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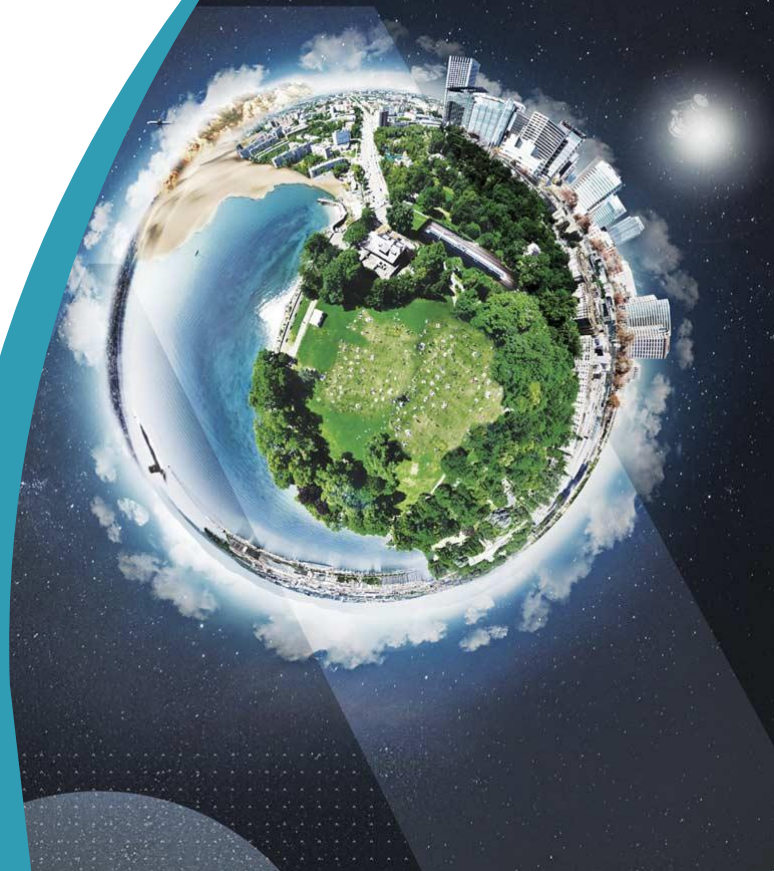

RPAS in Australian Skies 2019

Safe and Secure Solutions
For
Long Range Surveillance and Inspection

The French way : Government/Industries coordination

New civil use of drones that could impact safety are coordinated and monitored by the French Civil Drones Council (CDC):

ie Long range/ delivery/Urban mobility

- **Led by DGAC**, involving the French market leaders **Airbus, Safran, Thales, as well as SMEs and Start-Ups, and academics**
  - To propose evolutions to the regulations
  - To assess the state of the art in drone safety, technologies, set up road-maps
  - To develop solutions for the key technological challenges

    → but **safety avionics solutions only**

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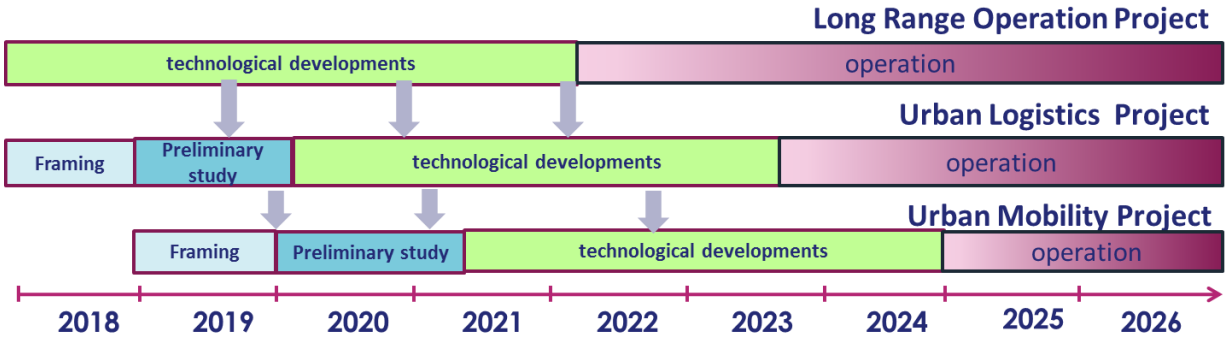
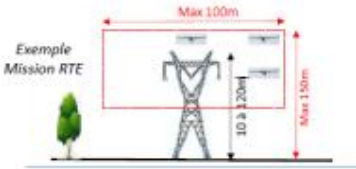
Civil Drone Council : simplified road map



Formal aeronautics R/D cycle but with real experimentation in parallel

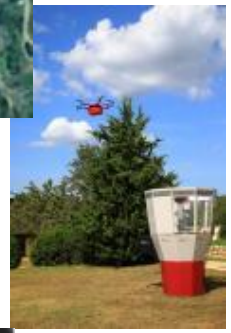
- **Experimentations for long range inspection and delivery : 2014**
- **First long range inspection authorized with " constraints" : 2016**
- **First delivery routine operation Aix en provence area: 2017**

Objective :
from experimentation to full routine operations



Bordeaux
Urban
delivery
CDiscount

Sub Urban
delivery
DPD La poste



Taxi drone
City Airbus

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Long Range Operation projects (Avocettes)

→Surveillance and inspection of linear infrastructures

→ Use cases defined by French users but simplified in 2 representative ones

- **Use case 1: objective ASAP**
  - **Remote areas or/and under restriction of operations**
- **Use case 2: objective No constraints**
  - **Near or over populated areas**
- **Technical challenges**
  - **Global safety avionics architecture**
  - **Trajectory follow-up**
  - **High integrity electronic platform**
  - **Air/Ground Communication for Assistance and Autonomy management**
  - **Detect and avoid**
  - **Cyber security**

300 km range given as an objective by users from 30km to 500km

Drastic cost per flight hour objective

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Long Range Operation : French Operators and DGAC feedback

Mainly experimentations but

under too many restriction of use to become routine operations

- 2014-18: > 50 authorised operations
  - Check of operating conditions
  - Check of technical reliability and safety feature
  - No specific guidelines except safety assessment (SORA not used)
  - Complex restriction of use , case by case
- Burden for the operators and DGAC
- Need to streamline the authorisation process (e.g. concept of light UAS operator certificate from future EU regulation)
- Need to define agreed safety requirements

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Use case 1 - Remote area or under restriction

Operational scope and limitations

Remote Pilot	Remote pilot manages flight preparation, take-off/Landing and emergency situations when possible. Automatic flight guidance along a predefined trajectory.
UA characteristics	Fixed or Rotary wings. Today drones less than 25kg
Range	BVLOS operation between 2 km to 150 km
Overflown areas	No flight over or near people and with operational restrictions to limit the risk according to environment
Terrain	Reasonable relief conditions
Airspace	Low height flight < 150m (500ft AGL), 120 m now with EU regulations Non segregated and uncontrolled airspace

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Use case 1 - Remote area or under restriction

Risk management

- **Ground Risk** for sparsely populated environment
  - Set up a risk buffer depending on the drone characteristics and the operational environment
  - Monitor trajectory deviations (GPS position + Video)

- **Air Risk** (collision with other aircraft)
  - No capacity (Air or Ground) to manage separation
  - Set up a temporary restricted Area (ANSP)
  - Set up a solution to mitigate fly away failure cases

- **SORA style assessment**
- **Consequential damages not taken into account**
- **Minimum cyber security**

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Use case 1 - Remote area or under restriction

Technical solutions : 2019 ready

- Containment via aviation grade Geocaging < 10-4/FH, (10-7/FH 2021)
- Independent Flight Termination System (Auto/Manual)
- C2 Link loss management
- Review of failure modes of the control & guidance system
- Flight preparation with emergency scenario and emergency landing spots
- Lighting system for night operations
- Operational and maintenance manuals

➔ First DGAC approval given to Altametris (Electricity network) / Delair for routine operation

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Use case 2 - Near or over populated areas

Operational scope and limitations

Remote Pilot	Remote pilot manages flight preparation, take-off/Landing and emergency situations when possible. Automatic flight guidance along a predefined trajectory. Onboard autonomy of decision for aleas and emergency
UA characteristics	Fixed or Rotary wings or better mixed. Drones between 20kg to 150kg
Range limit	BVLOS operation no limit
Overflown areas	Near or crossing any kind of populated areas but no urban operations
Terrain	All conditions including mountains
Airspace	Low height flight < 150m (500ft AGL), temporary over if necessary Non segregated and uncontrolled airspace

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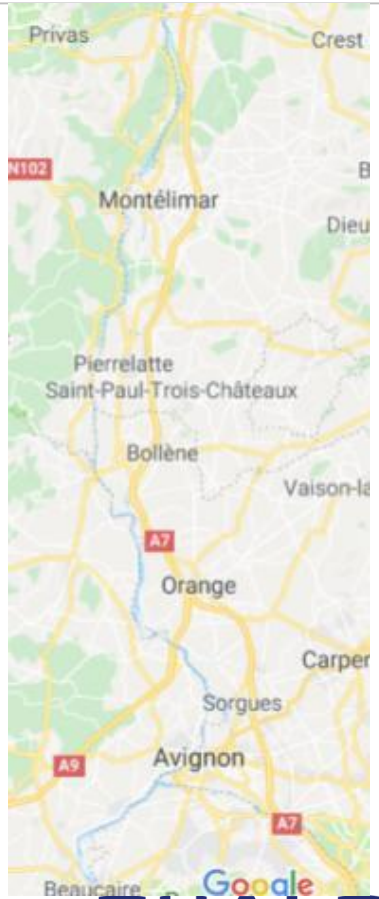
Use case 2 - Example of « high risks » operation

Complex area

- Densely populated
- Few emergency safe landing spots
- Parallel to high speed train lines
- Parallel to the main automotive highway
- Nuclear power plants
- Military sites
- Helicopters and other drones

400km range
Flight over cities

Autonomy of operation
Multi-drones



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Use case 2 - Near or over populated areas

Risk management

- **Ground Risk**
  - No risk Buffer (not operational)
  - Native system integrity and aviation development assurance : 10 time better than transport aircraft : 10-7 FR/H
  - Navigation with both accuracy and integrity (RNP type Corridor navigation performances)
  - Adequate strategic unforeseen events and emergency management (Autonomy strategy) with air/ ground allocation

- **Air Risk (collision with other aircraft)**
  - No temporary restricted area (not operational)
  - Embed capacity for separation and avoidance,
    - collaborative and not
  - Resilience to fly away

- **Certified category style risk assessment**
- **Consequential damages taken into account**
- **cyber attacks protection**
- **Remote piloted to remote supervised**

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Use case 2 - Near/over populated areas

First Technical solutions 2023 ready, full solution 2025 ready

- Optimised Ground/ On board aviation grade avionics providing **a global 10-7 FH safety level**
- Assistance to Safety checking during mission preparation,
- High on board autonomy of mission but
  - with Autonomy strategy giving priority to the ground in case and when ever possible
    - unforeseen events management to come back to nominal operation
    - Emergency management when mission interruption is necessary , and with emergency landing
- GPS based but integrated multi-sensors navigation
- Smart communication servers , multi communications means LTE + LOS/SATCOM
- Collaborative and stand alone Sense and Avoid
- Hard ware and cyber protection : interferences, cyber attacks or malicious use

- Artificial intelligence and multi-drones later on

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Link with EU/EASA rulemaking plan

Approval conditions according to future EU regulation

SPECIFIC - Increased risk

Authorisation by NAA based on specific operation risk assessment (SORA)

Declaration in case of standard scenario; LUC

BVLOS operations (linear inspections, aerial work, ...)

Transport of goods

- Typical operation falling in **the "specific" category** or in some cases **in certified categories** (e.g large drones > 3m or over assembly of people)
- France work may be used as a basis to develop a standard scenario for linear infrastructure surveillance
- EASA relying on JARUS SORA
  - Risk assessment methodology
    - CONOPS=>GRC=>ARC=>OSO
  - Scalable Assurance and Integrity Levels
    - High level aligned with aeronautical standards for civil aviation

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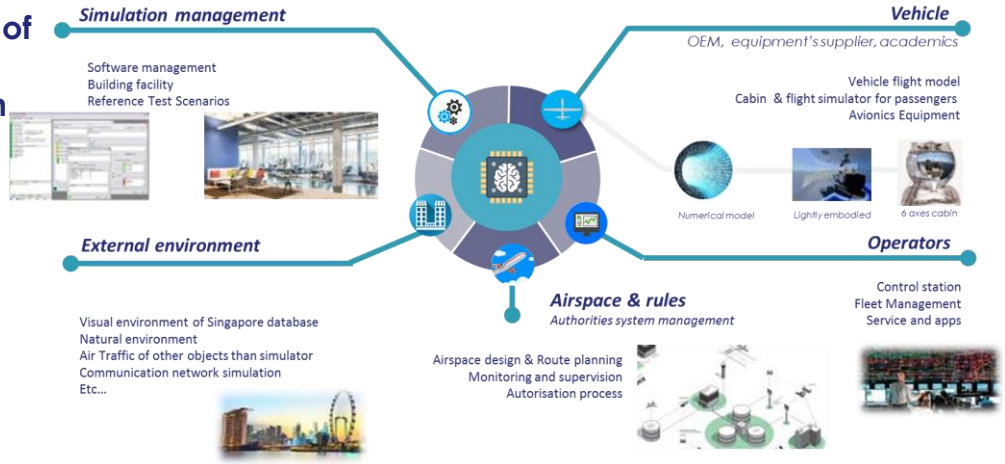
Focus on simulation platform for autonomy

Autonomy strategy : logic , decision criteria , on board on ground allocation, unforeseen events consequences, emergency landing….

is studied / set up / validated through a simulation plateform

Simulation plateform supports the development of equipment and vehicles but is also used to work on regulations and mission optimization

- Real flight data (representative situations) and simulation within a synthetic environment
- Many scenarios are played to define the best solutions
- Simulation platform will be used later on for AI learning or criteria selection and even as part of “certification”



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Video

Very first example of the work done presented on a shortened mission

- **Main C2 information (Flight parameters /Video view /synthetic flight representation / mission view)**
- **On ground Assistance functions**
- **On board Decision functions**
- **Environment**

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