Preparing for an Unmanned Future in SESAR
Real-time Simulation of RPAS Missions

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RPAS peculiarities

Flight plan stages

- Civil RPAS applications: Surveillance, SAR, terrain mapping...

![Flight plan stages diagram](image-url)
The mission stage\textsuperscript{1}

- VFR-like missions in an IFR environment.

\textsuperscript{1}Courtesy of NASA (V. Ambrosia); Google Earth background image used by permission to the NASA Wildfire Research and Applications Partnership project.
The mission stage\(^2\)

TS Nadine September 26-27

TS/Hurricane Nadine September 14-15

TD14/TS Nadine September 11-12

\(^2\)Courtesy of NASA
**RPAS peculiarities**

### Performance dissimilarities

<table>
<thead>
<tr>
<th>Performance Parameter</th>
<th>RPAS</th>
<th>Manned Aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cruise airspeed</td>
<td>↓↓↓</td>
<td>↑↑↑</td>
</tr>
<tr>
<td>Rate of climb</td>
<td>↓↓↓</td>
<td>↑↑↑</td>
</tr>
<tr>
<td>Cruise altitude</td>
<td>≈</td>
<td>≈</td>
</tr>
<tr>
<td>Endurance</td>
<td>↑↑↑</td>
<td>↓↓↓</td>
</tr>
</tbody>
</table>

### Other issues

- **Datalink related:**
  - Communication latency.
  - Lost-link.

- **Contingency related:**
  - Loss of control/navigation capabilities.
Gaps for the integration of civil RPAS into the European aviation system have been identified. They are related to:

- **EC 1**: Development of a methodology for the justification and validation of RPAS safety objective.
- **EC 2**: Secure command & control / data links / bandwidth allocation.
- **EC 3**: Insertion of RPAS into the air traffic management system, detect & avoid (air and ground) and situational awareness (including for small RPAS), weather awareness.
- **EC 4**: Security issues attached to the use of RPAS.
- **EC 5**: Safe automated monitoring, support to decision making and predictability of behaviour.

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Research goals

Regarding the roadmap

- To provide an environment that permits the analysis of specific areas/gaps.

Towards higher levels of automation

- To investigate the active interaction of the RPAS pilot and the ATCo through the extensive use of automation and information exchange.
- Higher automation to provide flexibility and situational awareness rather than become an obstacle to perform a safe operation.
What we propose

A novel real-time simulation environment

- Simulation of a realistic RPAS operation.
- ATC simulation environment that can integrate traffic and RPAS.
- Historical or predicted IFR traffic and its corresponding airspace structure.
Outline

1. Introduction
2. ISIS+
3. Use case
4. Conclusions & Further work
The ISIS+ ATM-RPAS simulation environment

Characteristics

- Integration of two separated simulators:
  - ISIS: In charge of running an environment in which RPAS operations and subsystems can be tested.
  - eDEP\(^4\): Low cost, lightweight ATC simulation platform.

\(^4\)Developed by EUROCONTROL Experimental Center
**ISIS. Internal architecture**

**Air Segment**

- **VAS-FMo**: In charge of abstracting from the particular autopilot.
**ISIS. Internal architecture**

**Air Segment**

- **FPMa-FPMo**: The core of the autonomous operation of the RPAS under the supervision of the PiC.
Flight Plan Manager (FPMa)

- Towards a high semantic level of flight plan specification.
- Usage of extended leg and path terminator concept (RNAV):
  - Basic (RNAV) legs:
  - Control (extended RNAV) legs:
    - Iterator.
    - Conditional.
  - Parametric (extended RNAV) legs.
    - Flight path generated using a reduced number of parameters.
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ISIS. Internal architecture

Air Segment

- **CMa-CMo**: In charge of managing contingency situations.
Air Segment

- **Separation Management**: In charge of dealing with separation issues with other collaborative traffic.
eDEP. Overview

- **Airspace File**
- **Traffic File**
- **Resource Files**
- **Map Files**
- **Graphic Displays**

**Characteristics**

- Human-in-the-Loop ATC simulator.
- Provides access to the ATC controller’s capabilities and interactions.
- Two working stations are provided:
  - Controller Working Position
  - Pilot Working Position


**ISIS-eDEP integration**

**ISIS+ = eDEP + ISIS**
Description

- Departure, arrival and approach are also simulated.
- Mission is formed by two scan patterns and four hold patterns.

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SID 2013
Conclusions & further work

Conclusions

- ISIS+ development to study and evaluate complex scenarios in which RPAS are integrated into non-segregated airspace.
- RPAS simulator is integrated with eDEP, an Eurocontrol air traffic simulator.

Further work

- Some work need to be done to tackle specific RPAS airspace integration gaps