

# BUBBLES: A new concept for UTM separation management service.

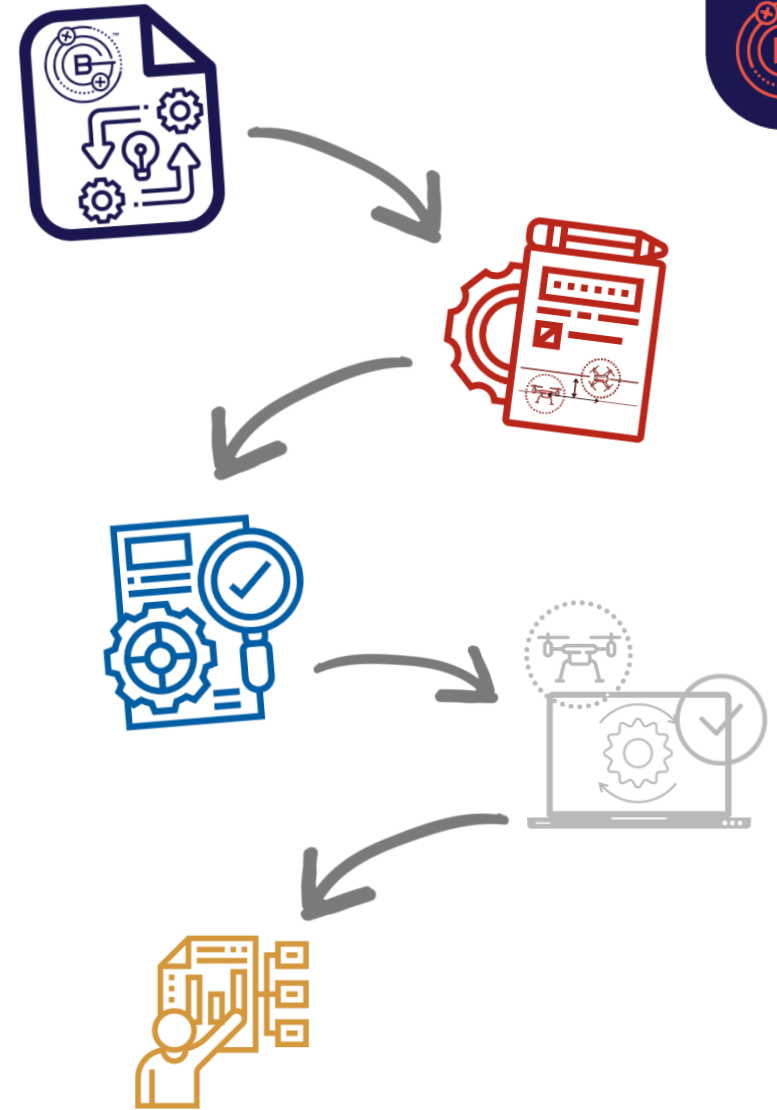
**Cecilia Claramunt Puchol**

[ceclapuc@itaca.upv.es](mailto:ceclapuc@itaca.upv.es)

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# BUBBLES – OVERALL APPROACH



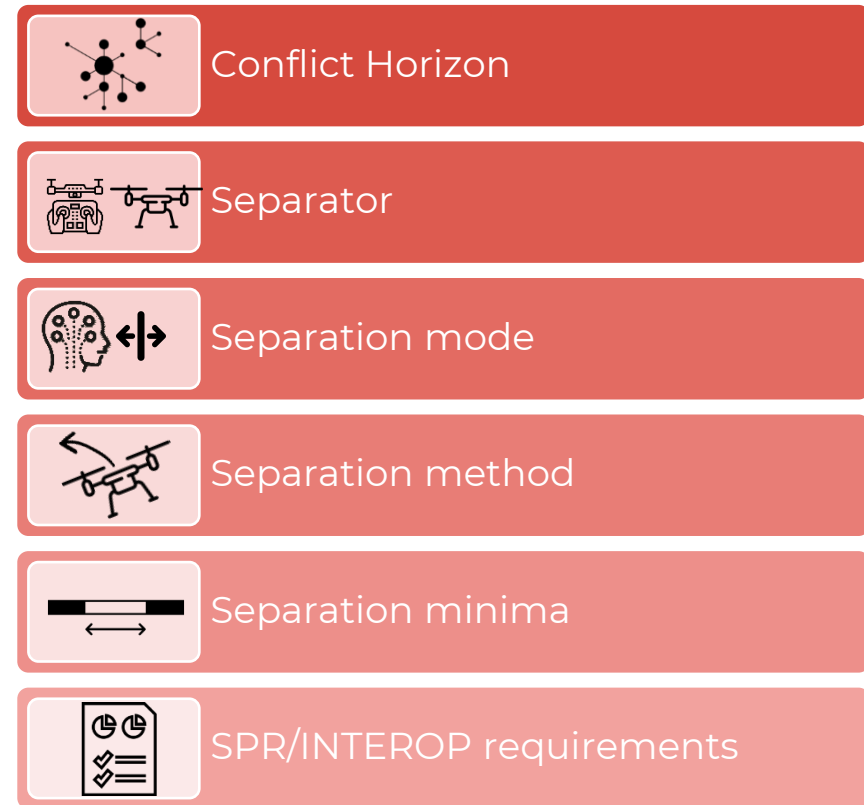
## HIGH-LEVEL OBJECTIVE

The **main goal** of BUBBLES is to formulate and validate a **Concept of Operations for providing separation management by means of the UTM**, defining the basic blocks supporting it and describing how they must be assembled and operated.



# SEPARATION MANAGEMENT CONCEPT

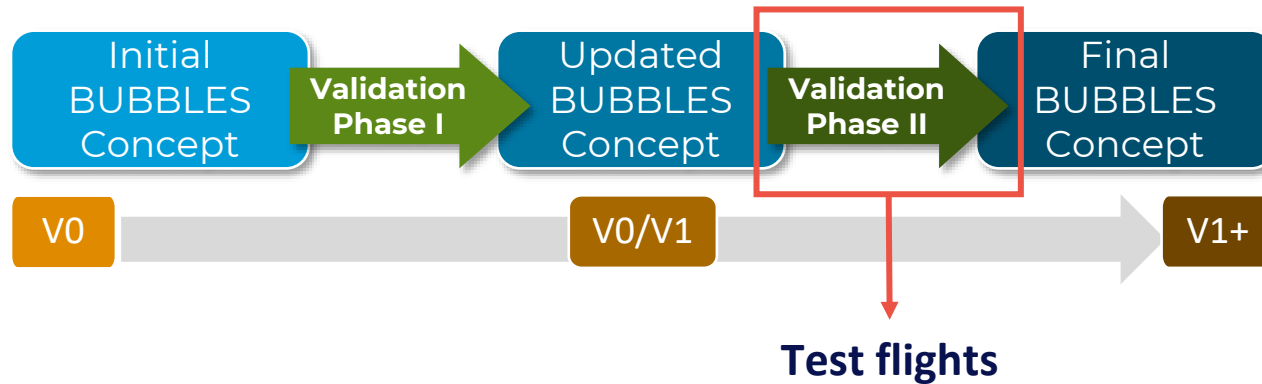
- The objective of **Separation Management Service (SMS)** is to **make available all the information** required for UTM users to univocally define the separation mode and separation minima, in order to ensure that **all tactical conflicts are managed using the same set of rules and procedures**, and a Target Level of Safety (TLS) is attained.
- Hence, this service **should be provided in a centralized way**.
- The SMS provide information about:



# CONCEPT VALIDATION PLAN

## Exercise description

- Validation process:

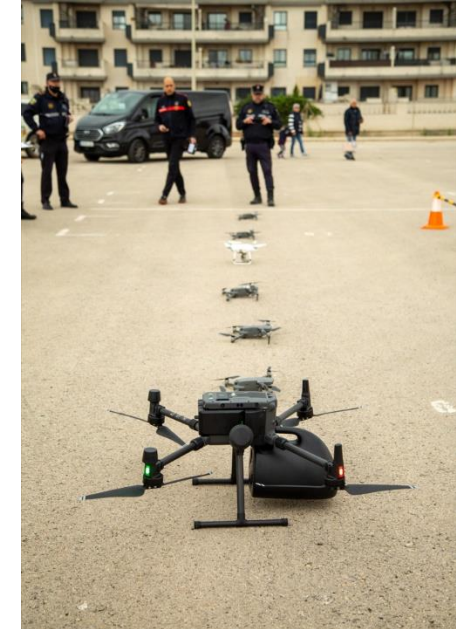


### High-level objective:

1. Validate the BUBBLES separation management concept.

### Low-level objectives:


1. Test the BUBBLES SME platform.
2. Test the dynamic separation minima concept.
3. Collect feedback from pilots on the feasibility/usability of the SME platform and their needs.




# CONCEPT VALIDATION PLAN




## How the flights has been organized?




Rural scenario of 15 km<sup>2</sup> under uncontrolled airspace in the north of Valencia (Spain).



14 drones from 7 different operators flying simultaneously connected to the SME platform.

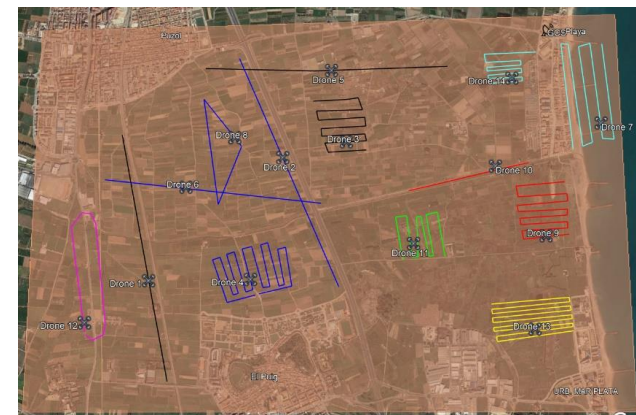


Open category and Specific category under Spanish National Standard Scenarios.



4 tests (combining autonomus and manual flights).

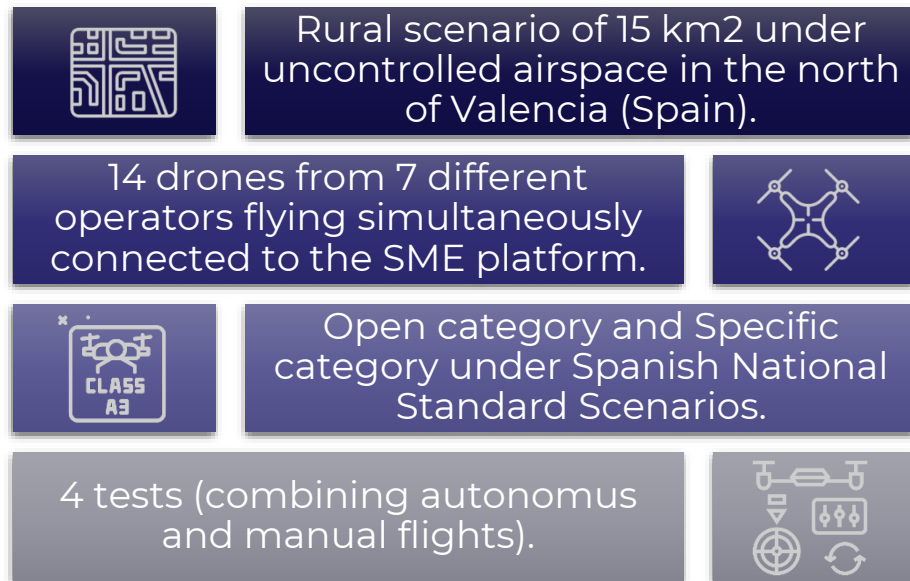
iD	Mission	Drone Operator	Operational Category	Dron type
1	Railway inspection	UPV	STS-ES-02	DJI Matrice 300 RTK
2	Road Inspection	Local Police of Valencia	STS-ES-02	DJI Mavic Dual
3	Agricultural tasks	UPV	A3	DJI Mavic Zoom
4	Surveillance tasks	Local Police of Valencia	A3	DJI Mavic Zoom
5	Transport between towns	UPV	STS-ES-02	DJI Mavic Zoom
6	Transport between industrial parks	Local Police of Valencia	STS-ES-02	DJI Mavic Dual
7	Beach surveillance	Local Police of Benidorm	A3	DJI Mavic Zoom
8	Precision agriculture	Local Police of Valencia	STS-ES-02	DJI Mavic Zoom
9	Surveillance of orchards due to fire risk	Firefighters of Valencia	STS-ES-02	DJI Mavic 2 Advanced
10	Fire brigade action to rescue an animal	Firefighters of Valencia	STS-ES-02	DJI Mavic 2 Advance
11	Precision agriculture	AsDrón Spain	A3	DJI Phantom 4 PRO
12	Surveillance	UAV works	A3	Valaq Patrol
13	Agricultural tasks	ASD drones	A3	DJI Mavic 2 Advanced
14	Photogrammetry	Local Police of Benidorm	A3	DJI Mavic 2 Advanced



SME: Separation Management Environment platform

# CONCEPT VALIDATION PLAN

## How the flights has been organized?



FL: Flight Layer(s)

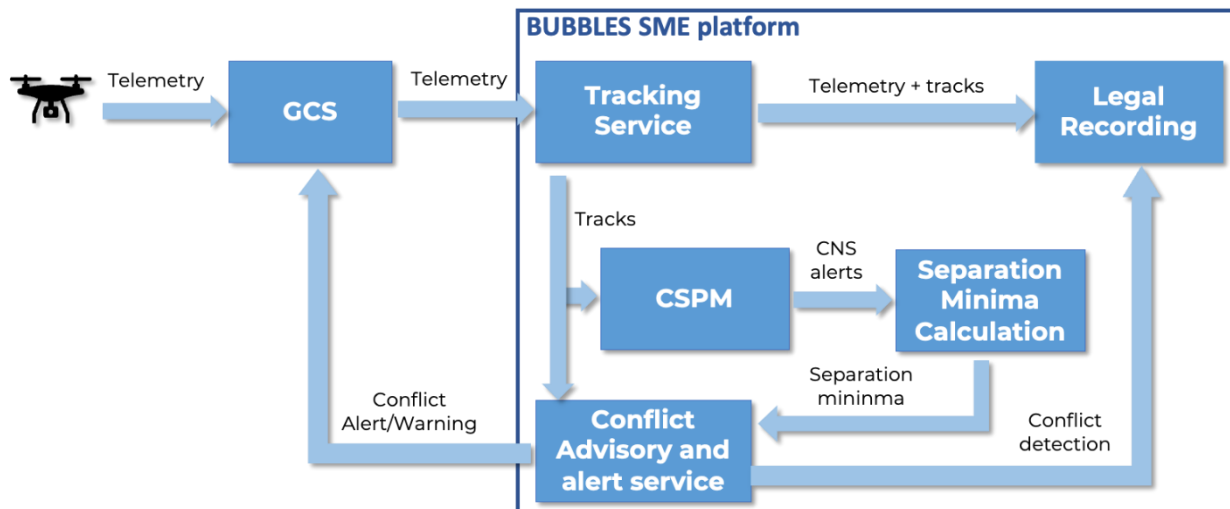
- *During the operations, **drone positioning data was sent to SME platform, which detected any conflict and provided** the required **alerts** to the pilots.*
- **CNS performance degradation** was manually induced (GPS positioning errors, packet losses and communication latencies).
- *After the flights, pilots were **questioned to receive their feedback** on conflict/separation management and the SME platform.*



# CONCEPT VALIDATION PLAN

## How the SME platform works?

- The SME is a platform that implements the BUBBLES separation management concept and includes some “UTM services”.



GCS: Ground Control Station  
 CSPM: Communications and Surveillance Performance Monitoring  
 SMC: Separation Minima Calculation

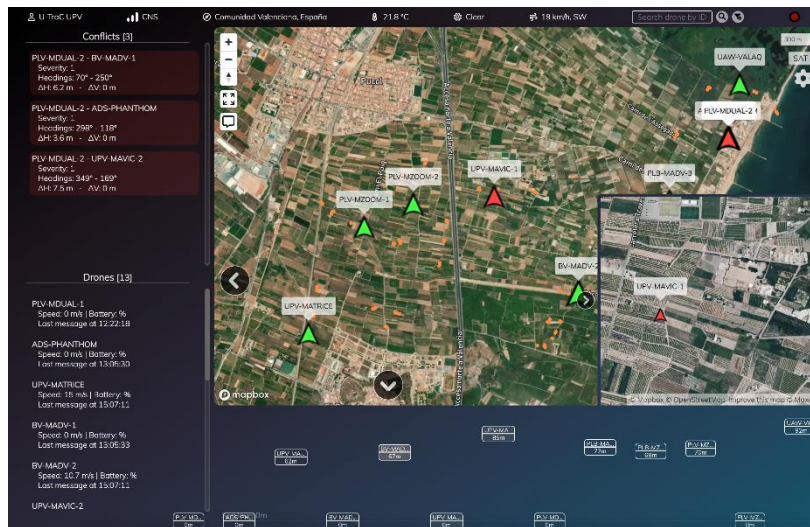
- Telemetry data is transmitted to the tracker.
- The tracker processes that data and generates drone tracks.
- The CSPM evaluates the degradation effects.
- When degradation is detected, SMC computes the new separation minima applying AI.
- The Conflict Advisory and Alert service detects conflicts.
- When a conflict is detected, it transmits an alarm/warning to the GCS.
- Telemetry data, tracks, and the information about conflicts are recorded for post-processing.



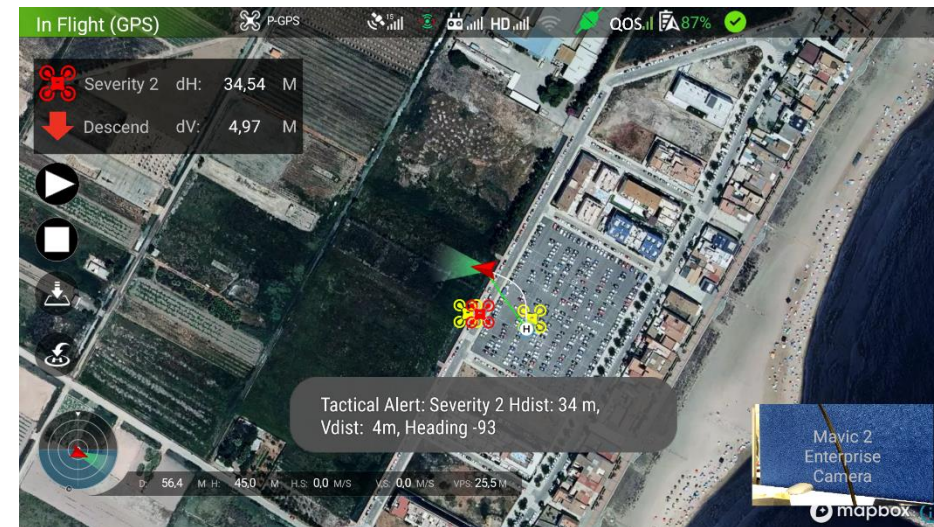
# CONCEPT VALIDATION PLAN

## How the SME platform works?

- The platform includes a graphical interface and an APP for the pilot commands.



Web interface

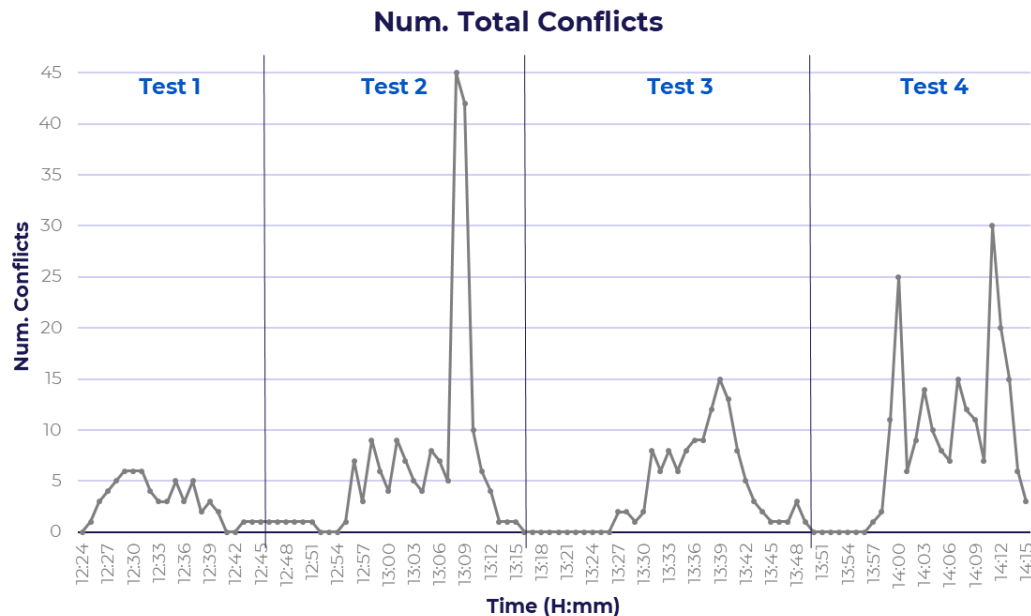


Pilot APP interface

# CONCEPT VALIDATION RESULTS



## Technical results



Test	Total Conflicts detected	Mean conflicts duration (s)
1	27	82.92
2	109	47.52
3	76	37.70
4	158	21.75

### SME platform

- Most of the conflicts were correctly detected.

### Airspace organization

- Flying in assigned flight layers (FL) reduced the number of conflicts.
- When flying in the same layer the conflicts were shorter, i.e., easier to resolve.
- Flying in structured airspace is safer in terms of the number of conflicts, although solving them costs a few seconds more.

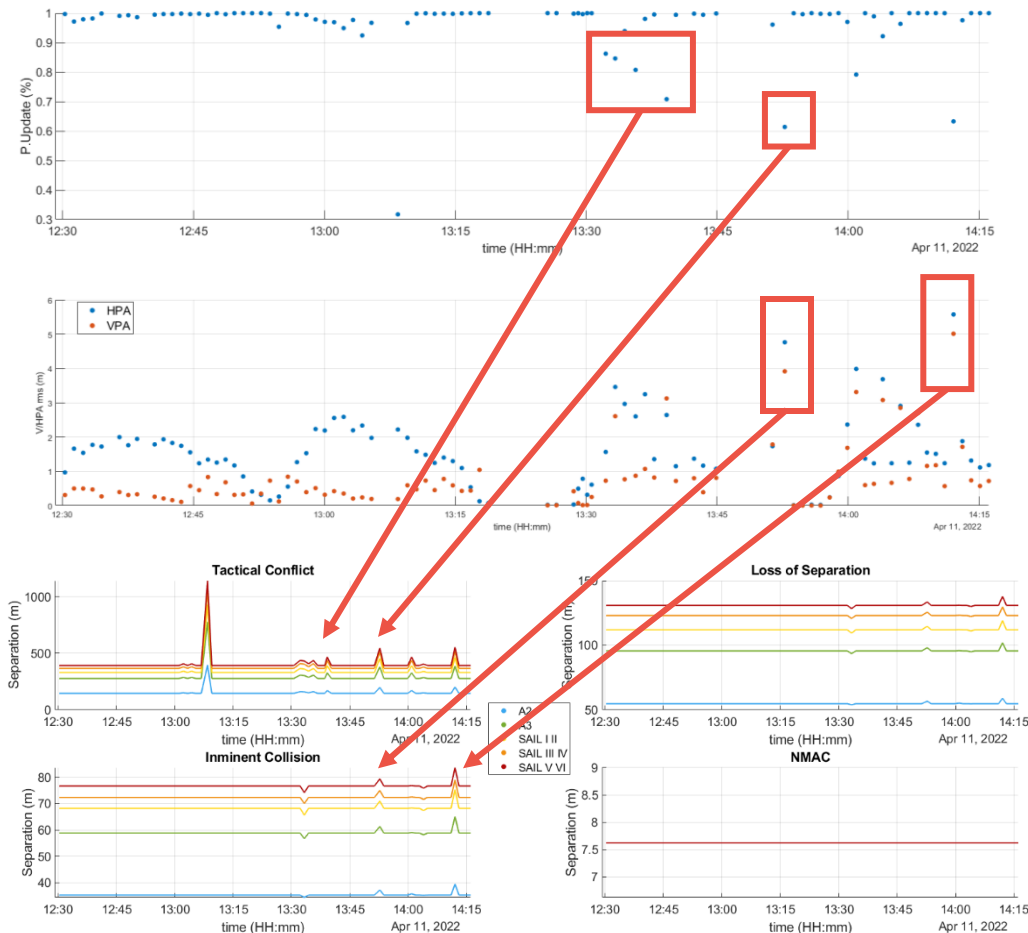
### Separation management

- Providing the separation management service and issuing an alert to pilots is very useful to resolve potential conflicts. This has prevented more than 95% of tactical conflicts from evolving into Imminent collisions.

# CONCEPT VALIDATION RESULTS



## Technical results



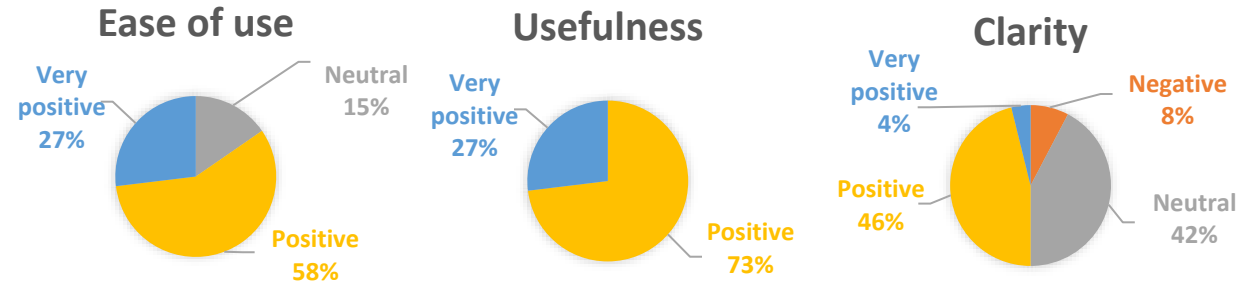
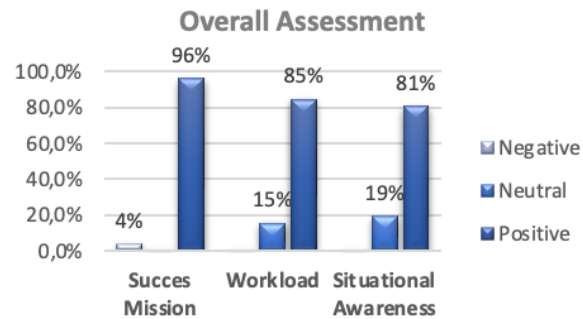
### Dynamic separation minima

- NMAC distance is not affected by the CNS performance, it is an aircraft size-dependent parameter.
- The other 3 distances are affected when performance is degraded:
  - The GPS degradation affects the Vertical and Horizontal Positioning Accuracy (VPA/HPA).
  - Packet loss affects to the message update probability ( $P_U$ ), i.e. the % of drone telemetry reports that have arrived at the tracker.
- When VPA/HPA worsens with respect to the predefined threshold, the Imminent Collision distance is affected.
- When  $P_U$  is below 95% the Tactical conflict distance increases.

Details on the validation plan and validation results can be found at: <https://bubbles-project.eu/work-packages/>

# CONCEPT VALIDATION RESULTS

## Human performance results



- The **provision of the separation management service** has a positive impact on mission success, helping to improve situational awareness without penalizing the pilots workload.

- The **ease of use** and **usefulness** of the SME platform are rated positively.
- The **clarity** of the information provided by the SME is viewed positively by 50%, and negatively by 8% because the proposed vertical deconfliction maneuver creates confusion for the pilot.

# CONCEPT VALIDATION RESULTS

## Human performance results



### Conflict alerts

- All pilots found the information provided by the SME platform useful to solve conflicts.
- All of them also considered it useful to know the severity of the conflict, i.e., which protection volume is infringed.
- 96% considered that when they receive a conflict alert they had enough time to react.

- **Additional information they needed:**

- Position of the other drone in conflict on the command map as well as its heading and speed.
- A more understandable and direct maneuver recommendation.
- Audible warnings.
- In the event of a conflict with another drone in priority, it would also be interesting to display this information.

# CONCLUSIONS AND NEXT STEPS

## Lessons learned

- The pilot's feedback is very useful to draw conclusions and continue improving the separation management service with the information they would need to enhance drone operations in terms of safety and efficiency.
- Pilots express the need for a UTM conflict management service for their safe drone operation.
- They find very useful the conflict alerts as well as the suggestion of an evasive maneuver to improve their situational awareness.
- It is useful to know the position, speed, and heading of the other aircraft in conflict and have it displayed on the command map.
- Pilots stated that it is very complicated to know if the drones are going to collide or not with direct vision, since it is not possible to appreciate the distances or if they are at the same flight altitude.
- The separation management service should be provided to all UTM users (both VLOS and BVLOS users), including non-UAS aircraft, as they can pose a safety hazard, especially training aircraft or helicopters than operates in lower levels.
- From a workload point of view, giving them the information in a simple and comfortable way at the controllers, the pilots did not experience any major difficulty in the operation.



# CONCLUSIONS AND NEXT STEPS



## What's needed for a better future?

- The need for a common altitude reference system (CARS) since drones show the AGL altitude referred to the take-off point, but different terrain elevations cause problems in knowing whether two drones are at the same altitude or not.
- Flight rules supporting the resolution of conflicts.
- Standards for the development UTM/U-space services (especially, tracking or tactical conflict resolution).

## What's next after BUBBLES?

- Develop more UTM services linked to the separation management service and conduct more E2E operational testing to increase the maturity level to V2 (TRL4).
- BUBBLES has used a rather simplistic TSE model, considering fixed, nominal-case, NSE and FTE values, and didn't address the PDE. This is a limitation of the model that should be addressed by future R&D activities.



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**BUBBLES**<sup>TM</sup>

SEPARATION  
MANAGEMENT  
SERVICE

**Cecilia Claramunt Puchol**

[ceclapuc@itaca.upv.es](mailto:ceclapuc@itaca.upv.es)



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**THANK YOU FOR  
YOUR ATTENTION.**

**ANY QUESTION?**

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