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Eighth North American, Central American and Caribbean Working Group Meeting (NACC/WG/8)
Mexico City, 29 August - 1 September 2023

Agenda Item 4: **2024 NACC/WG Work Programme**
4.4 Emerging Technologies and Regional Challenges

INTEGRATION OF UNMANNED AIRCRAFT OPERATIONS INTO AIR NAVIGATION OPERATIONS

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This working paper presents information about the operations of unmanned aircraft and the integration of these aircraft into the daily operations of air navigation services in the region.

Action:	Suggested actions are presented in Section 4.
Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency • Economic Development of Air Transport
References:	• Unmanned Operations in the CAR region.

1. Introduction

1.1 Circular 328 AN/190 provides information on Unmanned Aircraft Systems (UAS), since civil aviation has so far been based on the notion that a pilot directs the aircraft from inside itself and, very frequently, with passengers on board. Removing the pilot from the aircraft poses important technical and operational problems, the magnitude of which is presented in the Circular indicated, in **Appendix A** of this Working Paper.

1.2 ICAO has developed a series of documentation to support States in the process of developing their regulations, and procedures, among others, for the integration of these operations in their airspace. This documentation supports the States in the establishment of harmonization in the development of their regulation, the establishment of security for the integration of the operations of unmanned aircraft, and, above all, establishes in terms of its documentation how the States must take this issue and in accordance with ICAO documentation, integrate the requirements and regulations for their operations.

1.3 Remotely manned aircraft are a type of unmanned aircraft. All unmanned aircraft, whether remotely piloted, fully autonomous, or a combination of both, are subject to the provisions of Article 8 of the International Convention on Civil Aviation entitled Pilotless Aircraft.

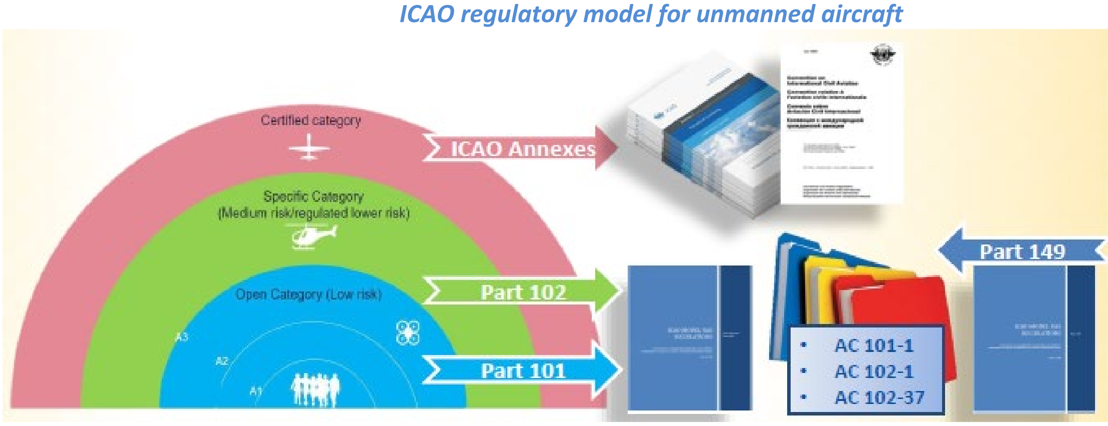
1.4 ICAO has established the following documentation for the operation of unmanned aircraft:

Categorization:

- Open category and specific categories: ICAO model for the regulation of UAS Part-1 and Part-2, which is an example for ICAO Member States to establish regulations for unmanned aircraft operations. Document under the following link: https://www.icao.int/safety/UA/Documents/Final%20Model%20UAS%20Regulations3%20-%20Parts%20101%20and%20102.pdf
- Certified category: All ICAO annexes apply.
  Approval of aviation organizations (AAO): For operators of unmanned aircraft, example for the development of the regulation: ICAO Model for the regulation of UAS Part-149: https://www.icao.int/safety/UA/Documents/Final%20Model%20UAS%20Regulations3%20-%20Part%20149.pdf

1.5 In addition to information and guides that ICAO has developed to support States in dealing with the operation of unmanned aircraft due to the diversity of applications.

ICAO regulatory model for unmanned aircraft



2. Analysis

2.1 The Operations of Unmanned Aircraft affect all areas of air navigation, the incorporation of their operations must be analyzed, regulated, and supervised by the State.

2.2 ICAO recommends to the States the analysis of the operations in their airspace, the development of a national regulation that regulates their operations, and adequately trained personnel that perform surveillance functions.

2.3 The ICAO documentation is an important basis for the development of this regulation, as well as taking into account the regulations of other States and the lessons learned to establish a continuous improvement process since both the regulation and the procedures developed by the status must be continuously improved.

3. Regulation available for analysis

3.1 The ICAO SAM Regional Office has developed a series of documentation to regulate the operations of these aircraft:

1. UAS LAR 100: General requirements for operations of unmanned aircraft systems (UAS).
2. LAR UAS 101: Operations of unmanned aircraft systems (UAS) in the open category.
3. Concept of operations for UAS traffic management (UTM)
4. concept of operations (CONOPS) for unmanned aircraft systems (UAS).

3.2 ICAO/SAM has shared these documents with our region to support the work of the CAR Region in its analysis and implementation of a homogeneous regulation.

3.3 It is necessary to review the documentation provided by ICAO and its application to the operations of the different types of unmanned aircraft and identify its regional application.

3.4 In this sense, the ICAO NACC Regional Office proposes the creation of a Multidisciplinary Group that can carry out the work of analysis and recommendations for the development and application of a regulation to unmanned aircraft operations in the region.

3.5 This Group should converge with the Group that will carry out the analysis of Annex 10, Volume VI.

3.6 The rest of the **Appendices** to this working paper reflect the information of the UAS LARs developed by ICAO/SAM.

4. Suggested actions

4.1 The States are invited to:

a) note of the information presented in this working paper;

b) approve and support the proposals in sections 3.4 and 3.5 of this working paper; and

c) any other activity that applies.

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Unmanned Aircraft Systems (UAS)

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and published under his authority

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FOREWORD

Civil aviation has to this point been based on the notion of a pilot operating the aircraft from within the aircraft itself and more often than not with passengers on board. Removing the pilot from the aircraft raises important technical and operational issues, the extent of which is being actively studied by the aviation community. Many of these issues will be identified in this circular.

Unmanned aircraft systems (UAS) are a new component of the aviation system, one which ICAO, States and the aerospace industry are working to understand, define and ultimately integrate. These systems are based on cutting-edge developments in aerospace technologies, offering advancements which may open new and improved civil/ commercial applications as well as improvements to the safety and efficiency of all civil aviation. The safe integration of UAS into non-segregated airspace will be a long-term activity with many stakeholders adding their expertise on such diverse topics as licensing and medical qualification of UAS crew, technologies for detect and avoid systems, frequency spectrum (including its protection from unintentional or unlawful interference), separation standards from other aircraft, and development of a robust regulatory framework.

The goal of ICAO in addressing unmanned aviation is to provide the fundamental international regulatory framework through Standards and Recommended Practices (SARPs), with supporting Procedures for Air Navigation Services (PANS) and guidance material, to underpin routine operation of UAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations. This circular is the first step in reaching that goal.

ICAO anticipates that information and data pertaining to UAS will evolve rapidly as States and the aerospace industry advance their work. This circular therefore serves as a first snapshot of the subject.

Comments

Comments from States on this circular, particularly with respect to its application and usefulness, would be appreciated. These comments will be taken into account in the preparation of subsequent material and should be addressed to:

The Secretary General
International Civil Aviation Organization
999 University Street
Montréal, Quebec, Canada H3C 5H7

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ABBREVIATIONS/ACRONYMS

ACAS	Airborne collision avoidance system
ADS-B	Automatic dependent surveillance — broadcast
AM(R)S	Aeronautical mobile (route) service
AMS(R)S	Aeronautical mobile satellite (route) service
ARNS	Aeronautical radio navigation service
ARNSS	Aeronautical radio navigation satellite service
ATC	Air traffic control
ATM	Air traffic management
ATS	Air traffic services
C2	Command and control
C3	Command, control and communications
CAA	Civil Aviation Authority
CPDLC	Controller-pilot data link communications
EASA	European Aviation Safety Agency
EUROCAE	European Organisation for Civil Aviation Equipment
HF	High frequency
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
ITU	International Telecommunication Union
PANS	Procedures for Air Navigation Services
QOS	Quality of service
RPA	Remotely-piloted aircraft
RPAS	Remotely-piloted aircraft system
RTCA	RTCA, Inc.
SAR	Search and rescue
SARPs	Standards and Recommended Practices
SATCOM	Satellite communication
SMS	Safety management system(s)
SSP	State safety programme
UA	Unmanned aircraft
UAS	Unmanned aircraft system(s)
UAV	Unmanned aerial vehicle (obsolete term)
UOC	UAS operator certificate
VDL	VHF digital link
VFR	Visual flight rules
VHF	Very high frequency
VLOS	Visual line-of-sight
VMC	Visual meteorological conditions
WRC	World Radiocommunication Conference

GLOSSARY

Explanation of Terms

*Note.— The terms contained herein are used in the context of this circular. Except where indicated, they have no official status within ICAO. Where a formally recognized ICAO definition is included herein for convenience, this is noted with an *. Where a term is used differently from a formally recognized ICAO definition, this is noted with an **.*

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.

Aircraft — category*. Classification of aircraft according to specified basic characteristics, e.g. aeroplane, helicopter, glider, free balloon.

Autonomous aircraft. An unmanned aircraft that does not allow pilot intervention in the management of the flight.

Autonomous operation. An operation during which a remotely-piloted aircraft is operating without pilot intervention in the management of the flight.

Command and control link. The data link between the remotely-piloted aircraft and the remote pilot station for the purposes of managing the flight.

Commercial operation. An aircraft operation conducted for business purposes (mapping, security surveillance, wildlife survey, aerial application, etc.) other than commercial air transport, for remuneration or hire.

Crew member*. A person assigned by an operator to duty on an aircraft during a flight duty period.

Detect and avoid. The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action to comply with the applicable rules of flight.

Flight crew member*. A licensed crew member charged with duties essential to the operation of an aircraft during a flight duty period.

Flight recorder**. Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation. In the case of remotely-piloted aircraft, it also includes any type of recorder installed in a remote pilot station for the purpose of complementing accident/incident investigation.

Flight time — aeroplanes*. The total time from the moment an aeroplane first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight.

Flight time — helicopters*. The total time from the moment a helicopter's rotor blades start turning until the moment the helicopter finally comes to rest at the end of the flight, and the rotor blades are stopped.

Flying pilot. A person who operates the flying controls of an aircraft and is responsible for the flight trajectory of the aircraft.

Handover. The act of passing piloting control from one remote pilot station to another.

Instrument flight time*. Time during which a pilot is piloting an aircraft solely by reference to instruments and without external reference points.

Lost link. The loss of command and control link contact with the remotely-piloted aircraft such that the remote pilot can no longer manage the aircraft's flight.

Operational control*. The exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of safety of the aircraft and the regularity and efficiency of the flight.

Operator*. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot (to)*. To manipulate the flight controls of an aircraft during flight time.

Pilot-in-command*. The pilot designated by the operator, or in the case of general aviation, the owner, as being in command and charged with the safe conduct of a flight.

Radio line-of-sight. A direct electronic point-to-point contact between a transmitter and a receiver.

Remote crew member. A licensed crew member charged with duties essential to the operation of a remotely-piloted aircraft, during flight time.

Remote pilot. The person who manipulates the flight controls of a remotely-piloted aircraft during flight time.

Remote pilot station. The station at which the remote pilot manages the flight of an unmanned aircraft.

Remotely-piloted. Control of an aircraft from a pilot station which is not on board the aircraft.

Remotely-piloted aircraft. An aircraft where the flying pilot is not on board the aircraft.

Note.— This is a subcategory of unmanned aircraft.

Remotely-piloted aircraft system. A set of configurable elements consisting of a remotely-piloted aircraft, its associated remote pilot station(s), the required command and control links and any other system elements as may be required, at any point during flight operation.

RPA observer. A remote crew member who, by visual observation of the remotely-piloted aircraft, assists the remote pilot in the safe conduct of the flight.

Segregated airspace. Airspace of specified dimensions allocated for exclusive use to a specific user(s).

Unmanned aircraft. An aircraft which is intended to operate with no pilot on board.

Unmanned aircraft system. An aircraft and its associated elements which are operated with no pilot on board.

Visual line-of-sight operation. An operation in which the remote crew maintains direct visual contact with the aircraft to manage its flight and meet separation and collision avoidance responsibilities.

REFERENCES

ICAO DOCUMENTS

Annex 1 — *Personnel Licensing*
Annex 2 — *Rules of the Air*
Annex 3 — *Meteorological Service for International Air Navigation*
Annex 6 — *Operation of Aircraft*
    Part I — *International Commercial Air Transport — Aeroplanes*
Annex 7 — *Aircraft Nationality and Registration Marks*
Annex 8 — *Airworthiness of Aircraft*
Annex 10 — *Aeronautical Telecommunications*
    Volume II — *Communication Procedures including those with PANS status*
    Volume IV — *Surveillance and Collision Avoidance Systems*
Annex 11 — *Air Traffic Services*
Annex 13 — *Aircraft Accident and Incident Investigation*
Annex 14 — *Aerodromes*
    Volume I — *Aerodrome Design and Operations*
Annex 16 — *Environmental Protection*
    Volume I — *Aircraft Noise*
    Volume II — *Aircraft Engine Emissions*
Annex 18 — *The Safe Transport of Dangerous Goods by Air*

Doc 4444 *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM)
Doc 7300 *Convention on International Civil Aviation*, signed at Chicago on 7 December 1944 and amended by the ICAO Assembly
Doc 8643 *Aircraft Type Designators*
Doc 9284 *Technical Instructions for the Safe Transport of Dangerous Goods by Air*
Doc 9854 *Global Air Traffic Management Operational Concept*
Doc 9863 *Airborne Collision Avoidance System (ACAS) Manual*
Doc 9869 *Manual on Required Communication Performance (RCP)*

OTHER DOCUMENTS

RTCA, DO-304, Guidance Material and Considerations for Unmanned Aircraft Systems
Issued 03-22-07 • Prepared by SC-203

This document addresses all Unmanned Aircraft Systems (UAS) and UAS operations being considered for realistic implementation in the United States National Airspace System (NAS) in the foreseeable future. It is intended to educate the community and used to facilitate future discussions on UAS standards. It provides the aviation community with a definition of UAS, a description of the operational environment, and a top-level functional breakdown. The guidance material provides a framework for developing standards through RTCA Special Committee 203.

EASA, Policy Statement – Airworthiness Certification Policy of Unmanned Aircraft Systems (UAS)
Doc E.Y013-01 • Issued 25-08-2009

This policy establishes general principles for type-certification (including environmental protection) of an unmanned aircraft system. The policy represents a first step in the development of a comprehensive civil UAS regulation. This policy statement is an interim solution to aid acceptance and standardization of UAS certification procedures in Europe.

Chapter 1

INTRODUCTION

BACKGROUND

1.1 On 12 April 2005, during the first meeting of its 169th Session, the Air Navigation Commission requested the Secretary General to consult selected States and international organizations with respect to: present and foreseen international civil unmanned aerial vehicle (UAV) activities in civil airspace; procedures to obviate danger to civil aircraft posed by UAVs operated as State aircraft; and procedures that might be in place for the issuance of special operating authorizations for international civil UAV operations.

First informal ICAO meeting on UAVs

1.2 Subsequent to the above, the first ICAO exploratory meeting on UAVs was held in Montreal on 23 and 24 May 2006. Its objective was to determine the potential role of ICAO in UAV regulatory development work. The meeting agreed that although there would eventually be a wide range of technical and performance specifications and standards, only a portion of those would need to become ICAO SARPs. It was also determined that ICAO was not the most suitable body to lead the effort to develop such specifications. However, it was agreed that there was a need for harmonization of terms, strategies and principles with respect to the regulatory framework and that ICAO should act as a focal point.

Second informal ICAO meeting on UAVs

1.3 The second informal ICAO meeting (Palm Coast, Florida, January 2007) concluded that work on technical specifications for UAV operations was well underway within both RTCA and EUROCAE and was being adequately coordinated through a joint committee of their two working groups. The main issue for ICAO was, therefore, related to the need to ensure safety and uniformity in international civil aviation operations. In this context, it was agreed that there was no specific need for new ICAO SARPs at that early stage. However, there was a need to harmonize notions, concepts and terms. The meeting agreed that ICAO should coordinate the development of a strategic guidance document that would guide the regulatory evolution. Even though non-binding, the guidance document would be used as the basis for development of regulations by the various States and organizations. As regulatory material developed by States and organizations gained maturity, such material could be proposed for inclusion in the ICAO guidance document. The document would then serve as the basis for achieving consensus in the later development of SARPs.

1.4 The meeting felt strongly that the eventual development of SARPs should be undertaken in a well-coordinated manner. Because this was a newly emerging technology it was felt that there was a unique opportunity to ensure harmonization and uniformity at an early stage and that all ICAO efforts should be based on a strategic approach and should support the emerging work of other regulatory bodies. The meeting had also suggested that from this point onwards, the subject should be referred to as unmanned aircraft systems (UAS), in line with RTCA and EUROCAE agreements.

1.5 Finally, it was concluded that ICAO should serve as a focal point for global interoperability and harmonization, to develop a regulatory concept, to coordinate the development of UAS SARPs, to contribute to the development of technical specifications by other bodies, and to identify communication requirements for UAS activity.

PURPOSE OF THE CIRCULAR

1.6 The purpose of this circular is to:

a) apprise States of the emerging ICAO perspective on the integration of UAS into non-segregated airspace and at aerodromes;

b) consider the fundamental differences from manned aviation that such integration will involve; and

c) encourage States to help with the development of ICAO policy on UAS by providing information on their own experiences associated with these aircraft.

1.7 Unmanned aircraft (UA) are, indeed, aircraft; therefore, existing SARPs apply to a very great extent. The complete integration of UAS at aerodromes and in the various airspace classes will, however, necessitate the development of UAS-specific SARPs to supplement those already existing.

DOCUMENT STRUCTURE

1.8 UAS issues span all of aviation, and as such, it is an ongoing challenge to determine the most effective and efficient means of addressing the broad scope of topics. This document is organized to reflect the three traditional areas of aviation: operations, equipment and personnel. This systems approach will facilitate a comprehensive view of the issues, as well as better align the discussions with the appropriate disciplines.

Chapter 2

ICAO REGULATORY FRAMEWORK

PILOTLESS AIRCRAFT

> **Article 8** of the *Convention on International Civil Aviation*, signed at Chicago on 7 December 1944 and amended by the ICAO Assembly (Doc 7300) (hereinafter referred to as "the Chicago Convention") stipulates that:
>
> 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….

2.1 The *Global Air Traffic Management Operational Concept* (Doc 9854) states "An unmanned aerial vehicle is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous." This understanding of UAVs was endorsed by the 35th Session of the ICAO Assembly.

2.2 The regulatory framework under development by ICAO is being shaped within the context of the above statement. All UA, whether remotely-piloted, fully autonomous or a combination thereof, are subject to the provisions of Article 8. Only the remotely-piloted aircraft (RPA), however, will be able to integrate into the international civil aviation system in the foreseeable future. The functions and responsibilities of the remote pilot are essential to the safe and predictable operation of the aircraft as it interacts with other civil aircraft and the air traffic management (ATM) system. Fully autonomous aircraft operations are not being considered in this effort, nor are unmanned free balloons nor other types of aircraft which cannot be managed on a real-time basis during flight.

2.3 Integrating remotely-piloted UA into non-segregated airspace and at aerodromes can likely be achieved in the medium-term. The premise behind the regulatory framework and the means by which contracting States will be able to grant special authorizations is that these UAS will meet the identified minimum requirements needed to operate safely alongside manned aircraft. The remotely-located pilot with the fundamental responsibilities of pilot-in-command is a critical element in reaching this status. It is possible that States may be able to accommodate UA which are not remotely-piloted through use of special provisions or in segregated airspace; however this accommodation is not equivalent to integration.

MODEL AIRCRAFT

2.4 In the broadest sense, the introduction of UAS does not change any existing distinctions between model aircraft and aircraft. Model aircraft, generally recognized as intended for recreational purposes only, fall outside the provisions of the Chicago Convention, being exclusively the subject of relevant national regulations, if any.

FUNDAMENTALS

2.5 ICAO recognizes many categories of aircraft, among them balloons, gliders, aeroplanes and rotorcraft. Aircraft can be land, sea or amphibious. Whether the aircraft is manned or unmanned does not affect its status as an aircraft. Each category of aircraft will potentially have unmanned versions in the future. This point is central to all further issues pertaining to UA and provides the basis for addressing airworthiness, personnel licensing, separation standards, etc.

2.6 To the maximum extent possible, all terms in common use in ICAO documents will remain unchanged by the introduction of UAS. The definition of "operator" remains unchanged from existing use while "controller" equates only to "air traffic controller". With regard to "pilot", the function of this position remains unchanged despite the person or persons being located other than on board the aircraft. To distinguish those pilots who conduct their piloting duties from other than on board the aircraft, the term "remote pilot" will be applied. Consideration of the applicability of the terms "pilotless" and "flown without a pilot", as contained in Article 8 of the Chicago Convention, is elaborated in Chapter 4.

2.7 Another fundamental of the assessment undertaken by ICAO is that a UA will not, for the foreseeable future, have passengers on board for remuneration. This point relates directly to many of the existing SARPs contained in Annex 6 — *Operation of Aircraft* and Annex 8 — *Airworthiness of Aircraft* such as use of seatbelts and safety harnesses by crew members during take-off and landing, pilot windshield features and emergency equipment. While recognizing that there may come a time in the future when passengers are transported on UA, development of SARPs for that scenario will only be addressed as and when required.

REGULATORY FRAMEWORK

2.8 The principal objective of the aviation regulatory framework is to achieve and maintain the highest possible uniform level of safety. In the case of UAS, this means ensuring the safety of any other airspace user as well as the safety of persons and property on the ground.

2.9 Identifying the commonalities and differences between manned and unmanned aircraft is the first step toward developing a regulatory framework that will provide, at a minimum, an equivalent level of safety for the integration of UAS into non-segregated airspace and at aerodromes. Technical specifications to support airworthiness, command and control (C2), detect and avoid, and other functionalities are being addressed by various industry standards-development organizations around the world. ICAO's focus will remain on the higher-level performance-based standards, e.g. specifying minimum performance requirements for communications links, rather than how to achieve said requirements, along with harmonizing terms and definitions needed to support this activity.

2.10 Development of the complete regulatory framework for UAS will be a lengthy effort, lasting many years. As individual subjects and technologies reach maturity, the pertinent SARPs will be adopted. It is envisioned that this will be an evolutionary process, with SARPs being added gradually. Non-binding guidance material will often be provided in advance of the SARPs for use by States that face UAS operations in the near term. Therefore close adherence to the guidance material will facilitate later adoption of SARPs and will ensure harmonization across national and regional boundaries during this development phase. It is to be noted that elements of the regulatory framework for UAS certainly already exist inasmuch as UA are aircraft and as such major portions of the regulatory framework applicable to manned aircraft are directly applicable.

2.11 Data collection is critical to the development of SARPs. This process requires time and inherently serves as a prelude to a robust understanding of the unique characteristics of UAS. Therefore, every effort should be made amongst contracting States to collect data in a coordinated manner and share it openly to expedite the development of international civil aviation standards.

CASE FOR HARMONIZATION

2.12 To date, most flights conducted by UAS have taken place in segregated airspace to obviate danger to other aircraft. Current UA are unable to integrate safely and seamlessly with other airspace users, the reasons for which are twofold — the inability to comply with critical rules of the air, and the lack of SARPs specific to UA and their supporting systems.

2.13 A key factor in safely integrating UAS in non-segregated airspace will be their ability to act and respond as manned aircraft do. Much of this ability will be subject to technology — the ability of the aircraft to be controlled by the remote pilot, to act as a communications relay between remote pilot and air traffic control (ATC), the performance (e.g. transaction time and continuity of the communications link) as well as the timeliness of the aircraft's response to ATC instructions. Performance-based SARPs may be needed for each of these aspects.

2.14 Personnel licensing provides harmonization within a single airspace as well as across national and regional boundaries. The remote pilot of a UAS and the pilot of a manned aircraft have the same ultimate responsibility for the safe operation of their aircraft and therefore have the same obligation for knowledge of air law and flight performance, planning and loading, human performance, meteorology, navigation, operational procedures, principles of flight and radiotelephony. Both pilots must obtain flight instruction, demonstrate their skill, achieve a level of experience, and be licensed. They must also be proficient in the language used for radiotelephony and meet medical fitness levels, although the latter may be modified as appropriate for the UAS environment.

2.15 The lack of an on-board pilot introduces new considerations with regard to fulfilling safety-related responsibilities such as incorporation of technologies for detect and avoid, command and control, communications with ATC, and prevention of unintended or unlawful interference.

2.16 Technologies are continuously evolving in both manned and unmanned aviation. Automation plays an ever increasing role, particularly in transport category aircraft. Automation systems are already capable of operating the controls, keeping the aircraft on course, balancing fuel use, transmitting and receiving data from various ground facilities, identifying conflicting traffic and providing resolution advisories, plotting and executing optimum descent profiles and in some cases even taking-off or landing the aircraft. All of these activities are, of course, being monitored by the pilot.

SAFETY MANAGEMENT

> ***Safety.*** The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management.

2.17 Aircraft operating without a pilot on board present a wide array of hazards to the civil aviation system. These hazards must be identified and the safety risks mitigated, just as with introduction of an airspace redesign, new equipment or procedures.

2.18 The term "safety management" includes two key concepts. First is the concept of a State safety programme (SSP), which is an integrated set of regulations and activities aimed at improving safety. Second is the concept of a safety management system (SMS) which is a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

2.19 States are required to establish an SSP to include safety rulemaking, policy development and oversight. Under an SSP, safety rulemaking is based on comprehensive analyses of the State's aviation system. Safety policies are developed based on safety information, including hazard identification and safety risk management, while safety oversight is focused on the effective monitoring of the eight critical elements of the safety oversight function, including areas of significant safety concerns and higher safety risks. As operators introduce UAS into operation, the State's SSP should support analysis of the potential effect on safety of the air navigation system, the safety of the UAS itself and of third parties. It should also determine what role, if any, “equivalent level of safety” and “acceptable means of compliance” will have.

2.20 Operators and service providers are responsible for establishing an SMS. States are responsible, under the SSP, for the acceptance and oversight of these SMS. Assuring the safe introduction of UAS into the aviation system will fall under the responsibility of the State in accordance with Annex 6 — *Operation of Aircraft*, Annex 11 — *Air Traffic Services* and Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*. It is envisaged that Annex 6 will be expanded to include UAS at which point the SMS requirement will become applicable for the UAS operator. Detailed analyses will need to be conducted to determine what risks are likely to be encountered. Analysis may need to include, inter alia, the type of UA involved, the construct and location of the remote pilot station, if any, and its ability to interface with the UA, and the location and type of operation being proposed.

2.21 Safety levels are established by States based on many criteria. Proper application of SARPs, PANS and guidance material assists States in maintaining the agreed level of safety. UAS present a new dilemma for the airworthiness authority to consider. In most respects, UAS will be required to comply with existing regulations; however, there will be aspects which must be addressed differently as a result of not having a pilot on board the aircraft. For these cases, the authority will have to determine if an alternate means of compliance is possible to achieve the same safety level.

Chapter 3

OVERVIEW OF UAS

GENERAL CONCEPT OF OPERATIONS

3.1 UAS will operate in accordance with ICAO Standards that exist for manned aircraft as well as any special and specific standards that address the operational, legal and safety differences between manned and unmanned aircraft operations. In order for UAS to integrate into non-segregated airspace and at non-segregated aerodromes, there shall be a pilot responsible for the UAS operation. Pilots may utilize equipment such as an autopilot to assist in the performance of their duties; however, under no circumstances will the pilot responsibility be replaced by technologies in the foreseeable future.

3.2 To better reflect the status of these aircraft as being piloted, the term “remotely-piloted aircraft” (RPA) is being introduced into the lexicon. An RPA is an aircraft piloted by a licensed “remote pilot” situated at a “remote pilot station” located external to the aircraft (i.e. ground, ship, another aircraft, space) who monitors the aircraft at all times and can respond to instructions issued by ATC, communicates via voice or data link as appropriate to the airspace or operation, and has direct responsibility for the safe conduct of the aircraft throughout its flight. An RPA may possess various types of auto-pilot technology but at any time the remote pilot can intervene in the management of the flight. This equates to the ability of the pilot of a manned aircraft being flown by its auto flight system to take prompt control of the aircraft.

3.3 RPA is a subset of unmanned aircraft. Throughout this document, “unmanned aircraft” or “unmanned aircraft system” will be used as all-encompassing terms, whereas “remotely-piloted aircraft” or iterations thereof will refer only to the piloted subset.

3.4 The roles of RPA will continue to expand as technologies and performance characteristics become better understood. Long flight durations, covert operational capabilities, and reduced operational costs serve as natural benefits to many communities, such as law-enforcement, agriculture and environmental analysis.

3.5 As technologies develop, mature and become able to meet defined standards and regulations, RPA roles could expand to include operations involving carriage of cargo and eventually — possibly — passengers. In addition, domestic operations will likely expand to trans-border flights subject to pre-approval by the States involved.

3.6 RPA may have the same phases of flight — taxi, departure, en-route and arrival — as manned aircraft or they may be launched/recovered and/or conduct aerial work. The aircraft performance characteristics may be significantly different from traditional manned aircraft. Regardless, the remote pilot will operate the aircraft in accordance with the rules of the air for the State and airspace in which the RPA is operating. This will include complying with directions and instructions provided by the air traffic services (ATS) unit.

RECENT GLOBAL DEVELOPMENTS

3.7 The potential of RPA for civil use has long been evident and is now beginning to be realized. Migrating current military RPA types into civilian roles and applications is actively being considered. Meanwhile newer designs are being tailored specifically for the civil market. Additionally, while military RPA are State aircraft and therefore not subject to the Chicago Convention and its SARPs, States face a dilemma when attempting to integrate military RPA in airspace and at aerodromes also used by civil aircraft. The regulatory framework being developed for civil application may therefore carry the added benefit of facilitating operations for its military counterpart.

RPA SYSTEM CONCEPT

3.8 The remotely-piloted aircraft system (RPAS) comprises a set of configurable elements including an RPA, its associated remote pilot station(s), the required C2 links and any other system elements as may be required, at any point during flight operation. Other features might include, inter alia, software, health monitoring, ATC communications equipment, a flight termination system, and launch and recovery elements.

3.9 The system, in many cases, will not be static. An aircraft can be piloted from one of many remote pilot stations, during any given flight or from one day to another. Likewise, multiple aircraft can be piloted from a single remote pilot station, although standards may dictate a one-aircraft-at-a-time scenario. In both of these cases, the configuration of the system in operational use changes as one element or the other changes on a real-time basis.

3.10 This RPAS concept introduces many challenges for the airworthiness and operational approvals that are required. These challenges are described in Chapter 6.

3.11 Payload on RPA is not a factor considered within this document except as it pertains to dangerous goods. Likewise, any communications/data link requirements for the payload are not addressed herein.

UAS POTENTIAL MOST SUITED TO CIVIL OPERATIONS

3.12 UAS are popularly commended as being well suited to civil applications that are dull, dirty or dangerous, in other words, tasks that entail monotony or hazard for the pilot of a manned aircraft. However, there is a far broader potential scope for UAS, including, inter alia, commercial, scientific and security applications. Such uses mainly involve monitoring, communications and imaging.

3.13 Typical monitoring and surveillance tasks include border and maritime patrol, search and rescue, fishery protection, forest fire detection, natural disaster monitoring, contamination measurement, road traffic surveillance, power and pipeline inspection, and earth observation. Moreover, the ability of some UAS to keep station for days, weeks or even months makes them particularly well suited for use as communication relays. Other UAS are already being exploited for commercial imaging purposes such as aerial photography and video.

EXPECTED EVOLUTION OF THE UAS CIVIL MARKET

3.14 A civil market already exists for UAS. This market will likely remain limited until appropriate regulatory frameworks are in place. Any significant expansion will also depend upon the development and certification of technologies required to enable the safe and seamless integration of RPA into non-segregated airspace.

3.15 The demand for small civil RPA flying visual line-of-sight (VLOS) (see Figure 3-1) for law enforcement, survey work, and aerial photography and video will continue to grow. Larger and more complex RPA — able to undertake more challenging tasks — will most likely begin to operate in controlled airspace where all traffic is known and where ATC is able to provide separation from other traffic. This could conceivably lead to routine unmanned commercial cargo flights.

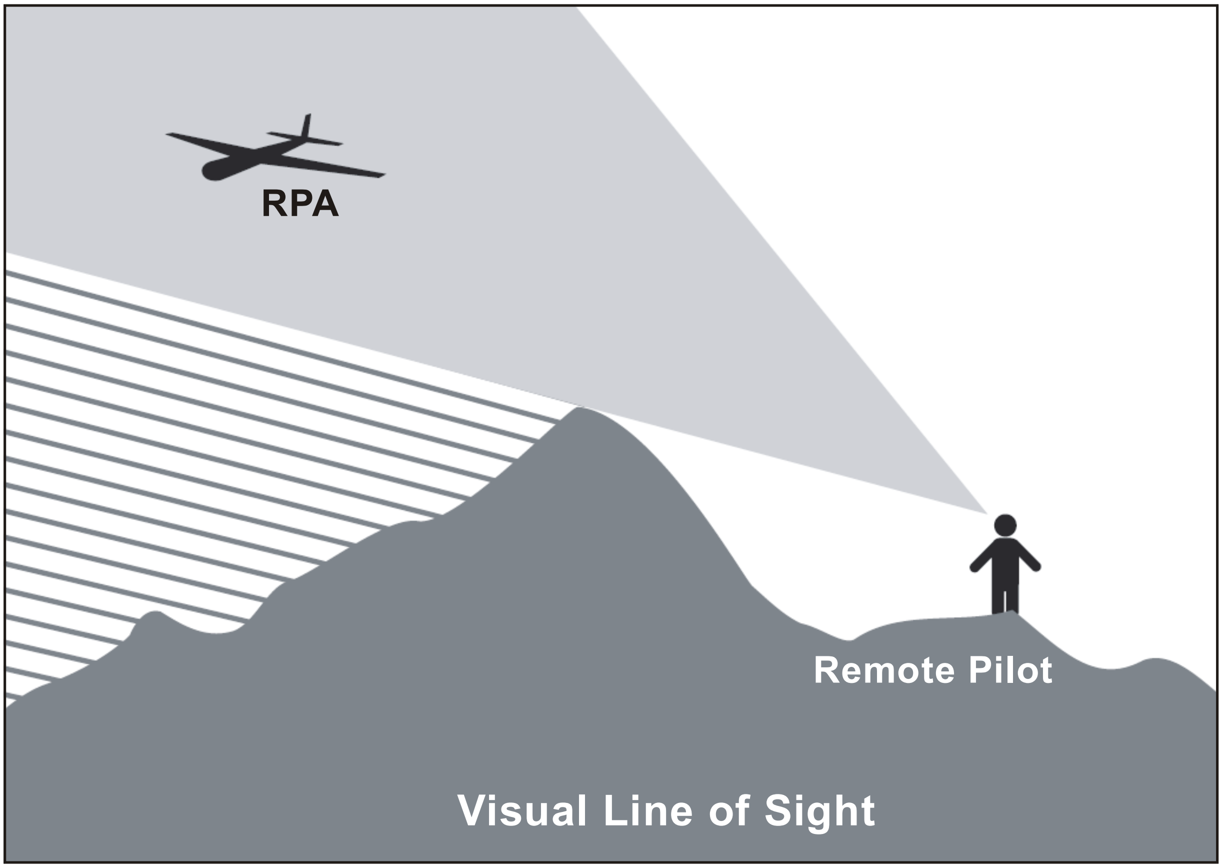

Figure 3-1. Visual line of sight

3.16 Paradoxically, the benefits of RPA to conduct visual surveillance/observation missions, which typically occur in visual meteorological conditions (VMC), are far more challenging due to the need to avoid collisions without benefit of separation service provided by ATC. activities as diverse as gliding, ballooning, parachuting, leisure flying, military training and law enforcement operations are likely to occur under the same conditions. Technology to support the pilot in meeting the collision avoidance responsibilities is not yet in place; hence the civil market for RPA operating outside controlled airspace could possibly be the slowest to evolve.

3.17 In cooperation with the scientific community, civil aviation authorities are working on the means to permit use of RPA in support of research on climate change, meteorological forecasting, and wildlife monitoring, among others. Many, if not most, of these flights cannot be conducted by manned aircraft due to the remote locations, harsh conditions, or altitudes at which the flights need to operate.

3.18 The RPA civil market is expected to develop incrementally, with usage increasing as confidence in RPA safety and reliability grows, as SARPs and technical specifications are developed, and public and industry confidence grows.

HIGH SEAS OPERATIONS

3.19 Operators must have approval from the State of the Operator before conducting operations in high seas airspace. They must likewise coordinate their operations with the ATS provider responsible for the airspace concerned.

ENVIRONMENTAL CONSIDERATIONS

3.20 Like manned aircraft, UA operations will have an impact on the environment, the extent of which will depend on the category and size of the UA, the type and amount of fuel consumed, and the nature and location of the operation, among many other factors. It is critical that as UA are designed, built and operated, their environmental footprint, noise and gaseous emissions, are compliant with the applicable standards. Environmental issues are further addressed in Chapter 6.

Chapter 4

LEGAL MATTERS

INTRODUCTION

4.1 Specific rights and obligations have been agreed by the contracting States in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically. These rights and obligations will, in principle, apply equally to both manned and unmanned civil aircraft. Where new measures must be developed for UAS operations, or existing requirements met using alternative means, they will be identified herein and addressed according to the Chicago Convention.

SPECIFIC ARTICLES AND THEIR APPLICABILITY TO UAS

Article 3 *bis*

b) The contracting States recognize that every State, in the exercise of its sovereignty, is entitled to require the landing at some designated airport of a civil aircraft flying above its territory without authority…. it may also give such aircraft any other instructions to put an end to such violations.

c) Every civil aircraft shall comply with an order given in conformity with paragraph b) of this Article….

4.2 Contracting States are entitled, in certain circumstances, to require civil aircraft flying above their territory to land at designated aerodromes, per Article 3 *bis* b) and c). Therefore the pilot of the RPA will have to be able to comply with instructions provided by the State, including through electronic or visual means, and have the ability to divert to the specified airport at the State's request. The requirement to respond to instructions based on such visual means may place significant requirements on certification of RPAS detection systems for international flight operations.

Article 8

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 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.

4.3 Article 8 details conditions for operating a "pilotless" aircraft over the territory of a contracting State. To understand the implications of this Article and its inclusion from the Paris Convention of 1919 (Article 15) into the Chicago Convention of 1944, the intent of the drafters must be considered. Remote-control and uncontrolled aircraft were in existence at the time, operated by both civil and military entities. "[A]ircraft flown without a pilot" therefore refers to the situation where there is no pilot on board the aircraft. As a consequence, any RPA is a "pilotless" aircraft, consistent with the intent of the drafters of Article 8.

4.4 Second, emphasis was placed on the significance of the provision that aircraft flown without a pilot "shall be so controlled as to obviate danger to civil aircraft", indicating that the drafters recognized that "pilotless aircraft" must have a measure of control being applied to them in relation to a so-called "due regard" obligation similar to that of State aircraft. In order for a UAS to operate in proximity to other civil aircraft, a remote pilot is therefore essential.

4.5 More recently, the Eleventh Air Navigation Conference (Montréal, 22 September to 3 October 2003) endorsed the global ATM operational concept which contains the following text: "[a]n unmanned aerial vehicle is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous."

4.6 Standards to facilitate application and processing of the mandated requests for authorization will be contained in an Appendix to Annex 2 — *Rules of the* Air. In all cases, the safety of other civil aircraft will have to be considered. It is envisaged that once the broad range of SARPs are adopted for each of the Annexes affected, contracting States will be able to facilitate and foster international operations of RPA to a similar extent as that being enjoyed by manned aviation.

Article 12

Rules of the Air

Each contracting State undertakes to adopt measures to insure that every aircraft flying over or maneuvering within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force. Each contracting State undertakes to keep its own regulations in these respects uniform, to the greatest possible extent, with those established from time to time under this Convention. Over the high seas, the rules in force shall be those established under this Convention. Each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable.

4.7 The rules of the air apply to all aircraft, manned or unmanned. Furthermore, they oblige contracting States to maintain national regulations uniform with ICAO Standards, to the greatest possible extent, and to prosecute all persons violating them. This is the basis for international harmonization and interoperability, which is as essential for unmanned as manned operations to be conducted safely.

4.8 In accordance with Article 12 and Annex 2, the pilot-in-command is responsible for the operation of the aircraft in compliance with the rules of the air. This also extends to having final authority as to disposition of the aircraft while in command. This is true whether the pilot is on board the aircraft or located remotely.

4.9 RPA operations may involve the pilot and all associated responsibilities being handed over while the aircraft is in flight. The remote pilots may be co-located or situated thousands of kilometres apart, e.g. for an oceanic flight of a long range RPA, handover of piloting responsibilities to a remote pilot situated in Asia from a remote pilot situated in North America or between an en-route remote pilot and a local (terminal) remote pilot. Handover may also occur as a result of routine shift work of the remote pilots. Changes will be required to address the handover of such responsibilities between different remote pilots. Adding to the complexity of this scenario is the possibility that the remote pilots and their stations may be located in different States.

Article 15

Airport and similar charges

Every airport in a contracting State which is open to public use by its national aircraft shall likewise, subject to the provisions of Article 68, be open under uniform conditions to the aircraft of all other contracting States....

4.10 This provision applies equally to UA. Contracting States remain free to permit civil UA operations only to/from designated aerodromes, providing that no discrimination is introduced with respect to national or foreign registration of the aircraft.

Article 29

Documents carried in aircraft

Every aircraft of a contracting State, engaged in international navigation, shall carry the following documents in conformity with the conditions prescribed in this Convention:

a) Its certificate of registration;

b) Its certificate of airworthiness;

c) The appropriate licenses for each member of the crew;

d) Its journey log book;

e) If it is equipped with radio apparatus, the aircraft radio station license;

f) If it carries passengers, a list of their names and places of embarkation and destination; and

g) If it carries cargo, a manifest and detailed declarations of the cargo.

4.11 Regarding Article 29, every aircraft of a contracting State engaged in international navigation shall carry the specified documents on board the aircraft. For an RPA, carrying paper originals of these documents may be neither practical nor appropriate. Use of electronic versions of these documents may be considered. The requirement for certain documents to be carried on board the aircraft will be reviewed to determine if alternative means can be developed for RPA.

Article 31

Certificates of airworthiness

Every aircraft engaged in international navigation shall be provided with a certificate of airworthiness issued or rendered valid by the State in which it is registered.

4.12 Article 31 applies equally to unmanned aircraft engaged in international navigation; however there may be differences in how airworthiness will be determined. These differences are explored in Chapter 6. Until such time as SARPs for Certificates of Airworthiness are adopted in Annex 8 — *Airworthiness of Aircraft*, a gap will exist in how States issue these certificates.

Article 32

Licenses of personnel

a) The pilot of every aircraft and the other members of the operating crew of every aircraft engaged in international navigation shall be provided with certificates of competency and licenses issued or rendered valid by the State in which the aircraft is registered.

4.13 Remote pilots and other members of the remote crew are not subject to Article 32 which was drafted specifically for those individuals who conduct their duties while on board aircraft. Despite this, remote pilots and other members of the remote crew must be properly trained, qualified and hold an appropriate licence or a certificate of competence to ensure the integrity and safety of the civil aviation system. Until such time as SARPs for remote pilot licenses and certificates are adopted in Annex 1 — *Personnel Licensing*, a gap will exist in how States issue, render valid or recognize such licenses and certificates.

> **Article 33**
>
> *Recognition of certificates and licenses*
>
> Certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State in which the aircraft is registered, shall be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licences were issued or rendered valid are equal to or above the minimum standards which may be established from time to time pursuant to this Convention.

4.14 Article 33 is the basis for mutual recognition of certificates and licences; however, it should be noted that significant differences will exist in how UAS certificates will be considered. As with manned aircraft, the UA must possess a Certificate of Airworthiness. The other elements comprising the system which allows the RPA to operate (remote pilot station, C2, etc.) will also have to be addressed.

4.15 Assembly Resolution A36-13, Appendix G, Certificates of airworthiness, certificates of competency and licenses of flight crews (clause 2) resolves that States shall recognize the validity of certificates and licenses issued by other States when international standards for certain categories of aircraft or classes of airmen have not (yet) been developed. While ICAO is developing SARPs for RPAS, States are encouraged to develop national regulations that will facilitate mutual recognition of certificates for unmanned aircraft, thereby providing the means to authorize flight over their territories, including landings and take-offs by new types and categories of aircraft. An update to Assembly Resolution A36-13 may be necessary to include mutual recognition of licenses of remote pilots and other members of the remote crew.

Chapter 5

OPERATIONS

RULES OF THE AIR

5.1 Annex 2 — *Rules of the Air* constitutes Standards relating to the flight and manoeuvre of aircraft within the meaning of Article 12 of the Chicago Convention. Over the high seas, therefore, these Standards apply without exception. In addition, Annex 2 is applicable to aircraft bearing the nationality and registration marks of a contracting State, wherever they may be, to the extent that the marks do not conflict with the rules published by the State having jurisdiction over the territory overflown.

COLLISION AVOIDANCE

5.2 The pilot-in-command of a manned aircraft is responsible for detecting and avoiding potential collisions and other hazards (see Figure 5-1). The same requirement will exist for the remote pilot of an RPA. Technology to provide the remote pilot with sufficient knowledge of the aircraft's environment to fulfil the responsibility must be incorporated into the aircraft with counterpart components located at the remote pilot station. As stated in Annex 2, paragraph 3.2:

> *Note 1.— It is important that vigilance for the purpose of detecting potential collisions be exercised on board an aircraft, regardless of the type of flight or the class of airspace in which the aircraft is operating, and while operating on the movement area of an aerodrome.*

5.3 Paragraph 1.5.3 of the *Airborne Collision Avoidance System (ACAS) Manual* (Doc 9863) states that: "ACAS II was not designed with the intent of being installed on tactical military (e.g. fighter aircraft) or unmanned aircraft. As such, there are technical and operational issues that must be addressed and resolved prior to installing ACAS II on these types of aircraft." The nature and extent of the technical and operational issues will have to be assessed before any determination can be made as to the applicability of ACAS II for the RPA.

5.4 A fundamental principle of the rules of the air is that a pilot can see other aircraft and thereby avoid collisions, maintain sufficient distance from other aircraft so as not to create a collision hazard, and follow the right-of-way rules to keep out of the way of other aircraft. Integration of RPA may not require a change to the Standards, however, as RPAS technology advances, alternate means of identifying collision hazards will have to be developed with appropriate SARPs adopted. Regardless, the right-of-way rules will remain essential for the safe operation of aircraft, with or without a pilot on board. Likewise, for the surface movement of RPA in the aerodrome environment, it is necessary that RPA operations be conducted safely and efficiently without disrupting other aircraft operations.

5.5 Aircraft pilots are required to observe, interpret and heed a diverse range of visual signals intended to attract their attention and/or convey information. Such signals can range from lights and pyrotechnic signals for aerodrome traffic to signals used by intercepting aircraft. Remote pilots will be subject to the same requirements despite not being on board the aircraft, necessitating development and approval of alternate means of compliance with this requirement.

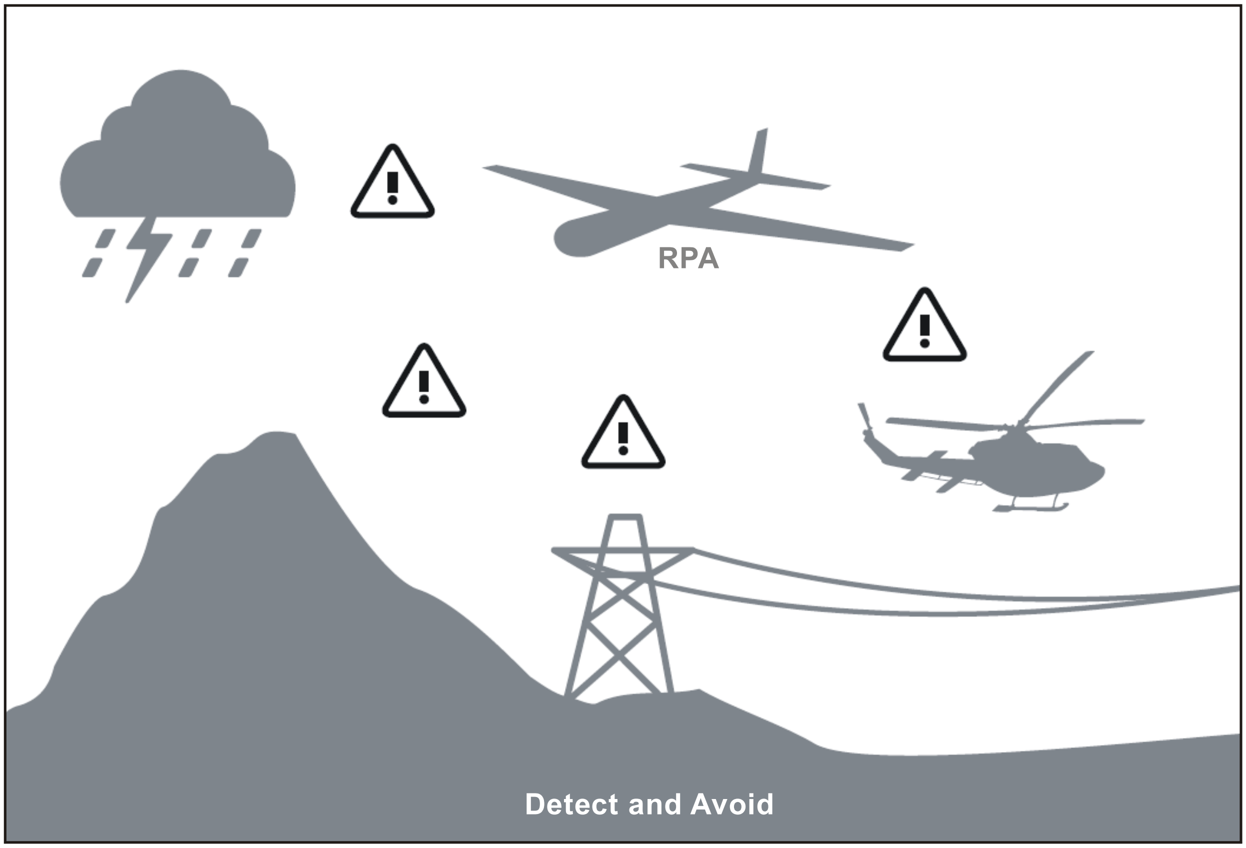

Figure 5-1. Detect and avoid

5.6 Considering each of the above, RPAS detect and avoid solutions will be required to meet specified performance requirements related to flight crew responsibilities. Both the aircraft and the remote pilot station will need to incorporate aspects of this functionality to achieve the complete technical solution required as part of the RPA operational approval. Depending on the type and location of the operations the RPA will conduct, these could include the ability to:

a) recognize and understand aerodrome signs, markings and lighting;

b) recognize visual signals (e.g. interception);

c) identify and avoid terrain;

d) identify and avoid severe weather;

e) maintain applicable distance from cloud;

f) provide "visual" separation from other aircraft or vehicles; and

g) avoid collisions.

5.7 The aerospace industry will continue to face a major challenge in the development of cost-effective solutions meeting RPAS detect and avoid performance requirements. It is possible that initial detect and avoid solutions which may not meet all performance requirements could nevertheless be accommodated on the basis of restricted or limited operational approvals and/or permits to fly as a function of associated safety assessments. Typically such restrictions or constraints would relate to airspace classifications, flight rules or specific geographical areas and associated traffic densities.

AIR TRAFFIC SERVICES

5.8 Annex 11 — *Air Traffic Services* relates to the establishment of airspace, ATS units and services necessary to promote a safe, orderly and expeditious flow of air traffic which, together with Annex 2, is intended to ensure that flying on international air routes is carried out under uniform conditions designed to improve the safety and efficiency of air operation.

5.9 For RPA, the following specificities need to be addressed:

a) ATM provisions may need to be amended to accommodate RPA, taking into account unique operational characteristics of the many aircraft types and sizes as well as their automation and non-traditional IFR/VFR capabilities; and

b) air navigation service providers will need to review emergency and contingency procedures to take account of unique RPA failure modes such as C2 link failure, parachute emergency descents and flight termination.

5.10 Whether the aircraft is piloted from on board or remotely, the provision of ATS should, to the greatest practicable extent, be one and the same. The introduction of RPA must not increase the risk to other aircraft or third parties and should not prevent or restrict access to airspace. ATM procedures for handling RPA should mirror those for manned aircraft whenever possible. There will be some instances where the remote pilot cannot respond in the same manner as could an on-board pilot (e.g. to follow the blue C172, report flight conditions, meteorological reports). ATM procedures will need to take account of these differences.

5.11 *Wake turbulence*. As RPA enter into routine service, there may be a need to review the current aircraft wake turbulence categories and any associated separation standards or procedures.

5.12 *Flight plans*. ATC must receive pre-flight notification/application that an aircraft is remotely-piloted. The *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) will likely be amended to include a specific flight plan annotation for this purpose. *Aircraft Type Designators* (Doc 8643) will certainly be amended to incorporate RPA type designators.

EQUIPMENT

5.13 All applicable equipment mandated in the Annexes, both for airworthiness and for operation, will be required for the RPAS, either directly or through an alternative (e.g. a digital compass instead of a magnetic compass). The difference will be that the equipment will be distributed over the RPA and remote pilot station. In addition to the equipment already required, there will be new equipment introduced to allow the RPAS to operate as a system. This may include, but is not limited to:

a) detect and avoid technologies; and

b) command and control systems to provide the connection between the RPA and remote pilot station.

ATS/REMOTE PILOT COMMUNICATIONS

5.14 ATS/remote pilot communication requirements must be assessed in the context of an ATM function, taking into account human interactions, procedures and environmental characteristics. An SMS approach should be employed to determine the adequacy of any communications solutions.

5.15 Current telecommunication procedures ensure voice and data messages are composed in a standardized format for both air-to-ground and ground-to-ground communications. For RPA, communications procedures will likely be based upon current practices applicable in the airspace classes in which the RPA operate.

5.16 Any requirements on type and level of interaction RPA must be capable of achieving with other users and service providers will need to be fully addressed prior to RPA integrating with manned aircraft. Topics such as situational awareness will require a deeper understanding of RPA's benefits and problems. Benefits that have been coincidentally achieved within manned aviation will need to be specifically charted for RPAS as they may not be automatically available in future designs (e.g. remote access to electronic aeronautical information). In addition, other new ATS features such as 4-dimentional trajectories must be reviewed for RPA use and adoption.

5.17 As with manned aviation, current communication technologies for RPA must continue to be supported with clear and proven procedures. Novel techniques may need to be employed to support the use of current technologies for ATS/remote pilot communications. Several technical solutions are available (addressed in Chapter 6), however it will be vital that any such solution which is not the norm for the particular ATS unit will have been approved by the ATS authority prior to the flight/operation. (See Figure 5-2.) Essential considerations include but may not be limited to volume of traffic, type and location of operation, ease of access to the communications method and its reliability.

5.18 Technical and operational interoperability with manned aircraft must be maintained. A prerequisite for this is compliance with the provisions of Annex 10 — *Aeronautical Telecommunications*, Volume II — *Communication Procedures including those with PANS status*. In the case of RPAS, the provisions dealing with loss of communication will most likely require special technical solutions.

5.19 *Transaction time*. The air-to-ground communication links may prove to be inadequate if there are substantial transmission delays between ATC and the remote pilot. This may have implications for future technological solutions to be used for direct controller/pilot communications.

5.20 The traditional requirement for a pilot to monitor an assigned ATC frequency channel for analogue radiotelephony must be assessed. Aside from the obvious need to respond to ATC, there is a collateral benefit in that pilots gain situational awareness by listening to the voice traffic, particularly regarding the intentions and positions of other aircraft.

5.21 *Phraseology*. To increase the situational awareness of air traffic controllers and other pilots on the frequency, remote pilots may be directed to prefix their call signs with "remotely-piloted" or something similar, possibly only on the first call, during voice communications between ATC and the remote pilot station.

5.22 Chapter 3 introduced the concept of more than one remote pilot station being utilized for a single flight (see Figure 5-3). Technical protocols and operational procedures will be required to support the handover of piloting functionality between the remote pilot stations. The aircraft must be under the piloting control of only one remote pilot station at a time. The system should be capable of supporting the automatic transfer of C2 data link authority between designated remote pilot stations using digital data interchange. Remote crew procedures would verify the link and ensure the "relief" crew briefing was complete prior to terminating the C2 data link with the transferring remote pilot station. An analogy exists with controller-pilot data link communications (CPDLC) in the technical protocols used for transferring data link authority from one ATC facility to another as an aircraft approaches a transfer-of-control point.

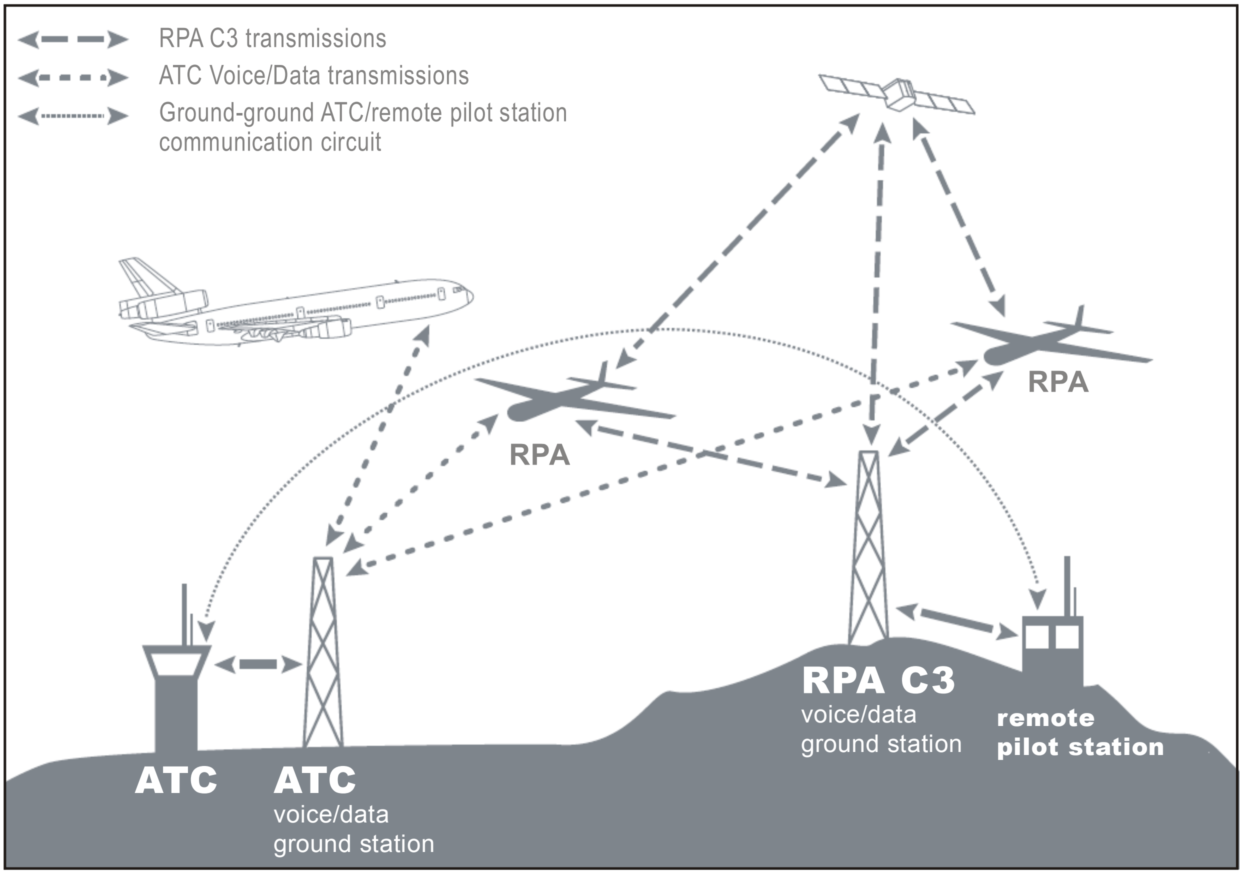

Figure 5-2. Communication links

AERODROMES

5.23 It is generally recognized that integration of RPA into aerodrome operations will prove to be among the greatest challenges. At issue are provisions for the remote pilot to identify, in real-time, the physical layout of the aerodrome and associated equipment such as aerodrome lighting and markings so as to manoeuvre the aircraft safely and correctly. RPA must be able to work within existing aerodrome parameters. Aerodrome standards should not be significantly changed, and the equipment developed for RPA must be able to comply with existing provisions to the greatest extent practicable. Moreover, where RPA are operated alongside manned aircraft, there needs to be harmonization in the provision of ATS.

5.24 Consideration may be given to the creation of airports that would support RPAS operations only. Current provisions regarding aerodrome design, construction and operations would continue to apply, however some amendments or additions may be necessary to accommodate unique RPAS issues.

5.25 Annex 14 sets forth the minimum SARPs that prescribe the physical characteristics and obstacle limitation surfaces to be provided for at aerodromes, and certain facilities and technical services normally provided. It is not intended that these specifications limit or regulate the operation of an aircraft. The Annex does provide for the accommodation of current types of manned aircraft and, therefore, should equally address the same or comparable types of RPA. However, changes may be necessary to the Annex should unique issues arise that cannot be addressed with the current provisions.

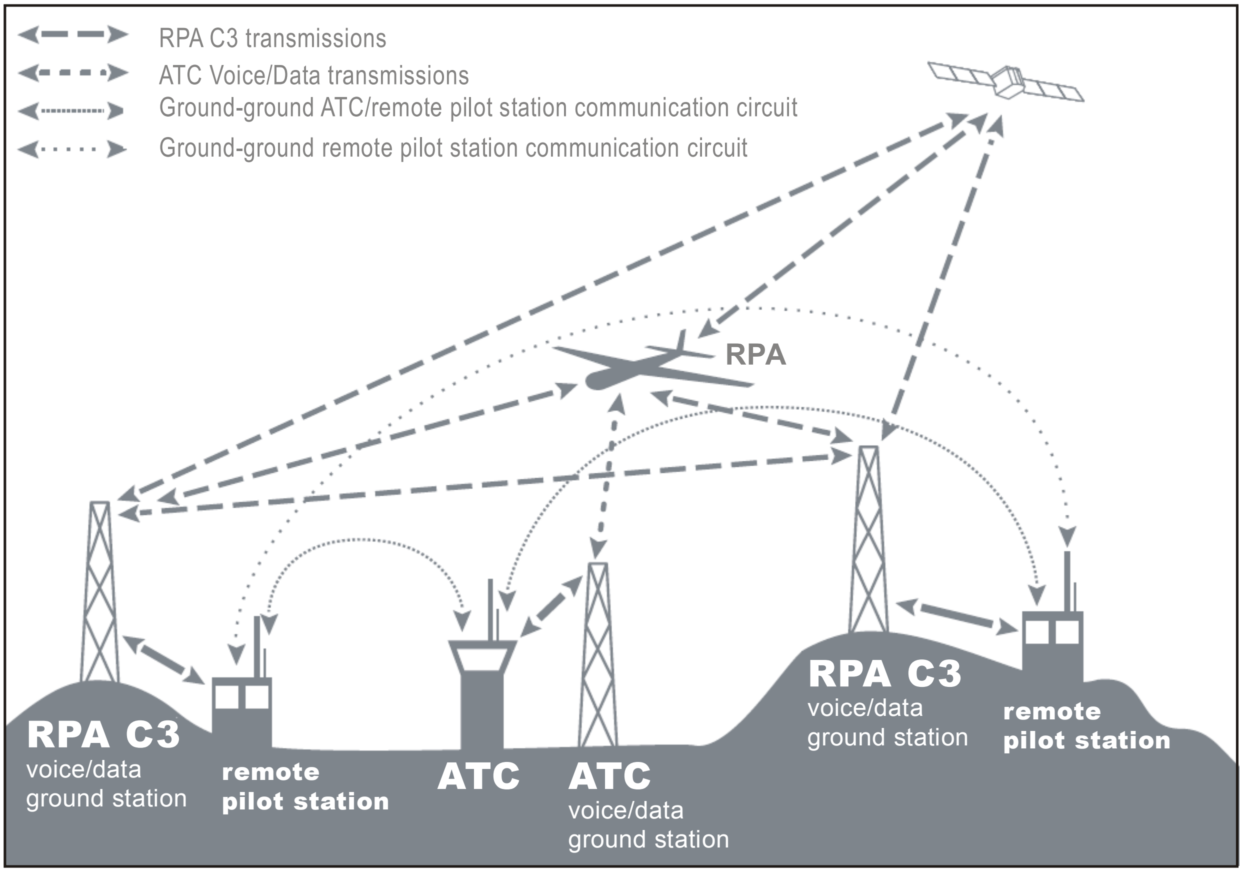

Figure 5-3. Communication links

5.26 The unique characteristics of RPA that would affect aerodrome operations will need to be considered to facilitate the integration of these aircraft. Some of the areas to be considered are:

a) applicability of aerodrome signs and markings for RPA;

b) integration of RPA with manned aircraft operations on the manoeuvring area of an aerodrome;

c) issues surrounding the ability of RPA to avoid collisions while manoeuvring;

d) issues surrounding the ability of RPA to follow ATC instructions in the air or on the manoeuvring area (e.g. "follow green Cessna 172" or "cross behind the Air France A320");

e) applicability of instrument approach minima to RPA operations;

f) necessity of RPA observers at aerodromes to assist the remote pilot with collision avoidance requirements;

g) implications for aerodrome licensing requirements of RPA infrastructure, such as approach aids, ground handling vehicles, landing aids launch/recovery aids, etc.;

h) rescue and fire fighting requirements for RPA (and remote pilot station, if applicable);

i) RPA launch/recovery at sites other than aerodromes;

j) integration of RPA with manned aircraft in the vicinity of an aerodrome; and

k) aerodrome implications for RPA-specific equipment (e.g. remote pilot stations).

METEOROLOGICAL SERVICE

5.27 Meteorological information plays a role in the safety, regularity and efficiency of international air navigation and is provided to users as required for the performance of their respective functions. Meteorological information supplied to operators and flight/remote crew members covers the flight in respect of time, altitude, and geographical area. Accordingly, the information relates to appropriate fixed times, or periods of time, and extends to the aerodrome of intended landing. It also covers meteorological conditions expected between the aerodrome of intended landing and alternate aerodromes designated by the operator.

5.28 Meteorological services are critical for the planning, execution and safe operation of international aviation. Since the remote pilot is not on board the aircraft and may not be able to determine meteorological conditions and their real-time effects on the aircraft, obtaining meteorological information from appropriate sources prior to and during flight will be especially critical for the safe operation of these aircraft.

5.29 Annex 3 — *Meteorological Service for International Air Navigation* has a requirement for aircraft on its registry operating on international air routes to make automated routine observations, if so equipped. RPA may not be so equipped. Likewise, there is a requirement for all aircraft to make special observations whenever severe turbulence, severe icing, severe mountain wave, thunderstorms, hail, dust, stone and volcanic ash are encountered during a flight. However, RPA may not be able to comply with these provisions as the pilot is remote from the aircraft, and the aircraft may not have the sensors to detect these phenomena.

5.30 Conversely, the RPA specifically equipped for such purposes may in fact be used to monitor meteorological conditions, relaying information back to ground sensors. These aircraft could potentially be used in conditions and locations where manned aircraft cannot safely operate such as in hurricanes, convective weather or in the vicinity of volcanic ash/gases.

5.31 Besides natural turbulence, there is also the problem of wake turbulence. Wake turbulence information is critical for the planning and execution of safe operations of all aircraft and especially RPA which may be unusually light in comparison to manned aircraft. The wake turbulence separation minima may need to be amended as very small RPA are much more sensitive to wake turbulence than larger and heavier manned aircraft. Near-term measures in this area, including implementation of dynamic wake vortex separations and wake vortex avoidance systems, will need to be reviewed for application to RPA.

SECURITY

5.32 Security is a vital issue for RPA with aspects that are both similar and unique when compared with manned aircraft. As a remote pilot station is similar in purpose and design to a cockpit, it must likewise be secure from sabotage or unlawful malicious interference. Chapter 13 of Annex 6, Part I — *International Commercial Air Transport — Aeroplanes* contains SARPs to secure the flight crew compartment. However, due to the fixed and exposed nature of the remote pilot station (as opposed to the restricted nature of a commercial aeroplane where the intrusion and use of heavier weapons is less likely) further consideration should be given to the potential vulnerability of the premises against unlawful interference.

5.33 Similarly, the aircraft itself must be stored and prepared for flight in a manner that will prevent and detect tampering and ensure the integrity of vital components. The *Aviation Security Manual* provides further details concerning protection of aircraft.

5.34 Systems for controlling access to the remote pilot station should be at least of equal standard to those already in place in the commercial aviation industry. In that regard, ICAO publishes information on procedures to be followed and systems to be implemented to ensure the security of the flight crew compartment, and this may be used as general reference material when addressing the unique nature of the remote pilot station. Identification technologies such as the use of biometrics for access control systems may offer a higher degree of security. Furthermore, distinction in access control level may be considered between the remote pilot station itself and the premises wherein it resides.

5.35 Remote pilots should be subjected, at a minimum, to the same background check standards as persons granted unescorted access to security restricted areas of airports (Annex 17 — *Security* – Standard 4.2.4). Further details concerning background checks can be found in the *Aviation Security Manual*.

5.36 The software and data/communications link provides functions as vital as traditional wiring, control cables and other essential systems. These links may utilize diverse hardware and software that may be provided and managed by third parties. Safety and security of these links and services are equally important as those for the aircraft and remote pilot station. They must be free from hacking, spoofing and other forms of interference or malicious hijack.

SAFE TRANSPORT OF DANGEROUS GOODS BY AIR

5.37 Article 35 of the Chicago Convention addresses cargo restrictions, specifically regarding the carriage of munitions or implements of war and other dangerous goods. The provisions of Annex 18 — *The Safe Transport of Dangerous Goods by Air* further govern the international transport of dangerous goods by air. The broad provisions of this Annex are amplified by the detailed specifications of the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) and its supplement, *Supplement to the Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284SU). Most of the dangerous goods carriage requirements contained in Article 35 and within the third edition of the Annex are considered applicable to RPA as written. While there are references to crew, these relate to the crew being informed about the dangerous goods or informing other parties. Again, operators of RPA would be expected to comply with the requirements.

5.38 At such time as civil RPA are utilized for the transportation of goods internationally, the provisions of Annex 18 and Article 35 of the Chicago Convention will be applicable.

AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION

5.39 The safety of UA operations is equally important to that of manned aircraft. Third party injury and damage to property can be equally severe, whether caused by a manned or unmanned aircraft. Proper investigation of each accident or serious incident is necessary to identify causal factors and/or contributing factors in order to prevent recurrences. Similarly, the sharing of safety information is critical to reducing the number of accidents and serious incidents globally.

5.40 An amendment to Annex 13 — *Aircraft Accident and Incident Investigation* has already been adopted to bring UA accidents and serious incidents under the same umbrella as those of manned aircraft. The following revisions became applicable on 18 November 2010:

CHAPTER 1. DEFINITIONS

. . .

Accident. An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

. . .

Note 3.— The type of unmanned aircraft system to be investigated is addressed in 5.1.

. . .

Serious incident. An incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down.

CHAPTER 5. INVESTIGATION

. . .

5.1 The State of Occurrence shall institute …

. . .

Note 3.— In the case of investigation of an unmanned aircraft system, only aircraft with a design and/or operational approval are to be considered.

5.41 Although the amendment to Annex 13 for investigation of UA accidents and serious incidents covers only those with a design and/or operational approval, it is recommended that within contracting States the investigation of UA accidents be undertaken regardless of UA certification status. Data collected by these investigations should be shared to the extent practicable with the other States.

SEARCH AND RESCUE

5.42 Article 25 of the Chicago Convention states that “Each contracting State undertakes to provide such measures of assistance to aircraft in distress in its territory as it may find practicable, and to permit, subject to control by its own authorities, the owners of the aircraft or authorities of the State in which the aircraft is registered to provide such measures of assistance as may be necessitated by the circumstances. Each contracting State, when undertaking search for missing aircraft, will collaborate in coordinated measures which may be recommended from time to time”.

5.43 By definition, search and rescue (SAR) is based on the idea that the main purpose of “search” is to ensure that assistance is rendered to persons in distress. This is most often seen as rendering assistance to persons who were on board the aircraft, but includes third parties as well. Assuming that the number of persons on board an aircraft, if any, will already be determined through the use of current provisions, these same provisions may need to be reviewed to reflect any assumptions regarding potential injuries to those on the ground or otherwise.

5.44 As mentioned in Chapter 3, RPA may fulfil roles in SAR activities due to their ability to operate for extended duration even in remote and hazardous environments and their usefulness in providing communication relay platforms. Provisions for RPA and the remote pilots to undertake these activities within the SAR framework of ICAO and the International Maritime Organization will need to be developed.

FACILITATION

5.45 Under Article 22 of the Chicago Convention, each contracting State accepts the obligation "to adopt all practicable measures, through the issuance of special regulations or otherwise, to facilitate and expedite navigation by aircraft between territories of contracting States, and to prevent unnecessary delays to aircraft, crews, passengers and cargo, especially in the administration of the laws relating to immigration, quarantine, customs and clearance." This obligation would apply to UA as well.

5.46 Any UA which departs from and lands in two different States will have to satisfy the facilitation requirements of the States involved. There may be a need to address current definitions, types of operations, documentation and remote pilot station requirements to support routine international operations of UA.

Chapter 6

AIRCRAFT AND SYSTEMS

CERTIFICATION

6.1 RPA are integrating into a well-established certification system and are subject to demonstrating compliance in a manner similar to that of manned aircraft. The fact that these aircraft cannot operate without supporting system elements (remote pilot station, C2 data links, etc.) brings new complexities to the subject of certification. One cannot assume that a single RPA will always be flown from the same remote pilot station using the same C2 data link. Rather, it is likely that each of these system elements will be changeable. It is even likely that for long-haul operations, the remote pilot station and C2 data links will be changed during flight and that as a remote pilot station is released from one aircraft it can then be used for another in real time.

6.2 Taking this new concept one step further, it is also likely that components will be located in different States. The long-haul flight operating from one region of the world to another will face increasing C2 and communications performance issues as the aircraft travels further from its remote pilot station. While the performance (e.g. data link transaction time, availability) may not be detrimental in the oceanic and remote en-route environments, it will be different in the congestion of the continental and aerodrome environments. To address these issues, it may be necessary to handover piloting control from the “home” remote pilot station to one in the destination locale. Legal issues related to certification, licensing and the recognition of documents in this new scenario would have to be addressed.

6.3 The remote pilot station, particularly looking at possible future scenarios, could be operated as a commercial enterprise by a “remote pilot station operator”. This remote pilot station operator would be responsible for obtaining approval from the State Civil Aviation Authority (CAA) to operate and maintain the remote pilot station. Among the factors to be considered would be specific aircraft types that can be piloted from the remote pilot station. It should be noted that the State of the remote pilot station operator would not necessarily be the same as the State of the Operator of the RPA. Complex legal issues and agreements between States would have to be addressed prior to this scenario becoming feasible.

6.4 From an operational point of view, it is desirable to have maximum flexibility in using remote pilot stations when conducting a flight. Implementing this concept would lead to a flexible operational system configuration. Two possibilities envisaged to facilitate this flexibility are described in 6.5 and 6.6.

6.5 The first option envisaged is that the certification of the RPAS is documented with the Type Certificate issued to the RPA. The configuration of the RPAS as a whole would be included in the Type Certificate of the RPA, under the responsibility of one unique Type Certificate holder. The remote pilot station associated with the aircraft would be a separate entity, likely to be treated in a manner similar to engines and propellers in that it could have a Type Certificate issued by the remote pilot station State of Design. The configuration of RPA and remote pilot station(s) would be certified in conjunction with the RPA by the State of Design of the aircraft and documented in the Type Certificate data sheet. The remote pilot station then is “part” of the RPAS. This would give the RPA State of Design responsibility for the overall system design. The RPA State of Design would also have responsibility for providing any mandatory continuing airworthiness information. The State of Registry would have responsibility for determining continuing airworthiness of the RPAS in relation to the appropriate airworthiness requirements. More than one remote pilot station could be associated with the RPA as long as the configuration is described in the Type Certificate. A Certificate of Airworthiness would be issued for the RPA, and it would remain the responsibility of the operator to control the configuration of the RPAS (RPA, remote pilot station and data links). SARPs for the design standard of the remote pilot station would have to be developed for Annex 8 — *Airworthiness of Aircraft.*

6.6 The second option envisaged would require not only new SARPs to be developed for Annex 8, but also new certificates comparable to the existing Type Certificate and Certificate of Airworthiness for the remote pilot station(s). This option diverges significantly from the traditional approach in that the design configuration of the RPAS would be defined separately for the RPA and remote pilot station. This means that the airworthiness of the RPA and the comparable certification for the remote pilot station would be dealt with individually. An RPAS designer would have responsibility for verifying the RPA, and remote pilot station(s) could be configured into an "airworthy" system. It is not clear yet what the exact RPAS design process approval (similar to what is currently called Type Certificate) and RPAS production process approval (currently called Certificate of Airworthiness) would be, but they would require a fundamental change to the approach to certification provided in Annex 8.

6.7 The aircraft must, of course, have a Certificate of Airworthiness. In the first option the remote pilot station associated with the aircraft will be linked to the RPA Certificate of Airworthiness, either through the Certificate of Airworthiness directly or through configuration control mechanisms per flight (e.g. RPA logbook). In this option, only the RPA will be registered. In the second option, the remote pilot station will have a separate certificate, similar to the RPA Certificate of Airworthiness, and there must be an operator-controlled system document with which the RPAS (i.e. RPA and remote pilot station) configuration is controlled. In this option, requirements for registration of the RPAS elements will have to be explored.

6.8 In both options, a method will need to be developed to certify the adequacy of the connection between the remote pilot station(s) and the RPA. Traditionally, the equipment only is certified; the data link(s) are not. In this new scenario, the data link replaces the traditional cables connecting flight controls to control surfaces. As such, the appropriate State authority will need to consider the data link performance as part of the RPA/RPAS certification process.

6.9 Due to the unique characteristics involved in UAS operations, a new UAS operator certificate (UOC), similar in nature and intent to the existing air operator certificate, is envisaged. This UOC would authorize the operator to conduct UAS operations in accordance with the operations specifications. Issuance of the UOC would be dependent upon the operator demonstrating an adequate organization, method of control and supervision of flight operations, and training programme as well as ground handling and maintenance arrangements consistent with the nature and extent of the operations specified. The operator would have to demonstrate arrangements for use of approved remote pilot stations and voice and data links that will meet the quality of service (QOS) appropriate for the airspace and the operation to be conducted. Furthermore, the operator's SMS will have to be approved by the State authority.

AIRWORTHINESS

6.10 All aircraft, whether manned or unmanned, share a large degree of commonality with regard to airworthiness. A majority of UAS assessments will likely rely on what is already prescribed for manned aviation. Interestingly, the small number of areas unique to UAS that are not addressed in current ICAO documents are more critical because of the potential magnitude of their impact. Review of these areas will likely result in dramatic changes to technology growth, international infrastructures, regulations and standards, and operational procedures.

6.11 Many existing SARPs are applicable to UAS; others may require interpretive or innovative solutions. Relief from regulations may be possible given the policy that should a condition not exist, then the requirement(s) do(es) not apply. As an example, the absence of the flight crew and passengers from the on-board environment will provide relief from seat belt requirements, life vests and life rafts. Conversely, while the pilot windshield becomes irrelevant, the necessity for an undistorted field of vision may still have to be addressed in some way.

6.12 Article 31 of the Chicago Convention requires that every civil aircraft engaged in international aviation be issued a Certificate of Airworthiness by the State of Registry.

6.13 Article 33 states Certificates of Airworthiness must be based on compliance with at least the minimum international (airworthiness) Standards established by Annex 8. Where there is a failure to comply with international airworthiness requirements, the Certificate of Airworthiness must be properly annotated on those areas of failure.

6.14 Annex 8 requires the following:

a) that the State of Design provide evidence of an approved type design by issuing a Type Certificate;

b) that an aircraft be produced in a controlled manner that ensures conformity to its approved type design;

c) that a Certificate of Airworthiness be issued by the State of Registry based on satisfactory evidence;

d) that the aircraft comply with the design aspects of the appropriate airworthiness requirements; and

e) that the State of Design, State of Registry and the type certificate holder collaborate in maintaining the continuing airworthiness of the aircraft.

6.15 The following is a general (non-inclusive) summary of the different design aspects contained in Annex 8 for manned aeroplanes and helicopters, engines and propellers:

a) unsafe features or characteristics;

b) flight characteristics;

c) structural strength and other characteristics;

d) design and construction;

e) powerplant and installation;

f) rotor and power transmission (for helicopters);

g) instruments;

h) systems and equipment;

i) operating limitations and information;

j) systems software;

k) crashworthiness and cabin safety;

l) operating environment and Human Factors;

m) tests and inspections; and

n) security (for large aeroplanes only).

6.16 Airworthiness and certification are based on a well-established airworthiness design standard provided in Annex 8. However, performance standards currently in use for manned aviation may not apply or satisfactorily address UAS operations. The following UAS-related issues will have to be addressed:

a) SARPS are limited to aircraft over 750 kg intended for carriage of passengers or cargo or mail;

b) SARPS for remote pilot stations; and

c) provisions for C2 data links.

6.17 Current categorization of manned aircraft certification standards may not adequately support new UAS technology. A few areas to be addressed may include:

a) new types of airframes and powerplants;

b) non-traditional construction methods; and

c) technologies and methods for detect and avoid, operational communications, C2 data links (including infrastructure, protected spectrum and security), etc.

6.18 Contingency situations (emergencies) where the pilot is no longer able to manage the flight will require additional on-board systems, which in turn will require new performance-based SARPS and/or PANS. This includes loss of C2 data link, loss of ATC communications and flight termination, among others.

REMOTE PILOT STATION(S)

6.19 Remote pilot stations will require regulatory oversight as do other safety-critical elements of the aviation system. Details of how this will be achieved by the appropriate State authority are to be determined.

6.20 Traditional operational positions for manned aviation are confined to a single cockpit environment. The presence of the flight crew within the airframe plays an integral role in the overall certification of the aircraft and development of flight procedures. By removing the cockpit environment from the aircraft, interactions between the remote crew and their operational positions will pose new complexities, the extent of which is not yet identified. Flight procedures will have to be amended to accommodate this scenario.

6.21 Airworthiness and certification considerations require many airborne systems to be provided in a redundant configuration for manned aircraft. Achieving a similar level of redundancy for an RPAS involves the RPA, remote pilot station and the connecting C2 data links. For an RPAS, all systems and their constituent components[1] may necessitate the same degree of redundancy or greater than those in manned aircraft. This will be subject to further study. Likewise, many supporting systems will require a similar or greater level of redundancy, one example being flight recorders, which might be required for both the RPA and the remote pilot station.

6.22 As discussed in certification above, remote pilot stations involved in the operation of the RPA must be certified for such purpose in line with standards yet to be developed. This presents special opportunities and challenges in developing new work environments and determining implications on the Type Certification of the RPA. New designs and standards will need to be developed to support functions, such as assuring the dedication of the data link connecting the remote pilot station to the aircraft, and the ability to handover the data link between remote pilot stations,

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1. In the case of RPAS, the link between the remote pilot and ATC may comprise a link between ATC and the RPA and a link between the RPA and the remote pilot station.

along with many more. Situations like these will involve technology and equipment not traditionally assessed in the current airworthiness process.

6.23 Regarding the subject of continuing airworthiness, the remote pilot station should be treated similarly to the RPA. Additionally, due to the operational nature of the RPAS on long-haul flights, the option of “In Flight Maintenance” should be studied. It can be foreseen that the remote pilot station intended for later stages of the flight could be taken out of service after the RPA has initiated its flight, a situation which would not necessarily prevent the RPA from continuing. If the remote pilot station can be returned to service or an alternate one used, the flight may be unaffected.

NATIONALITY AND REGISTRATION MARKS

6.24 Annex 7 — *Aircraft Nationality and Registration Marks*, specifies the minimum Standards for the display of aircraft marks to indicate appropriate nationality and registration. It is important for UA to comply with aircraft marks so the UA can be identified in cases where they come in close proximity to other aircraft, are intercepted, or land at aerodromes other than the designated landing site.

6.25 Some UA may have difficulty meeting the readily identified mark requirement as well as the height requirements for both lighter-than-air and heavier-than-air aircraft as the airframe may be too small. Exemptions for marks or alternative systems, such as labelling already used for aircraft parts that adequately allow identification may be required for small UA. Requirements for changes to Annex 7 SARPs as regards to their applicability to UA will be considered in due time.

RADIO NAVIGATION AIDS AND AIRBORNE NAVIGATION EQUIPMENT

6.26 As a general statement, all aircraft, whether manned or unmanned, must meet the navigation performance requirements for the specific airspace in which they will operate.

6.27 RPA that utilize VLOS as the basis for navigation would not require an on-board means for determining position or the ability to fly an instrument approach. Operations of these aircraft are usually conducted under VMC to ensure the remote pilot can maintain continuous and direct visual observation of the RPA and its surrounding environment.

6.28 RPA that traverse several airspace volumes may operate for the most part under IFR. Such RPA will have to meet the communications, navigation, and surveillance requirements and have an appropriate aircraft operational certification associated with the airspace.

6.29 In cases where small RPA have a requirement to fly beyond VLOS, they will need a means to meet navigation capabilities for the airspace within which they are operating. This could involve an alternate means of achieving the navigation performance.

SURVEILLANCE SYSTEMS

6.30 Unless exempted by the appropriate authorities, all UA will likely be required to be equipped with pressure-altitude reporting transponders which operate in accordance with the relevant provisions in Annex 10, Volume IV — *Surveillance and Collision Avoidance Systems*.

6.31 Additionally, other means of surveillance (automatic dependent surveillance — broadcast (ADS-B) or other derived positional information) may enable UA to meet the ATS surveillance requirements to the same level as mandated for manned aircraft.

6.32 Smaller, lighter transponders are being developed which may allow small UA to be appropriately equipped.

AERONAUTICAL COMMUNICATIONS

6.33 The information exchange between ATC and the remote pilot will likely require the same levels of reliability, continuity and integrity, referred to as QOS, that are required to support operations with manned aircraft in the airspace in which a UA is intended to operate.

6.34 The exchange of control information between the aircraft and its remote pilot station will require an extremely high level of availability, reliability, continuity and integrity. The determination of required communication performance and associated QOS levels will be based on functionality considering the level of ATS being provided.

6.35 The handover of piloting functionality will require the development of technical protocols to support this. These protocols must also support the operational procedures for the handover of piloting responsibility.

6.36 The time taken for a controller or pilot to transmit a message and receive an answer varies considerably depending on the communications medium used. In oceanic airspace it may be acceptable to transmit a request and receive a reply within a matter of minutes (e.g. HF or SATCOM) whereas operations in terminal areas and congested en-route airspace require instantaneous radiotelephony response times (e.g. VHF). The RPA has increased time built-in to any communication transaction as a function of the message being retransmitted from the aircraft to the remote pilot (or vice versa) and back along the same route to ATC. This transaction time could cause increased blocked transmissions and unacceptable delays in receiving and reacting to ATC clearances and instructions.

6.37 ATM requirements associated with acceptability (or otherwise) of such transaction times are expected to be the subject of specific communication performance requirements which will be vested in the RPA airworthiness certification and operational approvals.

6.38 To operate in controlled airspace, the remote pilot must have not only a C2 data link with the aircraft, but also a voice and/or data link (as appropriate for the airspace/operation) between the remote pilot station and the relevant ATS unit. Studies have demonstrated that different technical solutions may exist, taking into consideration the envisaged operation, altitude and range of the RPA. In most cases, the ATS communications are relayed through the aircraft, making use of a voice/data link between the RPA and the remote pilot station. In other cases, the connection with ATC can be established via a ground wired interface between the ATS unit and the remote pilot station, relayed through ground-based radio stations or via satellite. The options are spelled out below:

a) In order for the RPA/remote pilot station to comply with the current infrastructure and communicate with service providers via air-to-ground, several issues will need to be addressed regarding additional equipage, transaction times, contingency capabilities, security, procedures, etc. Standards may need to be developed for the new equipment and the spectrum they will operate within. Some of this work has now been initiated within the International Telecommunication Union (ITU) with a request for the accommodation of aeronautical safety type (AM(R)S, AMS(R)S, ARNS) spectrum to support this function. A methodology has been adopted which focuses on analysing and defining the problem and presenting a recommendation at the WRC-2012. The adopted approach was selected as the one which has the least impact on the service providers as communication will be mostly transparent to manned aviation.

b) In the second approach, remote crews have the unique opportunity to take advantage of ground-to-ground infrastructures to communicate with the ATS provider. This approach presents a complex issue for both the users and the service providers in that current ground-based systems do not support this type of communication for routine services. If this approach is utilized, Standards would need to be developed for the equipment that will manage the communication pathway between the remote crew and the air traffic controller. Likewise, new procedures will need to be developed alongside the introduction of any new equipment. The telecommunications service providers would have to develop new systems and communication infrastructures. UAS operators would need to furnish remote pilot stations with appropriate equipment to link with this new infrastructure, as would the ATS providers.

6.39 Due to the nature of aeronautical VHF communications, the VHF frequency is shared by all aircraft within range. The common audio supports a limited but beneficial level of situational awareness for flight crews and remote crews. This is a feature of the first approach.

6.40 Rather than mandating a specific technical solution using a specific communication architecture, the efficacy of the design chosen must be demonstrated by the applicant when requesting an airworthiness certification. Furthermore, approval to operate in any given airspace would have to consider whether the communication architecture meets the needs of the ATS provider.

6.41 Either of the two approaches given above will, in all likelihood, be affected by the medium-term planning of the NextGen (United States) and SESAR (European Union) modernization efforts, which rely heavily on an integrated network for digital communications. It is possible that this combined effort may provide efficient solutions for both air-to-ground and ground-to-ground communications between the remote crews and ATS providers.

6.42 Small UA may have difficulty carrying a VHF radio to support ATS communication and to meet the requirements for emergency services and communications at outlying locations. In some cases, these communications can be achieved with the remote pilot utilizing a portable radio for communications, if agreement is reached with the designated authorities to permit this solution. These radios would still likely have to meet Annex 10 spectrum and frequency requirements, despite not being carried on the aircraft.

6.43 It may be difficult or even impossible for small RPA to continuously monitor the aeronautical emergency frequency 121.5 MHZ when operating in areas where this requirement exists, the implications of which are currently being assessed.

AERONAUTICAL RADIO FREQUENCY SPECTRUM

6.44 It is essential that any ATC communication relay between the RPA and the remote pilot meet the performance requirement applicable for that airspace and/or operation, as determined by the appropriate authority. As with manned aviation and to reduce the potential of external interference, this will necessitate the use of designated frequency bands, i.e. those reserved for aeronautical safety and regularity of flight under AM(R)S, AMS(R)S, ARNS and ARNSS allocations as defined in the ITU Radio Regulations. These regulations dispose that these bands require special measures to ensure their freedom from harmful interference. As such they are not available for non safety-related activities, with few exceptions.

6.45 Furthermore, it is essential that any communication between the remote pilot station and RPA for C2 meet the performance requirement applicable for that airspace and/or operation, as determined by the appropriate authority. This too necessitates use of the designated frequency bands reserved for aeronautical safety and regularity of flight.

6.46 Long-range high altitude long endurance RPA can cover great distances and cross national boundaries during their missions. These aircraft will need VHF voice/data radios meeting spectrum requirements to talk or transmit data with ATS. They will also need very long-range communications, such as SATCOM, between the aircraft and remote pilot who may be thousands of kilometres away. SATCOM may be an appropriate solution for these operations, although there may be a need for a redundant means of communications to be in place, in particular for those circumstances where SATCOM shadows exist, precluding effective real-time communication capability. There may be an additional requirement for frequencies and spectrum for these long-range communications.

AERONAUTICAL CHARTS

6.47 Additional symbology pertinent for UAS operations may be needed. Remote pilots may have greater dependency on aeronautical information conveyed on charts to maintain their situational awareness of the airspace in which they are operating or on the aerodrome surface movement areas. As experience is gained in this arena, the full subject of aeronautical information as it pertains to UAS operations will be considered.

ENVIRONMENTAL PROTECTION

6.48 Annex 16 — *Environmental Protection*, Volume I — *Aircraft*, defines the requirements for aircraft noise as applicable to aircraft which are issued with a Certificate of Airworthiness and are engaged in international operations.

6.49 The UA may or may not be operated out of traditional airports where compliance with noise standards would be required. Operations may occur in ad hoc or semi-prepared locations that are away from populated areas, giving argument to whether noise requirements would apply.

6.50 Noise requirements for current aircraft categories will apply to UA assuming similar airframes and propulsion systems are used.

6.51 Engine emission standards as specified in Annex 16, Volume II — *Aircraft Engine Emissions* apply to UA assuming similar products are used. As new products and aircraft come into use, it may become apparent that additional noise and emission standards are necessary.

Chapter 7

PERSONNEL

PERSONNEL LICENSING

7.1 Annex 1 — *Personnel Licensing*, establishes the minimum training, operation and licensing standards to be met by aviation personnel involved in international air navigation.

7.2 The issuance of licences in accordance with Article 32 of the Chicago Convention provides the State of Registry a measure of control over whom may be involved, and under what conditions, as flight crew or in the maintenance of manned aircraft operating internationally. The introduction of RPA operations brings new dimensions to licenses for remote pilots and other members of the remote crew in that they are outside the scope of Article 32. First among these is a question as to whether the remote pilot is affiliated primarily with the RPA or the remote pilot station. If the decision is made that the primary relationship is between the remote pilot and the remote pilot station, the conclusion may be reached that the State of the remote pilot station rather than the State of Registry of the RPA, if different, would grant the licence. The implications of this new dimension will have to be assessed in detail before a decision can be reached. In either case, the RPA and the remote pilot station would be considered as a unit by the designated licensing authority.

7.3 Licensing authorities and medical examiners will have to consider the location and configuration of the remote pilot station (e.g. in a building, vehicle-based, ship-based, airborne, handheld, large suite) when issuing remote pilot licenses. The type of RPA (e.g. aeroplane, helicopter, powered-lift) a remote pilot is authorized to pilot and any related privileges the license holder may exercise will have to be stipulated.

7.4 Unusual Human Factors, including sensory deprivation or motions inconsistent with the aircraft being piloted, may place unique physical or mental demands on the remote pilot. Some remote pilots may only be required and trained for take-off/launch and landing/recovery. Other remote pilots may only need to be trained for en-route flight responsibilities excluding take-offs and landings.

7.5 With reference to the present definition of “aircraft certificated for single-pilot operation”, a similar definition for “aircraft certificated for remote pilot operation” may be considered for RPA operations.

7.6 The RPA operating internationally is distinct and different from the operation of manned aircraft in a number of significant ways. For example, the remote pilot licence will be issued to an individual who will not be with the aircraft as it arrives in a foreign State. Authorities in the destination State will not have direct personal contact with the remote pilot or members of the remote crew.

7.7 A major change to current provisions in Annex 1, which envisions aircraft with the pilots on board, is the addition of a remote pilot station and its links with the aircraft. The principal factors which must be considered are remote pilot skill, knowledge, training and medical fitness to ensure they are commensurate with the particular license or rating being sought by the pilot candidate.

LICENSING AND TRAINING FOR PILOTS AND OTHER MEMBERS OF THE REMOTE CREW

7.8 Remote pilots and other members of the remote crew shall be trained and licensed in accordance with Annex 1.

7.9 Licensing and training requirements will be developed similar to those for manned aviation and will include both the aeronautical knowledge and operational components. Specific adjustments may be needed considering the particular and unique nature and characteristics of the remote pilot station environment and RPA applications (from both a technical and flight operations perspective, e.g. VLOS or beyond VLOS) as well as aircraft type (e.g. aeroplane, helicopter). In that context, qualifications for certain categories of remote crew (e.g. VLOS helicopter) may be significantly different from those pertaining to the traditional qualifications pertaining to manned aviation.

7.10 On the basis of the foregoing, current and previous notional designations for personnel piloting RPA will need to be replaced with applicable terms as contained in Annex 1, appropriately modified to indicate their position being external to the aircraft, such as “remote pilot”, “remote navigator” and/or “remote engineer”, each of which is a member of the remote crew. A new crew position unique to some VLOS operations is “RPA observer”, an individual who, by visual observation of the RPA, assists the remote pilot in the safe conduct of the flight. Additional crew positions unique to remote pilot station/RPA operations may be identified over time. These new positions will need to be incorporated into Annex 1 for international standardization.

LICENSING AND TRAINING FOR AIR TRAFFIC CONTROLLERS

7.11 Licensing of air traffic controllers will not be affected by UAS. However, when UAS are introduced within an ATC environment, additional training requirements specific to different types of UAS characteristics could be required for ATC personnel including, inter alia, performance, behaviour, communication, operating limitations and emergency procedures.

Appendix

EXAMPLES OF STATE/REGIONAL UAS INITIATIVES

GENERAL

1. This Appendix provides examples of policy and current practices being used by various CAAs at the regional[1] or national level. These examples are relevant to this circular and may provide guidance to other CAAs when drafting their own regulations or guidance material.

LEGAL

2. A number of CAAs have adopted the policy that UAS must meet the equivalent levels of safety as manned aircraft. UAS operations must be as safe as manned aircraft insofar as they must not present a hazard to persons or property on the ground or in the air that is any greater than that attributable to the operation of manned aircraft of equivalent class or category. In general, UAS should be operated in accordance with the rules governing the flight of manned aircraft and meet equipment requirements applicable to the class of airspace within which they intend to operate. UAS must be able to comply with ATC instructions.

3. It is United States policy that introduction of UAS into the national airspace system (NAS) does not harm nor put undue burden on the existing system and users of the system, and the inability of UAS, with current technology, to comply with basic requirements such as the need to see and avoid other traffic means that UAS access to the NAS is necessarily very limited.

4. In the United States, the process for acquiring an Experimental Airworthiness Certificate for UAS operations is specified in FAA Order 8130.34 and in Interim Operational Approval Guidance Document 08-01.

5. A group of national authorities (JARUS) under the leadership of The Netherlands and in cooperation with EASA are developing harmonized operational and technical regulations for "light" (i.e. less than 150 kg) UAS. The group dealing with technical requirements is focusing on establishing certification specifications for various types of aircraft, starting with light unmanned rotorcrafts. A group is also working on licensing requirements.

6. For civil UA above 150 kg, a Type Certificate issued by EASA is normally required in the EU based on the applicable policy Doc E.Y013-01 (issued 25-08-2009). Furthermore, EASA plans to propose common EU rules for operations and flight crews of these UAS by 2014.

7. *EUROCAE WG-73* is recognized as the European UAS expert group to propose technical inputs to EASA for additional airworthiness criteria and/or special conditions that have not been detailed in the earlier rule-making proposals.

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1. For example, the European Aviation Safety Agency (EASA) in the European Union (EU).

8. *RTCA SC 203* is recognized as the United States UAS expert group to propose technical inputs to the FAA for additional airworthiness criteria and/or special conditions that have not been detailed in the earlier rule-making proposals.

9. The NATO UAV Flight in Non-Segregated Airspace Working Group (FINAS WG) recommends and documents NATO-wide guidelines to allow the cross-border operation of UAVs (sic) in non-segregated airspace. To date, the FINAS WG has provided NATO Standardization Agreements (STANAGs) on Recommended Guidance for the Training of Designated UAV Operators [pilots] and UAV System Airworthiness Requirements[2] (USAR). The latter is intended primarily for the airworthiness certification of fixed-wing military UAVs with a maximum take-off weight between 150-20 000 kg.

ENVIRONMENTAL CONSIDERATIONS

10. No reviews have been conducted for determination for the need for noise and emissions control with respect to UAS. However it is generally accepted that the existing noise and emissions standards for manned aircraft should be applied to UAS.

11. UA can be made lighter and smaller than the aircraft currently being used for many operations thus making them more fuel efficient, producing less carbon dioxide emissions and less noise.

12. Comparisons between a small single-engine, manned aeroplane and a small UA show that the UA will, on average, use a tenth of the fuel, produce a tenth as much CO_2, have noise levels 6 to 9 dB lower and operate five to ten times as long.

13. The link below shows a comparison between a Cessna Skylane and a UA with a 10 kg payload:

    http://www.barnardmicrosystems.com/L4E_environment.htm

RADIO NAVIGATION AIDS AND AIRBORNE NAVIGATION EQUIPMENT

14. The United States has established the policy that UAS operations must be transparent and seamless. This implies that UAS will meet navigation performance specifications for the type of operation and for the airspace in which it will be operated. Consequently, RTCA, in collaboration with EUROCAE, is developing minimum aviation system performance standards (MASPS) for UAS operations.

SURVEILLANCE AND COLLISION AVOIDANCE

15. In the United States, large UA that are allowed access to non-segregated airspace are required to have a transponder on board. These UA do not have ACAS systems, or if they are equipped, are prohibited from being used. Smaller UA are generally required to fly line-of-sight from the pilot. These UAS do not normally have transponders and usually have a separate visual observer to accomplish detect (see) and avoid and collision avoidance responsibilities.

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2. STANAG 4671

16. Russia has developed equipment and carried out test flights for surveillance and control of UAS (take-off weight of 350 kg, single engine turbojet, speed of 700 km/h, and ceiling of 9 km). Surveillance operations, based on ADS-B and C2 based on CPDLC were carried out using VHF data link Mode 4 transponders. Russia is considering the use of ADS-B and VDL Mode 4 as a means to manage UAS flights in civil airspace.

AIR TRAFFIC SERVICES

17. The United States prescribes the following guidance in determining procedures for loss of C2 data link: "In all cases, the UAS must be provided with a means of automatic recovery in the event of a lost link. There are many acceptable approaches to satisfy the requirement. The intent is to ensure airborne operations are predictable in the event of lost link". ATC/pilot voice communication continues to be required for UAS in all airspace and operations, as appropriate, and in a manner transparent to the controller.

18. CAP 772, the United Kingdom UAS policy and guidance document, recognizes that specific ATS integration issues do exist and that operational procedures will need to be developed to facilitate the provision of ATS to UAS. Notwithstanding, unless special provision is made with the ATS unit handling the UAS activity, the provision of a service to a UAS must be seamless for both air traffic controller and pilot. In other words, the same communications methods, rules and procedures apply. Accordingly, UAS must be able to comply with instructions from the ATS provider applicable to the class of airspace within which they intend to operate, and within a timescale comparable to that of a manned aircraft.

AERODROMES

19. According to the United Kingdom CAA CAP 722, the aerodrome license holder is required to demonstrate how the safety of those aircraft requiring the use of a licensed aerodrome will be assured when UAS operations are permitted at that aerodrome. The aerodrome license holder should provide an operating manual or other documents pertaining to the operation of UAS at that aerodrome, to ensure that risks from all aspects of the intended UAS operation are assessed and mitigated. Finally, it is essential that those managing UAS operations be familiar with the relevant rules and procedures applicable at the aerodrome from which they operate.

20. Australian CASA Regulations (CASR Part 101) consolidate the rules governing all unmanned aeronautical activities into one body of legislation. Whilst the focus of the regulations is not entirely UAS-related, Subpart 101.F covers the operation of a large UAS and the operation of a small UAS for purposes other than sport or recreation. This is supported by advisory circulars which provide guidance to controllers and manufacturers of UAS in the operation and construction of UAS and the means whereby they may safely and legally operate UAS within Australian airspace.

AERONAUTICAL TELECOMMUNICATION PROCEDURES

21. Currently within the United States unmanned aircraft operating in controlled airspace on an IFR clearance are required to maintain communications with the appropriate ATC facility. Where UAS are not able to accommodate traditional air-to-ground communications with ATC, alternate methods are developed and required as part of the authorization.

22. Additionally, communication among the flight crew, including with those having visual observer responsibilities, is also mandated. This replicates the communication that occurs among the flight crew for manned operations.

23. Current navigation systems that rely on ground-based aids are not utilized because the weight of the on-board equipment cannot be accommodated by most unmanned aircraft designs. GNSS or direct pilot visual observances are predominantly used.

— END —

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Regional Safety Oversight Cooperation System

Latin American Aeronautical Regulations

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

First edition
March 2023

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

Record of amendments to LAR UAS 100

Amendment No.	Date applicable	Date entered	Entered by

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

Amendments to LAR UAS 100			
Amendment	**Origin**	**Topics**	**Approved JG SRVSOP**
First edition	Seventh Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/7) Fast track acceptance and approval	Chapter A – General requirements	13 January 2023 (approval made on the due date of the approval letter)

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

List of effective pages

Detail	Pages	Amendment	Dates
Preamble	iii to vi		March 2023
Chapter A: General requirements	A1 to A4		March 2023

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

TABLE OF CONTENTS

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

PREAMBLE

Background

Due to the increasing number of unmanned aircraft (UA) operating in ***low-level*** airspace that could potentially conflict with manned aviation, the International Civil Aviation Organization (ICAO) was requested to develop a global baseline of provisions and guidance material for the appropriate harmonisation of regulations for unmanned aircraft systems (UAS) that fall outside the framework of international instrument flight rules (IFR).

To regulate the operations of UA and remotely piloted aircraft (RPA), the States of the ICAO South American (SAM) Region and of the Regional Safety Oversight Cooperation System (SRVSOP) started developing the strategic planning and the regulatory framework for these operations based on documents published by ICAO, regional organisations and States.

To this end, the SAM and SRVSOP States designated their UAS/RPAS focal points to carry out such planning and to develop the concept of operations (CONOPS) for UA and for UAS traffic management (UTM) and the associated LARs and guidance material.

In this context, the SAM and SRVSOP States defined the common technical requirements of the open category and the operational and administrative considerations to be taken into account in the development of their national regulations and guidance material related to this category.

In order to develop the strategic planning and the regulatory framework of the SAM Region and the SRVSOP, the following meetings of the UAS/RPAS focal points were held:

First meeting

The First Virtual Meeting of the UAS/RPAS Focal Points of SAM and SRVSOP States (RVPF-UAS-RPAS/1) was held on 26 February 2021, and proposed the following work programme:

- UAS/RPAS strategic planning of the Region;
- regulatory framework for UAS/RPAS operations; and
- roadmap for the conduction of these activities.

Work teams and a rapporteur for each group were appointed. Likewise, it was agreed that these work teams would meet independently and that, at the Second Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/2), the progress achieved would be reported.

Second meeting

The Second Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/2) was held on 26 April 2021, where the following conclusions were adopted:

- further development of the UA CONOPS structure;
- establishment and implementation of a technical and administrative coordination channel to deal with requests for international RPAS operations;
- acceptance of the structure and development of the UTM CONOPS;
- acceptance of the development of the UAS regulatory framework by parts; and
- postponement of the development of the RPAS regulatory framework.

Third meeting

The Third Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/3) was held on 26 July 2021. The rapporteur of the task force in charge of developing the UA CONOPS proposed to the meeting to first define the open category before developing the UA CONOPS, which was accepted by the meeting. The meeting adopted the following conclusions:

- approval of the schedule of activities for further development of the UTM CONOPS for the SAM Region and the SRVSOP;
- approval of the work schedule for the definition of the open category;
- approval of the work schedule for the development of LAR 101 and CA 101-1; and
- adoption of the format for reporting international RPAS IFR operations.

Fourth meeting

The Fourth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/4) was held on 4 November 2021. This meeting reviewed: the progress made by the work team in charge of developing the UTM CONOPS and updating its work schedule; the progress made on the definition of the open category for unmanned aircraft systems (UA); the progress made on the draft LAR 101; and the progress made on draft Advisory Circular (AC) 101-1. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- approval of the modified schedule of activities for the further development of the UTM CONOPS for the SAM Region and the SRVSOP;
- second survey with five (5) additional questions for the final definition of the open category;
- survey to define the LAR UAS regulatory framework; and
- approval of the work schedule for the final definition of the open category, definition of the LAR UAS regulatory framework, development of the CONOPS for unmanned aircraft (UA), and development of the LAR UAS(s) and associated AC.

Fifth meeting

The Fifth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/5) was held on 15 December 2021. This meeting was presented with the following: the results of the second survey conducted for the definition of the open category and the results of the survey conducted for the definition of the regulatory framework for unmanned aircraft (UA). After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- acceptance of the final definition of the open category for SAM and SRVSOP States; and
- acceptance of the LAR UAS regulatory framework for the open and specific categories.

Sixth meeting

The Sixth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/6), was held on 3 March 2022. The meeting was presented with the following: the progress made on the final draft of the UTM CONOPS for consideration of the meeting and the final draft of the UA CONOPS for its approval. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- Acceptance of the 45-day deadline for reviewing the draft UTM CONOPS
- Acceptance of the concept of operations (CONOPS) for unmanned aircraft (UA)

Seventh meeting

The Seventh Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/7) was held on 9 May 2022. The final drafts of LAR UASs 100 and 101 and the UTM CONOPS were presented at this meeting. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- Acceptance of the UTM CONOPS
- Acceptance of LAR UASs 100 and 101
- Development of LAR UAS 102 and Advisory circulars (AC) 101-1 and 102-1

LAR UAS 100

General requirements for unmanned aircraft system (UAS) operations

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ICAO model advisory circular (AC) 101-1

SAM

CONOPS for unmanned aircraft in the SAM Region

CONOPS for unmanned aircraft traffic management (UTM) in the SAM Region

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Chapter A: General requirements

100.001 Applicability

(a) This regulation prescribes the requirements governing the operation of civil unmanned aircraft (UA) operating under this regulation and the following Latin American Aeronautical Regulations (LARs):

(1) LAR 101 for UAS operations in the open category; and

(2) LAR 102 for UAS operations in the specific category.

100.005 Definitions

In this regulation and in LARs 101 and 102, the following definitions apply unless otherwise specified:

(a) **Accident investigation authority (AIA)**: Designates the entity responsible for accident and incident investigation in the State.

(b) **Accident with unmanned aircraft:** An occurrence associated with the operation of an unmanned aircraft, which takes place between the time the aircraft is ready to move for the purpose of flight until such time as it comes to rest at the end of flight and the primary propulsion system is shut down, in which:

(1) a person is fatally or seriously injured as a result of:

(i) direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or

(ii) direct exposure to jet blast; or

(iii) in the event of a collision with a manned aircraft, any person on board the manned aircraft who suffers fatal or serious injuries.

(2) the aircraft sustains substantial damage or damage that adversely affects its structural strength, performance or flight characteristics as a result of collision with another manned or unmanned aircraft.

(3) significant damage is caused to third party property as a result of a collision.

(c) **Aerial work:** An aircraft operation in which an aircraft is used for specialised services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement, etc.

(d) **Aerodrome:** A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

(e) **Aeronautical information publication (AIP):** A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

(f) **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.

(g) **Air traffic service (ATS):** A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

(h) **Approved UA area**: A defined area as approved under 101.015.

(i) **Command and control link (C2):** The data link between the remotely piloted aircraft and the remote pilot station for flight control purposes.

(j) **Detect and avoid (DAA):** The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.

(k) **First-person view (FPV) device**: A device that generates and transmits a streaming video image to a control station display or monitor that gives the pilot of an unmanned aircraft the illusion of flying the aircraft from an on-board pilot´s perspective.

(l) **Flight termination system:** A system that when activated, terminates the flight of an unmanned aircraft

(m) **Fly-away:** In respect to a remotely piloted aircraft, an interruption or loss of the C2 link such that the remote pilot is no longer controlling the aircraft and the unmanned aircraft is not flying its preprogrammed procedures in the predicted manner.

(n) **Handover:** The act of passing piloting control from one remote pilot station to another.

(o) **Incident**: An occurrence, other than an accident, associated with the operation of an aircraft that affects or could affect the safety of operation.

(p) **Instrument meteorological conditions (IMC):** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

(q) **Notice to airmen (NOTAM)**: A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

(r) **Operator:** A person, organisation or enterprise engaged in or offering to engage in an aircraft operation. In the context of remotely piloted aircraft, an aircraft operation includes the remotely piloted aircraft system.

(s) **Remote pilot:** A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and to manipulate the flight controls, as appropriate, during flight time.

(t) **Remotely piloted aircraft (RPA):** An unmanned aircraft that is piloted from a remote pilot station.

(u) **Remotely piloted aircraft system (RPAS):** A remotely piloted aircraft, its associated remote pilot stations, the required command and control links and any other components as specified in the type design.

(v) **Remote pilot-in-command:** The remote pilot designated by the operator as being in command and charged with the safe conduct of a flight.

(w) **Remote pilot station:** The component of a remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft.

(x) **Risk mitigation**: The process of incorporating defences or preventive controls to lower the severity and/or likelihood of a hazard and its projected consequences.

(y) **Safety:** The state in which risks associated with aviation activities related to, or in direct support of, the operation of aircraft, are reduced and controlled to an acceptable level.

(z) **Safety management system (SMS):** A systematic approach to managing safety, including the necessary organisational structures, accountability, responsibilities, policies and procedures.

(aa) **Segregated airspace:** Airspace of specified dimensions allocated for exclusive use to a specific user(s).

(bb) **Serious incident**: An incident involving circumstances indicating that there was a high probability of an accident, that is associated with the operation of an aircraft and that, in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move for the purpose of flight until such time as it comes to rest at the end of flight and the primary propulsion system is shut down.

(cc) **Shielded operation:** Means an operation of an aircraft within 100 m of, and below the top of, a natural or man-made object.

(dd)

(ee) **State safety programme (SSP**): An integrated set of regulations and activities aimed at improving safety.

(ff) **Unmanned aircraft (UA):** An aircraft that is intended to be operated with no pilot on board.

(gg) **Unmanned aircraft (UA) observer:** A competent person designated by the operator who, by visual observation of the unmanned aircraft, assists the remote pilot in the safe conduct of the flight.

(hh) **Unmanned aircraft system (UAS):** An unmanned aircraft and its associated components.

(ii) **Visual line-of-sight (VLOS):** An operation in which the pilot or UA observer maintains direct unaided visual contact with the unmanned aircraft.

(jj) **Visual meteorological conditions (VMC):** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.

100.010 Falsification, reproduction or alteration

(a) No person shall make or cause to be made:

(1) any fraudulent or intentionally false record or report that is required to be made, kept, or used to show compliance with any requirement under this regulation and LARs 101 and 102; or

(2) any reproduction or alteration, for fraudulent purpose, of any certificate, authorisation, record or report under this regulation and LARs 101 and 102.

(b) The commission by any person of an act prohibited under Paragraph (a) of this section is a basis for any of the following:

(1) denial of an application for any remote pilot certificate or authorisation; or

(2) suspension or revocation of any certificate or authorisation issued by the CAA under this regulation and LARs 101 and 102 and held by that person.

100.015 Inspection, testing, and demonstration of compliance

(a) A remote pilot shall, upon request, make available to the CAA:

(1) the remote pilot licence, if this is required by the type of operation; and

(2) any other document, record, or report required to be kept under this regulation and LARs 101 and 102.

(b) The remote pilot, unmanned aircraft (UA) observer, owner, operator, or person manipulating the flight controls of a UA shall, upon request, allow the CAA to make any test or inspection of the UAS to determine compliance with this regulation and LARs 101 and 102.

100.020 Accident and serious incident reporting

(a) A pilot-in-command of an aircraft and any operating personnel involved in an accident/serious incident, or the operator, or the owner or operations personnel or if that aircraft is lost, shall report the accident or serious incident immediately and directly to the Accident Investigation Authority (AIA).

(b) Reporting under paragraph (a) of this section shall be in a manner acceptable to the AIA and shall, as far as possible, contain at least the following data:

(1) the date and time of the accident or serious incident;

(2) the nature of the accident or serious incident;

(3) details of the aircraft;

(4) the name of the operator or owner of the aircraft;

(5) place of occurrence or location;

(6) type of operation;

(7) point of departure of the aircraft;

(8) number of persons killed or seriously injured as a result of the accident or in the case of a serious incident, number of persons with other types of injury; and

(9) details of aircraft damage.

100.025 Preservation of site, aircraft, contents and records

(a) An operator or any operations personnel shall take all necessary precautions for the preservation of the site, aircraft, wreckage, records and its contents after an accident/serious incident.

(b) No person shall access, interfere with or remove an aircraft and its contents, except as previously coordinated and authorised by the AIA.

Regional Safety Oversight Cooperation System

Latin American Aeronautical Regulations

LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

First edition
March 2023

LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

Record of amendments to LAR UAS 101

Amendment No.	Date applicable	Date entered	Entered by

LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

Amendments to LAR 101

Amendment	Origin	Topics	Approved by JG SRVSOP
First edition	Seventh Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/7) Fast track acceptance and approval	Chapter A – Operation requirements	March 2023

LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

List of effective pages

Detail	Pages	Amendment	Dates
Preamble	iii to vi		March 2022
Chapter A: Operation requirements	A1 to A5		March 2022

Operation of unmanned aircraft systems (UAS) in the open category

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LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

PREAMBLE

Background

Due to the increasing number of unmanned aircraft (UA) operating in ***low-level*** airspace that could potentially conflict with manned aviation, the International Civil Aviation Organization (ICAO) was requested to develop a global baseline of provisions and guidance material for the appropriate harmonisation of regulations for unmanned aircraft systems (UAS) that fall outside the framework of international instrument flight rules (IFR).

To regulate the operations of UA and remotely piloted aircraft (RPA), the States of the ICAO South American (SAM) Region and of the Regional Safety Oversight Cooperation System (SRVSOP) started developing the strategic planning and the regulatory framework for these operations based on documents published by ICAO, regional organisations and States.

To this end, the SAM and SRVSOP States designated their UAS/RPAS focal points to carry out such planning and to develop the concepts of operations (CONOPS) for UA and for UAS traffic management (UTM) and the associated LARs and guidance material.

En este marco, los Estados SAM y del SRVSOP, definieron los requisitos técnicos comunes de la categoría abierta y las consideraciones operacionales y administrativas a tener en cuenta en el desarrollo de sus reglamentos y materiales de orientación nacionales relacionados con esta categoría.

In order to develop the strategic planning and the regulatory framework of the SAM Region and the SRVSOP, the following UAS/RPAS focal point meetings were held:

First meeting

The First Virtual Meeting of the UAS/RPAS Focal Points of SAM and SRVSOP States (RVPF-UAS-RPAS/1) was held on 26 February 2021, and proposed the following work programme:

- UAS/RPAS strategic planning of the Region;
- regulatory framework for UAS/RPAS operations; and
- roadmap for the conduction of these activities.

Work teams and a rapporteur for each group were appointed. Likewise, it was agreed that these work teams would meet independently and that, at the Second Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/2), the progress achieved would be reported.

Second meeting

The Second Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/2) was held on 26 April 2021, where the following conclusions were adopted:

- further development of the UA CONOPS structure;
- establishment and implementation of a technical and administrative coordination channel to deal with requests for international RPAS operations;
- acceptance of the structure and development of the UTM CONOPS;
- acceptance of the development of the UAS regulatory framework by parts; and
- postponement of the development of the RPAS regulatory framework.

Third meeting

The Third Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/3) was held on 26 July 2021. The rapporteur of the task force in charge of developing the UA CONOPS proposed to the meeting to first define the open category before developing the UA CONOPS, which was accepted by the meeting. The meeting adopted the following conclusions:

- approval of the schedule of activities for further development of the UTM CONOPS for the SAM Region and the SRVSOP;
- approval of the work schedule for the definition of the open category;
- approval of the work schedule for the development of LAR 101 and CA 101-1; and
- adoption of the format for reporting international RPAS IFR operations.

Fourth meeting

The Fourth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/4) was held on 4 November 2021. This meeting reviewed: the progress made by the work team in charge of developing the UTM CONOPS and updating its work schedule; the progress made on the definition of the open category for unmanned aircraft systems (UA); the progress made on the draft LAR 101; and the progress made on draft Advisory Circular (AC) 101-1. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- approval of the modified schedule of activities for the further development of the UTM CONOPS for the SAM Region and the SRVSOP;
- second survey with five (5) additional questions for the final definition of the open category;
- survey to define the LAR UAS regulatory framework; and
- approval of the work schedule for the final definition of the open category, definition of the LAR UAS regulatory framework, development of the CONOPS for unmanned aircraft (UA), and development of the LAR UAS(s) and associated AC.

Fifth meeting

The Fifth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/5) was held on 15 December 2021. This meeting was presented with the following: the results of the second survey conducted for the definition of the open category and the results of the survey conducted for the definition of the regulatory framework for unmanned aircraft (UA). After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- acceptance of the final definition of the open category for SAM and SRVSOP States; and
- acceptance of the LAR UAS regulatory framework for the open and specific categories.

Sixth meeting

The Sixth Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/6), was held on 3 March 2022. The meeting was presented with the following: the progress made on the final draft of the UTM CONOPS for consideration of the meeting and the final draft of the UA CONOPS for its approval. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- Acceptance of the 45-day deadline for reviewing the draft UTM CONOPS
- Acceptance of the concept of operations (CONOPS) for unmanned aircraft (UA)

Seventh meeting

The Seventh Virtual Meeting of the UAS/RPAS Focal Points (RVPF-UAS-RPAS/7) was held on 9 May 2022. The final drafts of UAS 100 and 101 LARs were presented at this meeting. After reviewing the working papers (WPs) presented, the meeting adopted the following conclusions:

- Acceptance of the UTM CONOPS
- Acceptance of LAR UASs 100 and 101
- Development of LAR UAS 102 and Advisory circulars (AC) 101-1 and 102-1

LAR UAS 101

Operation of unmanned aircraft systems (UAS) in the open category

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ICAO model advisory circular (AC) 101-1

SAM

CONOPS for unmanned aircraft in the SAM Region

CONOPS for unmanned aircraft traffic management (UTM) in the SAM Region

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Chapter A: Operation requirements

101.001 Applicability

(a) This regulation applies to:

(1) registration; and

(2) operations in the open category using an unmanned aircraft (UA) with a gross mass of less than 25 kg on take-off and throughout the duration of the operation, including all items that are on board and/or attached to the aircraft, and the UA is operated under Section 101.010.

101.005 Unmanned aircraft registration and certificate of registration

(a) Every person lawfully entitled to the possession of a UA who will operate the UA in accordance with the requirements of LAR 101 shall register that UA and hold a valid certificate for that aircraft from:

(1) the CAA;

(2) the appropriate aeronautical authority of a contracting State of ICAO; or

(3) the appropriate aeronautical authority of another State that is party to an agreement with the CAA of a State that provides for the acceptance of each other´s registrations.

101.010 Conditions for the operation of unmanned aircraft in the open category

(a) An UA will be operated in the open category:

(1) within the visual line-of-sight of the person operating the UA;

(2) at or below a height of 400 ft (122 m) above ground level (AGL);

(3) when the person operating the UA is only operating that UA; and

(4) in accordance with Section 101.065;

(b) An UA will not be operated:

(1) in a prohibited area;

(2) in a restricted area; or

(3) over an area where a fire, police or other public safety or emergency operation is being conducted, without the approval of a person in charge of the operation.

101.015 Approval of areas for operation of unmanned aircraft

(a) A person may apply to the CAA for the approval of an area as an area for the operation of:

(1) UA generally, or a particular category of UA.

(i) An approval has effect from the time written notice is issued to the applicant, or a later day, or day and time stated in the approval.

(ii) An approval may be expressed to have effect for a particular period (including a period of less than 1 day) or indefinitely.

(2) The CAA may impose conditions on the approval in the interests of the safety of air navigation.

(3) If the CAA approves an area under (a) (1) of this section, it shall publish details of the approval (including any condition) in a NOTAM, AIP supplement or amendment, as appropriate.

(b) The CAA may revoke the approval of an area, or change the conditions that apply to such an approval, in the interests of the safety of air navigation; likewise, the CAA shall publish details of any revocation or change in NOTAM or on an aeronautical chart.

(c) The CAA shall also give written notice of the revocation or change:

(1) to the person who applied for the approval of the area; or

(2) if that person applied for that approval as an officer of an organisation concerned with UA and no longer holds that office, to the person who now holds the office.

101.020 Airspace

(a) A person shall not operate a UA:

(1) within segregated airspace unless the person has approval to do so from the administering authority responsible for the segregated airspace area.

(2) in controlled airspace (A, B, C, D and E) without authorisation from the ATS unit responsible for that airspace;

(3) in controlled airspace unless he or she:

(i) holds a relevant qualification for the use of a radio transmitter;

(ii) maintains a listening watch on a frequency or frequencies specified in the instructions of the ATS unit; and

(iii) makes broadcasts on a specified frequency or frequencies and/or maintains other ways of communication requested by the ATS unit at the specified interval giving the information specified in ATS instructions.

(b) The CAA may direct, with respect to a particular UA or type of UA, that a person shall not operate that UA, or that type of UA, unless the person complies with the requirements of paragraph (a) (3) of this section.

(c) A person operating a UA shall:

(1) maintain observation of the surrounding airspace in which the aircraft is operating for other aircraft; and

(2) make sure that the UA does not operate above 400 ft (122 m) AGL.

(d) The person to whom this section applies shall comply with all of the requirements set forth herein.

(e) For the purposes of this section, the following definitions apply:

(1) ***Relevant qualification*** means any of the following qualifications:

(i) a radio transmitter operator licence;

(ii) a remote pilot licence (or flight crew licence);

(iii) an air traffic controller licence; or

(iv) a military qualification equivalent to a licence mentioned in (1) (ii) and (1) (iii) of this paragraph.

(2) ***Segregated airspace*** means airspace of specified dimensions allocated for exclusive use of one or more specific users, with operations that cannot be safely integrated with those of other airspace users.

(3) ***Specified aeronautical frequency*** for a particular airspace means a frequency specified in the AIP or by ATS as a frequency for use in the airspace.

(4) ***Specified information*** for a particular airspace means information specified in the AIP or by ATS as information that must be broadcast in the airspace.

(5) ***Specified interval*** for a particular airspace means the interval specified in the AIP or by ATS as the interval at which broadcasts must be made while in that airspace.

101.025 Airspace knowledge

A person to whom this requirement applies shall:

(a) ensure that before each flight, the person is aware of the airspace designation and classification under LAR 211 and any applicable airspace restrictions in place in the area of intended operation; or

(b) conduct the operation under the direct supervision of a person who is aware of the airspace designation under LAR 211 and the corresponding AIP, and of any applicable airspace restrictions in place in the area of intended operation.

101.030 Hazard and risk minimisation

A person operating a UA shall take all practicable steps to minimise hazards to persons, property and other aircraft.

101.035 Dropping of articles

A person operating a UA shall not allow any object to be dropped in flight if such action may create a hazard to other persons or property.

101.040 Aerodromes

(a) A person shall not operate a UA on or within the established boundaries of:

(1) an uncontrolled aerodrome, unless:

(i) the operation is undertaken in accordance with an agreement with the aerodrome operator;

(ii) each remote pilot has a UA observer in attendance while the aircraft is in flight.

(2) a controlled aerodrome, unless it is operated in accordance with an authorisation from the relevant ATS unit.

(3) any aerodrome, unless the person:

(i) is the holder of, or is under the direct supervision of the holder of, a remote pilot qualification that is acceptable to the CAA;

(ii) is under the direct supervision of a person appointed to give instruction in the operation of a UA by a person or organisation acceptable to the CAA; or

(iii) is the holder of a remote pilot licence or certificate issued under 102.05.

(b) Paragraph (a) of this section does not apply to an operation that is conducted in airspace that is physically separated from the aerodrome by a barrier that is capable of arresting the flight of the UA.

101.045 Visual line-of-sight (VLOS) operations

(a) A person shall not operate a UA to which this requirement applies in:

(1) any area in which the person´s view of the surrounding airspace in which the UA will operate is obstructed; or

(2) meteorological conditions that obstruct the person´s ability to maintain visual line-of-sight of the aircraft.

(b) A person who operates a UA to which this requirement applies shall at all times:

(1) maintain visual line-of-sight with the UA or be in direct communications with a UA observer that maintains visual line-of-sight with the UA;

(2) be able to see the surrounding airspace in which the UA is operating; and

(3) operate the UA below any cloud base.

(c) For the purposes of this section, visual line-of-sight means a straight line along which the remote pilot or UA observer has a clear view and which may be achieved with the use of spectacles, contact lenses, or a similar device used for vision correction of the user to no better than normal vision but not the use of an electronic, mechanical, electromagnetic, optical, or electro-optical instrument.

101.050 Weather and day limitations

(a) A person shall not operate a UA:

(1) in or into a cloud;

(2) at night; or

(3) in conditions other than visual meteorological conditions (VMC), unless permitted by another provision of this regulation, or in accordance with an air traffic control clearance.

101.055 Night operations

(a) A person shall not operate a UA at night unless the operation is:

(1) indoors; or

(2) a shielded operation.

101.060 Right-of-way

A person who is operating a UA shall give way to and remain clear of all manned aircraft on the ground and in flight.

101.065 Operation over or near people

(a) No person shall operate a UA over a person unless that person is:

(1) directly participating in the operation of the UA;

(2) located under a covered structure or inside a stationary vehicle that can provide reasonable protection; or

(3) directly associated with the operation of the UA or the UA is operated no closer than 30 m, measured horizontally from a second person not directly associated with the operation of the UA.

(4) (a) (3) does not apply if the second person is standing behind a fixed wing UA while the fixed wing UA is taking off;

(b) (a) (1), (a) (2) or (a) (3) of this section do not apply if:

(1) the person has consented that the UA is allowed to fly over or near him or her; or

(2) the UA is operated by the police, fire brigade, civil defence or other public institution authorised by the CAA.

101.070 Knowledge for acting as a remote pilot

For operations under LAR 101 conducted within the established boundaries of an aerodrome, the remote pilot shall have knowledge of the use of aeronautical charts and of the airspace.

101.075 Prohibited UAS operations

(a) No person shall operate a UA in such a careless or reckless manner as to endanger or be likely to endanger aviation safety or the safety of any person or property.

(b) No person shall operate a UA while operating a moving vehicle, vessel or manned aircraft.

101.080 Psychoactive substances

(a) No person shall act as a remote pilot, member of a flight operation or a UA observer:

(1) within 8 hours after consuming an alcoholic beverage;

(2) while under the influence of alcohol; or

(3) while using any psychoactive substance that impairs the person´s faculties to the extent that aviation safety or the safety of any person is endangered or likely to be endangered.

INTERNATIONAL CIVIL AVIATION ORGANIZATION
SOUTH AMERICAN REGIONAL OFFICE

Unmanned aircraft systems (UAS)

concept of operations (CONOPS)

UAS CONOPS

First edition – March 2023

Contents

Unmanned aircraft systems (UAS) concept of operations (CONOPS)

Development and production:
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Abbreviations

AAO	Approved Aviation Organizations
AC	Advisory Circulars
AIP	Aeronautical Information Publication
AMC	Acceptable Means of Compliance
ANSP	Air Navigation Service Providers
ASBU	Aviation System Block Upgrades
ATS	Air Traffic Services
BVLOS	Beyond Visual Line of Sight
C2	Command and Control Link
CAA	Civil Aviation Authority
CONOPS	Concept of Operations
FRZ	Flight Restriction Zone for UA (Unmanned Aircraft)
ICAOI	International Civil Aviation Organization
IFR	Instrument Flight Rules
ITU	International Telecommunication Union
LAR	Latin American Aeronautical Regulations
MTOW	Maximum Takeoff Weight
OM	Operations Manual
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft Systems
RPS	Remote Pilot Station
SAM	South American Region
SMS	Safety Management System
SRVSOP	Regional Safety Oversight Cooperation System
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UAS CONOPS	Unmanned Aircraft Systems Concept of Operations
UOC	Unmanned Aircraft System Operator Certificate
UTM	Unmanned Aircraft Systems Traffic Management
UTM CONOPS	Unmanned Aircraft Systems Traffic Management Concept of Operations
VFR	Visual Flight Rules
VLOS	Visual Line of Sight

Definitions

Aeronautical Information Publication (AIP)	A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.
Air Traffic Service (ATS)	A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).
Beyond Visual Line of Sight (BVLOS)	Operation in which the remote pilot or UA observer does not use visual reference to the aircraft in conducting the flight.
C2 Link	The data link between the remotely piloted aircraft and the remote pilot station for the purposes of managing the flight.
Dangerous Goods	Articles or substances which are capable of posing a risk to health, safety, property or the environment and which are shown in the list of dangerous goods in the Technical Instructions or which are classified according to those Instructions.
Detect and Avoid	The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.
Handover	The act of passing piloting control from one remote pilot station to another.
Maintenance	The performance of tasks on an aircraft, remote pilot station, engine, propeller or associated part required to ensure the continuing airworthiness of an aircraft, remote pilot station, engine, propeller or associated part including any one or combination of overhaul, inspection, replacement, defect rectification, and embodiment of a modification or repair.

Operator	The person, organization or enterprise engaged in or offering to engage in an aircraft operation.
Operations Manual (OM)	A manual containing procedures, instructions and guidance for use by operational personnel in the execution of their duties.
Remote Pilot	A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time.
Remotely Piloted Aircraft (RPA)	An unmanned aircraft which is piloted from a remote pilot station.
Remotely Piloted Aircraft System (RPAS)	A remotely piloted aircraft, its associated remote pilot station(s), the required C2 Link(s) and any other components as specified in the type design.
Remote Pilot Station (RPS)	The component of the remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft.
Safety Management System (SMS)	A systematic approach to managing safety, including the necessary organizational structures, accountability, responsibilities, policies and procedures.
Unmanned Aircraft (UA)	An aircraft that is intended to be operated with no pilot onboard.
Unmanned Aircraft Flight Restriction Zone	Specific area in which the flight of unmanned aircraft is not permitted under normal conditions.
Visual Line of Sight Operation (VLOS)	An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft.

1 Foreword

Unmanned aircraft (UA) should be integrated into the existing aviation system in a safe and proportionate manner and this integration should foster an innovative and competitive UA industry in South America, creating jobs and growth. The proposed regulatory framework should set a level of safety and of environmental protection acceptable to the society and offer sufficient flexibility for the new industry to evolve, innovate and mature. Therefore, the exercise is not simply transposing the system put in place for manned aviation but creating one that is proportionate, progressive, risk-based, and the requirements should express objectives that will be complemented by industry standards.

Considering the broad range of operations and types of UA, the South American Region (SAM) has established the categories of operations **open, specific and certified** and their associated regulatory regime.

The ***open*** operation category for small UA (drones) should not require an authorization by a civil aviation authority (CAA) for the flight, as long as they stay within defined boundaries for the operation.

The ***specific*** operation category requires a risk assessment that would lead to an operation authorization with specific limitations adapted to the operation.

The ***certified*** operation category comprises operations with a higher associated risk that would require integration in non-segregated airspace.

Protection of other public interests such as the privacy and security entailed by UA operations should be addressed at the same time as the safety risk and would be dealt with at both, national and regional level. Within this context, the regulatory framework could envisage provisions to reduce such risks. Likewise, the developing regulations should need to be complemented by safety promotion actions to support SAM States.

The continued development of UA and their integration in non-segregated airspace pose new challenges and a significant amount of additional research needs to be performed, therefore, this concept of operations (CONOPS), the CONOPS for UAS traffic management (UTM) (UTM CONOPS) and the CONOPS for remotely piloted aircraft systems (RPAS) (RPAS CONOPS) need to be further developed and evolved. In addition, the harmonization of regulations and availability of a frequency spectrum, essential for successful UA operations, should need to be envisaged. Finally, the development of the UA market and the development of the technologies should need to be carefully monitored and the planning adapted to the evolution of these aircraft.

2 Background

Unmanned aircraft systems (UAS) are a new component of the aeronautical system, which ICAO, the SAM States and the aerospace industry seek to understand, define and ultimately integrate. These systems are based on state-of-the-art aerospace technological developments, which offer breakthroughs that may give rise to new and improved commercial or civil applications, as well as safety and efficiency enhancements for all civil aviation. The safe integration of UAS in non-segregated airspace will be a long-term activity, with many stakeholders contributing their experience and expertise on topics as diverse as licensing and medical qualification of remote pilots, detect and avoid system technologies, frequency spectra (including their protection from unintentional or unlawful interference), requirements regarding separation from other aircraft, and development of a robust and effective regulatory framework.

Unmanned aircraft systems (UAS) are aircraft and their associated components that are operated with no pilot on board.

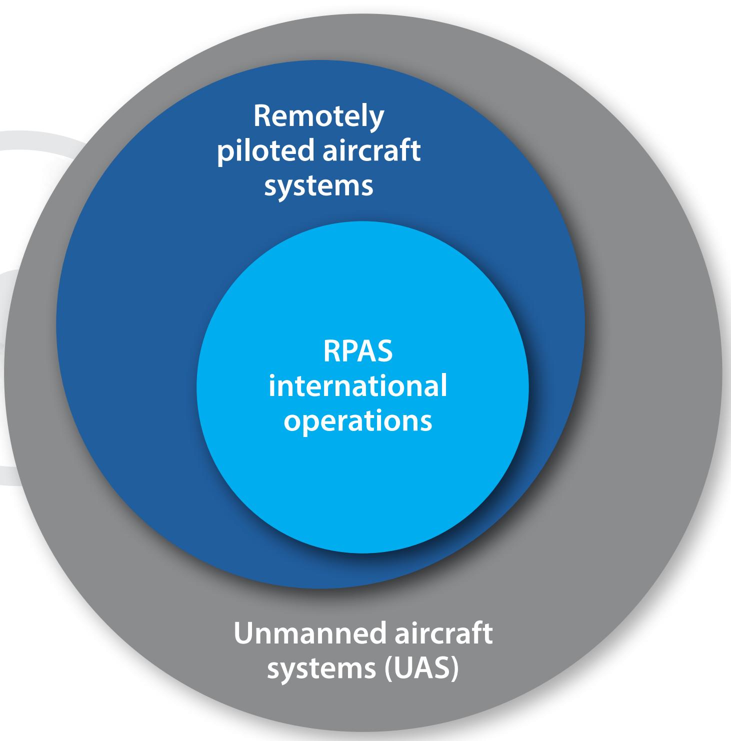
RPAS are a set of configurable elements consisting of a remotely piloted aircraft (RPA), its associated remotely piloted pilot stations (RPS), the required command and control (C2) links and any other system elements as may be required at any point during flight operations. RPA are a subset of UA.

A UA operator is a person, organization or enterprise engaged in, or offering to engage in, an operation of these aircraft. This definition assumes that UA will be remotely piloted and with no people on board.

The use of UA is developing at a quick pace worldwide. At present, the utilization of the UAs is extremely varied. Some examples are: precision agriculture, infrastructure inspection, wind energy monitoring, pipeline and power inspection, highway monitoring, natural resource monitoring, environmental compliance, regulatory compliance, atmospheric research, media and training, sports photography, filming, wildlife protection and research, hunting and anti-hunting monitoring and disaster relief, amongst others.

3 Classification of unmanned aircraft

The figure below shows the classification of UA and the key terms of unmanned aviation are described further below.



Unmanned aircraft (UA)

UA operate as part of an unmanned aircraft system (UAS) that also includes a remote pilot station (RPS), a command and control C2 link, and other necessary components.

Unmanned aircraft (UA) include a broad spectrum of aircraft, from unmanned free balloons and model aircraft to highly complex aircraft piloted from remote locations (RPA) by licensed aviation professionals.

Remotely piloted aircraft (RPA)

RPAs are a subset of UAs. An additional subset of RPAS is expected to have the capability for international operations in accordance with instrument flight rules (IFR) in the near future.

It is important to note that, although this document uses the term RPA to designate only certified UAs operating in integrated airspace, the definition of RPA, as presented in the previous section, is much broader, so some States may choose to use the term RPA, too, to identify other UAs that fall into the open and specific categories.

4 Concept of operations

The operation of UA should be regulated in a manner commensurate with the risk of the specific operation. Considering the broad range of operations and types of UA, three categories of operations -open, specific and certified- and their associated regulatory regimes have been established for the SAM Region through the Latin American Aeronautical Regulations (LARs), developed and published by the Latin American Regional Safety Oversight Cooperation System (SRVSOP).

UA flying in the **open** operation category should not require authorization by a CAA. However, the UA flight requests for access to non-segregated airspace should be registered based on the requirements of each State, in order to monitor and trace operations. Likewise, this operation should stay within the limitations defined by each State (e.g., distance from aerodromes, from people, etc.). The **specific** operation category should require an operations authorization by a CAA, with specific limitations adapted to the operation. The **certified**

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operation category would be used for operations with the highest associated risk due to the type of operation. This category is being developed by ICAO and would cover international IFR operations conducted with RPAS and other types of operations outside the scope of IFR operations.

This UAS CONOPS has been developed to address two main goals:

a) the integration and acceptance of UA into the existing aviation system in a safe and progressive manner; and
b) the promotion of an innovative and competitive South American UA industry, creating new jobs for all the SAM States.

To achieve both goals simultaneously, the regulatory regime in SAM States needs to set a level of safety and of environmental protection that is acceptable to the society. Likewise, this would provide protection to other public interests, such as privacy and aviation security, on the one hand, and offer enough flexibility for the new industry to evolve, innovate and mature on the other hand.

The regulatory framework should not simply transpose the system put in place for manned aviation but should be proportionate, progressive, and risk-based, and the requirements should express objectives that will be complemented by industry standards. Only in this way, the SAM Region could address the challenges posed by the wide variety of UA and their operation, allowing us to learn and progress from simple operations to more advanced and higher risk operations as we gain experience with such operations.

The regulatory framework should be an enabler and not an impediment. Hence, the right balance would be struck between innovation and the societal concerns about safety, environmental protection, privacy and security.

This approach puts commercial and non-commercial operations (including classical aero models or UA used for recreational purposes) on equal footing. This concept focuses on safety risks but recognizes the importance of privacy and security risks to people and property. These subjects are briefly addressed at the end of this CONOPS.

The following main risks should be taken into account in the formulation of certification and operating regulations:

- mid-air collision with manned and unmanned aircraft;
- harm to people; and
- damage to property, in particular critical and sensitive infrastructure.

4.1 Open category

The open category covers those operations with small UA (drones) weighing less than 25 kg that are considered low risk. Operations in the open category should not require an operational authorization by the civil aviation authority (CAA) or a declaration by the UAS operator before starting the operation, unless otherwise required for particular operations by the national regulations of SAM States.

In this category, there are no direct requirements on remote pilot competencies and qualifications unless it is demanded by the competent authority of each State for certain type of operations.

In the open category, the following technical requirements regarding the UAs and their operation should be observed:

- have a maximum certificated take-off weight (MTOW) of less than 25 kg;
- be limited to a maximum height from the take-off point of 400 ft. (122 m);
- limited to operations within visual line-of-sight (VLOS);
- all operations should be supervised by a remote pilot who has the ability to intervene in flight control;
- the carriage of dangerous goods should not be allowed, unless expressly authorized by the State in accordance with its national regulations;
- the dropping of items from unmanned aircraft (UA) should not be allowed, unless specifically authorized by the State for occasions that shall be regulated;
- the State should include on unmanned aircraft, the registration number of the operator and/or of the UA; and
- the State should consider UA operations in airspace under UA traffic management (UTM).

In addition to the technical requirements, the SAM Region established the following operational and administrative considerations:

- for authorizing flight operations, no prior risk assessment would be required, as they are considered to be low risk;
- safety could be ensured through operational limitations, compliance with industrial safety standards, and by applying operational requirements;

- it is advisable that UA be controlled by the police in compliance with any legislation or regulations that may be enacted, and that each State do so in accordance with its own legislation and regulations;
- the take-off weight for this category should be defined as less than 25 kilograms (kg). However, each State could determine the fraction of kg and its technical requirements in its national regulations;
- the State may establish, according to its needs, flight restriction zones for UA, which could be published in the aeronautical information publication (AIP) of each State;
- the requirement for software to restrict access to areas defined by the State would be subject to the operational decisions of each State regarding this open category;
- the definition of subcategories are subject to the needs of each State as it deems appropriate, and should be set out in its regulations;
- each State could establish an operator and/or UAS registry, which should preferably be based on a web service;
- in the open category, flights not supervised by a person should not be allowed, since the remote pilot or observer should always have the aircraft in sight under VLOS conditions;
- the holding of licenses, ratings or certificates for a remote pilot to perform in this category in command of an aircraft would be defined in the regulations of each State;
- the responsibility of the remote pilot-in-command, the sole and ultimate authority while operating the aircraft under all circumstances, should be established in the regulations of each State;
- each State could establish requirements for safety devices when UAS operations in the open category are conducted over people, populated areas or protected flora or fauna sites;
- most States considered not having a specific regulation for sporting operations; and
- States may incorporate sporting UA operations into the open category.

4.2 Specific category

The specific category covers all operations with UA weighing 25 kg or more or UA weighing less than 25 kg but which do not meet the requirements of the open category.

The specific category should cover operations that do not meet the characteristics of the open category, where risk needs to be mitigated by additional operational limitations or higher technical capability of the UA and/or equipment and personnel involved.

This category is designed for operations involving higher risk. It is flexible in the sense that very few activities are prohibited. Instead, a UAS authorization or UAS operator certificate (UOC) should be granted on a case-by-case basis, once the CAA is satisfied that the operator has identified the hazards and their consequences associated with the operations and has a plan to mitigate the identified risks, in the scenario in which the operation is to be carried out

The safety risk assessment should address airworthiness, operational procedures and environment, competence of involved personnel and organizations, as well as airspace issues. These assessments could be based on guidance for an authorization for low-level operations or equivalent processes acceptable to the CAA, either as industry standards, advisory circulars (AC), or acceptable means of compliance (AMC).

The minimum level of safety for airworthiness should be based on the results of the assessment of identified safety risks. It may be defined and demonstrated through compliance to acceptable industry standards. Also, it may be acceptable to compensate certain airworthiness risk factors by operational risk mitigating factors, such as limitations on the operations, special qualifications for the personnel, etc. Conversely, in some cases the outcome of the assessment may require a certification of the UA or of specific functions [for example, safety devices, communication, navigation and surveillance capability to conduct operations beyond visual line-of-sight (BVLOS)], by the competent authority. Therefore, the approval certifications related to the equipment suppliers at their request could simplify the requirements in the evaluation of safety risks of the operators and, in this way, allow the operator to expand the scope of its operations.

The airworthiness assessment is closely related to the operational environment and procedures; *e.g.* the operation close to crowds could be acceptable when the UA has some additional functionality (*e.g.* automatic loss of link procedures, impact energy, such as parachutes; reliability and performance navigation systems suitable for BVLOS operations, etc.) and that the operating procedures are adequate and have the endorsement of the CAA, when the renewal of their permits corresponds.

The required competence of the staff involved should also be established on the basis of the safety risk assessment. It could range from specific training up to a license issued by the CAA, to carry out an aerial activity of this type. States could develop standards for the assessment of pilots and staff based on which such staff may demonstrate a basic competence.

An operations manual (OM) could be required to define the operating procedures, the required airworthiness level, as well as the required competence of staff involved and type of airspace, taking into account the results of the safety risk assessment.

As soon as an operation starts posing more significant aviation risks to persons overflown or involves sharing the airspace, the operation should be placed in the specific category. For these activities, the risks should be analyzed based on an operational risk assessment within the framework of safety management systems (SMS) and the mitigation should be agreed upon by the CAAs, according to the results, before a new operation. This process should be materialized with the issuance of an authorization.

4.3 Certified category

The certified category would include RPAS certified to operate in high-risk operating conditions or internationally within IFR controlled airspace, in non-segregated airspace and at aerodromes.

By 2030, a large number of RPA would share the airspace with manned aviation, some of which would operate under IFR. While some RPAS operations would take place under IFR for part of their flight, others would operate only under visual flight rules (VFR). Furthermore, RPA would operate on domestic and international routes, as well as in controlled and uncontrolled airspace. These RPA would take off from less congested areas and would land at similar destination aerodromes while others would use congested areas and aerodromes.

Other RPA would only operate at low altitudes where manned aviation activities are few or minimal. For example, for border protection, environmental applications, service inspection or forest fire-fighting activities, these RPA could fly in international airspace, depending on whether there are letters of agreement between the States.

All RPA are expected to comply with applicable procedures and airspace requirements defined by the State, including emergency and contingency procedures that would be established and coordinated with the respective air navigation service providers (ANSPs).

The operation of RPA in this category would be quite comparable to what is done for piloted aircraft. It may be expected that the competent authorities would be the same as for manned aircraft. These competent authorities could rely, as of today, on qualified entities to perform technical tasks.

A type certificate also covering environmental certification, an individual certificate of airworthiness, and an individual noise certificate would be issued for each RPA. Demonstration of capability for the designer and the manufacturer would take the form of design and production organization approvals, respectively. Combined approvals could be envisaged if the necessary requirements for these approvals are formulated.

Certification requirements would be adopted to cover different configurations: fixed wing, rotorcraft, airship, and powered lift. Requirements for the command and control station (C2) would be included.

Maintenance above a predetermined threshold would be performed in approved aviation organizations (AAO) and the maintenance personnel approving release to service would be licensed or authorized.

Pilots would be licensed and the operator would receive an approval by the organization (CAA), according to the regulations of each State.

Integration in non-restricted airspace would be subject to a safety assessment by the air traffic service (ATS) provider.

5 Safety promotion actions

The development of regulations and guidance material would be complemented by safety promotion actions that the SAM Region and the SRVSOP may undertake to support their member States. The following promotion actions are recommended for the open category:

- Develop support material to indicate the do's and don'ts for small UA (drone) operators in the open category. This material would be published on the SAM Office, SRVSOP and member States' websites and would be distributed with the support of the UA/RPAS community. This material would be translated into Spanish and Portuguese with the support of the UA/ RPAS community.
- That each State of the SAM Region and the SRVSOP carry out their educational campaigns and publish them on the SAM Office portal, in the same way that it is done on the ICAO Headquarters portal, in Montreal, Canada, using the following link:

  https://www.icao.int/safety/UA/UASToolkit/Pages/State-Regulations.aspx

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- Organize public video campaigns.
- As the police and other law enforcement agencies in charge of citizen control are expected to support in the supervision of operations in the open category, an information manual and a training syllabus should be provided to these organisms, as considered by each State. It would also be necessary to translate these manuals into Spanish and Portuguese with the cooperation of member States.

In order to perform safety promotion actions, help and advice could be sought from the federations, clubs and associations that develop model UAS/RPAS throughout South America.

6 Data protection, privacy, security and spectrum

This concept document has focused on safety aspects, which is a top priority for aviation. However, the aviation security risks involved in UA operations would need to be addressed at the same time as the safety risks.

The privacy/data protection risk should be dealt with at national level. The regulatory framework may envisage provisions that could reduce that risk and also the aviation security risk. For example, the privacy (data protection) risk could be mitigated through the operators' self-registration in a web-based application maintained by the local authorities. Another solution would be to install remote identification devices, such as chips/sim cards in UA. Such a web-based application or chip/sim cards could also contribute to mitigate the aviation security risk.

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

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

The registration of operations could solve some privacy, aviation security and enforcement issues. For example, a requirement in certain areas could be to have a printed copy of the registration with the applicable conditions.

The availability of spectrum is fundamental to the success of UA. Spectrum decisions are taken in the International Telecommunication Union (ITU). It is recommended that member States have an active coordination through this organism for the assignment of radio frequency spectrum to UA operations.

7 Outlook

The integration of UA in non-segregated airspace will pose new challenges. While today flying a single UA in non-segregated airspace with cooperative aircraft can be done with appropriate coordination and special procedures, operation of several of them, possibly with non-cooperative aircraft, will be much more complicated and will require additional measures. This CONOPS will need to evolve and be further developed to address the issues related to operations of UA fleets in non-segregated airspace.

UA fleet operations will pose new, unexplored challenges when conducted alongside manned aircraft operations. This integration will need to be done in full coordination with ICAO aviation system block upgrades (ASBU).

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

- detect and avoid;
- airspace and aerodrome access;
- command and control (C2) communications;
- human factors;
- contingency;
- aviation security; and
- autonomy.

This will need a significant amount of additional research to be performed, in particular by the SAM Region and SRVSOP. Cooperation will be necessary to increase synergies and avoid duplication of work.

Factors to be taken into account could be the following (not exclusive list):

- transfer of UA from one control station to another: some UA have a significant range and the transfer from one control station to another will be envisaged. Experience has already shown that such transfer must not coincide with the transfer from one ATC sector to another;
- operational control of several UA from one control station: this is a real possibility and will lead to formation flights, with coordinated flights of the various UA, for example for efficient fire-fighting or for crop spraying;
- ATC and operational control performed by the same person: this is an extension of the previous case, but will entail new risks and raise new liability issues;
- communications with ATC with an acceptable latency period;
- full autonomy and cooperative operations (for example, operation in swarms, network-centric operations); and
- extreme flight range (several days even months) at very high altitude (20 000 m): how to maintain the necessary surveillance to face emergencies.

Integration in non-segregated airspace will require the following for air navigation services and operators:

- minimum navigation, communication and surveillance performance standards;
- adaptation of the infrastructure;
- new procedures; and
- adaptable training.

The UTM CONOPS will need to be further developed, addressing short-, medium-, and long-term perspectives. However, these perspectives must be based on the development of the UA market and of the technologies. These should be carefully monitored and the planning adapted accordingly.

8 Planning

Planning will reflect a progressive introduction in non-segregated airspace. The development of rules will be market-driven, so the following short-, medium-, and long-term actions are identified in this CONOPS:

Short term: Until December 2023

- development and approval of the UAS CONOPS;
- development and approval of the UTM CONOPS;
- development and approval of UAS LARs 100, 101 and 102 and the related guidance material that includes:
  - ➢ the definition of subcategories in the open and specific categories; and
  - ➢ in the specific category:
    - ✓ risk assessments;
    - ✓ the development of OM; and
    - ✓ the competencies of the remote pilot and personnel in charge of operations;

- development of competencies, job profiles and functions and responsibilities (roles) of the personnel in charge of UA certification and inspection;
- development of training programmes and training plans for inspectorate staff;
- implementation of training plans for inspectorate staff; and
- start of operations in the open and specific categories.

Medium term: From 2024 to December 2026

- development and approval of the RPAS CONOPS;
- development and approval of the RPAS/ATM CONOPS;
- initiation of the development and approval of RPAS LARs and the related guidance material that includes:
  - ➢ the definition of subcategories in the certified category; and
  - ➢ the issuance of type and noise certificates for RPAs;
- development of competencies, job profiles and functions and responsibilities (roles) of the personnel in charge of RPAS certification and inspection;
- development of training programmes and training plans for inspectorate staff;
- implementation of training plans for inspectorate staff;
- development of model programmes for training centres (in order to achieve regional standards)
- development of maintenance programmes for UAS/RPAS equipment
- start of operations in the certified category;
- continued implementation of operations in the open and specific categories; and
- surveillance of operations in the open and specific categories;

Long term: From 2027 to December 2030

- implementation of the RPAS CONOPS;
- implementation of the RPAS/ATM CONOPS;
- completion of the development and approval of the RPAS LARs and the related guidance material;
- continued implementation of training plans for inspectorate staff;
- implementation of operations in the certified category;
- surveillance of operations in the certified category; and
- implementation of RPAS requirements, adjusted to industry requirements.

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Unmanned aircraft system traffic management (UTM) concept of operations (CONOPS)

UTM CONOPS

First edition – March 2023

Contents

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Figures

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Abbreviations and acronyms

4D	Four dimensions
AAO	Authorized area of operations
ADS-B	Automatic dependent surveillance - broadcast
AGL	Above ground level
ANAC	Agencia Nacional de Aviación Civil (Civil Aviation Nacional Agency)
ANSP	Air navigation service provider
API	Application programming interface
APP	Application
ASBU	Aviation system block upgrades
ATC	Air traffic control
ATS	Air traffic services
ASM	Airspace management
ATM	Air traffic management
BR-UTM	Brazilian UTM
BVLOS	Beyond visual line-of-sight
CA	Certification authority
CAA	Civil aviation authority
CNS	Communications, navigation and surveillance
CONOPS	Concept of operations
CORUS	Concept of operations for European UTM systems
C2	Command and control link
DAA	Detect and avoid
DECEA	Department of Airspace Control
ERP	Emergency response plan
FAA	Federal Aviation Administration
FRZ	Flight restriction zone for UA
FT	Foot
FUA	Flexible use of airspace
GPS	Global positioning system
GRAIN	Global resilient aviation information network
HITL	Human in the loop
IATF	International aviation trust framework

ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
KPI	Key performance indicator
NM	Nautical mile
NOTAM	Notice to airmen
PBA	Performance-based approach
PIREP	Pilots reports on manned aircrafts
PVR	Priority volume reservation
RA	Registration authority
RID	Remote identification
RID USS	Remote identification service provider
RPA	Remotely piloted aircraft
RPAS	Remotely piloted aircraft system
RPIC	Remote pilot-in-command
RPS	Remote pilot station
SARPS	Standards and recommended practices
SARPAS	Request for access to airspace to use RPAS
SISANT	System for unmanned aircraft
SDSP	Supplemental data service provider
SMS	Safety management system
SORA	Specific operations risk assessment
SSR	Secondary surveillance radar
UA	Unmanned aircraft
UAS	Unmanned aircraft system
UAS-ID	UAS identification
UREP	Unmanned aircraft report
USS	UAS service supplier
UTM	Unmanned aircraft system traffic management
UVR	UAS volume reservation
V2V	Vehicle to vehicle
VFR	Visual flight rules
VLOS	Visual line-of-sight
VLL	Very low level
VMC	Visual meteorological conditions

Definitions

Note: The definitions contained in this document are used in the context of this document. Except where indicated, they have no official status within ICAO. When a formally recognized ICAO definition is included for convenience, it is marked by an asterisk (*). When a term is used differently from a formally recognized ICAO definition, it is indicated by the symbol (**).

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.

Air navigation service provider (ANSP) *

An organization that provides the service of managing the aircraft in flight or on the maneuvering area of an aerodrome and which is the legitimate holder of that responsibility.

Air traffic

All aircraft in flight or operating on the maneuvering area of an aerodrome.

Air traffic control service (ATC) *

A service provided for the purpose of:

a) preventing collisions:
   - between aircraft, and
   - on the maneuvering area between aircraft and obstructions; and

b) expediting and maintaining an orderly flow of air traffic.

Air traffic management (ATM) *

The dynamic, integrated management of air traffic and airspace (including air traffic services, airspace management and air traffic flow management) - safely, economically and efficiently - through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.

Air traffic management system	A system that provides ATM through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground and/or space-based communications, navigation and surveillance.
Air traffic service (ATS) *	A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).
Automatic dependent Surveillance broadcast (ADS-B)	A means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in broadcast mode by means of data link.
Beyond visual line-of sight (BVLOS) *	An operation in which the remote pilot or UA observer does not use visual reference to the remotely piloted aircraft in the conduct of flight.
Certification authority (CA)	An authority responsible for the digital signature and disclosure of the public key linked to a given entity, with a view to compliance with the identity cybersecurity policies applicable to UTM.
Command and control link (C2) *	The data link between the remotely piloted aircraft and the remote pilot station for the purpose of managing flight.
Data link communications	A means of communication for the exchange of messages using data link.

Detect and avoid (DAA) *	The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action with a view to complying with the applicable flight rules.
Flight restriction zone for UA (FRZ)	Specific area in which UA flight is not allowed under normal conditions.
Flight termination system	A system that provides the ability to intentionally end the flight in a controlled manner in the event of an emergency. *Note: Flight termination systems are designed to minimize the possibility of injury or damage to people, property or other aircraft on the ground and in the air.*
Global resilient aviation information network (GRAIN)	Considered as the network of networks interconnecting aviation stakeholders for all information exchanges.
NOTAM *	A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
Operator *	A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Priority volume	Portion of airspace, with the objective of supporting emergency land and air operations (air ambulance, search and rescue, catastrophe) and/or public security, generally of short duration (in hours and not in days or weeks), with specified airspace limits, as well as established start and end times by notifying UTM operators of the airspace blocks in which these activities occur.
Priority volume reservation (PVR)	Procedure to establish a portion of airspace for the purpose of supporting emergency ground and air operations (air ambulance, search and rescue, disasters) and/or public safety operations, generally of short duration (hours rather than days or weeks), with specified airspace boundaries, as well as established start and end times, by notifying UTM operators of the airspace blocks in which these activities occur. *Note: The definition of priority volume reservation (PVR) is based on the UAS volume reservation (UVR) concept defined by the FAA [1] and does not imply that the volume established is for the exclusive use of unmanned aviation.*
Registration authority (RA)	An authority responsible for verifying the identity of entities applying for certificates to be stored by the CA.
Remote identification (RID)	Is the ability of a drone in flight to provide identification and location information that can be received by other parties.
Remotely piloted aircraft (RPA) *	An unmanned aircraft that is piloted from a remote pilot station.

Remote pilot *	A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time.
Remote pilot-in-command (RPIC) *	The remote pilot designated by the operator as being in command and charged with the safe conduct of a flight.
Remotely piloted aircraft system (RPAS) *	A remotely piloted aircraft, its associated remote pilot station(s), the required C2 links and any other components as specified in the type design.
Remote pilot station (RPS) *	The component of the remote pilot aircraft system containing the equipment used to pilot the remotely piloted aircraft.
Responsible authority	(i) For flights over the high seas: the appropriate authority of the State of registry. (ii) For flights other than over the high seas: the appropriate authority of the State having sovereignty over the territory overflown.
Restricted area	An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.
RPA observer	A trained and competent person designated by the operator who, by visual observation of the remotely piloted aircraft, assists the remote pilot in the safe conduct of the flight.

Standards and recommended practices (SARPS)	Technical specifications adopted by the ICAO Council in accordance with Article 37 of the Convention on International Civil Aviation in order to achieve the highest practicable degree of uniformity in regulations, standards, procedures and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation.
Supplemental data service provider (SDSP)	An entity responsible for the provision of essential or enhanced services, including data such as: (a) terrain and obstacles, (b) specialized weather, (c) surveillance, and (d) constraint information.
UA identification	A unique data element that can be traced back to a UA and its operator.
UAS service supplier (USS)	An entity that assists UAS operators with meeting UTM operational requirements that enable safe and efficient use of airspace.
Unmanned aircraft (UA)	An aircraft which is operated with no pilot on board.
Unmanned aircraft system (UAS)	An aircraft and its associated elements, which are operated with no pilot on board.
Unmanned aircraft system traffic management	A system that provides UTM through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground or space-based communications, navigation and surveillance.

Unmanned aircraft system traffic management (UTM)	A specific aspect of air traffic management which manages UA operations safely, economically and efficiently through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions.
Very low level (VLL)	Portion of airspace below that in which VFR is normally used.
Visual line-of-sight (VLOS) *	An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft.

1 Introduction

Unmanned aviation has evolved rapidly and, consequently, the capabilities of so-called drones continue to improve, based on technological evolution. The promising market in this new era of aviation has shown diversified potential, which can be applied in critical infrastructure inspection and monitoring, surveying and mapping, filming and photography, precision agriculture, search and rescue, disaster relief and public safety, among other uses. This accelerated development has led to a boom in the use of this type of aircraft, whether for commercial or recreational purposes.

To exploit this technology to its full capacity, it cannot be limited to visual line-of-sight (VLOS) operations, and a mechanism to allow beyond visual line-of-sight (BVLOS) flight is needed. Furthermore, the air traffic management (ATM) system, as conceived, does not meet the needs of the sector in a cost-effective manner. The concept of an unmanned aircraft traffic management (UTM) system emerges as an effective alternative.

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According to the definition adopted by the International Civil Aviation Organization (ICAO) in the document Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization, 3rd [2] UTM is defined as an ATM subsystem whose objective is to manage unmanned aircraft system (UAS) operations safely, economically and efficiently through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions. The system will provide a management model through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground or space-based communications, navigation and surveillance.

ATM is a system with more than 75 years of history, whose function is to manage airspace and aircraft operations, based on airspace design principles and systems operated in cooperation between pilots and air traffic controllers, who have clearly-defined roles and responsibilities. The emerging unmanned aircraft sector offers many opportunities, but to integrate seamlessly into the current system, unmanned aircraft will need to co-exist with the existing aviation systems.

The insertion of new entrants into this well-regulated environment must be done on the basis of risk assessments and proposed mitigation actions, ensuring the safety of other airspace users, people and property on the ground. Privacy, safety, reliability and the environment are additional factors of public interest and must be taken into account by the authorities when implementing and operating the UTM system.

For the development of this concept of operations (CONOPS), the experience of other countries was taken into account, as embodied in documents, mainly the aforementioned Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization, 3rd edition [2], U-space Concept of Operations (CORUS) [3] and FAA Concept of Operations v2.0 [1]. It is important to note that this is a constantly evolving subject, and it is hoped that, like in other countries, the CONOPS will be considered a living and evolving document.

While this CONOPS is not prescriptive, it can serve as a basis for States to address, inter alia, issues related to interoperability between UTM and ATM systems, UAS certification and the integration of UAS operations into the ATM environment.

1.1 Need for UTM

Integration of UAS in very low-level (VLL) airspace, an environment where operational procedures are based on human ability to maintain safety levels consistent with aeronautical activity, presents a variety of issues and challenges. The volume of UAS operations in this environment can be on a scale comparable, if not greater, to that of manned air traffic, presenting a significant challenge to authorities in the airspace management process.

The VLL environment is defined as the airspace below that used by aircraft under visual flight rules (VFR), as set out in chapter 4, paragraph 4.6 of Annex 2 [4] of the Chicago Convention, as transcribed below:

> ***"Except when necessary for take-off or landing, or except by permission from the appropriate authority, a VFR flight shall not be flown:***
> ***a) ...***
> ***b) elsewhere than as specified in 4.6 a), at a height less than 150 m (500 ft) above the ground or water."***

However, to increase the level of safety for manned aircraft, a 100 ft buffer zone was established between UAS operations in the UTM environment and aircraft operating VFR above 500 ft, limiting the VLL environment to 400 ft. Although there are many reasons why manned aircraft may fly in VLL airspace, this does not affect its definition.

Currently, States have authorized, based on Art. 8 of the Chicago Convention, UAS operations, commercial or recreational, by accommodating the described technology. Accommodating, according to ICAO, means restricting the operation to specific conditions (e.g., VLOS, 400 ft, etc.) or to low-risk airspaces (segregated, away from densely populated areas, etc.).

On the other hand, some operators have obtained authorization from the civil aviation authorities to operate BVLOS or above 400 ft AGL, following a case-by-case assessment. However, this case-by-case approach does not allow the market to be explored to its full potential, preventing operations on a wider scale.

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Given the number, type and duration of planned UAS operations, the existing air traffic management system infrastructure and associated resources cannot be economically scaled to provide services to UAS. In addition, the nature of most of these operations does not require direct interaction with the ATM system.

In order to safely manage the expected rapid increase of UAS operations in the airspace, solutions are needed that go beyond the current ATM infrastructure and air traffic control (ATC) personnel resources. Solutions are needed that change the current paradigm of manned aircraft operations, moving towards one that promotes shared situational awareness among operators.

Therefore, the ATM system, as conceived, does not fully meet the requirements of unmanned aviation, calling for the creation of this new management model, whose main function is to provide a cooperative environment that allows for the increase of UAS operations, more specifically BVLOS, in VLL airspace.

1.2 UTM evolution

In Latin America, as in the rest of the world, over the last seven years the UAS sector has undergone a dizzying evolution from military applications to professional and commercial developments in the civil sector.

Day after day, numerous applications for these aircraft are discovered in different economic sectors; creativity and innovation have been the permanent driving force of this industry that has gained great relevance in areas such as agriculture, mining, security and surveillance, topography, fire prevention, cinema and television, energy, construction, transport, search and rescue and recreation, among many others.

The unmanned aviation sector has a huge potential for expansion, which points to great growth in the medium term in the region, where continuous technological development makes available better aircraft to realize the extraordinary prospects for development of the global industry, where drones become fundamental tools in the production and service sectors. Thus, new applications and uses emerge every day which, with their versatility and efficiency, offer clear advantages (economic, ecological and in terms of execution time) over traditional solutions.

In Latin America, the aeronautical authorities of each country have analyzed the development of this new technology, and have adopted the provisions of ICAO and other aeronautical authorities. These authorities issued the first regulations for UAS operations. Thus, the first general airworthiness and operational requirements for UAS became known in 2009. This was the first regulatory framework for administrative and operational control of UAS and their safe insertion in the airspace.

The new regulatory framework set forth the administrative procedure to register companies, persons, pilots and equipment before the aeronautical authority. Following this registration and after receiving a document authorizing them as UAS operators, they could start their professional or commercial air operation.

The information for registration as an individual or a corporation consisted of the documents of the company or individual, the certificate of the basic UAS pilot course given by an aeronautical training center authorized by the aeronautical authority, the technical and operational information of the UAS to be used, and the safety management system (SMS) [5].

Following the issuance of these first standards, the process of updating the regulations began, with the aim of adapting the regulations to the technological development of these aircraft and to the demands of the industry. This is achieved by creating direct communication channels with the industry to listen to their demands and by actively participating in the different events related to the UAS sector.

These channels, which involve the use of technological tools (Internet and APP) that allow companies to register, request an operation and obtain subsequent approval by the aeronautical authority, can be considered the first phase of implementation of the UTM system in Latin America.

1.3 Scope of the CONOPS

This CONOPS will apply to both VLOS and BVLOS operations conducted in VLL environment, up to 400 feet above ground level (AGL) within controlled and uncontrolled airspace.

This CONOPS is not intended to propose or endorse any specific UTM system design or technical solutions to meet the UTM challenge. Its main objective is to provide a comprehensive framework for such a system. Accordingly, the information contained herein proposes a common set of guiding principles and enabling actions.

With respect to classes of airspace, unmanned aircraft operations may take place in controlled airspace, uncontrolled airspace or in transit across them.

Uncontrolled airspace is the portion of the airspace where no air traffic control service is provided and is therefore classified as Class G airspace. As there is no provision of air traffic control service, manned operations are managed in a cooperative manner and mainly by visual means, based on well-defined principles and rules of operation (Rules of the Air) and applicable to air traffic management (ATM). In order to ensure fair access to airspace, UTM seeks to provide a similar means of cooperative traffic management for unmanned aircraft and other aircraft participating in uncontrolled airspace.

Unmanned aircraft operating in UTM environment in controlled airspace will be subject to authorization and will not be provided with air traffic control services.

Any UTM system must be able to interact with the air traffic management (ATM) system in the short term and integrate with the ATM system in the long term. The introduction and management of unmanned traffic, as well as the development of the associated UTM infrastructure, should not adversely affect the safety or efficiency of the existing ATM system.

In this respect, a common framework would facilitate global harmonization of UTM systems and provide a step-by-step approach for integration into the ATM system. This would allow the industry, including manufacturers, service providers and end users to evolve safely and efficiently without disrupting the existing manned aviation system.

For the purpose of this guidance material, in the short and medium term, UTM will be considered as a separate system but inter-operable with the ATM environment, while in the long term, integration and potential convergence with ATM is considered as a realistic solution.

1.4 UTM principles

Controlled airspace includes airspace designated as Class A, B, C, D and E, and is characterized by the provision of air traffic control service. This service is based on "pilot x air traffic controller" human interaction *(Human - In - The – Loop - HITL)*, which is a fundamental characteristic of the ATM system in these environments.

Therefore, for safe and efficient operations, UTM systems must be inter-operable and consistent with the ATM environment. While requirements have not yet been developed, some basic principles can be established to guide their development. In addition, the principles currently used in the existing ATM structure are still valid for services provided in the UTM environment. Accordingly, it is proposed that the following principles be taken into account:

a) The regulator is ultimately responsible for system oversight, whether UTM or ATM;
b) Existing rules for priorization of aircraft, such as emergency and support to public safety operations, must remain applicable in the UTM system, and practices unique to that environment must be compatible with those procedures;
c) Access to airspace should remain equitable, provided that each aircraft is capable of meeting the requirements of the airspace in which it intends to operate; and
d) The UAS operator must be duly qualified to perform the normal and contingency operational procedures established for the airspace in which it intends to operate.

In order to fulfill their oversight and safety responsibilities, the responsible authorities must have unrestricted access, upon demand to UAS operators, to the position, speed, planned path and performance capabilities of each UA in the airspace, through the UTM system.

1.5 Purpose of the CONOPS

The purpose of the CONOPS is to describe the conceptual elements associated with UAS operations in VLL airspace that will guide the adoption of solutions by the various parties involved in implementation.

Likewise, the CONOPS seeks to establish a phased implementation approach, through field demonstrations and in a controlled environment, providing the data collection necessary for system maturation. Based on this premise, CONOPS will be updated as necessary to reflect the progress of research and the continued maturation of concepts resulting from collaboration among all stakeholders.

It is possible, and indeed desirable, that additional features, although not considered essential for the safety of operations, are available in the UTM environment. However, once implemented, these services must comply with the principles described above.

In order to describe the requirements associated with the development of the system, the following elements will be addressed:

a) UTM concept of operations, which provides the foundational principles around which the system is based, as well as a description of a conceptual architecture and the systemic relationship among all stakeholders;

b) Roles and responsibilities of each participant in the UTM environment; and

c) Timeline of actions inherent to the development of hypothetical cases in the UTM environment.

2 UTM concept of operations

2.1 General information

The road towards UTM should run parallel to the guidelines developed in the Global Air Traffic Management Operational Concept (Doc 9854) [7] so that they converge almost seamlessly towards the expected transition. Differences or inconsistencies will appear between the two concepts, accepting UTM as an ATM subsystem, but the threads should be consistent, facilitating their assimilation through the identification and recognition of the same instruments, tools and designs towards a quality end product that incorporates flexibility, ensures equity, promotes collective participation, enables the exchange of reliable information and data, allows interconnectivity to make these available and to jointly choose a more efficient, convenient, environmentally-friendly and cost-effective operation, without departing from the highest safety standards.

2.1.1 UTM system

Considered an ATM subsystem, the UTM system is cooperative in nature, where all participants have a direct impact, and entails a comprehensive use of all its components (technology, facilities, information, data and communication, navigation and surveillance), in which human participation (from the regulator, the oversight entity, the service provider, the manufacturer, external suppliers, to the user) permits a dynamic and seamless interconnection and interaction.

2.1.2 Commitment of the sectors involved

2.1.2.1 UAS industry

UAS manufacturers and developers must understand the UTM approach and identify its guiding principles in order to focus their attention on incorporating capabilities, navigation, communication, identification systems, with a view not only to VLL, but also thinking ahead to integration beyond this first phase of the CONOPS.

This will permit an initial alignment with the ATM platform, through a non-invasive integration consistent with its requirements and capabilities, and will provide sustainable alternatives towards a common benefit.

2.1.2.2 Regulatory bodies

Regional standardization is urgently needed in terms of the regulatory framework, classification and registration of UAS, certifications and ratings for both unmanned aircraft and their remote pilots, observers and support personnel, certified workshops, risk management, operator certification, DAA and command and control (C2) link, thus enabling the standardization of these documents (ideally in digital form), the adoption of the use of geo-barriers, mapping and design of airspace structures, identification and oversight of restricted or prohibited areas of operation, agreements with security forces or institutions for the control of documentation and operators. In short, such standardization would provide added value by allowing equitable, orderly and seamless access to UAS operations across neighboring States and, at a later stage, at the regional level, as the UTM system evolves.

2.1.2.3 Operators

The aviation industry as we know it has more than 75 years of evolution, together with standards and recommended practices, which have enabled an efficient, smooth and safe organization and development.

The so-called drones have emerged thanks to accelerated technological development in recent years, and their applications seem endless. Their easy access brings with it a community of users with little or no aeronautical background. UTM must establish training and eligibility requirements to bridge this gap. Users must be consciously involved in the environment where they intend to carry out their operations, developing situational awareness, identifying hazards, mitigating risks, becoming part of the system, in all its components and in a participatory manner.

2.1.2.4 External USS service providers

The USS service provider is an element that enables operators to meet the operational requirements of the UTM system, providing safe and efficient use of airspace. The USS is an important element in the management of this system and must perform functions such as:

a) acting as a communication bridge between UTM system users, in order to support operators' ability to meet the regulatory and operational requirements of UAS operations;

b) providing operators with information on planned operations in and around a volume of airspace to enable them to verify their ability to carry out the mission safely and efficiently; and

c) archiving, in historical databases, information related to operations for analytical and regulatory purposes.

In general, these basic functions enable a USS network to provide cooperative management of low-altitude operations without the direct involvement of the authorities. The services provided by the USS give UAS operators the ability to plan operations, share flight intentions, resolve strategic and tactical conflicts, monitor operational compliance, provide remote identification, request airspace access authorization, manage airspace of interest, and consider off-nominal situations.

The USS can provide UAS operators with the following services:

a) discovery: allows system-authorized users to identify active USS, as well as services available on the USS network;
b) registration: enables operators to register data related to their aircraft; and
c) message security: provides data protection, as well as the assurance that data is exchanged only with authorized users.

With the growth of the sector, other needs will emerge, prompting the USS to provide new services.

At present, such applications are under development, but they depend on a cooperative user who voluntarily initiates a communication by launching an "intent-to-fly". In other words, it depends solely on the user's discretion to initiate a link.

2.1.3 Interconnection between stakeholders

An agile interconnection platform, allowing for real-time exchange of information, protected from malicious interference, capable of transmitting reliable data, that is sustainable, continuous, allowing for different levels of access based on user credentials, could be an investment that the States of the region should consider based on a cost-benefit analysis. However, it would not necessarily be too far away from similar projects within the ATM framework. It depends exclusively on the reality of each State and its projects or investment plans. The UTM system would recommend obtaining such a platform or extending the existing one.

2.2 Civil/military coordination

The use of UAS in reconnaissance and defense tasks is growing at an accelerated pace. The States of the Latin American region have adopted or are in the process of concluding agreements between these institutions, the ANSP and the aeronautical authority in order to define procedures, based on the type of mission or objective pursued with the use of UAS.

Several types of actions can be identified:

a) Defense;
b) Surveillance;
c) Training;
d) Demonstrations; and
e) Joint military operation exercises.

In general, it is common to use restricted areas that are included in the national aeronautical information publication, except in defense missions where the procedures defined in agreements take precedence.

2.3 Benefits

The harmonized implementation of the UTM system in the Latin American region will create synergies among the States, enabling solutions for the establishment of short-, medium- and long-term strategies.

This approach will allow States to promote, in a harmonized manner, the scalability of safe UAS operations while preserving the safety of other airspace users, people and property on the ground.

Accordingly, efforts are being made to develop operational procedures and requirements for ATM automation systems, with a view to identifying potential conflicts in UAS integration. These concepts, once validated, will ensure seamless interoperability between the two systems (ATM - UTM) and the parties will be sufficiently prepared to coexist, allowing the aircraft to move seamlessly between these two environments in a safe and orderly manner.

2.3.1 For all stakeholders

The UTM system provides an innovative approach to meeting operational requirements, leveraging the fact that its needs greatly accelerate the commitment to provide services due to market forces and incentives to meet operator demand, while placing a much smaller infrastructure and manpower burden (cost) on the States to implement.

Thus, full implementation of the UTM system will bring common benefits to all stakeholders, including:

a) A flexible and extensible structure that can adapt and evolve as the commercial spectrum changes and matures; and

b) A structure that allows the responsible authority to maintain its authority over the airspace, while allowing industry to manage operations in areas authorized for low-altitude UAS flight.

2.3.2 For the State

a) It provides an integrated approach within the safety framework that brings together most UAS operations (without unduly hampering innovation);

b) It gradually expands existing regulations for small UAS operations, initially focusing on less complex operations;

c) It provides, in harmonious collaboration with the Region, guidance to enable future, more complex operations;

d) It provides, together with an advisory group, risk mitigation expertise through mechanisms for collaboration among stakeholders, both from the industry and the State, to guide safety developments involving new regulations and/or amendment of existing ones;

e) It encourages suitable regional assistance for data collection and analysis, and involvement of members of the industry, strengthening the RPAS community's commitment to adopting and implementing safety improvements;

f) It matures its regulations based on lessons learnt;

g) It integrates, in a participatory manner, the development of new UAS technologies in cooperation between the State and the industry to achieve viable solutions enabling:

   i. routine UAS operations in VLL airspace;

   ii. coordination and priorization of the technical, procedural, regulatory and policy solutions needed for capacity building;

   iii. development of a plan to assist the community concerned in facing new or unprecedented situations when so required; and

   iv. resolution of conflicts between different types of operations.

h) It addresses new challenges, developing recommendations for UAS requirements and policies, in response to issues raised, such as:

   i. unexpected risks to public safety and national security due to the extent of UA operations;

   ii. the need for a robust system that is immune to cyber-attacks, allowing for reliable information sharing; and

   iii. development of a regulatory framework that addresses the right to privacy, accountability and transparency for commercial and private use of UAS.

2.3.3 For the industry

It allows industry, through cooperation with regulatory authorities, to play a key role in the process of identifying the operational needs of UAS, developing technological solutions that enable scalable operations of this new technology, at very low altitudes, in a safe and efficient manner.

2.3.4 For UAS operators

One of the main objectives of the UTM system is to create a business environment that allows for scalability of UAS operations, provided the market is fully explored, without impairing the safety of other airspace users, people and property on the ground. UTM will enable many companies to operate, innovate, compete and deliver services in a cost-effective manner.

In addition to managing complex operations at very low altitudes, the UTM system contributes to public acceptance by balancing commercial pressures resulting from the growth of these activities with issues such as:

a) nature preservation;
b) the health and privacy of individuals; and
c) security.

2.3.5 For other airspace users

Airspace at very low altitudes may be used by other types of airspace users, such as:

a) military aircraft;
b) rotary-wing aircraft;
c) balloons;
d) hang-gliders; and
e) parachutists.

Therefore, the UTM system enables safe interaction among all these users, ensuring enhanced situational awareness of all who thrive in, and interact with, this system.

2.3.6 Civil community

In the absence of a UTM system, UAS operations related to humanitarian aid and emergency response require pre-planning and careful coordination, and it is not possible to use these capabilities in unforeseen situations to assist victims of natural or man-made disasters. Humanitarian missions as a result of a catastrophic event (e.g., a natural disaster causing great urgency) require swift approval to operate and a lengthy CAA filing and review process would be inappropriate and even ineffective.

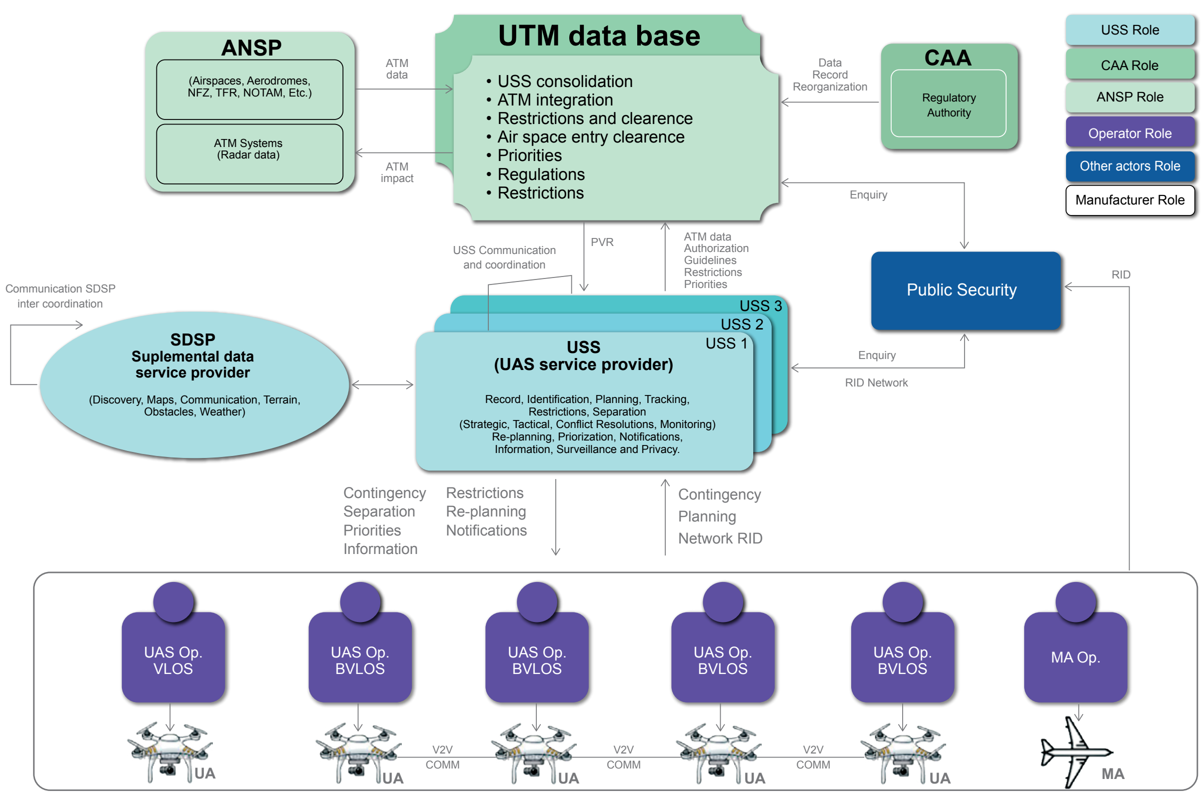
With the implementation of the UTM system, the operator, in possession of an authorization to operate, will be able to request, through its USS, the establishment of priority volumes, which will be instantly communicated via the USS network, ensuring that the operations are known to other users participating in this collaborative environment. In this way, civil society will have at its disposal a range of services whose main objective is to safeguard human life.

2.4 Architecture

Within the UTM environment, the responsible authority maintains its regulatory and operational authority for airspace and manned and unmanned aircraft operations; however, the operations are not managed by ATC. Rather, they are organized, coordinated and managed by a set of authorized actors in a distributed network of highly automated systems via application programming interfaces (APIs).

Figure 1 depicts a notional UTM architecture that provides a high-level, graphical identification of the various actors and components, their contextual relationships, as well as high-level functions and information flows.

Figure 1. UTM system architecture



Cooperative Air Space Traffic

As shown, UTM comprises a sophisticated relationship between the authority, the operator and the various entities providing services and/or demonstrating a demand for services within the UTM environment. The illustration highlights a model, which heavily leverages utilization of third-party entities to support the authority and the operator in their respective roles and responsibilities. Sections 2.4.1 and 2.4.2 describe elements of this notional architecture.

2.4.1 Participants and roles

The UTM environment is seen as a cooperative and digitized ecosystem, in which all actors are expected to interact with each other through a robust and reliable network for information/data exchange, and whose main objective is to provide high situational awareness to all stakeholders. In addition, the responsible authority, when deemed necessary, is expected to interact with the UTM system for regulatory oversight, ensuring that airspace users have access to the necessary resources for safe operation in this complex environment.

2.4.1.1 Civil Aviation Authority (CAA)

In the context of UTM, the civil aviation authority will be responsible for:

a) providing a regulatory framework for the efficient, orderly and safe operation of UAS;
b) registering, rating, inspecting and auditing both remote pilots and UAS, certified workshops and training centers;
c) issuing proficiency certificates, registration documentation, ratings and limitations to unmanned aircraft, pilots and unmanned aircraft systems;
d) defining scope and exceptions;
e) defining the requirements to be met by service providers (USS and SDSP), in accordance with the regulatory basis, operational ratings, data transmission security, information accuracy, link requirements, CNS integration, meteorological information, density, capacity, etc.;
f) auditing and certifying ANSP processes in UTM; and
g) validating ATM-UTM integration processes.

2.4.1.2 Air navigation service providers (ANSPs)

a) provide USS and SDSPs with the operational requirements to be met within the airspace under its management (ASM), such as: airspace constraints, flight restriction zone (FRZ), special activity airspace, operational layers or ceilings, geo-barriers, type and quality of data to be provided, additional relevant information, communication channels, etc.

b) establish airspace management processes and channels for UAS operations beyond the UTM environment;

c) design airspace structures tailored to the operational needs of the sector;

d) harness CNS capabilities for efficient and secure exchange of relevant data;

e) manage the integration between ATM and UTM systems; and

f) participate with the State in awareness-raising programmes, information campaigns, social participation, in aspects of safety, quality, management and transparency.

2.4.1.3 Operator

The operator is the person or entity responsible for the overall management of their operation. Its role is to meet regulatory and operational responsibilities, plan operations, share flight intent information, and conduct operations in a mindful and safe manner using all available information. Use of the term "operator" in this document is inclusive of airspace users electing to participate in UTM, including manned aircraft operators, except when specifically referred to as one or the other separately.

2.4.1.4 Remote pilot-in-command (RPIC)

The remote pilot-in-command (RPIC) is the person responsible for the safe conduct of each UAS flight. An individual may serve as both the operator and the RPIC. The RPIC adheres to operational rules of the airspace in which the unmanned aircraft is flying; avoids other aircraft, terrain and obstacles; assesses and respects airspace constraints and flight restrictions; avoids incompatible weather conditions and environments; and monitors the flight performance and location of the aircraft. If flight safety is compromised, due to system/equipment degradation or environmental vulnerabilities, the RPIC will be aware of these factors and may intervene appropriately. More than one RPIC may take control of the aircraft during the flight, provided that one person is responsible for the operation at any given time and is identified.

2.4.1.5 Other stakeholders - Public safety and general public

Other stakeholders can also access information and/or utilize UTM services via the USS network. Stakeholders include public safety entities and the general public. Public safety entities, when authorized, can access UTM operations data as a means to ensure safety of the airspace and people and property on the ground, security of airports and critical infrastructure, and privacy of the general public. Data can be accessed through dedicated portals or can be routed directly to public safety entities upon request. Data in the public domain can be accessed by the general public.

2.4.2 Services and supporting infrastructure

UTM services are modular and discrete, allowing for increased flexibility in the design and implementation of new services. This modular approach allows the authority to provide tailored oversight of services in order to strike a balance between providing State oversight and spurring industry innovation.

At the most basic level, services may be characterized in one of the following ways:

a) services that are required to be used by operators due to regulations issued by the responsible authority and/or have a direct connection to their systems. These services must be qualified by the responsible authority against a specified set of performance rules;

b) services that may be used by an operator to meet all or part of a regulatory or operational requirement. These services must comply with specific policies and must be individually approved by the responsible authority; and
c) services that provide additional assistance to an operator, but are not used for regulatory or operational compliance. These services may meet industry standards, but will not necessarily be qualified by the authority. The format of these additional services must have a standard structure to achieve uniformity in their presentation by each and every provider.

2.4.2.1 UAS service supplier (USS)

A USS is an entity that assists UAS operators with meeting UTM operational requirements that enable safe and efficient use of airspace in accordance with the regulatory framework.

The USS is an important link in the management of this system and must perform functions such as:

a) acting as a communication bridge between the associated UTM actors to support operators' abilities to meet the regulatory and operational requirements for UAS operations;
b) providing information about planned operations in and around a volume of airspace, so that operators can ascertain the ability to safely and efficiently conduct the mission; and
c) archiving operations data in historical databases for analytics, statistics, accountability assessment, or others purposes of interest to users, companies or manufacturers.

In general, these key functions allow for a USS network to provide cooperative management of low-altitude operations without direct authority involvement. However, they may be available to the authority for research purposes.

USS services support operations planning, intent sharing, strategic and tactical de-confliction, conformance monitoring, remote identification (RID), airspace authorization, airspace management functions, and management of off-nominal situations. Likewise, these services exchange information with one another over the Internet or other compatible and certified platform to enable UTM services (e.g. exchange of flight intent information, notification of airspace changes, etc.).

The USS may provide UAS operators the following services:

a) services that enable authorized UTM stakeholders to discover active USSs and their available services within the USS network;
b) services enabling vehicle owners to register data related to their UAS;
c) services for USS registration; and
d) message authentication to ensure data is secured and exchanged only with authorized users.

The USS may also provide other additional services to support UTM participants as market forces create opportunity to meet business needs.

2.4.2.2 USS network

The term "USS network" is the amalgamation of USSs connected to each other, exchanging information on behalf of subscribed operators. The USS network shares operational intent data, airspace constraint information, and other relevant details across the network to ensure shared situational awareness for UTM participants. In the UTM structure, multiple USSs can operate in the same geographical area.

The USS network must implement a shared model, with industry agreed-upon methods for de-confliction and/or negotiation, and standards for the efficient and effective transmission of intent and changes to intent. This reduces risk to operators and improves overall capacity and efficiency in the shared space.

The USS network is also expected to facilitate the ready availability of data to the authority and other entities as required to ensure safe operation in the airspace, and any other collective information sharing functions, including security and identification.

2.4.2.3 Supplemental data service providers (SDSP)

Operators and USSs can access supplemental data service providers (SDSPs) for essential or enhanced services, including terrain and obstacle data, specialized weather data, surveillance, and constraint information. SDSPs may connect to the USS network or directly to operators through other means (e.g., public/private Internet sites).

2.4.2.4 UTM database

The UTM database has the function of establishing an interface between UTM system users and the various governmental agencies with the objective of sharing data necessary for the safety of operations. Through the UTM database, authorities share airspace constraint data as well as interact with the UTM system, accessing on request information related to the status of operations. The UTM database also provides a means for public or private entities, through an access policy established by the responsible authority, to query and receive data for purposes of incident or accident investigation and compliance audits.

2.4.2.5 Airspace system data sources

Airspace data provided by the responsible authority is connected to the UTM environment through a UTM database. This allows for flow of essential and discrete data across the UTM community. Furthermore, access to shared data is only allowed for authorized users. The database interface between the authority and UTM stakeholders external to the authority acts as a gateway such that external entities do not have direct access to authority systems and databases. Access to this database is restricted, that is, it can only be used under license of the owner, being permeable the data voluntarily made available to meet the needs of the UTM system.

The data sources that may be connected to the UTM database for information exchange purposes include UAS registrations, airspace authorizations, operational waivers, and constraints.

2.5 Operations

One of the main premises of the UTM system is that users will cooperate and operate in accordance with the appropriate operating rules and procedures for their operations. The various services provided in this ecosystem are mainly aimed at allowing, through information exchanges, operations to be conducted safely and in accordance with the safety levels established for manned aviation.

The UTM system supports the management and safe conduct of operations through:

a) the issuance of operating authorizations in accordance with the operational requirements of the intended airspace;

b) the issuance of flight permit categories, depending on whether it is for controlled or uncontrolled airspace;

c) facilitating operations planning (strategic phase), based on flight intent data made available to the users;

d) notifying and disseminating airspace constraint information, identifying active priority volume reservations (PVR);

e) versatile information in the face of unforeseen restructuring of the priority volumes established under special conditions or circumstances arising from unforeseeable events (e.g., intervention of public forces or emergency response); and

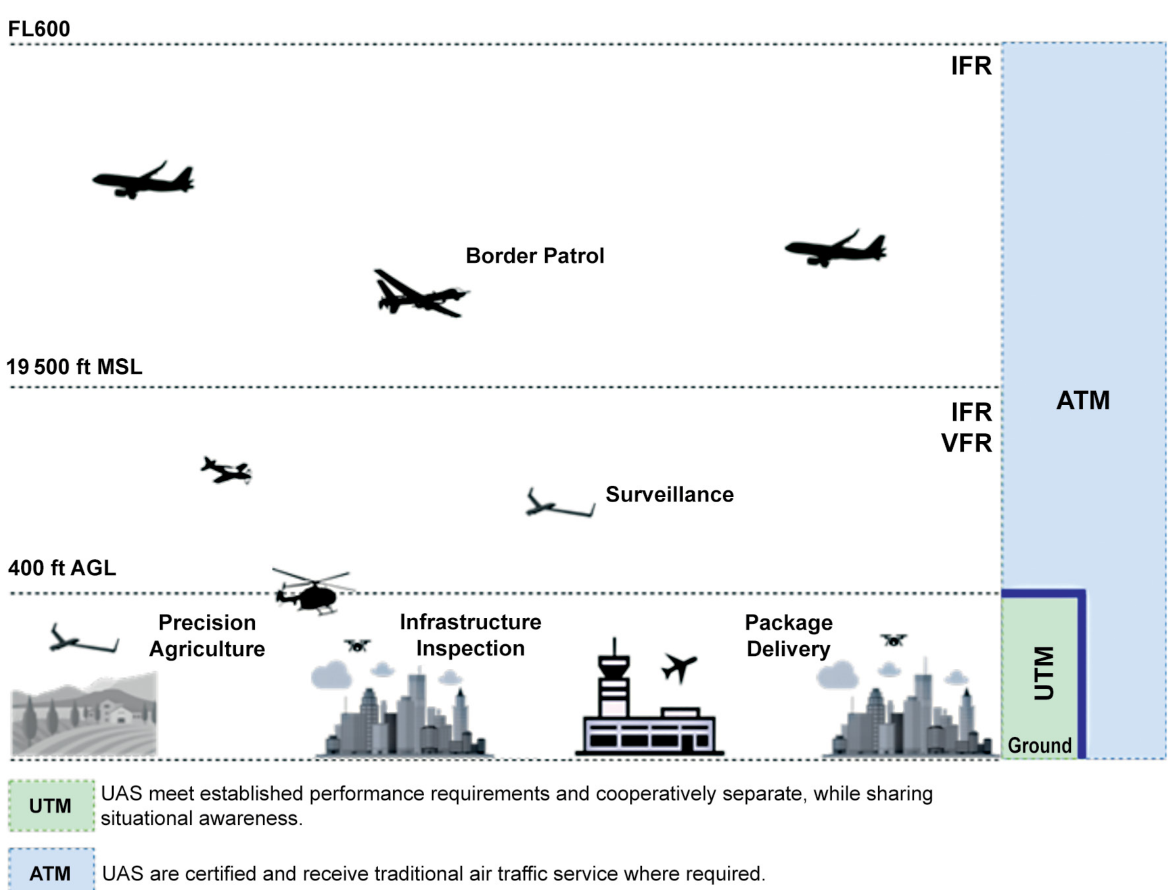
f) de-conflicting capability.

2.5.1 Participation

A robust UTM system ensures equitable, safe and efficient interaction at all times, provides data, information, maps, operational limits, quality and availability of priority volumes that allow operators to self-manage their flight needs, helping them to identify their environment, generating, in a broad sense, situational awareness that enables them to detect and evade other UAS and manned aircraft, understanding that this is an unavoidable and primary responsibility during the operator's tactical phase.

Therefore, all UAS operators not receiving ATC separation services are required to participate in the UTM system at some level, using applicable services to meet the performance requirements of their operations. The number and type of services required vary based on the type and location of the intended operation and the associated communication, navigation, and surveillance (CNS), and other operational needs.

Figure 2. UTM in the context of ATM operations



2.5.1.1 BVLOS UAS operators

To date, most BVLOS operations are not able to identify and visual separate from other UAS and manned aircraft. It is expected that UAS manufacturers and service developers will adopt tools compatible with the corresponding communication, navigation and surveillance (CNS) capabilities and with those adopted for the ATM environment. However, this document refers to very low-level (VLL) operations, and thus, an approach outside of this block should be envisaged exclusively for the ATM environment, requiring management based on those principles, involving airspace reservation or segregation and the respective NOTAM publication. In a first stage, the UTM system can only provide information regarding the channel and the way to request authorization for that type of operation.

Therefore, BVLOS operators must use UTM services to enable their operations, including, inter alia:

a) UA registration data;
b) remote identification (RID) transmission;
c) priority volumes;
d) identification of other UAS operators involved in each priority volume established;
e) strategic de-confliction through the sharing of flight intent and negotiation;
f) monitoring of flights and their conformance to flight intent;
g) notification/alerts of in-flight conflicts;
h) in-flight rerouting options;
i) weather; and
j) navigation and surveillance.

2.5.1.2 VLOS UAS operators

Unlike BVLOS operation, VLOS flights allow the UAS operator to visually manage conflicts. Given that the ability to safely operate VLOS is not predicated upon data exchanges with other UTM system participants, the use of UTM services will be directly related to meeting existing requirements and legislation. Recreational or non-recreational operators performing VLOS flights must meet requirements related to aircraft registration, remote identification, and obtaining airspace authorization for flight in controlled airspace. The operators satisfy such requirements through use of the services provided by the responsible authority, or through a USS that has been qualified to provide said services.

2.5.1.3 Manned aircraft operators

Manned aircraft operators are not required to participate in UTM, but may, and are encouraged to voluntarily do so to obtain the safety benefits that are gained from shared awareness among airspace users. Manned aircraft operators have access to information regarding the conduct of UTM operations and can voluntarily participate at different levels:

a) Passive participation - Manned aircraft operators use information from the USS network (flight intent of UAS operators) to gain situational awareness of nearby operations and plan their activities, but do not make available their flight intent information to UAS operators; and
b) Active participation - Manned aircraft operators make their flight intent available to other UTM participants via the USS network, fostering situational awareness for other participants with active operations near their own.

Furthermore, manned aircraft operators may actively participate in the UTM system, without the need to connect to the USS network, by simply equipping their aircraft with features that will make them detectable by other airspace users, such as:

a) ADS-B; and
b) remote identification.

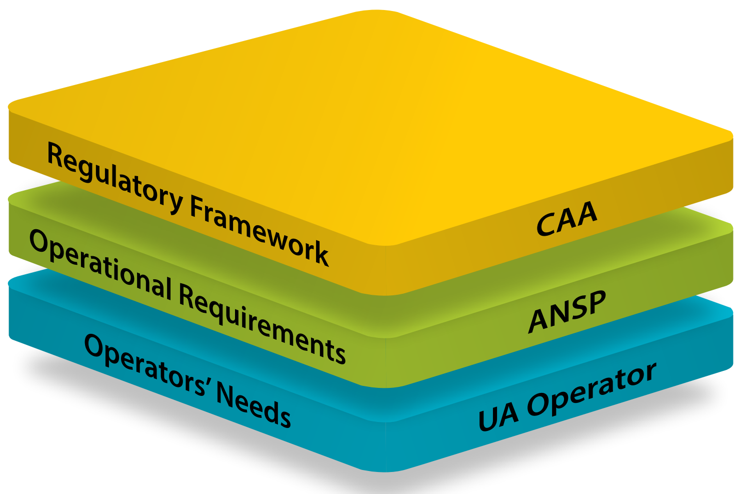
2.5.2 Performance authorization

2.5.2.1 Fundamentals

The advent of unmanned aircraft has turned us towards a different approach to airspace management than we have had for 75 years. Flight rules, separation techniques, communication, navigation, performance and surveillance requirements together make for a robust and safe manned air traffic management system. Today, this know-how and processes, while a starting point, do not allow for the full integration of UAS operations.

Successful operations in a UTM environment will depend on a correct initial identification of the needs of three key parties, as shown in Figure 3: the UAS users or operators, the air navigation service provider (ANSP) and the civil aviation authority (CAA) or regulator. The product that responds to these needs will become a "performance authorization", which cannot be managed in the traditional way or through the channels we currently use to conduct manned aircraft operations. It becomes essential to incorporate new players to effectively manage this product, using new platforms for communication, identification and data exchange. Thus, related third parties emerge to consolidate rules, processes, essential information, requirements, limitations or restrictions and make them available to the UTM system. These are the USSs and SDSPs. The next step is to non-invasively integrate the ATM and UTM systems as far as their compatibility allows, taking advantage of the benefits of CNS management. USSs shall take into account variability, while preserving safety and equity in the airspace.

Figure 3. Fundamental needs for integration into UTM database



In UTM, the ANSP, the CAA and the USS are jointly responsible for ensuring interoperability of the system actors. Interoperability in UTM focuses on how data is exchanged and interpreted. A common understanding of CNS requirements among actors is critical to the overall safety case. Depending on the overall risk of the underlying operation, substantiating data may be required of the applicant.

2.5.2.2 Obtaining a performance authorization

The performance authorization concept provides operational criteria for the assessment of different and emerging technologies, geared to the evolution of operations. Once the criteria have been established and accepted, the operation, including technical and human performance, and even its feasibility, can be assessed against these operational parameters.

Operations in the UTM environment will take a similar approach, requiring the issuance of performance authorizations related to communications, navigation and surveillance (CNS). UAS operations present a wide range of CNS performances, considering the many types of aircraft and operations envisaged. The expectation is that this variation will be managed by the USS, through the provision of differentiated services. The USS will need to take into account the different CNS performances, ensuring equitable access to airspace, without impairing the safety of other users, people and property on the ground.

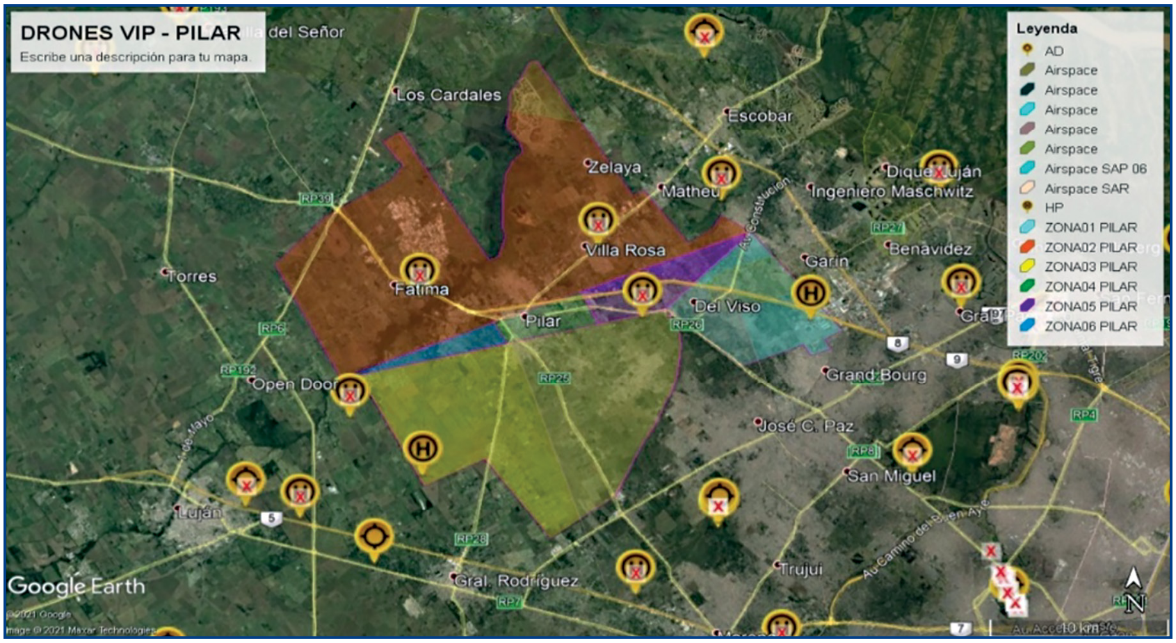
Operators are required to obtain a performance authorization from the responsible authority prior to conducting a class or type of UTM operation. The performance authorization will be granted to operators that substantiate to the authority their ability to meet the requirements established for the intended airspace. Performance authorizations are envisioned to provide credibility, stability, uniformity and accountability to operators participating in the UTM environment.

Each performance authorization request must demonstrate compliance of the overall system, including air and ground assets, USS/SDSP services, personnel, suitability, procedures and capabilities associated with the applicable performance requirements, as well as the ability of the system to maintain the aircraft within a specific operating volume, notify deviations or adverse conditions and de-conflicting.

The aggregation of performance authorizations leads to the creation of authorized areas of operation, with defined geographical boundaries. It is possible to have access to more than one authorized area of operation under a single performance authorization. Different levels of performance may be required based on the underlying airspace infrastructure.

The universe of operators is expected to obtain from the USS network the data that will lead to an efficient and safe operation, with authorizations being issued based on variables of capacity, proximity, detect and avoid (DAA) resources, obstacle or hazard identification, proximity to predefined airspaces containing and conducting manned flights.

Figure 4. Multiple areas of operation authorized for a UAS operator



The authorized areas of operation will vary in complexity and access requirements based on the airspace involved, geographical location, demographic density, accessibility to USS networks, availability and reach of USS and SDSP servers, communication and data exchange effectiveness, demand and capacity. All this information must be provided to the UTM system by the USS and SDSP. It will also depend on a prior analysis of probability data on the likelihood of a conflict or incident occurring, supported by risk analysis data. This criterion incorporates questions such as: How likely is it to occur; how often is it likely to occur; what would be the severity of the conflict or incident; and what would be the likelihood of a conflict or incident occurring?

The "static" information available in the UTM system can be provided by the CAA and the ANSP, based on the design of existing airspace structures. These structures are subject to continuous updating and may be modified as a result of redesign or new requirements. The UTM system must provide for this possibility and articulate a process for reporting and updating the information.

2.5.3 Airspace authorization

All UAS operators conducting UTM operations must obtain ANSP authorization when operating within the bounds of controlled airspace. This authorization is referred to as an airspace authorization and is separate from a performance authorization.

The performance authorization substantiates an operator's ability to meet flight performance capabilities in the intended area of operation, while the airspace authorization grants access to operate in controlled airspace and provides the air traffic facility with jurisdiction over the airspace and access to information about operations being conducted. An airspace authorization grants an operator access to controlled airspace for a limited period of time, typically short term.

UTM operators can apply for airspace authorizations directly through ANSP systems or they can use a CAA-qualified USS to provide automated authorization services.

USSs qualified to provide airspace authorization services identify operations that require airspace authorization (i.e. identify any portion of operation intent that lies in controlled airspace). USSs notify operators of the need for ATC authorization and support.

2.5.4 Operation planning

With UTM, flight intent is submitted and shared among operators for situational awareness in the form of an operation plan. In this regard, it differs from a "flight plan" that is propagated through ATC automation systems for aircraft operations managed by the air traffic control service.

The operation plan is developed prior to the operation and indicates the four-dimensional volume of airspace within which the operation is expected to occur, the times and locations of the key events associated with the operation, including launch, recovery, and any other information deemed important (e.g. segmentation of the operation trajectory by time). While a single volume can be used, segmentation of that four-dimensional volume promotes the efficient use of airspace and reduces the likelihood of overlapping operations.

The operation plan as proposed may be impacted by other planned operations (e.g., overlapping airspace volumes), airspace constraints (e.g., airspace restrictions, special use airspace, NOTAMs, UAS volume reservations), or ground constraints (e.g., public gatherings, sensitive areas, obstacles), therefore the operator must assess all appropriate information affecting the planned operation and make amendments to the plan as applicable. The operator identifies operational conflicts and strategically "de-conflicts", potentially via the capabilities provided by the service providers (USS) (e.g., operator collaboration and de-confliction algorithms) designed to provide fair access to the airspace.

Following this sharing of intent to the USS network, the operator's USS continues to offer de-confliction support up to the start of the operation.

2.5.5 Constraint information and advisories

UAS operators are responsible for identifying unexpected operational conditions or flight hazards that may affect their operation. This information is dynamic and constantly updated, collected and assessed both prior to and during the operation in order to ensure the safe conduct of the operation. The USS must support this operator responsibility by supplying airspace constraint and advisory information, weather and other relevant data.

Near real-time advisories are provided through the USS network, and are made available to affected users regarding:

a) traffic (e.g., aircraft known and unknown that may represent a hazard for the operation, as well as non-conforming operations);
b) weather and winds (gusts that could exceed the operating capacity of the aircraft); and

c) other hazards pertinent to low altitude (e.g., unexpected obstacles such as a crane or power-line NOTAM, bird activity or migratory information, local UAS restrictions, or other specific hazard information.

d) Priority Volume Reserve (PVR) information.

The static and dynamic information made available on the network comes mainly from the USS and/or the SDSP. UA operators may participate in the distribution of information through a report, advising of specific phenomena or conditions experienced or encountered first-hand. The FAA [1] has termed these reports as "unmanned aircraft reports (UREPs)", comparable to "manned aircraft pilot reports (PIREPs)". These reports, as well as the type of information to be reported, should be in a standard format, achieving a harmonized and clear criterion for the handling of this type of information.

UAS priority volume reservations (PVRs) may be established when activities on the ground, or in the air, present a potential risk to UTM safety interests. PVRs are designed to support safety of transient flights (e.g., police activity, emergency response, public safety) by notifying UTM operators about blocks of airspace in which these activities occur. PVRs are generally short in duration, have specified airspace boundaries, and have an established start and end times. A USS that has been qualified to provide PVR services creates and routes PVR data through the USS network to notify affected operators and stakeholders.

2.5.6 Separation

UTM operators are directly responsible for maintaining separation from other aircraft, airspace, weather, terrain, and hazards, and avoiding unsafe conditions throughout an operation.

Separation is achieved through efficient management aimed at sharing flight intent, creating collective situational awareness, strategic de-confliction of airspace volumes (planning and negotiation), aircraft trajectory tracking and conformance monitoring, tactical de-confliction, and establishing rules of the road (e.g., right-of-way rules).

Operators/RPICs (if separate entity) are responsible for remaining within the bounds of their flight volume(s) and tracking the aircraft location during all phases of flight, while meeting required performance criteria for the operation performed. Operators monitor for vehicle non-conformance and/or on board equipment failures or degradation (e.g., lost link, engine failure).

For situations where corrections cannot be made, operators are responsible for notifying affected airspace users as soon as practical and executing a predictable response.

The USS can assist the operator in providing path tracking and conformance monitoring capabilities and notifying affected airspace users when a particular off-nominal event occurs causing a deviation from the original flight intent. Such events, when they jeopardize the operation of manned aircraft or require ATC intervention, must be immediately communicated by the USS to the ANSP for action to be taken to protect manned air traffic. This link should be channeled through the UTM database.

The operator is responsible for in-flight coordination with other operators, and can use services of a USS to facilitate this coordination. The operator's performance authorization may require on-board communications, navigation, and detect and avoid (DAA) equipment to maintain separation tactically. In the event intent needs to be updated in-flight, USSs will accommodate operator updates.

USSs and/or SDSPs support the operator by supplying weather, terrain, and obstacle clearance data specific to the area of operation during the pre-flight planning phase to ensure strategic management of the UTM operation, as well as in-flight updates ensuring separation provision. The USS maintains and provides near real-time and forecast weather information for the region. Operators monitor weather and winds throughout flight. In the event their aircraft performance is inadequate for flight in current or forecast weather, operators take appropriate action to safely land as soon as practical and possible.

Using in-flight connection capabilities, operators also monitor terrain and obstacle data to ensure the aircraft does not collide with the ground, wires, terrain, mountains, or other obstacles. Data providers maintain and provide the most current terrain/obstacle databases in order to develop accurate avoidance information for UTM operators.

2.6 Roles and responsibilities

The table summarizes the roles and responsibilities of the UA operator, USS and responsible authority associated with a UTM operation.

Table 1. Roles and responsibilities

FUNCTION		Actors/Entities R = Primary responsability S = Operations support		
		UAS Operator	USS	Competent Authority
Separation	UAS from UAS (VLOS and BVLOS)	R	S	-
	VLOS UAS from Low-Altitude Manned Aircraft	R	S	-
	BVLOS UAS from Low-Altitude Manned Aircraft	R	S	-
Hazards	Weather Avoidance	R	S	-
	Terrain Avoidance	R	S	-
	Obstacle Avoidance	R	S	-
Status	UTM Operations Status	R	S	-
	Flight Information Archive	R	S	-
	Flight Information Status	R	S	-
Advisores	Weather Information	R	S	-
	Alerts to Affected Airspace Users of UAS Hazards	R	S	-
	Hazards Information (e.g., obstacles, terrain)	R	S	-
	UAS-Specific Hazard Information (e.g., Power-Lines, UA-NFZ)	R	S	-
Plannin, Intent and Authorization	Operation Plan Development	R	S	-
	Operation Intent Sharing (pre-flight)	R	S	-
	Operation Intent Sharing (in-flight)	R	S	-
	Operation Intent Negotiation	R	S	-
	Controlled Airspace Authorization	-	S	R
	Control of Flight	R	-	-
	Airspace Allocation & Constraints Definiton	-	S	R

2.7 Remote identification (RID)

Remote identification provides a means to address public concerns and protect for public safety vulnerabilities associated with low-altitude UA operations, including privacy and security threats. RID allows electronic identification of a UA/operator through use of a unique identifier (similar in concept to an automobile license plate), eliminating anonymity and preserving the operational privacy of remote pilots, companies and their customers.

RID enables accountability and traceability, particularly for BVLOS operations, where an operator and aircraft are not co-located. USSs that provide RID services process and distribute RID data to the general public, law enforcement, the authority, and other public officials according to protocols established by the responsible authority.

Public officials, with a need to know, have credentials that give them access to an expanded set of data compared to the general public.

RID uses a combination of technology and services to identify UAs and associated operators who may pose safety, security, and /or privacy concerns to the public. As a member of the independent service provider system exchanging information across a common network, the UTM architecture supports RID through various means, including:

a) providing the architecture, infrastructure, and services by which operators transmit RID information through network publishing; and
b) providing services by which authorized persons may obtain information relevant to public safety concerns.

RID is predicated upon transmission of a set of information that enables a recipient to determine location and establish traceability back to a UAS operator/RPIC responsible for a specific aircraft. It is assumed that there is a minimum set of information that operators transmit that is publicly accessible, termed an RID message.

For the purposes of this document, it is assumed that the RID message elements include, at a minimum:

a) a unique identification number - UA ID;
b) UA location; and
c) a timestamp.

The information in the publicly accessible RID message may be used by authorized entities to obtain additional information relevant to public safety. While rules regarding RID for UA are still under development, two methods are recommended for UA to transmit RID and tracking information:

a) Direct broadcast [8]: transmission of radio signals directly from the UA to recipients in the vicinity of the UA. Data can be received by anyone within broadcast range;
b) Network publishing [8]: transmission via the Internet or a remote identification service provider that interacts directly or indirectly with the UA or with other sources in the case of non-equipped network participants. Customers can access the published data to obtain UA identification and tracking information.

An operator transmitting via the public network sends an RID message to a USS that has been qualified by the authority to provide RID services - termed RID USS. The RID USS makes the RID message available to all other RID USSs, and vice versa, such that the complete set of messages held by the various USSs comprises a distributed database. The general public may utilize services provided by RID USSs. An example of a potential service would be a cell phone application supporting queries to publicly-accessible data.

Any query through a single RID USS results in a return of all transmitted RID messages that conform to the bounds of the query, regardless of the original RID USS that received each transmission. Additionally, the authority is able to query RID USSs via the USS network for relevant RID messages when such information is needed.

Authorized public safety entities that need to obtain information beyond the publicly-accessible RID message elements are able to query the USS network. A USS that has been qualified by the authority to provide public safety services may have increased access-to-information privileges within the USS network, compared to USSs not providing public safety services. For example, an authorized law enforcement officer may subscribe to a public safety USS, which could support queries to the USS network for information relating to a submitted UAS ID. USSs that have or provide services to the operator tied to the UAS ID will provide information back to the public safety USS commensurate with the level of information access associated with the requesting law enforcement officer, which could include operator name and contact information.

2.8 Airspace Management

UTM is designed to ensure UA operations are authorized, safe, secure, and equitable in terms of airspace access. UTM imposes requirements on operations and performance commensurate with operator, aircraft, services, operational environment, and airspace class considerations. Airspace management is predicated on a layered approach to safety, security, and equity of airspace access through the following:

a) performance authorizations and certifications that ensure operators, equipment, and USSs meet the appropriate capability and performance requirements for the operations planned;

b) airspace authorizations that provide situational awareness to air traffic management stakeholders of UTM operations in controlled airspace;

c) strategic traffic management of operations through interactive pre-flight planning;

d) separation provision through de-confliction services and in-flight conflict alerts to UTM participants, including aircraft intent, airspace constraints, and hazards using DAA for appropriate guidance;

e) contingency management through operation planning, coordinated procedures and response protocols, and pre-programmed system or aircraft responses to flight anomalies;

f) near real-time notifications of airspace constraints and advisories that safeguard the safety of the airspace;

g) obstacle and aircraft avoidance through the use of appropriate ground-based or on-board equipment, including collision detect and avoid (DAA); and

h) identification of aircraft operators and UAS/RPICs through RID information exchanges.

In addition, security of the airspace is ensured through airspace data and system protection, as well as through the collection, maintenance, and provision of identity information for UTM operations, aircraft and operators through RID, aircraft registration, operator logs, USS services, and appropriate aircraft identification mechanisms. Finally, equity of airspace access for UTM operations is fostered through operation orchestration and operator negotiation to optimize airspace use among the participants.

2.8.1 Safety

Safety refers to the safety of people and property on the ground, as well as in the air. UTM has multiple layers of separation assurance to ensure the safe conduct of operations, from strategic flight planning and management tools to tactical aircraft and obstacle avoidance capabilities.

2.8.1.1 Strategic management of operations

UTM operations can be strategically managed through interactive planning and orchestration of intent information as well as relevant environmental considerations that enable strategic de-confliction for multiple UAS operations. Operation intent sharing, strategic de-confliction, airspace constraint evaluation, weather reporting and forecasting capabilities, and other key supporting features of UTM reduce the need for tactical separation management and reduce the likelihood of in-flight intent changes due to weather or airspace restrictions.

Operators planning to fly beyond visual line-of-sight (BVLOS) are required to share operation intent with other operators/airspace users via the USS network. Intent data predominantly consists of the spatial and temporal elements of an operation. At a minimum, operation intent includes operation volume segments that make up the intended flight path. Operation volumes are four-dimensional blocks of airspace that have specified entry and exit times for the operator's UA. These volumes may be stacked in sequence such that one volume's exit time coincides with the entry time of an adjacent volume along the flight path. The result is that each operation volume in the sequence comprises a segment of the overall flight profile.

Operation volumes are contained within the operator's authorized areas of operation, as defined in their flight intent. UAS performance capabilities will typically determine the size of operation volume segments, with UAS of higher navigational performance being able to maintain flight within smaller navigation volumes as compared to lower-performance UAS. Navigational performance requirements may be more stringent in certain airspace during periods when traffic density/operational tempo is high. UASs assist in managing and minimizing overlap of operation volume segments when necessary, with the goal of maintaining separation through strategic de-confliction.

Intent information is made available by operators to UTM participants and other airspace users via the USS network to promote situational awareness and support cooperative interactions.

Operator data submitted during the planning stage does not need to be pre-verified with records for compliance at the time of submission (e.g., compliance with provisions for authorized areas of operation, pilot certifications, use of specified equipment/technologies).

Tactical de-confliction methods--the next layer of separation--are necessary when strategic de-confliction alone is not adequate to support the safety of operations (e.g., operations in areas with dense air traffic) or people/property on the ground.

Intent data serves several primary functions:

a) it informs other operators, manned and unmanned, of nearby operations to promote safety and shared awareness;
b) it enables de-confliction of operating volumes (i.e., strategic separation); and
c) it supports monitoring and tracking.

USSs can also utilize elements of operation intent (e.g., operation volume location and entry/exit times) to enable automatic distribution of spatially and temporally relevant advisories.

Constraints, weather, and the exchange of supplemental data assist operators in determining whether environmental conditions or other factors encountered are suitable for the flight at the planned location at the specific date and time (e.g., weather and wind forecasts, expected obstacles). This data assists operators with determining whether they can meet their responsibilities for safe flight or successfully complete their mission given the predicted conditions.

Strategic management services alone may be sufficient to ensure the safety of low-risk, low-complexity UAS operations. For example, a BVLOS operator conducting a flight in a rural/remote area (where UAS/manned activity at low altitudes is scarce) shares intent via the USS network, providing others the information necessary to maintain separation. Due to the low density of operations at these low altitudes, those who become aware of this operation via a USS, plan around that operation, or when objectives result in a potential overlap, spatial or temporal adjustments are made to ensure strategic separation.

Conversely, higher risk, higher complexity operations, such as over densely populated areas with manned aircraft activity, would likely require additional separation beyond strategic management.

2.8.1.2 Separation/conflict management

UTM services/capabilities support a range of UAS operations from rural areas with minimal manned aircraft activity and no people or property on the ground, to urban vicinities with considerable manned traffic, terrain, and surface obstructions. The corresponding requirements for separation provision--in terms of data exchange, tracking and conformance monitoring, equipage, and operator responsibilities--are commensurate with the risks to people and property. Aircraft/capability requirements are addressed in the performance authorization obtained by the operator prior to the operation.

UAS operators share separation responsibility with other UAS operators (BVLOS and VLOS) and other traffic. UAS operators desiring to operate in areas with high density or heterogeneous traffic may be required to equip with DAA technologies to meet these responsibilities.

Low-altitude manned aircraft operating in both uncontrolled and controlled airspace have access to, and are encouraged to, utilize UTM operation planning services to de-conflict their operations. Low-altitude manned aircraft pilots share some responsibility with BVLOS UAS operators for maintaining separation from each other (though they do not share responsibility for separation from VLOS UAS operators).

Because UASs can be difficult to identify when small in size, certain UASs may be required to comply with visibility requirements specifically designed to achieve visual identification.

During flight, the operator is responsible for complying with all rules and regulations associated with the operation, including avoiding other aircraft, complying with airspace restrictions, and avoiding terrain and obstacles. Commercial services, or third-party providers, can provide assistance to operators in meeting responsibilities. For operations in areas with minimal air traffic, advisories regarding known or uncooperative traffic (e.g., USS alerts on non-conforming aircraft, unmanned reports (UREPs)) may assist operators with maintaining separation.

The operator maintains a connection with the USS to support data exchange pertaining to aircraft tracking and monitoring, terrain and obstacle clearance data, weather, and/or notifications and advisories regarding airspace constraints, traffic, or other hazards that could affect the flight. In the case of a notification or advisory, the RPIC is responsible for safety and acts accordingly.

Manned and unmanned operators that are not required to share intent, but operate near or below 400 feet AGL, are encouraged to, at minimum, utilize services to identify operations that could impact their route of flight as part of their pre-flight responsibilities.

When UAS operate in areas where manned aircraft are more prevalent, operators are responsible for maintaining separation from all aircraft, including UTM participants and non-participants.

This may be done using USS in-flight de-confliction services designed to identify and alert operators of airborne traffic or through ground-based or airborne technological solutions (e.g., position sharing, vehicle-to-vehicle (V2V) equipment, ground-based surveillance data, airborne surveillance data, and DAA capabilities). USSs can further assist with in-flight separation responsibilities by providing services that assist operators with staying within the bounds of their volume (for example, aircraft tracking and monitoring services), disseminating information that facilitates avoidance of flight hazards (e.g., weather/wind information, terrain and obstacle data, UREPs) and coordinating with affected airspace users to facilitate effective airspace management responses in the event of a contingency.

All low-altitude aircraft sharing airspace do so with a clear understanding of responsibilities, rules, and procedures, regardless of whether they are participating in/receiving services from UTM or ATC. Right-of-way rules, established procedures, and safe operating rules enable harmonized interaction when aircraft encounter one another. Though low-altitude manned aircraft and VLOS unmanned aircraft are not required to share intent, they are encouraged to, at minimum, utilize UTM services that enable them to identify UAS operations that may affect their route of flight to increase the likelihood they identify UAS.

BVLOS UTM operators must be capable of tracking their vehicle and remaining within the bounds of their shared intent volumes. USSs can assist operators in meeting this requirement through aircraft tracking and conformance monitoring services whereby UAS transmit near-real time tracking data to the USS, so the USS can provide services that enable operators to monitor the UA's position and conformance to applicable system-based operation volume boundaries during BVLOS portions of flight. USSs may also use conformance monitoring to track operator conformance to the geographical boundaries specified in the performance authorization.

The responsible authority makes real-time airspace constraint data available to the USS through the UTM database to support airspace management services, but it does not receive intent or other data from the USS during nominal operations. During off-nominal operations, the USS notifies the authority of an event via the UTM database (per established USS policy) only if the situation meets the criteria for ATC authority attention that take into account the ability of ATC to take action in a timely manner.

If a PVR goes into effect, an automatic notification is sent to the USS network so that affected UTM participants can be identified and informed of the PVR. If impacted by a PVR, operators exercise discretion when deciding to take action, understanding they are responsible for the overall safety of the flight.

The operator /RPIC can:

a) proceed with the operation if confident it is safe to continue;
b) avoid or exit the airspace; or
c) land.

The authority also receives information pertaining to PVRs through the UTM database and publishes the data to a public portal for airspace user access, sends prescribed data to internal authority stakeholders, and archives records according to policy and procedures.

Operators receive data for weather, wind, terrain, obstacles, and other supplemental service-provided data pertinent to flight to assist them in meeting their responsibilities. Weather services provide the operator with information regarding winds, temperatures, pressure, precipitation, and visibility. Operators are encouraged to submit UREPs on observed weather phenomena and other aviation information (e.g., uncooperative traffic) so that this information can be shared across the USS network with other affected operators.

Operators are responsible for ensuring endurance and/or fuel levels are adequately maintained to remain compliant with rules or regulations, or to support safe operations. Endurance/fuel levels (actual or reserves) may be provided to the USS to enable monitoring and alerts for endurance level checks and/or enable estimates of endurance levels in the event of a contingency (e.g., estimation of fuel/endurance levels when aircraft is not expected to return to conformance).

2.8.1.3 Contingency management

In the event of a contingency, the operator is responsible for notifying affected airspace users. A USS can assist the operator in meeting this obligation by establishing and maintaining communications with affected UAS operators, authority entities (as required), and other airspace users as appropriate, via the USS network.

If an operator/RPIC determines that safety is compromised, the USS must be notified as soon as practical of the compromised condition, and relevant operational information provided to the USS.

If an active flight is: (a) experiencing a critical on-board equipment failure or degradation (e.g., lost link, engine failure); (b) not tracking, or vehicle position is unknown for some period of time, or (c) not conforming to flight intent and/or conformance is not expected to be restored, USS-assisted response protocols are in place to support the operator/RPIC in mitigating potential for damage or injury.

Contingency procedures or protocols, such as pre-programmed aircraft loss of command-and-control link responses, shared with the USS during the operation planning process, or updated in-flight, facilitate network-wide de-confliction of affected flights. USSs actively work to contain their support operations within operation volumes despite uncertain conditions (e.g., USSs update the operation intent of the compromised operation by modifying or creating operation volumes that reflect a new route; if RPIC has limited/no control of the UA, USSs generate new operation volumes based on the UA's projected path).

USS supporting compromised operations notify (and update) the USS network of potentially hazardous situations according to established UTM guidelines, notification standards, and messaging protocols. Impacted operators are notified/alerted and respond accordingly.

USSs also notify potentially impacted, connected non-UTM users of off-nominal or potentially hazardous situations, providing relevant data to assist with managing the situation effectively (e.g., position data, contact information). Non-UTM users could include public/private/commercial entities.

Aircraft capabilities also support notification to impacted airspace users during contingencies. If a UA is equipped with V2V communication capability (e.g., V2V broadcast capability), it broadcasts relevant information (e.g., position) to nearby aircraft with cooperative equipment, allowing for affected stakeholders (e.g., nearby operators in four-dimensional proximity to the compromised aircraft) to gain awareness of the situation and respond accordingly.

In the event an off-nominal event poses a threat to the ATM system (e.g., accidental or non-conforming "rogue" aircraft), UTM participants must be able to notify the authority with timely and actionable information.

ATC's role is to provide safety mitigations to aircraft receiving ATC services from a hazardous UAS operation that poses a credible safety risk. The UTM database provides a connection through which the USS network can send pertinent UTM operations data, including flight status, aircraft location (if known), and intent information until the hazard no longer poses a risk.

USSs or operators acting as their own USS send notification of errant flights, along with required data, to the UTM database for routing to the appropriate ATC facilities/entities.

During a contingency event, impacted operators act in accordance with rules and regulations to avoid the UA. Once a contingency event is over, the USS provides notice of recovery to affected entities, including the USS network, for distribution to airspace users. The USS network also notifies the authority via the UTM database, providing data required restoring nominal ATM operations and complying with archiving requirements, reporting requirements, and procedures. The UTM database routes the data according to established protocols. Operators, USSs, and other stakeholders are encouraged to track and share performance and operational issues with the UTM community to identify and improve aircraft, systems, procedures, and services associated with the operational environment.

2.8.1.4 Aircraft and obstacle avoidance

BVLOS and VLOS UA operators are responsible for separating from and remaining well clear of all other aircraft.

Because risks associated with different areas of operation can vary, the requirements for on-board DAA systems for UAS also vary. In airspace where risk to life in the air and on the ground is low, a relatively higher risk of UAS-to-UAS collision may be accepted, and thus the authority may not require DAA technologies.

Conversely, operations in more heterogeneous environments (e.g., mix of manned and unmanned aircraft, controlled airspace) could imply higher risk to manned aircraft due to the higher risk of collision, therefore, increased performance requirements may be imposed (e.g., on-board systems, real-time avoidance equipment, network-based solutions).

The geographical area, proposed DAA means, both air- and ground-based, and other criteria must be taken into account during the performance authorization process.

Data communications between UAS and manned aircraft could allow the exchange of position information from the manned aircraft to support the DAA at intervals appropriate to the operation according to the performance authorization and relevant regulatory requirements.

2.8.2 Security

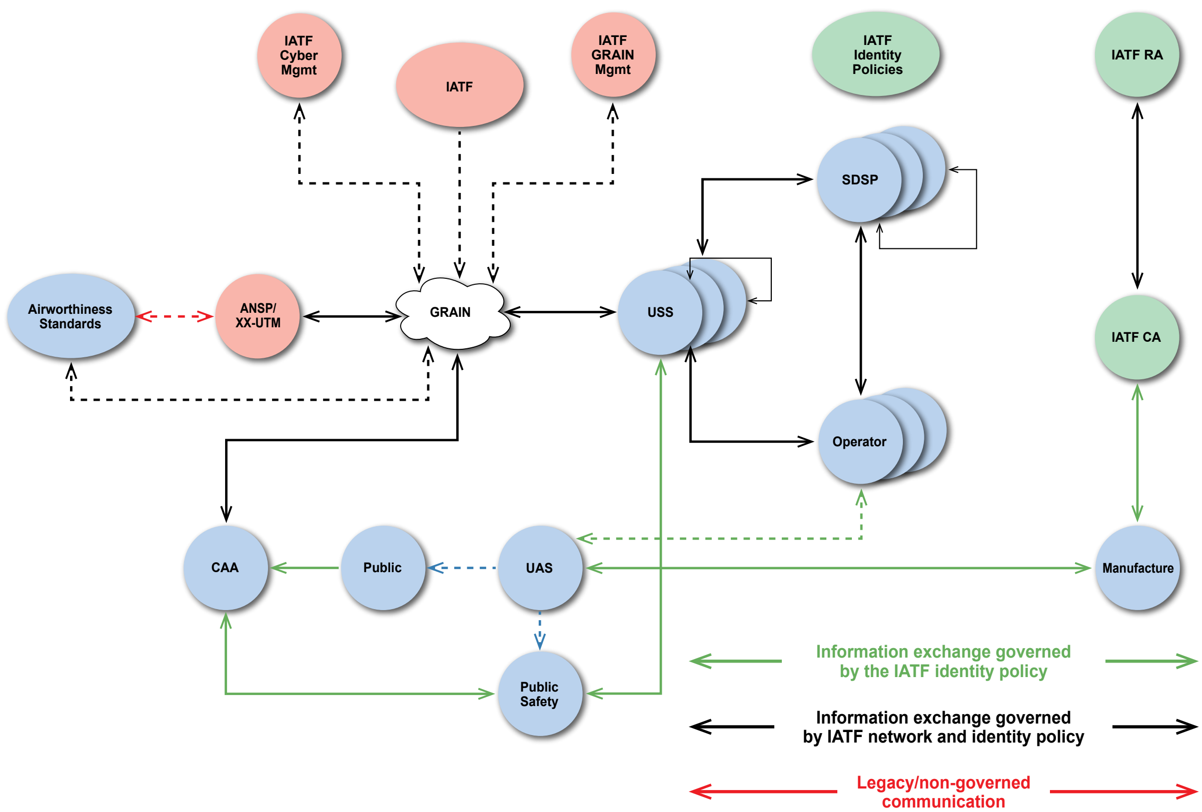
In addition to ensuring safety of operations, security is a priority of UTM, and is an expectation of the public. Security refers to the protection against threats that stem from intentional acts (e.g., terrorism) or unintentional acts (e.g., human error), affecting people and/or property in the air or on the ground. UTM contributes to security, while UTM systems and information are protected from external and internal security threats.

Security risk management goals include balancing the needs of the members of the UTM community that require access to the airspace with the need to protect stakeholder interests and assets, including the authority, public safety entities, airspace participants, and the general public. In the event of threats to aircraft or threats using aircraft, UTM provides relevant information and assistance to responsible authorities.

A key component of security is the integrity of the information being exchanged among actors. An example of an information integrity concept that could be applied to UTM is the effort currently being made by an International Civil Aviation Organization (ICAO) study group that is working to ensure integrity in a uniform way across all aspects of aviation. To this end, the aviation community, industry, and States are collaborating with ICAO to define a cybersecurity network and identity policies for the International Aviation Trust Framework (IATF). The purpose of the IATF is to create an international operational network and identity policy framework creating a Global Resilient Aviation Information Network (GRAIN). GRAIN is a network of networks interconnecting aviation stakeholders for all information exchanges.

Figure 5 depicts the cybersecurity and network policy relationship with reference to UTM stakeholders. Not all networks that operate under the IATF network policies are necessarily interconnected. Some network connections use the IATF network policies without being "connected" to GRAIN; other network connections use the identity policies without the network policies.

Figure 5. Identity and network cybersecurity policies applicable to UTM



All UTM stakeholders using IATF policies use an IATF-compliant registration authority (RA) to perform the vetting and proofing of the identities. In addition, all UTM stakeholders using the IATF policies use an IATF-compliant certificate authority (CA). The RA and the CA can be implemented by commercial entities.

Identities issued by different CAs under IATF policies are inter-operable and can trust each other. The trust relations between identities can be managed by stakeholders and by application domain.

UTM supports the required security and accountability functions. The UAS operating community meets security requirements that are imposed by the responsible authorities and designed to guard airspace systems and architectures against security threats.

UTM meets applicable security requirements through data collection, archival, and provision protocols within the IATF, ensuring operations data is available to support stakeholder needs.

2.8.2.1 The Authority

The authority establishes requirements and response protocols to guard airspace systems and the public against associated security threats. It uses UTM data (e.g., intent, RID messages) as a means of traceability to:

a) ensure operators are complying and conforming to regulatory standards;
b) identify and hold accountable those who are responsible during accident/incident investigations; and
c) inform other airspace users, if needed, of UAS activity in the vicinity of the airspace in which they are operating.

The authority can use near-real time data from UTM to address security needs with respect to operations conducted under ATM, including managing off-nominal and exigent circumstances. They use archived data as a means to analyze UTM operations and ensure airspace needs and security objectives are being met. The authority can also use UTM data to notify federal entities of security threats. It leverages the GRAIN and IATF policies to ensure the integrity and authenticity of the information received from all UTM stakeholders.

2.8.2.2 Public stakeholders

Municipal, state, and federal entities (e.g., state police, etc.) require access to UTM data to inform responses to local or federal complaints and safety/security incidents, and the conduct of investigations. Data access limitations are set by the authority for individual federal and public safety/security entities (e.g., public information, classified information). Depending on the nature of the safety or security situation, historical or near-real time information may be needed.

Data deemed publicly-accessible (e.g., RID messages) may be obtained by the general public through third-party services/applications and/or the government. UTM data that is not publicly accessible (e.g., operator contact information) is managed and provided based on the need to know, the credentials, and the level of access to information authorized for the request or using identities issued in accordance with IATF policies.

2.8.2.3 Data management and access

Operators must satisfy archiving and sharing requirements stipulated by the authority, to support safety and security. Stakeholders may need information on active UTM operations for the purposes of aircraft separation and identification of UAS affecting air/ground activities, among other things, such that operators respond to requests from authorized entities in near-real time. An example of such information is RID messages. Operators are required to archive certain data to support post-flight requests by authorized entities (e.g., the authority, public entities), as previously noted; examples of such data may include:

a) operation intent;
b) 4D position tracks;
c) reroute changes to intent; and
d) off-nominal event records (e.g., rogue UAS).

USSs providing services to operators satisfy applicable data management requirements set by the authority, such as responding to authorized requests for operator data that must be provided in near-real time.

USSs may also support authorized historical information requests of an operator when providing data archiving services. USSs use IATF-compliant network communications and identities to communicate.

The authority retains information obtained from operators and USSs relevant to regulatory and policy needs, such as operator registration information, airspace authorization records, and operational waivers.

In some cases, information may be requested by the authority to address a specific need, but not a situational need, but is not retained after the need has passed. A theoretical example is the authority requesting network-published RID messages in real time to assist authorized public safety personnel in identifying a UAS operator.

From the messages obtained from the USS network, the operator identity is determined. The set of RID messages, however, is not retained as the situational need was satisfied. The IATF-compliant operator and UA identities are used to ensure the integrity and authenticity of the RID messages in transit and archived.

The authority provides services to certain federal public entities in support of public safety and security needs; services may include provision of portals designed to facilitate automated information exchanges and queries to the USS network for authorized data. Local, state public entities may have dedicated portals external to the authority by which they can request and receive authorized information. USSs meet applicable security requirements and protocols when collecting and provisioning data to such entities.

Authorization and authentication between entities, using IATF-compliant identities, ensure data is provided to those permitted to obtain it. Authorized entities utilize USS network discovery services to identify individual USSs from which to request and receive data commensurate with access credentials.

Therefore, USSs must be:

a) discoverable to the requesting entity;
b) available and capable to comply with the request; and
c) a trusted source, as mitigation/enforcement actions may be taken as a result of the information provided.

2.8.2.4 Networked systems

UTM introduces new security challenges due to UAS operator reliance on interconnectivity and integration. USS connections to other USSs, operators, public entities, general public, and government assets increase overall network complexity and provide opportunities for cyber incidents and attacks--including threats to system security and unintended or malicious degradation of system performance.

To protect for these system vulnerabilities, cybersecurity architectures, requirements, and structures are developed and implemented to mitigate the potential for malicious activities and prevent unlawful access to third-party and authority systems.

Protection methods include authentication/access control, data security, information protection processes and procedures, maintenance and protection technology.

Access control will be implemented at various levels of communication (application, system and network) by all key stakeholders, and these access controls must comply with industry requirements and best practices.

Two communicating parties will perform mutual authentication based on the exchange of their inter-operable and globally trusted digital identities. The receiving party will verify the authenticity of the sending party to determine whether or not access is allowed, and at what level.

These cybersecurity architectures, requirements, and structures are defined by IATF network policies. USSs authenticate one another using IATF-compliant identities that ensure trust in their respective network capabilities when engaging in information exchanges, through compliance with the IATF network policies.

2.8.2.5 Aircraft systems

UAS design architectures, which vary by manufacturer and/or model, can be manipulated in ways that impact the safety and security of people on the ground and in the air. Command and control link infrastructure, cellular communications, RPS security, and global positioning system signal vulnerabilities, create potential for misuse (intentional and unintentional) and malicious interference (e.g., hacking, hostile takeovers) of UAS technologies.

The authority considers security risks and requirements proposed for an operation during the performance authorization process and evaluates the adequacy of proposed solutions (e.g., encrypted links). UAs are registered in accordance with authority rules and regulations prior to operating in the airspace. Although UTM assumes an operator's registration is valid, operator records are subject to auditing by the authority at the latter's discretion. Operators are required to certify, register, and obtain all appropriate authorizations and demonstrate compliance with performance and capacity requirements per regulatory policy prior to performing UTM operations.

Aircraft systems, including the aircraft and the RPS, are operated in accordance with applicable RID requirements, which may include transmission by the aircraft (via over-air broadcast) or network publication (via a USS qualified by the State to provide RID services). When required for the mission, the authority may require the RID to be cryptographically protected by an authentication message, ensuring the authentication, non-repudiation, and integrity using an IATF-compliant UAS identity.

2.8.3 Equity

UTM provides an operating environment that ensures airspace users have right of access to airspace needed to meet their specific operational requirements, and that the shared use of airspace by different users can be achieved safely. Within the cooperative rules and processes for the shared UTM initiative, there is no assumption of a priority scheme that would diminish equity of access for users that have received a performance authorization to operate in an authorized area of operation. In airspace with moderate demand, equitable access is achieved through operator collaboration, efficient airspace design, and authority rules. As demand for a volume of airspace increases, the performance requirements for the performance authorization may increase to ensure continued free access. If demand for a volume of airspace becomes too great to maintain safety of flight, or support all types of operations, the authority may be required to manage the demand for access.

2.8.3.1 Airspace access

When contentions arise at points in UTM airspace, and operators have already planned and shared their intent with the network, USSs assist with resolving or minimizing the issues via alteration of spatial or temporal elements of the operation intent and/or operator collaboration and negotiation. Operators adjust plans to de-conflict overlapping airspace according to personal preferences or with USS tools (e.g., operation planning service). USS collaborative flight planning capabilities (e.g., route planning functions, airspace configuration options) offer equitable solutions to competing users and/or enable operator negotiation using collaborative USS tools (e.g., real-time operator exchanges) to identify acceptable alternate plans that minimize volume overlap. Operators and USSs consider airspace volume efficiency during the intent sharing process to optimize UTM-wide airspace capacity. Operators ensure intent changes are accurate and up to date, pre-emptying unnecessary de-confliction of airspace (e.g., an operator updates intent when a planned operation is canceled). Business rules ensure that individual operators cannot optimize their own operations at the expense of sub-optimizing other operators and the UTM ecosystem as a whole.

2.8.3.2 Priority flights

Priority access demands for airspace may overlap with UTM operational volumes.

In the event of a public safety incident (e.g., emergency medical services or first responders must access airspace), authority-authorized entities (e.g., law enforcement, fire department) can request PVR to alert UTM participants of the public safety activity.

PVRs do not exclude UTM participants from the airspace; however, operators/RPICs are expected to exercise caution if they continue their operations, as they are responsible for the overall safety of their flight and are accountable for their actions.

3 Operational scenarios

3.1 Scenario overview

Operational scenarios will consist of commercial, scientific, security, defense, and recreational or sport operations, conducted in controlled, uncontrolled airspace, up to an upper limit of 400 ft AGL.

The scenarios, as proposed, emphasize aspects related to unmanned operation, as well as the interaction among the different participants in the system, with a view to promoting situational awareness among the different operators through the exchange of information such as: (a) flight intent; (b) aircraft position; (c) airspace constraints; and (d) traffic volumes.

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3.2 Summary of scenarios

Table 2. Summary of scenarios

Scenario	Title	Description
3.2.1	BVLOS/VLOS operations in controlled and uncontrolled airspace.	Conduct of BVLOS/VLOS operations in controlled and uncontrolled airspace, through the use of services such as: (a) flight planning; (b) airspace access authorization; (c) strategic de-conflictions; and (d) user messaging.
3.2.2	Establishment of a priority volume and its operational impact on the UTM environment.	Allows an accredited operator involved in operations related to the safeguarding of human lives to request the priority volume through a UAS service supplier (USS) or directly through the means made available by the responsible authority, The information on the priority volume created must be shared with the other users of the system via the USS network. Those responsible for previously authorized volumes whose operations are impacted by the priority volume must take the necessary actions for the safety of operations, maintaining separation from the priority operation.
3.2.3	Interaction between unmanned aircraft (BVLOS) and manned aircraft operating at very low level (VLL).	Enables unmanned aircraft to interact with manned aircraft, providing enhanced situational awareness through information sharing over the USS network, cooperative V2V communication, and detect and avoid technologies.
3.2.4	Interaction between UAS operators and those responsible for restricted airspace for use of the FUA concept in the UTM environment.	Enables interaction between UAS operators and those responsible for portions of restricted airspace. The outcome of the interactions between the stakeholders has as its main objective the implementation of the FUA concept in the UTM environment.

3.2.1 BVOS/VLOS operations in controlled and uncontrolled airspace

This scenario takes into account BVLOS/VLOS operations in controlled and uncontrolled airspace, operating at very low level (VLL).

UAS operators intending to operate BVLOS must mandatorily participate in the UTM system and share their intention to operate through the USS network, thereby promoting situational awareness of other system participants.

BVLOS operations must be requested through a UAS service supplier (USS) accredited by the responsible authority, the choice of which will be at the discretion of the operators. VLOS flights and/or flights for recreational purposes may be requested directly through the means made available by the authority, which will contain all the information necessary for the conduct of the operation, such as: (a) airspace constraints; (b) operational volumes in force; (c) flight restriction zones (FRZ); and (d) NOTAMs.

Manned aviation operators may interact with the system through a dedicated USS network or directly through the means made available by the responsible authority, by sharing their flight intent and/or accessing information on previously authorized volumes that may conflict with the intended operation.

Note: Intentions to operate in controlled airspace must be subject to ATC clearance through the interface between ATM and UTM systems provided by the responsible authority.

3.2.1.1 Operation planning – "Strategic phase"

The operator transmits via its USS its intent to fly BVLOS, using an interface made available by the supplier. However, VLOS operations may be requested directly through the means made available by the responsible authority.

Thereby, the operator provides initial planning information to its USS, such as an area of operation, points of interest, and times (arrival, departure, occupancy, etc.). Through the discovery services, the USS identifies other USSs responsible for possible operations in the area of interest that may conflict with the planned operation, and requests flight intent information from other operators belonging to its network. As a result of these interactions, operational volumes already authorized and potentially conflicting with the intended operation will be obtained, provided that the operator plans the operation, thus avoiding operational volumes already in place.

If the volume or volume segment has no conflict with any operational volume previously authorized, no planning action will be required. If, however, there is a conflict between volumes, strategic de-confliction action will be required, such as: (a) adjustments to the lateral/vertical boundaries of the desired volume; (b) temporal adjustments; or (c) a combination of both.

If there is conflict, as mentioned above, operators will be able to strategically de-conflict by coordinating with other operators through the USS.

Once planning has been completed by the operators, the USS will make available, as soon as it is accepted, the planned operational volume through the USS network.

3.2.1.2 Execution of the operation

Once ready to conduct the operation, the remote pilot will notify its respective USS, which will pass the status of the requested volume to "activated", disseminating this information to its networked operators and other UTM system users via the USS network.

Upon receipt of the "activated" status confirmation, the remote pilot will start the operation and the volume will remain in this condition until the remote pilot notifies the end of the activity or the period reported during the planning phase comes to an end.

The remote pilot must conduct the operation in accordance with the activated volume, ensuring separation between their aircraft and other airspace users. The USS may assist the remote pilot in maintaining the authorized volume by providing the compliance monitoring service. To this end, the remote pilot must share, throughout the operation, the aircraft position with their USS.

Operations that are not in compliance with the previously shared flight intent will have their status changed to "non-conforming" by the respective USS and this information shall be made available to all system users via the USS network. If the non-conforming status affects manned operations, the USS shall alert the responsible authority. In addition, the USS shall alert the supervisory authority, which shall use resources to determine the causes of the deviation and if appropriate, apply the corresponding penalty.

3.2.1.3 End of the Operation

Upon being informed by the remote pilot of the end of the activity, the USS will change the status of the operation to "closed", sharing this information with other airspace users through the USS network. Also, the operation may be considered as completed upon reaching the end of the total planned duration of the flight reported in the plan. Likewise, the USS will change the status of the operation to "closed", sharing this information with other airspace users through the USS network.

3.2.2 Establishing a priority volume and its operational impact on the UTM environment

This scenario addresses the request for a priority volume in order to respond to an emergency situation, as well as the operational impact on the UTM environment.

As a basic assumption, the scenario considers that the priority volume request will be made by a duly authorized user, taking into account the ability to approve the request, to establish the required volume, and to disseminate it to other users of the system through the USS network. The USS responsible for the priority volume will also notify the responsible authority through the available means.

The USS shares with the responsible authority the details of the emergency operation, as well as the constraints resulting from the establishment of the priority volume. Once in possession of the information, the responsible authority automatically shares it via other means with other airspace users. As a result of the information exchange, all USSs will be aware of the priority volume established, identifying the operations (VLOS and/or BVLOS) potentially affected within their respective networks.

Once notified of the activation of the priority volume, the impacted users and those already operating take the necessary de-confliction actions. Operations that have not yet started their activities make modifications based on the characteristics of the priority volume, such as flight intent and contingency responses that would violate the airspace associated to the priority volume.

Upon completion of the operation, the operator informs their USS, which, via the USS network, will disseminate the information to other system users, and operations that may have been interrupted can be restored to normal.

3.2.3 Interaction between (BVLOS) UAs and manned aircraft operating at VLL

This scenario examines the different possibilities through which unmanned aircraft participating in the UTM system can interact with manned aircraft. The scenario is based on the assumption that BVLOS operations are cooperative and provide real-time electronic identification and positioning information. Manned aircraft operate in accordance with existing rules, procedures and regulations.

3.2.3.1 Unmanned aircraft on-board detection capability

The unmanned aircraft will use on-board capabilities, such as visual sensors, to search the environment for other airspace users that may pose a risk to the operation.

When an object is detected close to the aircraft, the on-board collision avoidance systems relay the information to the remote pilot station, alerting the pilot to the potential conflict. Depending on the characteristics of the detected object, such as: (a) distance; (b) speed, (c) trajectory;

and (d) flight attitude, the remote pilot will take appropriate action to stay clear. Additionally, the on-board collision avoidance system can be pre-programmed to maneuver automatically when an object is detected, especially in situations of loss of command-and-control (C2) link.

3.2.3.2 Ground-based detection capability

In this scenario, a provider uses a ground-based structure to detect and identify objects via sensors (radar) or to receive signals transmitted by cooperative aircraft (ADS-B/SSR). While individual operators can set up this equipment, the structure needed to support the scalability of BVLOS operations requires that the service be provided by a third party, either a USS or a supplemental data service provider (SDSP).

The ground system, managed by the SDSP, detects and identifies an airborne aircraft and thus the USSs belonging to the provider's network have automatic access to this information. With the information from the SDSP, the USSs can identify, in their network, the intentions and/or operations that are already in progress and that will need to know about the detected aircraft. Once the intentions and/or operations in progress are identified, the USSs send messages/alerts to their operators and/or the affected remote pilots, who are responsible for taking appropriate action to maintain safe operation.

3.2.3.3 Aircraft on-board cooperative equipment

In this scenario, UAS operators use devices capable of interacting with the on-board equipment of manned aircraft, such as ADS-B. The equipment may transmit/receive data (ADS-B OUT/IN) or just receive information (ADS-B IN).

While in flight, on-board systems can obtain information about equipped aircraft in the vicinity of the volume used, relaying it to the remote pilot via the remote pilot station (RPS). With this information in hand, the remote pilot takes appropriate action to stay clear of the manned aircraft.

If the unmanned aircraft is actively interacting, capable of transmitting data (ADS-B OUT), the manned aircraft equipment (ADS-B IN) will capture this information and relay it to the pilot, allowing the pilot to stay clear of unmanned operations in accordance with current regulations.

3.2.3.4 Voluntary passive participation of manned aircraft in UTM

In this scenario, manned aircraft operators operating in the UTM environment voluntarily use the services provided by a USS or SDSP, gaining access, among other things, to data related to the planned operations, as well as to volumes that are active and in the area of interest. The information received will provide the pilot, during planning or in-flight, with a better situational awareness of the airspace involved, thus avoiding possible conflicts with other airspace users. As this is a passive participation, it is assumed that the pilot of the manned aircraft does not share any information with their USS.

Note: VLOS operations can participate in the UTM system passively and under the same conditions as manned aviation. The UAS operator could make use of the information available on the USS network but not share its own information with other users of the system.

3.2.3.5 Voluntary active participation of manned aircraft in UTM

Manned aircraft operators that do not have on-board equipment capable of interacting cooperatively with unmanned aircraft can opt to actively participate in UTM by providing their own operation intent to the USS network. Participation allows other UTM system users to be aware of the intent of the manned aircraft and understand the limitations of this aircraft in relation to coordination with other system users. The exchange of information during the planning phase is considered strategic and is similar to that proposed in scenario 1, paragraph 3.2.1.

3.2.4 Interaction between UAS operators and those responsible for restricted areas

This scenario will address the flexible use of airspace through interaction among stakeholders, allowing the use of a restricted area without impairing the safety of operations.

UAS operators that need to use restricted airspace, which is either permanently or temporarily activated, shall request de-confliction of the activities involved through their USS.

Restricted areas that are not permanently activated will be available in the planning phase (strategic phase) and may be part of the planned route, provided that their unavailability is not previously registered by the party responsible for the area.

Once the unavailability of the restricted area is registered, the restricted airspace will be activated and this information will be passed through the USS network, not allowing it to be made available to the UAS operator in the flight planning phase.

Those responsible for airspaces that are permanently activated or whose activation has been requested shall first enter information on the use of the area (actual activity), which will be used as a basis for de-confliction.

NOTE 1: The interaction between the person in charge of the temporary restricted area and the UTM system may be regulated by the competent authority in accordance with local specifications.

NOTE 2: The competent authority may establish the priority on the activation information, as well as the effective use of the restricted zones, based on local specificities. The USS, in possession of this information and of the characteristics of the intended operation of its UAS operator, may authorize the use of restricted airspace and make the authorization data available on the USS network.

4 UTM implementation

4.1 General

The ATM system, conceived more than seven decades ago, is an extremely conservative environment, very well regulated, with well-defined roles and responsibilities. The introduction of a new entrant into this ecosystem requires, on the part of the authorities, a careful risk assessment and subsequent proposal of mitigation actions. Therefore, to enable full implementation of the UTM system and the subsequent interoperability with the ATM environment, a step-by-step approach involving all stakeholders is required. In this regard, cooperation between authorities, industry and the UAS community is necessary, with a view to the spiral development of the UTM system.

The spiral concept states that each cycle will generate a prototype slightly different from the previous one, consisting of a more sophisticated version of the system. From the perspective of UTM system implementation, it can be said that each cycle will generate a scenario that is more complex than the predecessor is, either by increasing air traffic density and distribution, introducing new services or a combination of both. Initial tests and assessments are related to low-complexity operations, and more complex concepts and operational requirements are built upon the maturity attained throughout the process. Each new development cycle is designed to make the UTM system architecture evolve to accommodate a variety of UAS operations, ranging from remotely piloted aircraft to fully autonomous operations.

The spiral approach to UTM development provides several advantages. Firstly, the use of lower complexity environments, where current resource utilization meets safety requirements and simplifies the implementation process. Secondly, the development of the UTM system according to a complexity scale allows for scalable, flexible and adaptable services that are sized to the specific characteristics, rather than applying a one size fits all approach. The UTM project must be able to adapt to new technologies, both ground-based and airborne, and allow for more advanced forms of interaction, through inter-operable systems capable of digital information and data exchange. Ultimately, the UTM system must satisfy a diversified demand for operations, business models, applications and technologies, and support safe and efficient operations that coexist with manned aviation and without harming the ATM environment, ensuring fair and equitable access to airspace.

4.2 Transition to UTM implementation

Doc 9854 [7] – Global Air Traffic Management Operational Concept - provides guidance particularly applicable to the UTM through the stated objectives and the identification of system needs. Implementation is an evolving and continuous process.

Its guiding principles coincide with the considerations of this UTM CONOPS:

a) safety;
b) human beings;
c) technology;
d) information;
e) collaboration; and
f) continuity.

Stakeholder expectations are the creative and evolutionary driving force towards a dynamic product, which accepts change as it matures, based on safety, commercial goals, cost/benefit analyses, and sustainability, and in a participatory manner within its community. The achievement of goals will be based on a successful exchange of experiences gained in the Regions, ensuring the sharing of data and timely information to avoid negative or low-impact experiences with a view to sustained progress. Therefore, the final outcome depends on a defined regional programme, with clear goals and constant reviews leading to a system aligned with the needs and opportunities.

To supplement this concept, Doc 9882 [9] – Manual on Air Traffic Management System Requirements, together with Doc 9883 [10] - Manual on Global Performance of the Air Navigation System, contribute to the implementation and transition to the UTM system, as the principles and concepts described therein provide an approach fully harmonized with the architecture proposed in this CONOPS.

Concepts such as the performance-based approach (PBA) and its principles offer:

a) focus on desired or required results through the adoption of performance objectives and goals;
b) informed decision-making, motivated by desired or required results; and
c) decision-making based on facts and data.

These concepts lead to the methodical application of a series of well-defined steps such as: recording indicators (KPIs), using metrics to consistently support data, assessing progress in achieving objectives, setting performance goals, identifying gaps, selecting decisive factors to achieve target performance, identifying solutions to exploit opportunities and solve problems, and even implementing solutions. It is a cyclical and flexible process, allowing for numerous revisions towards the achievement of new or enhanced objectives.

Finally, Doc 9750 [11] - Global Air Navigation Plan, invites us to design UTM implementation using the Aviation System Block Upgrades (ASBU) methodology, based on which progress milestones, implementation dates and scope will be established, thus maintaining the dynamic and evolutionary principle of the system.

A new set of blocks for UTM must be considered in order to define the implementation phases. These phases must define specific milestones towards the achievement of goals. To this end, each State within the Region shall provide data and information in a participatory manner, including:

a) identified technical and operational needs;
b) demand/capacity measurements;
c) cost-effectiveness assessment;
d) quantification of UTM system efficiency;
e) possible impact of the UTM system on the environment;
f) levels of flexibility of the UTM environment;
g) levels of harmonization with globally consolidated practices;
h) levels of participation of the UTM community;
i) predictability levels;
j) safety indicators; and
k) security indicators.

The impact of the socio-economic and political reality of each State as part of the Region is unfailing. Identifying these gaps and agreeing on a selfless model for joint achievement of goals and objectives, through plans, support projects and mutual cooperation, emerge as a new challenge towards UTM harmonization at regional and global level. It is therefore essential to share the experience gained by those States that have experienced a high demand for unmanned aircraft operations, prompting them to quickly evolve to meet the new challenges. Such experience offers an assertive path towards a product of excellence and in constant evolution. Regional standardization of procedures, regulations, services, tools and technologies must be part of the agenda towards UTM implementation.

4.3 Latin American initiatives

To meet the enormous challenge of the unmanned aircraft industry, Latin American authorities have been working to safely promote the full integration of this technology into traditional aviation. Some States in the Region already have initiatives in place that are implemented in isolation and seek to meet domestic demand.

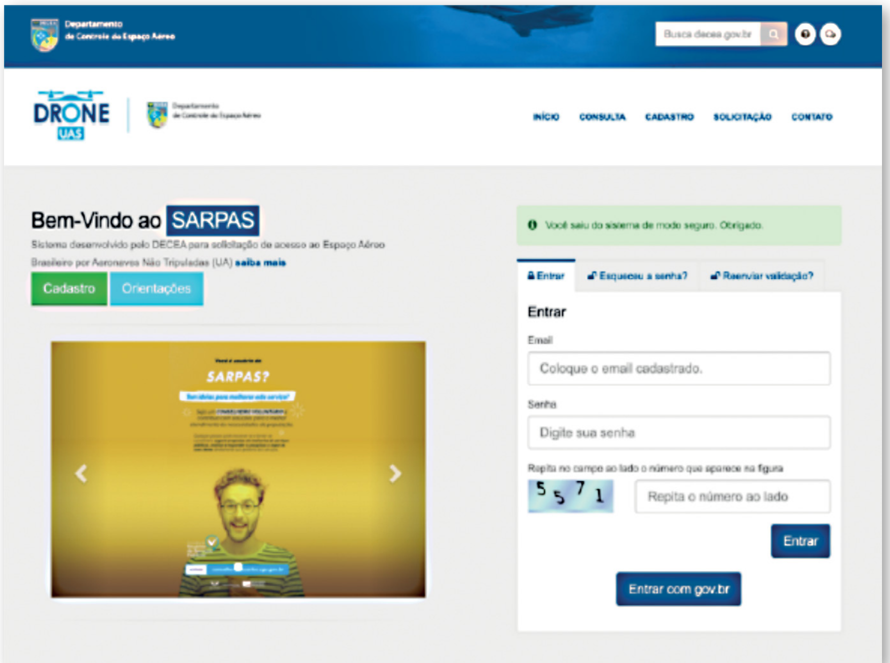
An example is Brazil, a State that has been promoting the unmanned aviation sector since 2009. In this regard, the Brazilian authorities, mainly the National Civil Aviation Agency (ANAC) and the Department of Airspace Control (DECEA) have issued special authorizations, based on Art. 8 of the Chicago Convention [12], with a view to promoting the sector while preserving the safety of other airspace users, people and property on the ground.

Initially, access to Brazilian airspace by unmanned aircraft entailed a manual process, which could take weeks. The first step in the process was to obtain an authorization to operate from ANAC. Once the documentation was received, the operator started the airspace access application process with DECEA, attaching the document issued by ANAC. Each application was analyzed by experts from both Brazilian authorities, which made the process very time-consuming because of the regulations.

However, with the increase in demand, it was felt that the manual procedure would not meet airspace access requests by unmanned aircraft in a scalable manner. Thus, DECEA, the main Brazilian ANSP, started the development of a system, whose main objective was to streamline the airspace access authorization process while preserving the safety of other users, people and property on the ground.

As a result, at the end of 2016, DECEA launched the SARPAS System [13], as part of its SIRIUS Strategic Programme. Considered the forerunner of the Brazilian UTM system (BR-UTM), SARPAS [13] is a web-based monolithic system that revolutionized the airspace access request process through services provided to the operator, such as: a) aircraft and pilot registration; b) flight planning interface; c) Brazilian airspace access rules; and d) prohibited flight zones.

Figure 6. SARPAS [13]



Furthermore, in 2017 ANAC issued Brazilian Civil Aviation Regulation number 94 (RBAC-E94) [14], establishing the general requirements for unmanned aircraft for civil use. With the advent of RBAC-E94 [14], the Agency launched the Unmanned Aircraft System (SISANT) [15], which allows the operator to register online unmanned aircraft with a maximum take-off weight of 25 kg. intended for VLOS operations up to 400 ft. AGL and with a maximum take-off weight not exceeding 25 kg.

After the Brazilian authorities implemented the systems, the airspace access process, which previously could take weeks, now takes 45 (forty-five) minutes to 18 (eighteen) days, depending on the characteristics of the operation, such as: a) type of flight - visual range (VLOS) or beyond visual range (BVLOS); b) intended flight altitude; and c) distance from aerodromes.

To this end, the SARPAS system [13] compares the information provided by the operator during flight planning with existing regulations and decides whether the authorization will be issued automatically or needs to be issued by an airspace expert, through ATM analysis. If the request needs to be assessed by an airspace management specialist and a NOTAM is not required, the clearance can be issued within 2 (two) days, and within 18 (eighteen) days if the notice needs to be issued.

Figure 7. SISANT [15]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CERTIDÃO DE CADASTRO DE AERONAVE NÃO TRIPULADA – USO NÃO RECREATIVO
UNMANNED AIRCRAFT INSCRIPTION CERTIFICATE – NON-RECREATIONAL

Esta certidão de cadastro, emitida de acordo com o RBAC-E nº 94, é válida até **04/11/2023**, salvo em caso de cancelamento, suspensão ou revogação pela Autoridade de Aviação Civil Brasileira.

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O descumprimento da regulamentação aplicável pode ensejar consequências administrativas, civis e/ou criminais para o infrator.

Nº do cadastro ***(Inscription Number)*****:**
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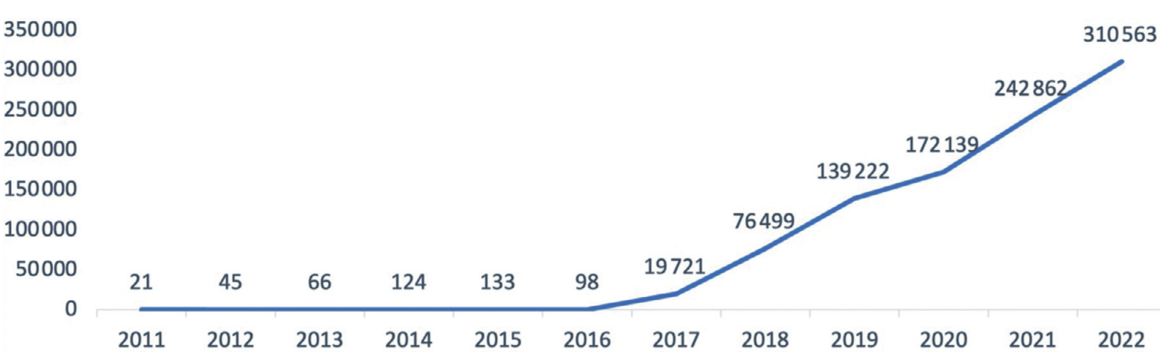
Uso *(Purpose)*: não recreativo *(non-recreational)*
Ramo de atividade *(Business)*: Aerofotografia
Fabricante *(Maker)*: DJI
Modelo *(Model)*: Phantom 4 Pro
Nº de série *(Serial Number)*: OAXDDCHOA20273
Peso máximo de decolagem *(MTOW)*: 1,40 kg
Foto *(Picture)*:

Informações adicionais *(additional information)*:

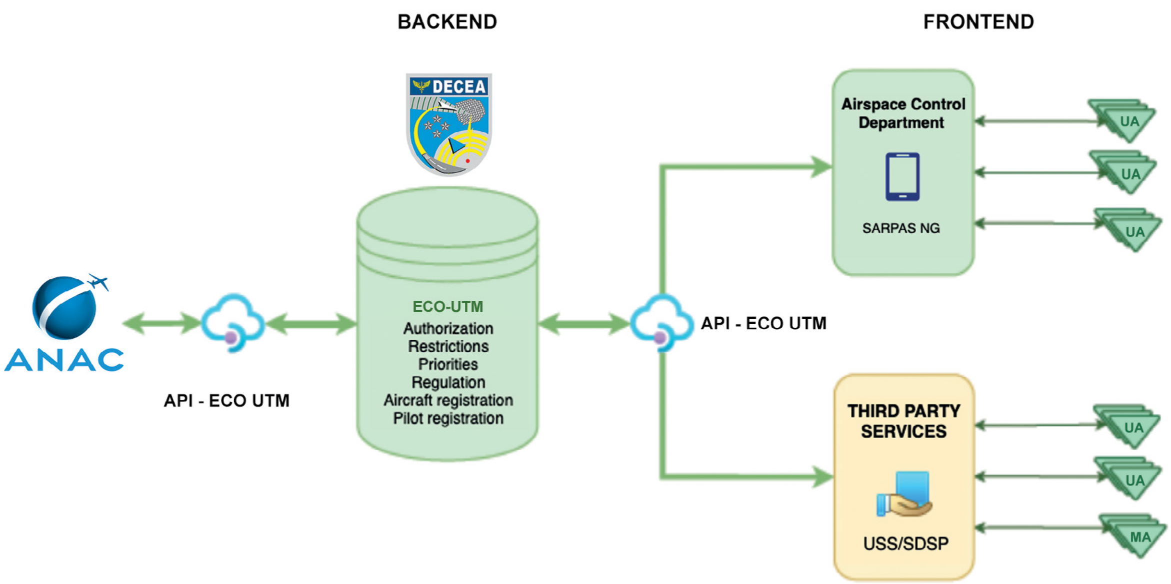
Immediately after the launch of SARPAS [13], the number of airspace access requests by unmanned aircraft increased significantly from just a few dozen to more than 19 000 (nineteen thousand) in 2017, as shown in Figure 8.

Figure 8. Airspace access requests



After almost 5 (five) years and more than 600 000 (six hundred thousand) airspace access requests, SARPAS was updated and renamed SARPAS NG [16]. As shown in Figure 9, the main modification consisted in the division of the initially monolithic system into two subsystems: the backend, called ECO-UTM [17] and the frontend, called SARPAS NG [16], which is considered the first USS of the Brazilian UTM system. Unlike the previous SARPAS [13], the SARPAS NG [16] went on to allow potential USSs to connect to the ECO-UTM [17] through the application-programming interface (API), under the rules established by DECEA.

Figure 9. New structure of the SARPAS system [16]



During 2021, DECEA made available the beta version of SARPAS NG [16], considered the first BR-UTM provider. The main objective of this strategy was to give the community the possibility to provide DECEA with feedback on the new functions available, including strategic de-confliction, which was not available in the previous version of the system.

For testing the new SARPAS NG functionalities [16], operators were invited to interact with the system, providing DECEA with feedback on the results obtained and obstacles encountered. To this end, DECEA provided a specific link through which stakeholders could give their opinions and/or suggestions on the new generation of the SARPAS system [13]. Based on the proposals submitted, events will be organized for integration with the industry and research will take place for consolidation of concepts, clarification of integration issues, and use testing.

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