


# Departamento de Controle do Espaço Aéreo

DEPARTMENT OF AIR SPACE CONTROL - DECEA

www.decea.gov.br

*"The issue is real. We have plenty of pilot reports of drones where they were not expected, particularly at low altitudes around airports... There is no denying that there is a real and growing threat to the safety of civilian aircraft (coming from drones)"*

•Mr. Tony Tyler, Director-General of IATA (Singapore Airshow Aviation Leadership Summit, on February 15, 2016



*“Drone invaded airspace over Congonhas, in São Paulo, flights were impacted”*

(http://g1.globo.com/jornal-nacional/noticia/2017/11/drone-invade-espaco-aereo-de-congonhas-em-sp-e-prejudica-voos.html. Access: 11/13/2017)

*“Drones are changing the way of thinking about maintenance and monitoring services.”*

(PWC, ***global report on the commercial applications of drone technology***, 2016)

## How will drones impact business?

*Predicted commercial applications and market value by industry*

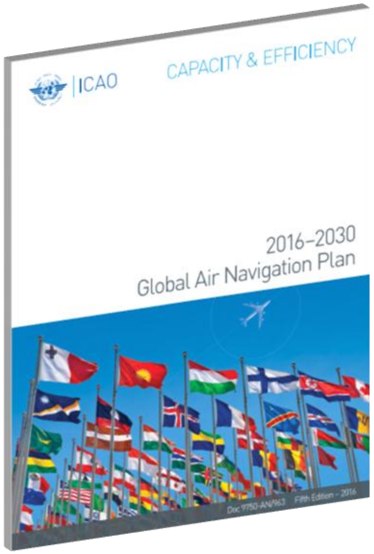
| Industry | Applications | Market value |
|---|---|---|
| Infrastructure | Investment monitoring, maintenance, asset inventory | $45.2bn |
| Agriculture | Analysis of soils and drainage, crop health assessment | $32.4bn |
| Transport | Delivery of goods, medical logistics | $13.0bn |
| Security | Monitoring lines and sites, proactive response | $10.5bn |
| Entertainment & Media | Advertising, entertainment, aerial photography, shows and special effects | $8.8bn |
| Insurance | Support in claims settlement process, fraud detection | $6.8bn |
| Telecommunication | Tower maintenance, signal broadcasting | $6.3bn |
| Mining | Planning, exploration, environmental impact assessment | $4.3bn |

”If regulated and operated correctly and safely, unmanned vehicle technologies can revolutionize future air transport, airport operations, cargo operations and ground handling, besides others…”

Mrs. Céline Hourcade, Head Cargo Transformation of IATA


ACTUAL FLIGHT FOOTAGE
NOT SIMULATED

# GLOBAL AIR NAVIGATION PLAN




| B2-RPAS | Remotely piloted aircraft (RPA) integration in traffic |
| --- | --- |
| | Continuing to improve the remotely piloted aircraft (RPA) access to non-segregated airspace; continuing to improve the remotely piloted aircraft system (RPAS) approval/certification process; continuing to define and refine the RPAS operational procedures; continuing to refine communication performance requirements; standardizing the lost command and control (C2) link procedures and agreeing on a unique squawk code for lost C2 link; and working on detect and avoid technologies, to include automatic dependent surveillance – broadcast (ADS-B) and algorithm development to integrate RPA into the airspace. |
| | **Applicability** |
| | Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements. |


Figure 6: The ASBU Modules converge over time on their target operational concepts and performance improvements

# *UNMANNED TRAFFIC MANAGEMENT & BRAZILIAN AIRSPACE*

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# GOAL

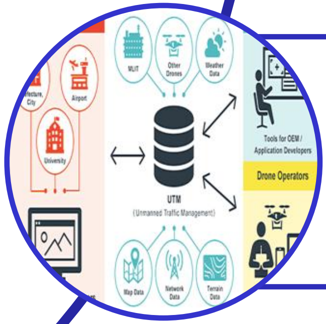
➢FIGURE OUT THE UTM CONCEPT OF OPERATIONS;

➢KNOWN THE INITIAL DRAFT OF BRAZILIAN UTM CONCEPT OF OPERATIONS.

# OVERVIEW

## UNMANNED TRAFFIC MANAGEMENT (UTM)

## DRAFT UTM BRAZILIAN CONCEPT

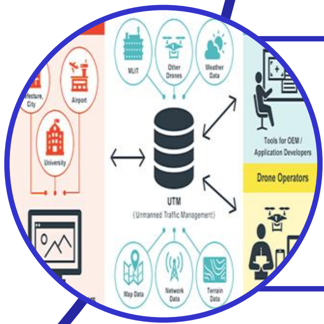



## UTM CONSTRAINTS & CHALLENGES

# OVERVIEW

UNMANNED TRAFFIC MANAGEMENT (UTM)

DRAFT UTM BRAZILIAN CONCEPT




UTM CONSTRAINTS & CHALLENGES

# How will drones impact business?

## *Predicted commercial applications and market value by industry*

### Infrastructure
Investment monitoring, maintenance, asset inventory

**$45.2bn**

### Agriculture
Analysis of soils and drainage, crop health assessment

**$32.4bn**

### Transport
Delivery of goods, medical logistics

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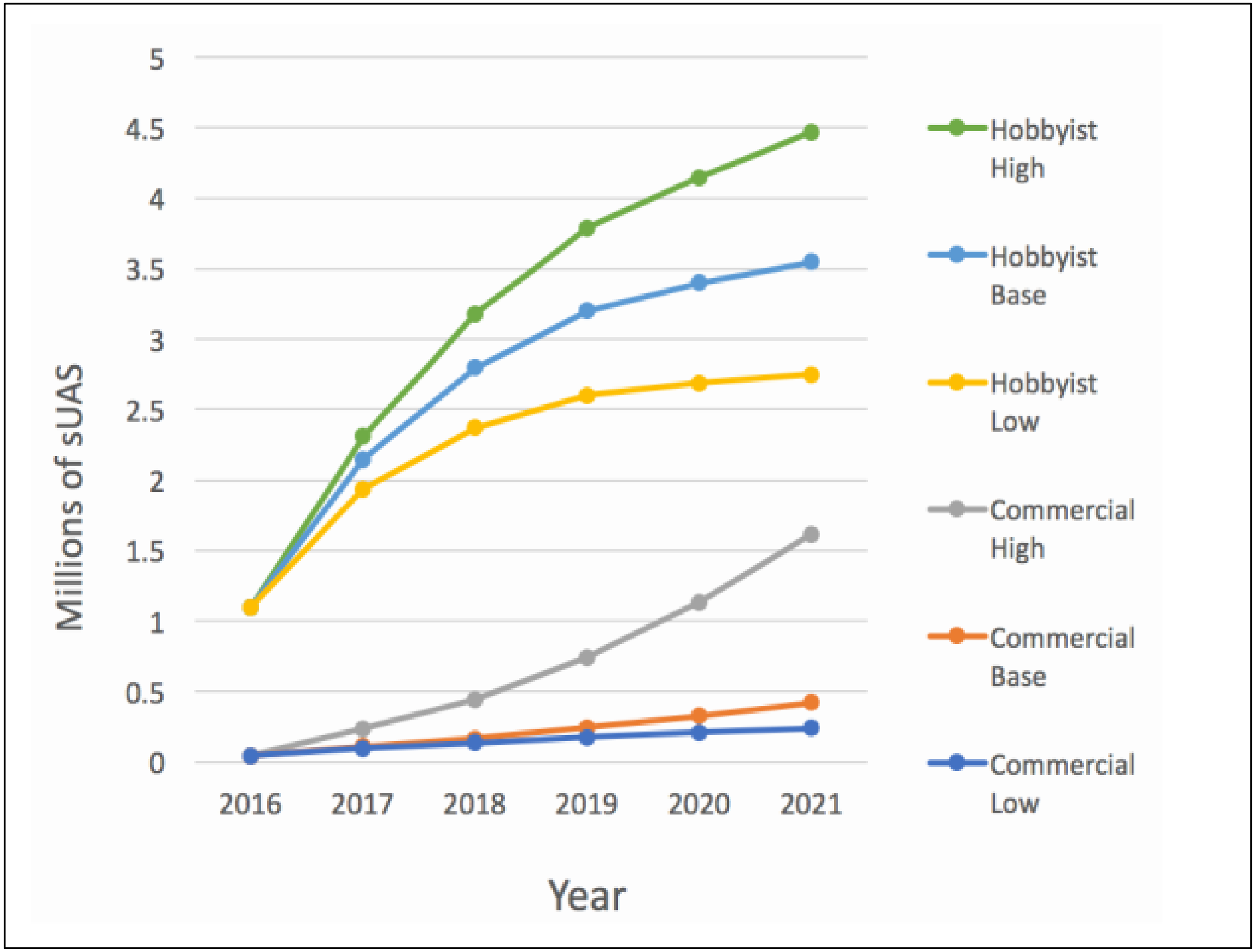
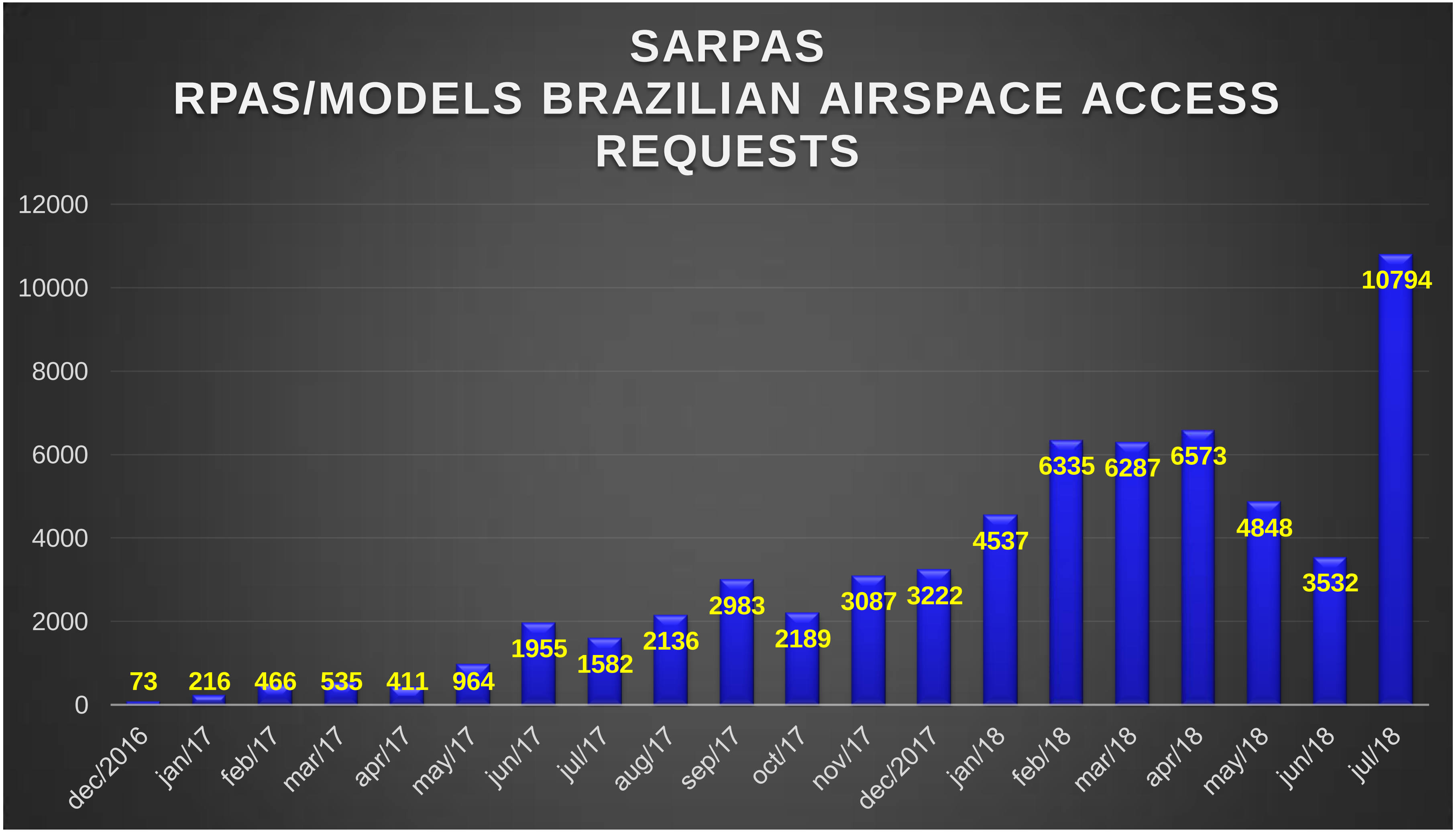
### Mining
Planning, exploration, environmental impact assessment

**$4.3bn**

# *PROJECTED UAS GROWTH*



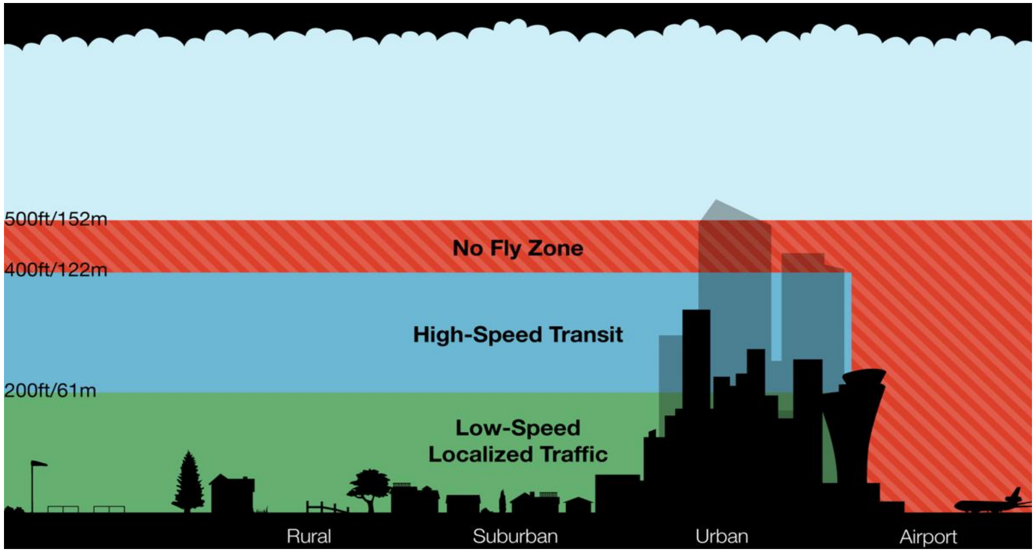

Source: Schaufele, Ding, Miller, et al, "FAA Aerospace Forecast, Fiscal Years 2017-2037", 2017




Source: SARPAS statistics (DECEA)

*“Amazon’s **plan to integrate high and low altitude airspace is both simple in concept and ambitious in implementation.** The company proposed an organized, layered structure of airspace combined with a system of “federated” traffic controllers to allow aircraft of all types to communicate with controllers and each other”*

*Source: https://dronelife.com/2016/05/03/amazon-unveils-plan-drone-integration/*




NASA and Amazon Turn to France for UTM Tests

*A Delair-Tech drone flies over a vineyard*

NASA and Amazon.com Inc. are tapping experts in France to figure out how to coordinate drone traffic, bolstering the country's role as a hub for evolving regulation of unmanned aircraft.

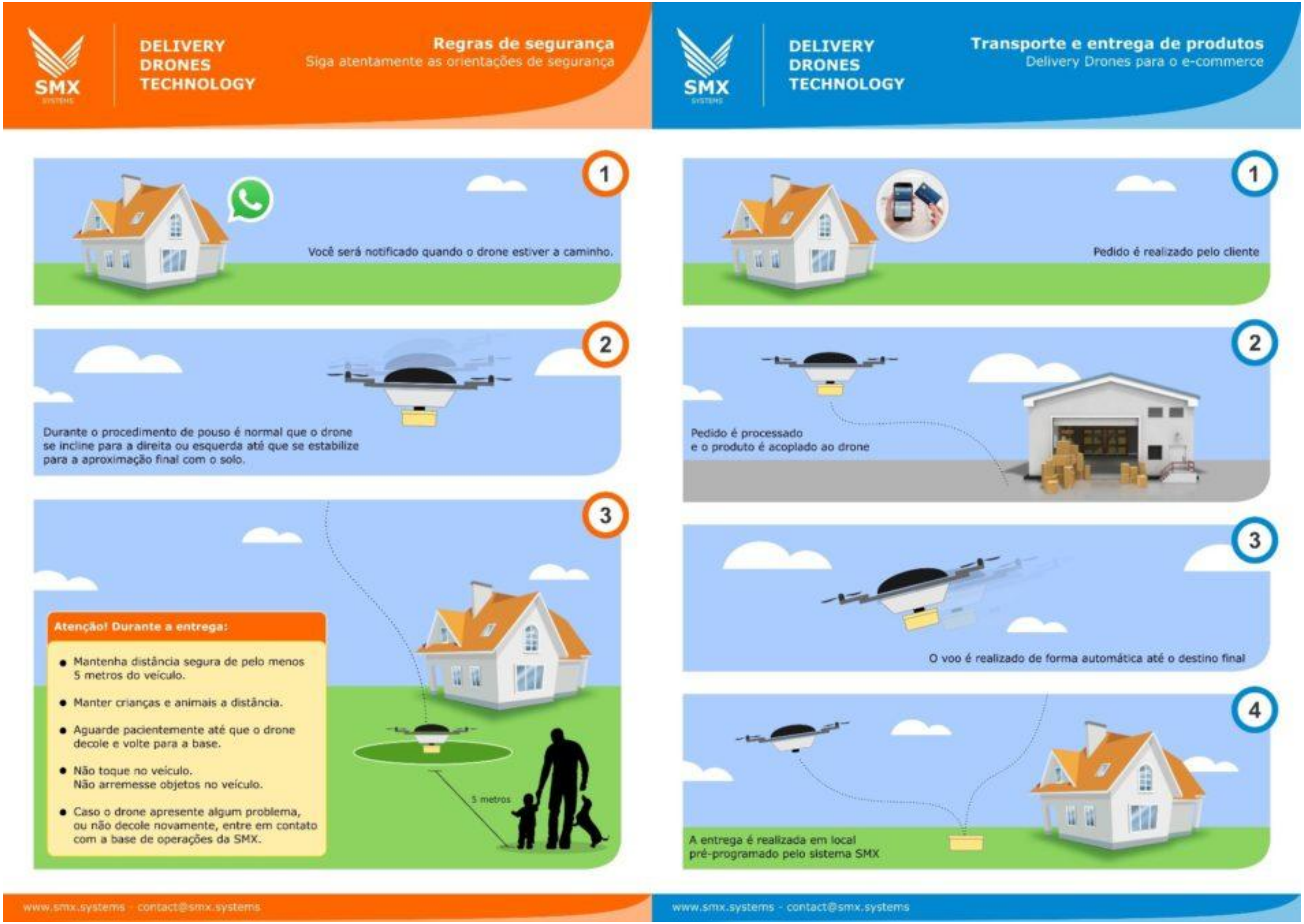
While Amazon hired a team in a Paris suburb, NASA headed closer to plane-maker Airbus SE's home in Toulouse, calling on drone designer Delair-Tech to test prototypes for air traffic management software. It's a key part of convincing regulators unmanned vehicles are safe to fly higher and further out of sight from their operators, such as while delivering goods.

# SMX realiza teste inédito no Brasil de entregas usando drones

*Moradores têm que atravessar o rio ou enfrentar estradas de terra para chegar até mercados e farmácias. Pela primeira vez no Brasil, drones realizaram entregas para consumidores de forma legal e respeitando a regulamentação vigente*


A SMX Systems, em parceria com a Prefeitura Municipal de Rifaina, no Estado de São Paulo, realizou uma prova de conceito (POC) da solução de Drone Delivery da empresa.

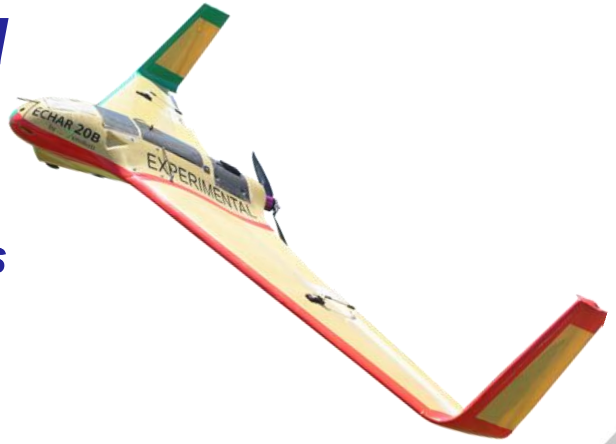
No último domingo (19/8) às 11:24 (hora de Brasília) aconteceu com sucesso a primeira entrega usando drone no Brasil. Esta foi a primeira entrega realizada por um drone pós regulamentação do setor, desde maio de 2017 . O drone utilizado foi o SMX-DLV1, que está homologado na ANATEL, tem cadastro ativo na ANAC e obteve autorização do DECEA para realizar o voo.


SMX SYSTEMS
DELIVERY DRONES TECHNOLOGY
Regras de segurança
Siga atentamente as orientações de segurança
1
Você será notificado quando o drone estiver a caminho.
2
Durante o procedimento de pouso é normal que o drone se incline para a direita ou esquerda até que se estabilize para a aproximação final com o solo.
3
Atenção! Durante a entrega:
Mantenha distância segura de pelo menos 5 metros do veículo.
Manter crianças e animais a distância.
Aguarde pacientemente até que o drone decole e volte para a base.
Não toque no veículo. Não arremesse objetos no veículo.
Caso o drone apresente algum problema, ou não decole novamente, entre em contato com a base de operações da SMX.
5 metros
www.smx.systems - contact@smx.systems
SMX SYSTEMS
DELIVERY DRONES TECHNOLOGY
Transporte e entrega de produtos
Delivery Drones para o e-commerce
1
Pedido é realizado pelo cliente
2
Pedido é processado e o produto é acoplado ao drone
3
O voo é realizado de forma automática até o destino final
4
A entrega é realizada em local pré-programado pelo sistema SMX
www.smx.systems - contact@smx.systems

# UNMANNED TRAFFIC MANAGEMENT CONOPS

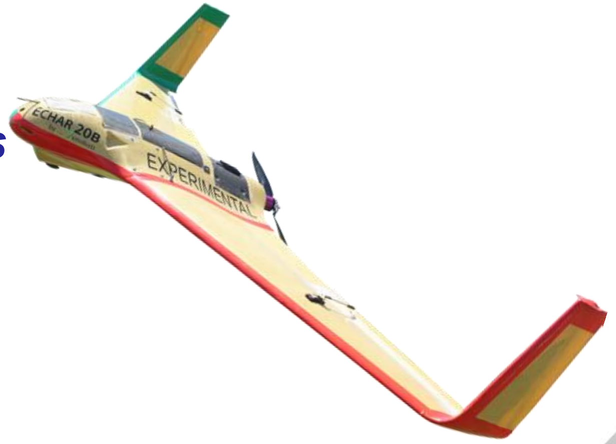
***"The term 'UTM' refers to a set of federated services and an all-encompassing framework for managing multiple UAS operations. These services are separate, but complementary to those provided by the ATM system, and are based primarily on the sharing of information between Operators on flight intent and airspace constraints"***

*UTM NEXTGEN Concept of Operations*

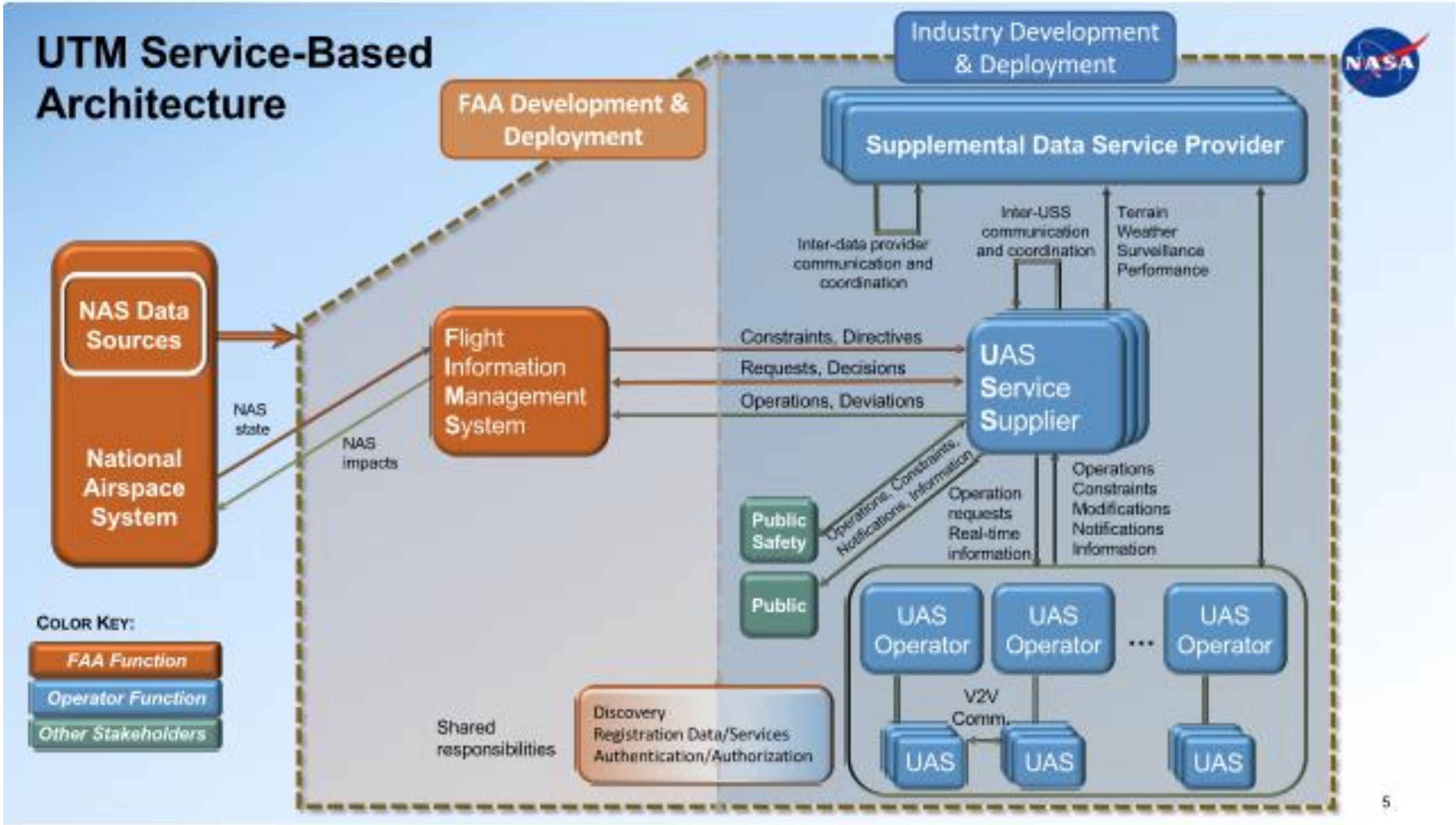


***"U-space is a set of new services and specifc procedures designed to support safe, effcient and secure access to airspace for large numbers of drones […] U-space provides an enabling framework to support routine drone operations, as well as a clear and effective interface to manned aviation, ATM/ANS "***

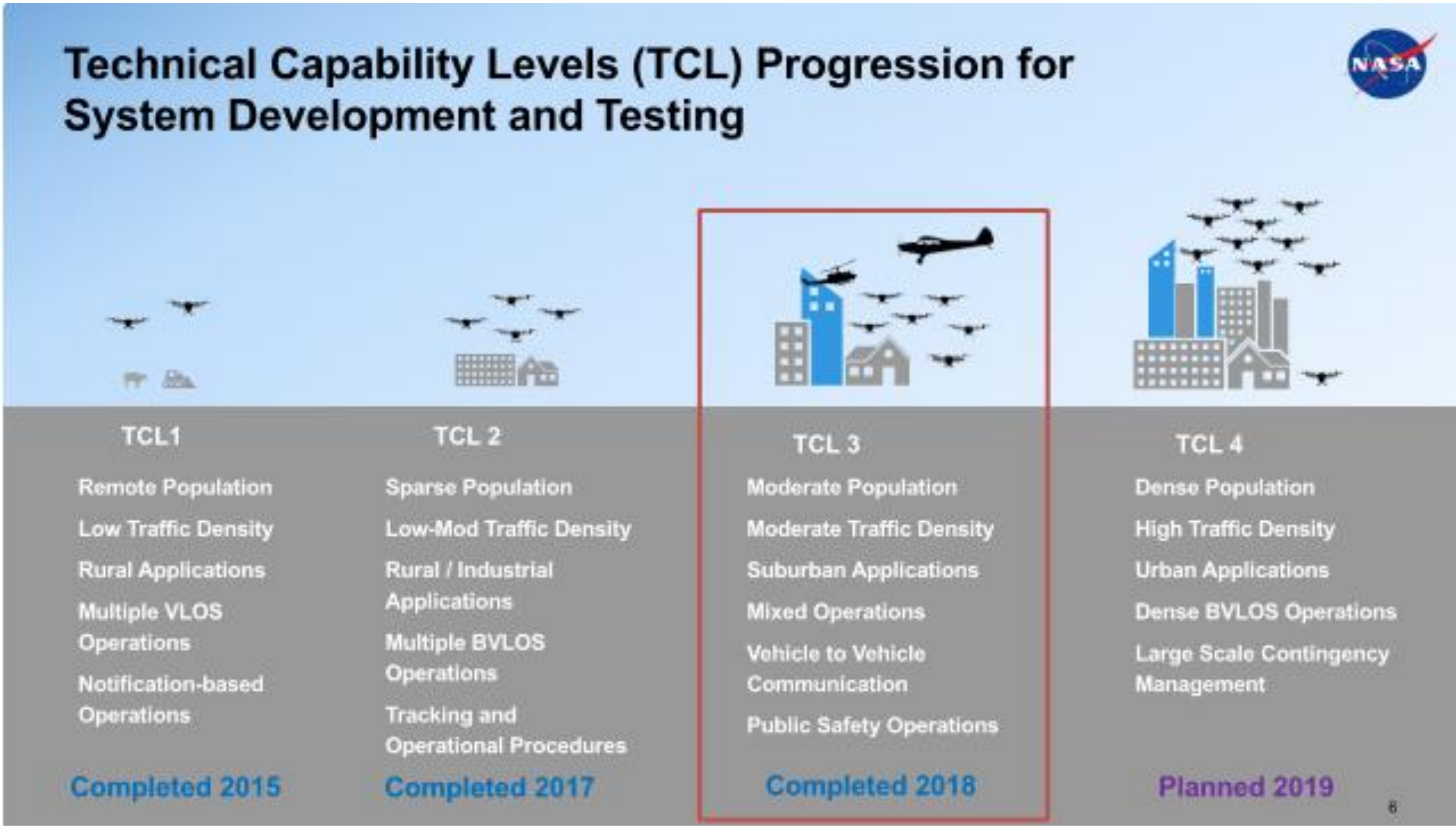
*U-SPACE Concept of Operations*



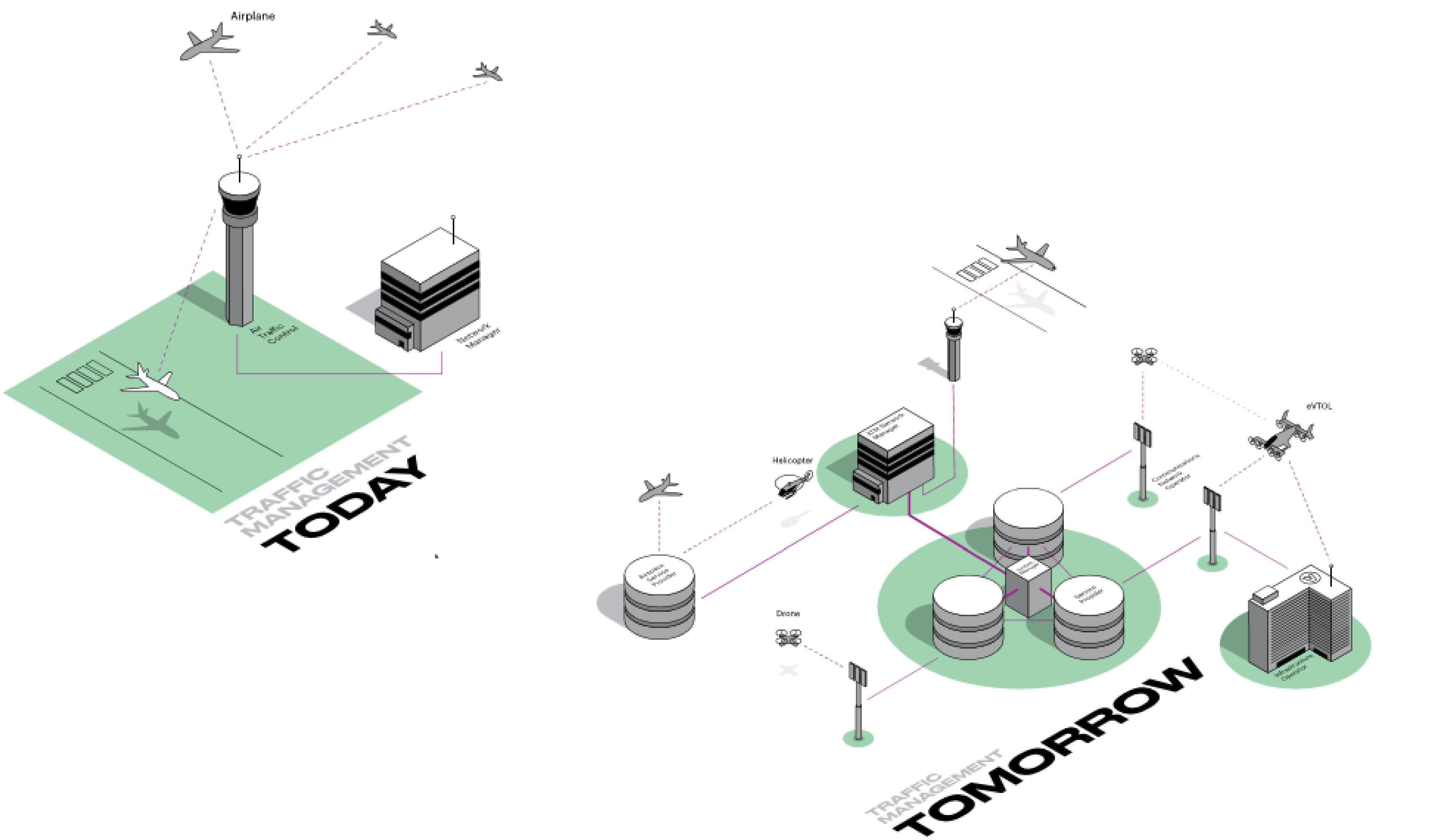

*Source: AIRBUS UTM Blueprint*



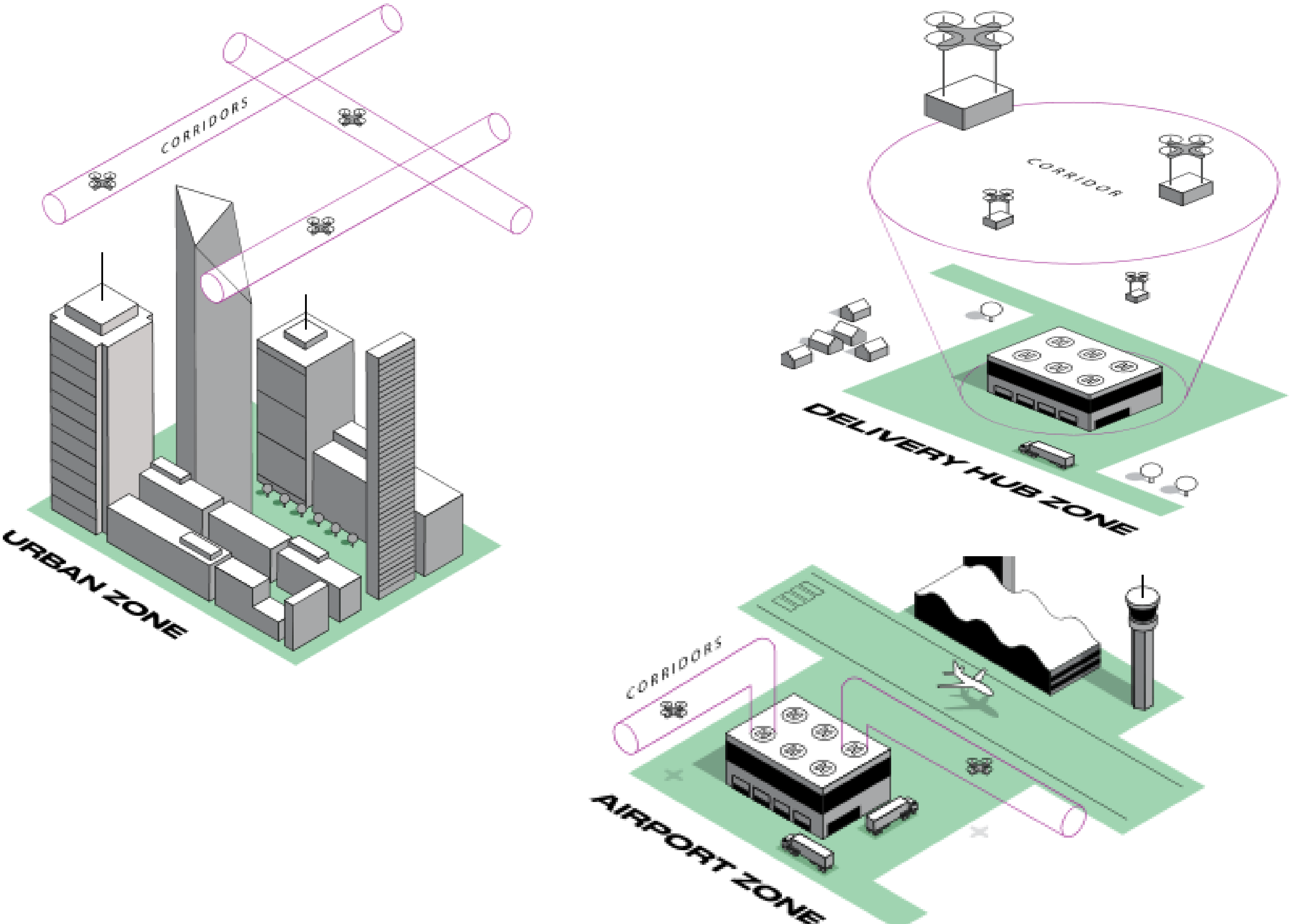

***Source: NASA UTM Project***



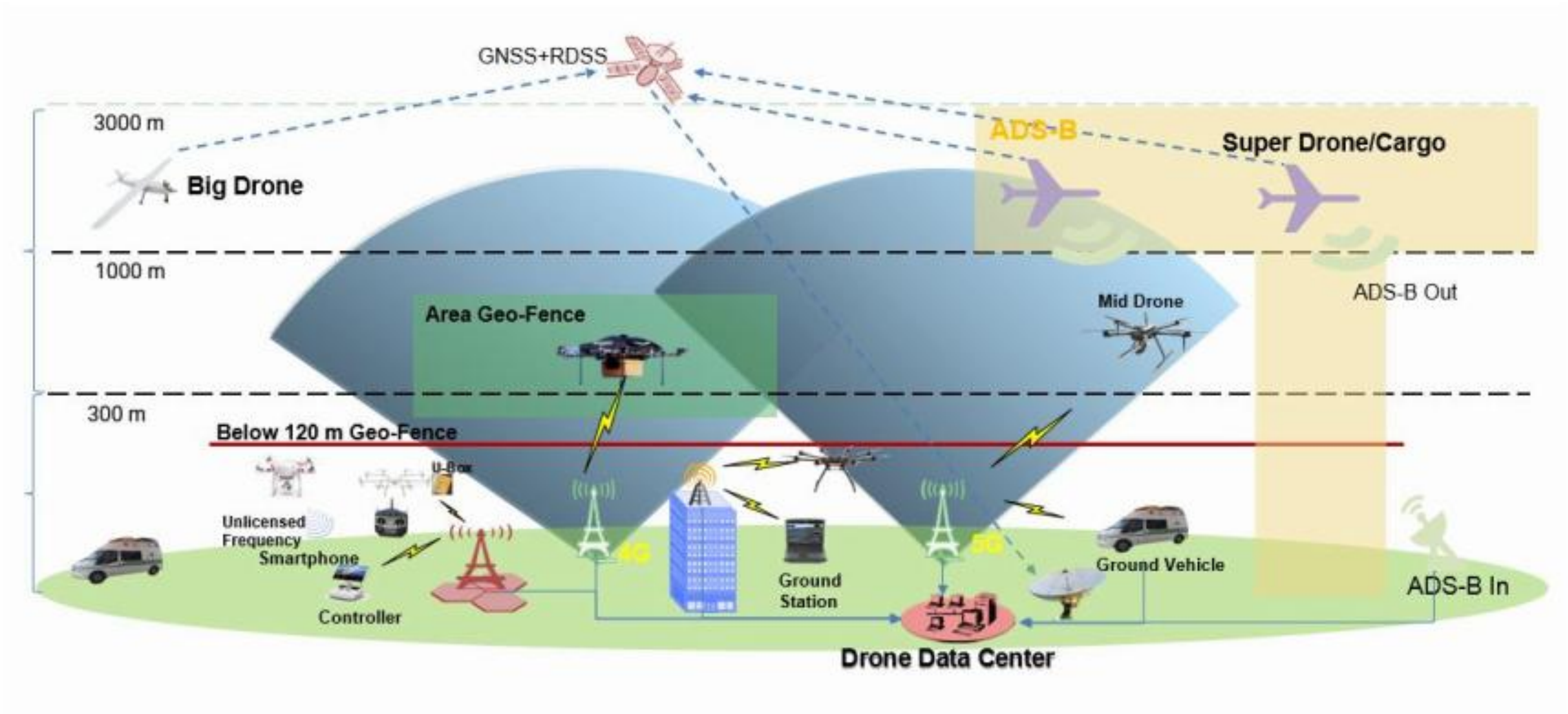

***Source: NASA UTM Project***



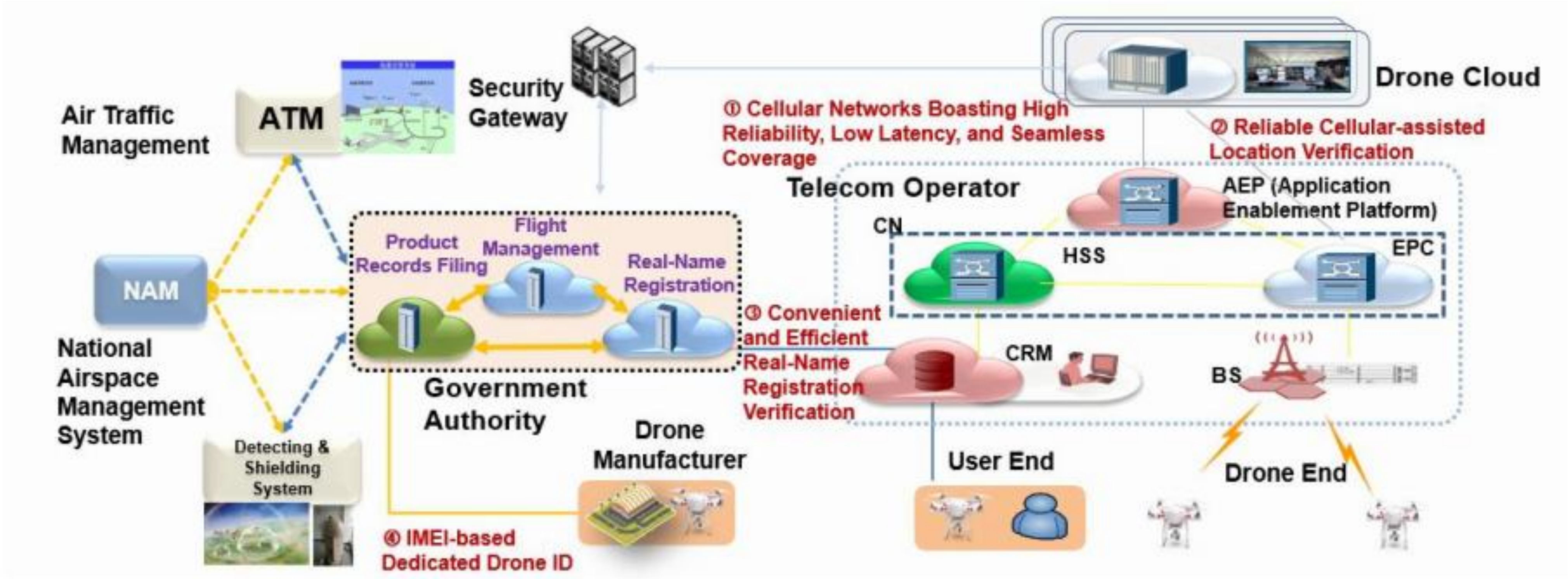

*Source: AIRBUS UTM Blueprint*




*Source: AIRBUS UTM Blueprint*

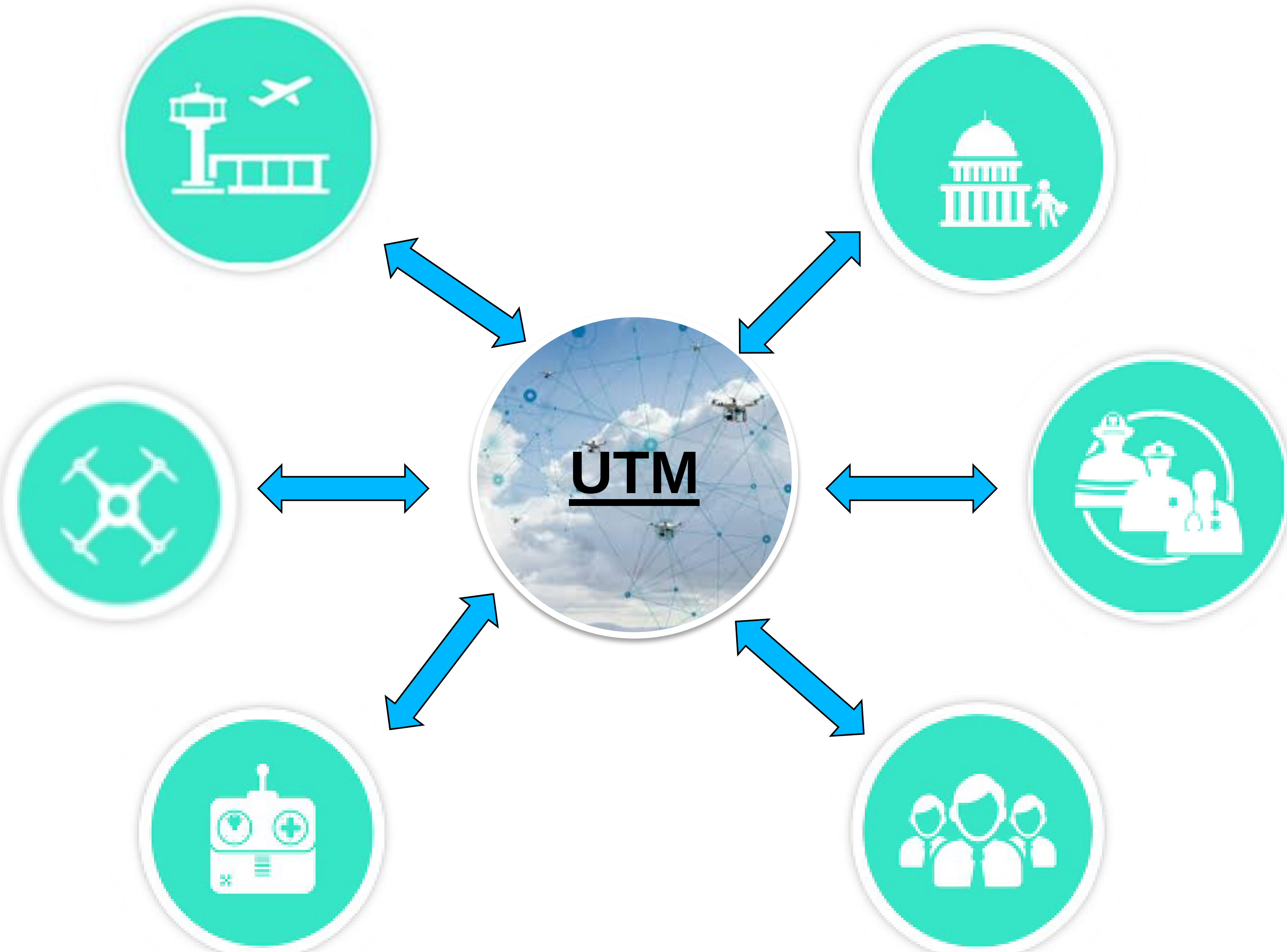



*Source: CAAC, Low-Altitude Connected Drone Flight Safety Test, 2018. Report*




*Source: CAAC, Low-Altitude Connected Drone Flight Safety Test, 2018. Report*

# UTM STAKEHOLDERS



**_RPAS_**

*Remotely Piloted Aircraft System*

**_UAS_**

*Unmanned Aircraft System*

**_SUAS_**

*Small Unmanned Aircraft System*

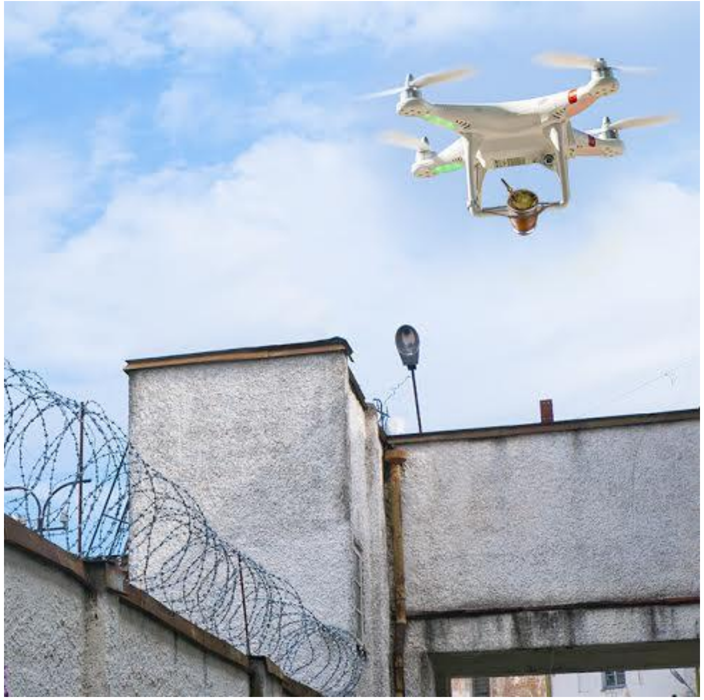
“*however, disruptive technologies emerge: innovations that result in worse product performance, at least in the near-term.*”

” *Products based on disruptive technologies are typically cheaper, simpler, smaller, and, frequently, more convenient to use*

(CHRISTENSEN, ***THE INNOVATOR’S DILEMMA When New Technologies Cause Great Firms to Fail*** , 1997)

# FLAWS

- “FLY-AWAY”;
- MISFUNCTION;
- LOW AUTONOMY;
- LOW ROBUSTNESS & INTEGRITY IN C² LINK;
- SATCOMM EXPENSIVE;
- POOR AERONAUTICAL CULTURE IN THE UAS COMMUNITY;
- ....



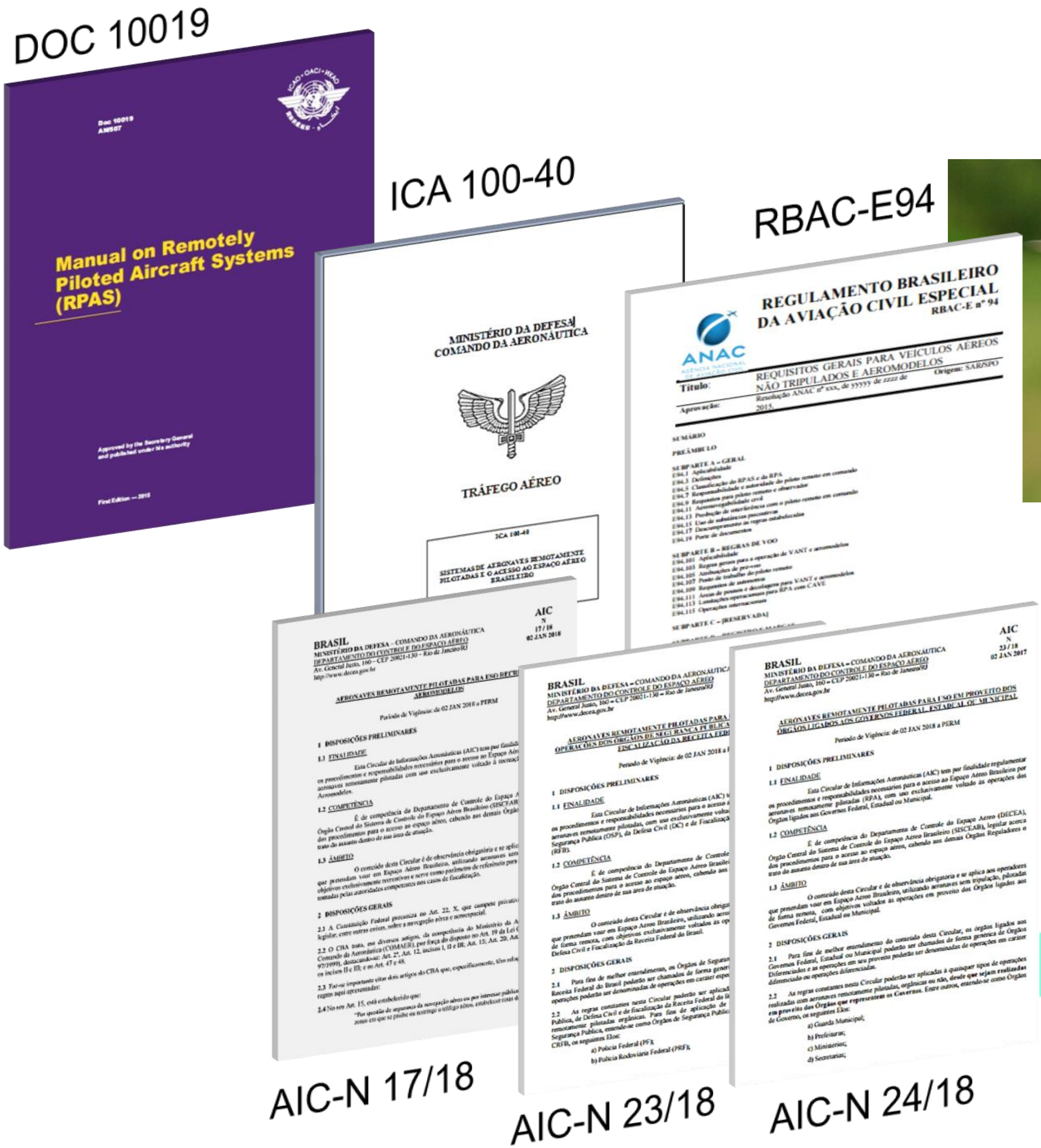

UBER

# OVERVIEW

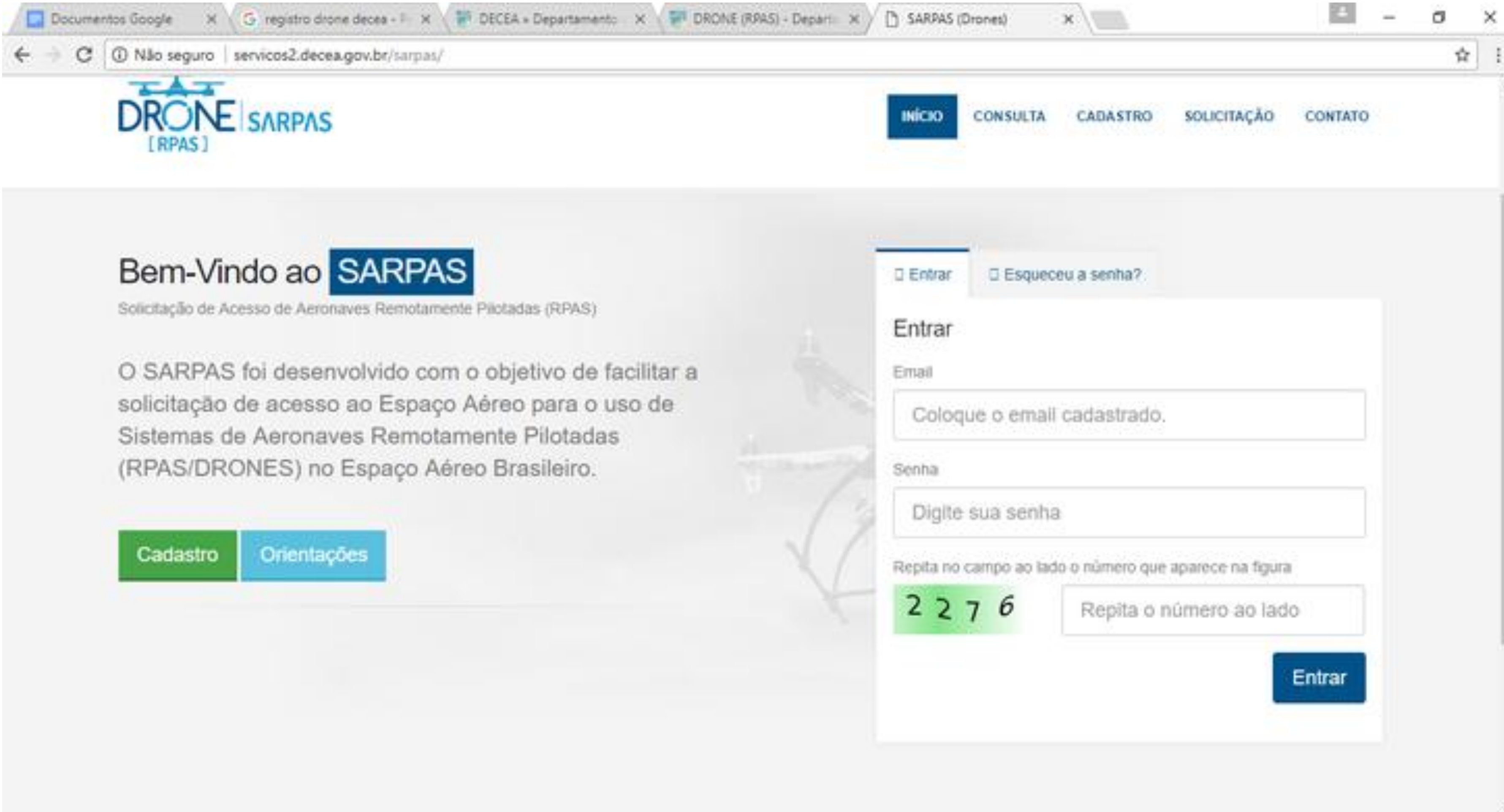
UNMANNED TRAFFIC MANAGEMENT (UTM)

DRAFT UTM BRAZILIAN CONCEPT


UTM CONSTRAINTS & CHALLENGES




**www.decea.gov.br/drone**

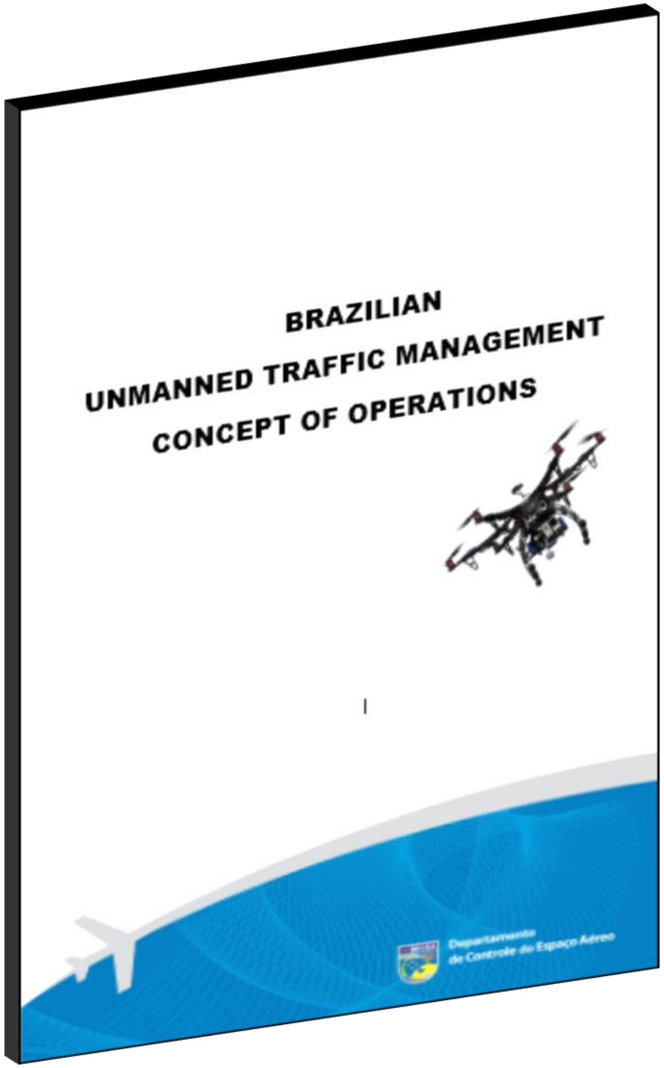

Documentos Google
registro drone decea
DECEA » Departamento
DRONE (RPAS) - Depart
SARPAS (Drones)
Não seguro
servicos2.decea.gov.br/sarpas/
DRONE [RPAS] SARPAS
INÍCIO
CONSULTA
CADASTRO
SOLICITAÇÃO
CONTATO
Bem-Vindo ao SARPAS
Solicitação de Acesso de Aeronaves Remotamente Pilotadas (RPAS)
O SARPAS foi desenvolvido com o objetivo de facilitar a solicitação de acesso ao Espaço Aéreo para o uso de Sistemas de Aeronaves Remotamente Pilotadas (RPAS/DRONES) no Espaço Aéreo Brasileiro.
Cadastro
Orientações
Entrar
Esqueceu a senha?
Entrar
Email
Coloque o email cadastrado.
Senha
Digite sua senha
Repita no campo ao lado o número que aparece na figura
2276
Repita o número ao lado
Entrar

# RPAS DECEA Project
# PFF019 – RPAS

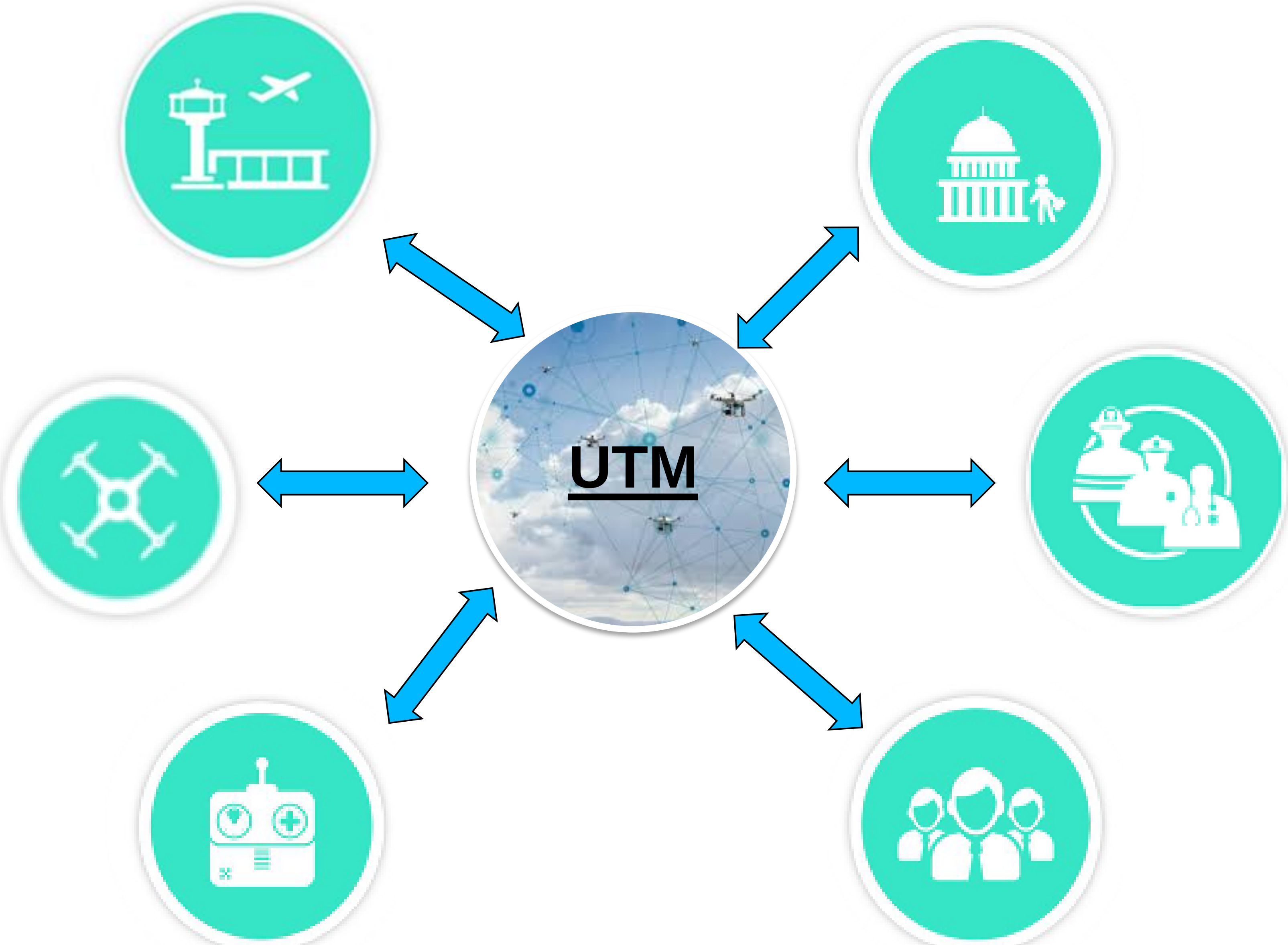
# RPAS DECEA Project
# UTM

***"Unmanned Aircraft Systems Traffic Management (UTM) is a set of capacities that provides robustness, integrity, safety and coordination to UAS operations, which could use capacities like BVLOS and autonomous pre-determined behavior, as an specific Air Traffic Service at specific airspace volume. "***

*Brazilian UTM Concept of Operations*



# BRAZIL UTM STAKEHOLDERS



# BRAZIL UTM AIRSPACE

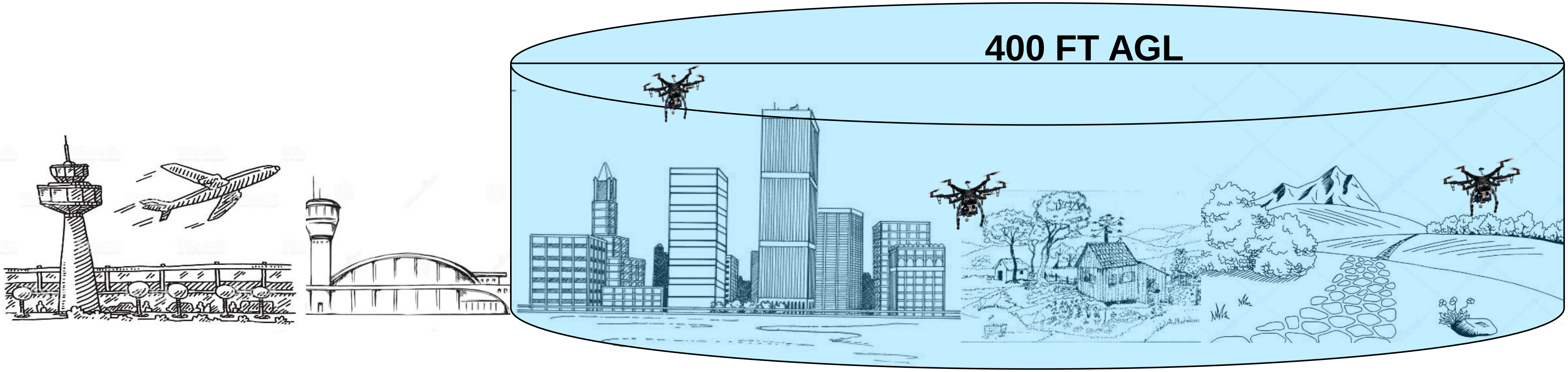
- ✓ UTM LEVEL;
- ✓ UTM LEVEL SCENARIO.

# BRAZIL UTM AIRSPACE

- ✓ UTM LEVEL 1 – GROUND UP TO 400FT AGL;
- ✓ UTM LEVEL 2 – “G” CLASS AIRSPACE;
- ✓ UTM LEVEL 3 – ATM INTERACTION.

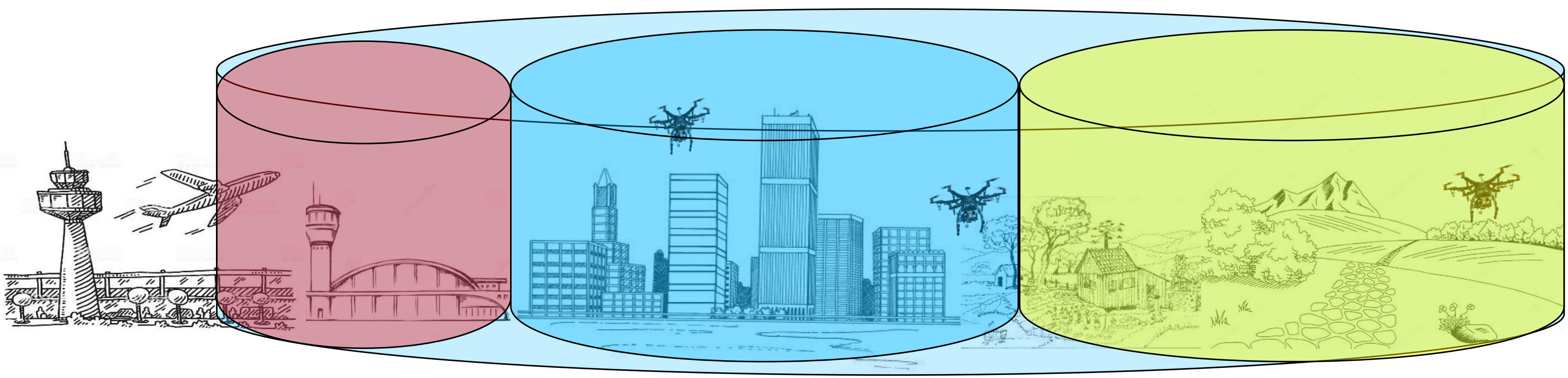
# BRAZIL UTM AIRSPACE

✓ **UTM LEVEL 1 – GROUND UP TO 400FT AGL**



# BRAZIL UTM AIRSPACE

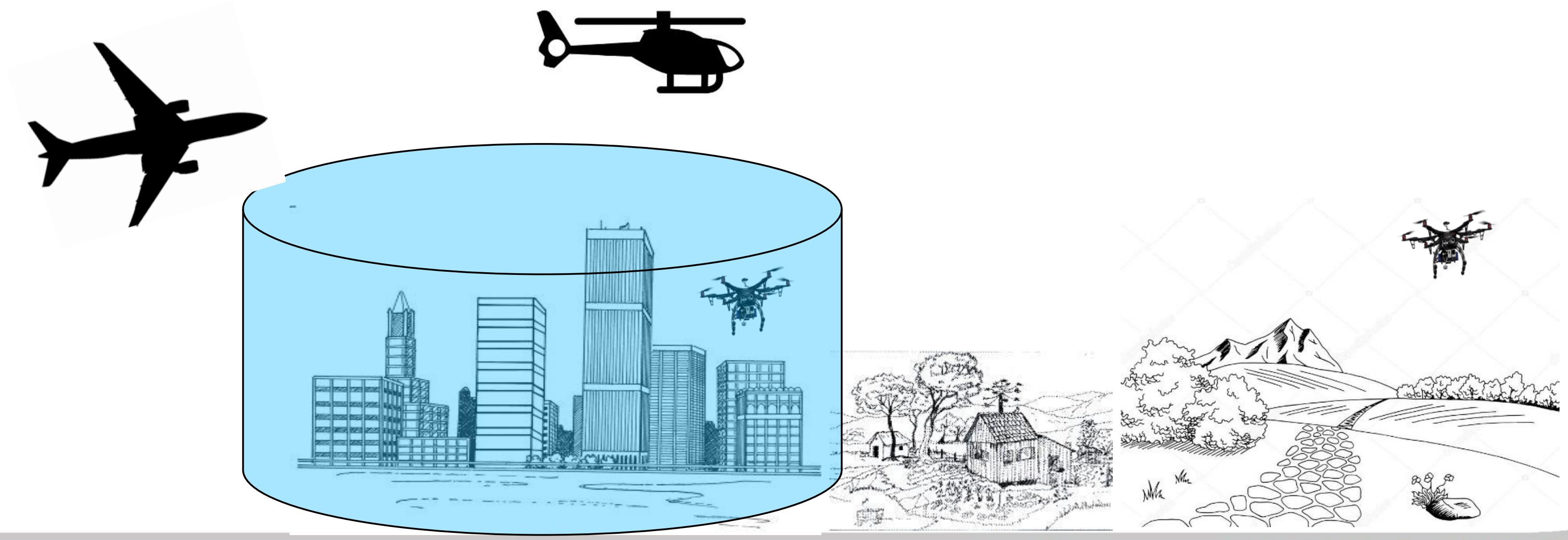
- ✓ **UTM LEVEL 1 – GROUND UP TO 400FT AGL**
  - ✓ **SCENARIO 1: URBAN AREA;**
  - ✓ **SCENARIO 2: NON URBAN AREA;**
  - ✓ **SCENARIO 3*: ATM INTERACTION.**



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 1 (URBAN AREA)***

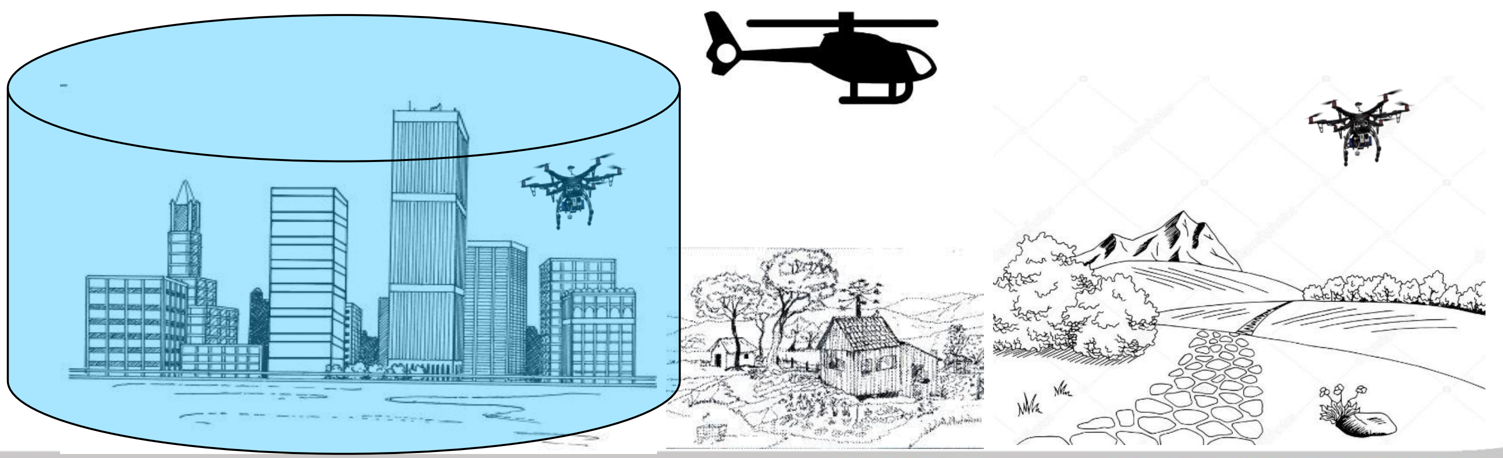
- ✓ ***MANNED A/C FLY AT HIGH LEVELS;***
- ✓ ***COOPERATIVE A/C;***
- ✓ ***CELL PHONES NETWORKS;***
- ✓ ***DENSELY POPULATED AREAS (FLY OVER PEOPLE);***
- ✓ ***SUSTAINABLE PROJECT (ECONOMIC INTERESTING).***



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 1 ARCHITECTURE***

- ✓ ***UAS HUBS;***
- ✓ ***SEPARATED PRE-PLANNED ROUTES;***
- ✓ ***GNSS / VISUAL GEO-REFERENCING MILESTONES NAVIGATION;***
- ✓ ***ELECTRONIC ID & ACCESS CLOUD;***
- ✓ ***INTERACTIVE INTERFACE HUMAN-SYSTEM (IHS).***



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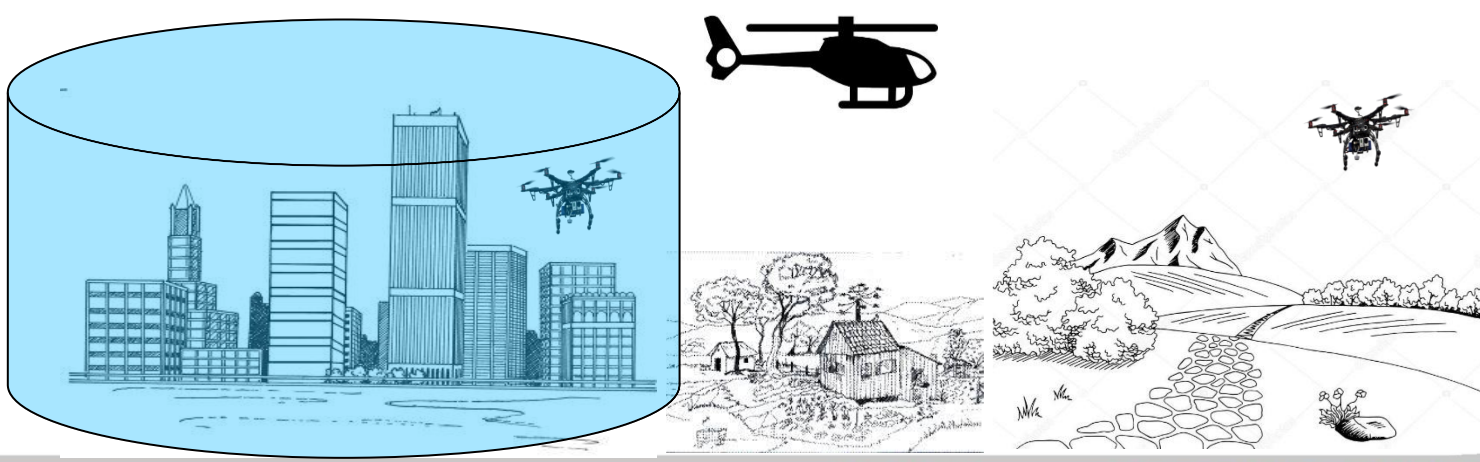
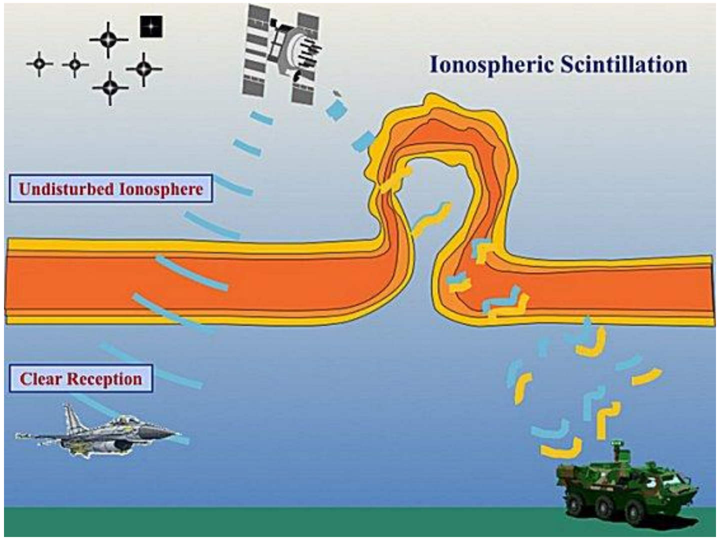
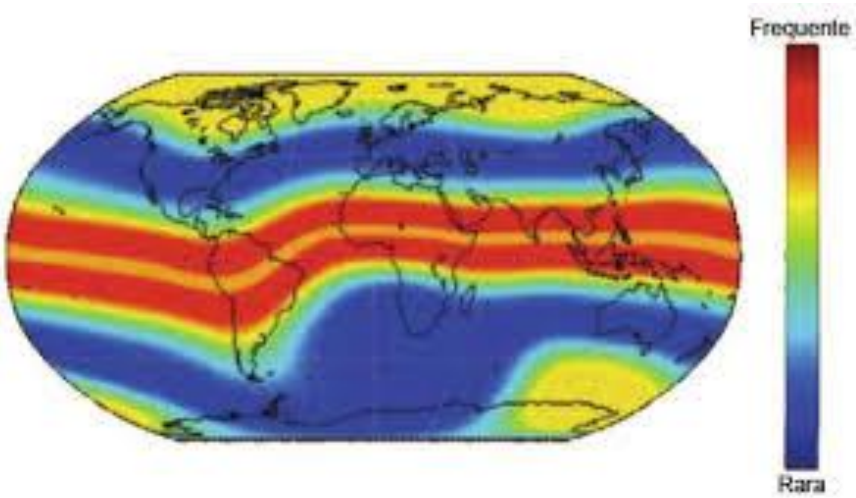
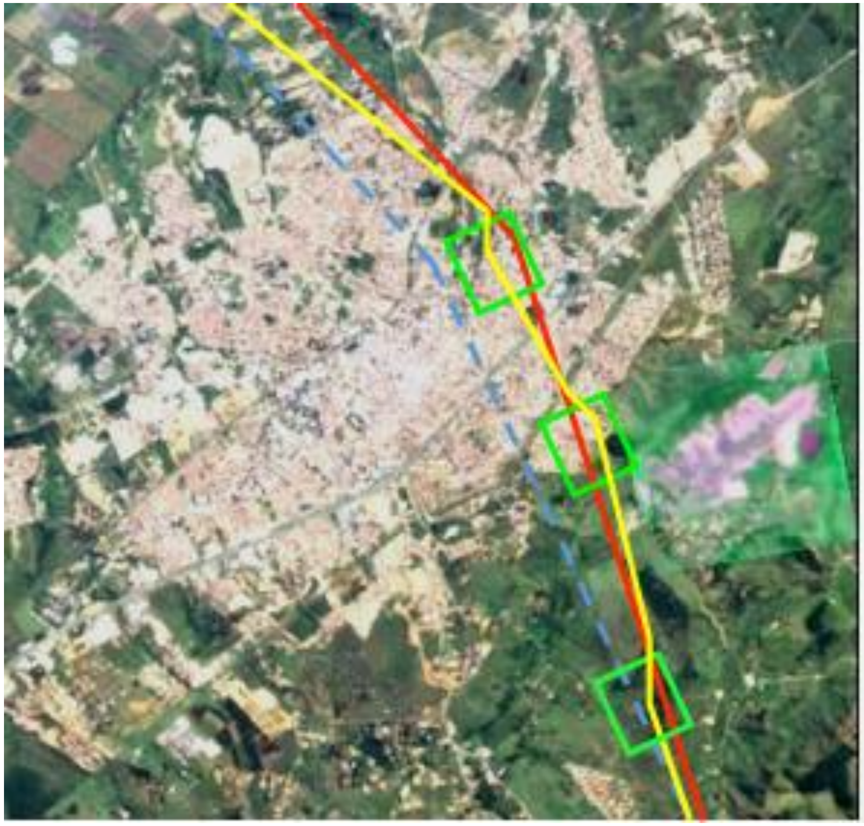


# NAVIGATION IN UTM CORRIDORS



**INS Deviation**
**Pre-Planned Route**
**Route Milestone Correction**

Photo Source: 1T Silva Filho, Seleção Automática De Marcos Para Navegação Aérea Autônoma Por Imagens De ARP, IEAV

# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 1 ARCHITECTURE***

- ✓ ***UAS HUBS;***
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- ✓ ***GNSS / VISUAL GEO-REFERENCING MILESTONES NAVIGATION;***
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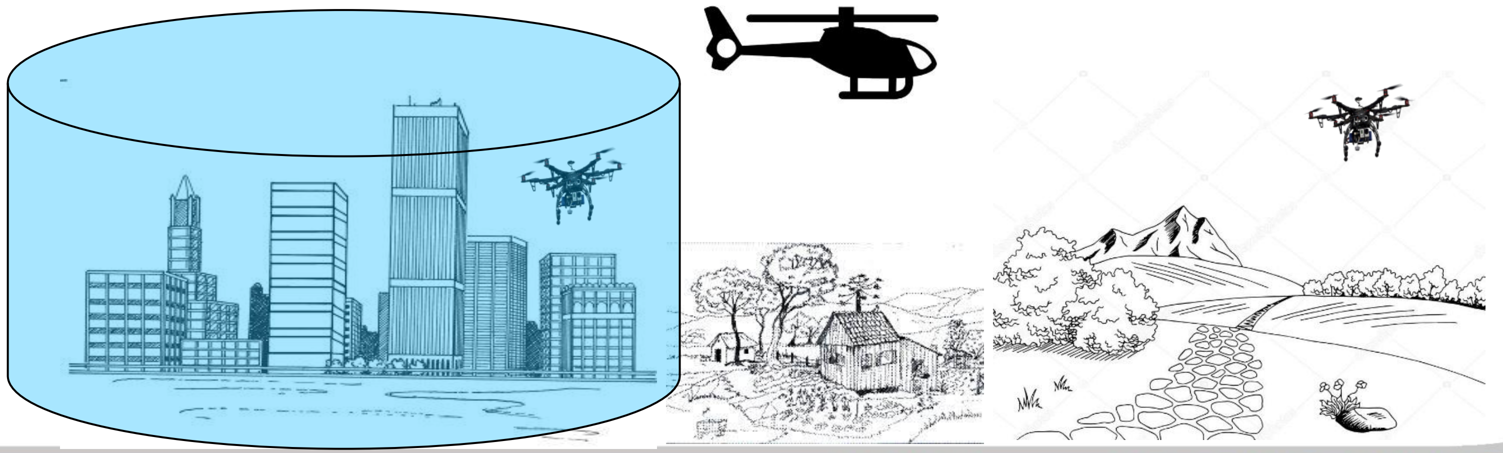
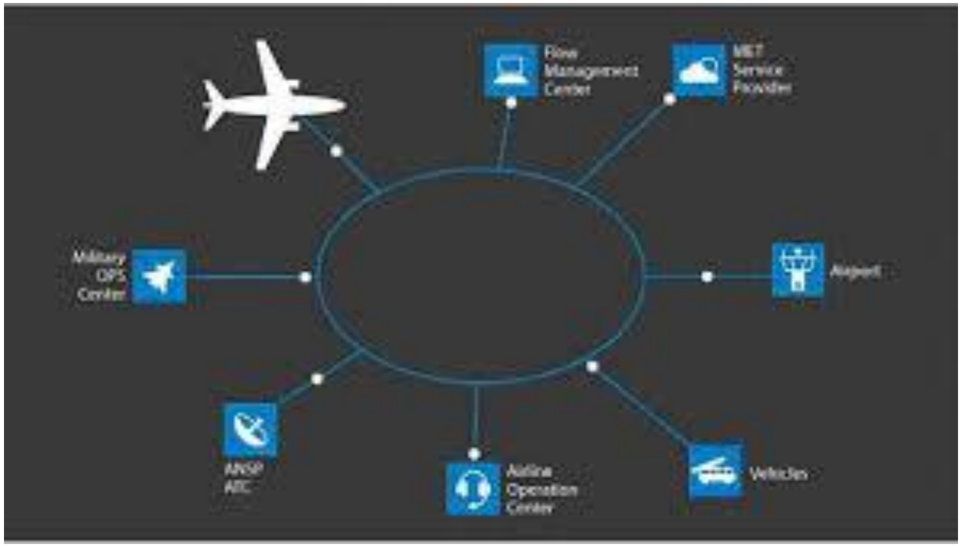
- ✓ ***INTERACTIVE INTERFACE HUMAN-SYSTEM (IHS).***



# IHS UTM



Flow Management Center
MET Service Provider
Military OPS Center
Airport
ANSP ATC
Airline Operation Center
Vehicles


0.5 Miles
6:22


# BRAZIL UTM AIRSPACE

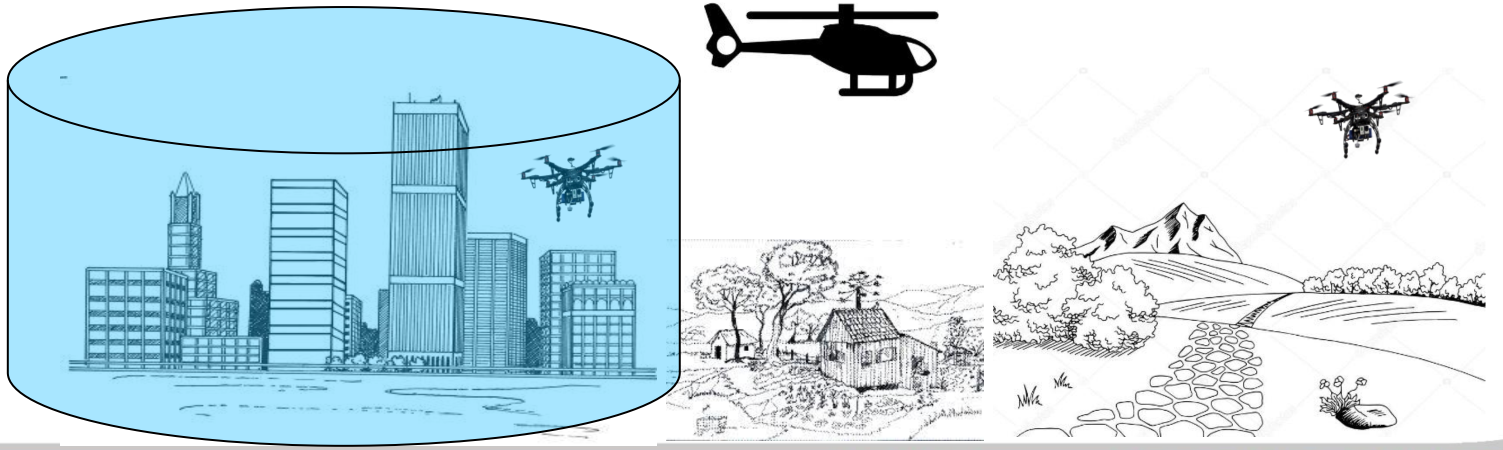
***UTM LEVEL 1 - SCENARIO 1***

***<u>MANAGEMENT CAPACITIES</u>***

- ✓ ***DYNAMIC RE-ROUTING (LAW ENFORCEMENT / RESCUE & RELIEF ACTIVITIES….);***
- ✓ ***GEO-FENCING MANAGEMENT;***
- ✓ ***DYNAMIC UTM INFORMATION DISTRIBUTION***

***(E.g.: WEATHER);***

- ✓ ***UTM SERVICE PROVIDER (UTSP).***



# BRAZIL UTM AIRSPACE

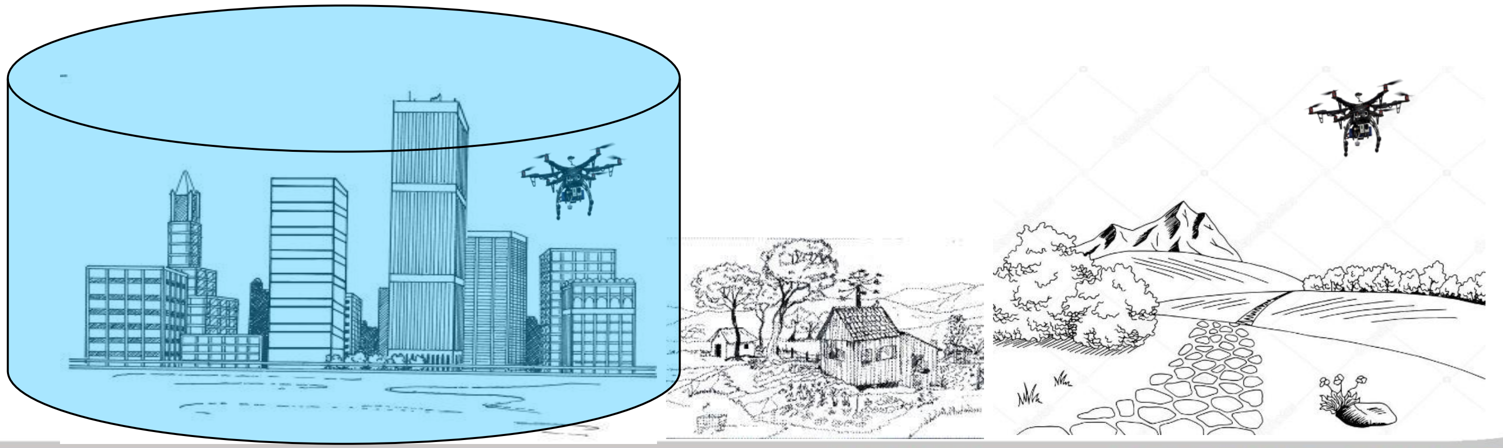
***UTM LEVEL 1 - SCENARIO 1***

***<u>UAS CAPACITIES</u>***

- ✓ ***DAA: UAS X UAS / UAS X OBSTACLES;***
- ✓ ***DYNAMIC REROUTING NAVIGATION;***
- ✓ ***GEOFENCING & SAFETY EQUIPMENTS (E.g.: PARACHUTES);***
- ✓ ***C² LINK & GNSS TAMPERING, ROBUSTNESS & INTEGRITY***

***(E.g.: Spoofing)***

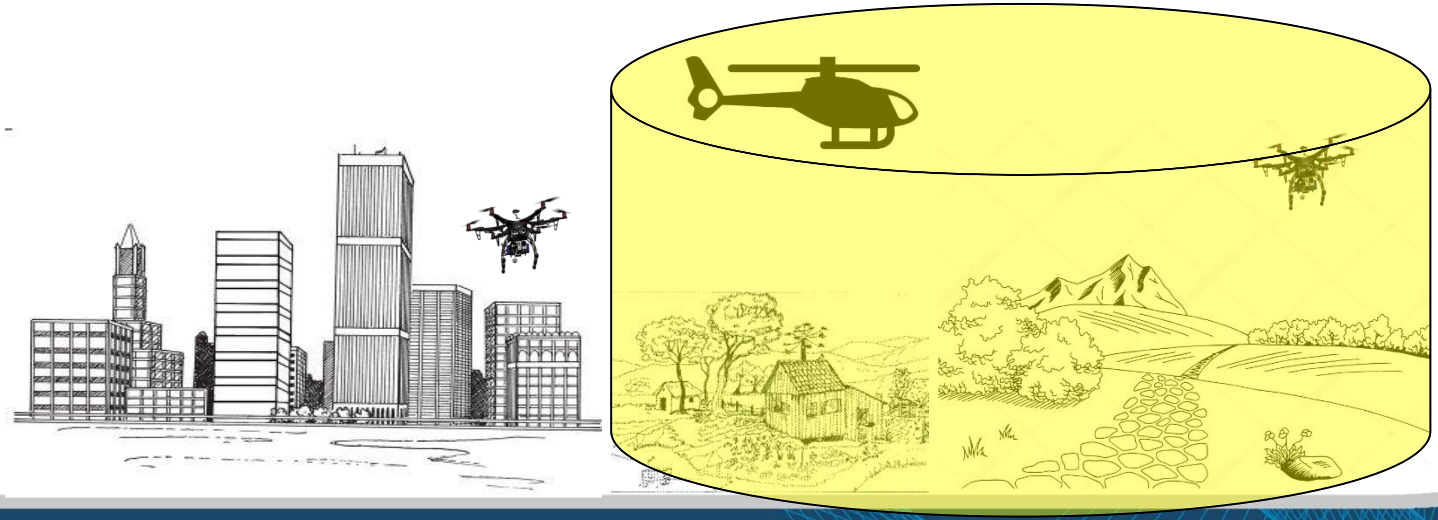
- ✓ ***NOISE REDUCTION;***
- ✓ ***BATTERIES ENERGY X PAYLOAD X ENDURANCE.***



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 2 (NON URBAN AREA)***

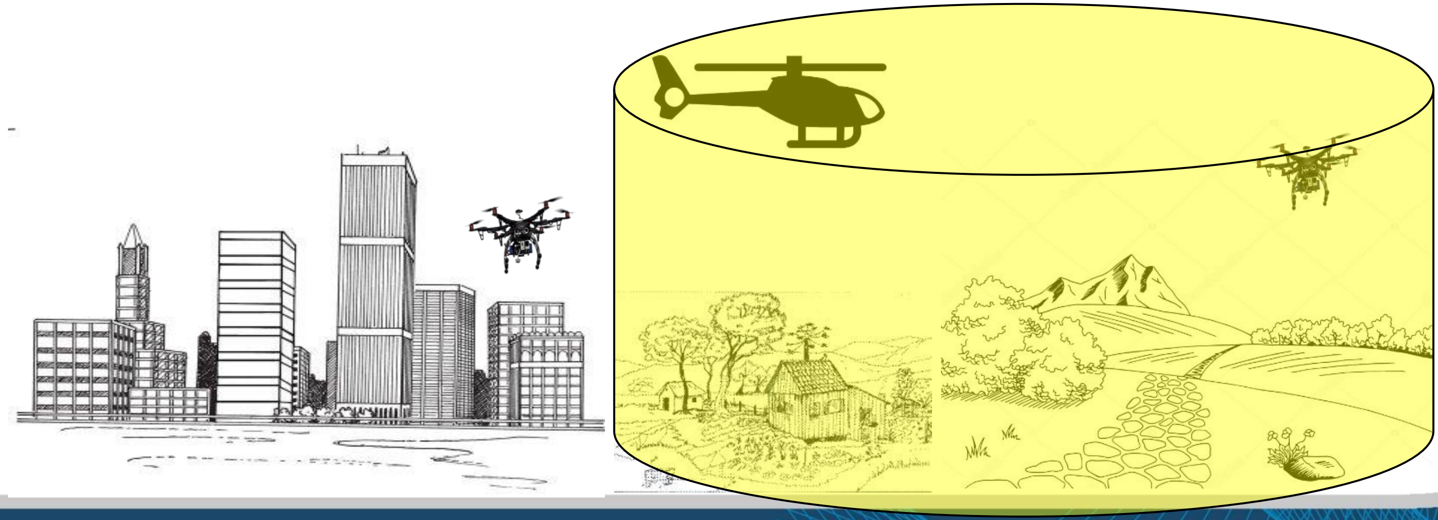
- ✓ ***MANNED A/C FLY AT LOW (HELO) & NEAR LEVELS (ICA 100-4);***
- ✓ ***MANNED NON COOPERATIVE A/C (E.g.: AGRICULTURAL A/C);***
- ✓ ***LESS CELL PHONES NETWORKS;***
- ✓ ***LESS DENSELY POPULATED AREAS (FLY OVER PEOPLE);***
- ✓ ***SUSTAINABLE PROJECT (HUMANITARIAN INTERESTING).***



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 2 ARCHITECTURE***

- ✓ ***UAS HUBS;***
- ✓ ***SEPARATED PRE-PLANNED ROUTES;***
- ✓ ***GNSS NAVIGATION;***
- ✓ ***ELECTRONIC ID & ACCESS CLOUD;***
- ✓ ***INTERACTIVE INTERFACE HUMAN-SYSTEM (IHS).***



# BRAZIL UTM AIRSPACE

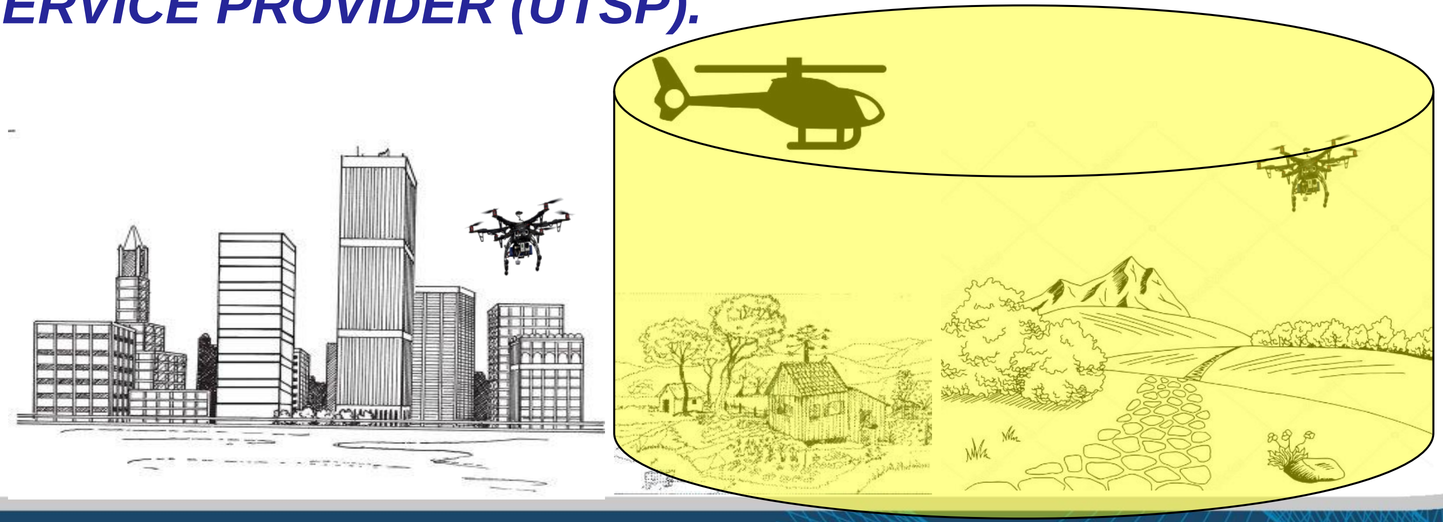
***UTM LEVEL 1 - SCENARIO 2***

***<u>MANAGEMENT CAPACITIES</u>***

- ✓ ***DYNAMIC REROUTING (LAW ENFORCEMENT / RESCUE & RELIEF ACTIVITIES….);***
- ✓ ***GEO-FENCING MANAGEMENT;***
- ✓ ***DYNAMIC UTM INFORMATION DISTRIBUTION***

***(E.g.: WEATHER);***

- ✓ ***UTM SERVICE PROVIDER (UTSP).***

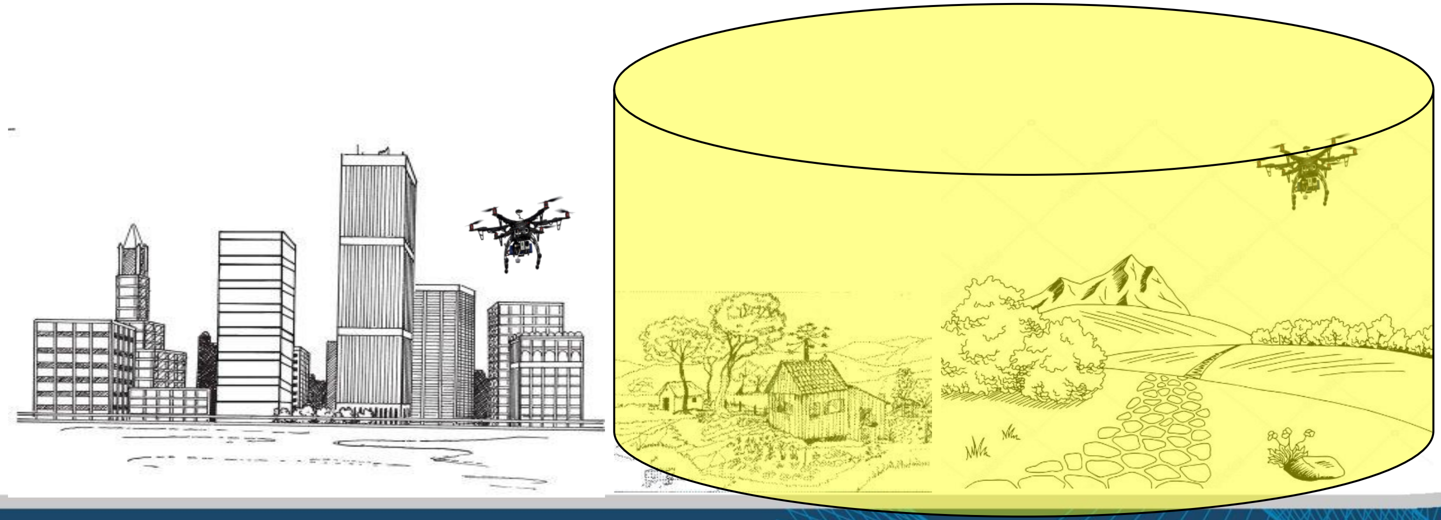


# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 2***

***<u>UAS CAPACITIES</u>***

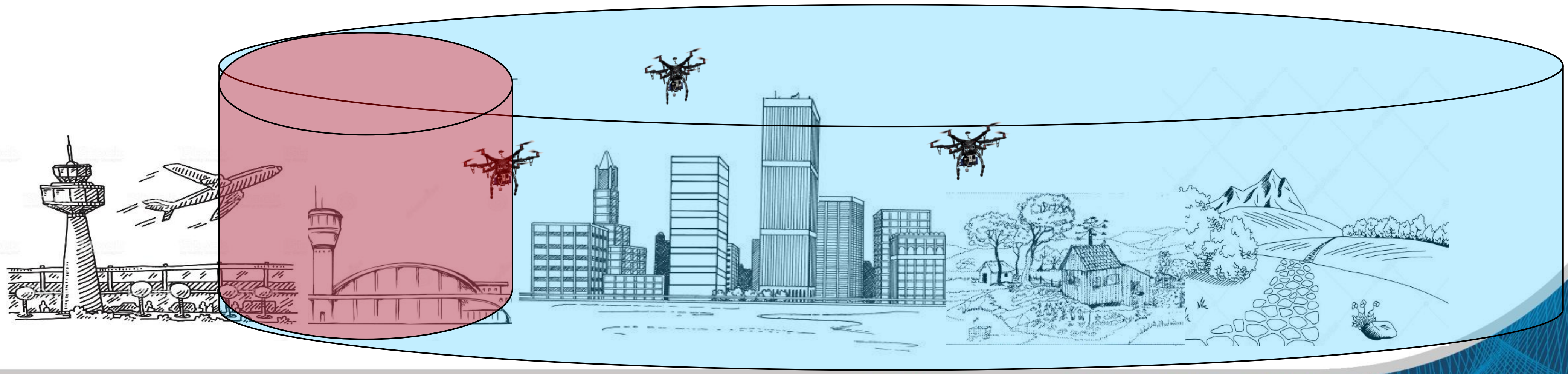
- ✓ ***DAA: UAS X UAS / UAS X OBSTACLES / UAS X MANNED A/C;***
- ✓ ***DYNAMIC REROUTING NAVIGATION;***
- ✓ ***GEOFENCING & SAFETY EQUIPMENTS (E.g.: PARACHUTES);***
- ✓ ***C² LINK & GNSS TAMPERING, ROBUSTNESS & INTEGRITY;***
- ✓ ***NOISE REDUCTION;***
- ✓ ***BATTERIES ENERGY X PAYLOAD X ENDURANCE.***



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 3 (ATM INTERACTION)***

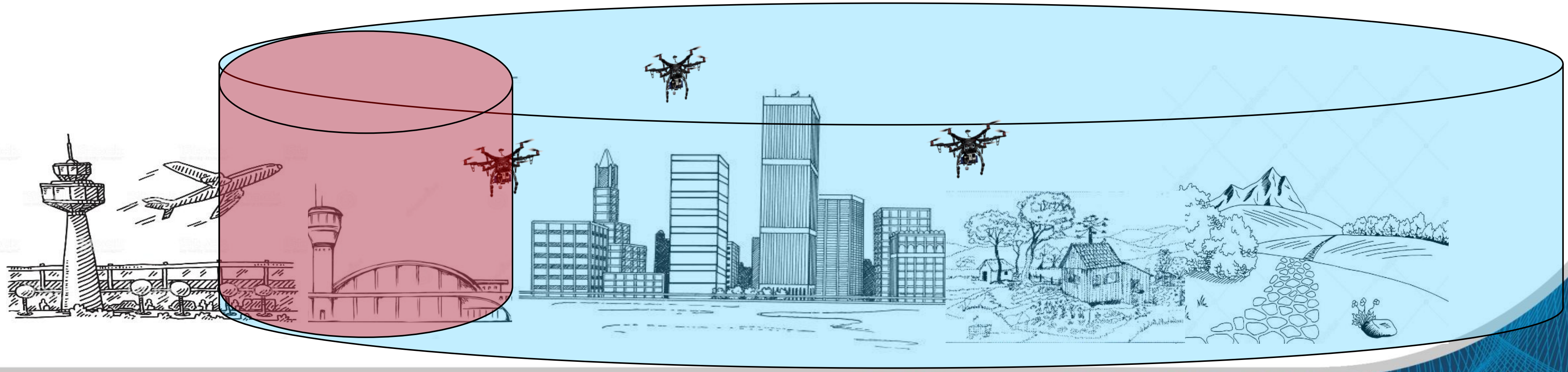
- ✓ ***MANNED A/C FLY AT LOW HEIGHTS (DEP/ARR PATHS);***
- ✓ ***CELL PHONES NETWORKS;***
- ✓ ***CONSTANTLY RISK ASSESSMENT;***
- ✓ ***MORE ANSP X UTSP SERVICE PROVIDER INTERACTION.***



# BRAZIL UTM AIRSPACE

***UTM LEVEL 1 - SCENARIO 3 ARCHITECTURE***

- ✓ ***UAS HUBS;***
- ✓ ***SEPARATED PRE-PLANNED ROUTES (NOT CROSSING DEP/ARR NEAR LOW PATHS)***
- ✓ ***GNSS NAVIGATION;***
- ✓ ***ELECTRONIC ID & ACCESS CLOUD;***
- ✓ ***INTERACTIVE ANSP & UTSP RELATIONS;***
- ✓ ***INTERACTIVE INTERFACE HUMAN-SYSTEM (IHS) WITHIN ANSP.***



# BRAZIL UTM AIRSPACE

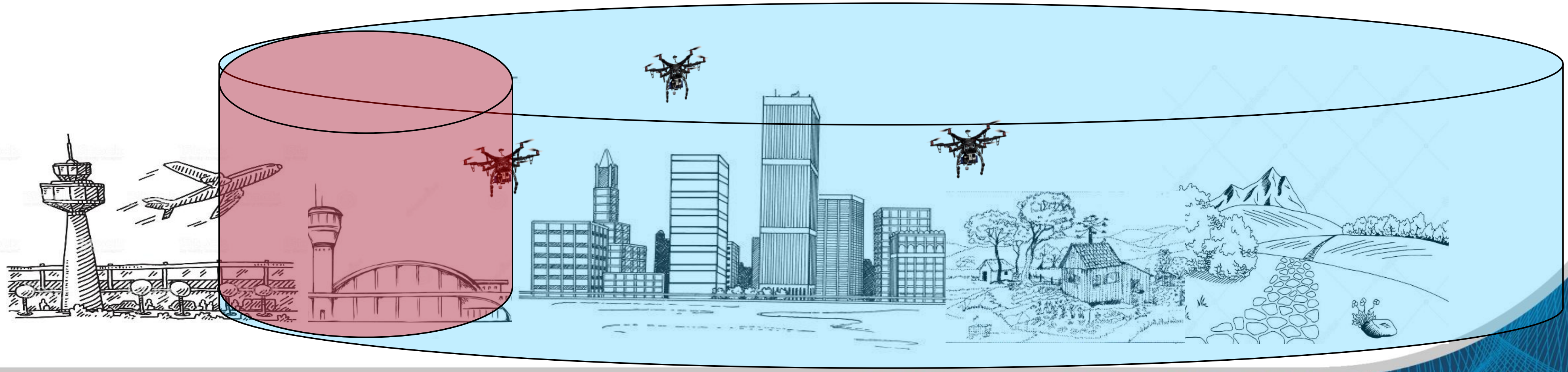
***UTM LEVEL 1 - SCENARIO 3***

***<u>MANAGEMENT CAPACITIES</u>***

- ✓ ***DYNAMIC CANCEL ROUTING (LAW ENFORCEMENT / RESCUE & RELIEF ACTIVITIES….);***
- ✓ ***GEO-FENCING MANAGEMENT;***
- ✓ ***DYNAMIC UTM INFORMATION DISTRIBUTION***

***(E.g.: WEATHER);***

- ✓ ***UTSP FAST COMMUNICATIONS W/ ANSP & UAS OPERATOR.***

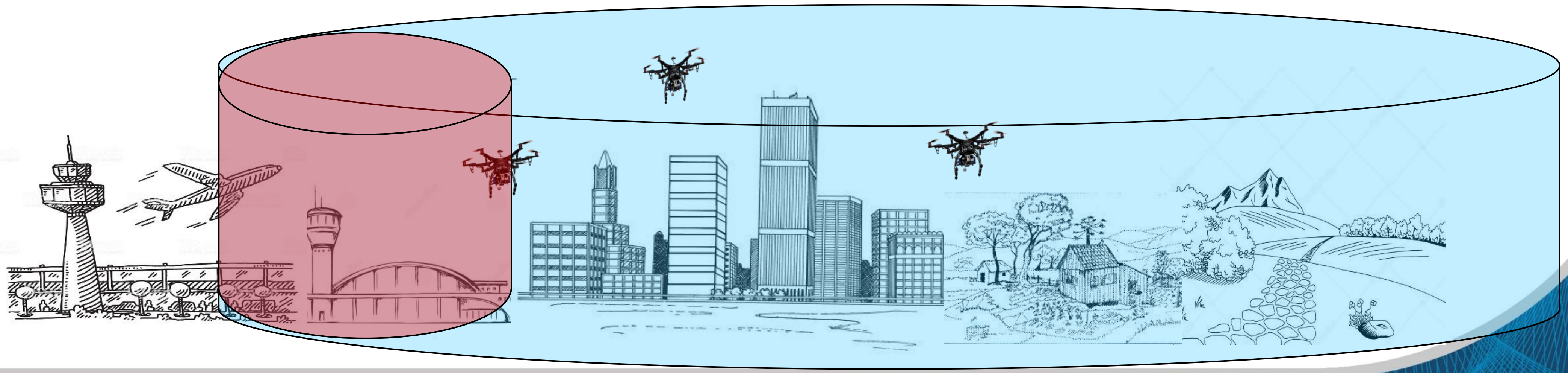


# BRAZIL UTM AIRSPACE

*UTM LEVEL 1 - SCENARIO 3*

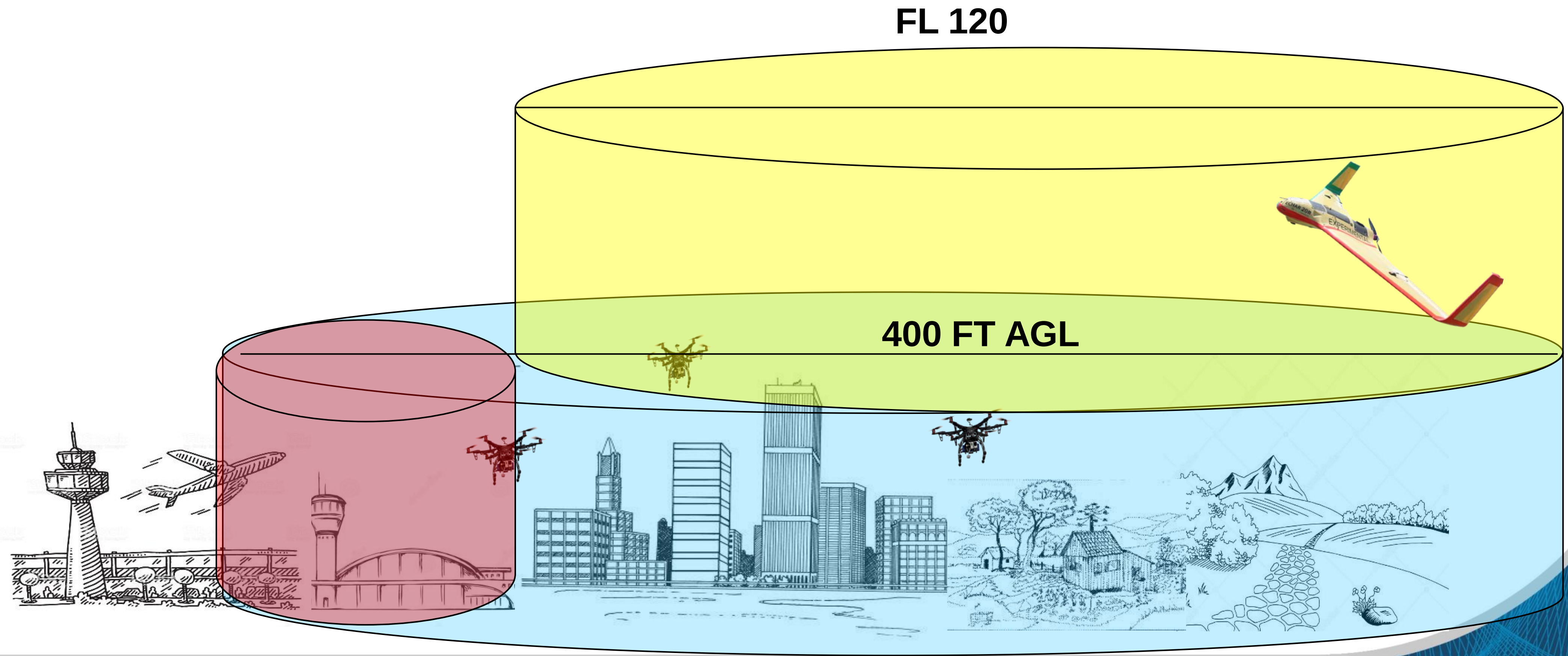
*<u>UAS CAPACITIES</u>*

- ✓ *DAA: UAS X UAS / UAS X OBSTACLES / UAS X MANNED A/C;*
- ✓ *GEOFENCING;*
- ✓ *DYNAMIC REROUTING NAVIGATION;*
- ✓ *C² LINK & GNSS TAMPERING, ROBUSTNESS & INTEGRITY;*
- ✓ *TERMINATE FLIGHT PROGRAM.*



# BRAZIL UTM AIRSPACE

✓ **UTM LEVEL 2 – AIRSPACE CLASS "G"**



# BRAZIL UTM AIRSPACE

***UTM LEVEL 2 – "G" AIRSPACE***

- ✓ ***MANNED A/C FLY AT LOW (HELO) & NEAR LEVELS (ICA 100-4);***
- ✓ ***MANNED NON COOPERATIVE A/C;***
- ✓ ***WEATHER CONSTRAINTS.***

# BRAZIL UTM AIRSPACE

***UTM LEVEL 2 – “G” AIRSPACE***

- ✓ ***SEPARATED PRE-PLANNED ROUTES (NOT CROSSING DEP/ARR NEAR LOW PATHS)***
- ✓ ***PBN REQUIREMENTS;***
- ✓ ***COOPERATIVE ATC EQUIPMENT;***
- ✓ ***ELECTRONIC ID;***
- ✓ ***INTERACTIVE ANSP & UAS OPERATOR RELATIONS (WHEN APPLICABLE);***
- ✓ ***SAFETY BUFFER (“G” AIRSPACE & CONTROLED AIRSPACE).***

# BRAZIL UTM AIRSPACE

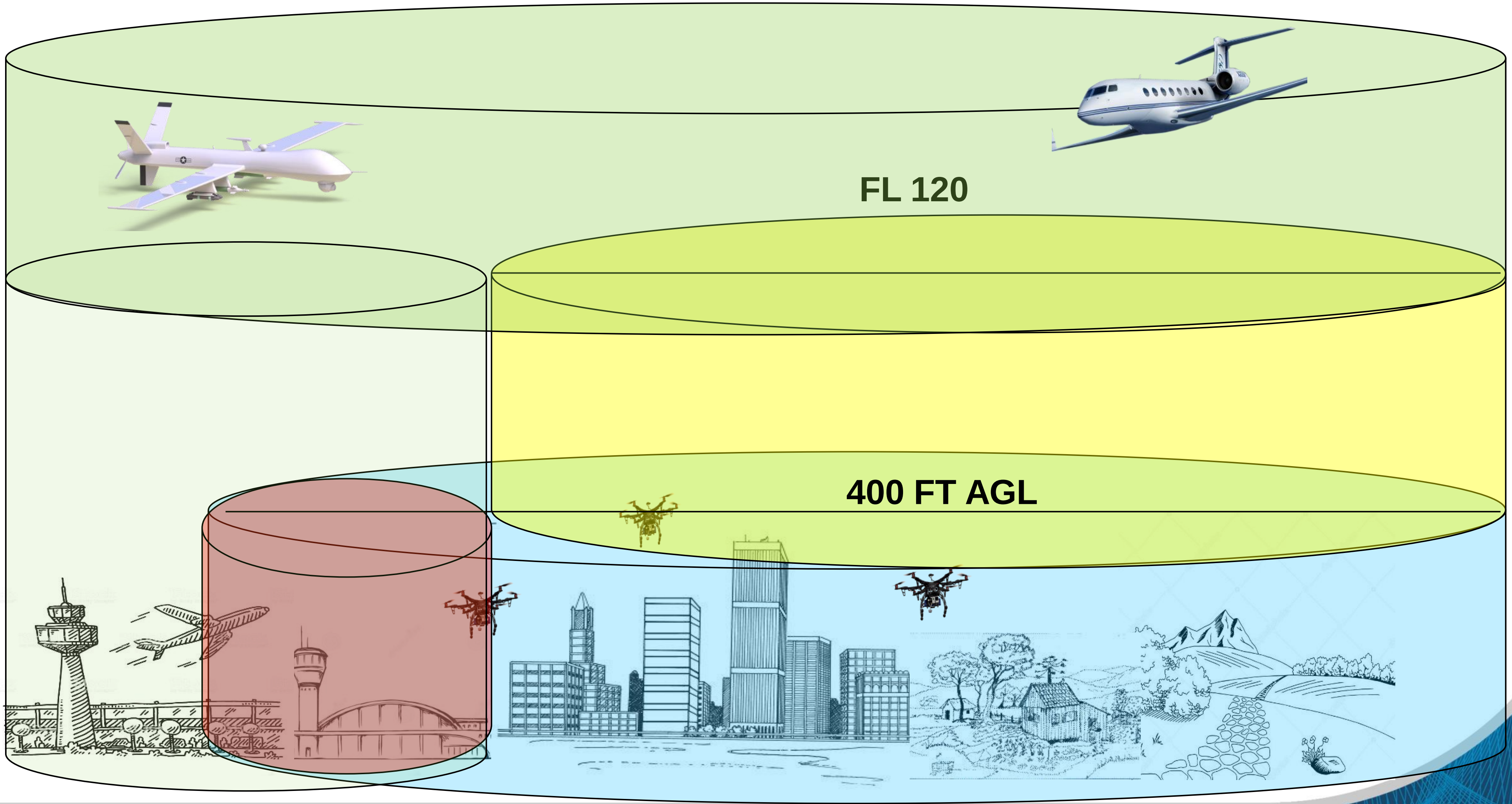
***UTM LEVEL 2 – “G” AIRSPACE***

***<u>UAS CAPACITIES</u>***

- ✓ ***DAA: UAS X UAS / UAS X OBSTACLES / UAS X MANNED A/C / UAS X WEATHER;***
- ✓ ***“GEOFENCING” (“G” AIRSPACE X CONTROLLED);***
- ✓ ***PBN REQUIREMENTS;***
- ✓ ***COOPERATIVE INTERACTION W/ ATC;***
- ✓ ***$C^2$ LINK & GNSS TAMPERING, ROBUSTNESS & INTEGRITY;***
- ✓ ***TERMINATE FLIGHT PROGRAM.***

# BRAZIL UTM AIRSPACE

✓ **UTM LEVEL 3 – ATM INSERTION**



# BRAZIL UTM AIRSPACE

***UTM LEVEL 3 – ATM INSERTION***

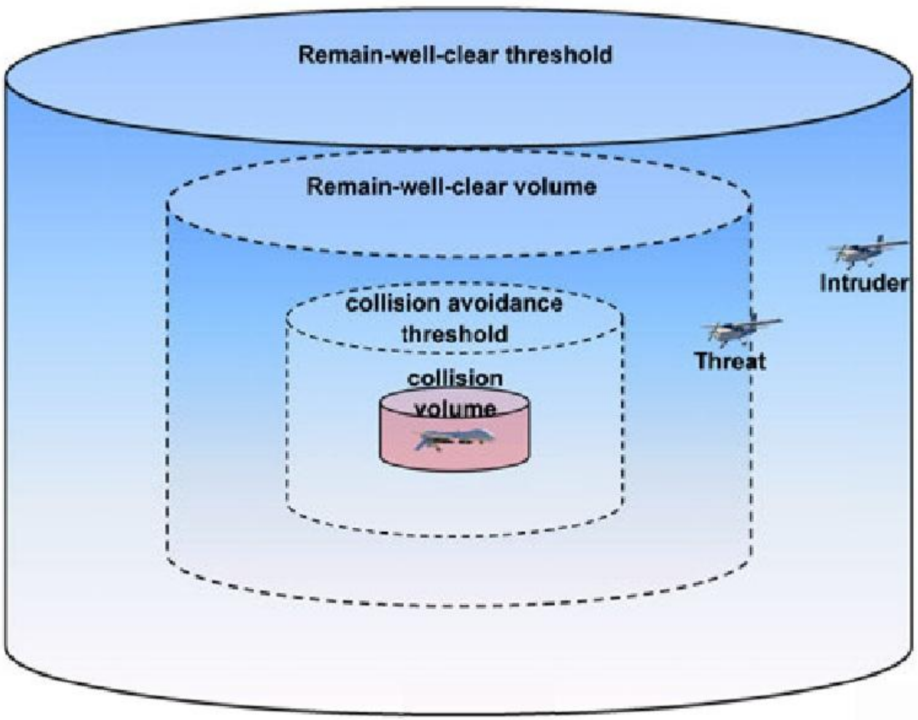
- ✓ ***MANNED A/C & RPAS INTERACTION;***
- ✓ ***ROBUST & INTEGRATED DAA;***
- ✓ ***CONTROLLED AIRSPACE;***
- ✓ ***WEATHER CONSTRAINTS;***
- ✓ ***ANSP & RPAS OPERATOR INTERACTION;***
- ✓ ***SUMMARIZE:***
  - ✓ ***ATM REQUIREMENTS***

# BRAZIL UTM AIRSPACE

***UTM LEVEL 3 – ATM INSERTION***

***<u>UAS CAPACITIES</u>***

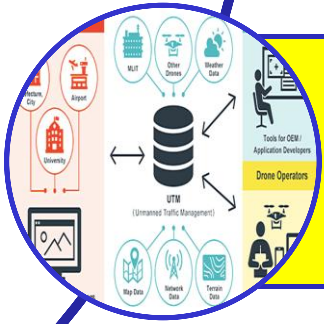
- ✓ ***DAA: UAS X UAS / UAS X OBSTACLES / UAS X MANNED A/C / UAS X WEATHER;***
- ✓ ***PBN REQUIREMENTS;***
- ✓ ***COOPERATIVE INTERACTION W/ ATC;***
- ✓ ***C² LINK & GNSS TAMPERING, ROBUSTNESS & INTEGRITY;***
- ✓ ***TERMINATE FLIGHT PROGRAM.***



# OVERVIEW

UNMANNED TRAFFIC MANAGEMENT (UTM)

DRAFT UTM BRAZILIAN CONCEPT




UTM CONSTRAINTS & CHALLENGES

# CONSTRAINTS & CHALLENGES

- AIRWORTHINESS X PAYLOADS;
- AUTONOMOUS OPS;
- DETECT & AVOID;
- CONSPICUITY;
- ATM COORDINATION;
- MONITORING;
- ENDURANCE REQUIREMENTS;
- BATTERIES ENERGY;
- BRAZILIAN INTERNET CAPACITY;
- C2 LINK INTEGRITY;
- "CULTURE".


# CONSTRAINTS & CHALLENGES

- AIRWORTHINESS X PAYLOADS;
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# CONSTRAINTS & CHALLENGES

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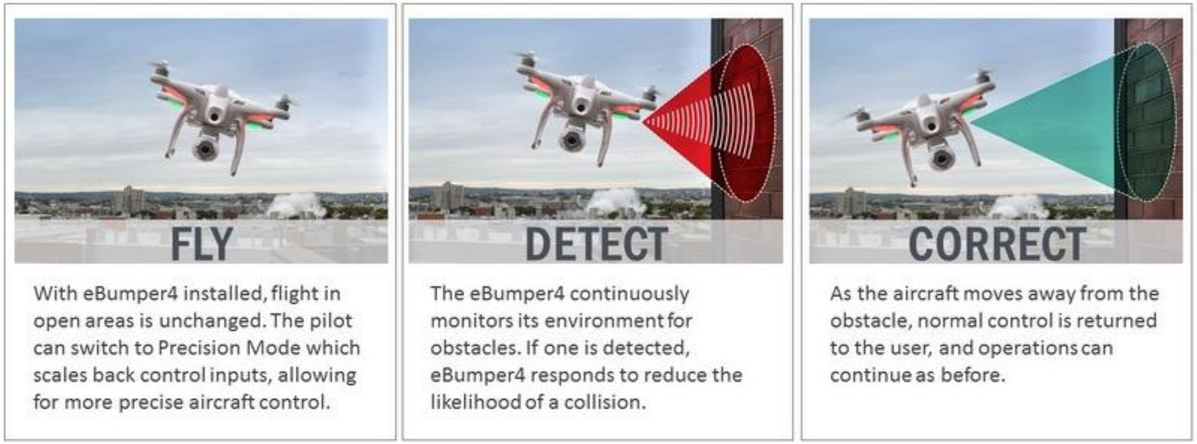

# CONSTRAINTS & CHALLENGES

- AIRWORTHINESS X PAYLOADS;
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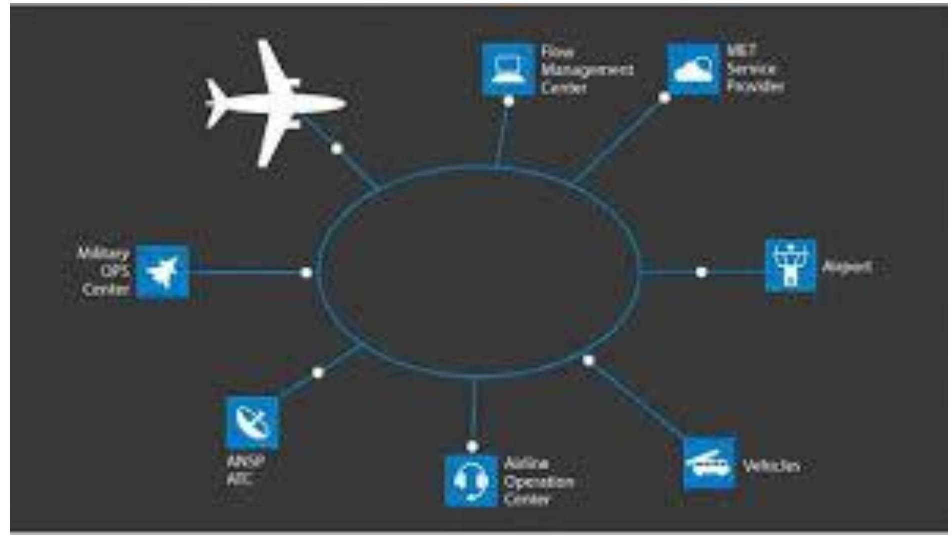


ICAO SAFETY

WG 6 – ATM

LOST OF $C^2$ LINK PROCEDURES & RPA FAILURES

# CONSTRAINTS & CHALLENGES

- AIRWORTHINESS X PAYLOADS;
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- MONITORING;
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- BATTERIES ENERGY;
- BRAZILIAN INTERNET CAPACITY;
- C2 LINK INTEGRITY;
- “CULTURE”.

**ADS-B MIXED SUAS AND NAS SYSTEM CAPACITY ANALYSIS AND DAA PERFORMANCE**

*Konstantin J. Matheou*
*Zin Technologies Inc. Brook Park, OH, 44142*
*Rafael D. Apaza, Alan N. Downey, Robert J. Kerczewski, John Wang*
*NASA Glenn Research Center Cleveland, OH, 44135*

**I. Abstract**

Automatic Dependent Surveillance-Broadcast (ADS-B) technology was introduced more than twenty years ago to improve surveillance within the US National Airspace Space (NAS) as well as in many other countries. Via the NextGen initiative, implementation of ADS-B technology across the US is planned in stages between 2012 and 2025. ADS-B's automatic one second epoch packet transmission exploits on-board GPS-derived navigational information to provide position information, as well as other information including vehicle identification, ground speed, vertical rate and track angle. The purpose of this technology is to improve surveillance data accuracy and provide access to better situational awareness to enable operational benefits such as shorter routes, reduced flight time and fuel burn, and reduced traffic delays, and to allow air traffic controllers to manage aircraft with greater safety margins. Other than the limited amount of information bits per packet that can be sent, ADS-B's other hard-limit limitation is capacity. Small unmanned aircraft systems (sUAS) can utilize limited ADS-B transmission power, in general, thus allowing this technology to be considered for use within a combined NAS and sUAS environment, but the potential number and density of sUAS predicted for future deployment calls into question the ability of ADS-B systems to meet the resulting capacity requirement. Hence, studies to understand potential limitations of ADS-B to fulfill capacity requirements in various sUAS scenarios are of great interest. In this paper we, validate/improve on, previous work performed by the MITRE Corporation concerning sUAS power and capacity in a sUAS and General Aviation (GA) mixed environment. In addition, we implement its inherent media access control layer capacity limitations which was not shown in the MITRE paper. Finally, a simple detect and avoid (DAA) algorithm is implemented to display that ADS-B technology is a viable technology for a mixed NAS/sUAS environment even in proposed larger mixed density environments.

**II. Introduction**

ADS-B modelling and simulation work has been on-going at NASA's Glenn Research Center (GRC) for the past few years. The motivation to simulate ADS-B technology is due to its acceptance by the Federal Aviation Administration (FAA). Due to the emergence of smaller drones being sold throughout the US and the rapid evolution of drone technology, many safety, commercial, and recreational types of applications will drive the number of drones (aka sUASs) to populate the skies, such that the inclusion of ADS-B technology on future drones may be a logical safety-enhancing extension. Thus, work on two tasks are presented that show simulation results in a mixed sUAS capacity environment, and further extends the analysis to display initial DAA algorithmic results.

**III. Inspiration and Approach**

Thus, the first step is to understand ADS-B performance in a mixed, sUAS and NAS, capacity environment. This has been completed previously by Guterres, Jones, Orrell, and Strain [1]. In work supporting UAS Traffic Management (UTM) research, GRC leveraged the work in [1], validating the results with GRC's ADS-B simulation model. GRC's model includes theoretically proven channel includes theoretically proven channel model algorithms for UTM including: 1) AWGN, 2) link budget, 3) multipath propagation (Fresnel coefficient), and 4) 900-1090MHz band co-carnel interference, a somewhat different approach from [1]. In implementing individual channel models, the GRC model specific channel impairments to be analyzed, thus allowing better checks to the overall model.

# CONSTRAINTS & CHALLENGES

- AIRWORTHINESS X PAYLOADS;
- AUTONOMOUS OPS;
- DETECT & AVOID;
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- ATM COORDINATION;
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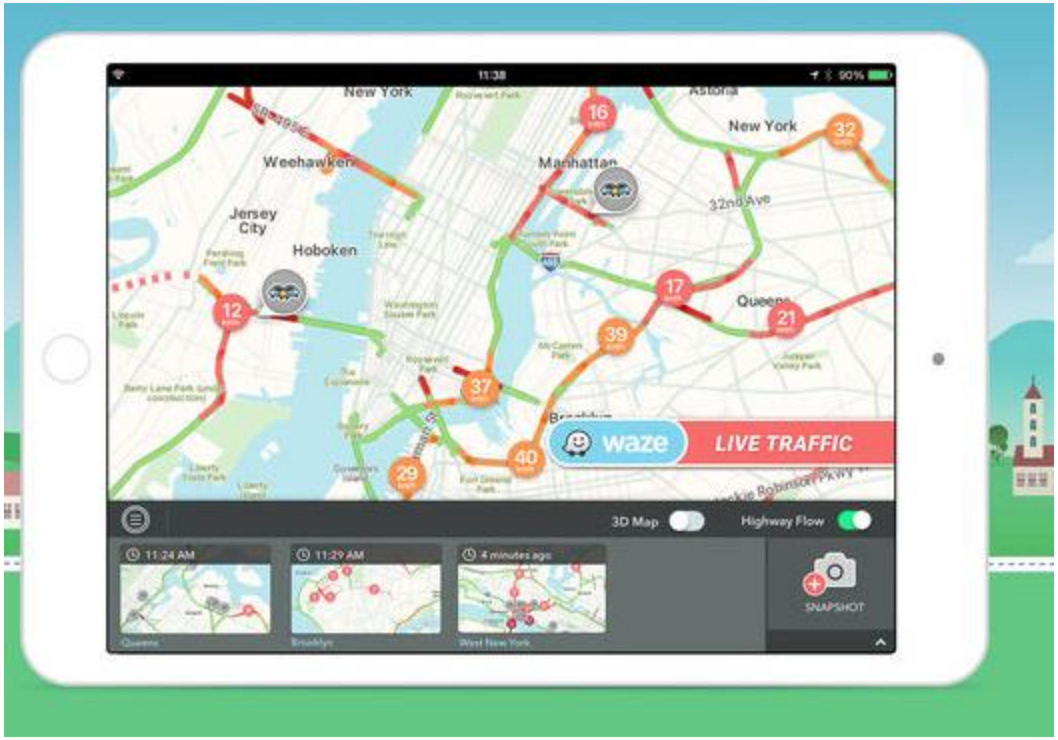

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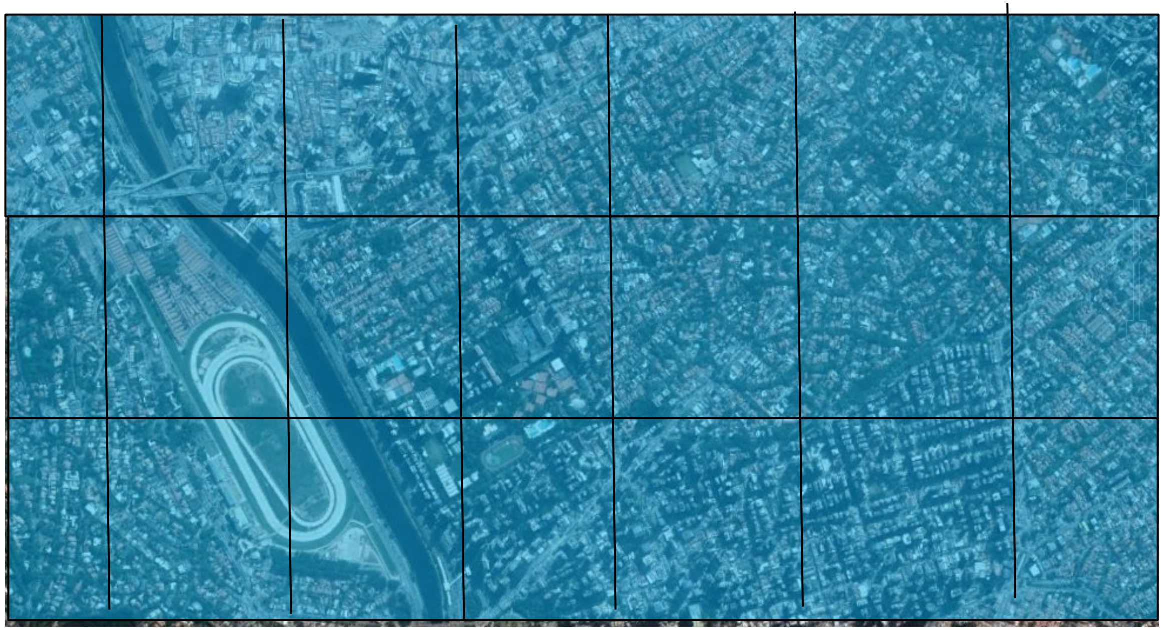

*E.G.: HUBS POSITIONING*

# CONSTRAINTS & CHALLENGES

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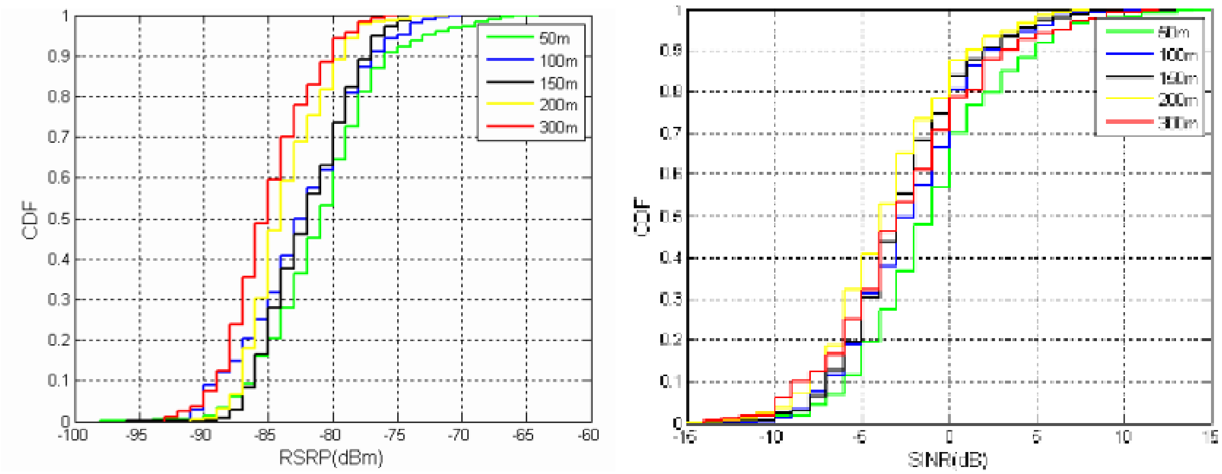


**Figure 13 Low-altitude cellular network coverage test results**

***Source: CAAC, Low-Altitude Connected Drone Flight Safety Test, 2018.***

# CONSTRAINTS & CHALLENGES

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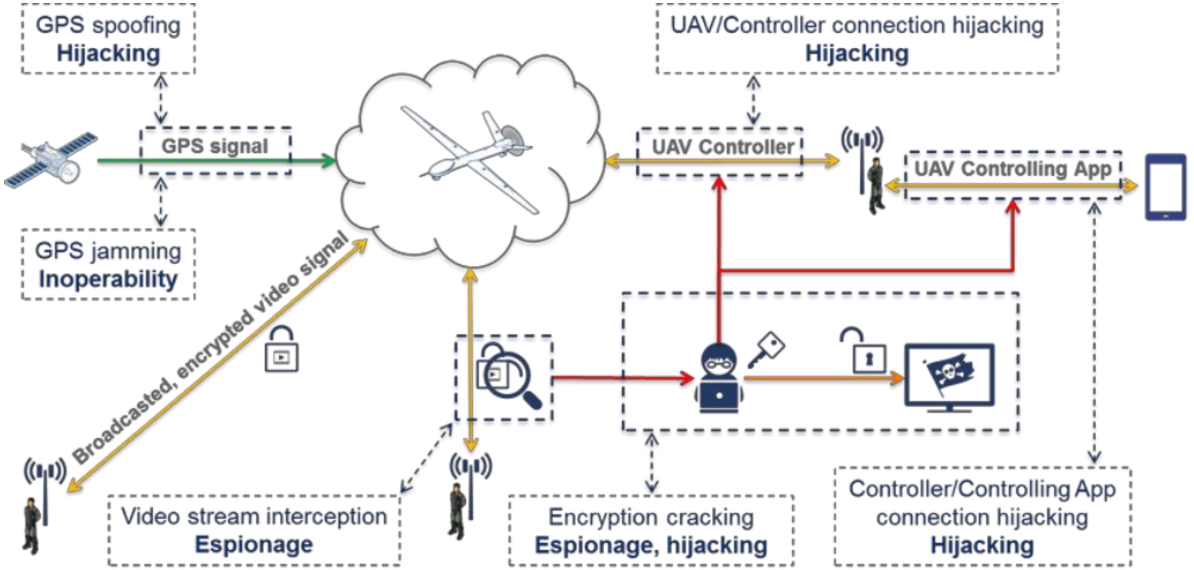

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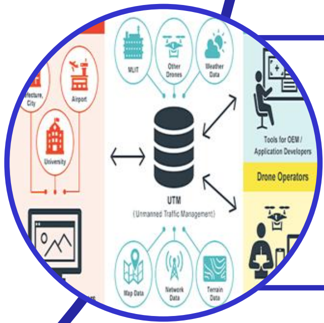
DRAFT UTM BRAZILIAN CONCEPT




UTM CONSTRAINTS & CHALLENGES

# GOAL

➢*FIGURE OUT THE UTM CONCEPT OF OPERATIONS;*

➢*KNOWN THE INITIAL DRAFT OF BRAZILIAN UTM CONCEPT OF OPERATIONS.*

*"The emergence of new theories is usually preceded by a period of pronounced professional insecurity as it requires a large-scale explosion of paradigms and* ***major changes in the problems and techniques of normal science****".*

***THOMAS KUHN***

*THANK YOU!!!*

*For Further Informations:*

*DECEA RPAS COMMITTEE – Future Projects*
*Major Leonardo André HABERFELD Maia*
*Email: haberfeldlahm@fab.mil.br / haberfeldlahm@decea.gov.br*