



# The challenges and expectations of UAS traffic management for airspace integration in Brazil

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## ► To cite this version:

Cristiano Leal. The challenges and expectations of UAS traffic management for airspace integration in Brazil. Other. 2021. dumas-03727892

**HAL Id: dumas-03727892**

**<https://dumas.ccsd.cnrs.fr/dumas-03727892>**

Submitted on 19 Jul 2022

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Mastère Spécialisé Air Navigation Management 2018

**Cristiano LEAL**

MS ANM18

# End of Studies Project Memoir

March 26, 2021

The Challenges and Expectations of UAS Traffic Management for Airspace Integration in Brazil.

**2021**

# ABSTRACT

The safe and efficient integration of Remotely Piloted Aircraft Systems (RPAS) and manned aircraft into Air Traffic Management (ATM) is one of today's biggest challenges in aviation.

When we talk about Unmanned Traffic Management (UTM), besides Unmanned Aircraft System (UAS), Brazil as an aircraft manufacturing state cannot forget to include in the planning the urban air mobility systems that are closer and closer to become a reality.

In the 400 feet range we can have flying "drones", in the most diverse urban activities, whose developing companies will have to break paradigms and prove that their aircraft are reliable from the standpoint of airworthiness, detect and avoid, but also prove that the pilots will be aware of what it is required to fly in an area that eventually will have manned aircraft controlled by ATC agencies.

Therefore, it is possible to affirm that the flow of air traffic will intensify, which can generate air traffic conflicts both between UA and UA and eventually between manned aircraft and UAs.

This work intends to show how Brazil deals with the regulation of UAs with their respective aviation authorities in the country (ANAC and DECEA), as well as to show a possible proposal that seeks to facilitate the integration of ATM airspace through an interdisciplinary study group involving both authorities.

This research team will have the mission to develop guidelines for a technical proposal so that both stakeholders in civil aviation regulation can jointly develop the requirements for the integration of the airspace.

ANAC - ATM - BRAZIL – DECEA - DRONES – RPAS – UAS - UTM

# ACKNOWLEDGMENT

During the past two years, mixed feelings have occurred within me. In first place euphoria: I couldn't believe that I was accepted by ENAC for Advanced Master in Air Navigation Management course. It was a unique opportunity and probably that door would not be opened again in my life.

So, one day it turned into confusion, the head of my superintendency didn't allow my attendance into the course with ANAC paying all the costs. I was the only one, during all course, paying to be in class.

Despite the confusion, during the course I learned several things and knew fabulous persons that became friends. All professors were amazing, and I have gratitude for all of it.

We finished the classes and we had to start the internship. At this moment the feeling of uncertain began. Could I be able to study, write the thesis, work and help my family? So, as if that wasn't enough the world knew SARS-Cov-2 / COVID 19. Then uncertainty doubled.

In the first days that the internship was supposed to be, the pandemic started. The dates set for the studies were useless. Therefore, it was at this moment that we found caution in the actions of Mr. Philippe Jeanson, Mr. Philippe Notry and Mr. Kevin Le Fevre. They said that we should wait and that the delivery time would be extended. And then relief came.

The pandemic days continued, cases increased in Rio de Janeiro, the place where I live. It was then that I found myself at a time when I needed to take my best friend to the hospital. He didn't want to go because he was afraid that he wouldn't come home anymore. I took him to the hospital, kissed him on the forehead and promised to pick him up soon. After five days I was entering the same hospital, alone and to stay for another fifteen days. It was then that I experienced the feeling of inability.

I was very happy to see my wife and oldest daughter after all this time in the hospital. They were also diagnosed with COVID, but luckily with milder symptoms. Happiness passed quickly, because I missed a lot my youngest

daughter, she was in isolation since the beginning of the pandemic with my mother-in-law, due to her comorbidities and care needs. I think that added to the sadness for not fulfilling my promise to bring my best friend home, or even saying goodbye before his departure, presented me with the feeling of depression.

Since then, the days have been very difficult, but I didn't quit. Thanks to my wife, Vanessa Leal, who never let me give up, even with your constant struggle, as the head nurse in a COVID emergency (since the beginning of the pandemic) you still have the strength to give me love and care. Being with you and seeing you gives me hope for a better world. I love you. Just as I love our wonderful and lovely girls. Mariana and Gabriela, you will always be inside my heart.

I owe a deep gratitude to my brother-in-law, Julien Parsi, who took care of my sister and my nephews in Tournefeuille. I can't help but thank my godmother Celia Moreira for supporting my mother for me. I also thank my father-in-law José Galvonete, my mother-in-law Suely Lippi and my second godmother Maria do Carmo for all the affection not only with me, but with my daughters.

I can't forget to express my gratitude for my ANAC colleagues and friends: Jorge Viégas, Gesse Silva, Paulo Jesus, Carla Campello, Regina Neves, André Strauss and specially to my Internship Tutor Ailton Júnior. Ailton was always available to assist and guide me when I requested and shared with me his knowledge about RPAs (Remotely Piloted Aircrafts Systems). These people showed me understanding and fraternity when I needed it.

Finally, I would like to thank my mother Clara and sister Tati for all the love and support I received since ever. I love you two. Furthermore, I would like to apologize to them for not keeping my promise. Unfortunately, my best friend, my father, died of complications from COVID 19 while I was admitted to the hospital by COVID 19. After all of this, I understood that family is love, gratitude, fraternity, forgiveness so that together they help us to be resilient. That is the reason for not giving up. For all of you and especially my father.

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# Acronyms

**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 traffic control service** - A service provided for the purpose of preventing collisions between aircraft; and on the maneuvering area between aircraft and obstructions; and 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 (ATM) system** - A system that provides ATM through the collaborative integration of humans, information, technology, facilities and services, supported by air and ground- and/or space-based communications, navigation and surveillance.

**Air traffic service** - 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).

**ANAC** – Agência Nacional de Aviação Civil, Brazilian CAA

**CGNA** - Centro de Gerenciamento da Navegação Aérea / Air Navigation Management Center.

**DDA / Detect and avoid** - The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.

**DECEA** – Departamento de Controle do Espaço Aéreo / Department of Airspace Control.

**Geofence** - A virtual three-dimensional perimeter around a geographic point, either fixed or moving, that can be predefined or dynamically generated and that

enables software to trigger a response when a device approaches the perimeter (also referred to as geoawareness or geocaging).

**Operator** - A person, organization or enterprise engaged in or offering to engage in an aircraft operation. Note.— In the context of unmanned aircraft, an aircraft operation includes the unmanned aircraft system.

**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 and any other components as specified in the type design.

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

**Unmanned aircraft system traffic management (UTM)** - A specific aspect of air traffic management which manages 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.

**Unmanned aircraft system traffic management (UTM) system** - 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 (UA)** - An aircraft intended to be operated with no pilot on board.

**Unmanned aircraft system (UAS)** - An aircraft and its associated elements which are operated with no pilot on board.

**Visual line-of-sight (VLOS) operation** - An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft.

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# Chapter 1:

## Introduction

### 1 Introduction

Technological development has always been linked to aviation, so with remote piloting systems it would be no different. During the last ten years the aviation industry has been impacted by Unmanned Aircraft (UA) / Remotely Piloted Aircraft (RPA) industry. It introduced technological advancements and enhanced capabilities faster than ever. Every day new Unmanned Aircraft Systems (UAS) / Remotely Piloted Aircraft Systems (RPAS) are created across the world.

These systems provide safety to several complex operations such as spraying, surveying, mapping, and inspections in hazardous areas and have also brought money and time savings with deliveries, construction, agriculture, Search and Rescue and several other activities. All of that allows a nation to be developed and have great benefits.

The Latin American and Caribbean Air Transport Association (ALTA) reports that airlines operating in the region transported 177.3 million passengers in 2020, thus Brazil maintained its leadership in Latin America and the Caribbean in the midst of the pandemic, by registering the largest volume of air passengers transported in 2020.

Since the publication of RBAC-E No. 94 - General Requirements for Unmanned Aircraft for Civil Use, by ANAC in 2017, the increase in UAs varied from 30% to 50% per year, a factor that shows the accelerated growth of the sector and the imminent trend of need to share airspace with manned aircraft.

Growing at the current rate, Remotely Piloted Aircraft Systems (RPAS) operations are expected to outperform manned operations in the future, so it is natural for the density of Remote Pilot Aircraft (RPA) / Unmanned Aircraft (UA) to increase in airspace. While many of them are bringing new technologies and thinking about possibilities like Unmanned Aerial Mobility, this forces Air Navigation Service Providers (ANSPs) to create solutions, but the solutions are not simple, as there are several paradigms and challenges in the operational and technical aspects.

As the UTM concept consolidates itself, systems that provide initial levels of capacity begin to emerge and the demand for access to airspace keeps growing, so it is important to address specific challenges that must be sent to provide the implementation of UTM systems in a arranged, safe and effective manner.

Thus, like their ATM counterparts and manned aircraft, UAS and UTM systems should soon deal with the objectives such as: settling the performance requirements inherent to the UTM and the unmanned aircraft that are managed by such systems; how UTM will demonstrate and achieve the level of trust normally associated with certified aviation systems; and how UTM will be effectively integrated into an aerodrome environments and activities.

Each of these objectives raises numerous questions and concerns. As the development of the UTM progresses, there is still a need to focus on the next evolution of the UA's skill to securely integrate into a finite airspace structure. It remains the primary requirement to make easier this integration without negatively impacting the safety of manned aviation operations, people and properties on the ground, considering safety and equity of access for all airspace users. In this way, the work seeks to initiate discussions of hypotheses in ways that allow states, regulatory agencies and industry to continue the advance of the development of UTM systems and make the integration of airspace and reality.

The management of civil aviation in Brazil is a "sui generis" case, air traffic control is managed, supervised, regulated and executed (for the most part) by DECEA – Department of Airspace Control, a military agency belonging to the Brazilian Air Force, while the other links of Brazilian civil aviation are regulated

and overseen by ANAC – National Civil Aviation Agency, Brazilian CAA. In this way DECEA provides the service, but also oversees the provision of its own airspace services, while ANAC oversees and regulates other civil aviation issues provided by aviation stakeholders.

The integration of RPAS operations will require that stakeholders must be bold, innovative, proactive and seek synergy between regulators and market members, since safety must be a priority for all of them, because a catastrophic situation would end in this project for decades.

## 1.1 Objectives

The scope of this work is to analyze the hard points of both system users and their regulators on the aspects of UTM integration.

It is expected that it will be possible to identify and indicate the main gaps, issues and challenges to be solved, not only from the technical operational point of view, but also in terms of regulatory issues.

Once the problem had been identified, the attention of the activities will shift to the resolution of the problem and a recommended action to be taken.

It is also worth to mention that the empirical study, which was planned to be carried out during the activities, was cancelled due to the pandemic.

## 1.2 Thesis Report organization

The organization of this thesis project is as follows. Chapter 2 This chapter introduces the work environment where I work and includes a personal introduction of myself.

Chapter 3 This chapter presents the state-of-the-art of the studies related to UTM and ATM integration.

Chapter 4 This chapter will bring a brief analysis of the UTM scenario with a subsequent identification of the points of difficulty that exist for ATM integration.

Chapter 5 At this section a few points that were seen as problems will be discussed and then a suggestion will be given on how to solve the issue.

Chapter 6 This section covers the conclusion, as well as the potential work that is about to come, remaining tasks to be done and personal feedback on the learned experience.

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# Chapter 2

## Work Environment

This chapter introduces the work environment where I work and includes a personal introduction of myself. It covers, as well, a description of the subject addressed by the theme of the thesis.

### 2.1 Personal Introduction

I have been working in the aeronautical field since 1997, when I joined the Brazilian Air Force as an Air Traffic Controller. I worked in São Paulo, at Congonha's Airport Tower - SBSP (1998-2000) and in Rio de Janeiro at Galeão's Airport Tower - SBGL (2000-2008). In the latest, I also obtained radar controller and instructor qualifications. A few time later, I left DECEA (Brazilian Airforce) (August - 2008) and then I began to work for ANAC.

Still in the early 2000s, besides working as an air traffic controller, I had also graduated as bachelor in Aeronautical Sciences and I had started teaching in aviation schools. Afterwards, in 2004, I obtained a post-graduate degree in higher education.

When I joined ANAC in 2008, I needed to stop teaching classes due to regulatory issues and as personal choice and also because of the brazilian law, to dedicate myself exclusively to ANAC. I was responsible for activities of inspection, oversight and development of standards. In particular, working on standards for General Aviation in ANAC.

I had also worked in ICAO's UASSG (Unmanned Aircraft Systems Study Group). In addition, I had collaborators under my supervision work in the JARUS (Joint Authorities for Rulemaking on Unmanned Systems) studying group. So then, I worked with Remotely Piloted Aircraft from 2009 to 2014. In 2015, I moved to the Superintendence of Oversight Actions to assist in actions to combat irregular air transport and in actions related to the *Rio 2016 Summer Olympic Games*. I am still working in the same field.

## 2.2 Presentation of the Interested Parties

### 2.2.1 Introduction to ANAC, the internship company

I accomplished my internship at ANAC, remotely, at offices based in São José dos Campos, which specializes in airworthiness and in Rio de Janeiro where I am based, with mostly operations activities.

I intended to work with ANAC, DECEA, Xmobots and Embraer, but due to the pandemic, I only had a few meetings with DECEA employees and exchanged some emails with people from companies, so I mainly concentrated on working at ANAC and with some DECEA material.

#### 2.2.1.1 ANAC Overview

Agência Nacional de Aviação Civil - National Civil Aviation Agency (ANAC), is one of the country's federal regulatory agencies. It was created to regulate and supervise civil aviation activities, aeronautical and airport infrastructure in Brazil. Established in 2005, it started operating in 2006 replacing the Department of Civil Aviation (DAC) as the new National Civil Aviation Authority. It is a federal agency with a special regime and is linked to the Ministry of Infrastructure - Transport, Ports and Civil Aviation, however it is not hierarchically subordinate to the Ministry and it has administrative independence, financial autonomy and fixed mandate for its directors. The Agency has nearly 2,200 employees. ANAC's actions fall within the macro-processes of certification, inspection, standardization and institutional representation.

#### 2.2.1.2 ANAC Scope

ANAC acts in the oversight, regularization, inspection, aircraft certification and personnel licensing. Besides that, ANAC has an important role with society inviting people to participate in the development via public hearing, which are analyzed and may be incorporated into new regulations.

Unlike other Civil Aviation Authorities (CAA) the ANAC still has a tie to the quality of services provided to passengers. So, in addition to working on civil aviation safety, ANAC also provides some support to passengers in matters that

they feel aggrieved as consumers purchasing a product. To fulfill this mission ANAC has the following structure below:

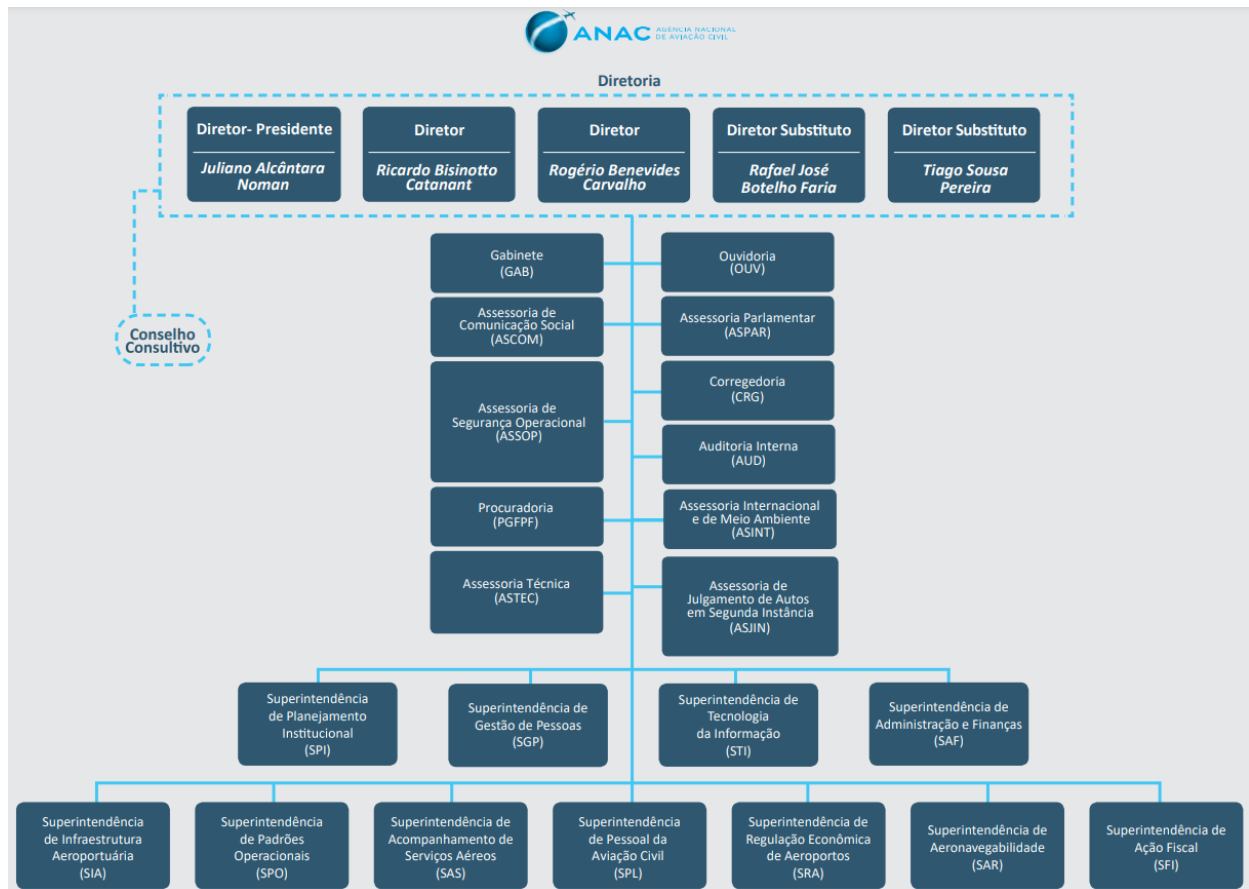


Figure 2: ANAC organization chart (source: [www.gov.br/anac](http://www.gov.br/anac))

Acting in a pragmatic and objective way, and without undervaluing the other areas, the superintendencies that most impact this study are Superintendence of Operational Standards (SPO), Superintendence of Civil Aviation Personnel (SPL) and Superintendence of Airworthiness (SAR). Because of this from now on the work will be focused on these superintendencies.

## 2.2.2 DECEA

The Department of Airspace Control (DECEA) is a governmental organization, subordinated to the Ministry of Defense and to the Brazilian Air Force. It's responsible for the management of all the activities related to the safety and efficiency of the Brazilian airspace control. Its mission is to manage and

control the air traffic in the Brazilian sovereign airspace as well as to guarantee its defense.

As the main organization of the Brazilian Airspace Control System (SISCEAB), DECEA plans and approves the deployment of equipments and systems and oversees technical and operational organizations responsible for activities related to SISCEAB.

DECEA provides services such as Aeronautical Information System (AIS), Air Traffic Management, Aeronautical Cartography, Search and Rescue, Aeronautical Meteorology, Information Technology, Flight Inspection, Military Air Operation Support, Air Navigations Aids and Aeronautical Telecommunication.



*Figure 2: ACC BS – Brasília Center (source: <https://www.decea.gov.br/>)*

### 2.2.3 XMobots

Xmobots was created in 2007 and it is today the largest company in Latin America in the segment of development and manufacturing of Remotely Piloted Aircraft (RPA'S). The company presents as pioneering one of the great characteristics in its development aspects being the first to obtain a Certificate of

Experimental Flight Authorization for the Nauru500A Aircraft in May 2013, being also the first company to receive Design Authorization by the National Civil Aviation Agency in reference to the Arator 5B project.

Currently, the company also has the products ECHAR 20D<sup>1</sup>, NAURU500C and DRACTOR25A, all of them with design authorization process in progress at the National Civil Aviation Agency. The company develops all the mechanics, hardware and software present in its drones, being the only company in Brazil that develops 100% of the technologies present in its RPAs.



*Figure 3: ECHAR 20D During Certification campaign – (source: <https://www.anac.gov.br/>)*

## 2.3 Internship Tutor and Internship Duties

I carried out my project with the support of my mentor, Mr. Ailton Junior, coordinator for drones and new technologies of the ANAC's Airworthiness Superintendence, who helped me initially as follows:

- With the activities related to airworthiness and requirements that are currently being applied and that tend to be used in the future.

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<sup>1</sup> Echar 20D was authorized in march 2021 available: <https://www.gov.br/anac/pt-br/noticias/2021/anac-autoriza-drone-com-capacidade-para-voar-distancias-de-ate-30-km>

- Contact and coordination with the personnel responsible for RPAS / UAS at DECEA.
- Contact and coordination with the people responsible for XMOBOTS.

After the contact with the stakeholders, it was agreed that the text of the thesis would be based on some texts and presentations made by DECEA about UTM and work done at ANAC. Within Xmobots a short interview was made via e-mail, that follows as an attachment to the thesis, with their opinions about the needs and realities of airspace integration between manned and remotely piloted aircraft.

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# Chapter 3

## Related Work

This chapter presents the state-of-the-art of the studies related to UTM and ATM integration. Initially, the original intention of the work will be mentioned, as well as the approach chosen, which are the studies based on ICAO's framework and on the presentations made by DECEA in several panels, and also on ANAC's own requirements.

### 3.1 Original Work Concept

The initial proposal of the work would be to suggest to DECEA and Xmobots a pilot project to test the feasibility of a practical proposal for the use of an integrated airspace, since there was a remotely piloted aircraft in the certification process with ANAC whose flight proposal would be to be performed in BVLOS flights for mapping.

It would certainly be an interesting proposal for ANAC, DECEA and the company itself that would already perform the flights for the certification process, ANAC could check not only technical requirements, but also could check new operational requirements. However, due to issues related to the COVID-19 pandemic it was not possible to advance with the project.

### 3.2 Course Correction and Thesis Adjustment

With the change of course, the focus became theoretical but still searching for new ideas and proposals.

By ceasing to be a project with a single type of flight, which would be mapping, and becoming a project of low altitude flights, the work has become a wider issue with larger points of concern.



“Drone” pilots are not necessarily aviation enthusiasts, and if so, they don't necessarily know the rules and regulations of aviation. This does not mean that remote pilots should have the same knowledge of the regulations as pilots of manned aircraft have, but they do need to have basic knowledge about the structure of Brazilian civil aviation, safety, meteorology, and air traffic regulations, for example.

### 3.3 Brazilian RPAS Airspace Authorization

As mentioned earlier, Brazilian aviation is administered by ANAC and DECEA. Thus, each institution has their respective standards for RPAS, ANAC with RBAC 94 E - General Requirements for Unmanned Aircraft and DECEA with ICA 100-40 - Unmanned Aircraft and Access to Brazilian Airspace. It is also worth mentioning the existence of the Brazilian Aeronautical Code, which is the law 7565/1986, and establishes the authorization for the use of airspace.

The rules in question define, in general terms, that flights must be approved by DECEA through the SARPAS (Solicitação de Acesso de Aeronaves Remotamente Pilotadas) system: for flights up to 100 feet, the operation must not occur within three nautical miles of airfields. And for flights between 100 and 400 feet, operation must not occur within 5 nautical miles of airfields.

To access SARPAS, a prerequisite is that the applicant has its RPAS registered with ANAC.

SARPAS collects information related to the flight directly, in addition to some pilot information, but focuses mainly on airspace information, such as coordinates, location, altitude and time of the mission. SISANT (Sistema de Aeronaves não Tripuladas) is an ANAC system that collects data from the pilot, the aircraft, and the system itself.

As you can see, a DECEA system asks the operator to obtain a registration from an ANAC system before being able to proceed with the authorization. This fact ends up generating some difficulty of understanding for the less inexperienced users of the Brazilian aviation system, because they don't

understand very well the limits and actions of each institution. It is important to note that even the institutions themselves have converging points that share responsibilities and that need to be better detailed, because they create doubts about how far the responsibility of each aviation authority goes.

Speaking specifically of RPAS, ANAC and DECEA, we have been working together on UAS related actions since 2009, or even before, including the participation of representatives in several ICAO (International Civil Aviation Organization) and JARUS (Joint Unmanned Systems Regulation Authorities) working groups. This partnership has produced benefits (talking about standards) such as "Decisão 127" da ANAC, in November 2011, which authorized the operations to be carried out by the RPA / UA of the Federal Police Department of Brazil.

Besides what was already mentioned ICA 100-40, DECEA has also published the following standards<sup>2</sup> for RPAS:

- MCA 56-1 - Unmanned Aircraft for exclusive use in support of emergency situations
- MCA 56-2 - Unmanned Aircraft for recreational use - model aircraft
- MCA 56-3 - Unmanned Aircraft for the benefit of federal, state and municipal government agencies
- MCA 56-4 - Unmanned Aircraft for Public Security, Civil Defense and Internal Revenue Service

Nowadays, in order to perform any flight, it is necessary to be registered in SARPAS and follow the conditions of height and distance from aerodromes described previously. If there is any request different from these conditions, the application will be analyzed by both DECEA and ANAC on a case by case basis, each one in their own area of competence.

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<sup>2</sup> All the regulations mentioned in this paper are currently in effect.

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# Chapter 4

## Analysis of Situation

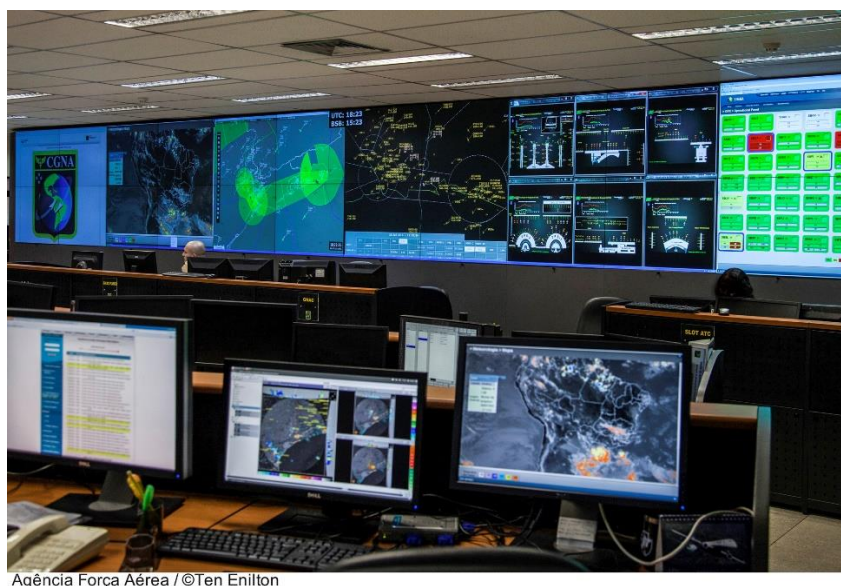
This chapter will bring a brief analysis of the UTM scenario with a subsequent identification of the points of difficulty that exist for ATM integration.

In addition, observations and hypothetical work scenarios will be registered for potential solutions to these issues, as well as the motivations for these options.

### 4.1 Brazilian ATM Stakeholder: CGNA

The Air Navigation Management Center (CGNA) is a Brazilian Air Force Command Organization (COMAER), and has as its purpose, based on flight intentions, to harmonize air traffic flow management and other activities related to air navigation, providing the operational management of the current actions of the Air Traffic Management (ATM) processes and their respective infrastructure, aiming at the sufficiency and quality of the services provided within the Brazilian Airspace Control System.

The responsibility for the implementation of the UTM integration belongs to the CGNA the **Air Traffic Flow Management (ATFM)** manager in Brazil.



Agência Força Aérea / ©Ten Enilton

Figure 4: CGNA – (source: <https://www.decea.gov.br/>)

## 4.2 Major Gaps, Issues and Challenges to be solved to enable safe integration

There is a discussion in this section of the several gaps, issues, and challenges that have to be addressed to enable UAS Operations within the UTM and ATM systems.

ANSPs anticipate that UAS operations will encompass everything from operations that are entirely contained within airspace where no air traffic control services are provided and to for those that transits across the boundary between controlled and uncontrolled airspace or are operated exclusively within controlled airspace.

Safe airspace and the efficient integration of RPAS, particularly small RPAs, into existing controlled and uncontrolled airspace presents a variety of new issues and challenges. Recent studies predict significant growth in RPAS operations, leading to a shift in focus to operations in low-level environments and above populated areas, with various types of operations and RPA. We can see some of them:

- Operations at altitudes in the very low-level structure (e.g. below 150 meters or 500 feet above ground level (AGL).
- systems with high levels of automation and connectivity.
- greater number of operations, which raises questions about the sustainability and scalability of a UTM system and the ability of ATM infrastructure to accommodate these new users;
- flights not conducted in accordance with IFR or visual flight rules (VFR) with the potential of establishing UAS-specific flight rules; and
- reliance on data links (either non-traditional ground-based links, C2 Links or data links associated with UTM systems), raising new challenges related to frequency spectrum, resilience and cybersecurity.

#### 4.2.1 Gaps<sup>3</sup>

Many of the gaps discussed below become more significant at the boundaries between UTM and ATM systems and/or when RPA transition between these systems.

- **Airspace classification:** The current airspace classification scheme as developed for manned aviation may not effectively support visual line-of-sight (VLOS) or BVLOS operations. This gap includes the potential modification of current classes of airspace or potentially creating new classes of airspace to accommodate the range of needs brought by UAS operations.
- **Airspace access:** The policies, rules and priorities required to support equitable access to airspace must be developed (the European Union, for example, is examining policies on fair access to airspace).
- **Rules of the Air:** Rules of the Air which specify flight rules, right-of-way, altitude above people and obstructions, distance from obstacles and types of flight rules, all of which, as written, are incompatible with the intended operations within UTM systems.
- **Operational procedures.** Procedures specific to the UTM system, including normal, contingency and emergency scenarios, are needed. Such procedures would need to be harmonized with ATM systems whenever UAS operations are planned near the boundary between UTM and ATM or if UA will transit from one system to the other.
- **Liability:** Liability and insurance implications for USPs in relation to UAS operators must be determined.

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<sup>3</sup> ICAO, 2020. *Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization Edition 3*. Montreal: International Civil Aviation Organization. Access in January and available from <https://www.icao.int/safety/UA/Documents/UTM%20Framework%20Edition%203.pdf>

- **Certification:** Certification of the UTM system, particularly when interacting with an ATM system, and, for UA, meeting the principles of airworthiness, scaled to an appropriate level based on risk(s).
- **Data standards:** Appropriate data standards (e.g. data quality specifications, data protection requirements) and protocols to support UTM safety-related services and the exchange of data between UTM and ATM systems as well as between multiple UTM systems are needed.
- **Positional references:** Common altitude, navigation and temporal references for manned and unmanned operations are needed. Gaps in the use of reference points and equipment providing different levels of accuracy and performance in the measurement of altitude, navigation or time introduce safety concerns which must be resolved. Determining the extent to which traditional aviation standards can be used remains a work in progress. Traditional standards which address the provision of such references should be utilized whenever possible.
- **Interface between UTM and ATM:** There is a need to develop procedures and adequate tools to ensure the sharing of information, the interoperability of the two systems, and to identify roles, responsibilities and limitations.
- **Data recording:** Data-recording policies and capabilities, similar to ATC data retention and aircraft flight recorder requirements, are needed to support accident/incident reporting and investigative requirements.
- **Communications:** Remote pilot interfaces as well as capabilities and performance requirements for communications with the UTM

system must be developed. These include the ability to interface/communicate with ATC and pilots of manned aircraft.

- **Alerting systems:** The safety and integrity of the UTM system, failure-alerting and failure management must be addressed. Policies, guidance and procedures will need to be developed to address the degradation or failure of the various UTM components or entire UTM system as well as the restoration of systems after such degradations or failures.
- **Contingency management protocols:** A dynamic operating environment must have operating protocols that account for contingencies both of the UTM system(s) providing multiple services and of the aircraft operating within the UTM system.

#### 4.2.2 Issues<sup>4</sup>

The air traffic applicability and navigation performance requirements should be studied. As previously mentioned, ANAC and DECEA share attributions in civil aviation. While airspace is DECEA's responsibility, overseeing educational institutions and pilot certifications is ANAC's responsibility, as well as the subjects that students must learn, even in subjects related to air traffic control. If there is not an approach and joint work in extreme harmony, the quality of work and by consequence safety can be endangered, in the specific case of Brazil.

However, to ensure system reliability and safety, it is necessary to determine frequency spectrum availability and supportability based on the UTM system architecture.

The establishment of a UTM service within a volume of airspace may affect the classification of that airspace (e.g. from Class G to D airspace).

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<sup>4</sup> ICAO, 2020. *Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization Edition 3*. Montreal: International Civil Aviation Organization. Access in January and available from <https://www.icao.int/safety/UA/Documents/UTM%20Framework%20Edition%203.pdf>



The UTM and ATM interface, including responsibilities and procedure development, should be addressed to ensure compatibility between manned and unmanned operations.

UTM and ATM systems may have different communication, navigation, and surveillance (CNS) requirements for different aircraft. The systems need to exchange data effectively so that each system can manage relevant aircraft relevant to its responsibilities. CNS requirements in UTM may differ from ATM.

#### 4.2.3 Challenges<sup>5</sup>

Aircraft participating in the UTM system must be separated from each other and from other hazards. This separation management must include guidance and responsibilities supplemented by other tools and procedures to adequately address scalability. Separation management may need to be supported by additional standards, policies, capabilities or tools, including:

- a DAA capability to identify/detect and avoid conflicting aircraft and any other hazards;
- methodologies to allow improved or enhanced detectability and conspicuity of RPA by manned aviation;
- assignment of responsibility for conflict management and separation provision, particularly in low-level airspace, which may include unique solutions such as separation provision being delegated to the RPA or the UTM system;

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<sup>5</sup> ICAO, 2020. *Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization Edition 3*. Montreal: International Civil Aviation Organization. Access in January and available from <https://www.icao.int/safety/UA/Documents/UTM%20Framework%20Edition%203.pdf>

- development of RPA separation standards within the UTM system, which may include the need for safety margins based on elements such as airspeed, weight and RPA equipment;
- assessment of existing and future separation standards between RPA and manned aircraft whenever they operate in proximity to each other;
- determination of the relevant surveillance capability and performance for the UTM system to support the integration of new or novel aircraft and operations;
- development of policies to address means of compliance or system approval for UTM systems;
- implementation and maintenance of a safety management system as currently required by aviation systems related to manned aviation; and
- achievement of a required data quality (e.g. on accuracy, resolution, integrity, timeliness, completeness, traceability, format) of the system. The standards applied to UTM systems that are intended to interface with the ATM system will need to be compatible and interoperable.
- forecasting and dissemination of micro-weather to address localized weather patterns that may impact low altitude RPA operations (e.g. urban canyon phenomenon, windshear, diurnal effects caused by urban structures, etc.).

## 4.3 ANAC's rules review for integration

In the previously mentioned RBAC 94 E, there are most of the requirements for airworthiness and operations to be complied with in order to allow the RPAs to fly, however, to fly in an integrated area, certainly these requirements should be updated, due to safety, operations and airworthiness reasons. Thus, a study (preferably involving not only DECEA, but market players) in order to seek viable solutions not only from the technical point of view, but also financially so as not to make the activity unviable.

### 4.3.1 The involvement of the market players

For example, the company Xmobots believes <sup>6</sup>it is already possible to start a basic airspace integration project using DAA (Detect and Avoid) technologies in BVLOS operations, Remote Identification (Remoted ID), solutions involving broadcast with identification and location information such as Traffic Information Service - Broadcast (TIS-B), ADS-B, Technologies that move towards flight information management (Flight Information Management System - FIMS), 5G (Digitization of Information / large scale data and information exchange / lower latency).

The company representative also believes that by using data encryption with anti-jamming and anti-spoofing protections and frequency hopping the system would be protected from cyber-attacks.

### 4.3.2 The most important points of the ANAC's rules to be reviewed

For the airspace integration to be possible, several airworthiness requirements will have to be attested, as well as the new ones for operations, since the operation should be more precise, technical, with a faster response and increased safety.

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<sup>6</sup> The complete interview, in Portuguese, with Mr. Décio Gomes from Xmobots follows as Appendix A

Improvements and enhancements in DAA and collision avoidance systems, improvements in navigation and aircraft communication systems, as well as another existing requirements.

The most significant of the operations requirements will be the pilot's proficiency with other aircraft in the integrated airspace or at the border of the UTM environment with the integrated area.

The pilot of the remotely piloted aircraft must be proficient in contacting the ATC service and he or she must know the air traffic rules and other DECEA regulations that are applicable. Finally, new requirements and tests should be created that can check the technical capabilities of these pilots before they enter in the shared airspace.

The operation's risk management plans and contingency planning should also be updated to bring them up to date with the intended reality.

ANAC's assignments that impact DECEA  
Cristiano Leal | April 2, 2021

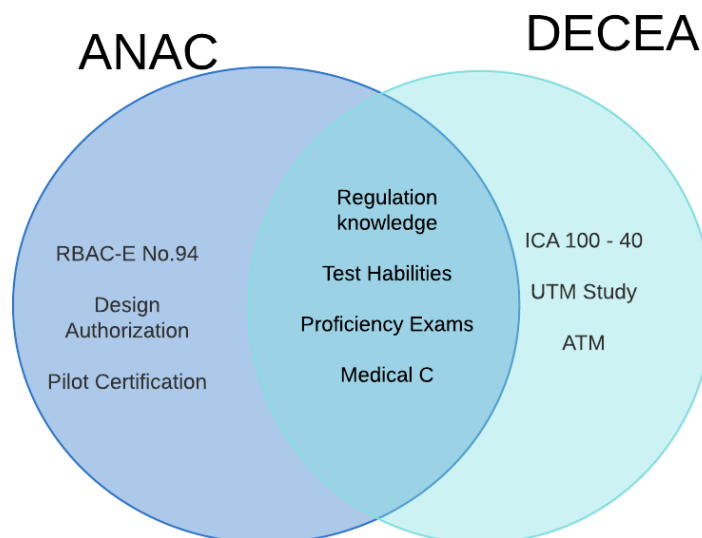


Diagram 1

#### 4.4 Work Done x Work Planned

The first proposed project was designed to use a Specialized Air Service, probably mapping, and then work exclusively on it to plan airspace integration between remotely piloted aircraft and manned aircraft.

However, due to restrictions and personal problems caused by the pandemic caused by COVID 19 the project did not succeed and I had to make a major adjustment modifying it to general sUA integration.

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# Chapter 5

## Problem identified. How to fix it?

At this section a few points that were seen as problems will be discussed and then a suggestion will be given on how to solve the issue.

### 5.1 Remembering the whole matter

The whole world is currently focused on finding a solution for the integration of UTM environment. The question is not easy, because at the same time that manned aviation keeps growing, unmanned aviation keeps growing exponentially, not only numerically, but also in technology.

The first step would make operations possible in the VLL (very low level) area, up to 500', but for flights to advance on the edges of the UTM areas and then converge with the ATM areas, it is necessary to prove several requirements in terms of safety, because the concept of "safety first" is fundamental.

In the specific case of Brazil, there is the "Sui Generis" condition that brings another difficulty factor: unlike most countries, here we have two Aviation Authorities, ANAC is the Civil Aviation authority, which deals with the entire scope of Brazilian aviation except for military aviation and air traffic control, including civilian ones, which is the responsibility of the Brazilian Air Force through DECEA, the country's Aeronautical Authority.

Despite all the efforts of the employees of both institutions, sometimes the work may not be as fast as the market demands. Whether it is for reasons of the institutions' philosophy, schedule, or other cases.

## 5.2 Feasible actions to be taken

I recommend creating a working group with the participation of ANAC, DECEA and members of the market with interest in UTM development, for example Xmobots, which has already had two models of aircrafts certified with eleven "Certificados de Autorização de Voo Experimental" (Certificates of Authorization for Experimental Flight) (CAVE) issued by ANAC, or Embraer, which has an ongoing project of an eVTOL, in short, stakeholders who can and want to help technically.

This working group should have goals, deadlines, and leaders defined by areas, being responsible for delivering and reporting on the results of the work. If it is possible, it would be interesting to have a member of the Ministry of Infrastructure as a coordinator of the process to demand the deliveries and deadlines.

This way the group could be composed of two experts from ANAC, one from Airworthiness and one from Operations, two from DECEA, one from ATM and one from UTM, two market nominees from invited companies and a coordinator to be chosen.

The result of the work should be public and discussed by all interested parties via forums, seminars and other press.

Stakeholders	Cost	Actions	Human Resource
ANAC	Low	Standards + certification	SPO / SPL / SAR
DECEA	Low	Standards + UTM Environment	DECEA / CGNA
MARKET	Need to research	Technological Solutions	Xmobots, Embraer or other

Table 1



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# Chapter 6

## Conclusion

This section covers the conclusion, as well as the potential work that is about to come, remaining tasks to be done and personal feedback on the learned experience.

The use of remotely piloted aircraft and its industry stands with a growth of up to 30% per year in Brazil, according to the specialized magazine DroneShow.<sup>7</sup> The finding of new uses brings economical and often safety benefits to many activities. For example, how can we ignore the preservation of life in pipeline inspection activities? Or even ignore the facilitation and gain of time in search and rescue actions, when every second makes a difference to someone who needs to be rescued? Integration work must be done, so that actions like these can happen. Of course, bringing wealth to yourself or to the state is excellent, but preserving and saving lives is even better.

Helping to integrate the airspace, with safety, fluency and speed is a great reward for someone who worked as an air traffic controller for 12 years and even out of the activity still follows it with passion.

Ending the work with a feasible recommendation of a Working Group to develop a proposal for an ATM test area, even if it is a small one, is rewarding for someone who worked with RPAs for a long time at ANAC and saw much of the development of the process of analysis and regulation in ANAC itself. I had the pleasure to participate in the drafting process of Decision 127 of 2011, mentioned in this paper, as well as the certification process of the first CAVE for an RPA. Recently ANAC issued another CAVE for delivery operations by sUA and also issued specific authorizations for an RPAs.

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<sup>7</sup> <https://droneshowla.com/artigo-setor-de-drones-apresenta-novos-numeros-para-o-brasil/>

In this way, I am comfortable in making the recommendation of the Working Group with members of ANAC, because I am sure that in ANAC there are competent and experienced people to deal with the subject. And who knows, maybe leave a seed to eventually unify the Brazilian civil aviation structure into a single authority, like the other CAAs.

About the growth during the internship, I certainly had both: personal and professional growth. Working as an air traffic controller for 12 years, I loved reviewing the concepts and classifications of airspace and remembering my times at São Paulo Towers (SBSP), Galeão (SBGL) and APP RJ. And I could learn watching the AFTM concept applied to Drones, because it was exactly the time when I left FAB to join ANAC that the CGNA was established.

I grew up as a human being because of Covid. Living and learning, as they say.

I lost my father, friends, relatives. I, myself, spent 15 days at hospital. I needed to struggle through a huge depression for almost 9 months. I still kept fighting with the support of people I have to protect and care for, because they care for me.

This Master has been an intense and unique experience.

Thank you.

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# APPENDIX A

## Entrevista Sr. Décio Gomes - Xmobots

### 1 – Poderia apresentar a sua empresa?

Resposta: A Xmobots foi criada em 2007, como resultado do sonho de tornar a robótica móvel uma realidade cotidiana. Após um rápido e acentuado desenvolvimento a Xmobots é hoje a maior empresa da América Latina no segmento de desenvolvimento e fabricação de aeronaves remotamente pilotadas (*Remotely Piloted Aircraft – RPA'S*). A empresa apresenta como pioneirismo uma das grandes características nas suas vertentes de desenvolvimento sendo a primeira a obter um Certificado de Autorização de Voo Experimental para a Aeronave Nauru500A em maio de 2013, sendo também a primeira empresa a receber Autorização de Projeto pela Agência Nacional de Aviação Civil em referência ao projeto Arator 5B. Atualmente a empresa conta também com os produtos ECHAR 20D, NAURU500C e DRACTOR25A, todos com processo de autorização de projeto em tramitação na Agência Nacional de Aviação Civil.

Sediada em São Carlos (SP), um dos principais polos aeronáuticos do Brasil, e com filiais em Altamira (PA) e Itajubá (MG), a XMobots vivencia atualmente o momento de maior expansão de sua história. Um dos grandes diferenciais que possibilitaram esse crescimento é o investimento constante em inovação. Com um time de P&D composto por mais de 60 engenheiros, a empresa desenvolve toda a mecânica, hardware e software presente em seus drones, sendo a única companhia do Brasil que desenvolve 100% das tecnologias presentes em seus RPAs. Fatores como robustez estrutural, confiabilidade em todas as etapas do voo e o amplo histórico em certificação tornaram a XMobots líder do mercado brasileiro e uma das principais empresas do mundo dedicadas ao segmento. Até hoje, a XMobots é a única empresa do Brasil com RPA autorizado pela ANAC a realizar operações comerciais com drones acima de 400 pés.

*Missão: Desenvolver o mercado de robôs móveis com tecnologia de ponta*

*Visão: Tornar a robótica móvel uma realidade cotidiana para nossos filhos e netos*

*Valores Corretude: “Corretude em absolutamente todos os processos adotando como filosofia: na dúvida, não faça.”*

*Excelência: “Melhoria constante nos processos visando a excelência nas relações com os clientes, colaboradores, investidores e fornecedores.”*

*Rentabilidade: “O bom produto ou serviço é aquele que gera um alto nível de rentabilidade em toda a cadeia, por isso concentre-se nos resultados que devem atender a todos os requisitos com alto nível de objetividade.”*

*Inovação: “O conhecimento sustenta o caminho para a inovação eficiente em um mercado em constante mudança, por esse motivo, estude em todos os momentos.*

*Força: “Paixão com realismo, determinação com resiliência são as forças que definem os Xrobotianos.”*

*Orgulho: “Tenha orgulho, não é ficção, você realmente faz robótica como no seu sonho de infância.”*

**2 – Como você enxerga a integração do espaço aéreo com aeronaves remotamente pilotadas e aeronaves tripuladas? Hoje existem áreas segredadas de operação. É possível integrá-las?**

Resposta: Como empresa que se inspira no desenvolvimento de novas tecnologias que tragam benefícios socioeconômicos e de mobilidade urbana, a Xmobots apoia e ajuda a desenvolver o conceito de espaço aéreo integrado, via sistema UTM (*Unmanned Aircraft System Traffic Management*) como um subsistema do sistema de gerenciamento de tráfego (*Air Traffic Management ou ATM*) objetivando proporcionar o gerenciamento seguro e eficiente das operações do Sistema de Aeronaves não Tripuladas explorando esses sistemas em todas as suas capacidades operacionais. Acredita-se, portanto, que a integração do espaço aéreo é plenamente possível levando-se em conta claro o desenvolvimento de infra estruturas adequadas à implantação dessa plataforma, notadamente com relação à requisitos de segurança inerentes à existência de uma rede móvel e requisitos para estabelecimento de plataformas adequadas de prestação de serviços que obtenham conformidade com requisitos estabelecidos pela Autoridade Reguladora.

**3 – Acredita que o mercado brasileiro teria condições de iniciar essa conversão? Caso positivo, em quais áreas (aerolevanteamento, mobilidade urbana, entregas)?**

Resposta: O mercado brasileiro como um dos principais mercados do mundo, certamente possui elevadas demandas para o desenvolvimento de tecnologias nesse sentido, vale salientar, porém, que a implantação dessas plataformas requer o estabelecimento e o cumprimento com uma série de condicionantes relacionadas principalmente à infra estrutura e prestação de serviços necessários para implantação, podendo-se citar nesse sentido confiabilidade de rede móvel, susceptibilidade à cyber ataques, precisão dos sistemas de navegação e demais requisitos de segurança, identificação remota, tecnologias que permitam a separação segura (*Detect and Avoid*) entre outras. A plataforma possui aplicabilidade e potencial de utilização em diversas áreas e cenários, incluindo obviamente todos os cenários citados na indagação, porém respeitadas as fases de implantação da UTM acredita-se em um primeiro momento na aplicabilidade em espaços aéreos classes F/G, considerando áreas remotas, operações abaixo de 400 pés em pequenos centros urbanos, o que irá demandar certamente um menor nível de complexidade de infra estrutura para as operações realizadas, propiciando por exemplo atividades de mapeamento/aerolevanteamento, conforme citado. Já em um segundo momento espera-se que o desenvolvimento já permita a integração em centros urbanos maiores porém ainda operando em espaços aéreos classes F/G e abaixo de 400 pés e, em uma terceira fase avançando para grandes centros urbanos, em espaços aéreos controlados (C/E) já com interação com ATM, onde faz-se possível vislumbrar atuações como a de serviços de *delivery* e entregas. Dado o exposto, acredita-se possível e necessário o atingimento de diversas atividades, respeitando-se um cronograma de desenvolvimento que contemple a evolução das tecnologias aliado ao desenvolvimento da regulamentação pertinente.



**4 – Quais tecnologias acredita serem viáveis e necessárias para a utilização dos RPAs em espaço aéreo integrado? Como por exemplo 5G, ADS-B, constelação satelital de baixa órbita...**

Resposta: Algumas tecnologias podem ser citadas como necessárias, porém, por si só, não suficientes para utilização dos RPAs em espaço aéreo integrado, quais sejam: *Detect and Avoid (DAA)* garantindo maior confiabilidade e separação para operações BVLOS a partir de maior consciência situacional, Identificação Remota (*Remoted ID*), soluções envolvendo broadcast com informações sobre identificação e localização Ex *Traffic Information Service – Broadcast (TIS-B)*, ADS-B, Tecnologias que caminhem no sentido de viabilizar o gerenciamento de informações de voo (Flight Information Management System -FIMS), 5G (Digitalização de Informações/Troca de dados e informações em larga escala/ menor latência).

**5 – Com relação a segurança, existem métodos embarcados eficientes contra cyber ataques?**

Resposta: Podem-se citar criptografia de dados, proteções *anti jamming* e *anti spoofing*, saltos em frequência

**6 – Quais conhecimentos técnicos acredita que o piloto remoto deve ter para controlar a Aeronave Remotamente Pilotada.**

Resposta: Os conhecimentos técnicos requeridos para operação da aeronave remotamente pilotada (considerando ou não o conceito de espaço aéreo integrado) devem envolver não somente o conhecimento das características técnicas do equipamento operado, mas também toda legislação inerente àquele tipo de operação incluindo, por exemplo, conceitos de SISANT, SARPAS, CERTIFICADOS DE AERONAVEGABILIDADE e todo regimento estabelecido pelo Regulamento Brasileiro de Aviação Civil Especial nº94, procedimentos para Solicitações de Voo e devido acesso ao espaço aéreo dispostos pelas ICA's, conceitos envolvendo consciência situacional, gerenciamento de informações, procedimentos operacionais do equipamento que está sendo operado.

**7 – Algum ponto que considere ser essencial para a existência da integração? Por quê?**

Resposta: Existência de infra estrutura e tecnologias que permitam o desenvolvimento adequado e seguro de cada uma das fases de implantação da plataforma UTM, acredita-se que com a existência destes pré-requisitos o sistema consiga se desenvolver de maneira segura, acompanhado por um arcabouço regulatório robusto o suficiente para regular as operações em espaço aéreo integrado, permitindo a utilização de todo o potencial operacional das aeronaves remotamente pilotadas.

#### **8 – Como imagina ser a comunicação entre piloto remoto e ATC?**

Resposta: Considerando um contexto de implantação total da plataforma UTM, imagina-se que as todas as informações relacionadas ao registro, identificação, planejamento, análise de voo, rastreamento, *Deconflict*, tráfego, *Geofencing*, Alertas e notificações e demais informações aeronáuticas sejam recebidas, gerenciadas e fornecidas ao piloto remoto via figura de um prestador de serviços UTM.

### **9 – Alguma observação pertinente para contribuição?**

Resposta: A Xmobots acredita que, apesar de bastante complexa, a implementação de um espaço aéreo integrado é possível e necessária para exploração de todos os benefícios que as aeronaves remotamente pilotadas podem trazer à sociedade e, dada a grandeza da causa, e a competência das autoridades envolvidas (ANAC/ANATEL/DECEA), vislumbra um grande e próximo futuro, no contexto do advento de soluções e regulamentações pertinentes ao estabelecimento de tecnologias necessárias ao desenvolvimento, que possibilitam uma caminhada à passos concretos embasados em um corpo regulatório saudável permitindo a instauração de uma infraestrutura segura e condizente com a complexidade operacional envolvida.