Safety criteria for integration of Unmanned Aircraft Systems
INOUI Work package 5.0

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Contents

• Introduction
  – To UAS
  – To INOUI

• ESARR 4

• Setting up safety criteria
  – Scope of risks, traffic growth, aircraft size, apportionment, …

• Results

• Interpretation

• Conclusions
Introduction to UAS (1)

- ‘UAS – The Global Perspective 2008/2009’ lists 974 different UAS with
  - maximum speeds from 10 m/s to more than 1,000 km/h
  - endurances from minutes to months
  - ranges from 150 m (Line of Sight) to more than 20,000 km
  - Maximum Take-Off Weight from grams to more than 15,000 kg
Introduction to UAS (2)
Introduction to UAS (3)

• These UAS will be flying **somewhere**

• There is segregated airspace, which is normally closed for civil aviation
  – Too restrictive for many UAS applications to be confined to this

• Hence an inevitable question is: **Can UAS be integrated in non-segregated airspace?**
  – Uncontrolled airspace (aircraft responsible for separation)
  – Controlled airspace (ATC responsible, at least for IFR)
Introduction to INOUI (1)

- General objective:
  - Propose innovative concepts for the integration of UAS into the ATM system as designed by SESAR
- FP6 project for EC, October 2007 – February 2010

- Final dissemination forum: 1-2 December 2009, Cologne
- www.inoui.isdefe.es
Introduction to INOUI (2)

WP1
UAS ATM Concepts, Procedures and Requirements for 2020

WP2
UAS enabled ATM architecture

WP3
Certification Blue Print for UAS in Europe

WP4
2020 UAS Common Operation Picture (SWIM)

WP5
Safety analysis of civil UAS operations

WP6
New airport concepts for UAS

WP7
Dissemination and exploitation
ESARR 4

- Integration of UAS in non-segregated airspace presents an important **change** for ATM service providers

- ESARR 4 or its incorporation in the Common Requirements in principle apply
  - INOUI proposal **planned** ESARR 4 safety assessment

- However, the integration of UAS presents a change widely beyond ATM
  - Too restrictive to consider risk for which ATM is primary factor, even when considering integration of UAS in ATM
Setting up safety criteria (1)
Scope of risks

• In line with the primary task of ATC to prevent collisions, the following scope of risks is more appropriate
  – Collisions between aircraft, and between aircraft and vehicles
  – Wake vortex encounters

• “ATC related risk” concerns accidents of these types
  – Safety criteria of ATC the Netherlands (LVNL) in terms of this
    • Presented at the Eurocontrol Safety R&D Seminar, 2007
    • Published in ATC Quarterly

• For Commercial Air Transport (CAT) aircraft, high quality statistics exist for ATC related accidents
Setting up safety criteria (2)

• However

a) Many manned and unmanned aircraft are considerably smaller than CAT and may have different accident statistics

b) Should unmanned aircraft be ’as safe as’ manned aircraft?

c) Traffic growth between now and 2020 to be compensated

d) To be able to focus safety assessments, risk needs to be apportioned
Setting up safety criteria (3)
Aircraft weight/type

a) FAA aircraft system regulatory documents discern
   – Aircraft with MTOW above 2,730 kg
   – SET or MEP aircraft below 2,730 kg
   – SEP aircraft below 2,730 kg

• Compared to the first category
  – the second category has a ten times higher hull loss rate
  – the third a hundred times higher rate

• Identifying the first category with CAT, the proportions of ATC related accidents are assumed to be similar
  – assumption to be investigated!
Setting up safety criteria (4)
Manned/unmanned, Traffic growth

• Should unmanned aircraft be as safe as manned aircraft?
  – The consulted references indicate a **yes**
  – For collision type accidents, this makes sense
    • An unmanned aircraft flying among CAT aircraft needs to satisfy the same ATC related risk criteria
    • Unmanned aircraft exclusively flying among light aircraft only need to satisfy the corresponding criteria

• Up to 2020, air traffic will increase at most threefold
  – In line with the ATM 2000+ principle, the accident rate therefore needs to become reduced by the factor of three
Setting up safety criteria (5)
Risk apportionment
Setting up safety criteria (6)
LVNL Safety Criteria

Maximum allowable ATC related accident* probabilities for CAT aircraft per flight
*accidents as defined in ICAO Annex 13, due to collision or wake vortex encounter

<table>
<thead>
<tr>
<th>LVNL</th>
<th>Budget</th>
<th>ATC Type</th>
<th>Budget</th>
<th>ATC subproduct</th>
<th>Budget</th>
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<td>CTA inbound</td>
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<td>Init &amp; intern approach</td>
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<td></td>
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## Results

### INOUI D5.0

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<tr>
<th>ATC Type</th>
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<th>SEP &lt; 2,730 kg</th>
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</table>

Maximum allowable ATC related accident* probabilities per flight

*as before, but accident definition extended for UA by ICAO WG on UAS
Interpretation

- For each ATC subproduct these figures are Maximally allowable ATC related accident probabilities per flight
  - For manned aircraft
    - with a MTOW over 2,730 kg
    - MEP/SET aircraft of less than 2,730 kg
    - SEP aircraft of less than 2,730 kg
  - For unmanned aircraft
    - Apply the criteria for the ‘safest’ manned aircraft type around

- These figures are for the amount of traffic expected in 2020
Conclusion

• Safety criteria for the integration of UAS in non-segregated airspace have been developed based on
  – Statistics of ATC related accidents for CAT aircraft

• The developed safety criteria involve
  – Dependency on weight/engine category
  – Assumptions on how accident rates for categories relate
  – Same maximum ATC related accident probability per flight for unmanned aircraft as for ‘safest’ manned aircraft type around
  – Apportionment over flight phases
  – Compensation for air traffic increase up to 2020

• INOUI results
  – Final dissemination forum: 1-2 December 2009, Cologne
  – www.inoui.isdefe.es
Any questions?
Thank you!