

Real-time Simulations to Evaluate the RPAS Contingencies in Shared Airspace (WP-E project ERAINT)

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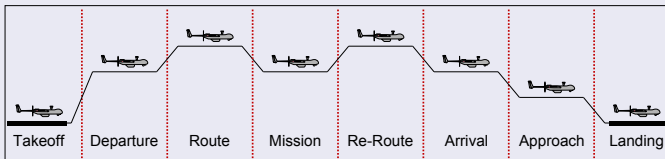
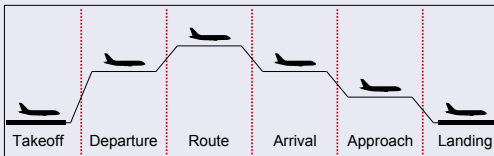


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RPAS particularities

Flight plan stages

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



RPAS particularities

The mission stage¹

- VFR-like missions in an IFR environment.

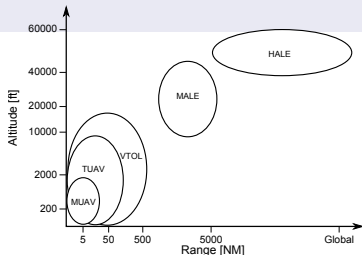


¹Courtesy of NASA (V. Ambrosia); Google Earth background image used by permission to the NASA Wildfire Research and Applications Partners project.

RPAS particularities

Performance dissimilarities

Performance Parameter	RPAS	Manned Aircraft
Cruise airspeed	↓↓↓	↑↑↑
Rate of climb	↓↓↓	↑↑↑
Cruise altitude	≈	≈
Endurance	↑↑↑	↓↓↓



RPAS particularities

Other issues

- Datalink related:
 - Communication latency.
 - Lost-link.
- Contingency related:
 - Loss of control/navigation capabilities.

Outline

- 1 Introduction
- 2 ERAINT
- 3 Step B: Contingency Management
- 4 Simulation Exercises results
- 5 Conclusion

ERAINT Project scope

The (not-so-simple) acronym

- ERAINT: **E**valuation of **RPAS-ATM** **INT**eraction in non-segregated airspace

Main goals

- To provide an environment that permits to analyse some of the Roadmap² identified gaps from the RPAS-ATM interaction point of view.

²Roadmap for the Integration of civil RPAS into the European Aviation System

ERAINT Project scope

Specific objectives³

- Separation provision.
- Response to RPAS contingencies.
- Lost-link procedures.
- Impact of changes on filled flight plan at a tactical level.

³mainly gaps EC-1.1, EC-1.2, EC-3.1, EC-3.2, EC-5.1, EC-5.3 and EC-6.1

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RPAS integration. The contingency perspective

- MQ-1B aerospace mishaps (2012, Source: United States Air Force).

Aircraft type	Contingency type	Contributed to the accident?
MQ-1B	LL	No
MQ-1B	LL + EP	Yes (EP)
MQ-1B	LL + Others	Yes (All)
MQ-1B	EF	Yes
MQ-1B	EF	Yes
MQ-1B	EF	Yes
MQ-1B	EP	Yes

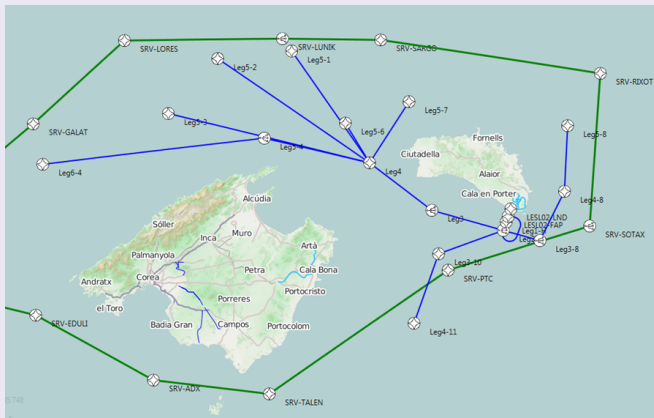
Step B: Contingency Management

Context of validation

- Managing contingencies on an RPAS is more complex than on manned aviation:
 - The automated nature of the vehicle.
 - Communication latency.
 - Reduced situational awareness.
- We evaluate two different contingency types:
 - an engine failure
 - a command and control communication failure (without affecting its airworthiness).

Step B: Contingency Management

Context of validation⁴

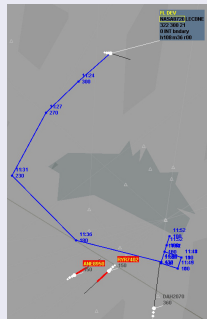
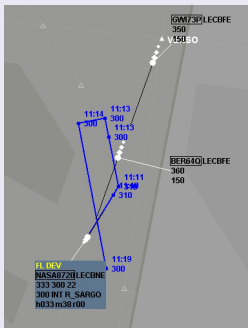


⁴E. Pastor et al. *In-Flight Contingency Management for UAV*, JACIC 2012

Step B: Contingency Management

Context of validation

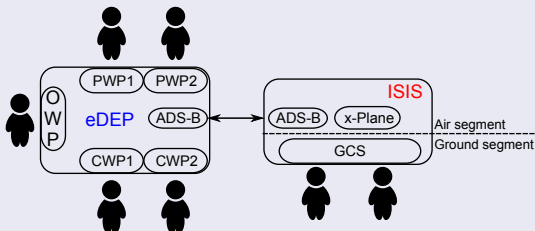
- We evaluate the use of flight intent technology in support to contingency management



Step B: Contingency Management

Validation experiment

- Validation through real-time simulations (ISIS+ environment⁵).
- Real airspace structure.
- Busy live traffic sample (30th august, 1000Z - 1200Z).



⁵P. Royo et al. *ISIS+: A Software-in-the-Loop Unmanned Aircraft System Simulator for Nonsegregated Airspace* Journal of Aerospace Information Systems Vol. 10 No. 11 Nov. 2013

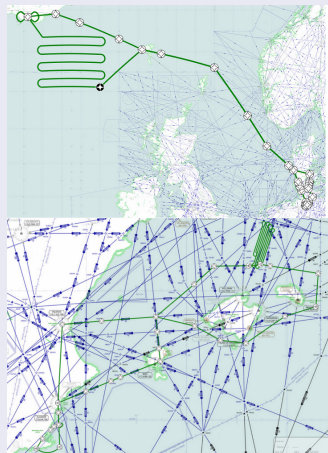
Step B: Contingency Management

Validation experiment

- Scenario 1 (baseline): No RPAS operating.
- Scenario 2: RPAS with engine failure, no flight intent.
- Scenario 3: RPAS with engine failure, with flight intent.
- Scenario 4: RPAS with lost link, no flight intent.
- Scenario 5: RPAS with lost link, with flight intent.

Simulation exercise definition

Exercise preparation



Simulation exercise definition

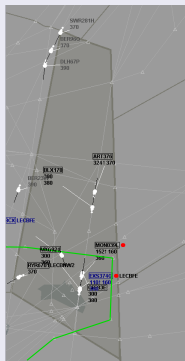
Exercise preparation

Mission type	Surveillance Palma	Surveillance Iceland
RPAS type	MQ-9 (MALE)	RQ-4 (HALE)
FIR involved	Barcelona (LECB)	Denmark (EKDK) Maastricht (EDYY)
# active sectors	2	2

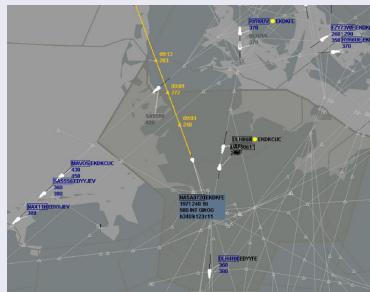
■ Remarks:

- Palma mission will mainly impact with traffic departing/arriving from/to LEPA, LEMH, LEIB.
- Iceland mission will mainly impact with en-route traffic.

Exercise preparation: Selected sectors for Palma mission



Exercise preparation: Selected sectors for Iceland mission



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Simulation Exercises results: Viability of the contingency operation

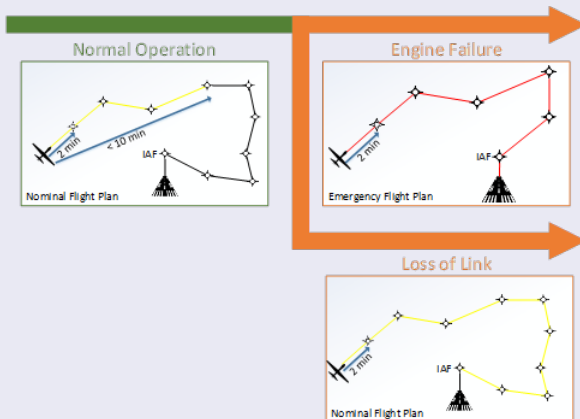
Remarks

- The development of contingency RPAS operation is viable and resulting into limited ATC workload impact.
- Coupled or chained contingencies will require further investigation.

Simulation exercises results: RPAS Flight Intent Availability

Remarks

- Simulations demonstrated that flight intent is a key technology enabler for contingency management.



Simulation Exercises results: RPAS Contingency ConOps

Remark

- RPAS contingency procedures should be similar to those of manned aircraft and have to provide an adequate level of safety and predictability.
- The concept of operation will be divided, at least, in three separated areas:
 - The airport selection.
 - The contingency trajectory to be followed .
 - The RPAS pilot ATC dialogue along the operation, before, at the time of and during the contingency.

Simulation exercises results: RPAS 4D Trajectory Prediction

Remarks

- The integration of RPAS into non segregated airspace should involve the creation of BADA-based APM for RPAS.
- Issues:
 - No one really knows exactly the flight performances of future RPAS
 - the information on performance of currently flying RPAS is not flowing smoothly.
 - ~~BADA-3~~ or BADA 4? (RPAS APM just arrived to 3.13)

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Conclusions and further work

- RPAS integration as a challenge:
 - Providing continual separation and contingency management are critical requirements for the integration.
 - Simulations demonstrated that contingency management is viable and resulted into limited ATC workload impact.
 - Simulations permitted to develop an initial concept of operations for RPAS trajectory intent when RPAS is suffering a contingency.
 - ~~RPAS specific aircraft performance models are also needed~~ (at least, we have BADA 3).

Thank you for your attention!!