European Space Policy Institute

Opening Airspace for UAS

A Regulatory Framework to Introduce Unmanned Aircraft Systems into Civilian Airspace

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Foreword

For some time already, Unmanned Aircraft Systems (UAS) have attracted the attention of civil authorities. Their use for high-risk civilian missions not only improves the efficiency of civil protection forces but also opens up wide market opportunities for state-of-the-art technologies. The realisation of such potential depends strongly on the elaboration of a regulatory framework that allows UAS to fly safely in non-segregated areas.

Aware of the potential of UAS markets for the achievement of its goals, the European Union has already taken the first steps to support the development of civilian UAS, first in the framework of FP6 with INOUI and currently with its efforts to develop a regulatory framework to allow the flight of UAS in civilian airspace. In this context, on 4 November 2010 ESPI hosted a workshop where the main European stakeholders gathered for an intensive exchange aimed at building joint understanding.

The current ESPI Report features the presentations given by participants in this workshop. It covers the key topics to sustain the regulatory framework for UAS such as the general European aviation framework and issues of certification and regulation of light UAS. The Report concludes with a set of recommendations and steps to follow addressed to European decision-makers in this field.

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1. Introduction

by Alfredo Roma

UAS range today from extremely simple, short-range vehicles to multi-million dollar aircraft with almost global reach. Large airframe UAS – sometimes equipped with jet engines – offer the possibility of complex missions, especially those related to civil protection or civil defence, requiring the UAS to fly at medium or high altitude and in difficult meteorological conditions. Light UAS normally fly at low altitude and for local or short-range missions. For both classes of UAS, the mission depends on the payload and the ground station capacities to collect, process and disseminate data for the mission's purposes, UAS piloting and the ATM information system.

Simple UAS generally carry little more than a video camera and sensors that send images and data over limited distances to a ground station that has limited links to other units. Larger UAS can carry sophisticated types of camera, while signal intelligence systems (ELINT/COMINT) and ground-surveillance radars are also becoming common. The ground stations are linked into a larger and faster network. In the near future satellites will play a key role in UAS piloting, communications and reliability.

1.1 The Market

Many non-EU suppliers are well established in the global UAS marketplace. According to 2007 data, the U.S. had 60% of the global market, Israel 35% and only 5% was left to Europe. We believe that today the situation is more or less the same. For the U.S. and Israel, demand has been driven by military applications. The solutions therefore are not necessarily well adapted to support civilian needs.

The applications and solutions market segment is fragmented, especially for UAS below 150 kg. With each EU Member State establishing its own regulations.

Enormous opportunities are now emerging for civil use of UAS and synergies need to be developed across different UAS applications (military, civil and commercial).

Today, UAS industries worldwide are designing new strategies in order to meet tomorrow's demand. Europe must face this situation and develop a cooperation policy for European stakeholders.

1.2 The European Industry

Europe has a solid aeronautical industry, especially dedicated to support its Large Civil Aircraft (Airbus) manufacturing capability as well as military manned systems, accompanied by a large academic and research institute knowledge base for UAS. Technological contributions by the space sector, such as satellite TLC and GNSS, must also be taken into account.

However, a full scale UAS market in Europe is unlikely to emerge if the airspace access issue is not fully resolved and if appropriate legislation and regulatory measures are not developed. The necessity of quickly establishing a full set of common European rules on UAS airworthiness, and integration of UAS within the non-segregated airspace, has become an unavoidable matter of urgency. The lack of such a regulatory framework is preventing industry from developing pertinent business plans and to commencing development activities that are necessary to meet civilian customer needs. In addition, it should be considered that major European industries (as well as SMEs) have already invested considerable capital in this sector and it is time they start to receive a reasonable return on investment through sales. These investments, both public & private, risk being "wasted" by the absence of a strategy at EU level capable of developing the UAS market for civil use.

Unlocking this market potential would bring concrete advantages to Europe: new opportunities for employment, development of new technologies by European industry which will set standards for the rest of the world, consistent reduction of air pollution through lower fuel consumption and CO_2 emissions, reduction of human life exposure, efficient protection of European resources and population. The contribution that large-scale use of UAS can make to improve the protection of citizens and infrastructure must be recognised.

All this appears to be perfectly in line with the Lisbon Strategy, which addresses these challenges in aiming to make the EU "the most dynamic and competitive knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment”.

In addition, UAS were identified in the European Framework Co-operation (EFC) between the *European Commission and the European Defence Agency* as a domain capable of strengthening research and creating an innovative nexus from ideas to products and services. Europe's efforts to develop UAS are an opportunity to strengthen the global competitiveness of its aerospace defence and security industry sector through the development and implementation of new technologies in the aviation business, especially the “Sense & Avoid” anti-collision technology and telecommunications.

1.3 Radio Frequencies

Radio frequencies for UAS operations are vitally important. The 'up-link' required for remotely piloted UAS needs to be extremely robust; thus, the use of 'Sense and Avoid' anti-collision technology requires additional aviation radio spectrum to be allocated. Furthermore, the 'down-link' for the UAS to transmit mission related data (e.g. video images or other data collected by special sensors) to ground control centres needs to be of high quality. UAS’ beyond line of sight (BLOS) operations require satellite links and/or data relays, which should be protected from jamming or spoofing. These issues have to be discussed at international level through ICAO and international conventions. Thus the EU can play a key role in the assignment of radio frequencies to UAS operations.

1.4 The Regulatory Framework

Over the past century, aviation rules and regulations have developed based on the use of manned aviation. Today military UAS can fly within segregated areas. The development of non-military UAS has raised the need for their integration into non-segregated airspace in order to perform required missions. Since EU airspace is going to be reorganized following the EU's Single-Sky programme, UAS operations must be included in this new scenario. Airworthiness is another important issue that is under examination by EASA. Finally, the complex problem of liability should be deeply examined.

1.5 Suggested Actions at EU level

We believe that the European Union should take the political lead on UAS. This would facilitate the development of necessary technologies and standards that could become valid worldwide, creating a common European and international regulatory framework embedded in the 'Single-Sky/SESAR programmes.

We need a “unified European position”, civil and military, to reach the target of having UAS flying in the common airspace. This requires strong co-operation among the various actors: European Commission, EASA, EUROCONTROL, ESA, SESAR JU, Eurocae WG 73, ECAC, EDA and NATO FINAS; acting in co-operation with ICAO.

Possible actions at EU level could be:

- Analyse the present situation and catalogue UAS activities; identify products currently in use and in development in the EU, in both categories (i.e. over and below 150 kg).
- Catalogue UAS-relevant research in the EU and identify the highest priorities and the next steps.
- Analyse the potential world market demand for military and non-military UAS for the next 10–15 years.
- Establish a set of targets to match the benefits, in terms of cost or environmental improvement, of missions performed by manned aircraft.
- Design a roadmap to achieve a coherent regulatory framework, including a liability regime.
- Co-ordinate the activities in place: JARUS, EUROCAE WG 73, INOUI, MIDCAS and EASA on the basis of common objectives.

1.6 The ESPI View

Also ESPI has identified UAS as a key area integrated in the European space activities. European institutions, academia and industries are here today to analyse the UAS sector from different perspective, but with the common objective of developing the European UAS market.

We feel sure that the presentations and discussions of this workshop will represent a valuable contribution for having the UAS flying in the civilian airspace.

Finally, we wish to point out the following that Article 8 of the Chicago Convention states that:

> » No aircraft capable of being flown without a pilot shall be flown over the territory of a contracting State without special authorisation by that State and in accordance with the terms of such authorisation. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.

Actually it is not *an aircraft without a pilot* as stated by article 8 of the Chicago Convention. An UAS is just a "System" formed by an aircraft and a ground station where the pilot commands the aircraft by a remote control telecommunication system.

Therefore, we raise a question: shouldn't we define UAS from now on as Remotely Piloted Aircraft System (RPAS) or simply Remotely Piloted Aicraft (RPA) instead of Unmanned Aerial System?

2. Civil Applications of UAS: The Way to Start in the Short Term

by Pablo González and Javier Caina

2.1 Introduction

Unmanned Aircraft Systems (UAS) have taken a boost on technologies and development during the last few years thanks to enhancements in electronics, RF systems and improvements on embedded components.

Several sectors are interested in a spread use of UAS, pushing their operations into non-segregated airspace. For this, initiatives several working groups and organizations have assumed the challenge to overcome the current barriers in line with some other efforts made by European agencies like the European Space Agency, ESA, and the European Defence Agency, EDA, and more recently the European Commission.

2.2 Civilian Applications

In the frame of a study held by ESA[1], a survey was conducted among UAS stakeholders in order to have an overview of those missions that keep more interest for the unmanned community. The set of stakeholders included UAS and payload manufacturers, satellite service providers, regulatory and standardisation bodies, and UAS-related working groups and associations.

The result of this survey is shown in Figure 1. During the study, it was confirmed that UAS missions requiring satellite services for BLOS operations are of high interest mainly because of the valuable use of the space sector for navigation and communications (command/control and payload) services.

As part of the results, Sense&Avoid was pointed as the most important challenge in the short-term for integration into non-segregated airspace, issue that is being developed by specific projects like MIDCAS (EDA).

The most feasible missions for a short-term demo would be:

2.2.1 Maritime Surveillance and Coastguard

UAS are an interesting option for maritime missions due to its often long-range and dull nature. As maritime missions are deployed over water and not highly populated areas, these type of missions are specially attractive for the introduction of civilian UAS in the short term.

For this kind of missions, some civilian applications will overlap military ones facilitating

Figure 1: UAS missions sorted according to interest of stakeholders.

[1] Satellite-Unmanned Aerial Vehicle (UAV) Cooperative Missions: Status and Outlook. Indra-MDA. 2009.

the utilisation of technology already in use with minimal modifications. It is to be noted that the combination of both civilian and military technologies will involve jurisdictional issues regarding flight rules and certification.

Some of the coastguard applications include search and rescue, fisheries protection and surveillance, maritime traffic monitoring, pollution monitoring, sea ice monitoring and coastal erosion monitoring.

2.2.2 Border Control

UAS are also suitable for land border, in particular for patrolling sparsely populated areas. These missions generally favours the use of MALE and tactical UAS rather than short-range, portable systems. Advances in payload miniaturisation, navigation systems and sensor technology allow for surveillance to be carried out regardless of weather conditions during day and night. The possibility to patrol under all weather conditions at all times is a crucial requirement for this kind of security operations.

MALEs and tactical UAS are specially suited to European border control operations, in particular, given the length of European borders. UAS are offer considerable advantages in mountain and remote regions where other ground-based solutions and radar technologies do not offer the same level of coverage.

2.2.3 Infrastructure Monitoring

Infrastructures like oil/gas pipelines are important candidates for both surveillance and monitoring missions to be performed cooperatively by satellites and UAS. Surveillance missions are demanded for assuring security of infrastructure whereas monitoring missions are necessary for achieving safety goals related to their use. So far, some initial research trials have been carried out using small UAS. Monitoring of oilfield infrastructure has been widely performed by manned aircraft (mostly VTOL) but due to the location of the area to be covered, it turns too demanding and time-consuming leaving a good opportunity for UAS to operate.

Usually, aircraft used for this purposes tend to be chartered rather than owned by end users, therefore they are able to carry out similar work for other customers. Another fact to be taken into account is that inspection cannot be totally automated so a “man in the loop” is necessary to interpret data whether in real time or for later processing.

2.2.4 Disaster Management and Mitigation: Disaster Relief, Fire Fighting

UAS can perform higher resolution/continuous observation of emergency situations in comparison to single or small constellations of satellites, or airborne (manned) systems alone, which are too costly for this goal. UAS are capable of rapid deployment, can be used under hazardous conditions, support valuable services from the point of view of emergency management, and offer a high degree of control of the situation to the involved stakeholders.

Between 200.000 and 600.000 hectares of forest are consumed by fire each year in Europe, threatening property and lives as well as destroying valuable woodland. Some of the features to be covered by UAS in these missions are:

- Longer patrol and loiter time over target area than manned aircraft for airborne early-warning (AEW) missions.
- Precision location and transmission in real time of fire hotspots, often obscured by dense smoke, using sensors capable of imaging through the visible spectrum into the infrared
- Communications relay for fires often located at inaccessible terrain and hostile conditions for clear short range radio traffic

2.3 Current Barriers

In order to implement civil application successfully, several barriers have first to be overcome. According to Air4All[2], the following challenges are identified including technical, regulatory, procedural and transversal issues.

Technical challenges:

- Separation
- Collision avoidance
- Secure and sustainable communications for C2
- Radio bandwidth allocation
- ATC interface
- Dependable emergency recovery
- Health monitoring/Fault Detection
- Automatic take off /landing systems
- Automatic taxiing
- Autonomous behaviour / decision making
- Weather detection and protection
- Interoperability
- Operator interface
- Visual landmark and obstacle avoidance

[2] Air4All Study Final report. UAS Insertion into General Air Traffic. Ref.: 07-arm-001, Issue: 1.0, June 2008.

Regulatory challenges:
- Harmonised military process
- Agreed rules and regulations with authorities

Procedural and training challenges:
- UAS pilot / Commander training
- Security of ground station

Transversal issues:
- Public acceptance
- Product liability
- Design organisation approval
- Product organisation approval
- Impact on environment

In particular, for the short-term, the key regulatory issues include:

- Internationally harmonised regulatory and standardisation framework for UAS
- Airspace and ATM system evolution to cope with the increasing demand of airspace users, among them the Unmanned Aviation community
- Certification: reliability of UAS and the safety of their operations
- Insurance liability costs & responsibility

2.4 Space Segment Benefits

Among the main services that satellites can provide today to UAS are (1) Navigation and Positioning, (2) Communications (safety and payload), and (3) cooperative surveillance (e.g. use of satellite images for UAS mission planning and execution). Although the first and the third services are not actually UAS specific, the second one is crucial for BLOS operations.

2.4.1 Navigation/Positioning

In an increasingly complex and sophisticated aviation environment, precise positioning and navigation capabilities are essential for airspace users. UAS require such capabilities even to a greater level than required by manned vehicles. In particular when it comes to vehicles with a high level of autonomy such as high altitude platforms.

In addition, it must be noted that operations using automatic take-off and landing (ATOL) capability is expected to be much more frequent in UAS (even for the smallest) than in manned aircrafts, and such capability relies on very precise positioning and navigation systems.

2.4.2 Safety/Payload Communications

Beyond Line Of Sight (BLOS) data links are key enablers for UAS operations requiring long ranges (> 200 km), typically performed for long endurance UAS, which are usually within MALE or HALE categories. So far, mission requiring BLOS operations are mainly performed in military missions using a segregated airspace or secured corridors. However, to perform BLOS operations in the non-segregated airspace, UAS will have to be integrated into the ATM system, which requires overcoming the issues previously mentioned and will enforce UAS to be "transparent" to the Air Traffic Control (ATC).

2.4.3 Cooperative Surveillance

Many UAS being operated today, mainly in the military field, have software for mission planning, execution and post-processing, which is based on digitalised raster maps. The information included in these maps must be up to date, sufficient and accurate. Therefore, the provision of images of the interest area taken by satellites is being of great value, as proved in current military missions together with their integration into the software for UAS mission planning, execution and post-processing.

It can be noted that, although presented here as a satellite service for UAS, it can be also considered as a potential application since satellites have a number of limitations (see Table 2) where UAS can assist on the provision of imagery for other UAS or other users.

The integration of satellites and UAS has the potential of unique civil and security global missions, including time-critical and life-critical operations. It is worth noting that the level of benefit of satellite services are UAS-category dependent as can be seen in Table 1.

The UAS-Satellite synergy stems from their complementary characteristics with regards to the capability to provide data to the operators or users. Strengths of one system can balance weaknesses of the other system, as shown in Table 2.

2.5 Feasibility Study: SINUE Project

The main idea of this project[3] was to analyse and demonstrate by simulation the feasibility of integrating UAS into non-segregated airspace relying on satellite-based systems for safety of flight communications as well as the use of satellite communications for the provi-

[3] Feasibility Study for Unmanned Aerial System supported by Integrated Space Systems (SINUE). SINUE Consortium. 2010.

UAS Category	Satellite Services for UAS			
	Navigation/ Positioning	Safety Comms.	Payload Comms.	Cooperative Surveillance
Micro	High	None	None	None
Mini	High	Low	None	Low
Tactical	High	Medium	Medium	Medium
MALE	High	High	High	High
HALE / HAP	High	High	High	High

Table 1: Satellite services for UAS according to UAS categories.

Characteristic	Satellite	UAS
Area Coverage	Better	Worse
Resolution (e.g. atmospheric effects on resolution)	Worse	Better
Availability (when and where required)	Worse	Better
Flexibility (to change mission parameters, type of payload, ...)	Worse	Better
Real Time (direct use of data and response time of the system)	Worse	Better
"Pre-conflict" data availability	Better	Worse
Maintainability and upgrade of the system and payload	Worse	Better
Data/Service Cost to Users	Better	Worse
Heterogeneity of quality for the same service	Better	Worse

Table 2: Complementary capabilities of Satellites and UAS.

sioning of high data rate mission payload data link. The goals of the mission simulations performed during the project were two-folded: on one side, demonstrate from a technical point of view the feasibility of using satellite systems for the provisioning of such services; on the other hand, illustrate to non-UAS aware audience how the integration issues are tracked.

This project studied different UAS mission types and the technology available for the short-term keeping the main stakeholders in the loop for designing a suitable demonstration.

The Consortium consisted of a group of companies from different countries of the European Union (Spain, Luxembourg, Portugal and Germany), bringing together the required expertise areas on UAS, ATM, Simulation, and Satellite technologies.

SINUE project was structured into three phases: (1) *Mission selection*, where user needs, state-of-the-art technology and scenarios were analysed for a suitable mission definition; (2) *Mission definition*, where a detailed mission definition was depicted and associated simulations were performed, and (3) *Mission plan*, where a mission plan together with an evaluation framework was defined, including viability analysis and roadmap.

Figure 2: SINUE Consortium.

Along the project, several aspects were considered including specific mission architecture, LOS/BLOS coverage, contingency plans, and ATC integration.

2.6 Short-Term Way: SINUE Demo

SINUE project is envisioned as the first step of a more ambitious road, which will culminate in a demonstration mission using currently available assets. For this purpose, as

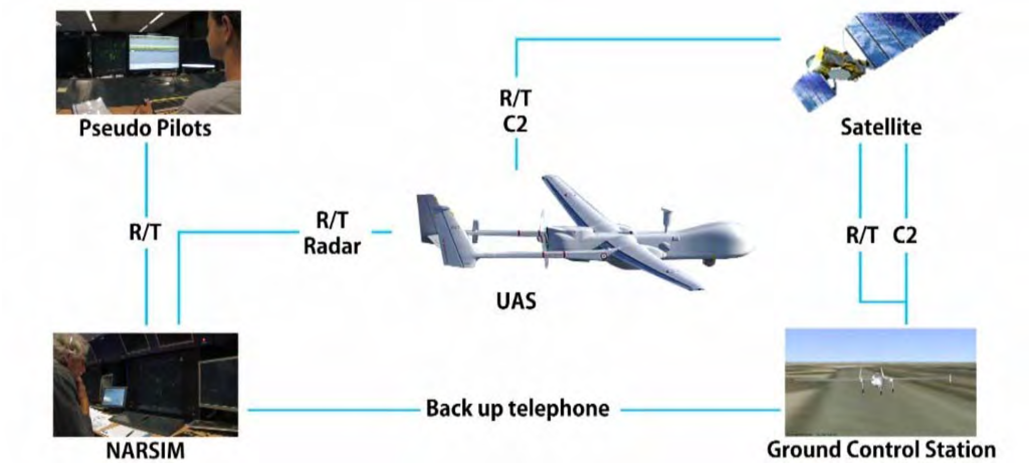

Figure 3: SINUE project architecture.

done during the project, it is deemed necessary the involvement of a certain number of stakeholders ranging from end users to regulatory and safety agencies and from UAS manufacturers/integrators to satellite service providers and governmental agencies.

In this line, SINUE paved the way for the next step, a demonstration in the short-term based on concepts and assets identified in feasibility studies in cooperation with satellites and achieving real civil end-user needs.

2.7 Conclusions

UAS integration into non-segregated airspace has several challenges that require a joint UAS community effort towards wide civil applications. As summary is worth noting that:

- Most interesting civilian applications for UAS stakeholders are security and emergency management
- It is possible in the short-term a maritime patrol demonstration operating from a dual-use airport and flying the mission in segregated airspace
- SINUE demonstration would be useful for:
  - Demonstrate added value for end-users
  - Test progressive ATC integration
  - Acquire operational experience
  - Demonstrate economic viability
- Open issues:
  - Certification/Permit to Fly
  - Crew qualification
  - Full/partial integration in non-segregated airspace

3. Identifying Regulatory Parameters to Integrate Unmanned Aerial Vehicles into Non-Segregated Airspace

by Stefan A. Kaiser

> » Aviation in itself is not inherently dangerous. But to an even greater degree than the sea, it is terribly unforgiving of any carelessness, incapacity, or neglect.[4]

In recent years unmanned aerial vehicles (UAVs) have made huge progress. They have become an integral element of military operations. This trend will continue and affect air forces worldwide. Their inventories will change and UAVs will steadily replace manned aircraft. The rapid development of military UAVs has been supported by the favourable conditions for the testing and collection of practical experience in military reserved airspace without formal airworthiness certification.

The experience gained in military operations has stimulated interest in civilian UAV operations in many roles, but predominantly related to tele-observation. Civilian UAVs are intended to operate in a different environment, in the common, non-segregated civilian airspace together with all other air traffic. What is acceptable in military operations and in segregated airspace does not apply to civilian applications. Currently, UAVs lack formal airworthiness certification by civilian aviation authorities. There are no airworthiness standards and acceptable means of compliance for those technical features of UAV technology that go beyond traditional manned aircraft. The main obstacle for civilian UAVs to be able to fly in non-segregated airspace is safety.

3.1 The Regulatory Background

3.1.1 The International Principles

Art. 8 Chicago Convention of 1944[5] is the paramount, universally accepted treaty rule governing "pilotless aircraft":

> » No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.

Despite being short and general, this provision has substantial content and the following principles can be derived from it:

1. Pilotless (civilian and State) aircraft are legally considered to be aircraft, so that aviation rules apply, but the "pilotless" element requires additional safeguards.
2. As a matter of sovereignty, any overflown State reserves the right to authorize flights of (civilian and State) pilotless aircraft over its territory.
3. The over-flown State has the right to determine *the terms of the authorization.* It has the authority to unilaterally establish (airworthiness and flight) rules for the operation of (national and foreign, civilian and State) pilotless aircraft in its national airspace.
4. The operation of pilotless aircraft must not to compromise safety (of other civil aircraft) in all regions open to civil aircraft, not only in national airspace.

3.1.2 The Systems Approach

The scope of State authorization will not be limited to UAVs, but will include all related system elements and their safe operation. In this context the term Unmanned Aerial Systems (UAS)[6] is normally used, which covers

- the UAV (the flight vehicle),

[4] Kranz, Gene. Failure is not an Option: mission control from Mercury to Apollo 13 and beyond. New York: Simon & Schuster (2000): 202.
[5] Convention on International Civil Aviation, Chicago, 7 December 1944.

[6] In this article the term "UAV" is used when the context relates to the aerial vehicle only, and "UAS" when the system is addressed.

- the ground operations centre(s) (where the UAV pilot-in-command is located),
- all required communication and data links, and
- the launch and recovery elements.

The systems approach, as implied by the term "UAS", is not only a technical concept – it is a comprehensive regulatory approach. The new technical elements of UAS reach beyond the traditional elements of airframe, power plant and avionics. For the safe operation of a UAV, all elements of the system (UAS) need to meet appropriate airworthiness requirements.

3.2 The "Pilotless" Element

Following the rationale of Art. 8 of the Chicago Convention, the technical elements that distinguish "pilotless" aircraft from conventional manned aircraft need to be specified. Once these elements are identified, it is possible to look more closely at special regulatory measures for UAS that are additional to those of manned aircraft.

In broad terms these elements either belong to the category of man-machine interfaces (or even machine-machine interfaces) or to flight automation. The man-machine interfaces are primarily a result of the remote control operations of UAS. Three main interfaces can be distinguished.

3.2.1 The Interface between Pilot and UAV

Most important is the link between the pilot on the ground and the UAV. The reason can be found in standards 2.3.1 and 2.4 of the Chicago Convention's Annex 2 (Rules of the Air), which determine the responsibility and authority of the pilot in command:

Standard 2.3.1: "The pilot-in-command of an aircraft shall, whether manipulating the controls or not, be responsible for the operation of the aircraft in accordance with the rules of the air, ..."

Standard 2.4: "The pilot-in-command of an aircraft shall have the final authority as to the disposition of the aircraft while he is in command."

UAVs are by definition "pilotless". Command and control must be exercised by a pilot on the ground, typically in an operations centre. Therefore the interface between the operations centre, the pilot in command and the vehicle is vital. The pilot in command on the ground needs to be put into the situation as if he were on-board the UAV. Technically this must be accomplished by reliable (radio) data links between ground control and vehicle and various sensors and actuators on board. The situational awareness of the pilot in command on the ground needs to be the same as on the flight deck, so that he can seamlessly exercise command and control of the UAV.

3.2.2 The Interface between Pilot and Air Traffic Control

When operating in controlled flight, typically under instrument flight rules, the pilot in command has to maintain radio contact with the responsible air traffic control (ATC) unit. The same has to apply when a UAV operates under the same conditions, except for the difference that this interface must be reliably established between the pilot on the ground and air traffic control. This can be achieved by radio or ground based voice and data communication

3.2.3 The Interface between Pilot and Air Traffic in the Vicinity of the UAV

Technically, the most challenging interface is the one between the pilot in command and other traffic. It is generally accepted that the pilot in command is responsible for avoiding collisions with other air traffic, regardless whether operating under visual or instrument flight rules.[7] In national US legislation, this principle is called "see and avoid".[8] When no pilot is on board, collisions avoidance needs to be (partially) automated. The pilot in command needs sensors to "detect, see and avoid" other traffic.

Putting a more or less normal video camera on board does not solve the problem because a lot higher resolution is required to cope with the high speeds and dynamics in air traffic.

The images taken by the camera on board a German army Luna UAV during a near miss with an Airbus A 300 of Ariana Afghan Airlines over Kabul on 30 August 2004 demonstrate their lack of suitability for collision avoidance.[9]

The technical key to the problem will be (semi-) automated sensors, which can detect other traffic either independently or cooperatively, by data exchange between the sensors of aircraft in the vicinity.

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[7] An introductory note to Chicago Convention, Annex 2, sec. 3.2., of the Chicago Convention mentions the importance of "vigilance for the purpose of detecting potential collisions be not relaxed on board an aircraft in flight…".
[8] 14 CFR Part 91.113 (b)
[9] After the near miss the UAV crashed into an urban area because of the wake turbulence of the Airbus.

3.2.4 Flight Automation

An even bigger technical and regulatory challenge for the "pilotless" element is flight automation. Automation of flight has been progressing for decades. One of the effects is the reduction of the flight deck crew from five down to two individuals.[10] Full automation will be the pinnacle of this development, which is strongly spurred by the technical advancement of communication and information technologies and their miniaturisation. Remote control and autonomous operations can complement each other in such a way that autonomous flight can be a fall back mode if a control link fails.[11] Even though partial or full autonomous flight operations are feasible, there must be human responsibility for and authority over the vehicle. Thus the various interfaces continue to be a crucial factor. For legal reasons it must be ensured that the responsible pilot in command on the ground can override the autonomous flight mode at any time, when necessary.

3.3 Planning Assumptions

There is already a broad spectrum of UAVs with different mass, payloads, performance, speeds and operating altitudes. Even without distinguishing various categories, it is clear that different classes of UAVs will use different portions of the airspace under different operating procedures. This will necessitate differences in their regulation. To facilitate the identification of regulatory parameters for operating UAVs in non-segregated airspace, the following planning assumptions can be made:

- Small and micro UAVs are cheaper and technically less sophisticated than medium and large UAVs.
- The population of small and micro UAVs will be by far greater than that of medium and large UAVs.
- Small and micro UAVs operate in lower[12] airspace, while medium and large UAVs operate primarily in higher airspace.

3.4 Airspace

3.4.1 Airspace Complexity

Airspace is the medium of aviation. It is a limited resource and regulation is needed for its use, to avoid collisions and to ensure safety. Though invisible, airspace is divided into segments where different rules apply. In exercise of their sovereignty, States structure their national airspace in different ways. Many opt to keep huge portions open to a broad user community and only reserve smaller portions of it, for example for military, security or experimental uses. If UAVs are intended to be used for civilian purposes, regulatory steps must be taken to integrate them into the commonly used airspace rather than the segregated airspace used by the military for defence exercises. One of the difficulties is the complexity of airspace structures. The distinction to be made is not only between controlled and uncontrolled airspace. ICAO has established eight different categories of airspace for different purposes, where air traffic must meet different requirements.[13] When trying to identify parameters for integrating UAVs into common airspace, it becomes apparent that there will be different solutions depending on the category of UAV and the type of airspace. A critical factor is the risk of mid-air collisions. This risk directly depends on the traffic density, and will be higher for uncontrolled traffic under visual flight rules (VFR) in high traffic density environments (airspaces E, F, G).

3.4.2 Metropolitan Areas

Metropolitan areas present special challenges. Most of them are within the control zones of airports where only controlled flights are possible down to the surface. Thus the prospective market for photo and surveillance flights over major cities of the world normally requires clearance by the responsible control tower. Tower controllers responsible for take-off and landing at major airports have only a limited capacity to handle additional flights of helicopters and light aircraft within the control zone, let alone a larger population of small and micro UAVs

3.4.3 Very Low Airspace

Opening very low (non-segregated) airspace, e.g. 500 ft (approximately 150 meters)

[10] In modern jets, radio officers, navigators and flight engineers have disappeared, leaving only the commander and co-pilot in the cockpit.
[11] Warwick, Graham. "Leading Edge: Good Behaviour". AW&ST, 29 November 2010.
[12] In this context, lower airspace is understood as airspace, where most of the general aviation is operated under visual flight. This is typically below 10 000 feet (approximately 3000 meters), although the ceiling of many micro UAVs will be far lower.
[13] Airspace classes A to G, see ICAO Standard 2.6 and Appendix 4 of Annex 11. The differences encompass the type of flight (visual or instrument flight rules), separation, service provided, speed limitation, requirement of radio communication and ATC clearance.

above ground level, for small and micro UAVs is no solution either. Although this airspace band is not used in the standard operations of general aviation[14] it is below the minimum safety altitude[15]. There are well-justified reasons why general aviation does normally not use these very low altitudes: obstacles must be avoided in difficult contour flight above the surface and are difficult to see or circumnavigate, such as power lines and wind mills. Conflict in very low airspace may also arise from low level high speed training flights by military combat aircraft.

3.4.4 Increased Separation for UAVs?

In airspace, where all traffic is subject to control,[16] increased separation for UAVs from other traffic could be considered.[17] But it is doubtful whether this would be a substantial improvement. Increased separation means buying some additional time for reaction, in the event of malfunction or signal loss of a UAV. This means nothing more than segregating airspace for UAVs, albeit in a dynamic fashion.[18] From the viewpoint of equitable airspace management, reserving over-proportionate shares of common airspace for the reason that (certain types of) UAVs do not meet the (certification) requirements of manned aircraft is not a solution.

3.4.5 Priority Right of Way for UAVs?

It is questionable whether a priority rule for the right of way of UAVs would contribute to the efficient de-confliction of traffic. The rules of the air recognize a priority right of way for airships, gliders, balloons and towing aircraft in relation to aircraft due to their limited manoeuvrability.[19] But from a distance, UAVs by their outer appearance are difficult to distinguish from manned aircraft. Moreover, priority rules are a weak tool, as every pilot will attempt to avoid conflicting traffic in his proximity, regardless of priorities.

3.5 Airspace Related UAV Scenarios

Given the diversity of UAVs and the complexity of airspace, an approach for integrating UAVs into common, non-segregated airspace must be multi-layered. For this purpose, the following three-tier structure is proposed:

- Large and medium UAVs will operate in high-level airspace, where other traffic operates mainly under instrument flight rules. In this environment, the Airborne Collision Avoidance Systems (ACAS), which are standard on all transport aircraft, can be used as a tool (together with other sensors and systems) to implement “detect and avoid” based collision avoidance in an instrument flight rule (IFR) context. Given the cost and payload of large and medium UAVs, ACAS and other certified sensor and collision avoidance equipment are not a limiting factor.
- Small UAVs will operate in (lower) airspace, where general aviation operates, a major part thereof under visual flight rules (VFR). In a VFR context, it will be more difficult and take longer to implement a “detect, see and avoid” collision avoidance scheme because general aviation aircraft are not required to be equipped with ACAS or similar type sensors. Under VFR, “see and avoid” is applied as a reciprocal collision avoidance tool. Human eyesight and reaction has its limitations. But the key assumption of VFR is reciprocal responsibility for collision avoidance. Two pairs of eyes are needed; and this would not be compromised by UAVs. An additional complicating factor is the compact size of small and micro UAVs that makes them more difficult to spot them. This leads to the conclusion that small UAVs have a greater collision risk in lower airspace (than large and medium sized UAVs at higher altitudes), especially in regard to the large population of general aviation aircraft operating in this airspace under VFR.
- Micro UAVs will primarily operate at lower altitudes than small UAVs and other air traffic. This reduces the risk of collisions with manned air traffic. Flying them in the same airspace as general aviation must be avoided because it is extremely difficult for the timely spotting of these tiny vehicles by VFR pilots. An appropriate regulatory measure could be a strict operating limitation for remote controlled operations under VFR rules with a maximum altitude (e.g. 500 feet / 150 meters above the ground) and within defined visual line of sight of the operator – similar to the operation of model aircraft. Such limitations may enable their use in the very low portion of

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[14] Except for take-off and landing.
[15] ICAO Standards 3.1.2, 4.6, 5.1.2 of Annex 2.
[16] Under instrument flight rules or controlled visual flight rules in airspaces A to D.
[17] ICAO Standard 3.4 of Annex 11 and PANS-ATM (ICAO Doc. 4444)
[18] As compared to the statically reserved airspace portions for military operations.
[19] ICAO Standard 3.2.2.3 of Annex 2

(non-segregated) airspace and in defined safety distances to airports, built-up areas and the public on the ground.

3.6 Airworthiness and Certification

3.6.1 Airworthiness and Certification Requirements for UAVs

Airworthiness and certification play an important role for the integration of UAVs into non-segregated airspace. Put simply, if UAS are certified as airworthy as manned aircraft, there is no obstacle to their integration. But certification is not only a formality or a paper exercise. The purpose of certification is flight safety, to protect other aircraft and the public on the ground. To be a meaningful tool, it must have substance. Therefore airworthiness standards and acceptable means of compliance need to be established also for those elements that are specific to the "pilot-less" nature of UAVs – and UAS as a system. These include remote control, the quality and reliability of data links and sensors and their protection against misuse, reliable technical means for a "detect see and avoid" collision avoidance regime and all aspects of autonomous flight.

How critical data links and software are, became apparent in an incident on 2 August 2010, when a US Navy MQ-8B Fire Scout unmanned helicopter went astray and violated the Air Defence Identification Zone surrounding Washington DC. The cause was a software anomaly and the loss of the control link.[20]

The crash of a General Atomics Predator B UAV on a border patrol mission close to the city of Nogales, AZ, USA, on 25 April 2006 illustrates the shortcomings of information technology and the applied procedures of use. This accident was later attributed to an "unresolved lock-up" of the computer console of the operating pilot on the ground and to a wrong setting of the fuel valve position of a stand-by console, which was quickly activated as an alternate system.[21]

The crash of a IAI Hunter UAV of the Belgian forces during a EUFOR mission killed two civilians in the streets of Kinshasa (Congo) on 3 October 2006. The cause was loss of situational awareness of the pilot, who was reported to have shut down the engines during take-off, unaware that the UAV was already airborne.[22]

Such causes are typical for the system complexity of UAS and the related human factors and man-machine interface problems. They illustrate the additional risk factors in comparison to manned aircraft. A U.S. Congressional Research Service report has assessed that the safety of UAVs is lower than that of manned aircraft by a factor of 100.[23]

From an airworthiness and certification viewpoint, UAS must meet or exceed the safety standards of manned aviation. UAS must be designed, manufactured and operated to avoid harm to other airspace users and the public on the ground. Manned aviation is not obliged to overcome the shortcomings of UAS situational awareness, remote control and automation. At stake is not only safety, but also security. If the control links of a UAV are hacked, third parties may "turn around" and use it for their own purposes, including terrorist attacks.

3.6.2 Information Technology Quality Standards

UAS represent a qualitative change in the automation of flight. Rapid advances in the fields of radio communication, information technologies, miniaturisation and robotics have made that possible, at seemingly low cost. However, the quality standards commonly practised in the information technology industry do not suffice as airworthiness standards. If computers, software and data links are used for UAS, the quality standards for aircraft need to be applied. The hardware and software used for office or computer game applications lack the reliability and stability necessary for aviation use. As a consequence, the price tag of UAS will go up, if aviation airworthiness standards are applied. This price impact will be significant in the low-cost segment of small and micro UAVs.

3.6.3 Physical Impact a Criterion for Certification?

Proposals for relaxing certification requirements for UAVs up to a maximum gross weight of 150 kilograms (kg) are questionable. UAVs below 150 kg do not fall under the responsibility (for certification) of the Euro-

[20] Caras, Christopher P."Lost Navy UAV enters Washington Airspace". Defense News, 25 August 2010.
[21] The wrong setting put the on board fuel valve to "off". The engine died for lack of fuel and the Predator crashed – without human casualties. Predators are high-end products with a multi-million U.S. dollars unit price. For more details see the publication of the US National Transportation Safety Board, NTSB Identification: CHI06MA121.

[22] Larson, George C. "UAVs, or Nothing Can Go Wrong, Go Wrong...". AW&ST, 29 January 2008.
[23] Ibid, with reference to this CRS report.

pean Air Safety Agency (EASA),[24] but EASA Member States remain responsible.[25] One argument for a proposed relaxation for this class of UAVs is the limited physical impact of vehicles with low mass, speed and height.[26] This is true for a risk assessment relating to property damage on the ground. But it does not take into consideration mid-air collisions. Objects of only a couple of kilograms can have a catastrophic effect on colliding aircraft and persons on board. The physical impact limitation is therefore not a valid risk mitigation tool for mid-air collisions. It does not take into consideration the speed of the aircraft colliding with the UAV and the increased difficulty of identifying that class of UAVs due to their small size.

3.7 Operating Procedures and Personnel Licensing

For the sake of completeness, it must be mentioned that airworthiness certification is not the only area of regulation relevant to UAS. Operational procedures need to be established for a seamless interface between the UAV and the operating pilots on the ground and air traffic control. Operational procedures must be in place to ensure that an identifiable pilot in command has responsibility for the UAV at any time and can exercise full authority over it. This includes transparent procedures for the hand-over of responsibility and authority from one pilot in command to another.

Equally important are regulations for the licensing of the pilot in command. Other than some justifiable exceptions for micro UAVs operating in a very limited range and visual line of sight by the operator, pilots in command should hold the same qualification as pilots of manned aircraft. In addition, psychological factors must be taken into account. Non-flying pilots on the ground do not pledge their lives for the safety of flight like a pilot on board an aircraft. Special attention must be paid to young people who grew up with computers and are used to operating in animated scenarios. But cyberspace is not airspace. Their skills of problem solving on a virtual user surface neither substitute for nor train them in their responsibility for the safety of humans in real life. Every "real world" pilot does his utmost to return home safely. For this reason, active piloting experience on board aircraft should be a prerequisite also for pilots of UAVs.

3.8 Outlook

The broad spectrum of UAVs will result in different solutions for their integration into common, non-segregated airspace. This may imply a phased approach with different timelines.

Certification of airworthiness and the use of non-segregated airspace are interdependent. If a UAS is fully certified like a manned aircraft, there are no obstacles to its use in non-segregated airspace. But if a UAV cannot be fully certified because of technical limitations, there will be restrictions on the use of (non-segregated) airspace.

Flight automation has been an ongoing trend for decades. Avionics, fly by wire technology, flight management systems, glass cockpits, and (satellite based) communication, navigations and surveillance systems have been breathtaking in their development. UAS are the pinnacle of this trend. At the same time, we see a confrontation between two technological philosophies: information technology on the one side, and aviation on the other.

Information technology is ground-breaking and has shown spectacular development in the last decades. But many products do not have high reliability and stability. Yet the competitive environment usually demands the roll out of pre-mature products. Defects are fixed later – often to the detriment of the customer.

Aviation was a pioneering and creative industry in its early years, but at the cost of casualties. Today aviation is based on a robust safety culture. It takes years and decades to develop new aircraft. Innovations trickle only slowly into market-ready aviation products. The result is a very good safety record.

It is highly attractive to merge the innovative power and competitive pricing of information technologies with aviation. UAS are a product of such a merger. No doubt, we will see UAVs and manned aircraft flying in the same airspace. To achieve this goal, all regulatory steps must be undertaken to maintain the safety levels the aviation industry has achieved over a century.

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[24] Regulation of the European Parliament and of the Council (EC) 1592/2002 of 15 July 2002 on common rules in the field of aviation and establishing a European Safety Agency [2002] OJ L240/1.

[25] This leaves it to Member States to decide if UAVs below 150 kg will be regulated at all, or if they should create their own national regimes.

[26] See the Joint JAA/ EUROCONTROL Initiative on UAVs, UAV Task-Force Final Report, Annex 1, 11 May 2004, which proposes a limitation to 95 kilo joules and equates to a maximum mass of 150 kg, maximum speed of 70 knots and maximum altitude of 400 feet / 120 meters.

4. The Main Elements for a European Regulatory Framework for UAS Flying in the Common Airspace

by Anna Masutti

4.1 Introduction

While in the military domain UAS are already widely used under specific conditions and in segregated airspaces, UAS for civil use are still at an early stage. However, recent studies have shown that UAS applications for civil use have been developed and their deployment, especially for security purposes, is considered more and more a necessity.

The Single European Sky (SES) will be implemented by the SESAR project (Single European Sky ATM Research) that is the European air traffic control infrastructure modernisation programme. SESAR aims at developing a new generation air traffic management system capable of ensuring the safety and fluidity of European air transport over the next 20 years.

SESAR brings a new dimension to European ATM, which has a wide effect on all airspace users including UASs. The SESAR Concept of Operations (CONOPS) for 2020 fully recognises UASs as potential users of the common airspace. It expects increasing numbers of UASs, starting with military missions and extending to many types of civilian tasks, with machines ranging from very light to heavy. The basic assumption is that when an UAS enters non-segregated airspace the provision of an Air Traffic Service (ATS) to the UAS must be transparent to ATC and other airspace users.

However, the potentiality of UASs cannot be proven until they can fly in the segregated area and this can only happen if appropriate legislation and regulatory measures are developed. Thus the need to have a full set of common European rules on UASs airworthiness and integration of UASs within the non-segregated airspace has become a matter of urgency and an unavoidable task. Lack of this regulatory framework prevents the industry from making appropriate business plans and initiating the developments required to meet the needs of civil customers.

The present contribution to the debate raised by ESPI on UASs examines the applicable current legislation at international level and at the European level, the basic principles that should be taken into consideration for designing a regulatory framework permitting UASs to fly in the common airspace and the contribution of international organisations (ICAO, EUROCAE) to this project.

The key role of EASA is outlined with regard to certification of UASs (aircraft and ground station) and pilot licensing, while also considering a regime of responsibility and accountability to identify the party liable in case of damages to persons or property caused by a UAS accident.

European legislation has divided UASs into two major groups, which are each regulated by different authorities:

- UASs with a maximum take-off mass of more than 150 kg.
- UASs with a maximum take-off mass of less than 150 kg, commonly designated as Light UASs.

This paper deals with UASs with a maximum take-off mass of more than 150 kg, which will be regulated by EASA, while the regulation of UASs with a maximum take-off mass of less than 150 kg is left to the civil aviation authority of each Member State and will be examined in detail by Prof. Pablo Mendes de Leon.

4.2 The Reference Legal Framework

The present legal framework offers a limited number of references. The most important one is certainly the 1944 Chicago Convention that introduces (Art.8) an actual over-fly prohibition for unmanned air vehicles without a specific authorisation[27]. In fact, this rule

[27] It should be recalled that the Chicago Convention is applicable, as stated by Art.3, only to civilian aircraft and does not apply to aircraft used for State flights, military flights, custom and police flights. For such aircraft, ex-

states that: "No aircraft capable of being flown without a pilot shall be flown over the territory of a contracting State without special authorisation by that State and in accordance with the terms of such authorisation. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft".

From this provision it appears clear that consent to over-fly contracting States is only granted when certain conditions are satisfied, such as authorisation from the over-flown State, respect of the over-fly terms, the obligation of the over-flown State to take all necessary measures to ensure that the overfly in airspace that is open to civil aircraft does not affect their safety.

There are thus several pre-conditions to authorise the over-fly of UAVs and these involve the adoption of complex initiatives aimed at guaranteeing the safety of related operations as prescribed by the Chicago Convention.

Consequently, international rules require the submission of the relevant authorisations demonstrating that the UAV comply with the airworthiness rules as stated, for example, by Articles 20 and succeeding, and Art. 29 and succeeding of the Convention as well as with the ICAO technical Annexes issued for putting into effect such rules[28]. These Articles require, for example, the possession of an airworthiness certificate, an ordinary license for the crew, the board documents, etc, as well as the acknowledgment of their validity by the contracting States.

While for ordinary aircraft this process has been followed since the adoption of international regulation, and has received a strong impulse thanks to the recent intervention of the European Union, for unmanned air vehicles, no technical rules capable of obtaining contracting States' approval and the release of the relevant authorisations have as yet been drawn up.

This deficiency has been noted on various occasions both at international and EU level and it has forced the relevant authorities to attempt to remedy this situation.

cluded from the international rules system, over-fly or landing in other States is possible only under previous special authorisation and conditions. (Art.3 letter c).

[28] Art.20 (nationality mark) of the Chicago Convention compels all aircraft to show their nationality and registration mark. Art.29 lists the documents that all aircraft of contracting States must carry on board.

4.3 Application to UAV of Principles and Airworthiness Rules Introduced by European Regulations.

The absence of a legal framework able to offer solutions to the various legal problems created by the use of the aircraft in question and the interest shown in their use for civil purposes, has encouraged the start of a process involving many international authorities at EU and international level thanks to the initiative of the *European Air Safety Agency* (EASA) as contained in Regulation (CE) 1592/02, as amended by Regulation 216/2008 and Regulation 1108/2009[29]. This Regulation, while stating the obligations of aircraft[30] to comply with the essential airworthiness prerequisites established in the relevant annexes, does not however extend this obligation to UAVs.

The absence of a specific mention of UAVs could suggest that they are excluded from the new airworthiness rules. Actually, a correct interpretation of these rules leads to the conclusion that even unmanned air vehicles are subject to EU rules and to the harmonisation action of the European Air Safety Agency.

The definition of aircraft and product, contained in the Art. 3 of Regulation (CE) 1592/2002 appears, in fact, insufficient to include the aircraft which are the subject of this analysis[31].

[29] Regulation (EC) No 216/2008 of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC, has been amended by Regulation (EC) No 1108/2009 of 21 October 2009. As a consequence of the formation of EASA, the ICAO Annex 8, containing airworthiness rules for aircraft, has received a more harmonious and exhaustive application in EU Countries and has also led to consent to draw up guidelines for the future technical-legal regulation for the use of UAV. S. SCIACCHITANO, *La nascita dell'European Aviation Safety Agency (EASA)* in News Letter, Bologna University Luglio-Settembre.

[30] The Regulation is applicable to the aircraft, including products, parts and pertinences installed, that have been designed or produced by an organisation for which the Agency or a Member State assures the safety control, or have been registered in a Member State or even registered in a third country, provided that they are managed by operators for which a Member State assures the surveillance of operations.

[31] These considerations have been anticipated also by the European Air Safety Agency which, describing the *policy for UAV systems certification (Airworthiness and Environmental Protection),* has observed that "The proposed policy is applicable to UAV systems with a maximum take off mass of 150 kg or more; which are not excluded by

However, support for a broad interpretation comes from Annex II of the Regulation, issued for the application of Art.4. This article, while stating the obligation for aircraft and related products, to comply with the technical rules of the Regulation, leaves to a specific annex the identification of the exempted categories and, among them, lists "(i) unmanned air vehicles having an operating mass below 150 kg.", which leads to the conclusion that those weighting 150 kg or more must comply with the essential airworthiness rules that the EU Agency will set.

The necessity of elaborating the essential requisites for UAV has also been recognised by the European Economic and Social Committee, which recently intervened on the matter of air safety. This Committee has reiterated the need that the *European Air Safety Agency* defines "the necessary protocols before considering the hypothesis to authorise the UAV flights out of the reserved airspace"[32].

In order to facilitate this process, and authorise the use of UAV in the general airspace, the European body has reiterated that these aircraft are subject to the existing set of rules for conventional aircraft, confirming the interpretation of the aircraft definition here above. Art 11.2 states, in fact, that "all rules relating to conventional aircrafts must also be considered compulsory for the UAV".

This conclusion, i.e. the application to the UAV of the same technical norms applicable to conventional aircraft, and the necessity (to make it work) of issuing the protocols required by Regulation (CE) 1592/2002, have encouraged EU authorities to identify some criteria as a basis for preparing the future legal framework.

4.4 The UAV Certification

The initial actions of the bodies charged to study UAV's essential airworthiness criteria have clearly indicated that the technical and operating features of this particular category of aircraft make the certification of the single aircraft insufficient to guarantee the safety of its flight operations.

This position was supported, for example, by the *Joint Aviation Authorities* (JAA) in a study made in conjunction with EUROCONTROL, anticipating an opinion later expressed by the European Air Safety Agency[33]. This conclusion was based on the principle that the flight of an unmanned air vehicle is operated by complex equipment from a control station and a link system between the station and the aircraft.

On this basis, and in order to guarantee the flight operation's safety, it has been deemed decided that the certification must refer to the entire equipment used for such purpose.

The equipment comprises the control station[34] and any other necessary element to realize the flight operations, like the communication link [35] and the *launch and recovery element*[36]. The equipment may allow the use of more than one vehicle, various control stations and *launch and recovery elements*.

Such a configuration of the UAV system raises many delicate questions that must be examined in order to identify the essential criteria capable of guaranteeing the flight's safety. Particular attention should be paid to the possible communications between the number of control stations and the number of flying aircrafts. When the configuration of the system foresees one or more stations controlling the same aircraft, no problem should arise as the airworthiness certificate stating the conformity of the vehicle with the safety regulations could be issued foreseeing the use of a range of control stations for one aircraft.

It appears more complex in the case of one station controlling more than one aircraft of different models. In such a case it should be decided whether to issue the control station with two or more airworthiness certificates (according to the number of guided aircraft) or a single certificate specifically created for control stations having this particular feature.

Besides these considerations, which up to now have not been resolved, it has been de-

article 1(2) or Article 4(2) and Annex II of EC Regulation 1592/2002".

[32] Opinion expressed by the European Economic and Social Committee on safety matters , 2006/C, 309/11, in GUUE of 16 December 2006, C.309/51.

[33] E.g. on this point JAA/EUROCONTROL Initiative on UAVs: Task force Final Report – A concept for European Regulation for civil unmanned air vehicles, 11 May 2004; European Aviation Safety Agency: Advance – Notion of proposed amendment (NPA) No. 16/2005 – Policy for Unmanned Aerial Vehicle (UAV) certification.

[34] In the above cited EASA document, the control station (CS) is defined as "A facility or device(s) from which a UAV is controlled for all phases of flight. There may be more than one control station as part of a UAV system.

[35] The Communication Link has been defined, on the contrary, as: "The means to transfer command and control information between the elements of a UAV System, or between the system and any external location. (e.g. Transfer of command and response data between control stations and vehicles and between the UAV System and Air Traffic Control)".

[36] For EASA "UAV Launch and recovery element" is "A facility or device(s) from which a UAV is controlled during launch and/or recovery. There may be more than one launch and recovery element as part of a UAV System".

cided to follow an approach similar to that adopted for conventional aircraft as far as the pilot in command is concerned, i.e. the need for such persons to be in possession of the same licences accepted at European level.

The tendency that has emerged at EU level to proceed towards a certification "of the system", not limited to the single aircraft, appears justified in view of the intrinsic working mechanism of UAV.

The complexity of the system and the necessity to reach a shared solution on the criteria and principles to be adopted in order to draw up a technical system of rules for the use of unmanned air vehicles, has persuaded EU authorities to involve other competent bodies of this sector.

The *European Organisation for Civil Aviation Equipment* (EUROCAE) has been requested to produce a study for the airworthiness certification and the operative authorisation of UAV [37]. This working group, after having underlined that the lack of a clear legal framework on this matter is limiting the use of unmanned air vehicles in Europe, has prepared a program to produce a proposal for a set of technical rules governing the entire UAV system.

Such a proposal, suggested above, shall be applied not only to the aircraft, but also to the personnel who are employed in the control stations (despite not being on board the aircraft), and to the structure organised by the operator for this purpose, to the airports and to the air traffic controllers.

Finally, an important working group has been set up by ICAO [38], under pressure from the Member States and from EU countries in particular, which have forced the international organisation to define its role in the creation of a set of rules for this sector in order to guarantee harmonisation of terminology, principles and strategies for the future regulation of the sector itself. Consequently it has been suggested that there also needs to be a review of the ICAO Annexes to introduce *Standards and Recommended practices* for this kind of aircraft.

Within ICAO, the *Air Navigation Commission*[39] has examined the indications of the mentioned working group on UAV, stressing the importance of the guidelines to give proper answers to the many questions that have been raised. In particular, it has been proposed to change the terminology of *Unmanned Air Vehicles* into *Unmanned Aircraft System* (UAS) and more recently, with Circular 328 of October 2010, to change the name to *'Remotely Piloted Aircraft System* (RPAS) as, actually, they are not unmanned vehicles but remotely piloted aircraft.

The necessity of guaranteeing the safety of the system requires the certification of the entire apparatus. However, this consideration raises many legal questions that need appropriate answers.

4.5 The Criteria to Identify the Essential Airworthiness Prerequisites for UAV. The Objective of Avoiding Excessive Burdens

The option to undertake certification of the entire system could lead to a complex legal framework with innovative contents not appropriate to reaching the goal, at EU and international level, of adopting a set of rules aimed at creating a legal framework for the development of this commercial sector.

In order to avoid such risk, since the first production of documents at EU level[40], it has been pointed out that the prerequisites necessary for the certification of UAV, and the relevant technical principles for assuring the safety of these flights should, possibly, be similar to those existing for conventional aircraft, thus avoiding the introduction of more obligations and excessive burdens.

For this purpose, some fundamental principles and disciplinary approaches have been outlined for the concrete implementation of the technical rules of this sector.

The *European Aviation Safety Agency,* while producing the criteria to be followed for the description of the essential features, has first of all deemed it appropriate to specify the unmanned air vehicles that will be affected by this regulation[41] and those that will be subject to rules established by their single national authorities only.

This latter category comprises unmanned air vehicles with a maximum take-off mass be-

[37] WG-73: Unmanned Aerial Vehicle – Working Paper, 25 October 2006.
[38] ICAO Exploratory Meeting on Unmanned Aerial Vehicles, Montreal, 23 and 24 May 2006, ICAO-UAV WP/2.
[39] Air Navigation Commission, Results of unmanned aerial vehicle (UAV) questionnaire – Progress report on unmanned aerial vehicle work and proposal for establishment of a study group, AN-WP/8221, 17 April 2007.

[40] Advance – Notice of proposed amendment (NPA) No 16/2005 – Policy for Unmanned Aerial Vehicle (UAV) certification. Doc. EASA, loc. cit.
[41] E.g. Advance – Notice of proposed amendment (NPA) No 16/2005, ult. cit.

low 150 kg., those designed for scientific or research purposes, or produced in limited numbers and, finally, the UAV used for military, customs or police activities. However, for the last case individual national authorities should take into consideration, as far as possible, principles and regulations suggested by EASA, when regulating these activities[42].

Beyond this distinction, great importance has been given to the objective of avoiding the introduction into the certification criteria of elements considerably different from those required for conventional aircraft whose regulation can be applicable to UAV, although amended in consideration of the particular nature of these aircraft.

To this end, it has been necessary to stress the importance of the *impartiality* (or fairness) principle and consequently to utilise as far as possible the existing legal framework for conventional aircraft excluding a tailored regulation for unmanned air vehicles only.

Therefore, the UAV too, will have to comply with the airworthiness rules in force for conventional aircraft and acknowledged by the ATC service providers, avoiding, as far as possible, the application of different rules (*transparency).* The same importance has been attributed to the *equivalence principle (equivalent risk, equivalent operation)* that refers to the necessity of maintaining a safety standard at least equivalent to the one required for conventional aircraft[43].

Finally, on various occasions it has been necessary to stress the importance of establishing rules on *responsibility (responsibility/accountability)* once again in accordance with the same rules applicable to conventional aircraft. To the contrary however, it is recommended that specific rules be adopted regarding the *transfer of command* and, consequently, the distribution of responsibilities among the operators, in case the command operations are distributed among various control stations [44].

[42] A working group at JAA had already suggested this route. See JAA/EUROCONTROL UAV Task Force Final Report.

[43] The matter of the rules regulating the use of UAV in non-segregated areas was discussed also within ICAO and it appears in a working document which recalls the above mentioned principles worked out by the EU bodies.

[44] In particular, the distribution of tasks between the operator that guarantees the operations of the system and the pilot in command entrusted to drive the flight operations should be clearly defined.

4.6 Legal Problems Deriving from the Use of UAV in the Common Airspace. The Identification of the Civil Liability Regime for Damages to Third Parties and of the Liable Party

From the examination of the recent initiatives adopted by the European Union, and in order to approve the use of unmanned air vehicles in non-segregated areas (and to overcome the prohibition established by Art.8 of the Chicago Convention), it appears that the will of the EU bodies is to create a reference regulating framework to guarantee safe use of UAV, without imposing onerous measures preventing their deployment.

Consequently, the efforts of such authorities is mainly dedicated to designing the specific legal framework, while modest attention has been given to further legal implications deriving from the use of such aircraft.

A theme of great importance concerns the regulation of civil liability deriving from the use of UAV. The liability for damages to persons or property that can occur by an incident caused by an unmanned air vehicle requires the solution of various questions such as, for example, the applicable law, the identification of the liable party, etc. To this end it should be decided whether the norms contained in the Rome Convention of 7 October 1952 can be considered applicable.

Naturally, this Convention does not contain any reference to UAV, but in some cases its rules have been considered applicable to all kind of vehicles, including spacecraft, provided they are “usable for transport”.

Whenever an extensive interpretation of aircraft notion occurs [already adopted in the 1944 Chicago Convention and in Reg. (CE)1592/02] the set of rules contained in the Rome Convention can be considered applicable.

For example, the Italian parliament has recently come to the same conclusion. The reformed air navigation code does not exclude the application of the rules in question to the UAV.

These regulations, based on the aircraft operator’s strict liability[45], allow them to benefit

[45] In determining the operator’s liability the subjective actions of the party (fraud or serious fault) are not relevant. Therefore, it is an objective liability based on the risk of a lawful activity. The regulation relating to the liability for

from the system of debit limitation and for each incident to reduce the amount calculated in proportion to the weight of the aircraft that has caused the damage [46].

The application to UAV of the same discipline on civil liability for damages caused to third parties raises another question related to the identification of the liable parties.

The traditional framework adopted implies the distribution of liability between the pilot in command of the aircraft and his operator. In the first case liability normally lies with the pilot in command as the head of the expedition [47] as he is personally responsible for the observance of such obligations. In contrast, the liability for any other obligations, contractual or extra contractual, is attributed to the operator and in such cases international regulation, mentioned above, makes the operator liable for damages to third parties or damages from collision.

Therefore, considering the complexity of the unmanned air system, it is vitally important to make a clear distinction between the pilot in command of the vehicle and the operator, i.e. between the person appointed as the crew chief and sole director of manoeuvres and navigation and the person that sets up an organisation to obtain an economic benefit.

As anticipated in the previous paragraphs, EU bodies have clearly suggested considering the entire system of UAV (aircraft, control stations, etc) when creating a set of rules for this kind of aircraft. As a consequence, both the UAV operator and pilot in command must be recognised.

In such a scenario, liability for damages caused by the fall of UAV on the ground should be attributed to the operator, i.e. to the person or entity that, on the basis of Art.2 of the Rome Convention[48] sets up the system, assures its functioning and publishes his/its position to avoid the presumption that the owner of the aircraft is also the operator.

The figure of the pilot can be identified as the subject to whom is entrusted the command of one or more aircraft owned or at the disposal of the operator[49].

4.7 Other International Regulations Applicable to UAV

The principle, already accepted at EU and international level, that applies to UAV the international rules adopted for conventional aircraft, especially those relating to safety, encourages the application of the same international set of rules such as, for example, the *Convention For The Suppression Of Unlawful Acts Against The Safety Of Civil Aviation* signed in Montreal on 23 September 1971, and the more recent *Cape Town Convention* of 16 November 2001. Both conventions are

damages to third parties on the ground is applicable any time an aircraft, even for force majeure reasons, causes damages to persons or property. In these cases the operator is liable on the basis of a strict liability regime (which is tempered by some exclusions listed in the same Convention).

[46] Art.11 of the Rome Convention states: “1. Subject to the provisions of Article 12, the liability for damage giving a right to compensation under Article 1, for each aircraft and incident, in respect of all persons liable under this Convention, shall not exceed: (a) 500 000 francs for aircraft weighing 1000 kilogramme or less; (b) *500 000 francs plus 400 francs per kilogramme over 1000 kilogramme for aircraft weighing more than 1000 but not* exceeding 6000 kilogramme; (c) *2 500 000 francs plus 250 francs per kilogramme over 6000 kilogramme for aircraft weighing more than 6000 but not* exceeding 20 000 kilogramme; (d) 6 000 000 francs plus 150 francs per kilogramme over 20 000 kilogramme for aircraft weighing more than 20 000 but not exceeding 50 000 kilogramme; (e) 10 500 000 francs plus 100 francs per kilogramme over 50 000 kilogramme for aircraft weighing more than 50 000 kilogramme. 2. The liability in respect of loss of life or personal injury shall not exceed 500 000 francs per person killed or injured (…).” The limited value of the amounts indicated and the use of the golden franc as reference currency – replaced in almost all uniform regulations by the Special Withdrawal Rights (SWR) – have forced the revision of the Convention. Work on the modernisation of the 1952 Rome Convention is in progress within ICAO. E.g. B. Izzi, *Prospettive di riforma della disciplina internazionale sulla responsabilità per i danni a terzi sulla superficie*, in *Dir. trasp.* 2004, 400-401.

[47] So provides art.878 of the Italian Air Navigation Code.

[48] It is appropriate to point out in this regard that the notion of operator contained in the Rome Convention is partially different from that consolidated in the Italian air navigation Code. The notion of operator in the Rome convention is connected to criteria referring to the navigation activity. In fact the Convention attributes liability to the operator, i.e. the person who was making use of the aircraft at the time the damage was caused: *operator shall mean the person who was making use of the aircraft at the time the damage was caused*” (art. 2.2). The Convention makes a distinction between *use and navigation control* with the consequence, for example, that in case of abusive use of the aircraft, without the authorisation of the person entitled, the temporary user or abusive user will be the liable party to whom a joint liability of the operator is added, but only for guarantee purposes. This difference applies in the case of leasing where, like the Italian regulation, liability falls on the person who maintains navigation control (lessor). E.g. L. Tullio, *Responsabilità per danni a terzi sulla superficie, op.cit* .

[49] In this respect the document produced by EASA (Advance – Notice of proposed amendment (NPA) No 16/2005 – Policy for Unmanned Aerial Vehicle (UAV) certification, 25, cit.) has defined the UAV commander as “A suitably qualified person responsible for the safe and environmentally compatible operation of a UAV System during a particular flight and who has the authority to direct a flight under her/his command”.

not applicable to military, customs or police aircrafts.

The second Convention mentioned above aims at creating a specific international guarantee, fully applicable in all Member States, concerning assets that normally, for business purposes, move from one State to another, like aircraft and spacecraft, whose regulation is contained in special protocols, adapted to specific needs.

On the occasion of the approval of the wording Convention, an aeronautical protocol was opened to signature and the application of regulations created for conventional aircraft was also extended to UAV[50].

4.8 Initiatives Taken by Some Non-EU Countries and in Europe

In consideration of the increasing demand for UAS for many civil applications, some countries have taken initiatives permitting the deployment of UAS under certain conditions. In some cases the first step has been to update the existing ATC regulations; in other cases a separate set of rules has been designed. Europe is very active in this field and is progressing regardless of the extreme prudence of ICAO.

The most relevant experiences of a few countries are briefly described here below.

Canada has established a working group to amend existing Canadian Aviation Regulations to incorporate UAS operations into Canadian airspace with minimal changes. At present in the United States a civil UAS operator may have access to NAS (National Airspace System) if it has a special Airworthiness Certificate. The FAA is making efforts to enable small UAS to operate in certain portions of NAS.

In Australia the Civil Aviation Safety Regulations consolidate rules governing all unmanned aeronautical activities into one body of legislation. Guidelines are published for manufacturers and controllers.

At European level there are the following initiatives and projects: EASA published the Advanced Notice of Proposed Amendment (A-NPA) in 2005, followed by its Comment Response Document (CRD) on 6 December 2007. The main findings are now explained in sufficient detail in a "policy document" published in 2009 and discussed with stakeholders, including EUROCAE WG-73. The objectives of this "policy" are to facilitate UAS applications and to ensure a level of safety/environmental protection at least equivalent to comparable manned aircraft.

JARUS: European National Authorities under the leadership of the Netherlands and EASA are developing operational and technical regulations for UAS.

EUROCAE WG 73 is developing a requirements framework that would enable unmanned aircraft to operate within the constraints of the existing Air Traffic Management (ATM) environment in airspace without segregation from other airspace users.

INOUI Project (Innovative Operational UAS Integration) funded by the 6th Framework Programme of the European Commission, focuses on the integration of Unmanned Aerial Systems (UAS) in non-restricted airspace in the context of SES.

4.9 Conclusions

The market for UAS for civil use is emerging, offering a wide range of applications including security. The existing regulatory framework is limited and permits UAS to fly in segregated airspace only. To unlock this market it is necessary to design a new regulatory framework allowing UAS to fly in the common airspace. The basic principles for airworthiness, certification and licensing have already been identified. Today's technologies are very close to allowing UAS to offer the same safety standards as manned aircraft.

The path to design the new regulatory framework is long and should be started now. ICAO, with its Circular 328 of October 2010 has expressed the intention to proceed towards the insertion of UAS in the common airspace. Europe should take lead of this process by setting up the High Level Group announced during the UAS International Conference of 1 July 2010 in Brussels.

[50] E.g. co-authors. Il protocollo aeronautico annesso alla convenzione relativa alle garanzie internazionali su beni mobili strumentali (Città del Capo, 16 novembre 2001) edited by L. TULLIO, Padova, 2005.

5. Integration of UAS into SES and SESAR

by Roderick van Dam

The integration of remotely piloted aircraft into non-segregated airspace is of course a global issue, not just limited to the countries that are subject to the Single European Sky Regulations. The EUROCONTROL membership encompasses 39 European States. The EU has 27 Member States, 26 of which are EUROCONTROL Member States. Latvia has joined the Organisation as 39th Member State on 1 January 2011 and Estonia which is already an EU member, is also expected to accede to the EUROCONTROL Convention. To follow are the last ECAC (European Civil Aviation Conference) States, not yet Members of the EUROCONTROL: Iceland, Georgia and Azerbaijan.

This illustrates that the integration of UAS into the European airspace cannot be limited to the Single European Sky's geographical scope. A few numbers may provide an idea of the complexity of Air Traffic Management (ATM) in Europe: on an average day, approximately 27.500 flights are performed in the EUROCONTROL area, controlled from 67 Area Control Centres (ACCs). The airspace is divided into 450 control sectors. There are 560 aerodromes, the busiest areas being those of London, Paris and Frankfurt.

In 2009 over 9.5 million flights, carrying some 700 million passengers took place. More than 30,000 flights are handled on busy days. The peak day up to now was 27 June 2008 with 34,476 flights. More than 80% of flights are intra European, in most cases flights under 2 hours. The forecast for the years to come up to 2020 predicts a capacity increase of 73% of air traffic to be handled.

The European airspace is a very complex and very crowded one. The integration of unmanned aircraft into this complex airspace will certainly present a major challenge.

At a global level the International Civil Aviation Organisation is presently driving the development of the regulatory framework for the integration of UAS into the non-segregated civil airspace and at aerodromes. Regional organisations like the European Aviation Safety Agency (EASA) and EUROCONTROL are called to prepare EU regulations regarding UAS airworthiness certification and its integration into civil Air Traffic Management (ATM). At national level, there are examples of policy or regulatory activity in respect of UAS in the United States of America, the United Kingdom and Australia.

ICAO has produced an UAS Circular to inform States of the emerging ICAO perspective on UAS integration which can be summarised as follows:

- In the foreseeable future, only remotely-piloted aircraft will be able to be integrated into non-segregated airspace and aerodromes;
- Fully autonomous or semi-autonomous aircraft are thus, for the time being, excluded from integration into the international civil aviation system;
- Model aircraft are exclusively dealt with under national law;
- Unmanned aircraft will not, in the foreseeable future, carry passengers on board for remuneration: they will carry cargo or be used for other purposes, such as scientific, security, meteorological, etc.

Since unmanned aircraft qualify as "aircraft" under the applicable ICAO rules, current Standards and Recommended Practices (SARPs) will apply to a wide extent, inasmuch as the regulatory framework applicable to manned aircraft is directly applicable to unmanned aircraft. However, additional, UAS-specific SARPs will need to be developed, in order to integrate UAS in the different airspace classes and at aerodromes.

ICAO has created a UAS Study Group (UASSG) whose task it is to develop Standards, Recommended Practices, Procedures and Guidance material, in order to support the safe, secure and efficient integration of UAS into non-segregated airspace and aerodromes. The Group serves as the focal point and coordinator for all ICAO UAS related work. It has been tasked to develop a UAS regulatory concept and associated guidance material, review the ICAO SARPs, propose amendments and coordinate with other ICAO bodies. Furthermore, it shall contribute to the development of technical specifications by other bodies, and coordinate with the ICAO Aeronautical Communications Panel (ACP), as needed, to support the development of a common position on bandwidth and frequency spectrum requirements for command and control of UAS for ITU World Radio Conference negotiations.

The UASSG is presently analysing all relevant SARPs, in order to identify the commonalities and differences between manned and unmanned aircraft and their operation, and to assess the need for amendment or new regulation. With regard to the Rules of the Air an Appendix to Annex 2 to the Convention on International Civil Aviation (Chicago Convention) will contain the standards for UA.

The issue of airworthiness certification and approval of operations of UAS is also being addressed. In this respect, EASA has a role to play. Personnel licensing, in particular of the remote pilot requires amendments to Annex 1 to the Chicago Convention. For instance, the medical conditions could be less stringent than those for a pilot on board, psychological requirements maybe similar to those for an ATCO. Furthermore, new equipment including detect and avoid technologies may be introduced. ATM provisions may need to be amended. Air Navigation Service Providers (ANSPs) will have to review their contingency procedures. Communication requirements in general and phraseology for voice communications in particular between ATC and the remote pilot will need to be considered.

In Europe, the INOUI Project (Innovative Operational UAS Integration) co-funded by the European Commission, delivered end 2009, *inter alia,* a "Regulatory Roadmap for UAS Integration in the SES". Its findings regarding regulatory requirements are basically the same as those identified by ICAO UASSG. The document confirms that most issues are of a global nature and need to be solved at ICAO level through amendments of SARPs, not too much is left for the European/or national regulator.

Anyhow, the ICAO standards system is based on generic performance-based standards, leaving it to States or industry how to implement these or develop them through standards-development organisations. The question is whether, in order to accommodate UAS in the SES airspace, there is also a need to review the SES Regulations and Directives and their implementing rules.

Whereas it is not obvious that the SES Framework Regulation would need to be amended, this is not certain for the other three SES Regulations dealing with Service Provision, Airspace and Interoperability respectively: it could be argued that UA as a category of Airspace users would need to be explicitly provided for (in the higher ranking legislative acts), in order for the European Commission to be able to adapt SES implementing rules for UAS integration.

In any case, it is submitted that the Common Requirements implementing rule will need to be amended, in order to provide for a proper Safety Management System applicable to States and ANSPs, assuring the safe introduction and operation of UAS in the SES airspace.

Moreover, the ATCO Directive will have to be amended, in order to cater for the additional training requirements linked to the specific characteristics of UAS integration in non-segregated airspace.

Regarding the integration of UAS into SESAR, it is important to recall that SESAR (Single European Sky ATM Research) is the European air traffic control infrastructure modernisation programme. It aims to develop the new generation air traffic management system capable of ensuring the safety and fluidity of air transport over the next 30 years. Under SESAR, European aviation stakeholders (civil and military, legislators, industry, operators and users) have come together in defining, committing to and implementing a pan-European programme. SESAR will contribute to eliminating the fragmented approach to ATM in Europe.

UAS are indirectly concerned in two SESAR work packages:

- WP 9 deals with performance improvement by the stepwise enhancement of airborne capabilities of aircraft systems, including UAS; it shall also ensure global interoperability and coordination with other important initiatives such as NextGen in the US;
- WP 15 addresses the development of CNS technologies, e.g. future mobile data link systems, best combination of GNSS and non-GNSS navigation technologies to support performance based navigation and precision approach requirements, the use of future surveillance applications, including ADS-B.

It is important to note that a number of potential risks relating to the integration of remotely piloted UA into non-segregated civil airspace will need to be addressed, e.g. safety risks, system reliability, etc.. Airspace capacity could be compromised if the integration of UA would require increased separation from other aircraft. The acceptance by the public of UA in non-segregated airspace will also have to be taken into account. Responsibilities and liabilities need to be clearly defined and allocated.

The process of assessing potential risks evokes further, extremely relevant questions for the manner in which the introduction and integration of UAS will have to be addressed at the global, regional and national level. This is not the moment to draw up any comprehensive lists, but, in addition to the issues referred to above, these will vary from questions whether UAS will be adequately covered by Chicago System; the interrelation of UAS with GNSS and the associated legal and institutional framework to allocation of oversight and enforcement and environmental issues.

The present approach to the UAS phenomenon is, not surprisingly, strongly inspired by the Chicago system as a basic, comprehensive, prescriptive as well advisory conglomerate of rules, standards, recommended practices and advisory material. It provides a surprisingly versatile basis for addressing the UAS issue. But at the same time it encourages an approach that essentially determines UAS as a species or genus of the order of aircraft (my apologies to Darwin).

As a consequence, it also seems to promote the continued application of the notion of the pilot accepting control and responsibilities for his/her "pilotless" or "unmanned" aircraft. Some authors have qualified this approach as what is poetically called the "silk scarf syndrome" – the pilot as the ultimate master of his or her aircraft – second only to God.

Reality, for both piloted and pilotless aircraft, seems to indicate that the human pilot, on the ground or in the air, increasingly will be yielding his or her supremacy to autonomous artificial intelligence and automation systems that are interacting with equally autonomous satellite systems.

It is too early to make the call for any rigorous change of approach. As mentioned earlier, the acceptance by the general public of fully autonomous UAS and Navigation is not imminent, to say the least. But it would be perhaps time to suggest a change from a backward looking approach based on the venerable Chicago System towards a more forward looking initiative that would recognise the ultimate values of fully autonomous UAS in an equally autonomous ATM environment.

6. Light UAS. European Regulation below 150 kg?

by Pablo Mendes de Leon

This article attempts to respond to the question whether European regulation is needed for the operation of light Unmanned Aerial Systems (UAS's), that is, craft weighing less than 150 kg. In doing so, the following approach has been chosen:

- brief explanation of the use of light UAS's;
- determination of the distinction between State and civil aircraft under international and European law;
- analysis of European regulations regarding Air Traffic Management, safety, the internal EU market and insurance, with special reference to their regulation of UAS's, and while paying attention to the relevance of national regulations;
- presentation of arguments in favour and against the formulation of European regulation on this subject;
- Evaluation and conclusions.

In short, this subject is regulated on different levels and by various regimes. The conclusion of this multi-level analysis is that the said regimes are not harmonised. This hampers regulation on any level as conflicts between regulations may arise. Hence, a more detailed regulatory assessment of the above question must be made. Depending on the outcome of that assessment, guidance on the optimum EU level regarding the present subject may be indicated.

6.1 The Use of Light UAS

Unmanned Aerial Systems (UAS) are used for public and civil, including commercial purposes. The more traditional uses concern military surveillance and exploration including data control, the performance of police functions, border control, search and rescue, pollution control and landings on naval ships with the purpose of taking environmental measurements. The latter function may also be regarded as a civil use.

Civil, including commercial use of UAS's, is progressing. Examples include sensing the depth and the quality of water, the registration of sea animals and plants, cartographic photography, the recording of videos for cinemas and commercials, searches for persons and substances, including cannabis, the provision of services to meteorology in order to enhance awareness regarding earthquakes, volcanic eruptions and chemical clouds, the surveillance of traffic and pollution and, generally, data collection.

To attempt to answer the question asked in the present contribution, the craft in question must comply with the requirements of the term "aircraft" as used in the Chicago Convention On International Civil Aviation of 1944, hereinafter referred to as the Chicago Convention, and as defined in the Annexes[51]. Light UAS's qualify as "aircraft" under the Chicago Convention. Since the Chicago Convention only regulates international civil aviation, that is, the operation of services operated by civil aircraft passing through the airspace of more than one contracting State,[52] domestic applications of UAS's do not fall under the regime set forth by the Chicago Convention and ICAO Annexes.

The EU is not a party to the Chicago Convention, and is not a Member State of the International Civil Aviation Organization (ICAO), but the 27 EU Member States are. Currently, 190 States have ratified this convention.[53] The more pertinent question addressed in this article concerns the application of European regulations to light UAS. Since all EU States are bound by the Chicago Convention and its Annexes, it seems appropriate to concisely examine that regime. Apart from Article 8 of the Chicago Convention addressing "Pilotless aircraft",[54] neither this convention nor the ICAO Annexes pay attention to the regulation of UAS's, let alone light UAS's.

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[51] See the definition of aircraft in various ICAO Annexes: Aircraft. "Any machine that can derive
support in the atmosphere from the reactions of the air other than the reactions of the air against
the earth's surface."

[52] See Article 96(b) of the Chicago Convention: "'International air service' means an air service
which passes through the air space over the territory of more than one State.

[53] See Article 96(b) of the Chicago Convention: "'International air service' means an air service which passes through the air space over the territory of more than one State.

[54] As referred to in the contribution made by Stefan Kaiser in the present Proceedings; see also: Stefan A. Kaiser, Legal Aspects of Unmanned Aeriel Vehicles, 55 Zeitschrift für Luft- und Weltraumrecht 344-363 (2005)

6.2 The Distinction between State Aircraft and Civil Aircraft

The Chicago Convention makes a distinction between State aircraft and civil aircraft, based on the use of the craft in question. Article 3(a) and (b) of the Chicago Convention read as follows:

> (a) This Convention shall be applicable only to civil aircraft, and shall not be applicable to state aircraft.
> (b) Aircraft used in military, customs and police services shall be deemed to be state aircraft.

However, Article 3 of the Convention does not contain a definition of State aircraft. It lays down a number of services that may be deemed to be services operated by State aircraft. State practice shows that the examples given by the Convention are not exhaustive. States have used their freedom to qualify aircraft as State aircraft pursuant to their national legislation and international practices.

Hence, the use of an aircraft determines its status under the Chicago Convention. If an aircraft is not used for the public services mentioned in Article 3(b) it is deemed to be a civil aircraft. The operation of civil aircraft falls under the terms of the Chicago Convention and its 18 Annexes. The operation of State aircraft is subject to national law and international agreements, including but not limited to the Red Cross Conventions and Protocols,[55] NATO arrangements[56] and EUROCONTROL.

[55] International Red Cross, the Geneva Conventions of 12 August 1949 for the Amelioration of the Wounded and Sick in Armed forces in the Field, http://www.icrc.org/eng/war-and-law/treatiescustomary-law/geneva-conventions/index.jsp, visited on 7 December 2011

[56] NATO's Standardisation Agreements (STANAG) which are designed to facilitate the use of military aircraft and to enhance the safe transportation of cargo. STANAG 4441 encompasses a Manual regarding the carriage of military munitions and explosives.

EUROCONTROL has defined State aircraft.[57] The objective of this organisation appears to be the limitation of the concept of State aircraft to the greatest extent possible while keeping with the conditions laid down in Article 3(b) of the Chicago Convention. The conclusions made in section (1) and the present section indicates that light UAS's may be identified as civil or State aircraft. The determining factor is the use of the aircraft. Consequently, different legal regimes may apply to the aircraft in question.

6.3 European Regulations

6.3.1 The Single European Sky

The most pertinent legislation for the present subject is the EU legislation on Air Traffic Management (ATM) as laid down in the Single European Sky (SES) regime.[58] This regime promotes the implementation of a "common transport policy".[59] Transport by air can be defined as the carriage of persons, in most cases passengers, their baggage, whether checked in or not, and cargo by an air transport undertaking. In this context, the question could be asked if and to what extent light UAS's fall under the common transport policy in cases where those craft do not transport.

On the other hand, the SES regime is designed to meet the requirements of all airspace users, meaning "operators of aircraft operated as general air traffic".[60] General air traffic is defined as "all movements of civil aircraft, as well as all movements of State aircraft (including military, customs and police aircraft) when these movements are carried out in conformity with the procedures of

[57] In the words of the Provisional Council, composed of civil and military representatives, the following Decision regarding the definition of state aircraft was made in 2001. "Principle 1: For ATM purposes and with reference to article 3(b) of the Chicago Convention, only aircraft used in military, customs and police services shall qualify as State Aircraft. Accordingly: Aircraft on a military register, or identified as such within a civil register, shall be considered to be used in military service and hence qualify as State Aircraft; Civil registered aircraft used in military, customs and police service shall qualify as State Aircraft; Civil registered aircraft used by a State for other than military, customs and police service shall not qualify as State Aircraft." See: http://www.eurocontrol.int/mil/public/standard_page/stateac.html

[58] European Parliament and Council Regulation (EC) No 1070/2009 of 21 October 2009 amending Regulations (EC) No 549/2004, (EC) No 550/2004, (EC) No 551/2004 and (EC)No 552/2004 in order to improve the performance and sustainability of the European aviation system.

[59] Preamble (1) of EC Regulation 549/2004 as amended; see also Article 100 of the Treaty on the Functioning of the European Union (TFEU)

[60] Article 1(1) of EC Regulation 549/2004 as amended

ICAO."[61] Consequently, the SES regime tries to implement Article 3(a) of the Chicago Convention, as it should, as confirmed by the statement that the SES regime is "without prejudice to the rights and duties of Member States under… the Chicago Convention."[62]

However, the SES regime is not as consequent as it could be as it only excludes "military operations and training"[63] from its scope. Therefore, the question is whether the operation of aircraft, including UAS's which are used for policy, customs and other typically public service purposes, is or is not subject to the provisions of the SES regime.

6.3.2 EU Safety Regulations, Including National Regulations

The application of European safety regulations to light UAS's is equally important for the present subject. Reference is made to EC Regulation 216/2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency,[64] in this subsection referred to as the EASA Regulation. This regulation excludes unmanned aircraft with an operating mass of less than 150 kg from its scope.[65] Thus, light UAS's are not subject to EU safety law but to local law administered by the National Aviation Authorities. Not all EU States have enacted regulations for the operation of light UAS's.

The UK has a well developed body of law governing the operation of military and all other, that is, civil aircraft. A civil aircraft registered in the United Kingdom which is exempted from the above EASA Regulation must have a certificate of airworthiness and a permit to fly issued by the UK Civil Aviation Authority pursuant to the terms of the Air Navigation Order of 2000.[66] Special rules apply to small aircraft, that is, aircraft weighing less than 20 kg, and even less stringent rules to very small aircraft, that is, craft weighing less than 7 kg. A differentiated regime applies to such small craft being used for recreational or commercial purposes. Those small aircraft may be flown without complying with requirements pertaining to airworthiness or the Rules of the Air. However, small aircraft (weighing between 7 and 20 kg) must meet more severe operational constraints than very small aircraft. Aircraft weighing between 7 and 150 kg are subject to exemption requirements for compliance with operational constraints, whereas recommendations as to the certification requirements must have been granted by the accredited body.

6.3.3 The Internal Market Regulation

Regulation 1008/2008 of the EU on common rules for the operation of air services in the Community dictates that "air services performed by non-power driven aircraft and/or ultra light power driven aircraft" are not required to hold a valid operating license. The same is true for the operation of local flights. Although the weight is not specified, it is assumed that light UAS's fall under the term "non-power driven aircraft or ultra light power driven aircraft". Should this assumption be the correct interpretation of the said provision, operators of UAS's are not required to apply for and hold an operating license under this EU regulation.

As a corollary, holders of such operating licenses are entitled to "operate intra-Community air services". Hence, operators are not entitled to carry out such services by virtue of European regulations. National law of the EU Member States must therefore grant that permission, as to which see above (sub-section 3.2).

6.3.4 Insurance

Another regulation exempting operators of light aircraft including UAS's from its scope concerns EC Regulation 785/2004 on insurance requirements for aircraft operators. Insofar as insurance obligations relating to the risks of war and terrorism are concerned, this Regulation does not apply to:

- State aircraft as referred to in Article 3(b) of the Chicago Convention;
- model aircraft with an Maximum Take Off Mass (MTOM) of less than 20 kg;
- aircraft, including gliders, with a MTOM of less than 500 kg, and,
- microlights which:
  - o are used for non-commercial purposes, or
  - o are used for local flight instruction which does not entail the crossing of international borders,[67]
- and other types of aircraft listed in this regulation.

Hence, it would seem that Regulation 785/2004 exempts operators of light UAS's operating non-commercial or domestic flights

[61] Article 1(1) of EC Regulation 549/2004 as amended
[62] Ibid.
[63] Ibid.
[64] Repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (Text with EEA relevance).
[65] As to which see Annex II par. (i) of EC Regulation 261/2008
[66] see Annex II par. (i) of EC Regulation 261/2008
[67] see Annex II par. (i) of EC Regulation 261/2008

from underwriting specific risks, that is, war and terrorism under the stated conditions.

6.4 Evaluation of Arguments

6.4.1 Arguments in favour of European Regulation

The EU regulatory system is designed to promote transparency, consumer protection and safety. These policy objectives could be used to stimulate the establishment of a regulatory regime governing the various aspects of the operation of light UAS's.

It appears that there is not only an increasing use of light UAS's but also an increasing cross border operation of such craft. In the absence of a regime based on uniform EASA regulations, this trend calls for international attention for issues such as recognition of certifications of airworthiness and cross border delivery of manufacturing components and services carried out by operators of light UAS's beyond national borders. International attention could very well be translated into supranational attention, in which case the sophisticated regulatory framework of the EU could be appealed to.

Increasing use also encourages regulation. Users and other parties must, and are entitled, to know what their rights, responsibilities and liabilities are.

A supranational, that is, EU regime could regulate an emerging internal market for the provision of services carried out by operators of light UAS's. From this perspective, the exemption from current internal market regulation (EC Regulation 1008/2008) would have to be reconsidered.

Finally, some but not all EU Member States have national regulations governing the use and operation of light UAS's. An EU regulation would fill gaps and enhance coherency between the various Member States as their regulations vary. The current scattered landscape could be better organised by some form of supranational regulation.

6.4.2 Arguments against European Regulation

A principal argument against regulation on the European level can be found in the *maxim De minimis non curat lex*: the law does not care about small things. The exemption of the use and operation of light UAS's from current European regulations in the field of ATM, safety, the organisation of the internal market and insurance is evidence of this. The same is true for other fields of law as to which see, for instance, the regulation of state aid and the regulation of procurement transactions involving the exemption of small amounts from their scope.

As a corollary, it could be stated that "overruling" should be avoided. A "lean and mean" approach helps operators, manufacturers, and other service and product providers to market their products and services. General EU law, including but not limited to the freedom to provide services, the freedom of establishment and the competition law regime, supplemented by national law covering specific aspects of their operations, could form a framework pursuant to which they should be carried out.

The above argument must also be tested against the subsidiarity principle following which: "any action by the Community shall not go beyond what is necessary to achieve the objectives of this Treaty." This premise can be found in the Preamble of Community legislation. Community action must only be undertaken if and insofar as such actions cannot be better achieved on the national level.

This issue could be related to the more specific characteristics of operations carried out by light UAS's. Local circumstances govern the use of light UAS's and their operation. That is why the need for EU action may be less than for the operation of aviation services at a larger scale and scope. As stated above, the legal basis for the conduct of a policy may have yet to be found. Air transport policy comes to mind but the question is whether this is the appropriate legal basis as light UAS's may not transport in the proper sense of the word. However, I feel that this question could be addressed fairly easily, and that one should not be hampered by discussions on semantics when the principal arguments in favour of the formulation of an EU law and policy on this subject have been articulated.

6.4.3 Conclusion

In conclusion, questions regarding the regulation of lights UAS's must be seen from the perspective of a number of regulatory regimes which do not necessarily match. Light UAS's can be used for civil and military purposes. That use determines their status under international and European law as they are exempted from the provisions laid down in the relevant international agreements and European regulations applying to the operation of non-military aircraft only.

However, the issue is not as clear cut as it may seem as international law – that is, the

Chicago Convention, ICAO Annexes and other international aviation agreements which have not been referred to in this article – exempts not only military aircraft but State aircraft at large from its scope. EU law sometimes appears to only, or even exclusively, exempt military aircraft from its scope. However, EU law is not necessarily consistent in this respect as it also refers to international law and claims that it is subject to that branch of law. Hence, it could be argued that not only military but all State aircraft generically fall outside the realm of EU law.

In addition, the term "State aircraft" is not defined. An effort should be made to clarify it, while using the sources referred to in this essay, and other sources.

The above contribution has focussed on specified aspects of the use and operation of light UAS's. However, there is a myriad of international and European regulations which may be made applicable – or not – to the use and operation of light UAS's. They include but are not limited to such areas as security, third party liability,[68] occurrence reporting and competition, including state aid. The applicability of the relevant rules to the operation of lights UAS's has yet to be determined.

Finally, we find ourselves in a scattered landscape. A more detailed analysis of the multilevel jurisdictional regimes is called for in order to respond to the question that was asked at the beginning of this article. That analysis could be based on a clarification of the current landscape, an endeavour to remove inconsistencies and enhance coherency, and a cost-benefit assessment, taking into account legal principles some of which haven been concisely mentioned above, and an economic perspective. Such examination could result in proposals for the drawing up of an EU Directive, supplemented with and implemented in national law regulations, and/or removing the exemptions currently in place for the operation and use of light UAS's laid down in the various EU regulations. However, more consideration is needed to arrive at that conclusion.[69]

[68] Kaiser, Stephan. "Liability of Unmanned Aerial Systems (UAS)". 2nd EUROCONTROL Workshop on Responsibility and Liability in ATM. Brussels, 18 and 19 February 2009.

[69] Masutti, Anna. "Proposals for the Regulation of Unmanned Aerial Vehicle Use in Common Airspace", Air And Space Law, XXXIV (1) (2009):1-12.

7. Certification and Approval of Unmanned Aircraft Systems (UAS) in Europe

by Filippo Tomasello

7.1 UAS: A New Market for Civil Aviation

At end of the First World War, in 1918, the "Kettering Bug" was designed and built in the USA. It was a sort of "flying bomb", or "aerial torpedo", without a pilot on board. At the time the world had been changed by the second industrial revolution (including the application of engines to automotive vehicles, such as trains, cars, vessels or even aircraft). Concern about an aircraft without a pilot on board penetrating a given airspace and dropping bombs, was present in Versailles, when the International Commission for Air Navigation (ICAN) was launched (1919). In fact this type of aircraft was subject to limitations on flying internationally. The same concern is the rationale for Article 8 of the Chicago Convention (1944) which requires a "special authorization" for a "pilotless" aircraft[71] to cross international borders. The progress of such flying machines has nevertheless been very slow. Only during the last decade, Unmanned Aircraft Systems (UAS) have been used by military services on a large scale and at long range, not only for combat missions, but even more for acquiring information from sensors installed on board. The manufacturing industry is therefore now trying to open the civil aviation market to its products. Although the possibility of air transport by UAS does exist (e.g. for freight, humanitarian, emergency or medical missions) early applications are mainly envisaged for the acquisition of information by governmental non-military entities (e.g. local police), as well as for commercial (e.g. videos of sport events), corporate (e.g. surveillance of pipelines or electric power lines) or scientific (e.g. exploration of volcanic clouds) purposes. In other words civil UAS are not expected in the foreseeable future to impact on the established passenger commercial air transport market, but on the contrary they will open the way for aviation to enter the third industrial revolution: i.e. towards the "information society". Assuming the above, it is likely that opening a new market segment will create new high quality jobs not only to build, operate and maintain (i.e. the classical aviation jobs) UAS, but also to acquire, process, distribute and exploit information acquired by on-board sensors.

[70] This article expresses the personal opinion of the author and does not represent the position of EASA

[71] According to the ICAO Legal Bureau, an aircraft is still "pilotless", even if there is a remote pilot on the ground. This interpretation of Article 8 of the Chicago Convention has been endorsed by the ICAO General Assembly.

7.2 Safety Regulation of UAS

Aware of this new emerging segment of civil aviation, in the last ten years a number of aviation regulatory agencies have taken action to promote safety (e.g. the Australian CAA, first in the world to introduce the concept of "UAS Operator", which is not a natural person, but the legal entity taking responsibility for organising the flight operations).

Traditionally, aviation safety rules aimed in the first place at protecting people on board (i.e. crews and passengers). In the case of UAS there are by definition no people on board. Therefore a different vision is required: regulating aviation safety in fact means identifying potential hazards, assessing the related risks, defining possible mitigation measures and imposing them on aviation stakeholders, through rules.

What then are the typical hazards related to UAS and relevant for aviation safety?

In the first place a crash of an Unmanned Aircraft (UA) on a non-populated ground (or at sea) is not a safety risk for any human. The economic damage connected to the loss of the airframe, could be mitigated through insurance, but this does not need to be regulated through aviation law. This is indeed the basic difference with "manned" aviation, where the prime concern is to protect people on board.

The absence of people on board does not however mean that there are no aviation safety risks. Four typical hazards need in fact to be considered:

- A crash of the UA on the surface, but hitting people and therefore causing injuries or even fatalities to a certain number of humans;
- A Mid-Air Collision (MAC) where the UA hits a second aircraft in flight;
- A risk of collision with other aircraft or vehicles during ground operations; and
- A collision on the ground on a runway (e.g. during landing operations).

The MAC risk has been so far mitigated by limiting operation of civil UAS into so called "segregated" airspace, i.e. a volume of airspace, like a Temporary Segregated Area to use the semantic of the European concept on the "Flexible Use of Airspace" (FUA). This is easy to implement, but of course imposes severe limitations on UAS operators.

The last risk is not likely to cause severe safety consequences: in fact Air Traffic Management and aerodrome operators ensure that the risk of human presence on a runway during landing operations is extremely low.

Rules for UAS operations at aerodromes can mitigate the risk of collisions during ground operations, while, for the time being, UA in fact do not need to operate at congested aerodromes.

The first risk, of paramount relevance over densely populated areas like Europe, can be mainly mitigated through the airworthiness approval processes, which ensure that the UAS will potentially "crash" against the ground only with a defined probability inversely proportional to the severity of the consequences. In other words, even in the absence of crews or passengers on-board, the risks for third parties have to be mitigated to an acceptable level and therefore airworthiness rules, processes and approvals are necessary.

Airworthiness rules are therefore the priority, since they apply to UA of any weight, in visual line of sight (VLOS) from the pilot or beyond (BVLOS) under Visual (VFR) or Instrument Flight Rules (IFR).

The MAC risk, for UAS wishing to fly in "non-segregated" airspace (i.e. in controlled or non-controlled airspace where other airspace users are legitimate) is the second priority. The community is today relatively advanced on airworthiness rules, while "Detect and Avoid" (D&A) is less mature. It is therefore likely that airworthy UA will be progressively allowed to enter some classes[72] of "non-segregated" airspace, in parallel to the development of D&A.

Conversely, safety of operations at or near runways could initially be mitigated by procedural measures, until the UAS functionalities do not allow the removal of some operational restrictions.

In any case, training of the crews and clarity on the legal responsibilities of UAS air operators, including third country operators, contribute to mitigate all the mentioned risks.

7.3 EASA Competence for UAS

In the European Union (EU) aviation safety is nowadays mainly regulated through the system centred on the European Aviation Safety Agency (EASA), within the limits adopted by the EU legislator and of the implementing rules adopted by the European Commission (EC) as delegated by said legislator. According to Article 2 of its Basic Regulation[73], EASA has to follow ICAO provisions when existing, which, for UAS was not the case until October 2010, as described below. Furthermore recital (1) of Basic Regulation 1108/2009 calls on EASA to look at the safety of the "total aviation system", which includes not only initial and continuous airworthiness, but also flight crew licensing, air operations, aerodromes, Air Traffic Management (ATM) and Air Navigation Services (ANS). In other words, while the legislation on the "Single European Sky"[74] also refers to safety (but only for ATM/ANS), there can be no doubt that the cornerstone of safety regulation of the total aviation system in the EU is EASA, including for UAS: i.e. the airworthiness of aircraft, the remote flight crew, the UAS air operators and, last but not least, also the insertion into non-segregated airspace, which includes avoidance of Mid-Air Collision, based on the so called "Detect and Avoid" (D&A) functionality.

Military aircraft and military aviation operations and aerodromes are outside the EASA scope, as well as other governmental but non military operations (fire brigades, police, customs, coast guard and similar). Undoubtedly, military services can properly oversee the safety of their UAS. However Article 2 of the

[72] Seven Airspace Classes (i.e. from A to G) are standardised by ICAO Annex 11.

[73] European Parliament and Council Regulation (EC) No 216/2008 of 20 February 2008 on common rules in the field of civil aviation and establishing a European Safety Agency, and repeling Council Directive 91/670 EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC.

[74] Regulations 549, 550, 551 and 552 of 2004 as amended by Regulation 1070/2009 and related implementing rules.

EASA Basic Regulation mandates not only striving for “highest” safety, but also for “uniform” safety. And today the market for small UAS is developing quickly, indeed for governmental non-military services. One could perhaps doubt that all the 27 EU Member States are sufficiently equipped in professional terms (both qualitative and quantitative) to oversee the safety of such governmental non-military UAS operations. After the entry into force of the Lisbon Treaty, the possibility of giving to EASA competence for safety regulation of such UAS operations by governmental non-military organizations might perhaps be explored for the benefit of EU society, not forgetting that clear and uniform rules also contribute to safely opening new aviation markets.

Equally, present legislation limits EASA competence to civil UAS with a minimum mass of 150 kg. Below this weight, the competence remains national. This means that EU industry for small UAS is confronted with 27 different sets of national rules (although the voluntary organization JARUS[75] is promoting harmonization), written only in respective national languages. This possibly jeopardizes the competitiveness of EU industry in comparison to other continents. The EU legislator could perhaps in the future consider leaving the competence for issuing type certificates to UAS of less than 150 kg to national authorities, for proximity and subsidiarity reasons, but based on common EASA rules in order to achieve and maintain on the one hand uniform safety, while on the other facilitating the work of industry and the standardisation of the regulatory processes (indeed necessary for uniform safety).

Finally EASA has responsibility for safety, not for security. But in the case of “command and control” (or C2) data links or C3 data links (i.e. C2 plus communications with Air Traffic Services) is it really possible to separate provisions for safety from provisions for security? Also on this topic, perhaps the High Level Group on UAS announced by the European Commission (EC) could devote attention to it in 2011?

Even if its present competences do not allow EASA to regulate the entire spectrum of UAS and related operations, within the limits of its legal competence (mainly civilian UAS above 150 kg) the Agency has nevertheless a vision and has already taken action.

[75] Joint Authorities for Rulemaking of Unmanned System, a sort of “mini JAA” for UAS, promoted by the Dutch CAA and today informally grouping a dozen of authorities including EASA and FAA.

7.4 EASA Airworthiness Policy

A principle of EASA is “airworthiness first”. In fact, if a machine is not able to safely fly in a sustainable and controlled way, there is no purpose in looking at the other facets of aviation safety. That is why, in August 2009[76] EASA published a “policy”[77] to guide industry for applying for airworthiness certification for their respective UAS products. This policy is based on the principle that the risk for third parties on the ground (this is the aim of airworthiness rules) is broadly proportional to the kinetic energy (KE) of the aircraft at the moment it hits the surface. In turn the kinetic energy is proportional to the mass of the UA and to the square power of its speed (i.e. a rotorcraft of 200 kg, descending in autorotation at a speed of no more than 30 knots, has much less KE than a jet aeroplane of the same mass, but impacting at 150 knots).

The principle of KE allows selecting from which EASA “Certification Specifications” to start to define the basis for the airworthiness approval (e.g. CS-25 for UA of high KE or CS-23 for smaller or slower machines). This principle (airworthiness risk driven by KE) is shared by other aviation authorities in the world (e.g. FAA in the USA, Transport Canada, Australian CAA and so on) and in Europe (for UAS of less than 150 kg). It in turn assumes that a catastrophe is an event leading to multiple fatalities (and therefore the probability that a single failure or condition will lead to a catastrophe has to be less than 1 × 10E-9 per flight hour), while an event leading to fatal injuries to a small number of people is hazardous (acceptable probability 1 × 10E-7).

The EASA CSs are written for “manned” aircraft and therefore they need to be customized (e.g. neither oxygen nor emergency exits are necessary on board UA) and complemented by special conditions to take into account UAS specificities (e.g. the Remote Pilot Station and the C2 link). Few applications have yet been received by EASA.

The Agency believes that in a few years, once the community will have acquired more experience, it could be possible to publish a Certification Specification for UAS (CS-UAS), which is in fact currently planned before the end of 2016. Meanwhile the negotiation of “special conditions” for each project will allow

[76] Following about five years of joint work by EUROCONTROL-JAA on UAS and public consultation through the EASA Rulemaking procedure.

[77] http://easa.europa.eu/ws_prod/c/doc/Policy_Statements/E.Y013-01_%20UAS_%20Policy.pdf

industry to progress without the need of waiting for the publication of specific EASA rules: this adaptability is one of the major advantages of the EASA regulatory framework[78], even in comparison with the Single European Sky.

7.5 ICAO Circular 328

In October 2010, ICAO published its Circular 328 on Unmanned Aircraft Systems (UAS): the first comprehensive and official ICAO document on the matter, which will be read in the entire world (ICAO has some 190 Contracting States). The Circular makes some important statements, among which:

- UAS are aircraft and therefore their possible accidents and serious incidents have to be investigated by the competent aviation bodies (Annex 13 to the Chicago Convention was already amended for this purpose in 2010);
- UAS can be without pilot (even none from the ground able to modify the trajectory, as is the case of unmanned balloons) or under the responsibility of a "Remote Pilot";
- The latter case is the most relevant and therefore such UAS are "Remotely Piloted Aircraft" (RPA) governed from a "Remote Pilot Station" (RPS) by said Remote Pilot, through a Command and Control (C2) data link;
- As there is no pilot on board, before operating across national borders, RPA need a "special authorization" on the basis of Article 8 of the Chicago Convention, but this could be facilitated on the global scale by a new Appendix 4 to ICAO Annex 2 which is being drafted (and which could be followed by EU rules for crossing borders inside the Union);
- The ultimate goal is to allow UAS under General Air Traffic (GAT) rules (i.e. civilian RPA or State owned aircraft, following ICAO rules for that specific flight) to fly across non-segregated airspace, controlled (i.e. ICAO Classes A to E) or uncontrolled (i.e. Classes F and G);
- The aircraft itself and the RPS station can be separately certified (as engines today are certified separately from the aircraft), which will give more possibilities to manufacturing industry to specialize in either segment, to customers to select among different types of RPS to fly their RPA, as well as to operators to save money (e.g. buy only 3 RPS to fly simultaneously no more than 3 RPA, but have in the fleet 5 aircraft in order to allow continuity of operations) or organize operations more flexibly (e.g. a cargo RPA flown by a first RPS located in the State from where the aircraft takes off, but later flown by an RPS in the State where the aircraft lands: a concept similar to the "harbour pilot" used for centuries at sea);
- The C2 link can be provided through different architectures, including via satellite (i.e. SATCOM); in this case, to ensure safety, proper oversight of the communication service provider (COM SP) is necessary by competent aviation authorities (one could note that in ICAO a COM SP offers services for the "safety and regularity" of flight, which comprises C2, while the SES legislation, in Art. 2.16 of Regulation 549/2004, limits the scope to ATC communications; in other words amendment of SES legislation may be necessary in this respect to ensure proper oversight of COM SP of C2);
- The communications between the remote pilot and Air Traffic Control (ATC) Units are necessary in controlled airspace (as well as for any flight under IFR), but they can be implemented through different architectures, like e.g. VHF radio on board the RPA and then the data link with the Remote Pilot including "Command, Control and ATC Communications" (= C3, not only C2), via satellite. Alternative architectures could be via VHF equipment on the ground or via wired ground-ground connections (the latter may materialize through SESAR, which indeed postulates a ground network to connect in real-time all relevant aviation actors).

7.6 ICAO UAS Manual and Annexes

Like any other ICAO Circular, Circular 328 is only "guidance material" and it will not be updated by ICAO. Its main value is to communicate principles and terminology. The ICAO Secretariat, assisted by the UAS "Study Group" (UAS SG) staffed by experts nominated by ICAO Contracting States (e.g. Australia, Brazil, France, Italy, USA, UK, etc.) and by international organisations (including EASA, EUROCONTROL and Eurocae), is now

[78] I.e. safety processes, responsibilities and privileges in implementing rules with force of law (i.e. Commission Regulations), but technical or operational details in so called "soft rules", like mentioned CS.

planning to publish a more detailed ICAO UAS "Manual" possibly by the beginning of 2013. In parallel the UAS SG will develop proposals to amend almost all ICAO Annexes. Such amendments could possibly be adopted by the ICAO Council from 2013 onwards. The main affected topics are presently expected to be:

- Remote Pilot Licence (RPL) and UAS Observer Licence in Annex 1;
- New Appendix 4 to Annex 2 to facilitate the "special authorisation", expected in 2013 and possibly followed by other proposals (e.g. priority rules) for this Annex in later years;
- New Part IV in Annex 6 on international UAS operations (with UA of any weight), which, different from existing Parts I, II and III, will contain ICAO standards applicable to aerial work (i.e. acquisition of information through on board sensors is indeed aerial work);
- Amendment to Annex 7 in order to allow proper labelling of registration marks even on "mini" or "micro" UA and catering for the consequences of the separate certification of the RPA and the Remote Pilot Station (RPS);
- New Part VIII in Annex 8 to in fact identify the RPS as a new aviation product subject to separate certification;
- Amendment to Annex 9 to cover the case of an UA carrying freight on international connections;
- Amendment to Annex 10 to cover the C2 link (not currently included), the "Detect and Avoid" functionality, the possibility of distributing redundancies not only on the UA itself, but also between the UA and its RPS, and, last but not least, provisions for the safety oversight of Communication Service Providers (CSP), in the EU belonging to the wider family of Air Navigation Service Providers (ANSPs);
- Possible further refinement of the accident and incident definition in Annex 13 (e.g. to cover the case of a rotor of an unmanned rotorcraft still moving after engine shut down);
- Amendment to Annex 18 to cover possible transport of dangerous goods by UA.

No major amendments are currently foreseen to ICAO Annexes 3 (MET), 4 (charts), 5 (units of measurement), 11 (ATS), 12 (SAR), 14 (Aerodromes), 15 (Aeronautical Information), 16 (Environmental compatibility) and 17 (security).

7.7 EASA Multidisciplinary Rulemaking Task MDM.030

EASA, having worked on the airworthiness "policy" mentioned above from 2004 to 2009, shares the policy line of ICAO Circular 328. In other words, once airworthiness is ensured, it becomes necessary to establish rules for licensing the Flight Crews (FCL) and the UAS air operators (OPS), including those from third non-EU countries (TCO) wishing to operate in EU airspace. Rules on the operators are a long established (in ICAO Annex 6) tradition in civil aviation, which is not paralleled in military aviation. In fact, in civil aviation private entities can operate aircraft according to their business needs, but in this case, in order to protect society with sufficient legal certainty, it is necessary to promulgate and apply rules for the responsibilities and privileges of such organisations. Hence, following the publication of the ICAO Circular, EASA will launch (beginning of 2012) a multidisciplinary Rulemaking Task (MDM.030[79]), not limited to the development of CS-UAS (for airworthiness) but comprising also rules for UAS FCL, OPS and TCO. OPS rules will of course clarify the respective responsibilities of the Pilot-in-Command (PIC) and the organisation employing him/her. Appropriate implementing rules, specifications, acceptable means of compliance and guidance material should hence be simultaneously available by end of 2016. These rules will apply even to UA in segregated airspace, to mitigate the risk to third parties on the ground.

It is not yet decided if these rules will contain specific provisions for operating UAS at aerodromes and in non-segregated airspace. Presently EASA believes that UAS operations at aerodromes are not an urgent issue, since initially RPA could easily operate from short (even non paved) runways at non congested aerodromes, and therefore the risk for third parties on the ground is extremely limited (the aerodrome perimeter is not open to free circulation), while the risk of collision with other aircraft can easily be mitigated (e.g. towing and/or limiting aerodrome operations when an UA is taxiing, taking off or landing, which is not a major problem at aerodromes with very reduced traffic).

In relation to ATM/ANS, few principles are expected to be applied:

- Rules of the air, as in present ICAO Annex 2 apply also to RPA (the need to adjust them will first be discussed in ICAO,

[79] http://easa.europa.eu/rulemaking/docs/programme/2011-2014/4-year%20Rulemaking%20Programme%202011-2014.pdf

e.g. in relation to the obligation for "micro" UAS to always give way to manned aircraft, since the dimensions of the former make it very difficult for the pilot of the other aircraft to "see and avoid" such a target);

- Remote pilots will use meteorological information, aeronautical charts and information as per ICAO Annexes 3, 4 and 15;
- UAS will use the same technologies as manned aircraft for communications with ATC (e.g. VHF radio-telephony or data link), navigation (e.g. satellite GNSS radio navigation signals) and surveillance (e.g. ATC Transponder or ADS-B in the airspaces where this is required);
- From the Air Traffic Services (ATS) perspective, including Air Traffic Control (ATC), UAS are just one more airspace user, but basically the same rules will apply (ratings of the air traffic controllers; obligation to tune to the frequency of the airspace sectors in which the aircraft is at a given moment and so on).

In this context, according to many experts, the major remaining issue to be solved is related to "Detect and Avoid" (D&A). It is understood that standard making organisations (e.g. Eurocae, RTCA) will develop specifications for airborne sensors, integrated systems and algorithms. However, one may also deem that regulatory authorities have to say something about the scope (only focused on preventing Mid-Air Collisions, or additional scopes as well?), basic functions (e.g. "self separation" as distinct from "collision avoidance") and safety objectives (e.g. 1 × 10E-9 in controlled airspace where any collision could be a catastrophe, but possibly 1 × 10E-7 in uncontrolled airspace, based on the fact that in this airspace, there are more than 10 MAC per year between small general aviation aircraft in both the U.S. and EU). EASA believes that standard making organisations need some guidance from the regulatory side and therefore has tried to promote debate, starting with ICAO fora[80].

7.8 Conclusions

Long dreamed (or seen with concern) UAS are presently creeping from military operations to civil aviation. The aviation safety regulators are fully aware of the benefits stemming from the opening of aviation to the third industrial revolution (i.e. "information society"). But they nevertheless have the duty to adequately protect third parties on the ground and other airspace users. A number of safety regulators around the world have already published initial sets of rules or at least guidance material. Among the latter are ICAO (i.e. Circular 328) and EASA (i.e. UAS airworthiness "policy"). Further work is planned by said regulators, as well as by industry standard making bodies (e.g. Eurocae, RTCA). The next milestones are the envisaged ICAO UAS "Manual" (2013) and a set of EASA rules for UAS (2016) covering the "total aviation system" (i.e. including rules for UAS Remote Pilots and UAS Operators). Development of "Detect & Avoid" functionality will allow progressive insertion of UA into "non-segregated" airspace.

[80] Study Note 3 to ICAO UAS SG/6 in December 2010.

8. Roundtable Report

At the end of the day one hour was dedicated to a roundtable discussion on the main points that had arisen during the day. The roundtable aimed at pinpointing the most relevant issues to be addressed by the High Level Group when preparing advice for regulatory action on UAS in Europe.

With that purpose a panel was composed of representatives of the main European stakeholder institutions; Filippo Tomasello (EASA), Carlo Magrassi (EDA), Roderick van Dam (EUROCONTROL) and Amnon Ginati (ESA). The panel was moderated by Kai-Uwe Schrogl (ESPI) and Alfredo Roma (ESPI). Also, with the aim of guiding the discussion a matrix had been devised identifying four areas for discussion: market development, international relations, UAS and space, action at EU level. In the course of the roundtable the discussion of these four areas touched upon which measures to take and which stakeholders to involve. The roundtable evolved with a spirit of open discussion and counted on high interaction with the audience who contributed with substantive remarks.

The first issue addressed was the development of UAS markets. It was stressed that the market is still at an incipient stage. Currently the market is mainly military but the opportunities for civilian use are wide. Despite the opportunities offered by the potential civilian market, there is need to build industrial capacity in Europe as well as to raise awareness of the potentiality of UAS among civilian users, namely, civil public actors. In addition, industrial capacity building and market development face market barriers in Europe which can best be tackled through regulation. Panellists elaborated on the idea of developing standards as the most important means to combat market barriers. Developing the European market should, however, not benefit providers from the U.S. and Israel (who currently dominate UAS production) but should go hand in hand with the growth of a European industrial base.

On this point it was agreed that all civil public actors are addressees of political measures in the field of UAS. It was agreed too that the main line of action of the High Level Group should focus on targeting market barriers as well as on providing security of supply and security of operation. These actions would require cooperation between the different market actors while the involvement of the military is essential in the lifting of market barriers.

The second topic was dedicated to international cooperation. The discussion focused on cooperation for the adoption of international standards and regulations. Participants discussed cooperation within Europe in order to develop European standards. Cooperation between EASA and EUROCONTROL was considered essential for the development of European standards that would not only serve for the development of a European industrial base but also as regional input to international regulations in the context of ICAO. Panellists agreed that international regulations for UAS are needed that will facilitate the international UAS market. While the appropriate forum for the adoption of international regulation would be ICAO through its UAS Study Group (UASSG), European standards could serve as a reference for the work of ICAO as well as as regional standards. Panellists highlighted that it is essential that Europe talks with one voice before ICAO with the European Commission being present in the ICAO UAS Study Group UASSG.

During the workshop consideration was given to the applicability of Art.8 of the Chicago Convention to UAS. The common understanding is that despite its exclusion of “aircrafts without a pilot”, UAS do fall in the scope of that Article as they are Remotely Piloted Aircraft (RPA) or Remotely Piloted Aircraft Systems (RPAS). This new wording was suggested as more appropriate and a proposal for using this new denomination was also raised.

The third topic of discussion was dedicated to the role of the space component in UAS. Although UAS typically rely on Satellite Communications (SatCom) and Satellite Navigation (SatNav), it was agreed that the type of technology applied is not relevant for regulatory purposes. In addition, liability questions were brought in. The discussion on liability was very participative and counted with input from Stefan Kaiser who commented from the audience. The prevailing view was that the different liability regimes pertaining to SatCom, SatNav and UAS should be kept separate and each service be liable according to its regime. As an example, it was mentioned that EGNOS channels liability towards companies whereas EASA channels it towards States. It was pointed out that it was not advisable to create a different liability regime for UAS that would incorporate satellite technologies. In the same vein, an international convention on the topic appears to be unnecessary. Integration of satellite liability issues would only incorporate more complexities and could also be used as a protectionist measure requiring that UAS use the regional GNSS system as the only acceptable liability standard. Consideration of space liability in UAS is not able to be envisaged.

Finally, the discussion dedicated to the European level looked forward in the direction of further actions to be taken. It was agreed that measures aimed at regulating UAS in Europe should be taken in the context of aviation and air traffic management, particularly in the context of SES and SESAR and in cooperation with ESA and EDA. The work initiated in this context should serve as regional input to further international standards. The roundtable finished with the common understanding that the High Level Group should work towards the achievement of a regulatory map for UAS.

Conclusions on a Way Forward

The European Union should take political action on UAS. This would favour the development of the industrial base and market creation by establishing a common European regulatory framework embedded in the Single European Skies and SESAR programme. This regulatory framework should provide for common European standards and serve as a reference for international regulation. EU action should seek a "unified European position", civil and military, to reach the target of UAS flying in the common airspace that assumes strong cooperation among the different relevant actors.

Proposed concrete actions towards that goal are:

- Analyse the present situation and catalogue existing UAS activities; identify the products in use currently and in development in the EU.
- Catalogue UAS relevant research in EU while identifying higher priorities and next steps.
- Analyse the potential world market demand for military and non-military UAS for the next 10 to 15 years.
- Build on existing knowledge under initiatives such as JARUS, EUROCAE, WG 73, INOUI, MIDCAS.
- Establish a set of targets to reach benefits in terms of costs or environmental improvement, comparable with missions performed by manned aircrafts.
- Design a roadmap to achieve a coherent regulatory framework addressing technical elements such as airworthiness, certification, safety risks, system reliability and airspace capacity as well liability and insurance questions. The regulatory roadmap should also address the integration of UAS in SES and SESAR as well as the role of the different institutions.

Alfredo Roma
Member of the ESPI Advisory Council

Matxalen Sánchez Aranzamendi
ESPI Resident Fellow

Kai-Uwe Schrogl
ESPI Director

List of Acronyms

Acronym	Explanation
AEW	Aerial Early Warning
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
ATOL	Automatic-Take-off landing
ATS	Air Traffic Service
AZ	Arizona
BLOS	Beyond Line Of Sight
COM SP	Communications Service Provider
CONOPS	Concept of Operations
CS	Certification Specification
D&A	Detect and Avoid
EASA	European Air Safety Agency
ECAC	European Civil Aviation Conference
EDA	European Defence Agency
ELINT	Electronic Intelligence
EU	European Union
EUFOR	European Union Force
EUROCAE	European Organization for Civil Aviation Equipment
EFC	European Framework Co-operation
FAA	Federal Aviation Administration
FCL	Flight Crew Licensing
FUA	Flexible Use of Air Space
GAT	General Air Traffic
GNSS	Global Navigation Satellites System
HALE	High Altitude Long Endurance
ICAN	International Commission for Air Navigation
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
INOUI	Innovative Operational UAS Integration
JARUS	Joint Undertaking for Rulemaking Unmanned Systems
JAA	Joint Aviation Authorities
KE	Kinetic Energy

Acronym	Explanation
MAC	Mid Air Collision
MALE	Medium Altitude Long Endurance
MIDCAS	MID-air Collision Avoidance System
MTOMS	Maximum Take Off Mass
NATO FINAS	North Atlantic Treaty Organisation Flight in Non-Segregated Air Space
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Air Systems
RPS	Remote Pilot Station
RTCA	Radio Technical Commission for Aeronautics
SATCOM	Satellite Communications
SATNAV	Satellite Navigation
SES	Single European Sky
SESAR	Single European ATM Research
SESAR JU	Single European ATM Research Joint Undertaking
UA	Unmanned Aircraft
UAS	Unmanned Aerial Systems
UASSG	UAS Study Group
UAV	Unmanned Aerial Vehicles
U.S.	United States
USA	United States of America
VFR	Visual Flight Rules
VLOS	Visual Line of Sight

Workshop Programme

Unmanned Aircraft Systems (UAS) have traditionally belonged to the military domain. More recently, their utility for other civilian governmental uses such as border control, fire fighting, ground traffic surveillance and pollution control are opening the new market opportunities. At the technological level civilian UAS benefit from the migration from the military and are capable of creating new civilian models. For its high innovation component and its need of highly qualified skills, this emerging market can bring important benefits for European society ranging from civil protection missions to long term market leadership.

However the lack of a regulatory framework applicable to the flight of UAS in airspace is halting the development of a promising sector. Decision makers have realised this obstacle and efforts are being made to create a regulatory framework that will allow the release of all the potential of this emerging market. After the hearing on Light UAS in 2009 and the development of the INOU project under FP6, on 1 July 2010 the European Commission launched a high level conference on UAS setting up the basis for the creation of such legal framework.

The present workshop has been organised against this background and aims at contributing to the ongoing discussions on the creation of a legal framework for UAS in Europe while highlighting the relevant role of the space component in the development of applications based on UAS. Representatives of the relevant European institutions and agencies together with industry and independent legal experts will expose and discuss the most relevant issues for the creation of a legal framework for civilian UAS in Europe.

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Opening Airspace for UAS

A Regulatory Framework to introduce Unmanned Aircraft Systems in the Civilian Airspace

Programme

ESPI
Vienna, Austria
4 November 2010

ESPI
European Space Policy Institute

9:00-9:15 **Welcome and introduction by the co-chairs**

Alfredo Roma, Member ESPI Advisory Council

Kai-Uwe Schrogl, Director ESPI

9:15-13:00 **Part 1: Policy foundations for regulation**

9:15-9:35 Civil applications of UAS: The way to start in the short term

Pablo González, INDRA

9:35-9:55 Advantages for citizens and European Industry

Peter Sorensen, Single sky and modernisation of air traffic control European Commission (delivered by Filippo Tomasello)

9:55-10:15 Military technology for broad societal benefits

Carlo Magrassi, EDA

10:15-10:35 Identifying regulatory parameters to integrate UAS in civilian airspace

Stefan A. Kaiser, Legal Office of NATO's AWACS Operations

10:35-11:00 Open Discussion

11:00-11:15 **Coffee Break**

11:15-11:35 The main elements for a European Regulatory framework for UAS flying in the common airspace

Anna Masutti, University of Bologna

11:35-11:55 Integration of UAS into SES and SESAR

Roederick Van Dam, Legal Services EUROCONTROL

11:55-12:15 Light UAS. European regulation below 150kg?

Pablo Mendes de Leon, University of Leiden

12:15-12:35 The certification and approval of UAS operations in Europe

Filippo Tomasello, ICAO study group on UAS of EASA

12:35-13:00 Open Discussion

13:00-14:00 **Buffet Lunch**

14:00-14:30 **Part 2: The space component in UAS**

14:00-14:20 Space, the essential component for UAS. The case of Integrated Applications

Amnon Ginati, Integrated and Telecommunications Related Applications Department , ESA

14:20-14:30 Open Discussion

14:30-15:30 **Part 3: Roundtable: Elements for a European roadmap**

Introduction: *Matxalen Sánchez Aranzamendi*

Moderators: *Alfredo Roma* and *Kai-Uwe Schrogl*

Participants: *Filippo Tomasello, Roederick van Dam, Amnon Ginati, Carlo Magrassi*

About the Contributors

Roderick D. van Dam

Roderick D. van Dam (LLM International Law and Air and Space Law) General Counsel EUROCONTROL in Brussels since 1996. Started at the Netherlands Department of Civil Aviation (RLD) where was Head Legal and Institutional Affairs until 1990, when he joined ICAO Legal Bureau. Publications on Air and Space Law related subjects; *inter alia,* in Air and Space Law, ICAO Journal, Revue Française de Droit Aérien et Spatial and McGill Annals of Air and Space Law, ABA Air&Space Lawyer and Max Planck Encyclopaedia on Public International Law. Guest lecturer at the International Institute of Air and Space Law of Leiden University and regularly teaches at number of postgraduate courses. Rapporteur to the ICAO Legal Committee for the creation of the 1988 Montreal Protocol on Acts of Violence against International Aviation. Member of the International Advisory Board of the International Institute of Air and Space Law of Leiden University, a Member of the Board of Editors of the Annals of Air and Space Law of McGill University and a Member of the Brussels Branch of the Royal Aeronautical Society. He is presently actively involved in a number of EUROCONTROL activities in the legal and institutional domain such as the provision of ATM in Europe in the context of ICAO and the EC Single European Sky legislation, ATM liabilities, Functional Airspace Blocks, Cross Border Service Provision, Global Satellite Navigation, GPS and Galileo and developments in the aviation safety domain such as the creation of a global Just Culture concept.

Speakers and moderators at the workshop (from left): Stefan A. Kaiser (Legal Officer of NATO's AWACS Operations), Matxalen Sánchez Aranzamendi (Resident Fellow at ESPI), Gen. Carlo Magrassi (EDA), Roderick D. van Dam (Legal Services Eurocontrol), Filippo Tomasello (EASA), Alfredo Roma (Chairman of the ESPI Advisory Council), Pablo Mendes de Leon (University of Leiden), Anna Masutti (University of Bologna), Pablo Gonzáles (INDRA), Kai-Uwe Schrogl (Director of ESPI) and Amnon Ginati (ESA)

Pablo González

Pablo González is Director of Unmanned Systems in Indra since the end of 2007. His business unit is currently developing and operating several kind of UAS and terrestrial and naval robotic systems (UGV, UUV and SUV), including in particular the PASI tactical system deployed in Afghanistan by the Spanish Army since 2008. His previous experience was mainly in the space field, working for Indra Espacio since 2000 as commercial manager for Europe. Within the institutional side, he was member of the Spanish Delegation to the European Space Agency (ESA) from 1995 to 2000 and Head of the ESA Department in CDTI (Spanish Ministry of Industry and Research) from 1997 to 2000. From 1990 to 1995 he worked in several defense and space programs in the company GMV as project engineer and project manager, mainly related with GNSS and space mission planning. He served as second lieutenant of the Spanish Air Force in 1989-90, working as engineeri in the Spanish Flight Test Centre in Torrejón Air Base with the F-18 fighter. Master degree in Aeronautical engineering by the Polytechnic University of Madrid (UPM) in 1989, during the university period he was working with different grants in NASA (Lewis and Langley Research Centers) and INTA (Torrejón Air Base). From 2000 to 2007 he was managing the European programmes of Indra Espacio, working for the customers as the European Space Agency, EUMETSAT and EUTELSAT among other customers.

Stefan A. Kaiser

Stefan A. Kaiser has been head of the legal office of NATO's AWACS operations (Airborne Early Warning and Control Force – E-3A Component) since 2002. From 1992 until 2002 he practiced law as in-house counsel in various international corporations in the telecommunication and high-tech industry, most of this period with Motorola. Before that, as a junior lawyer, he worked in a private air law practice, a regional German aviation authority and the law department of a German charter airline. He is a qualified German lawyer, holds an LL.M. from McGill's Institute of Air and Space law (class 1988) and is a graduate of the International Space University. As an aviator, his focus of legal research is on technical aspects of aviation, space flight and on air navigation in a broad sense.

Anna Masutti

Anna Masutti is Professor of Air Law at the University of Bologna, Faculty of Engineering, where she lectures Aerospace Law and Commercial Law. She is furthermore a member of the scientific committee of the Master in Aviation Sciences at the University of Bologna, and director of the Summer school in Aviation Management. As well as being a member of the Bologna Bar, Anna Masutti has been a Member of the Technical, Economic and Legal Committee of ENAC (the Italian Civil Aviation Authority) since 2002, and of the Technical and Scientific Committee for the implementation of the Monitoring Project – Land Surveying and Civil Engineering as part of the development program for the Galileo Satellite Project, which is funded by the European Union and the European Space Agency (ESA) and Member of the European Centre of Space Law (ECSL). Anna Masutti is senior partner at AS&T Law firm, which offers a comprehensive range of legal services specialising in aviation, aerospace, marine, transport, insurance, international trade and commerce, and European Union Law. She is furthermore part of the professionals cooperating for the definition of the legal scenario of the European projects Galileo EGNOS and SESAR (SWIM) and for the employment of Unmanned Air System (UAS). Anna Masutti has been a frequent speaker in national and international seminars. She is the author of various books on Air Law and contributes to a number of reviews including "Air and Space Law", "Diritto dei Trasporti", "Il Diritto Marittimo", and is the founder and Director of "The Aviation and Maritime Journal" of Bologna University.

Pablo Mendes de Leon

Pablo Mendes de Leon studied from 1974 to 1979 at the University of Utrecht, the Netherlands, after which he continued to study at the University of Paris 2, during which period he followed a training programme at the Organisation of Economic Co-operation and Development (OECD) in Paris. Subsequently, he worked for the EC Delegation at the United Nations in New York. In 1981, Dr. Mendes de Leon started his professional career at the Law firm Barents and Krans in The Hague, where he practised European Community Law, company law and bankruptcy law. In 1985, he commenced working for Leiden University, where he obtained his doctoral (PhD) degree (with honours) in 1992 on a thesis called "Cabotage in International Air Transport Regulation". In addition to his teaching functions, he acted as Director of the International Institute of Air and Space Law, which was formally established in 1986. In this capacity, he organised a number of world-wide conferences on topical developments in international aviation and space law. A list of conferences can be found by clicking here. Next to academic research as a Meijers fellow, Mr Mendes de Leon carries out studies for third parties (as to which see Research, under Air law research). From 2003 until 2007, Dr. Mendes de Leon was Director of Air Law Research of the International Institute of Air and Space law, and lectured private international air law and competition law in the LL.M. programme of the Institute. Moreover, he is a speaker at conferences on international aviation developments. Since 15 April 2008, he has been Professor of Air and Space law, Head of Department/executive chair of the Department of Air and Space law.

Alfredo Roma

Alfredo Roma is consultant for the aerospace industry and member of the Advisory Board of ESPI (European Space Policy Institute) in Vienna. Previously he was the National Coordinator for the Galileo Project in the Italian Prime Minister Cabinet as well as the Italian Delegate to the European Space Agency (ESA). Until 2003, Alfredo Roma held the chairmanship of the Italian Civil Aviation authority (ENAC) for a period of five years and was the president of the European Civil Aviation Conference (ECAC) since 2000. During this period he also formed part of the Single Sky High Level group set up by the former European Transport Commissioner Loyola de Palacio. In his previous career Alfredo Roma has been Managing Director and CEO of Agenzia ANSA Rome and also Chairman of three renowned international agencies: the European Alliance of Press Agencies, the Mediterranean Alliance of Press Agencies and the European Press Photo Agency. At his earliest carrier he was successively Director of Finance and Control then Director of International operations and finally Managing Director and CEO of Edizioni Panini Spa and Director of Finance and Human Resources of Ceramica SAIME Spa as well as Deputy Manager of the Foreign Department and responsible for international transactions at Banca Popolare dell'Emilia Romagna. Alfredo Roma holds a degree in Economics at the University of Modena and has been untenured professor of business finance at the Faculty of Economics at the University of Modena; lecturer on the master's courses in business management at Profingest – Bologna, Sinnea and LUISS. At present he co-operates as a teacher with the University of Tor Vergata for the Master Courses in Antitrust and Competition and with the Bologna University for the Master Courses in Aviation Science. He regularly publishes articles on national law and economic revues (University of Rome and Bologna) and in major Italian newspapers and magazines.

Matxalen Sánchez Aranzamendi

Matxalen Sánchez Aranzamendi is a Brussels based Associate Fellow of the European Space Policy Institute (ESPI) in Vienna, Austria, where she was Resident Fellow since 2008. Matxalen has specialised in National Space Legislation and Space Regulations and has published a number of papers in this field. Before joining ESPI she dealt with EC Space Policy and GMES issues during her internship at the European Commission and previously she was a Junior Policy Advisor for the Delegation of the Basque Country in Brussels where she dealt with EC Transport Policy and Galileo affairs. Since 2010 she is member of the International Institute of Space Law (IISL). Matxalen holds and Advance LLM in European Business Law from Leiden University and is occasionally invited to give guest lectures in Space Law and Policy master courses.

Kai-Uwe Schrogl

Kai-Uwe Schrogl is Director of the European Space Policy Institute (ESPI) in Vienna, Austria since 1 September 2007. Prior to this, he was the Head of the Corporate Development and External Relations Department in the German Aerospace Center (DLR). Previously he also worked with the German Ministry for Post and Telecommunications and the German Space Agency (DARA). He has been a delegate to numerous international forums and recently served as the chairman of various European and global committees (ESA International Relations Committee and two UNCOPUOS plenary working groups). He presented, respectively testified, at hearings of the European Parliament and the U.S. House of Representatives. Kai-Uwe Schrogl has written or co-edited 12 books and more than 130 articles, reports and papers in the fields of space policy and law as well as telecommunications policy. He is editor in chief of the "Yearbook on Space Policy" and the book series "Studies in Space Policy" both published by ESPI at SpringerWienNewYork. In addition he sits on editorial boards of various international journals in the field of space policy and law (Acta Astronautica, Space Policy, Zeitschrift für Luft- und Weltraumrecht, Studies in Space Law/Nijhoff). Kai-Uwe Schrogl is a Member of the Board of Directors of the International Institute of Space Law, Member of the International Academy of Astronautics (recently chairing its Commission on policy, economics and regulations) and the Russian Academy for Cosmonautics. He holds a doctorate degree in political science and lectures international relations at Tübingen University, Germany (as an Honorary Professor). He has been a regular lecturer at, for example, the International Space University (where he serves as Adjunct Faculty) and the European Centre for Space Law's Summer Courses.

Filippo Tomasello

Filippo Tomasello was a flight test engineer in the Italian Air Force until 1984, involved in testing the Tornado aircraft. Subsequently in ENAV (civil Italian provider of Air Navigation Services) he was responsible for R&D and for a number of projects, including consolidation of the Upper Area Control Centres from 4 to 3, achieved in 2000. Then he joined EUROCONTROL as manager for Northern Europe, coordinating the related medium term plans and some projects. Member of the ICAO FANS Committee, he then chaired the ADS Panel and the Mobile Communications Panel for about 5 years. In 2005 he joined the European Commission (DG-TREN) on aviation safety, dealing with accident investigation, safety data collection and extension of the competencies of the European Aviation Safety Agency (EASA). On 16 February 2007 he entered EASA to progress the extension of its mandate to aerodromes, ATM and ANS. EASA has also designated him to participate in different ICAO working arrangements, at headquarter or EUR level. Among the former, he is a member of the ICAO Study Group on UAS. In 2009 he was focal point for a study on UAS communications, in particular with ATC. In Italy he is, since 1991, visiting Professor at State University "Parthenope" in Naples and, since 2009 member of the Council of the Italian Institute of Navigation. In addition to teaching aviation safety regulation at “Parthenope” he has followed the development of several graduate dissertations (Papale “ATCO management tools”; Varchetta “Pre Departure Clearances”; Simonetti “Essential requirements for aerodrome safety” and others).

Mission Statement of ESPI

The European Space Policy Institute (ESPI) provides decision-makers with an informed view on mid- to long-term issues relevant to Europe's space activities. In this context, ESPI acts as an independent platform for developing positions and strategies