Low Level RPAS Traffic Management
Potential systems solutions

1st International Conference on RPAS related Technologies
Le Bourget, November 5-6, 2015

<u>Claude Le Tallec</u>, Patrick Le Blaye

ONERA
THE FRENCH AEROSPACE LAB

retour sur innovation

Context

Context

- The airspace below 500ft/150m is used by many air vehicles
- Small RPAS VLL operations (below 150m) raise safety/security/privacy concerns
- VLL operation regulations in progress in many European countries
- The increasing demand for BVLOS RPAS VLL operations (mostly commercial) makes the definition of enablers (technical and regulatory) necessary
- The small size of many RPAS modifies the basic and legacy See & Avoid principle : the pilot of a manned aircraft may not be able to detect a small RPA in time to pass well clear

What are the typical needs for BVLOS Ops?

- **Railways network monitoring**

SNCF Network

- **One of the densest and most complex network in Europe**
  - 58.000 km of tracks
  - 14.000 km of electrified lines
  - 2.500 km of High Speed Lines
  - 17.000 trains
  - 10 millions passengers each day

For safety and security, lines need to be controlled regularly

- **Power lines network monitoring**

Low Level flight: safety issues

- Do not harm people or damage properties on ground
  - Airworthiness
  - Concepts of operation
  - Pilot selection, education and training

- Pass well clear of other airspace users and, ultimately, do not collide with them
  - Detect and avoid
  - Concepts of operation
  - Pilot selection, education and training

LLRTM

Problem assessment:

- Conspicuity issue : RPA are so small that the conventional see and avoid principle is made dissymmetric
- Asking all airspace users to be cooperative in order to be seen by RPAS and to see cooperative RPAS is not a short term option

Potential solutions:

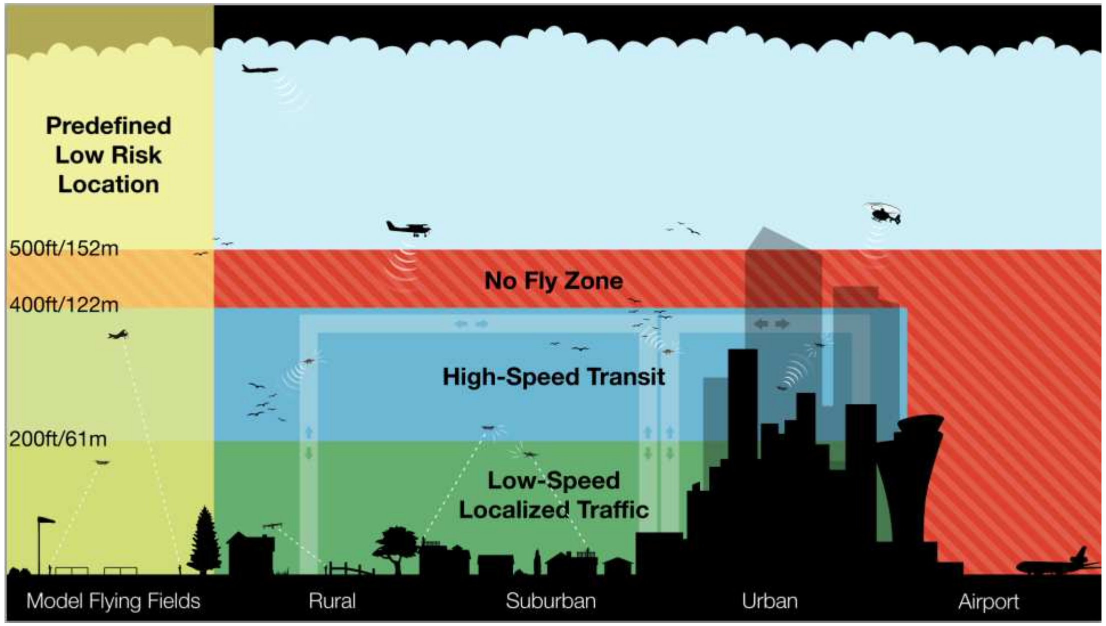
1. Equip the RPAS with an onboard D&A system
2. Transfer the Detect function to the ground and provide the pilot with traffic information (GBDAA) and/or to other actors (RPAS Traffic “Manager”):
    - *Easy to detect cooperative aircraft*
    - *More complicated to detect non-cooperative aircraft*
3. « Share » the airspace: creation of corridors /airspace layers for an exclusive RPAS use

Potential solutions:

1. Equip the RPAS with an onboard D&A system
   - *Need for low weight/low volume/low power cooperative & non cooperative sensors (transponders, ADS-B, FLARM & EO/IR sensors, radar) robust to weather conditions and to insects/ other elements contamination*
   - *Need reliable link to keep pilot in the loop at any time (separation/well clear + automatic collision avoidance)*
2. Transfer the Detect function to the ground and provide the pilot with traffic information (GBDAA) and/or to other actors (RPAS Traffic Manager):
   - *Need for ~~low weight/low volume/low power~~ cooperative & non cooperative sensors (transponders, ADS-B, FLARM & EO/IR sensors, radar) ~~robust to weather conditions and to insects/ other elements contamination~~*
   - *Need link to keep pilot in the loop at any time (GBDAA + RTM)*

Detect and avoid issues

3. « Share » the airspace: creation of corridors /airspace layers for an exclusive RPAS use
   - *Seems to be the Google and Amazon perspective*



   - "Amazon's Drone Highway – Organizing the Drone Friendly Skies" would restrict airspace use by other current users
   - Legal and societal acceptability ?
   - Safety and security issues

Operational context: where can we fly ?

In airspace classes and zones

Controlled airspace: Class A, Class B, Class C, Class D, Class E

Uncontrolled airspace: Class F, Class G

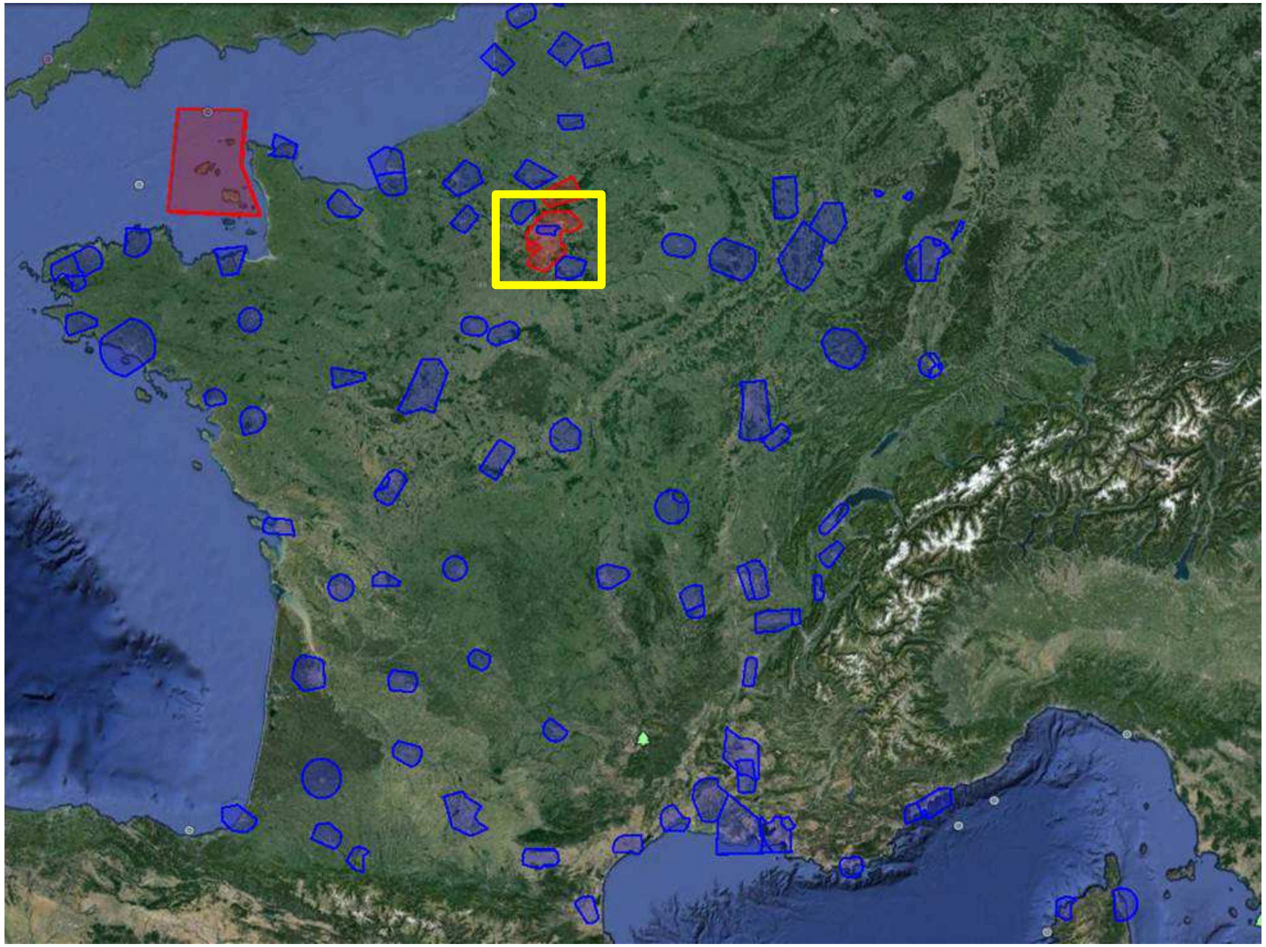
Traffic is known by ATC (Class A – Class D)

- Separation is provided by ATC
- Collision avoidance remains pilot's responsibility

No ATC or ATC does not know who is where (Class E – Class G)

Separation & Collision avoidance are pilot's responsibilities

Operational context: Airspace in France



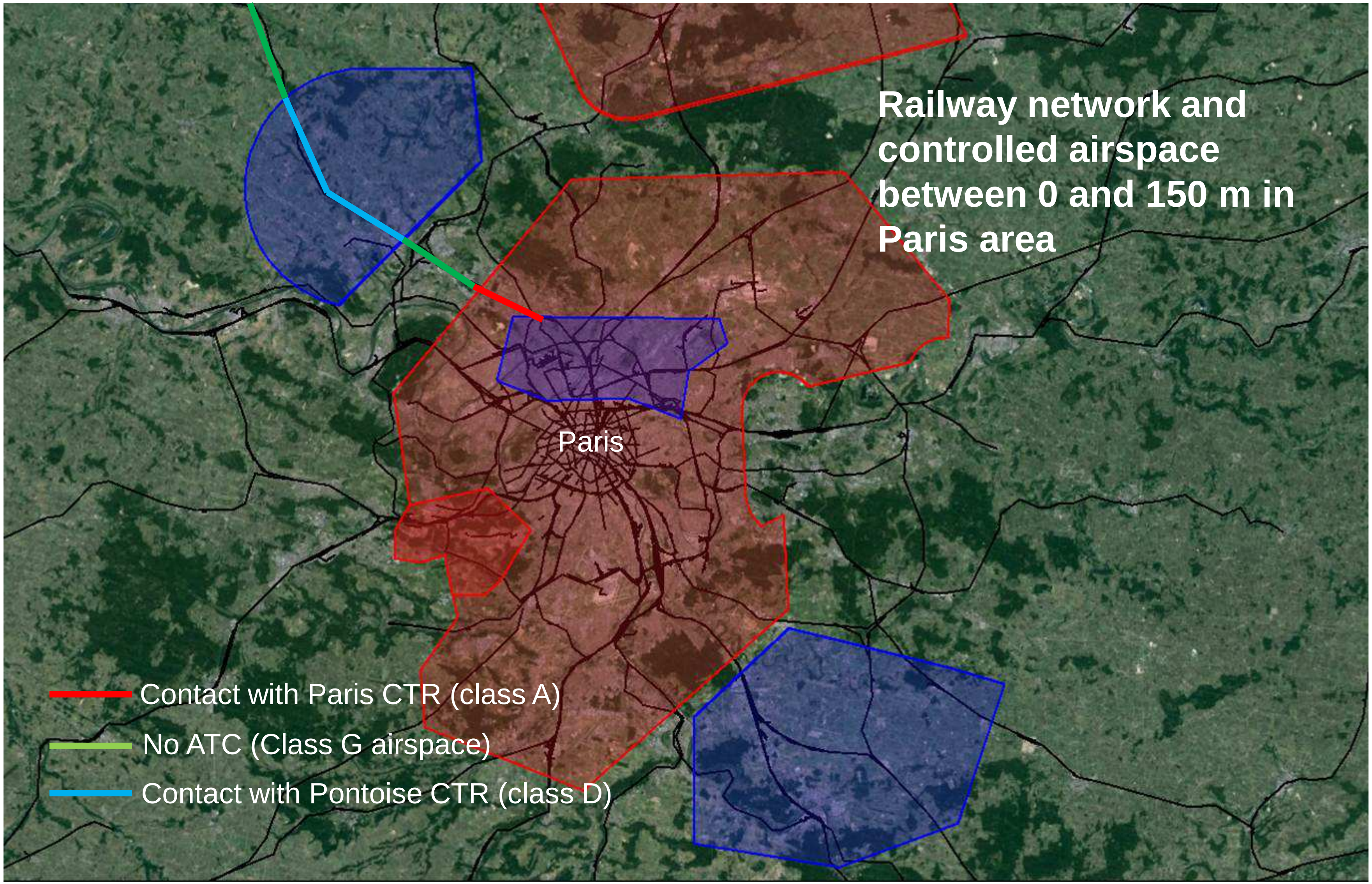
Controlled airspace between 0 & 150 m:

- Red: class A & C
- Blue: class D

Anywhere else, class E or G (or specific zones) where, generally, ATC do not know all traffics

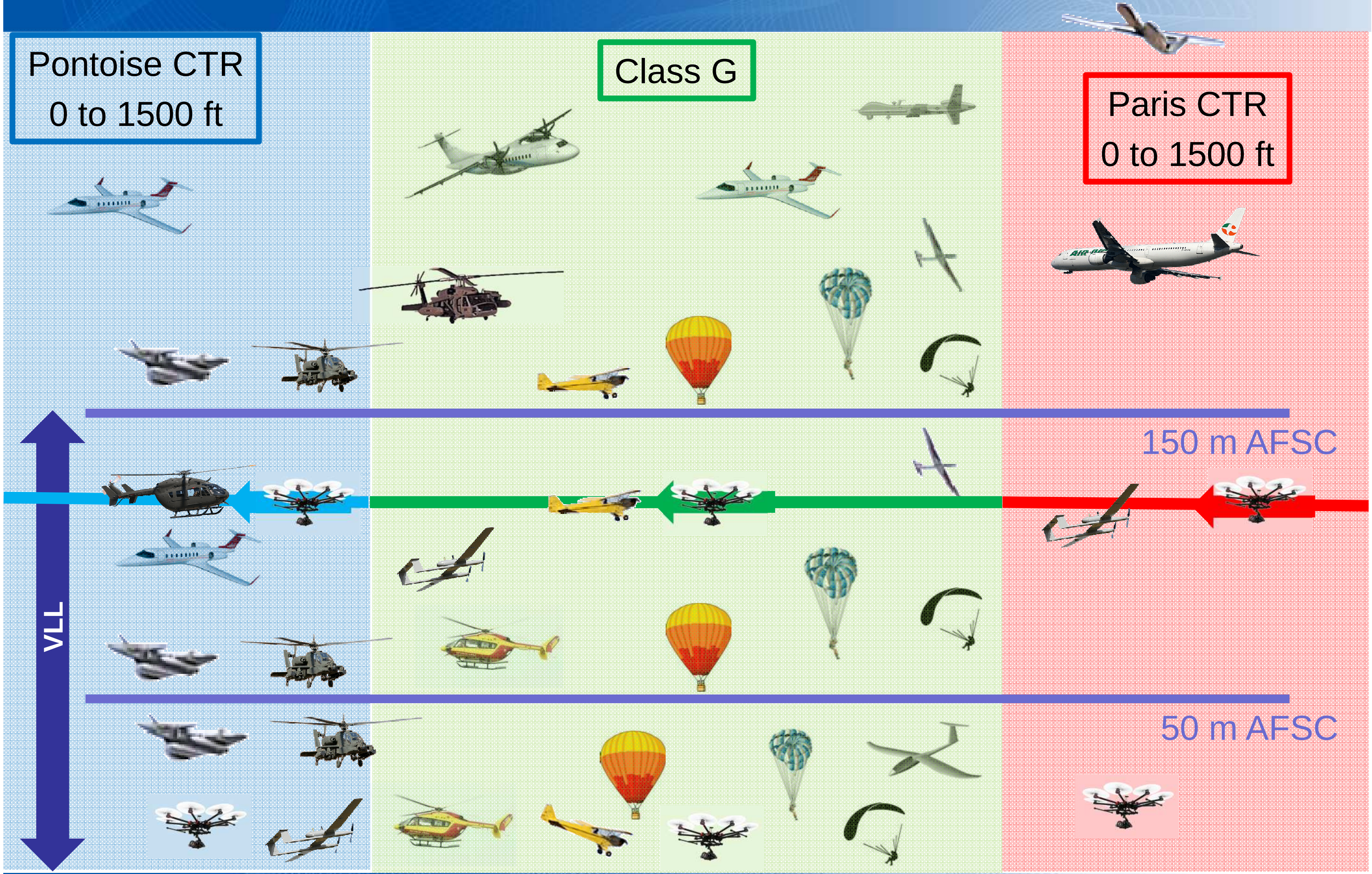
The largest portion of the low altitude airspace is uncontrolled

Operational context: a flight path example



ONERA
THE FRENCH AEROSPACE LAB

Operational context: a flight path example



LLRTM (Low Level RPAS Traffic Management) concept

LLRTM system provides a set of capabilities:

- All traffic monitoring & RPAS traffic management in uncontrolled airspace
- All traffic monitoring & coordination with ATC in controlled airspace
- Ground based detect and avoid functions

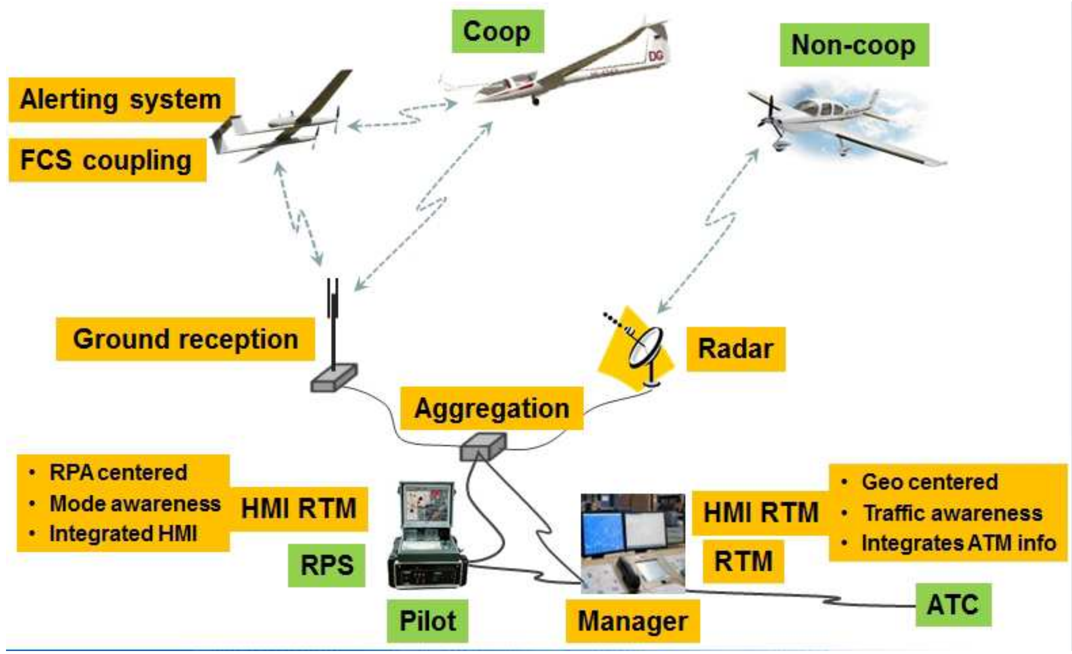
Controlled airspace					Uncontrolled airspace	
Class A	Class B	Class C	Class D	Class E	Class F	Class G

LLRTM manager coordinates with ATC and relays ATCOs instructions to RP, RP uses LLRTM system information to manage the flight and for collision avoidance

RP executes LLRTM manager instructions and uses LLRTM system information for self-separation and collision avoidance

Low Level RPAS Traffic Management (LLTRM)

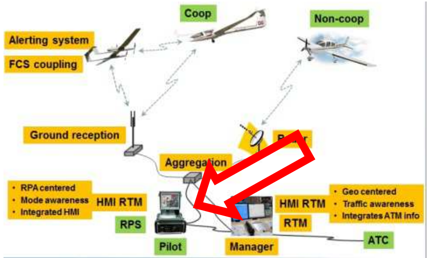
- **Ground-based system to manage RPAS operations below 500 ft (class E/G)**
- **Using a combination of sensors:**
  - Airborne collaborative alerting system
  - Ground sensor to detect non-cooperative traffic
- **Role of human actors:**
  - Remote pilot
  - Operation manager
- **HMI design**



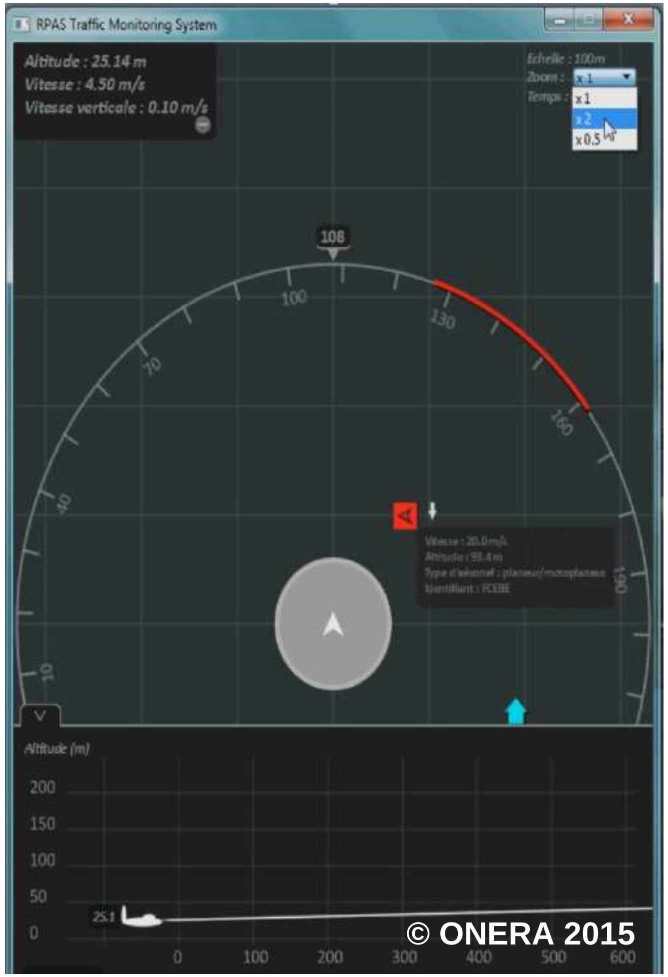
LLRTM system components

- **Cooperative sensors**
  - Mode A/C transponder receiver
  - Mode S & ADS-B receiver
  - FLARM receiver
- **Non cooperative sensor**
  - Radar
- **Sensors data processing**
- **HMI**
  - GBSAA
  - RPAS Traffic Management

Human centered design of HMI for UTM: detect & avoid by the remote pilot

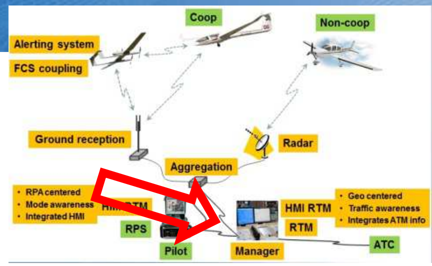


- **Preliminary development of an HMI for remote pilot alerting**
- **Some issues:**
  - Frame of reference, orientation
  - Filtering & timing
  - Alerting philosophy & modality
  - Resolution aids
- **Future work:**
  - Complete the integration
  - Testing in simulation & in real environment

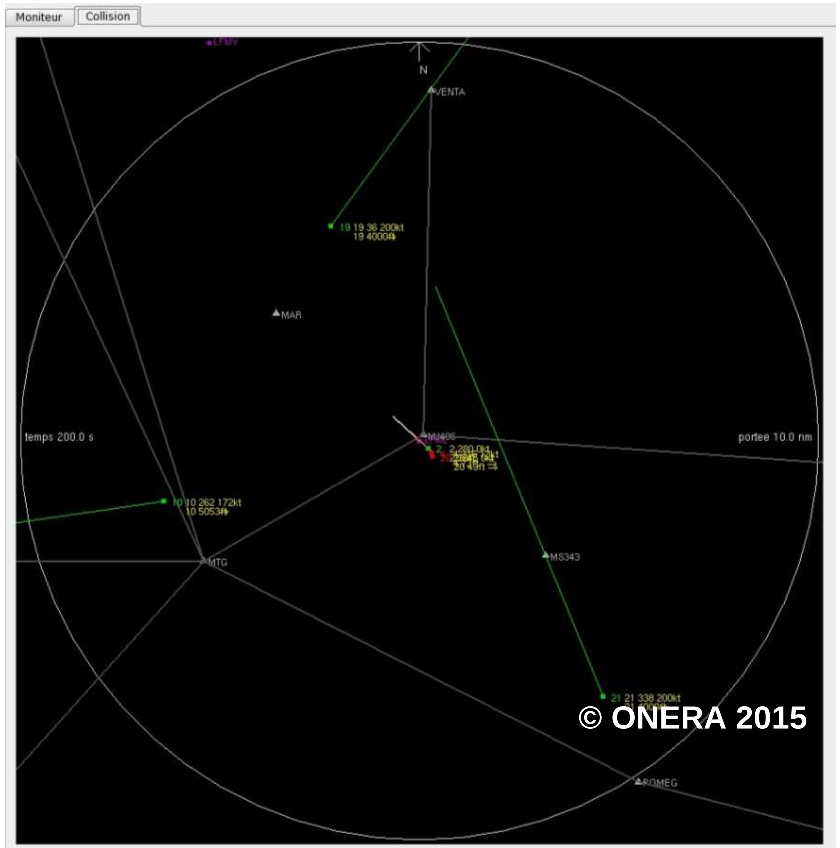


ONERA
THE FRENCH AEROSPACE LAB

Human centered design of HMI for UTM: RPAS traffic manager



- **Preliminary development of an HMI for in support of the RPAS traffic manager**
- **Some issues:**
  - Integration of flight planning and ATM information
  - Management procedures vs the remote pilots
  - Link and coordination with ATC (where present)
- **Future work:**
  - Refine the role & procedures
  - Testing in simulation & inflight



Conclusion & perspectives

- The increasing demand for BVLOS RPAS VLL operations requires efforts of the whole ATM community to find technical solutions and procedures to accommodate safely these new airspace users alongside legacy airspace users
- The LLRTM system can be a first step to enable some RPAS operations (airworthiness issue is still to be solved to overfly population)
- The LLRTM system architecture can be seen as an opportunity to experiment present and future global (all traffic, all classes of airspace) ATM principles, including new concepts/approaches: 4D contracts, task sharing between remote pilots and controllers, low cost technologies to make most of the airspace users cooperative…
- SESAR should help in making progress to guarantee airliners' safety when approaching airports

Conclusion & perspectives

Passenger Plane in Near Miss with Drone Close to Heathrow

Thank you for your attention...

and have a safe flight back!