What is mandatory in the different airspaces and the different requirements between VLOS and BVLOS (Beyond Visual Line Of Sight) operations?

Copenhaguen May 2018

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## Introduction

### UAS in the airspace

<table>
<thead>
<tr>
<th></th>
<th>High Altitude UASs</th>
<th>Drones sharing the airspace</th>
<th>Low Altitude drones</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations</strong></td>
<td>Above the ceiling of conventional manned aviation activities</td>
<td>RPAS applying IFR rules or accommodation</td>
<td>In parts of the airspace which are usually not open to manned aviation</td>
</tr>
<tr>
<td><strong>C2Link</strong></td>
<td>Reliable C2link + VHF relay?</td>
<td>Reliable C2Link + VHF relay</td>
<td>C2Link requirements TBD Low cost</td>
</tr>
<tr>
<td><strong>Surveillance</strong></td>
<td>TBD</td>
<td>Mode S / ADS-B (1090ES / UAT)</td>
<td>Identification, surveillance (situational awareness for the remote pilot) and tracking</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>ATM* + accommodation</td>
<td>ATM* + UTM** (U-Space)</td>
<td>UTM** (U-Space) but interface with ATM*</td>
</tr>
</tbody>
</table>

*Air Traffic Management  **UAS Traffic Management*
UTM (U-Space) = A new idea all over the world, many initiatives!!!
VLOS

The remote pilot is responsible for exercise of vigilance at any time:
- In VLOS, with his eyes;
- In BVLOS, using situational awareness provided by systems (sensors on-board or from UTM/ ATM)

BVLOS: Specific or Certified

*Visual Line Of Sight

**Beyond Visual Line Of Sight
### Categories of operations

<table>
<thead>
<tr>
<th>Approval Type</th>
<th>Open</th>
<th>Specific</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational approval</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Type Design (TC/STC)</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Certificate of Airworthiness</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Conformity to Design Standard</td>
<td>Maybe</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Pilot License</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Operator Approval</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Maintenance Approval</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
<tr>
<td>Production Approval</td>
<td>No</td>
<td>Maybe*</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* - implies that some approvals may not be mandatory depending on the outcome of the risks assessment

Source: JARUS

**UAS/RPAS Regulations Categorization**
Risk consideration (Category specific)

Specific Operational Risk Assessment (SORA)

- Operational risks
  - Safety risks
    - People on the ground
    - Other airspace users
    - Critical infrastructure
  - Other risks
    - Property
    - Privacy
    - Security
    - Environmental

Mitigations with 3 levels of robustness given by the SAIL (Specific Assurance and Integrity Level)
- Low
- Medium
- High

Note: SORA has been proposed by JARUS and is still under development
Specific Assurance and Integrity Level (SAIL) determination

SAIL

<table>
<thead>
<tr>
<th>UAS Lethality</th>
<th>Operation Ground/Air Risk Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>VI     VI     V     IV     III   II    I</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>VI     V      IV    III   II     I     0</td>
</tr>
<tr>
<td>LOW</td>
<td>V      IV     III   II    I     0     0</td>
</tr>
</tbody>
</table>

Source: JARUS WG-6
### Risk consideration (Category specific)

#### Example: C2Link required performances

<table>
<thead>
<tr>
<th>Technical issue with UAS</th>
<th>Level of Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C2Link Performances</strong></td>
<td>Low (Sail II and III)</td>
</tr>
<tr>
<td>Criteria</td>
<td>- RF spectrum usage</td>
</tr>
<tr>
<td></td>
<td>- Means to continuously monitor the performance of C2 to assure the adequacy of that performance to the operation requirements</td>
</tr>
</tbody>
</table>

**Notes**

- Unlicensed frequency bands might be accepted:
  - The operator demonstrate the compliance with other RF spectrum requirements (e.g. for EU: Directive 2014/53/EU)
  - The use of protection against interference (e.g. FHSS, frequency deconfliction by procedure)
- The RP has access at all times and in a timely manner to the relevant information on C2 affecting the safety of flight.

- The used of licensed frequency bands might be necessary depending on the operation, although the use of non-aeronautical bands (e.g. licensed bands for cellular network) might be acceptable

- A minimum level of performance, not limited to aeronautical licensed frequency bands is expected. Some operations may require the use of bands allocated to the aeronautical mobile (satellite or not) route service for the use of C2 (e.g. C-Band 5030-5091 MHz, L-Band 960-1164 MHz...)
- In any case, the use of licensed frequency bands needs to be authorized.

*Source: JARUS WG-6*
The aviation infrastructure used for Communication, Navigation, Surveillance, such as VHF, GPS and Automatic Dependant Surveillance

C2: Frequency Bands identified in ICAO SARPs* (Standards And Recommended Practices)
Surveillance: Mode S, ADS-B (1090ES/ UAT)

The mobile telecom infrastructure made available by mobile telecom operators or free frequency bands

C2: Wifi, LTE, 868 MHz, ...
Identification: Wifi, 868 MHz, LTE, ...
Surveillance: UTM?

*still under consideration, but the choice of the terrestrial frequencies does not seem to evolve for the band C and L
Communication infrastructure

Example of RLOS operation
Communication infrastructure

Example of RLOS operation

Source: Thales Alenia Space
Communication infrastructure

Example of BRLOS operation

Source: Thales Alenia Space
**Conclusion and way forward**

- Manned and unmanned aviation shall coexist in a common airspace with the same level of safety.

- Need for R&D in ATM and UTM: Tight collaboration between CAAs, laboratories, Industry, EASA, JARUS, ITU, CEPT and ICAO is needed!

Source: SESAR JU, 2017
Questions ?