RPAS ATM CONOPS

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Contact Person(s)	Tel/email	Division
Mike Lissone		ATM/STR
Dominique Colin		ATM/CMC/CNS

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TABLE OF CONTENTS

1. LIST OF ABBREVIATIONS

ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance – Broadcast
AFUA	Advanced Flexible Use of Airspace
AGL	Above Ground Level
ASBU	Aviation Systems Block Upgrades
ATC	Air Traffic Control
ATM	Air Traffic Management
BRLOS	Beyond Radio Line of Sight
BVLOS	Beyond Visual Line of Sight
C2	Command and Control Link
CFR	Code of Federal Regulations
CNS	Communications, Navigation, Surveillance
CONOPS	Concept of Operations
CPDLC	Controller Pilot Data Link Communication
D&A	Detect and Avoid
EASA	European Aviation Safety Agency
EC	European Commission
FCC	Flight Control Computer
FL	Flight Level
FUA	Flexible Use of Airspace
GA	General Aviation
GANP	Global Air Navigation Plan

2. INTRODUCTION

Unmanned Aircraft Systems (UAS), more specifically Remotely Piloted Aircraft Systems (RPAS), are increasingly becoming a part of our day to day lives. The vast range of possible uses is creating a new industry with a large economic potential. The technological developments are being developed at a much faster pace than that for manned aviation. The challenge lies in integrating the worlds of manned and unmanned aircraft in a safe and efficient way as both types of aircraft will use the same airspace.

As most regulations have been put in place as a reaction to market developments, harmonisation has not been achieved and this also affects the ATM perspective. This document, RPAS Concept of Operations (CONOPS), describes the operations of RPAS in European Airspace that are capable of meeting the requirements set per airspace classification including Very Low Level (VLL) operations. The CONOPS is presented from an air traffic management (ATM) perspective and is fully complemental to the EASA CONOPS.

2.1 Problem Statement

The rapid growth of civil and military RPAS has increased the demand for them to access non-segregated airspace. Due to the absence of a pilot on-board the aircraft, technical solutions have been developed to control the aircraft through data-link from a remote location. The absence of a pilot on-board also brings the challenge of matching the ability of the pilot to See and Avoid other traffic, managing dangerous situations, like potential collisions with other airspace users, clouds and severe weather conditions, obstacles and ground operations at airports.

The use of RPAS at lower altitudes is now a driving force for economic developments. Many of these smaller RPAS operate at altitudes below 500ft AGL. According to ICAO Annex 2 this is the lowest available VFR altitude, and thus creates a possible boundary between smaller RPAS and manned aircraft. However, nearly every State allows manned operations below this altitude and coexisting with small undetectable RPAS poses a safety challenge. For now, no restrictions have been put in place regarding the maximum number of small RPAS allowed to operate in a certain area.

Integration of RPAS into the airspace between 500ft and 60,000ft as either IFR or VFR is challenging due to the fact that RPAS will have to fit into the ATM environment and adapt accordingly. Many RPAS aspects such as latency and see and avoid have never been before addressed within this environment for manned aviation, simply because of the fact that a pilot is on-board the aircraft, capable of handling these issues in a safe and timely manner. Also, these human capabilities have never been translated into system performance as they were placed under "good airmanship" for see and avoid, or simply not addressed at all.

Unmanned aircraft will not only be encountered at low altitudes but also in the higher altitudes bands (i.e. above FL 600), normally used for specific military aircraft.[1]

Manned aviation is considered as safe due to the contributions of many factors (such as the ATC system, safety nets, cockpit automation etc.). These factors are now challenged by the introduction of a new airspace user, with high number of flights, different sizes and types. This challenge lies in the quantification of these safety attributes, due to the introduction of new aspects such as latency of communications[2], and contingency[3]. It also shows up potential areas where improvements are required in manned aviation (such as See and Avoid rule).

2.2 Scope

This RPAS ATM CONOPS aims at describing the operational ATM environment of manned and unmanned aircraft thereby ensuring a common understanding of the challenges, and aims to create a level playing field for all the ATM actors involved.

1 Private companies such as Facebook and Google are looking at the use of high-altitude unmanned aircraft to provide a 4G network in remote areas around the world. Such operations will take place above FL600 for weeks on end, but they will have to use the lower airspace volumes to reach or return from their operational environment. This can impact traffic flows. Facebook intends to use 6000 solar powered aircraft and Google, 12000 unmanned balloons to achieve this.

2 Delay experienced in the communication between the Remote Pilot and the air traffic controller and between the Remote pilot and the RPAS could be substantial.

3 In case of loss of communication between the pilot and the RPA, or other technical failure, the RPA shall have the capability to engage programmed contingency procedure.

The document describes the ATM Concept of operations for RPAS. It considers all types of unmanned operations and makes no distinction between civil or military operations as the integration challenges are identical. This CONOPS is aligned as closely as possible with the ICAO GANP, supports the EASA airworthiness CONOPS and addresses all phases of flight.

The CONOPS aims to adhere to the RPAS integration principles (section 1.3.1) and thereby ensure no negative impact on manned aviation while supporting the development of this new type of industry.

The CONOPS does not describe or address different detailed scenarios, but provides an operational ATM perspective based on areas of operation:

- **Very Low Level**
- **500ft up to FL600 (including airports)**
- **Very high level operations (above FL600)**

The transition from the present time-frame until full establishment of this ATM CONOPS is described in the Annexes. The transitional phase will be supported by the EC roadmap that describes the required R&D, regulations and standards development.

2.3 General Considerations

The CONOPS assumes the required technology, standards, procedures and regulations will be available in the 2018 to 2023 time-frame.

It is assumed that all RPAS operating as IFR/VFR traffic within airspace classes A-G will comply with the relevant airspace requirements in the same manner as manned aircraft. Operations in the airspace where transport aircraft normally operate could require additional performance requirements covering:

- Speed
- Latency
- Turn performance
- Climb/descent performance

Operations in a TMA are dependent on the complexity and type of traffic. If RPAS are not capable of flying the existing STAR and SID, additional arrival and departure procedures will have to be developed, placing a possible burden on existing operations. Operations outside the normal flows of arriving and departing traffic should therefore not provide additional workload.

Operations at airports pose an additional challenge, as ground operations also require RPAS to detect and act to visual signs. To date several small RPAS are used at airports in support of airlines, bird control, ATC and Meteo. Most of these RPAS should actually be categorised as in a different category than IFR/VFR as they are more used like tools; however this has not been addressed yet.

Dedicated RPAS airports or dedicated operating sites are to be taken into account in a similar way to how manned aircraft departing from/ arriving to uncontrolled aerodromes.

2.3.1 RPAS Integration Principles

The overall approach towards RPAS integration is that RPAS have to fit into the ATM system and not that the ATM system needs to be adapted to RPAS, to enable safe integration. The vision behind this concept is that RPAS, when meeting all the technical and regulatory requirements, are to be treated like any other airspace user. RPAS operations will certainly also have to be as close as possible to manned aviation for ATC purposes as it will not be possible for controllers to effectively handle many different types of RPAS with different contingency procedures.

To address the variety of RPAS operations, the CONOPS is primarily based on traffic classes, not RPAS categories or airspace classes. These 2 last typologies are used as secondary typologies. In this CONOPS, the traffic classes will therefore be defined along the document for each type of operations (Chapter 4) and is as follows:

→ **Type of operation: (VLOS, BVLOS. IFR/VFR)**
  → **Class of traffic:** Class 1, 2 etc
    → **Class of airspace:** Class A-Gc
      → **Category of RPAS** (from EASA CONOPS)

2.3.2 General Integration Requirements

There are 4 main integration requirements:

- The integration of RPAS shall not imply a significant impact on the current users of the airspace;
- RPAS shall comply with existing and future regulations and procedures;

- RPAS integration shall not compromise existing aviation safety levels nor increase risk: the way RPAS operations are conducted shall be equivalent to that of manned aircraft, as much as possible;
- RPAS must be transparent (alike) to ATC and other airspace users[4].

2.3.3 From Accommodation to full Integration: a two-step approach

Presently RPAS can benefit from the latest FUA/AFUA techniques, and operate as IFR either through dedicated corridors (as currently done over the Mediterranean), or through creating "a separation bubble" around the RPAS, which places fewer restrictions on airspace usage. This allows for early RPAS flights before the required technology, standards and regulations are in place. To fully integrate RPAS as any other airspace user, a two steps approach is proposed.

1. Accommodation from the present to 2023

Presently RPAS can benefit from the latest FUA/AFUA techniques, and operate as IFR either through dedicated corridors (as currently done over the Mediterranean), or through creating "a separation bubble" around the RPAS, which places fewer restrictions on airspace usage. This allows for early RPAS flights before the required technology, standards and regulations are in place. To fully integrate RPAS as any other airspace user, a two steps approach is proposed.

2. Integration from 2023 onwards

With the availability of regulations, standards and relevant supporting technology RPAS will, if necessary, be able to integrate as any other airspace user, when meeting the specific airspace requirements based on the principles explained above.

2.3.4 Airspace assessment

In manned aviation an airspace assessments (part of airspace design) is normally triggered by either a rise of traffic, environmental issues, capacity issues, and safety concerns or adapting the design to meet forecasted demands. Presently RPAS operations have not triggered an airspace assessment as most areas indicated as "no drone zones" are already known on aviation maps (airport, nuclear power stations etc.) However, there are similarities with RPAS operations below 500ft that can trigger this requirement for an airspace assessment like, but not exclusive:

- Increase of operations
- Introduction of BVLOS operations
- Safety concerns
- Environmental aspects

This assessment should develop a new type of airspace organisation able to cater for the new demand of operations and ensure safety levels are met. The airspace assessment can take into consideration, inter alia, the following aspects:

- Airspace classification
- Traffic complexity and density
- Zoning areas (hospitals, heliports)
- Geographic situation (mountains urban areas)
- Traffic flows
- Noise
- Privacy
- Security
- Traffic forecast

The assessments can also lead to defining specific RPAS airspace structures:

- No drone zones
- Limited drone zones
- Segregated routes

4 Specifically for contingency procedures (due to loss of data link) ATC will not be able to handle many different recovery procedures.

3. RPAS SYSTEM DESCRIPTION

The RPAS consists of three main components: the Remotely Piloted Aircraft (RPA), the Remote Pilot Station (RPS) and the Command and Control Link (C2).

3.1 Remotely Piloted Aircraft (RPA)

The RPA is the actual airborne vehicle, and one of the essential parts of the whole RPAS. It has a similar physical structure as an airplane, except for the cockpit as there is no need to fit an actual person in there. The RPA can have different shapes and sizes, ranging from a small craft that fits in your hand to a normal passenger jet such as the Boeing 737 or Airbus 320. They also have different flight endurance, performances and capabilities.

Associated components

RPA are piloted from a Remote Pilot Station (RPS) via a command and control (C2) link. Together with other components such as launch and recovery equipment, if used, the RPA, RPS and C2 link comprise the RPAS.

3.2 Remote Pilot Station (RPS)

The RPS is the component of the RPAS which is located outside of the aircraft and is used by a remote pilot to monitor and fly the RPA. The RPS can range from a hand-held device up to a multi-consoles station. It may be located inside or outside of a building, and be stationary or mobile (installed in a vehicle/ship/aircraft).

3.3 C2 Data Link

The C2 link connects the RPS and the RPA for the purpose of managing the flight. It may operate in direct radio line-of-sight (RLOS) or beyond radio line-of-sight (BRLOS).

- RLOS: refers to the situation in which the transmitter(s) and receiver(s) are within mutual radio link coverage (using direct radio frequency line); and
- BRLOS: refers to any configuration when the transmitters and receivers are not in RLOS, and in order to communicate other relays, such as satellite systems and terrestrial network, are used.

The distinction between RLOS and BRLOS mainly concerns variable delay in communications.

3.4 Other Components

The following components may be part of the RPAS:

- ATC communications and surveillance equipment (e.g. voice radio communication, controller/pilot data link communications (CPDLC);
- automatic dependent surveillance — broadcast (ADS-B), secondary surveillance radar (SSR) transponder);
- navigation equipment;
- launch and recovery equipment — equipment for RPA take-off and landing (e.g. catapult, winch, rocket, net, parachute, airbag);
- flight control computer (FCC), flight management system (FMS) and autopilot;
- system health monitoring equipment;
- flight termination system — allowing the intentional ending of the flight in a controlled manner in case of an emergency.

4. TYPES OF RPAS OPERATIONS

It is envisaged that RPAS will operate in a mixed environment adhering to the requirements of the specified airspace it is operating in. RPAS will be able to operate as follows:

- Very High Level operations (VHL sub orbital IFR operations above FL600).
- IFR (instrument flight rules) or VFR (visual flight rules): following the same rules that apply to manned aircraft. These can be conducted in RLOS or B-RLOS conditions.
- Very low level (VLL) operations.

4.1 Very High Level Operations (VHL)

Suborbital unmanned flights operating at altitudes above FL 600 are expected to grow fast in numbers[5]. Apart from military HALE RPAS, several other vehicles (i.e. space rockets, Virgin Galactic etc) operate through or in this block of airspace. At this moment, no management of this traffic is foreseen in most parts of the world. Particular attention should be given to the entry and exit of this high altitude volume as they need to interact with the airspaces below.

4.2 IFR/VFR Operations

For RPAS to fly either IFR or VFR requires that they meet the airspace requirements as set for manned aviation. These operations include: airports, TMA and Enroute. For IFR capable RPAS additional requirements can be set for flying in the volumes of airspace where normal transport aircraft operate. As such it is envisaged to have minimum performance standards for elements such as speed, climb/descent speed, turn performance and latency.

4.3 Very Low Level Operations (VLL)

Operations performed at altitudes below 500ft are not new to manned aviation as many operators - police, armed forces, balloons, gliders, trainings, fire-fighting, ultra-light aircraft etc. - are allowed to operate in this environment. The rule allows VFR traffic to operate, under specific conditions prescribed by the national competent authorities, conditions that can differ from State to State. RPAS operating in this volume of airspace do not however confirm either IFR or VFR as set in ICAO Annex 2.

- **VLOS** (Visual line of sight)
  RPAS operations within 500 meters range and max 500 ft altitude from pilot. One of the main responsibilities of the pilot is the safe execution of the flight through visual means. The distance can be increased by the use of one or more observers, sometimes referred to as Extended-VLOS (E-VLOS)

- **B-VLOS** (Beyond Visual Line of Sight)
  RPAS operations beyond 500 meters range but below 500ft. B-VLOS does not require the operator to ensure the safety of the flight visually, and technical solutions such as D&A and C2 data link are required. RPAS do not adhere to VFR or IFR requirements; however it is foreseen that these flights could be conducted in IMC or VMC conditions. B-VLOS operations are already being conducted in several States. Some examples are:

  - Powerline control
  - Maritime surveillance
  - Pipeline control
  - Agriculture

4.4 Transition of manned operations below 500 ft

RPAS are to remain clear of manned traffic operations below 500 ft. In VLOS this is done through visual acquisition and can be supported through means of information provision to RPAS operators that manned traffic is expected in their area of operations[6].

For BVLOS operations this will be catered for through Detect & Avoid systems. These systems will have to cater for cooperative and non-cooperative traffic ensuring interoperability with existing safety nets. Manned Traffic entering or starting in this airspace should be aware of RPAS flights in their vicinity in order to safely execute their VFR flights and local procedures. This will place an extra burden on the visibility requirements for RPAS and or the ATM-like management system. It is required that RPAS operating BVLOS use barometric altitude equipage like manned aircraft to avoid the use of different altimetry reference systems in the same airspace.

5 As already described in 2.1 Problem Statement, private companies such as GOOGLE and FACEBOOK foresee the extensive use of unmanned aircraft and balloons to ensure a global 4G/5G network supporting their internet business model.

6 Like police or medical flights.

5 CONOPS

5.1 Very Low Level RPAS Operations (below 500 ft)

This part of the CONOPS addresses the operations of RPAS at Very Low Level (VLL) in the airspace band between GND and 500ft. It assumes that the rules of the air will not be adapted for low level RPAS operations at this altitude, thereby maintaining the 500ft boundary as implemented around the world already.

5.1.1 VLL Management System

In order to accommodate the expected growth of traffic in this airspace and ensure a sufficient level of safety, it is anticipated the necessity for a supporting ATM-like management system. This VLL Traffic Management system will provide a series of localisation and information services, aiming to the provision of information to the RPAS pilots and manned traffic. The VLL ATM system will not provide an active control service for RPAS in a normal ATC fashion, due to the large number of RPAS involved. Such a system could be based on existing technologies, such as the mobile phone network. Specific RPAS reporting systems, providing authorisation and information capability, are already in use in several states.

The RPAS managements system will have to cater to the following aspects:

- RPAS Flight planning
- RPAS Flight authorisation
- Real time RPAS tracking capability
- Provision of actual weather and aeronautical information

As previously mentioned, it is envisaged that the VLL management system will not support the active controlling of RPAS at lower altitudes. The large number of RPAS will not make this possible, notwithstanding any liability aspects. The system will be supporting operations and will be able to provide sufficient data to safely execute an RPAS flight, based on the information available to it. Data required could include, but are not limited to:

- Planned flight plans
- Active RPAS flight plans
- Airspace data
- Notams
- Weather
- Infrastructure availability
- Geo-fencing
- Manned operations below 500ft

The following assumptions have been made:

- A C2 service is provided
- The State has executed an airspace and assessment Geofencing is in place
- RPAS have surveillance capability similar in terms of performance and compatible to manned aircraft surveillance capability (but not using 1090mhz[7])
- Specific RPAS ATM-like management system is in place.

5.2 VLL Traffic Classes Operations

As RPAS are very difficult to categorise due to the large variety of shapes, sizes and performance, different traffic classes have been developed to support the management of large numbers of RPAS operations. A "Class of RPAS traffic" is a set of flying rules, operational procedures and system capabilities applicable to the RPAS and to the operator when operating the RPAS in a portion of the airspace. The traffic classes are defined as follows:

- **Class I:** Reserved for RPAS (EASA[8] cat A VLOS only).
  The buy and fly category that will be able to fly in low risk environments and remains clear of no-drone zones like airports.

- **Class II:** Free flight (VLOS and BVLOS).
  Can be the specific or certified category (EASA CONOPS).

- **Class III:** Free flight or structured commercial route for medium/long haul traffic (BVLOS).
  Could be both specific and certified capable of operating for longer distances.

- **Class IV:** special operations (this category of RPAS traffic conducts very specific types of operation that will be assessed on a case by case basis. (VLOS and BVLOS).
  This type could be either specific or certified and can operate in urban areas, airports and other specific locations.

7 The use of 1090 Mhz has not been intended to cater for RPAS and can if overloaded negatively impact manned aviation and ATC system tracking capability.

8 EASARPAS Airworthiness CONOPS

5.3 VLL Operations

5.3.1 Class I Traffic

Class I traffic is primarily reserved for RPAS Category A (buy and fly). In areas of low traffic density this class can operate from ground up to 500ft and is a subject to the following requirements:

- Mandatory declaration of operation
- RPAS must be capable to self-separate in 3D
- VLOS operations only
- Geofencing capability which ensures that this category remains separated from no-drone zones.

5.3.2 Class II Traffic

Class II traffic operates in free flight due to the nature of their operations like: Surveys, filming, search and rescue and other operations that have no fixed route structure. Class II can operate from ground up to 500ft and is a subject to the following requirements.

- Mandatory authorisation for operation
- Surveillance capability (4G chip or other means)
- VLOS & BVLOS operations
- Free flight Capability
- RPAS must be capable to self-separate in 3D
- BVLOS will have barometric measurement equipage

5.3.3 Class III Traffic

Class III traffic only operates in BVLOS and is mainly used for transport purposes. It can operate as free flight or within a route structure pending on the requirements set by the airspace assessment.

- Mandatory authorisation for operation;
- Has surveillance capability;
- BVLOS operations only
- Free flight or route structure
- Shall have barometric measurement equipage
- Can operate from ground up to 500 ft

5.3.4 Class IV Traffic

Class IV traffic can operate within the layer between ground and 500 ft.. This category is designed for highly specialised operations and as such not many of these types RPAS are expected. These can be civil, state or military operations and as such:

- Require special authorisation
- Should be addressed on case by case basis
- VLOS & BVLOS
- Could require surveillance capability

5.4 Operational Conceptual Options

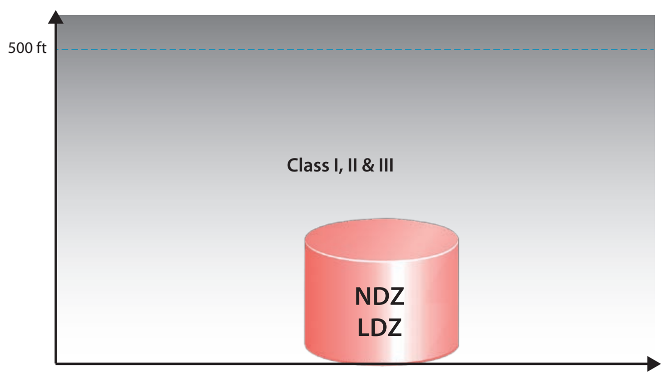
There are three options in how the RPAS operations can be organised. The three options also address a phased approach. This is largely dependent on the specificities that were identified in the Airspace assessment, like:

- Geographical situation
- Environmental aspects
- Airspace complexity
- Traffic flows
- Security
- RPAS traffic density
- Manned operations below 500ft

5.4.1 Present Situation

The first option is operations as they are conducted presently. This can be maintained due to the relatively low number of RPAS operations. It is not required to conduct an airspace assessment at this time as most no-drone zones (NDZ) or limited drone zones (LDZ) are already identified like:

- Airports
- Nuclear power stations
- Hospitals, etc



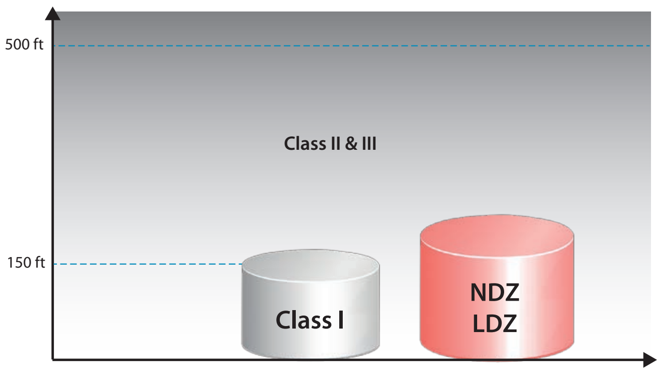
Present situation

5.4.2 Free Flight

The second option is where the RPAS traffic has increased to a level requiring a more articulate structure to be in place. The traffic complexity and density can still allow free flight for both Class II&III, but will require that Class I traffic is restricted to 150ft in geographical areas where the traffic volumes are high.

Detect and avoid could be based on a bubble concept around the RPAS, however the requirements of this system will be high due to the possible high conflict encounter models that are linked to free flight.

Note: the airspace assessment that is required will also identify the general RPAS traffic flows in support of defining the geographical areas where Class I will be restricted.

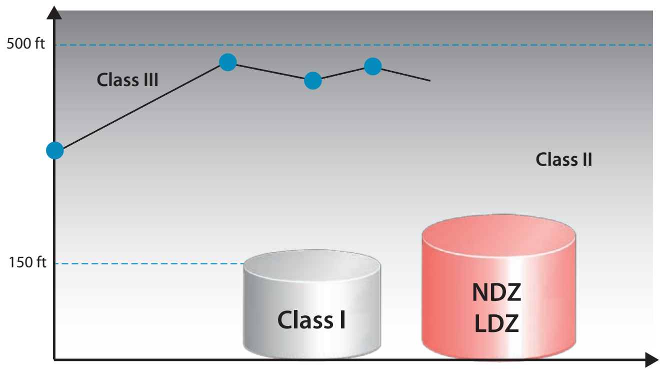


Free Flight

5.4.3 Route Structure

The third option is an alternative to the second option catering for higher traffic demands. Specifically in areas of repetitive flights to and from a certain area routes are naturally formed to cater for safety, security, noise and privacy issues. The airspace assessment will identify areas of minimal impact and as such the route structure could follow rivers, rail roads or other geographical areas where there is minimal impact on people on the ground.

Due to the route structure, the requirements for the DAA system might be lower, because of to the reduction of conflict encounter models, compared to free flight which should be less complicated.



Structured Routes

5.5 IFR/VFR Operations (between 500 ft – 600 FL)

Vertical area of impact 500ft AGL up toFL600, including airports.

5.5.1 Traffic Classes

Based on the area and type of operations 3 traffic classes which can operate in all airspace classes, are foreseen.

5.5.2 Class V Traffic

Class V is IFR/VFR operations outside the Network not flying SIDs and STARs. In this environment, RPAS not meeting Network performance requirements will be able to operate without negatively impacting manned aviation. Operations at airports will be accommodated through segregation of launch and recovery.

Ground operations can also be accommodated through either towing or wing walking.

Operations from uncontrolled airports or dedicated launch and recovery sites are to be conducted initially under VLOS/VFR until establishing radio contact with ATC.

No additional performance requirements will be set in this environment compared to manned aviation.

General requirements

RPAS operating in the environment will file a flight plan including information such as:

- Type of RPAS
- Planned operations (navigation, route, flight level etc)
- Contingency procedure
- Contact phone number
- RPAS will meet CNS airspace requirements
- RPAS will be able to establish two-way communication with ATC if required
- RPAS will remain clear of manned aircraft
- RPAS operator must be able to contact ATC (if required) in regard to special conditions such as:
  - data link loss
  - emergency
  - controlled termination of flight
- RPAS D&A capability will be compatible and cooperative? with existing ACAS systems

5.5.3 Class VI Traffic

Class VI is IFR operations, including Network, TMA and Airport operations with RPAS capable of flying SIDs and STARs as designed for manned operations. These are either manned transport aircraft enabled to fly unmanned with similar capabilities or new types able to meet the set performance requirements for the Network, TMA and airports.

General requirements

RPAS operating in this environment will file a flight plan including:

- Type of RPAS
- Contingency procedure
- Planned operation (navigation, route, level etc)
- Contact phone number
- RPAS will meet CNS airspace requirements
- RPAS will be able to establish two way communication with ATC
- RPAS operator must be able to contact ATC (if required) in regard to special conditions such as:
  - data link loss
  - emergency
  - controlled termination of flight
- RPAS D&A capability will be compatible and cooperative? with existing ACAS systems

5.5.4 Operations of Small RPAS above 500ft

In principle operations above 500ft by small RPAS are not allowed unless they meet the IFR/VFR airspace requirements and have a solution to be visible to manned traffic. Other aspect like wake turbulence and separation standards would also have to be addressed. However States can still on a case by case basis accommodate RPAS above 500ft if the risk assessment of the intended operation is acceptably low.

5.6 VHL operations (above FL 600)

VHL operations are expected to be performed from FL600 and above.

Based on the area and type of operations the traffic class which can operate in VHL airspace classes is foreseen:

5.6.1 Class VII Traffic

Class VII consists solely of IFR operations above FL600 and transiting non-segregated airspace.

These types of RPAS are solely designed for operations at very high altitudes. The launch and recovery of fixed-wing RPAS can be from dedicated airports and outside congested airspace, unled Class VI requirements are met. This airspace will be shared with many different RPAS. Although their operations will not directly impact the lower airspace, however they will have to transit through either segregated or non-segregated airspace to enter or exit the airspace above FL 600. For such cases, temporary segregated airspace should be considered. Transition performance in segregated or non-segregated airspace below FL600 will be very limited since they will be focusing on long missions (up to several months).

The airspace in which these types of operation take place is mostly seen as uncontrolled. This requires no management of this traffic; however due to the expected numbers - estimated to be around 18000 just for Google and Facebook - it will become necessary to manage this type of operation since the performance envelopes differ a lot. Speeds can vary from average wind speed at those altitudes (for Google balloons) up to above-mach.

Launch and recovery of unmanned balloons or aircraft, together with emergency situations, will also require a set of procedures and pre-arranged coordination capabilities to ensure the safety of traffic below this altitude.

5.6.2 General Requirements

- RPAS must file a flight plan
- RPAS will meet CNS airspace requirements
- RPAS must inform the responsible ATC unit in case of emergency re-entry into controlled airspace
- RPAS must inform ATC about the type of contingency procedures to be used (balloon deflating or orbiting descent)
- A regional centralised system should have an overview of the ongoing operations
- Departure and arrival procedures should be developed.

The flight plan should include:

- Type of RPAS
- Contingency procedure
- Planned operation (navigation, route, level etc)
- Contact phone number

APPENDIX I TRANSITION OF RPAS INTEGRATION BASED ON GANP

1.1 ASBU 1 Timeframe (1 Jan 2014 - 31 Dec 2018)

In this time frame VLOS RPAS operations will have become a daily occurrence. These types of RPAS operations could also be conducted over and in urban and highly populated areas by civil, military and governmental non-military operators with higher safety requirements.

It is expected that further progress will be made to integrate RPAS into class A-C airspace; however not in the standard arrival and departure operations in major Terminal Airspace, airports and busy en-route environments.

RPAS will also operate at altitudes above FL600 to provide internet in remote areas and for other purposes. In this time frame it is assumed that the essential SARPS, MASPS AND MOPS will not be finalised and will not yet allow full integration of RPAS into ATM.

B-VLOS operations will be further developed; this will enable initial operations by civil, military and governmental non-military users in very sparsely populated areas or over the high seas.

A low-level RPAS ATM support system will be developed in this time frame.

IFR operations and/or demonstrations will be allowed under certain conditions. No VFR operations are expected in this time frame.

1.1.1 Impact of RPAS operations on performance requirements

The foreseen performance requirements for ASBU-1 will not be affected by the envisaged operational scenarios. It is possible that D&A solution could contribute to enhancing safety for manned aviation.

The following operating environments/phases of flight will be included:

- Aerodrome (taxi, take-off and landing); segregated from other traffic;
- Terminal (arrival and departure); segregated from the existing STARs and SIDs;
- En-route, taking into consideration that the trajectories for aerial work may be significantly different from the routes used by commercial air transport flights from point A to B.

The following operational scenarios are envisaged in the timeframe of ASBU-1.

1.1.2 VLOS & E-VLOS scenario

Visual line of sight RPAS operations are already conducted in all airspace classes and initial operations are taking place from airports and urban areas.

Restrictions could still be applied over or in urban areas and environments with a permanent or temporary high population density or large crowds.

1.1.3 IFR operations

In this time frame it is assumed that there will be more IFR RPAS operations, though still under certain restricted conditions using a detect and avoid solution to enhance safety. It is expected that the first D&A system will be validated. The types of RPAS operation in this time frame will include civil operations.

This type of RPAS operation will encompass all phases of flight, keeping in mind that the arrival, departure and airport operations will possibly be integrated with manned aviation at this time on a small scale.

IFR RPAS operations will mostly be of a loitering nature with some initial point-to-point flights for cargo or dangerous goods. It is not expected that RPAS will be able to integrate busy and complex environments.

1.1.4 VFR operations

Initial VFR RPAS operations will start in this time frame, mostly with military RPAS. Due to the absence of standards and suitable, acceptable/approved D&A solutions, it is not foreseen that VFR operations will be conducted on a regular basis. There are likely to be demonstration and validation flights, however.

1.1.5 B-VLOS operations

Further investigation into the B-VLOS type of operation will be developed and it is expected that more trials will be conducted. Due to the similarities with VFR operations and the additional requirements for terrain & obstacle avoidance, it is not expected to have many operations in this time frame:

→ Demonstration flights
→ Scientific research flights
→ Inspection flights
→ Search and rescue

1.2 ASBU 2 Timeframe (1 Jan 2019 - 31 Dec 2023)

In this timeframe all the required documentation will be available to allow certified and operationally approved RPAS to operate IFR in all airspace classes based on the traffic classes as described in the CONOPS. It is expected that based on the performance requirements some areas will still be restricted to RPAS, such as major airports and Terminal Airspace and some bottlenecks in Europe for all airspace users. It is, for example, not foreseen to have IFR RPAS operations at Heathrow or in the London TMA.

Initial VFR RPAS operations will start, pending the maturity of the D&A system and expected simplification of airspace classification for all airspace users.

Low level operations will be fully supported by the RPAS ATM system.

VLOS and E-VLOS RPAS operations will be fully integrated into day-to-day life by all airspace users.

B-VLOS operations will be further expanded and possibly enter populated areas. These types of operation will also cater for cargo flights.

RPAS will be SESAR-compatible and will play a supporting role for SWIM.

1.2.1 Impact of RPAS operations on performance requirements

The foreseen performance requirements for ASBU-2 are to be met by RPAS operations and must not negatively impact operations. It is possible that a D&A solution could contribute to enhancing safety for manned aviation; for example RPAS could contribute to enhancing the Met information nowcast through SWIM by downloading crucial flight data.

RPAS will have to be able to exchange 3D/4D trajectories where required.

The following operating environments/phases of flight are included:

- Aerodrome (taxi, take-off and landing);
- Terminal (arrival and departure);
- En-route, taking into consideration that the trajectories for aerial work may be significantly different from the routes used by commercial air transport flights from point A to B;
- Oceanic.

The following operational scenarios are envisaged in the timeframe of ASBU-2.

1.2.2 VLOS & E-VLOS scenario

Visual line of sight operations will be fully integrated in day to day operations.

1.2.3 IFR operations

In this timeframe it is expected to have IFR partially integrated, by using approved D&A solutions. This type of operation will include civil operations in all phases of flight. It is not expected that RPAS will be integrated into all environments due to operational and economic restrictions.

IFR RPAS operations will be point-to-point and of a loitering nature, in mixed civil/military environments. Airport operations will start initial RPAS integration with manned aviation.

1.2.4 VFR operations

VFR RPAS operations could start in this time frame, mostly in areas remote from other airspace users. As D&A will be in place, it is expected that VFR operations will expand.

1.2.5 B-VLOS operations

B-VLOS RPAS will initially start operating in remote areas. These types of operation can be conducted from an airport or remote launching station, starting the operation in VLOS and later continuing as B-VLOS. It is not foreseen to have B-VLOS operations in urban areas yet.

APPENDIX II INTEGRATION ASPECTS TO BE ADDRESSED

Time-frame	Types of Operation	Integration aspects to be addressed						
		Airspace access	**Comms C2 datalink**	**D&A**	**Human factors**	**SESAR compatibility**	**Contingency**	**Security**
ASBU 1 2013 - 2018	**IFR** (instrument flight rules) IFR operations 2013-2018 Class A-C airspace Integrating RPAS into Class A-C airspace has the biggest potential of success IFR operations include all phases of flight including airport operations	ATM impact assessment Impact on Network Operations Airport operations Minimum Performance requirements for IFR operations CNS requirements Flight Planning	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions	Human Machine interface Impact on ATC ops Mixed operations	MAP ATM Master Plan requirements Trajectory management for RPAS Initial 4D operations SWIM Delegated separation	Transparent contingency procedures	Ground station Jamming GPS vulnerability Hijacking
	VFR (visual flight rules) Integrating RPAS VFR is the most challenging. This encompasses all airspace classes where VFR flights are allowed including all types of airport operations (controlled, uncontrolled, civil/mil etc.)	ATM impact assessment Impact on GA operations CNS requirements Flight Planning	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom Secure comms	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions	Impact on ATC operations Impact on GA operations Mixed operations	MAP ATM Master Plan requirements Trajectory management for RPAS SWIM	Transparent contingency procedures	Ground station Jamming GPS vulnerability Hijacking
	B-VLOS (very low level) To enable B-VLOS operations the following aspects need to be addressed: ■ Airspace assessment ■ Performance requirements ■ Types of flight rule applied ■ Terrain data base ■ C2 requirements ■ Security ■ D&A (B-VLOS specs) ■ Contingency Met Urban specific	Infra structure requirements Flight Planning	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom Secure comms	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions	General impact assessment	n/a	Transparent contingency procedures	Ground station Jamming GPS vulnerability Hijacking

Time-frame	Types of Operation	Integration aspects to be addressed						
		Airspace access	Comms C2 datalink	D&A	Human factors	SESAR compatibility	Contingency	Security
ASBU 2 2018 - 2023	**IFR** (instrument flight rules)	ATM impact assessment Impact on Network Operations Minimum Performance requirements for IFR operations in core area CNS Integrated Airport Operations	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions Link to possible manned solutions	Human Machine interface Impact on ATC ops Mixed operations	MAP ATM Master Plan requirements Trajectory management for RPAS Initial 4D operations SWIM	Development of Transparent contingency procedures	Ground station Jamming GPS vulnerability Hijacking
	VFR (visual flight rules)	ATM impact assessment Impact on GA Operations CNS requirements Flight Planning CNS Integrated Airport Operations	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions Link to possible manned solutions	Human Machine interface Impact on ATC ops Mixed operations	MAP ATM Master Plan requirements Trajectory management for RPAS Initial 4D operations SWIM	Development of Transparent contingency procedures	Ground station Jamming
	B-VLOS (very low level)	ATM impact assessment Impact on Network Operations Minimum Performance requirements for IFR operations in core area CNS Integrated Airport Operations	Integrity Availability Continuity of service Loss Link Latency Spectrum requirements Satcom	Minimum requirements Conspicuousness issues Interoperability Ground Based Solutions Link to possible manned solutions	Human Machine interface Impact on ATC ops Mixed operations	MAP ATM Master Plan requirements Trajectory management for RPAS Initial 4D operations SWIM	Development of Transparent contingency procedures	Ground station Jamming

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