categories) Insufficient safety of industrial products (low risk category) Insufficient information from manufacturer (e.g. Flight Manual) Insufficient continuous airworthiness Insufficient Operations Manual Insufficient specific operations risk assessment (SORA) Flying beyond limits of authorisation or declaration Overflying urban or congested areas Insufficient quantity of resources in aviation authority Unclear taxonomy (e.g. model aircraft, toys, recreational, etc.) Unclear operational limitations Insufficient standards for crew competence Insufficient assessment of pilot competence
Mid-air collision	Resilience of manned aircraft to collision with a small drone Inadequate rules of the air for Visual Line-of-Sight (VLOS) and Extended-VLOS operations at Very Low Level (VLL) Insufficient observer competence Insufficient Crew Resource Management (CRM) in Extended-VLOS Inadequate "Detect and Avoid" (DAA) for en-route operations Inadequate DAA for Very Low Level (VLL) Below Visual Line-of-Sight (BVLOS) operations Command and Control (C2) data link implemented in improper electromagnetic spectrum C2 link service provision under insufficient safety oversight High drone traffic density at VLL Lack of proper technologies, regulatory framework and procedures to manage UAS and manned traffic at VLL (sometimes called UAS Traffic Management = UTM) Lack of proper Air Traffic Management (ATM) procedures to accommodate very special drone operations at VLL Mixed manned/unmanned traffic along ATS routes or in Terminal Areas (TMA) or Control Zones (CTR) Mixed manned/unmanned traffic at aerodromes Insufficient procedures to manage Very High Level traffic (above FL 600) Interference with emergency response
Critical infrastructure or places	Lack of airworthiness codes Lack of standard scenarios to facilitate risk assessment Undefined privileges for organisations eligible to conduct safety assessments Lack of standards for Geofencing (or Geocaging)[15] Insufficient provision of communication service to drone operators Insufficient organisation of providers of information for management of VLL traffic

[15] Geofencing refers to the automatic function to maintain a UAS outside a defined area or volume. Geocaging refers to the functionality to maintain it inside a defined area (in the simplest case height and distance from the take off point).

PROBLEM	ROOT CAUSES
Security	Insufficient C2 link security Insufficient personnel security Insufficient physical security of drone or station
Damage compensation	Lack of compensation fund Lack of safety analysis Lack of evidence of risk mitigation available to insurers Insufficient information by manufacturer Insufficient minimum insurance coverage Possibility of escaping insurance obligation for small model aircraft
Enforcement	Undefined or disproportionate sanctions for illegal use Lack of registration Lack of identification Lack of access by law enforcement agencies to aviation databases Lack of guidance for law enforcement agencies Lack of training for law enforcement agencies

ANNEX II TERMINOLOGY

Annex 2 [45] to the Chicago Convention defines Remotely Piloted Aircraft Systems (RPAS) as a system comprising the remotely piloted aircraft (RPA), its associated remote pilot station(s) (RPS), the required Command and Control (C2) link and any other components as specified in the type design. The term Unmanned Aerial Vehicle (UAV) is considered obsolete by ICAO in the RPAS Manual [47].

In fact, in 2007 the second informal ICAO meeting (Palm Coast, Florida, 11 and 12 January 2007) on the subject[16] suggested that from that point onwards, the subject should be referred to as UAS, in line with RTCA [61] and EUROCAE [22] agreements, to clearly indicate that such systems are "aircraft", hence subject to aviation rules, and not "vehicles" to which aviation rules may not apply.

The term UAS is not standardised by ICAO, although it is explained in a Circular [44] as being an aircraft (UA) which is intended to be operated with no pilot on board. The same Circular explains that an "Autonomous aircraft" is an unmanned aircraft that does not allow intervention in the management of the flight by the remote pilot (RP). In other words, the term UAS includes both RPAS (already widespread on the market today) and autonomous UAS which may emerge in the future. In the legislative proposal under discussion [27], the European Commission proposes[17] to define the term UAS as any aircraft operated or designed to be operated without a pilot on board. This is consistent with the ICAO approach and open to future evolution. It is recommended to follow this approach and use the term UAS (not only RPAS) in the legislative proposal [27].

Conversely, some military services (e.g. NATO [1]) still use the term UAV to indicate just the aircraft without the associated ground control station. But, in line with ICAO and European Commission, the use of the term UAV should not be encouraged since it may introduce ambiguity due to the fact that a "vehicle" may be interpreted as not subject to aviation rules.

There is nothing wrong is using the term "drone" when referring to UAS or RPAS and addressing the grand public or the media, where in fact such a word is widely used.

However, the mentioned legislative proposal [27] does not define "manned aircraft" which may also lead to confusion. In fact this term is neither defined in any common aviation rule, nor any EASA document, although the term is used by that Agency in a certification specification for balloons [10]:

> "*CS 31TGB.1: These Certification Specifications (CSs) are applicable to non-free flying* ***manned tethered gas balloons*** *that operate up to a maximum altitude of 500 m above the surface, and that derive their lift from non-flammable gas being lighter than air."*

In this specififc case the interpretation is that "manned" means that the remote pilot could be on the ground or on-board, while the passengers are always on board; but this contrasts with the logic of the definion proposed for drones, being the latter focused on the pilot and not on the passengers. An additional definition for "manned aircraft" may hence be appropriate in the new regulation: **"manned aircraft" means any aircraft operated or designed to be operated with at least one pilot on board.**

Furthermore, "model aircraft" are mentioned but not defined in Regulation 216/2008 [32]. They are instead defined in Part C [28] of the standard European Rules of the Air, but making reference to "an operating mass not exceeding limits prescribed by the competent authority", which would lead to non uniformity and in any case is in contrast with the spirit of the categories.

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[16] Paragraphs 1.2.10 and 1.2.11 in mentioned Manual Doc 10019 [47].
[17] Article 3(29) in [27].

In its "prototype" rules [14] published in August 2016, EASA does not propose a definition for "model aircraft", but makes clear reference to aircraft used for recrational purposes, and used exclusively for leisure flights, air displays, sport or competition activities. EASA also states that in some States "large" model aircraft are considered those above 25 kg. In practice small model aircraft would belong to the open category as any other drone used within same operational limitations. Large model aircraft would go beyond the open category, but they are expected to be exempted from the processes of declaration or authorisation applicable to the specific category, when under oversight by their clubs or associations. This intention is contained in Article 9 of said prototype rules [14].

If nothing were done, a definition would remain in the standard European rules of the air, in contrast with the common threshold between the open and specific category. If the rules of the air would be amended to introduce a revised definition, it would probably be advisable to introduce the same defintion in the future Commission regulation on UAS operation. But one may also think that, instead of repeating the same definition in several implementing rules, it could be better to have a proper definition at the level of basic Regulation.

For these reasons, a definition of "model aircraft", to be introduced both in Regulation 785/2004 and in the legislative proposal [27] is proposed: **"model aircraft" means an unmanned aircraft that is capable of sustained flight in the atmosphere and that is used exclusively for leisure flights, air displays, sport or competition activities.**

A list of most relevant definitons used in the UAS domain, including the newly proposed ones, is contained in the following Table II - 1:

Table II - 1: Terms and definitions

TERM	DEFINITION	SOURCE	REMARKS
Airborne collision avoidance system (ACAS)	An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation. Anyway it excludes automatic collision avoidance
Aircraft	Any machine that can derive support in the atmosphere from the reactions of the air other than reactions of the air against the earth's surface	ICAO Annex 7 [46] and proposed Article 3(27) [27]	It equally applies to both manned and unmanned aircraft, including tethered ones
"Aircraft registered in a Member State" or "aircraft registered in a third country"	Aircraft registered in accordance with the international standards and recommended practices relating to Annex 7 to the Chicago Convention entitled "Aircraft Nationality and Registration Marks"	Proposed Article 3(31) [27]	In case MS decide to register small UAS elsewhere, these small UAS may not be considered registered aircraft
Autonomous aircraft	An unmanned aircraft that does not allow pilot intervention in the management of the flight	ICAO Doc 10019 [47]	Not an ICAO standard

TERM	DEFINITION	SOURCE	REMARKS
Autonomous operation	An operation during which a remotely piloted aircraft is operating without pilot intervention in the management of the flight	ICAO Doc 10019 [47]	Not an ICAO standard
Command and Control (C2) link	The data link between the remotely piloted aircraft and the remote pilot station for the purposes of managing the flight	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation
Detect and Avoid (DAA)	The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation. Anyway it includes automatic collision avoidance
Equipment to control unmanned aircraft remotely	Any equipment, apparatus, appurtenance, software or accessory that is necessary for the safe operation of an unmanned aircraft	Proposed Article 3(30) [27]	It includes not only the Remote Pilot Station (RPS), but also any necessary ground equipment, such as arresting cables, catapult, landing nets or other
General air traffic (GAT)	All movements of civil aircraft and state aircraft carried out in conformity with the procedures of the International Civil Aviation Organisation (ICAO)	Proposed Article 3(20) [27]	It also applies to unmanned state aircraft
Manned aircraft	**Any aircraft operated or designed to be operated with at least one pilot on board**	**N.A.**	**Proposed to be inserted into the legislative proposal**
Model aircraft	**An unmanned aircraft that is capable of sustained flight in the atmosphere and that is used exclusively for leisure flights, air displays, sport or competition activities.**	**N.A.**	**Proposed to be inserted into the legislative proposal and into Regulation 785/2004**
	An unmanned aircraft, other than toy aircraft, having an operating mass not exceeding limits prescribed by the competent authority, that is capable of sustained flight in the atmosphere and that is	Article 2(95a) of Part C [28] of Standard European Rules of the Air	First example of legal definition in an act different from national rule

TERM	DEFINITION	SOURCE	REMARKS
	used exclusively for display or recreational activities		
Non-installed equipment	Any equipment carried on board an aircraft but not installed in the aircraft and which may have an impact on safety	Proposed Article 3(28) [27]	It includes e.g. electronic flight bags (EFB) on manned aircraft, but not ancillary ground equipment necessary for UAS (e.g. catapult)
Operator	Any legal or natural person operating or proposing to operate one or more aircraft or one or more aerodromes	Proposed Article 3(10) [27]	It equally applies to both manned and unmanned aircraft
Pilot-in-command (PIC)	The pilot designated by the operator, or in the case of general aviation, the owner, as being in command and charged with the safe conduct of a flight	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation. Anyway it includes the case that the PIC is remote from the aircraft
Remote pilot (RP)	A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation
Remote pilot station (RPS)	The component of the remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation. Anyway, it includes RPS installed in a room, portable, on a vehicle, vessel or elsewhere.
Remotely piloted aircraft (RPA)	An unmanned aircraft which is piloted from a remote pilot station	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation
Remotely piloted aircraft system (RPAS)	A remotely piloted aircraft, its associated remote pilot station(s), the required Command and Control links	Chapter 1 of ICAO Annex 2 [45]	A subset of the UAS. It may be better to insert all UAS in the scope of the Basic Regulation, not to constrain industry

TERM	DEFINITION	SOURCE	REMARKS
	and any other components as specified in the type design		developments beyond RPAS. ICAO Secretariat tends to say that, since the definition mentions "type design" it applies only to RPAS in the certified category. MS have used the term more widely.
RPA observer	A trained and competent person designated by the operator who, by visual observation of the remotely piloted aircraft, assists the remote pilot in the safe conduct of the flight	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation
Single European Sky (SES) airspace	Airspace of the territory to which the Treaties apply, as well as any other airspace where Member States apply Regulation (EU) Not [not yet published] in accordance with Article 1(4) of that Regulation	Proposed Article 3(33) [27]	It may be used to extend scope also to drones not registered according to ICAO Annex 7
State aircraft	Aircraft when carrying out military, customs, police, search and rescue, firefighting, coastguard or similar activities or services under the control and responsibility of a Member State, undertaken in the public interest by a body vested with public authority powers	Proposed Article 3(32) [27]	It does not include similar flights undertaken by EU Agencies, such EMSA or FRONTEX, which are not under control and responsibility of any MS. It may also exclude flights by local administrations, if so decided by the State.
Toy aircraft	ASn unmanned aircraft designed or intended for use, whether or not exclusively, in play by children under 14 years of age	Article 2(129a) of Part C rules of the air [28]	Modelled from the "toy Directive"
Unmanned Aerial Vehicle (UAV)	For NATO is just the aircraft without ground control station	Working Paper to ICAO RPAS Panel [1]	Ambiguous definition: "vehicles" may be out of scope of aviation rules

TERM	DEFINITION	SOURCE	REMARKS
Unmanned aircraft (UA)	Any aircraft operated or designed to be operated without a pilot on board	Proposed Article 3(29) [27]	The definition does not exclude passengers on board. It encompasses autonomous UA, remotely piloted and partially remotely piloted aircraft
Unmanned aircraft system UAS)	An aircraft and its associated elements which are operated with no pilot on board	ICAO Circular 328 [44]	Not an ICAO standard
Visual line-of-sight (VLOS) operation	An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft	Chapter 1 of ICAO Annex 2 [45]	Definition not necessary at the level of Basic Regulation. The ERSG Roadmap [30] differentiates between VLOS and E-VLOS

ANNEX III REGISTRATION AND IDENTIFICATION

As explained in 4.1.3, it is expected that operators in the open category will receive simple information on "do and don't". Operators in the specific category, depending on the future common rules, may be subject to a process of declaration or operational authorisation. In both cases, the possibility exists that operators in such categories will exceed respective limitations. Since most of these operations will take place at Very Low level (VLL), below 500 ft (around 150m) above ground level and far from aerodromes, aviation authorities may not be in the position to patrol the territory to spot possible infringements.

Against any possible infringement, the first mitigation to put in place is a system for registration and identification of the drone and of the legally responsible operator.

Article 3(31) of the legislative proposal [27] defines "aircraft registered in a Member State" or "aircraft registered in a third country" as aircraft registered in accordance with the ICAO standards and recommended practices relating to Annex 7 [46]. These standards require, inter alia, a certificate of registration and nationality marks. The related procedures at national level (example in [19]), could be disproportionate for Small or Medium-sized Enterprises (SMEs), not needing to fly internationally on the global scale.

However ICAO has stated in the draft Concept of Operations [48] under development, that its scope is limited to certified RPAS operating internationally under instrument flight rules (IFR) in non-segregated airspace and at aerodromes - which means to the certified category.

And in fact Article 47(1)(e) of the legislative proposal [27] suggests to promulgate implementing rules not for "registration" (i.e. according to ICAO Annex 7) but only for the "marking and identification" of unmanned aircraft.

Some EU Member States already have in place registration mechanisms for UAS (French example in [7]), alternative to traditional aviation registry, and so not leading to nationality marks. The same happens in the USA, where in December 2015 FAA promulgated interim final rule Part 48 [38], which provides an alternative, streamlined and simple, web-based aircraft registration process for the registration of small drones, including small drones operated as model aircraft. Part 48 also provides a simpler method for marking small UA that is more appropriate for these aircraft.

In summary the European Commission proposal to "mark" UAS, but not necessarily through the traditional aviation registry (and related nationality) should be supported by the Legislator.

But, in addition, two details need to be clarified:

- If there is a minimum threshold below which not even the alternative registration is required; and
- Whether UAS in the specific category, not compliant with ICAO standards, including Annex 7, and therefore not eligible for international air navigation on the global scale, would be eligible for intra-community flights.

Paragraph 3.5.2 of the EASA Technical Opinion [12] proposes a threshold for a "harmless" subcategory of the open category of 250 gr, which is also the minimum threshold above which registration is required in FAA Part 48. This would allow children to continue to play (e.g. with balsa wood gliders) without any administrative burden, but also manufacturers to develop products for the mass consumer market. Several studies confirm that the probability that a drone of no more than 250 gr would cause serious injuries is extremely low, as reported in the Explanatory Note to the prototype rules [14]. Alternative registration is expected to be a regulatory process common to the open and specific categories above 250kg, although JARUS may propose to slightly revise this parameter and possibly complement it by other parameters (e.g. maximum speed which is the second factor of the kinetic energy).

UAS in the open category are not expected to be allowed to cross borders in flight. Instead, UAS in the specific category could. In fact, they would be registered through procedures alternative to ICAO Annex 7, out of scope of the other ICAO standards under development and therefore not eligible for international air navigation on the global scale. However, paragraph 3.2.2 of the already mentioned ICAO Manual on the subject [47], with the aim to facilitate the practical implementation and execution of the special authorisation process per Article 8 of Chicago Convention, recommends that States may agree mutually, upon simpler procedures through bilateral or multilateral agreements or arrangements for the operation of specific drones or categories of drones. This will reduce the workload on RPAS operators and the State authorities. Said Manual also adds that the same objective may be reached through regulatory measures at regional level, which legitimates action at EU level through common aviation rules.

Finally, registration by the operator shall be complemented by an identification code assigned by the aviation authority and issued to the operator. The operator will have the responsibility to affix the code on the drone, so allowing the law enforcement agencies to link the drone and the legal entity of the operator to the code. Technical aspects are discussed in Chapter 5 of this note.

ANNEX IV STANDARD SCENARIOS

According to EASA Technical Opinion [12] and the explanatory note accompanying the prototype rules [14], in the 'Open' (low risk) category, safety is ensured through compliance with operational limitations, mass limitations as a proxy of energy, product safety requirements, and a minimum set of operational rules. In other words, although not unique, the first parameter to consider is the mass and there should be an upper limit to be eligible to belong to such category. And in fact Proposal 16 in said Opinion [12] suggests a maximum mass of 25kg for drones in this category based on current thresholds used by several MS and internationally (e.g. USA in Part 107 [39], Transport Canada [64], Brazil) for the regulation of small unmanned aircraft and small model aircraft).

Below this mass of 25kg (confirmed by the prototype rules [14], although a different threshold might possibly be suggested by JARUS), however, still according to the EASA prototype rules [14], subcategories may be established. The precise limits of such subcategories and the corresponding drone classes will be defined at the level of implementing rules, following the EASA rulemaking procedure, which includes regulatory impact assessment and consultation of stakeholders.

However EASA already proposes in the prototype rules [14] four UA classes, the main envisaged characteristics of which are presented in Table IV-1:

Table IV - 1: UAS Classes proposed by EASA

CLASS	MASS	MAX POSSIBLE INJURIES	LIMITATIONS				Geo fencing	Electr. ID
			HEIGHT	DISTANCE	SPEED			
	kg	AIS[18]	m	M	m/s	Km/hr		
0	0,25	2	50	100	15	54	NO	NO
1	25	2	50	N.A.	N.A.	N.A.	NO	NO
2	25	4	50	N.A.	N.A.	N.A.	YES	YES
3	25	N.A.	150	N.A.	N.A.	N.A.	YES	YES

Classes are linked to subcategories: e.g. only Class 0 drones are eligible for operations in the harmless subcategory (labelled A0 in the EASA prototype rules [14]), but the same drone could escalate in a higher operations category, if so wished, but in this case of course complying with operational requirements for that category.

In envisaged prototype rules [14] MS would decide which categories and subcategories may access which airspace zones. However, to better explain the relation between airspace and drone categories and subcategories, further information is provided in Annex VII. For instance, a drone of e.g. 10kg, potentially causing medium severity injuries if hitting a human, could fly over the countryside in the open category, since there the probability of hitting a person would be minimal. Conversely the same drone could fly over urban areas, but in the latter case being included in the specific category (i.e. more stringent oversight), since it could be more likely to hit a person if crashed.

From the point of view of the regulatory processes, the open (except A0), specific and certified categories are all subject to some form of registration and identification. No other

[18] Abbreviated Injury Scale proposed in Annex I in the Explanatory Note accompanying [14].

aviation regulatory processes apply to the open category. Conversely, traditional aviation certificates (not declarations) are applied in the certified category. In the middle specific category, either a regime of declaration or of authorisation may apply, according to Article 46(1) and (2) of the legislative proposal [27].

Not surprisingly, in the UK [66] when permission is required, this is treated case-by-case, according to the culture of the common law. Equally not surprisingly, in France the aviation authority provides guidance in the form of pre-defined "scenarios" (already mentioned guidance material [7]) to which specific mitigation measures are linked. If the operation falls into one of the four pre-defined scenarios, then a declaration is sufficient. Otherwise, the operator shall apply for an authorisation. A similar approach is proposed by EASA in the prototype rules [14], which could be implemented at the level of implementing rules, without further intervention at legislative level.

ANNEX V EXTRACT FROM DRAFT FAA EXTENSION ACT 2016

SEC. 2203. SAFETY STATEMENTS.

(a) REQUIRED INFORMATION.— Beginning on the date that is 1 year after the date of publication of the guidance under subsection (b)(1), a **manufacturer of a small unmanned aircraft shall make available to the owner at the time of delivery of the small unmanned aircraft the safety statement** described in subsection (b)(2).

(b) SAFETY STATEMENT.—

(1) IN GENERAL.—Not later than 1 year after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall issue guidance for implementing this section.

(2) REQUIREMENTS.—A **safety statement required under subsection (a) shall include—**

(A) information about, and sources of, laws and regulations applicable to small unmanned aircraft;

(B) **recommendations for using** small unmanned aircraft in a manner that promotes the safety of persons and property;

(C) the date that the safety statement was created or last modified; and

(D) language approved by the Administrator regarding the following:

(i) A person may operate the small unmanned aircraft as a model aircraft (as defined in section 336 of the FAA Modernization and Reform Act of 2012 (49 U.S.C. 40101 note)) or otherwise in accordance with Federal Aviation Administration authorization or regulation, including requirements for the completion of any applicable airman test.

(ii) The definition of a model aircraft under section 336 of the FAA Modernization and Reform Act of 2012 (49 U.S.C. 40101 note).

(iii) The requirements regarding the operation of a model aircraft under section 336 of the FAA Modernization and Reform Act of 2012 (49 U.S.C. 40101 note).

(iv) The Administrator may pursue enforcement action against a person operating model aircraft who endangers the safety of the national airspace system.

(c) CIVIL PENALTY.—A person who violates subsection (a) shall be liable for each violation to the United States Government for a civil penalty described in section 46301(a) of title 49, United States Code.

ANNEX VI SERVICE PROVIDERS

The list of service providers under oversight already comprises around 15[19] of them in current Regulation 216/2008 [32]. Ground handling service providers are added by legislative proposal [27], since risk-based and performance-based regulation indeed achieves high levels of safety not only through prescriptive rules on equipment or hours of training of personnel, but in large measure through organisations and their management.

One has hence to check that all organisations involved in UAS and related operations have a proper legal basis to be put under proper safety oversight.

Organisations involved in design, production, maintenance and operations of UAS are clearly covered by Article 2 of the legislative proposal [27]. UAS operators may include not only operators of an entire UAS (i.e. the aircraft, the station and the link between the two), but also e.g. operators of only stations[20]. No gaps are deemed to exist in this respect.

However new providers may emerge in the fields of:

a) Communication and surveillance at Very Low Level, where traditional Communications, Navigation and Surveillance infrastructures may not provide sufficient coverage at a reasonable cost;

b) Satellite navigation on which UAS are heavily dependent;

c) Provision of information to UAS operators.

Article 3(16) of legislative proposal [27] states that “ATM/ANS” means the air traffic management functions and services as defined in Article 2(10) of (new) Single European Sky (SES) Regulation[21], and the air navigation services defined in Article 2(4) of that Regulation, including the network management functions and services referred to in Article 17 of that Regulation, and, in addition, services consisting in the origination and processing of data and the formatting and delivering of data to general air traffic for the purpose of safety-critical air navigation. So it is important to check whether the SES definitions cover the providers relevant for UAS, as listed in a) to c) above, which is done in the following Table VI -1:

[19] E.g. apron management service providers.
[20] Similar to harbour pilots in the long established tradition of maritime navigation.
[21] Not yet published; based on legislative proposal [25].

Table VI - 1: Definitions of service providers

Service Provider	SES2+ definition	Legislative proposal [27]	Comment
COM	"Communication services" means aeronautical fixed and mobile services to enable ground-to-ground, air-to-ground and air-to-air communications for ATC purposes	As SES 2+	Command and Control data link is excluded, since it is not "for ATC purposes"
SUR	"Surveillance services" means those facilities and services used to determine the respective positions of aircraft to allow safe separation	As SES 2+	Acceptable, assuming that in Very Low Level operations maintaining safe distance will be responsibility of the remote pilot
NAV	"Navigation services" means those facilities and services that provide aircraft with positioning and timing information	As SES 2+	Perfectly covering both manned and unmanned aircraft
AIS	"Aeronautical information service" means a service established within the defined area of coverage responsible for the provision of aeronautical information and data necessary for the safety, regularity, and efficiency of air navigation;	As SES 2+	Information and data necessary for UAS operations go beyond (e.g. areas interested by emergencies) traditional aeronautical data

Inserting some provisions at the level of implementing rules, as in Article 7 of the prototype rules [14], would not create a sufficient legal basis for oversight of these new providers, so amendment to the definition is deemed necessary at the level of the legislative proposal [27].

ANNEX VII – CATEGORIES OF DRONES AND AIRSPACE

The European RPAS Steering Group suggested in its final report [30] that UAS could fly above 500 ft above ground level in non-segregated airspace (i.e. mixed with traditional manned aviation), on condition that they comply with the rules applicable to all general air traffic to fly under Instrument (IFR) or Visual (VFR) flight rules.

This is, for the time being, confirmed also by the draft JARUS ATM Concept [54], which however also proposes a further demarcation at Flight level 600 (= 60,000 ft, circa 18km of altitude) above which e.g. solar powered drones may loiter for weeks, well above traditional manned aviation.

According to Article 12 of the prototype rules [14], Member States will decide in which airspace volumes or above which territory civil UAS would be allowed to fly.

Therefore, it would be neither the EU Legislator, nor the European Commission or EASA to dictate which drones could access which space. However, since more than 10 Member States have already promulgated specific rules for UAS, in this Annex some explanations are provided, to highlight the situations which may emerge.

Since above 500 ft traditional manned aircraft are encountered, it is legitimate to assume that the open category of drones (almost no involvement of the aviation authorities and no requirements on the operator) will not be allowed to fly there. Conversely, it is obvious that the certified category (subject to all traditional aviation processes and compliant with ICAO standards) would be allowed. It is unclear whether the specific category could fly above 500 ft. One might assume that at least the operators authorised in that category (i.e. not the ones having only filed a declaration), if so allowed by respective terms of approval, could indeed fly above 500 ft, under normal instrument or visual flight rules, like any other general air traffic flight.

Below 500 ft, the operations are at Very Low Level (VLL) and can be in Visual Line-of-Sight (VLOS), Extended-VLOS or Beyond (BVLOS).

According to the EASA Technical Opinion [12], no UAS will be allowed to enter "no drone" zones, which in addition to traditional Restricted or Prohibited areas, could be above major aerodromes, critical infrastructures or politically sensitive areas, or even open air gatherings of crowds (e.g. rallies, sport events, feasts, concerts, etc.). This approach is confirmed by existing national rules that prohibit e.g. the overflight of critical infrastructures or of crowds.

Vice versa, "limited" drone zones could be relatively near to aerodromes or above urban areas. In this airspace volumes, small harmless (e.g. below 250 gr; subcategory A0 in EASA prototype rules [14]) UAS could be allowed, but only below e.g. 150 ft (50 m) because above this height the small drone would no longer be visible from the position of the remote pilot on the ground. Equally, slightly more risky (i.e. only minor injuries probable in the case of hitting a person, which is subcategory A1 in mentioned EASA prototype rules [14]) could be allowed, as well as the specific category (e.g. subject to specific risk assessment) or the certified one (in fact subject to certification). In other words, drones in the open category, potentially causing medium severity (i.e. subcategory A2) or even fatal (A3) injuries, would be excluded, since a drone of e.g. 10kg, likely to cause moderate or severe injuries and overflying an urban area without safety assessment, could be considered too risky by society.

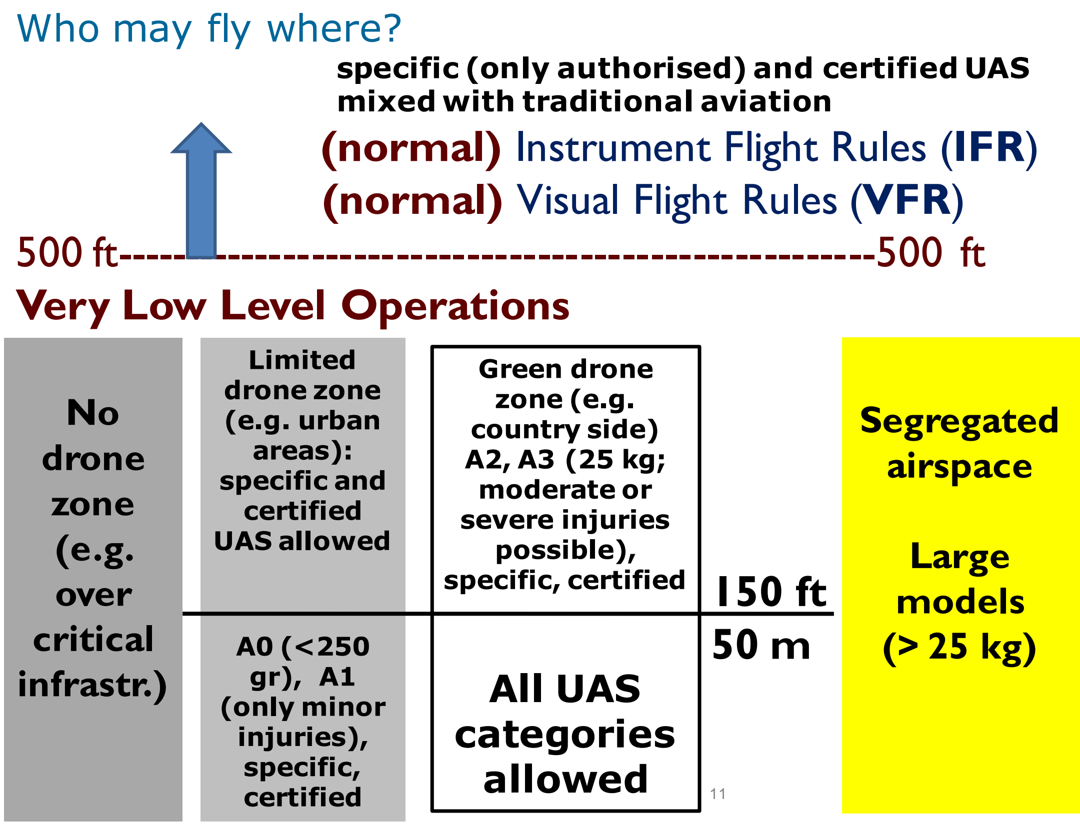
Such A2 and A3 subcategories would be allowed to fly in "green" drone zone (e.g. uncontrolled airspace, over the countryside, away from aerodromes and urban areas), where also all the other categories and subcategories would be allowed.

This means that a drone of e.g. 10kg, likely to cause moderate or severe injuries, could be flown over the countryside with minimal involvement of the aviation authority, but to overfly urban areas, it will need to enter the specific category and submit either a declaration or an application for operational authorisation.

Finally, the open category also encompasses toy aircraft and small model aircraft. Large model aircraft (> 25kg) would belong to none of the open, specific or certified categories, but only permitted to fly inside segregated airspace, under oversight and self-regulation by respective Clubs.

The above descriptions are summarised in the following figure:

Figure VII - 1: Categories of drones and Airspace



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